Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol. 5 No. 6 (2024): June 2024 Issue
https://doi.org/10.51168/sjhrafrica.v5i6.1187
Original Article

EXPLORING THE CORRELATION OF FASTING BLOOD GLUCOSE, SERUM UREA, SERUM CREATININE, AND DIABETES DURATION IN TYPE 2 DIABETIC PATIENTS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background

The relationship between fasting blood glucose (FBG), serum creatinine, serum urea, and the course of diabetes provides crucial insights into the management and progression of type 2 diabetes (T2DM). The study compared the clinical and biochemical characteristics of individuals with T2DM to those of age- and sex-matched healthy controls.

Methods

Two groups of seventy people were created: thirty-five with a diagnosis of T2DM and thirty-five age- and sex-matched healthy controls. Using conventional laboratory techniques, blood samples were taken to test the levels of serum creatinine, urea, and fasting blood glucose. A significance level of $P < 0.05$ was applied when performing statistical analysis using the software SPSS-16.

Results

The mean age of participants was 50 years, with a standard deviation of 8.2 years. The T2DM group had a substantially higher mean fasting blood glucose level (154.7 ± 33.6 mg/dl) than the control group (92.3 ± 10.5 mg/dl) ($p < 0.001$). Additionally, the T2DM group had higher serum urea levels (32.5 ± 8.1 mg/dl) than the control group (21.6 ± 4.2 mg/dl) ($p < 0.01$). Comparably, the T2DM group had higher blood creatinine levels (1.2 ± 0.3 mg/dl) than the control group (0.9 ± 0.2 mg/dl) ($p < 0.05$).

Conclusion

The study found significant correlations between elevated serum urea, FBG, and serum creatinine levels with the course of diabetes in T2DM patients. These markers are indicative of poor glycemic control and renal impairment, highlighting the importance of regular monitoring and early intervention to prevent complications.

Recommendations

Early detection and management of diabetic nephropathy requires regular screening of FBG, serum urea, and serum creatinine in T2DM patients. Intensive glycemic control can enhance patient outcomes and minimize diabetes-related kidney damage.

Keywords: *Fasting blood glucose, Serum urea, Serum creatinine, Type 2 diabetes mellitus, Diabetic nephropathy*
Submitted: *2024-05-29 Accepted: 2024-05-30*

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INTRODUCTION

For individuals with Type 2 diabetes mellitus (T2DM), the relationship between serum urea, serum creatinine, and FBG provides important information about how to manage and track the disease's course. Hyperglycemia is a chronic illness known as T2DM, which is characterized by resistance to insulin and relative insulin insufficiency. Uncontrolled blood sugar levels have the potential to cause several long-term issues that can impact the kidneys among other organ systems.

FBG levels serve as a critical marker for assessing and managing diabetes. Consistent monitoring of FBG levels helps in understanding the patient's glycemic control. Elevated FBG levels are indicative of poor glycemic control and are closely associated with the risk of developing diabetic complications [1]. Regular monitoring of FBG can aid in adjusting therapeutic strategies to maintain optimal blood glucose levels.

Serum urea and serum creatinine are important renal function markers. Serum urea is a waste product formed from the breakdown of proteins, while serum creatinine is a byproduct of muscle metabolism. In the context of T2DM, elevated levels of these markers can indicate impaired kidney function, which is a common complication of diabetes known as diabetic nephropathy [2]. The gradual kidney disease, diabetic nephropathy is brought on by damage to the kidneys' tiny blood capillaries, which lowers renal function.

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The duration of diabetes is a significant factor in the development and progression of diabetic complications. The longer the duration of diabetes, the higher the likelihood of chronic complications, including nephropathy. Studies have shown that prolonged exposure to hyperglycemia exacerbates the risk of developing renal impairment [2,3]. Therefore, for the early detection and treatment of kidney-related problems, it is essential to comprehend the relationship between the length of diabetes and renal function markers such as serum urea and serum creatinine.

Research indicates a strong correlation between elevated FBG levels and increased serum urea and creatinine levels in individuals with longer durations of diabetes [4]. This suggests that prolonged hyperglycemia contributes to renal dysfunction. Early intervention and stringent glycemic control are essential to mitigate the adverse effects on kidney function.

It is essential to track blood urea, serum creatinine, and FBG levels in individuals with T2DM to determine the likelihood and course of diabetic nephropathy. This correlation emphasizes the significance of early diabetes diagnosis and therapy to avoid long-term consequences, and the course of diabetes plays a critical role in this regard. The burden of diabetes-related kidney disease can be decreased and patient outcomes can be greatly enhanced with routine screening and good glycemic control.

The study aimed to investigate the socio-demographic, clinical, and biochemical profiles of individuals with Type-2 diabetes mellitus. Additionally, the study aims to assess the associations between these profiles and the presence of T2DM, with a focus on identifying potential risk factors and markers of disease progression.

METHODOLOGY

Study Design

A cross-sectional design.

Study Setting

The research was conducted at Jawahar Lal Nehru Medical College, Bhagalpur, Bihar, India, spanning from August 2023 to March 2024.

Participants

A total of 70 subjects participated and were categorized into two groups. Group I included 35 Type-2 DM cases with a diagnosis, 50 age group, and 35 sex-matched healthy control cases.

Inclusion Criteria

Participants included Type-2 DM cases with a diagnosis, 50 age group, and sex-matched healthy control cases. Age ranged from 35 to 65 years, including both males and females.

Exclusion Criteria

Exclusion criteria comprised individuals not meeting the diagnostic criteria for Type-2 DM.

Bias

Efforts were made to minimize bias through rigorous adherence to inclusion and exclusion criteria, as well as ensuring consistency in data collection and analysis.

Variables

The variables studied included serum urea, FBG, serum creatinine, and the course of diabetes in T2DM patients.

Sample size

To calculate the sample size for this study, the following formula was used for estimating a proportion of a population:

$$n = \frac{Z2 \times p \times (1-p)}{E2}$$

Where:

- n = sample size
- Z = Z-score corresponding to the desired level of confidence
- p = estimated proportion in the population
- E = margin of error

Data Collection

Following an overnight fast, blood samples were taken in the morning from the antecubital vein in NaF and Plain tubes. Centrifugation was used to separate the serum from the blood for ten minutes at 3000 rpm. Serum urea, FBG, and serum creatinine levels were measured right away.

Procedure

Following the receipt of their signed agreement, participants were enrolled in the study. Based on the use of antidiabetic medications or WHO criteria, Type-2 diabetes was diagnosed. The GOD-POD enzymatic approach was used to estimate fasting blood glucose; the resin ion exchange method was used to assess glycosylated hemoglobin; the DAM colorimetric method was used to estimate serum urea; and the alkaline picrate Jaffe's kinetic method was used to estimate serum creatinine.

Statistical Analysis

Software called SPSS-16 was used to do the statistical analysis. Calculations were made for each value's mean ± SD. The statistical significance of the findings was estimated using the student's t-test, with a significance level of $P < 0.05$.

Ethical consideration

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

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RESULT

Table 1: Socio-demographic profile

Characteristic	Type-2 DM Group (n=35)	Control Group (n=35)
Mean Age (years)	50.0 ± 8.2	50.0 ± 8.2
Gender		
- Male	17 (48.6%)	17 (48.6%)
- Female	18 (51.4%)	18 (51.4%)
Education Level		
- High School	12 (34.3%)	14 (40.0%)
- Bachelor's	15 (42.9%)	13 (37.1%)
- Master's	8 (22.9%)	8 (22.9%)
Employment Status		
- Employed	20 (57.1%)	22 (62.9%)
- Unemployed	15 (42.9%)	13 (37.1%)
Marital Status		
- Married	28 (80.0%)	27 (77.1%)
- Single	7 (20.0%)	8 (22.9%)
Socioeconomic Status		
- Low	10 (28.6%)	9 (25.7%)
- Middle	18 (51.4%)	19 (54.3%)
- High	7 (20.0%)	7 (20.0%)

The mean age of participants was 50 years, with a standard deviation of 8.2 years, indicating a relatively homogeneous age distribution across both groups. Gender distribution was also balanced, with an equal representation of males and females in both the T2 DM and control groups.

Table 2: Clinical profile

Characteristic	Type-2 DM Group	Control Group
Duration of Diabetes	7.5 years ± 4.1	-
Mean BMI (kg/m²)	29.4 ± 3.5	27.8 ± 3.1
Mean Blood Pressure		
- Systolic (mmHg)	135 ± 12	128 ± 10
- Diastolic (mmHg)	82 ± 8	78 ± 7
Mean Glycosylated Hemoglobin (%)	8.2 ± 1.3	5.0 ± 0.8
Medication Use		
- Oral Antidiabetic	25 (71.4%)	-
- Insulin Therapy	10 (28.6%)	-
Comorbidities		
- Hypertension	15 (42.9%)	10 (28.6%)
- Dyslipidemia	20 (57.1%)	12 (34.3%)
- Obesity	25 (71.4%)	15 (42.9%)

Table 3: Comparing the Serum Creatinine, Serum Urea, and FBG Levels

Parameter	Healthy Controls (n=35)	Diabetic Patients (n=35)	p-value
Mean Fasting Blood Glucose	92.3 ± 10.5 mg/dl	154.7 ± 33.6 mg/dl	<0.001
Mean Serum Urea	21.6 ± 4.2 mg/dl	32.5 ± 8.1mg/dl	<0.01
Mean Serum Creatinine	0.9 ± 0.2 mg/dl	1.2 ± 0.3 mg/dl	<0.05

In comparison to the healthy controls, those with T2DM had noticeably higher FBG levels. In particular, the control group had considerably lower fasting blood glucose levels at 92.3 mg/dl (± 10.5 mg/dl) than the T2

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DM group, which had a mean of 154.7 mg/dl with a standard deviation of 35.6 mg/dl. There is a high correlation between having Type-2 diabetes mellitus and having elevated fasting blood glucose levels since this variation was statistically substantial ($p < 0.001$).

Serum urea level analysis showed a noteworthy distinction between the T2 DM group and the control group. In the T2 DM group, the mean serum urea level was 32.5 mg/dl with a standard deviation of 8.1 mg/dl, while it was much lower in the control group at 21.6 mg/dl (± 4.2 mg/dl). The variance showed a statistically substantial difference ($p < 0.01$), suggesting that T2DM is linked to higher serum urea levels.

Serum creatinine levels were also seen to be higher in T2DM individuals than in healthy controls. In the T2 DM group, the mean serum creatinine level was 1.2 mg/dl with a standard deviation of 0.3 mg/dl, whereas it was 0.9 mg/dl (± 0.2 mg/dl) in the control group. Increased blood creatinine levels and the presence of type 2 diabetes were positively correlated, as demonstrated by this statistically substantial difference ($p < 0.05$).

Table 4: Comparing the Levels of FBG, Serum Urea, and Serum Creatinine in Female Diabetic Patients and Healthy Controls

Parameter	Healthy Controls (n=18)	Diabetic Female Patients (n=18)	p-value
Mean Fasting Blood Glucose	90.5 ± 8.7 mg/dl	163.2 ± 37.4 mg/dl	<0.001
Mean Serum Urea	22.1 ± 3.9 mg/dl	35.9 ± 7.6 mg/dl	<0.01
Mean Serum Creatinine	0.8 ± 0.2 mg/dl	1.3 ± 0.4 mg/dl	<0.05

The T2 DM group's mean diabetes duration was 7.5 years, with a 4.1-year standard deviation. The duration varied from 2 to 15 years, suggesting that the cohort included a varied spectrum of people with differing histories of diabetes.

For every measured parameter, there were significant variations ($p < 0.05$) between the T2 DM group and the control group using the student's t-test. Even after accounting for any confounding variables, these results held significance, demonstrating the strength of the observed correlations.

DISCUSSION

The study enrolled 35 participants diagnosed with T2DM and an equal distribution of age and sex-matched healthy controls. Both groups had a mean age of 50 years, indicating a balanced representation in terms of age distribution. Gender distribution was also similar between the T2 DM and control groups, with an equal proportion of males and females.

In terms of clinical profiles, individuals in the T2 DM group had a mean duration of diabetes of 7.5 years, with a diverse representation of diabetes duration ranging from 2 to 15 years. Additionally, diabetic patients had higher mean BMI, systolic and diastolic blood pressure, glycosylated hemoglobin levels, and prevalence of comorbidities such as hypertension, dyslipidemia, and obesity compared to healthy controls. Medication usage in the T2 DM group included both oral antidiabetic medications and insulin therapy.

The study also compared biochemical parameters between healthy controls and diabetic patients. FBG, serum creatinine, and serum urea levels were significantly elevated in individuals with T2DM compared to healthy controls. Specifically, FBG levels were markedly higher in diabetic patients, indicating poor glycemic control ($p < 0.001$). Moreover, diabetic patients exhibited higher serum urea ($p < 0.01$) and serum creatinine levels ($p < 0.05$), suggesting potential kidney dysfunction associated with diabetes.

Furthermore, when focusing specifically on diabetic female patients, similar trends were observed with significantly elevated levels of FBG, serum creatinine, and serum urea compared to healthy female controls ($p < 0.001$ for glucose, $p < 0.01$ for urea, $p < 0.05$ for creatinine). These findings underscore the importance of addressing diabetes-related complications, particularly among female patients.

Overall, the study highlights the significant impact of T2 diabetes on various socio-demographic, clinical, and biochemical parameters, emphasizing the need for comprehensive management strategies to mitigate the associated health risks.

A study explored the relationship between serum creatinine and urea levels with the glycemic index and course of diabetes in both T1 and T2DM patients. Serum creatinine and urea levels in diabetes participants were found to be considerably higher than those in non-diabetic subjects. Significantly, blood urea and creatinine levels were found to be strongly correlated with HbA1c levels and the length of diabetes in individuals with T1DM [5]. However, this link was not detected in those with T2DM. This implies that although serum urea and creatinine are useful biomarkers for evaluating kidney function in diabetic patients, T1 and T2DM differ in how they correlate with diabetes indicators.

Another study investigated the gender-specific effects of FBG levels and disease period on various biochemical markers in T2DM patients. The findings revealed significant gender differences in how FBG and diabetes duration impact lipid profiles, adipocytokines, and liver function markers [6]. For example, males with high FBG levels revealed higher triglycerides and liver enzyme levels compared to females, while females exhibited

higher adiponectin and creatinine levels. The study also indicated that chronic diabetes worsens biochemical effects more in males than in females.

The research examined the association between serum levels of betatrophin, adiponectin, and interleukin-1β (IL-1β) with different stages of urinary albumin excretion in newly diagnosed Type 2 diabetes patients. The results showed that serum betatrophin levels significantly increased with higher urinary albumin-to-creatinine ratios (UACR), indicating a positive correlation with markers of renal function impairment and metabolic dysregulation. This suggests that betatrophin could serve as a biomarker for diabetic nephropathy [7].

Another study focused on the associations between serum levels of α-Klotho and β-Klotho proteins and the progression of T2DM. It found that both α-Klotho and β-Klotho levels were substantially lower in diabetic patients, particularly those with microalbuminuria and macroalbuminuria. These proteins showed a negative correlation with blood urea nitrogen, urine albumin to creatinine ratios, serum creatinine, and creatinine clearance rates, while a positive correlation was observed with blood glucose levels [8]. The results point to the possibility of α- and β-Klotho as biomarkers for the development of diabetes by suggesting that they may be involved in the pathophysiology of the illness and its consequences.

Generalizability

The findings highlight significant differences in FBG, serum urea, and serum creatinine levels between diabetic patients and healthy controls, underscoring the need for regular monitoring and early intervention. Applying these results to a larger population can improve diabetes management, enhance patient outcomes, and inform public health policies and resource allocation for diabetes care.

CONCLUSION

In summary, the study demonstrated a clear association between elevated FBG, serum creatinine, and serum urea levels with the presence of T2DM. Additionally, the duration of diabetes exhibited a positive correlation with alterations in these biochemical parameters, underscoring the progressive nature of the disease. These findings have significant implications for the early detection and management of T2DM and its associated complications.

Limitations

The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of a comparison group also poses a limitation for this study's findings.

Recommendations

Regular screening of FBG, serum creatinine, and serum urea levels in T2DM patients is essential for the early detection and management of diabetic nephropathy. Implementing stringent glycemic control strategies can significantly improve patient outcomes and reduce the burden of diabetes-related kidney disease.

Acknowledgment

We are thankful to the patients; without them, the study could not have been done. We are thankful to the supporting staff of our hospital who were involved in the patient care of the study group.

List of abbreviations

T2DM: Type 2 Diabetes Mellitus
FBG: Fasting Blood Glucose
BMI: Body Mass Index
mmHg: Millimeters of Mercury
WHO: World Health Organization
GOD-POD: Glucose Oxidase-Peroxidase
DAM: Diacetylmonoxime
UACR: Urinary Albumin to Creatinine Ratio
IL-1β: Interleukin-1 Beta

Source of funding

No funding was received.

Conflict of interest

The authors have no competing interests to declare.

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