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Research Article

Assessment of Blood and Renal Biomarkers in Patients with Type 2 Diabetes Mellitus

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Abstract

Diabetes mellitus usually develops from defects in insulin secretion, sensitivity, action, or both. Numerous life-threatening health problems are more common in people with diabetes mellitus, which can reduce their quality of life, raise their medical costs, and increase their mortality.

Aim: Patients with type 2 diabetes in this study were evaluated for glycemic control, body mass index, and significant kidney biomarkers in both serum and urine.

Materials and methods: A total of 119 individuals with type 2 diabetes who selected among those who attended the center of Diabetes and Endocrinology at Al-sadder Teaching Hospital in the Najaf governorate were included in this study between February and June of 2025. Based on their albumin creatinine ratio (ACR), these patients had been divided into the three groups: those who have normoalbuminuria, microalbuminuria, and macroalbuminuria. All participants underwent a clinical evaluation that included a medical history, clinical examination, and a set of tests such as weight, height, and blood tests (glycated hemoglobin (HbA1c), serum albumin, blood urea, serum creatinine, estimated glomerular filtration rate, urine albumin, urinary creatinine, and albumin-to-creatinine ratio).

Result: About 119 T2DM patients had a mean age of 53.99 ± 9.76 years, 50.4% males and 49.6% females. Mean BMI was 30.59 ±5.47 kg/m^2 it ranged from 19.48 -52.89 kg/m^2. The mean of ACR was 680.23 ±1004.44, urinary albumin was 45.46 ±59.28 mg/dl, and urine creatinine was 100.55 ±298.46 mg/dl. 6 (5.0%) patients had normoalbuminuria, 44 (37.0%) had microalbuminuria, and 69 (58.0%) had macroalbuminuria. There was no significant difference in any of the blood parameters (HbA1c, blood urea, serum albumin, serum creatinine, and eGFR) between subjects with DN and subjects without DN ($P > 0.05$). Subjects with DN had significantly higher urine albumin levels (22.96 (38.15) mg/dl versus 0.98 (0.74) mg/dl) than subjects without DN ($P < 0.001$). Nevertheless, the mean urine creatinine did not significantly differ between subjects with and without nephropathy (P = 0.101). Subjects with DN had a considerably higher urine ACR (407.50 (564.75) mg/dl versus 13.50 (9.50) mg/dl) than subjects without nephropathy ($P < 0.001$).

Conclusion: Results from this study show that patients with type 2 diabetes had inadequate HbA1c control and an elevated body mass index, but there was not a significant difference in serum creatinine levels. This suggests that renal impairment may not be noticeable in the early stages when utilizing serum creatinine alone.

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1. Introduction

Diabetes mellitus is a category of metabolic disorders defined by persistently increased blood insulin levels resulting from deficiencies in insulin secretion, insulin action, or both [1].

According to the International Diabetes Federation (2015) [1, 2], diabetes is currently one of the most serious non-communicable diseases in the world. Type 2 diabetes is widespread worldwide. It is estimated that 347 million persons globally had type 2 diabetes mellitus in 2008, and that figure is expected to rise by 38% in 2030 over the next 20 years [3]. In Iraq, type 2 diabetes mellitus (T2DM) constitutes a considerable burden, with the age-adjusted prevalence reported to be between 8.5% and 13.9 % [4].

Diabetic nephropathy, commonly known as diabetic kidney disease, is one of the most common microvascular kidney conditions caused by type 1 diabetes (T1DM) and type 2 diabetes (T2DM). Early diagnosis is essential since DN is the most common cause of renal disease in its terminal stage and is associated with an increased risk of death overall, mostly from cardiovascular disease [5]. The increase in obesity and population aging can be attributed to two primary factors. Additionally, it has been demonstrated that almost 50% of those who may have diabetes may not receive treatment until ten years after the disease first manifests; therefore, the true prevalence of diabetes mellitus must be enormous [5–7]. Although the prevalence of DM is higher in men than in women, more women than men have DM. Urban populations in developing countries are expected to increase between 2000 and 2030. The most important demographic factor in the global frequency of DM appears to be the rise in the percentage of people over 65 [8].

Albumin is the most prevalent protein in plasma; it has a high water binding capacity and plays an important role in regulating blood volume and oncotic pressure, as well as transporting a variety of compounds such as ions, medicines, fatty acids, bilirubin, vitamins, and hormones [9].

Albumin in urine excretion is an essential part of diabetic kidney disease. As a result, it's critical to begin discussing the various urine albumin excretion grades. Microalbuminuria and macroalbuminuria are defined as urine albumin excretion (UAE) of 30-300 mg/day and $>$300 mg/day, respectively, while normoalbuminuria is defined as urine albumin excretion $<$ 30 mg/day [10]. Albuminuria, the presence of albumin in the urine, is a sign of glomerular injury and a predictor of renal disease development. Albuminuria and glomerular filtration rate (GFR) are utilized to assess the presence and progression of DN [10, 11].

Glomerular filtration rate the rate at which plasma is filtered and plasma waste products. The GFR steadily decreases if the kidney is damaged, and the GFR can be used to measure the glomerular work [12]. Glomerular filtration is the process of producing an ultra-filtrate of blood that passes through the glomerular capillaries. Serum levels of endogenous filtration indicators can be used to determine GFR; creatinine is the most commonly utilized endogenous filtration indicator for this purpose [13].

2. Subjects and Methods

2.1. Subjects

From February to Jun of 2025, 119 T2DM patients participated in the study, who were attended to at the Diabetes and Endocrinology Center of Al-Sadder Teaching Hospital in the province of Al-Najaf, ages ranging from 22 to 77. Of these, 59 were female and 60 were male.

The patients with diabetes were classified into three classes regarding to urinary albumin creatinine ratio (ACR): normoalbuminuria, microalbuminuria and macroalbuminuria.

The inclusion criteria include

- Type 2 diabetes patients who were diagnosed with diabetes on the basis of plasma glucose parameters, either fasting plasma glucose or HbA1C or oral glucose tolerance test (OGTT) (American Diabetes Association 2016)
- Specialist doctors have recommended all subjects with type 2 diabetes mellitus (T2DM). A questionnaire was scheduled to collect diabetic data. It included the age, name, sex, weight, height, BMI (weight / height^2), duration of disease, medical history and smoking.

Measurement of Body Mass Index (BMI)

The BIM is the metric used for defining anthropometric height/weight properties in adults and classification of the classes [14], as shown in Table 2. Body mass index was estimated by the following equation [15]:

$$\text{BMI} = \frac{(\text{weight in "kilogram"})}{(\text{height in "meters"})^2}$$

2.2. Methods

Anthropometric data was collected for each participant. Additionally, each patient had 5 milliliters of blood drawn while they were fasting to evaluate glycated hemoglobin HbA1c (a quantitative colorimetric technique in whole blood), serum albumin, urea, and creatinine (a quantitative colorimetric method).

Urine samples: urinary albumin and creatinine were measured using the enzymatic colorimetric technique.

2.3. Statistical analysis

Data was collected, shortened, analyzed, and submitted using SPSS version 23 and Microsoft Office Excel 2010. The number and percentage of qualitative (categorical) variables are expressed, but quantitative (numeric) variables were first measured for regularity dissemination using the Kolmogorov-Smirnov test, and normally disseminated numeric variables were communicated as mean and standard deviation. Although numerical variables are not usually disseminated, they have been expressed as median and interquartile range.

3. Results

3.1. Characteristics of Diabetic Patients Enrolled in the Current Study

The demographic characteristics of diabetic subjects are revealed in Table 1. The study included 119 patients with mean age of 53.99 ±9.76 years and an age range of 22 to 77 years. According to age, patients were distributed as following: 2 (1.7 %), 5 (4.2 %), 26 (21.8 %), 46 (38.7 %), 31 (26.1 %) and 9 (7.6 %) as 20-29 years, 30-39 years, 40-49 years, 50-59 years, 60-69 years and ≥ 70 years, respectively. With respect to gender, the study included 60 (50.4 %) males and 59 (49.6 %) females and the male to female proportion was 1.01:1. The duration of disease was 10 years in terms of median and it ranged from 1 to 38 years.

Table 1: Demographic and Clinical Characteristics of Studied Diabetic Patients

Characteristics	Value
Age (years)	
Range	22 – 77
Mean ±SD	53.99 ±9.76
20-29, n (%)	2 (1.7 %)
30-39, n (%)	5 (4.2 %)
40-49, n (%)	26 (21.8 %)
50-59, n (%)	46 (38.7 %)
60-69, n (%)	31 (26.1 %)
≥ 70, n (%)	9 (7.6 %)
Gender	
Male, n (%)	60 (50.4 %)
Female, n (%)	59 (49.6 %)
Duration of disease (years)	
Range	1-38
Median (IQR)	10 (11)

N: number of cases;
SD: standard deviation; IQR: inter-quartile range

A comparison of mean age between male and female patients has been carried out and presented in Figure 1. Male subjects were markedly older than female subjects (P = 0.012), 56.22 ±9.34 years versus 51.73 ±9.73 years, respectively.

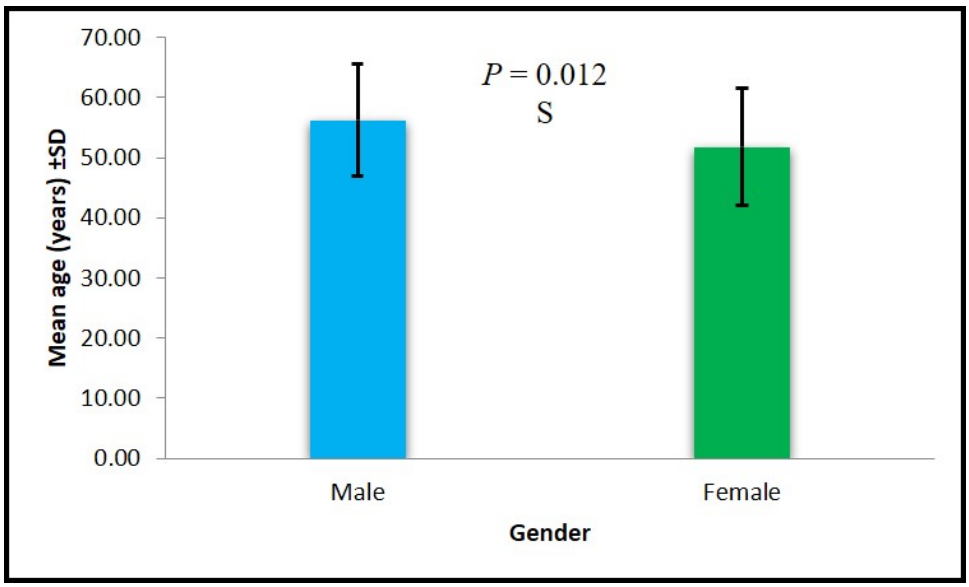

Figure 1: Comparison of Mean Age between Male and Female Diabetic Patients

Mean BMI of diabetic subjects was 30.59 ±5.47 kg/m^2 and it ranged from 19.48 -52.89 kg/m^2. The distribution of patients according to BMI was as follows: 16 (13.4 %), 43 (36.1 %), 35 (29.4 %), 20 (16.8 %) and 5 (4.2%) as Normal, Obese class I, II and III, respectively. Diabetic patients who used to smoke were 16 out of 119 (13.4 %). The duration of smoking of those 16 smokers was 30 (20) in terms of median (inter-quartile range) as shown in Table 3.

Table 2: BMI Distribution among Diabetic Patients

Characteristics	Value
BMI (kg/m^2)	
Range	19.48 -52.89
Mean ±SD	30.59 ±5.47
Normal (<25)	16 (13.4 %)
Overweight (25-<30)	43 (36.1 %)
Obese class I (30-<35)	35 (29.4 %)
Obese class II (35-<40)	20 (16.8 %)
Obese class III (≥40)	5 (4.2 %)

Table 3: Smoking Status and Duration Among Diabetes Patients

Smoking	Value
Number (%)	16 (13.4 %)
Duration of smoking, median (IQR) (years)	30 (20)

n: number of cases; IQR: inter-quartile range

3.2. Blood and Urinary Parameters in Patients with Diabetes Mellitus

The blood biochemical parameters of enrolled diabetic patients. The mean HbA1c was 8.20 ±1.91, the mean blood urea was 28.60 ± 8.40 mg/dl, the mean serum albumin was 4.60 ±0.58 g/dl, the mean of serum creatinine level was 0.92 ±0.32mg/dl and the mean eGFR was 109.39 ±55.65 respectively as shown in Table 4.

The mean Urinary Albumin was 45.46 ±59.28 mg/dl, the mean of urinary creatinine level was 100.55 ±298.46 mg/dl and the mean of ACR was 680.23 ±1004.44. Patients with normoalbuminuria were 6 (5.0 %), patients with microalbuinuria were 44 (37.0 %) and patients with macroalbuminuria were 69 (58.0 %) respectively as shown in Table 4.

Table 4: Blood and Urinary Biochemical Parameters and ACR in Patients with Diabetes Mellitus

Characteristic	Mean± SD
HAb1C %	8.20±1.91
Blood Urea mg/dL	28.60±8.40
Serum Albumin g/dL	4.60±0.58
Serum Creatinine mg/dL	0.92±0.32
eGFR	109.39±55.65
Urinary Albumin mg/dL	45.46 ±59.28
Urinary Creatinine mg/dl	100.55 ±298.46
ACR	680.23 ±1004.44
Normoalbuminuria	6 (5.0 %)
Microalbuminuria	44 (37.0 %)
Macroalbuminuria	69 (58.0 %)

3.3. Characteristics of Patients with Diabetes Mellitus According to Presence or Absence of Nephropathy

Patients classified according to urinary albumin to creatinine ratio were classified into two groups, diabetic patient without nephropathy (n = 6) and patient with nephropathy (n = 113) as shown in Table 5. Then diabetic patients with nephropathy were categorized according to ACR into patients with microalbuminuria and patients with macroalbuminuria.

Table 5: Clinical Characteristics of Patients with DM According to Presences or Absences of Nephropathy

Characteristic	Diabetic without nephropathy n = 6	Diabetic without nephropathy n = 113	P
Age (years)	47.83 ±13.29	54.32 ±9.50	< 0.05 † S
Gender (M/F)	3 /3	57 / 56	>0.05 ¥ NS
BMI (kg/m^2)	25.09 ±3.43	30.88 ±5.41	< 0.05 †S
Duration of disease (years)	10.00 (7.25)	10.00 (11.00)	>0.05 † NS
Smoking Number (%)	1 (16.7 %)	15 (13.3 %)	>0.05 ¥ NS
Duration of smoking, median (IQR)	22 (—)	30 (20)	>0.05 † NS

¥: Yates correction; †: Mann Whitney U test; S: significant difference at P ≤ 0.05; NS: not significant at P > 0.05; (—) IQR can't be calculated because of the small number of cases

3.4. Blood and Urine Parameters According to Presence or Absence of Nephropathy

There was non-significant difference in any of blood parameters, HbA1c, blood urea, serum albumin, serum creatinine and eGFR between subjects with DN and subjects without DN (P >0.05), as revealed in table 6.

Urine albumin was significantly greater in subjects with DN than in subjects without DN (P < 0.001), 22.96 (38.15) mg/dl versus 0.98 (0.74) mg/dl, respectively. However, there was no significant difference in mean urine creatinine among subjects with nephropathy and subjects without nephropathy (P = 0.101). Urine ACR was significantly greater in subjects with DN than in subjects without nephropathy (P < 0.001), 407.50 (564.75) mg/dl versus 13.50 (9.50) mg/dl, respectively as shown in Table 6.

Table 6: Blood and Urine Parameters in Patients with Diabetes Mellitus According to Presence or Absence of Nephropathy

Characteristic	Diabetic without nephropathy n = 6	Diabetic with nephropathy n = 113	P
HAb1C %	7.65 ±1.78	8.22 ±1.92	>0.05 NS
B.Urea mg/dL	26.67 ±8.62	28.70 ±8.42	>0.05 NS
S. Albumin g/L	4.63 ±0.67	4.60 ±0.58	>0.05 NS
S. Creatinine mg/dL	0.82 ±0.16	0.93 ±0.32	>0.05 NS
EGFR	95.00 (38.75)	97.50 (54.50)	>0.05 NS
U. Albumin mg/Dl	0.98 (0.74)	22.96 (38.15)	<0.001 HS
U. Creatinine mg/dl	59.10 (68.85)	70.70 (43.20)	0.101 NS
ACR ratio	13.50 (9.50)	407.50 (564.75)	<0.001 HS

HS: highly significant at p < 0.05, NS: non -significant at p < 0.05

4. Discussion

T2DM is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from reduced response to insulin, also referred to as insulin resistance. T2DM records for around 90% of total patients with diabetes [16]. According to American Diabetes Association, a diabetic patient, as compared with the typical non-diabetic one, has about seven years shorter life span resulting from different diabetic complications [17].

In this study, there is an increase in the frequency of DM with increasing age except decrease in age group ($\geq$ 70) years, the highest result was reported in age group (50-59) years. These findings are in line with the other studies, which reported an increase in the distribution of T2DM with increasing age [18–20]. Regarding the gender, the current results revealed an in-significant difference between males and female's diabetic patients. This outcome is consistent with the findings of [21] who said, "Although the differences were seen by gender in diabetes, the overall pervasiveness of DM in men was found to be very similar to that in women". Regarding the DN, in the present research, there was non-markedly variance among gender and diabetic nephropathy groups. García et al [22] found no effect of gender on the prevalence or progression of nephropathy in type 2 diabetic patients that is consistent with the results of this study.

The outcomes of this research revealed a significant decline in the number of diabetes mellitus patients with increasing body mass index from overweight group to obese class III group, the later reported the highest number among BMI groups, while obese class III represents the lowest number. The study conducted in the United States provided an explanation for the decline in diabetes mellitus in pre-obesity groups. They discovered that adults who had a little riskiness report that included regular physical activity, non-smoking, eating a healthy diet, and maintaining a healthy body weight had a significantly lower riskiness of DM than those who did not [23, 24]. The results of [25], who found no association between BMI and future risk for final-phase renal disease, and Bin [26] in Northeast Thailand, who found a negative relationship between chronic kidney disease and BMI and explained that by the fact that CKD patients typically lose weight, support the current study's findings regarding the DN. Rahim et al [27] revealed that more than fifty percent of the study participants were obese, one-third were overweight, almost one-fourth had hypertension, and nearly one-fourth had dyslipidemia. Significant risk factors for diabetic nephropathy include the presence of hypertension, dyslipidemia, and higher BMI.

The result of the present study showed that the percentage of smoker diabetics is 13% that agrees with the result of the study done by White [28], who reported that the rate of smoker diabetics is 17% and he concluded that the smoking status was non-significantly related with risk of incident DM. Nearly 13% of newly diagnosed diabetes patients were smokers, with the prevalence exceeding 25% among those with diabetic nephropathy. Smoking is a significant risk factor for diabetic nephropathy [27]. According to Aboelnasr et al [29] among Egyptian patients with newly diagnosed type 2 diabetes, non-smoking was protective against diabetic nephropathy.

According to the glycated hemoglobin results, the mean level of HbA1c of diabetes patients was 8.2% which is in line of other reports. In accordance with a cohort study of individuals with diabetes conducted in the United States from 1988 to 2014, it was revealed that individuals with newly diagnosed T2DM and HbA1c levels beyond 8.0% had a significantly greater decline in eGFR compared to those with HbA1c levels below 7.0% [30]. Several clinical studies have highlighted the association between elevated HbA1c at the time of T2DM diagnosis and the risk of developing CKD [31–33]. With regard to the prevalence of the DN, the current findings revealed a non-significant difference between the HbA1c and diabetic nephropathy groups. These results are in line with those of Al-Fehaid [34], who found no evidence of a significant correlation between diabetic nephropathy and HbA1c. Another study found a positive correlation between HbA1c and eGFR in patients with early CKD. However, the correlation between HbA1c and eGFR becomes negative when the disease progresses to CKD stage 3 or 4 [35].

The current findings show that the mean blood urea level in diabetic patients was 28.6 mg/dL. A study performed in India showed the mean of blood urea in diabetic patients was 29.2 mg/dL with a positive correlation between the blood urea level and hyperglycemia [36].The current findings indicate no significant difference in blood urea levels among diabetic nephropathy groups, consistent with the results of Sueud et al [25], who demonstrated that in chronic kidney disease, blood urea levels only exceed the standard threshold when over 60% of renal cells are nonfunctional. Furthermore, blood urea serves as an independent indicator of kidney function, limiting its variability due to extra-renal factors such as gastrointestinal hemorrhage, high protein diet, mild dehydration, and reduced renal perfusion. Increased levels of

blood urea with elevated blood glucose levels indicate that hyperglycemia causes impairment to the kidney, and poorly regulated blood glucose levels would cause the patient to suffer from diabetic nephropathy [37].

The results of this study indicated that the average level serum creatinine in patients with diabetes mellitus was 0.92 mg/dL. In a large case-control study involving over 260,000 adults, serum creatinine levels exhibited no significant association with the risk of type 2 diabetes after adjusting for critical confounders such as age, BMI, blood pressure, and fasting plasma glucose, especially in women, indicating that creatinine alone may not serve as a dependable predictor of T2DM onset [38]. Bamanikar et al [36] demonstrated an association between serum creatinine level and T2DM, which corresponds to the findings of this current study. The relationship between serum creatinine levels and the risk of developing diabetes is unclear. Several studies have shown the close connection between lower muscle mass and dysglycemia [39].

In the current study, the mean serum albumin level in diabetic patients is 4.6 g/L, with no correlation found between serum albumin and the incidence of T2DM. In terms of diabetic nephropathy, the current findings show that there is not a significant difference in albumin levels in serum across the groups. Lang et al [40] found that decreased serum albumin has no direct physiological foundation for contributing to the advancement of chronic kidney disease, which explains the findings of this study.

In this study, the mean level of eGFR is 109.3 in diabetic patients. According to eGFR and UACR, 33.7% of newly diagnosed T2D patients had accidental CKD. The main factor in the diagnosis of CKD was UACR. CKD diagnosis may be independently predicted by a patient's age and higher HbA1c. For prompt intervention to stop the disease's progression and related cardiovascular problems, early identification of CKD using both eGFR and UACR is essential [41].

In regard to ACR, the current result demonstrates a high mean level of urinary albumin creatinine ratio among diabetic patients (680), a result that is compatible with the results of [25], who found that the group of diabetic patients had a higher mean level of ACR than the group without diabetes [25]. In regard to DN, the urine ACR was significantly higher in individuals with macroalbuminuria than in those with microalbuminuria, and it was lower in the group with normoalbuminuria than in other groups with diabetic nephropathy. Urinary ACR and the duration of diabetes mellitus have been demonstrated to be strongly correlated in an Indian cross-sectional study by [42]. Similar results were identified in studies performed by [43].

Regarding the urine albumin, the present result shows that the mean level of urine albumin in diabetes patients is 45.4 mg/dL. Sueud et al [25] described that the urine albumin in control categorize was lesser than in diabetic patients categorize and the difference was highly significant. Urine albumin excretion is affected by a number of factors, including exercise, fever, and asymptomatic bacteriuria.

A recent study has demonstrated a significant correlation between both serum creatinine and albuminuria levels with the duration of diabetes in young patients with T2DM. Patients with a longer duration of diabetes were more likely to have elevated and high levels of these biomarkers, indicating progressive renal impairment. Compared to serum creatinine, albuminuria has been found to be a more sensitive test for early detection of diabetic nephropathy because it could identify renal impairment in patients with normal serum creatinine levels [44].

5. Conclusion

The majority of type 2 diabetes patients in Najaf exhibited micro- or macro-albuminuria, indicating nephropathy. Both age and body mass index (BMI) appear to have significant roles in the development of nephropathy, as there was a correlation between them and albuminuria (nephropathy). However, there was no association found between albuminuria and smoking, gender, or duration of diabetes. HbA1c, blood urea, serum creatinine, and urine creatinine weren't associated with albuminuria.

Article Information

Disclaimer (Artificial Intelligence): The author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.), and text-to-image generators have been used during writing or editing of manuscripts.

Competing Interests: Authors have declared that no competing interests exist.

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