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CLINICAL BIOCHEMISTRY

Prevalence of Type 2 Diabetes and Prediction of Renal Failure Phases in Males Attending Brack AlShatti Hospital

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ABSTRACT

Diabetes mellitus is a common non-communicable health problem that affects people all over the world. Many medical problems arise from long-term diabetes mellitus caused by insulin resistance in type 2 diabetes or insulin deficiency in type 1 diabetes. Diabetic nephropathy is one of the most common complications of this disease. This condition develops as a result of several factors, such as uncontrolled high glucose levels, smoking, obesity, and family history of diabetes. This paper aims to determine the incidence of type 2 diabetes mellitus in men attending Barak General Hospital and evaluate the kidney function of those affected. This study enrolled 142 adult male volunteers, from whom blood and urine samples were collected for the following tests: urea, creatinine, microalbuminuria, glycated hemoglobin (HbA1C), fasting blood sugar (FBG) and estimated glomerular filtration rate (eGFR) using the MDRD equation. The volunteers were divided into three groups based on their blood sugar concentration: the first group was healthy, with 54 volunteers (38%), the second group was pre-diabetic, with 28 volunteers (20%), and the third group was diabetic, with 60 patients (42%). There was a decrease in the estimated glomerular filtration rate, accompanied by an increase in the levels of urea, creatinine and micro albumin in the urine, in addition to an increase in blood sugar and glycated hemoglobin in diabetic group compared to healthy one (p value < 0.05). Moreover, there was a negative correlation between glycated hemoglobin and the estimated glomerular filtration rate and a positive correlation with microalbumin. Men who visit Brack Hospital have a high prevalence of diabetes, and those who have uncontrolled diabetes have a higher chance of acquiring renal failure as their illness progresses over time. Patients with type 2 diabetes should undergo a yearly test for protein in the urine (microalbuminuria) in order to avoid kidney deterioration in its early stages.in dusty and arid regions to ensure optimal performance and maximize energy efficiency.

معدل انتشار مرض السكري من النوع الثاني والتنبؤ بمراحل الفشل الكلوي لدى الذكور المترددين على مستشفى براك العام

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الملخص

يُعد مرض الداء السكري من المشكلات الصحية الغير معدية والشائعة، تؤثر على الناس في جميع أنحاء العالم. تنشأ العديد من المشاكل الطبية من الإصابة طويلة الأمد بهذا المرض الناجم عن مقاومة الأنسولين في مرض السكري من النوع الثاني أو نقص الأنسولين في مرض السكري من النوع الأول. يُعد اعتلال الكلية السكري أحد أكثر المضاعفات شيوعًا لهذا المرض. تتطور هذه الحالة نتيجة لعوامل عديدة، مثل ارتفاع مستويات الجلوكوز غير المنضبط، التدخين، السمنة، والتاريخ العائلي لمرض السكري. تهدف هذه الورقة لمعرفة نسبة الإصابة بالداء السكري من النوع الثاني لدى الرجال المترددين على مستشفى براك وتقييم وظائف الكلى لدى المصابين به. شملت هذه الدراسة 142 متطوعًا من الذكور البالغين، جُمعت منهم عينات من الدم والبول لإجراء الاختبارات التالية: اليوريا، الكرياتينين، البيلة الزلالية الدقيقة، الهيموجلوبين السكري (HbA1C) سكر الدم الصائم (FBG) وتقدير معدل الترشيح الكبيبي (eGFR) باستخدام معادلة MDRD. قُسم المتطوعين إلى ثلاثة مجموعات بناءً على تركيز السكر في الدم: المجموعة الأولى الأصحاء وكان عددهم 54 متطوع (38%)، المجموعة الثانية وهم في مرحلة ما قبل السكري وعددهم 28 متطوع (20%)، والمجموعة الثالثة يعانون من الداء السكري وعددهم 60 مريض (42%)، كان هناك انخفاض في معدل الترشيح الكبيبي المقدر مصحوبًا بزيادة في مستويات اليوريا والكرياتينين والميكرو ألبومين في البول بالإضافة إلى زيادة في سكر الدم في الدم وهيموجلوبين السكري التراكمي بين مرضى الداء السكري. علاوة على ذلك، كان هناك ارتباط سلبي بين السكر التراكمي ومعدل الترشيح الكبيبي المقدر وارتباط إيجابي مع الميكرو ألبومين في البول. ارتفاع في نسبة الإصابة بالداء السكري بين الرجال المترددين على مستشفى براك، وزيادة احتمالية الإصابة بالفشل الكلوي في الرجال المصابين بالسكر غير المتحكم فيه ومع زيادة مدة الإصابة.

الكلمات المفتاحية:
مرض السكري
الفشل الكلوي
الهيموجلوبين السكري
الميكرو ألبومين في البول
منطقة براك الشاطئ

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Introduction

Diabetes mellitus (DM) is a severe metabolic disease characterized by persistent hyperglycemia and altered metabolism of carbohydrates, proteins, and fats to variable degrees. It can have multiple causes and etiologies; but, at some time in its evolutionary history, all of them share irreversible changes in insulin secretion, insulin hormone sensitivity, or both [1, 2].

DM is one of the most important health problems facing the world today, latest estimates indicate that it will impact over 450 million people now and 690 million by 2045 [3].

According to Bhutani and Bhutani, diabetes is acknowledged globally as the fifth most common cause of morbidity and death, and it is ranked highly on the international health agenda [4].

The number of diabetics will increase from 8.8% (415 million) in 2015 to 10.4% (642 million) in 2040. Makarevich estimates that with 442.500 cases of the disease reported in 2017 [5], Libya would have the seventh-largest population of diabetics worldwide [6].

Chronic hyperglycemia in diabetics damages their organs and tissues. Diabetes frequently results in damage to the kidneys, heart, eyes, nervous system, and blood vessels (both small and large) [7].

Diabetic nephropathy (DN) or diabetic kidney disease (DKD) affects around 30% of all people with T1DM or T2DM and is the primary cause of end-stage renal disease (ESRD) worldwide [8]. A progressive loss of GFR, glomerular and tubular epithelial hypertrophy, increased urine albumin excretion (UAE), increased basement membrane thickness, and mesangial expansion with an accumulation of extracellular matrix proteins are the characteristics of the condition, according to [9].

Long-term diabetes results in kidney problems that, if unchecked, can lead to serious, perhaps fatal diabetic nephropathy (DN). Long-term diabetics will have renal histological and functional changes before the onset of microalbuminuria (MAU) [10].

UAE values have been used to describe the various stages of DN. According to Zelmanovitz, not all patients progress to macroalbuminuria and some may revert to normoalbuminuria, despite the theory that microalbuminuria increases the risk of acquiring this stage, based on a preliminary study, approximately 80% of T1DM individuals with microalbuminuria would acquire proteinuria between the ages of 6 and 14 years [11].

Comparing type 2 diabetes patients to controls, Prasad et al. found higher levels of microalbuminuria and HbA1c. These results are similar to those of the Lynch study. In another study, microalbuminuria was found in 37 out of 100 diabetics and, 8 out of 100 control subjects also had microalbuminuria, indicating that this condition may precede or possibly predict the later onset of non-insulin-dependent diabetes (NIDDM) [12- 14].

In a 2016 study on Japanese type 2 diabetic patients, Matsushita et al. revealed a strong correlation between eGFR declines and a later risk of ESRD. A 20% decline over two years is a potential surrogate endpoint of ESRD in diabetic renal disease [15].

However, no research focusing on diabetics has been conducted to date to determine the frequency of macro- and microvascular complications among T2DM patients at different stages of chronic nephropathy who have proteinuria or not. Furthermore, research demonstrated that proteinuria, rather than a decline in eGFR, was a more reliable indicator of problems resulting from diabetes [16]

This study was designed to assess the role that diabetes had in the development of diabetic nephropathy in Libyan Type 2 diabetics. It involved analyzing how long-term diabetes affects renal function. evaluating the effects of inadequate management of diabetes on renal stages. GFR calculation in T2DM patients to determine the level of CKD severity.

Materials and Methods

142 people from the AlShatti region in southern Libya took part in this study, In the period from March to May 2022 at Brack General Hospital. Questionnaires were completed by subjects who voluntarily participated in the study, both diabetic patients and control volunteers.

All patients provided written consent on their participation in the trial and their right to withdraw at any time, in accordance with the ethical guidelines outlined in the 1975 Declaration of Helsinki. After the study technique was approved by the Hospital Ethics Committee, blood samples were collected.

`Exclusion criteria, the trial was not open to participants with alcohol abuse, thyroid problems, thyroid cancer, prostate cancer, autoimmune diseases, cancer, or diabetic retinopathy.

Subjects were assessed for height and body weight while wearing loose-fitting clothes and without shoes. The formula for calculating BMI was weight in kilograms divided by height in meters (m) squared, with 1 kg deducted to allow for clothes.

Six millilitres of fasting blood were drawn from the Antecubital vein in the following manner for different biochemical analyses: The samples were divided into three sections: the first section was taken in an EDTA container for measurement of HbA1c using Nycocard reader, the second portion was taken in a florid oxalate tube for the analysis of fasting blood sugar using glucose oxidase method, and the third section was taken in a plain tube to determine a renal function test (urea by enzymatic reaction and creatinine by Jaff reaction) usingMindray 320. Urine samples have been taken in containers (without preservatives) from T2DM patients and healthy individuals to determine micro-albuminuria (MAU) also using Mindray 320.

The eGFR has been calculated using the Modification of Diet in Renal Disease (MDRD) formula. [Physical weight * age in kilograms] / [72 * Cr] [17].

SPSS version 20 for Windows 16 was used to statistically analyze the results, which are presented as mean ± SD. Tests for normal distribution were run on each set of data. The analysis of variance (ANOVA) was used to distinguish between several groups and for different stages, and the student's t-test was performed to identify significant $p < 0.05$ for unpaired data. The Pearson correlation was utilized to figure out the correlations between the variables.

Results

Among the enrolled volunteers, three groups were formed. Group 1 of participants who are healthy controls (n = 54). Group 2: Individuals with normal renal function but pre-diabetes (n = 28). Group 3: Individuals with diabetes (n = 60).

The anthropometric characteristics of the control pre-diabetic and patient groups are outlined in Table (1). ANOVA testing reveals statistically significant differences in age and body mass index (BMI) between the groups, with the diabetic group displaying the highest variation.

One-way ANOVA test was also used for the biochemical markers, (FBG, HbA1C, and microalbuminuria (MA). As compared to the control group, the mean difference for ward

Table 1: Anthropometric parameters in diabetic patients compared with the prediabetes and control group.

Parameters	Control (n = 54)	Prediabetes (n =28)	Diabetic (n = 60)	p-value
	Mean ± SD			
Age (years)	46.72 ± 20.64	56.61 ± 20.84	66.25 ± 2.81	0.01**
BMI (kg/m^2)	24.35 ± 4.57	25.00 ± 3.84	27.69 ± 3.63	0.01**

** high significant

Table 2: Biochemical parameters of diabetic patients group compared with the control group

Parameters	Control (n = 54)	Prediabetes (n =28)	Diabetic (n= 60)	p-value
	Mean ± SD			
FBS (mg/dl)	80.96 ± 9.45	111.46 ± 5.67	164.1 ± 63.06	<0.01**
HbA1c (%)	5.58 ± 0.44	6.10 ± 0.22	9.16 ± 1.70	<0.01**
Urea (mg/dl)	28.79 ± 11.45	29.36 ± 12.08	39.3 ± 16.50	<0.01**
Creatinine (mg/dl)	0.86 ± 0.13	0.82 ± 0.12	1.31 ± 0.953	<0.01**
MAU (mg/l)	10.22 ± 4.91	10.65 ± 4.92	94.9 ± 31.4	<0.01**
eGFR (ml/min/1.73m^2)	122.64 ± 20.6	121.78 ± 29.53	78.38 ± 31.34	<0.01**

**Statistically difference

patients was shown to be statistically significant (P = 0.01), When compared to the control group, the estimation glomerular filtration rate eGFR findings were statistically substantially lower (p = 0.01) as showed in Table (2).

Diabetic group divided to different stages according to e GFR: Stage 1: People with renal impairment and e GFR of 90 ml/min/1.73 m^2 or higher (n = 25). Stage 2 patients have moderately decreased eGFR of 60 to 89 (ml/min/1.73m2) and renal damage (n = 15). Stage 3 kidney impairment in patients with considerably reduced eGFRs of 30 to 59 ml/min/1.73m^2 (n = 10). Stage 4 patients (n = 10) have decreased eGFR<15 ml/min/1.73m^2, indicating kidney failure.

To differentiate between the four stages of eGFR in the diabetic group, a one-way ANOVA test was used, age and BMI did not reveal any statistically significant changes. as indicated by Table (3).

Except for FBS and HbA1c (p-value>0.05), Table (4) demonstrates how the biochemical markers alter significantly as the stage of renal failure develops.

Person correlation tests revealed a significant positive correlation between diabetes parameters (FBS and HbA1C) and renal failure measures (urea, creatinine, and microalbuminuria), but a negative correlation with e.GFR, as Table (5, 6) and figures (1, 2) illustrates.

Table 3: Anthropometric parameters for different renal failure Stages.

Parameter	Stage 1 (n =25)	Stage 2 (n =15)	Stage 3 (n =10)	Stage 4 (n = 10)	p-value
	Mean ± SD				
Age (years)	61.56 ± 12.79	66.13 ±12.47	75.10 ± 11.1	69.30 ± 10.8	0.059
BMI (kg/m^2)	28.55 ± 3.50	28.43 ± 4.00	25.48 ± 3.16	26.68 ± 3.04	0.086
Duration (years)	13.44 ± 6.20	13.60 ± 5.93	17.10 ± 5.57	20.10 ± 8.75	0.035*

* significant

Table 4: Biochemical parameters for different renal failure Stages.

Parameter	Stage 1 (n=25)	Stage 2 (n=15)	Stage 3 (n=10)	Stage 4 (n=10)	p- value
	Mean ± SD				
FBS (mg/dl)	165.1 ± 59.6	138.9 ± 40.6	176.1 ± 72.5	187.3 ± 83.4	0.253
HbA1c (%)	9.36 ± 1.94	8.56 ± 1.15	9.42 ± 1.61	9.33 ± 1.89	0.482
Urea (mg/dl)	28.87±10.17	44.76 ± 18.01	39.90 ± 12.4	56.57 ± 12.9	0.000**
Creatinine (mg/dl)	0.83 ± 0.12	1.07 ± 0.32	1.23 ± 0.35	2.94 ± 1.4	0.000**
MAU (mg/l)	15.59 ± 5.9	96.5 ± 113.0	78.0 ± 45.1	307.5 ± 146.6	0.000**
eGFR (ml/min)	109.07 ± 10.9	76.24 ± 4.94	52.98 ± 5.05	30.27±11.98	0.000**

**highly significant

Table 5: Pearson correlation between FBS and other prameters.

Parameters	Persons Correlation (r)	P-Value
Duration (years)	0.711	0.000**
HbA1C (%)	0.781	0.000**
Urea (mg/dl)	0.245	0.003**
Creatinine (mg/dl)	0.460	0.000**
MAU (mg/l)	0.384	0.000**

**highly significant

Table 6: Pearson correlation between HbA1C and other prameters

Parameters	Persons Correlation (r)	P-Value
Duration (years)	0.781	0.000**
FBS (mg/dl)	0.788	0.000**
Urea (mg/dl)	0.247	0.003**
Creatinine (mg/dl)	0.414	0.000**
MAU (mg/l)	0.414	0.000**

**highly significant

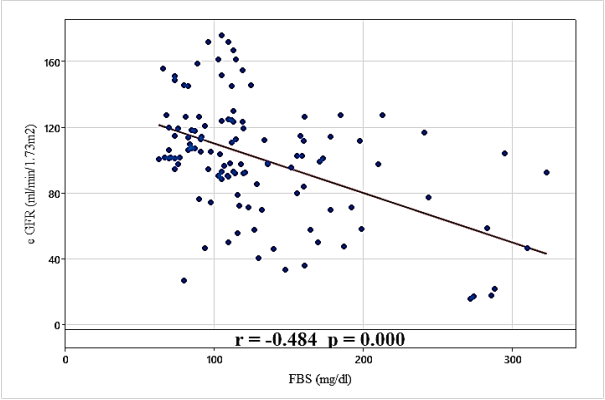

Fig. 1: Pearson correlation between FBS and estimated GFR.

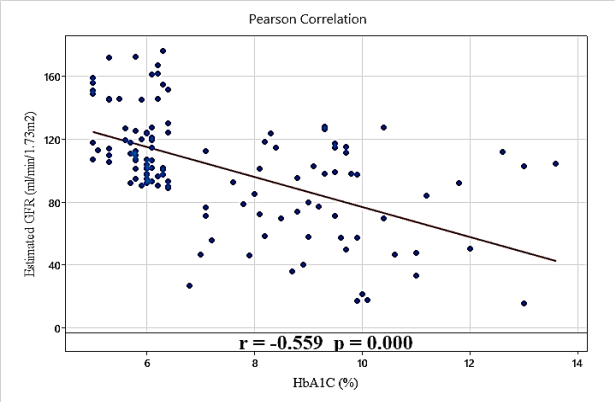

Fig. 2: Pearson correlation between HbA1C and estimated GFR**.**

Furthermore, using person correlation, it was feasible to demonstrate the strong positive associations between the duration of diabetes and the indices of renal failure, as demonstrated in Table (7), while Figure (3) illustrates the negative relationships with estimated GFR.

Table 7: the Pearson correlation between duration of diabetes and the other prameters.

Parameters	Persons Correlation (r)	P-Value
HbA1C (%)	0.788	0.000**
Urea (mg/dl)	0.379	0.000**
Creatinine (mg/dl)	0.482	0.000**
MAU (mg/l)	0.538	0.000**
e. GFR	-0.652	0.000**

** highly significant

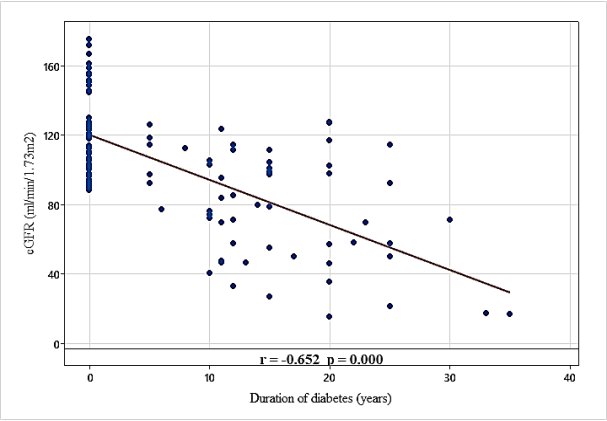

Fig. 3: Pearson correlation between duration of diabetes and estimated GFR.

Discussion

The most common cause of chronic kidney failure in both developed and developing nations is diabetes mellitus (DM), which poses a worldwide health concern [18].

This research showed significant age differences between the control, prediabetes, and diabetic groups. The direct relationship between the age at diabetes diagnosis and the risk of complications, including death, has been the focus of several research [19]. According to certain data, the invariable analysis revealed an inverse relationship between age at diabetes diagnosis and microvascular problems; however, this relationship was no longer significant when diabetes duration was taken into account [20]. The incidence rates of treated kidney failure were greater in those with older ages at diabetes diagnosis in the first two decades of the disease and reversed subsequently with increasing diabetes duration, according to a prospective analysis of nearly a million persons with type 2 diabetes in Australia [21]. The results of these investigations.

When type 2 diabetes is diagnosed, microalbuminuria, an early indicator of diabetic nephropathy, may be present. According to Ullah et al. [22], it develops into overt nephropathy, which then causes a drop in glomerular filtration rate and, finally, end-stage renal disease (ESRD) or premature cardiovascular death. Diabetic nephropathy is a clinical syndrome characterized by albuminuria (>300 mg/day or >200 mcg/min). It is sometimes referred to as Kimmelstiel-Wilson syndrome, nodular diabetic glomerular sclerosis, or interpapillary glomerulonephritis [22].

Our findings showed that male patients with diabetes had higher BMIs than the control group, along with pre-diabetic patients and those with CKD at any stage. The effectiveness of insulin may be impacted by obesity, which may result in low insulin sensitivity or high insulin resistance, which raises blood glucose levels and causes type 2 diabetes. These findings are consistent with research by Sepp et al. [3] and Huffman et al. [4], that demonstrate a positive correlation between diabetes and elevated BMI and blood glucose levels. The findings of our research define the population's status as overweight or obese according to Asian BMI categories as well as WHO classifications. one more study find that a person's chance of having type 2 diabetes increases with their BMI. In particular, BMI has a significant impact on the risk of type 2 diabetes onset, and this effect is the same for both sexes [5].

According to Mayega et al. the two metrics for early diagnosis and plasma glucose level monitoring in diabetic patients are fasting plasma glucose (FPG) and haemoglobin A1C. Our study found that diabetic patients had considerably higher FBG and HbA1C levels ($p<0.05$) compared to the control group. Additionally, there were significant ($p<0.05$) increases in the prediabetic and CKD patient groups [26].

The higher fasting blood sugar and HbA1c values suggest poorly controlled hyperglycemia, which is a major cause for worry in type 2 diabetes and prediabetes and could account for these findings. On the other hand, in individuals with poorly controlled diabetes, a low-glycemic load, a high-fat diet can considerably lower fasting blood glucose and HbA1c [27]. Glycemic management requires intensive blood glucose monitoring during fasting and postprandial phases; postprandial hyperglycemia is more likely to cause diabetes complications than average blood glucose [28].

Blood markers such as creatinine and urea are useful for evaluating kidney function. Increases in blood levels of urea and creatinine may be a sign of renal impairment. The patient group in this study had slightly higher creatinine levels than the control group, but the p-value did not indicate a significant difference. There was not a significant difference in serum creatinine levels between the control, prediabetes, and diabetes groups, according to a study by Nwose [29]

Shrestha et al. [30], who also discovered a substantial increase in urea levels with elevated blood sugar levels in diabetic individuals, and raise the possibility of a connection between urea and diabetes [30], however, it was additionally found that diabetics without renal disease had lower plasma creatinine levels, maybe as a result of higher glomerular filtration rate [31].

Certainly elevated blood sugar levels along with elevated creatinine and urea levels suggest renal impairment [32]. To prevent patients from developing renal nephropathy, it is necessary to closely monitor the levels of blood urea and

serum creatinine, which are simple indicators, particularly those in advanced stages of diabetic kidney disease, should be subjected to periodic and routine blood tests for FBS, HbA1c, urea, and creatinine to prevent kidney failure [33, 34].

Before overt nephropathy manifests in type 2 diabetes, urine albumin excretion can be detected through microalbuminuria, a sensitive biomarker and early predictor. Early diagnosis and therapy can lower the risk and postpone the onset of end-stage renal disease (ESRD). According to our findings, all diabetic patient groups had higher levels of microalbuminuria than the control group. Additionally, there is an increase in concentration in all stages of CKD save stage 1, which may be the result of glomerular cell destruction that causes some protein to be skipped in the urine. This destruction may be brought on by the patients' hyperglycemia, which causes microvascular glomerular cell destruction. Additionally, it was discovered that diabetes mellitus patients' microalbuminuria was much higher than that of the control group. Other studies have repeatedly shown that diabetes patients have a higher prevalence of microalbuminuria than do healthy controls [35 - 37].

Long-term diabetic nephropathy is thought to be a prevalent side effect. High blood glucose levels cause glucose to bind to proteins more strongly, which increases protein glycosylation and raises the quantities of glycated end products. Renal and glomerular hypertrophy as well as thickening of the glomerular basement membrane are caused by increased deposition of these glycated end products on the glomerular. This permits the leakage of albumin, a low molecular weight protein. This illness develops into early nephropathy [38].

MAU is a significant indicator of mortality in diabetic populations as well as a risk factor for end-stage renal failure in diabetes mellitus. The American Diabetes Association (ADA) has emphasized the need for early MAU detection in individuals with diabetes mellitus since prompt MAU treatment can slow the development of diabetic nephropathy. There are several risk factors for MAU, and research has identified several significant risk variables, including male gender, poor glycemic management, prolonged diabetes, and elevated creatinine [39]

With the exception of FBS and HbA1c, which do not vary between stages, there was a substantial statistical difference observed in the other renal function test. This is consistent with other research have consistently shown that the biochemical parameters in diabetic patients change significantly as renal failure progresses, with the HbA1c [40-41].

As the stage progressed, the other kidney function test parameters also revealed a significant statistical difference, consistent with Rai's (2013) finding that blood creatinine and microalbuminurea levels rise significantly with the progression of renal failure in diabetic patients [42].

Renal failure parameters (urea, creatinine, and microalbuminuria) and diabetic parameters (FBS and HbA1C) showed a strong positive correlation in this study, which was supported by several other studies [43, 44] that found a strong correlation between HbA1c and an increase in urine microalbuminuria. According to the current study's data, the most important element influencing a patient's transition from normoalbuminuria to microalbuminuria in type 2 diabetes patients appears to be their degree of glycaemic control. Conversely, there was a negative association between it and e.GFR. This study validated with study of Raghavani, and Patel, as demonstrated a negative relationship between HbA1C and e.GFR with no relation they found with FBS [45]

Conclusion

In diabetic patients, early detection of developing issues such as nephropathy can undoubtedly contribute to a reduction in morbidity. HbA1c monitoring helps prevent diabetic nephropathy by allowing time for treatment for adjustment to shifting levels.

There is a substantial correlation between microalbuminuria and reductions in eGFR in uncontrolled diabetes mellitus.

Recommendations

One of the main goals in diabetes care is to detect the disease in the early stages and intensify their treatment.

Patients with type 2 diabetes should undergo a yearly test for protein in the urine (microalbuminuria) to prevent kidney deterioration in its early stages.

Author Contributions: “A.S.D was involved in all phases of the study, including data collection, and interpretation, M.M.A did the analysis and write up the manuscript; and A.M.A and A.A.M designed and supervised the study. All authors read and approved the final manuscript.”

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