Research Article

Effects of Type II Diabetes Mellitus on Serum Creatinine Level & Estimated Glomerular Filtration Rate among Type II Diabetic Sudanese Patients Living in Khartoum State September – December 2020

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Abstract:

- ***Background***: Diabetic kidney disease (DKD) is one of the most frequent and dangerous complications of Type II Diabetes Mellitus (DMII), affecting about one-third of the Diabetic patients. Diabetic nephropathy is one of the most common and serious complications resulting from DMII. In addition to the increasing complexity of outpatient care for patients with DM, DKD results in increased hospitalization and mortality rates, especially due to cardiovascular complications.
- ***Objectives*****:** This study was designed to evaluate the serum creatinine level and estimated glomerular filtration rate eGFR among type II diabetic Sudanese patients attending to Abdulla Khalil Diabetes Center in Omdurman.
- ***Methods*****:** A cross sectional hospital based study was carried out during September - December 2020 included 100 type II diabetic adult Sudanese patients attending for followup in Abdalla Khalil Diabetes Center. The participants were not known suffering from other kidney problem. All participants were assessed after taking their consent by a questionnaire for medical history information's covered demographic data, duration of the diabetes, type of treatment and their compliance, nutritional history, other chronic health problems, other diabetic complications and smoking history. Body mass index was measured by standard technique. A sample of five ml venous blood was taken on the suitable blood containers to investigate the fasting blood sugar and serum creatinine level using a fully automated mindray B 300 device.
- ***Results*****:** The mean age of the participants was 55.8 ± 12.1 year(65% of them were female and 35% were males). The mean of serum creatinine and fasting blood glucose levels were 1.02±0.85mg/dl and 199.4± 77.5 mg/dl respectively. The mean of eGFR was 93.2±31.7 ml/min/1.73m2. According to the eGFR criteria, 13% of the participant have impaired renal function test. In the patients with impaired renal function test 53.8% of them had fasting blood glucose of 200 or more mg/dl, 69% have hypertension ± hyperlipidemia, 69% of them have had the diabetes for 10 years or more, and 77% of them have other complications of the diabetes.
- ***Conclusions*****:** our results showed that, 13% of the participants have impaired renal function test (eGFR), 77% of them have other complications of the diabetes, 69% have hypertension ± hyperlipidemia, 69% of them have had the diabetes for 10 years or more, and 53.8% of them have fasting blood glucose of 200 or more mg/dl.

Key words: Type II Diabetes Mellitus (DMII), Serum creatinine, estimated glomerular filtration rate (eGFR).

Introduction:

Diabetes Mellitus Type II (DMII) is a disease characterized by persistent hyperglycemia, resulting from partial or complete insulin deficiency, and it is associated with a clinical picture of insulin resistance. [1]

Recently, other organs have been recognized as being involved in the pathogenesis of hyperglycemia in DMII, and it known that not only dysfunction of the pancreas, but also liver, adipose tissue, intestine, kidneys, and central nervous system may contribute to this hyperglycemic state [1].

The prevalence and incidence of diabetes mellitus (DM) has increased significantly worldwide, mainly due to a higher prevalence of type DMII. DMII globally affects 18–20 % of adults over the age of 65 years. [2]

It is estimated that approximately 285 million people, between 20 and 79 years old, currently have DM, 70 % of whom live in middle- and low-income countries. This increase in DMII occurs disproportionately, affecting mainly developing countries, thus bringing enormous challenges in the public health care for these patients. The expectation for this number to increase by more than 50 % over the next 20 years if preventive programs are not implemented. By 2030, it is estimated that almost 438 million people, or 8 % of the adult population, will have DM [2]. Diabetic kidney disease (DKD) is one of the most frequent and dangerous complications of DMII, affecting about one-third of the diabetic patients. In addition to the increasing complexity of outpatient care for patients with DM, DKD results in increased hospitalizations and mortality rates, especially due to cardiovascular complications. [3]

DKD also increases the demand for renal replacement therapies, such as dialysis and kidney transplants. The combined economic and social costs of this disease are high and of concern to the world's health systems. [3]

DKD is typically characterized by persistent albuminuria, increasing serum creatinine and a progressive decline in estimated GFR (eGFR). Over time, worsening DKD is associated with increased risk of cardiovascular and cerebrovascular events, as well as renal morbidity and mortality [4]. So early detection of renal impairment can be done by measuring these biomarkers (albuminuria & serum creatinine) which can help in delaying or preventing the progression of the disease by controlling other measures such as blood glucose or blood pressure levels [4,5,6, 7].

Recent studies suggest that neutrophil gelatinase-associated lipocalin (NGAL), cystatin C and kidney injury molecule-1 (KIM-1) are the most promising potential biomarkers for early identification of CKD among DMII patients , and they found that the analyzed markers such as NGAL, cystatin C and KIM-1 are not more useful than eGFR calculated on the basis of serum creatinine in early diagnosis of CKD, however further studies are necessary, particularly with validation of these new biomarkers againist measured creatinine clearance or GFR. [8]

Domingueti and Cols. evaluate the performance of several formulas of GFR estimation in regard to albuminuria classification (normo-, micro- and macroalbuminuria). [9]
In their analysis, cystatin C-based formulas showed the best performance , followed closely by the new CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration) creatinine-based equation. [9]
A study was conducted in 1993 to investigate the effect of glycemic control on renal function in newly diagnosed DMII patients, they found that improved glycaemic control following the diagnosis of DMII produces a reduction in GFR, mainly in younger patients with GFR values above 120 ml. min -1. However, hyperfiltration persists in a significant proportion of the patients.[10]
Recently, the visit-to-visit variability (VVV) of systolic BP (SBP) has been shown to be a novel risk factor for progression of albuminuria and nephropathy in patients with DMII. [11, 12]. Other study showed that in patients with intact renal function, significant association between high VVV of SBP and DBP with renal function decline in the first decade of DM diagnosed. [13]
In 2001 a paper was published about evaluation of renal biopsy in patients with DKD, which showed that a complete evaluation of renal pathology in DMII could not be made by clinical parameters only, and that the progression of DKD could be accurately predicted by histopathological evaluation by renal biopsy in the overall management of patients with DMII and\ or DKD. [14]

Previous study done to identify the relationships of high-normal albuminuria and glycemic control on microalbuminuria development among DMII patients, and it showed that glycemic control is especially beneficial for DMII patients with baseline high-normal UACR (Urinary Albumin Creatinin Ratio) in preventing microalbuminuria development. [15]
Glomerular filtration rate (GFR) is an old method that is widely used as the sole indicator of renal function, In order to obtain more accurate values many methods for GFR measurement have been made through extensive research and experiments including the equations based on serum creatinine and serum cystatin C, and renal dynamic imaging method .The most common approach to estimate GFR is with a 24-hour urine for creatinine clearance. [16]. Serum creatinine levels and creatinine clearance are clinically used to monitor renal function in hospital, given that they are easily done, not expensive and give reliable results [17].
Therefore, this study was designed to evaluate the serum creatinine level and estimated glomerular filtration rate eGFR among type II diabetic Sudanese patients living in Khartoum State during September to December 2020.

Methods:

An analytical cross-sectional hospital-based study was conducted at Abdulla Khalil Diabetes Center- Omdurman during September to December 2020. The study was included 100 type II

diabetic adult patients who are not known suffering other kidney problem and attended to diabetes clinic for follow up.

Ethical Approval of this study was obtained from the Faculty of the Medicine, National Ribat University and from Abdulla Khalil Diabetes Center. The objectives of the study were explained to all individuals participating in the study. An informed consent was obtained from each participant after fully explaining the research.

An interview questionnaire was filled by the investigator to obtain relevant data that included age, address, occupation , duration of having diabetes and the medications for it, other comorbidities , any other diabetes complications and the smoking status.
Participants' weight and height were measured and BMI was calculated by the formula weight (kg)/height (m) ^{2}.

A sample of five ml venous blood was taken by standard technique on the suitable blood containers to investigate the fasting blood sugar and serum creatinine level using Autoanalyzer A 15 device and a fully automated Mindray *B 300* device respectively.

The eGFR was calculated using Android application of CKD-EPI Creatinine 2009 Equation. CKD-EPI is referring to Chronic Kidney Disease Epidemiology Collaboration. The formula of the equation is: **eGFR= 141 x min(S_{Cr}/κ, 1)$^{\alpha}$ xmax(S_{Cr} /κ, 1)$^{-1.209}$ x0.993^{Age} x1.018 [if female] x1.159 [if Black]** [18]

Where:

- eGFR (estimated glomerular filtration rate) = mL/min/1.73 m^2
- S_{Cr} (standardized serum creatinine) = mg/dL
- κ = 0.7 (females) or 0.9 (males)
- α = -0.329 (females) or -0.411 (males)
- min = indicates the minimum of S_{Cr}/κ or 1
- max = indicates the maximum of S_{Cr}/κ or 1
- age = years

Data Analysis:

Statistical analysis was performed by using SPSS version 25 statistical software Data were expressed in percentages and means ± standard deviation. Student T test was used to compared between means. Pearson Correlation test was used to correlated between studied variables. P value ≤ ,05 was considered significant.

Results:

A cross sectional study was aimed to evaluate the renal functions in type II diabetic Sudanese patients. 100 patients have participated in the study. 65% of the participants were females and 35% were males. (Figure 1)

Table (1) shows descriptive statistics for age of the participants, BMI, fasting blood glucose, serum creatinine level and eGFR. N=100

Variables	Mean	Std. Deviation
Age of participants	55.89	12.118
BMI	26.08	4.947
Fasting blood glucose level	199.40	77.583
Serum creatinine level	1.029	0.8513
eGFR	93.29	31.750

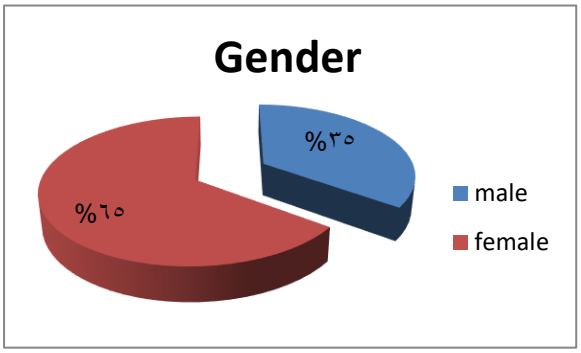

Figure (1):Shows the percentage of males and females who paticipated in the study n=100

There was no statistically difference in serum creatinine and eGFR level according to gender (P value was 0.37 and 0.12) respectively. Table (2)

Table (2) shows descriptive statistics for serum creatinine level and eGFR among the participants according to their gender. N=100

Investigation	Gender	N	Mean	Std. Deviation	P value
Serum Creatinine Level	Males	35	0.957	0.3458	0.371
	Females	65	1.068	1.0262	
eGFR	Males	35	100.37	26.592	0.102
	Females	65	89.48	33.786	

About 46% of patients have had the diabetes for 10 years and more, and about 28% have had it for less than 5 years**. Figure (2)**

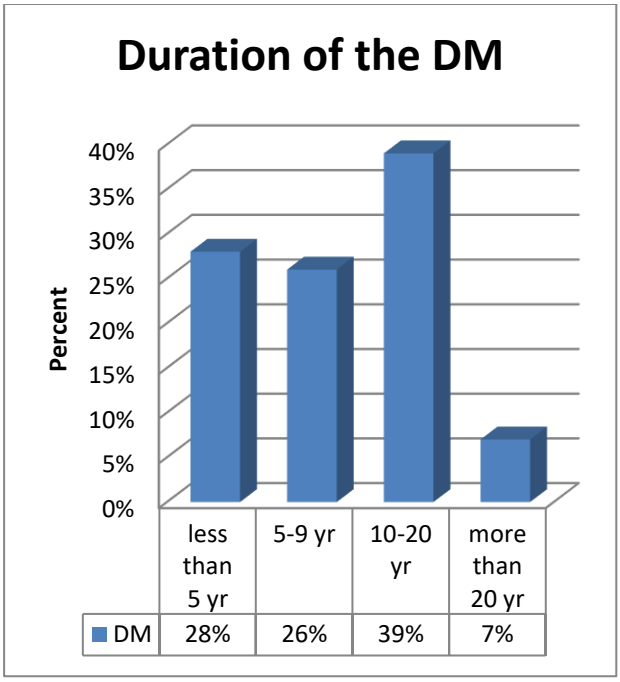

Figure (2) shows the distribution of the patients according to duration of the DM n=100

Figure (3) shows that, 63% of the participants using oral hypoglycemic agents, 30% using insulin, 4% on diet control and 3% use only metformin.

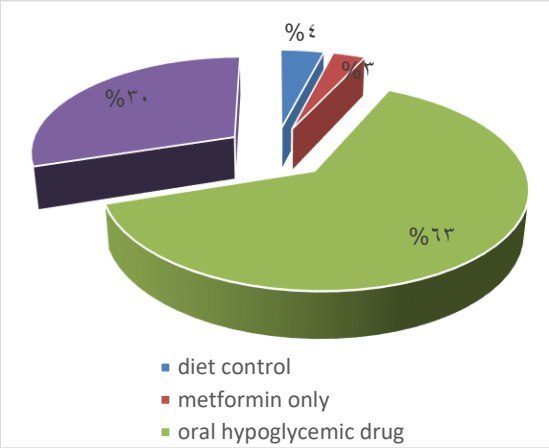

Figure (3): Shows the distribution the patients according to the type of treatment they use for the DM n=100

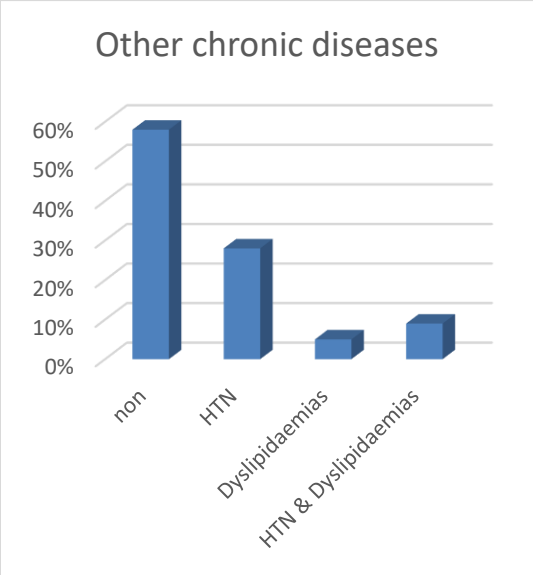

Figure (4): shows distribution of other chronic diseases among participants n=100
Among our participants, 57% had diabetic complications other than Nephropathy.

Figure (5)

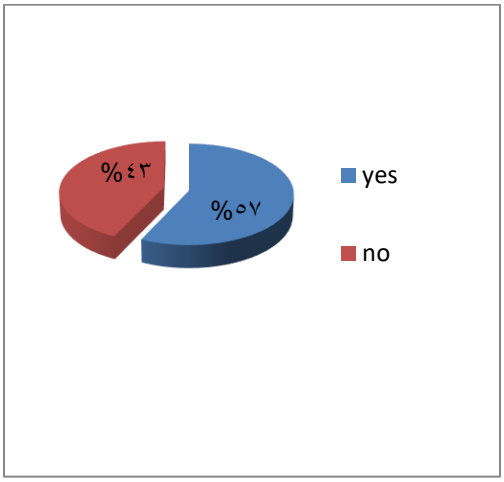

Figure (5): shows distribution of diabetic complications other than nephropathy among participants n=100

There was positive statistically significant correlation between age of the participants and serum creatinine level with eGFR at P value less than 0.002 and 0.000 respectively. In addition, there was no statistical correlation found between BMI and FBG with eGFR. **(Table 3)**

Table (3) shows correlation statistics for age, BMI, FBG and serum creatinine level with eGFR among the participants according to their gender. N=100

Test		Age of participants	BMI	Fasting blood glucose level	Serum creatinine level
eGFR	Pearson Correlation	-.303**	-.041	-.050	-.662**
	Sig. (2-tailed)	.002	.684	.622	.000
	N	100	100	100	100
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed).					

By using CKD-EPI Creatinine 2009 Equation the eGFR was calculated and the analysis revealed that 13% had impaired renal function or consider as having chronic kidney disease CKD where eGFR less than 60ml/min/1.73m^2. **Figure 6**

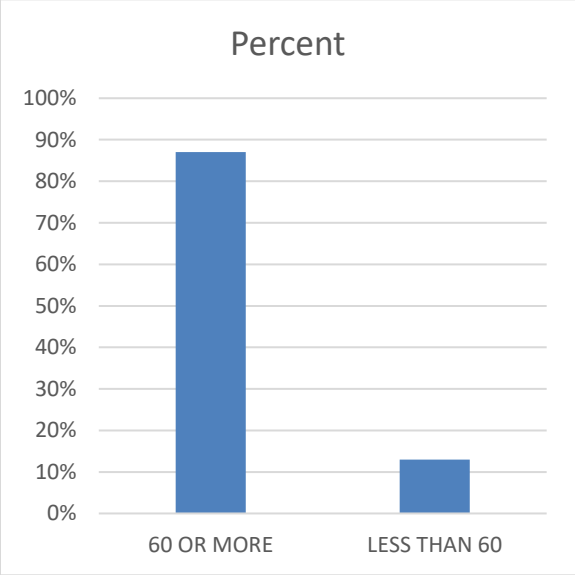

Figure (6) Shows distribution of participants according to normal and abnormal eGFR n=100

The correlation between impaired renal function and duration of the disease (DM), others DM complications, smoking, other chronic diseases, BMI and fasting blood glucose among the participants revealed**:**

Negative significant statistical correlation was found between eGFR and duration of DM with P value of 0.05

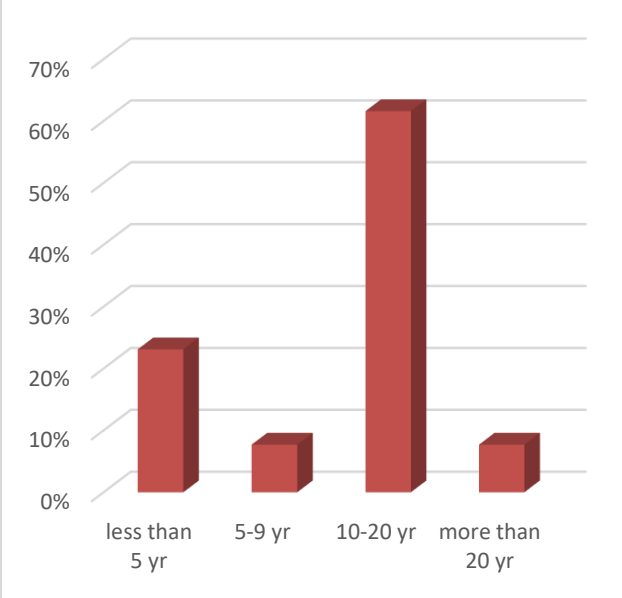

Figure (7)shows the distribution of participants who had abnormal eGFR according to the duration of DM n=13

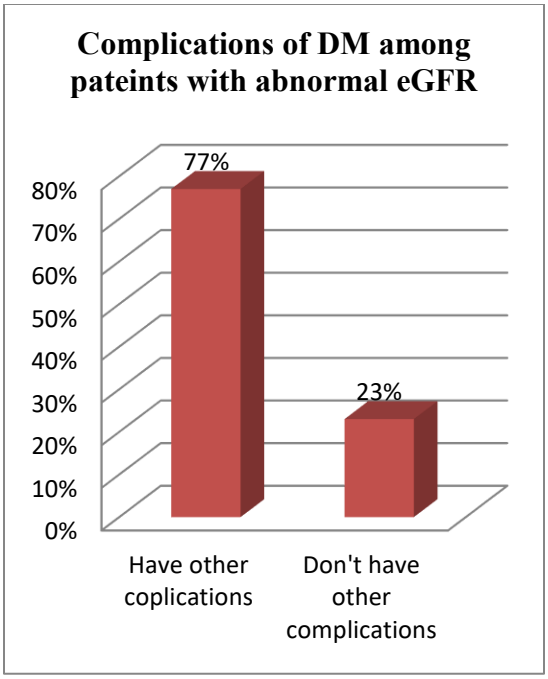

Figure (8)shows the distribution of participants who had abnormal eGFR according to the presence of other DM complications n=13

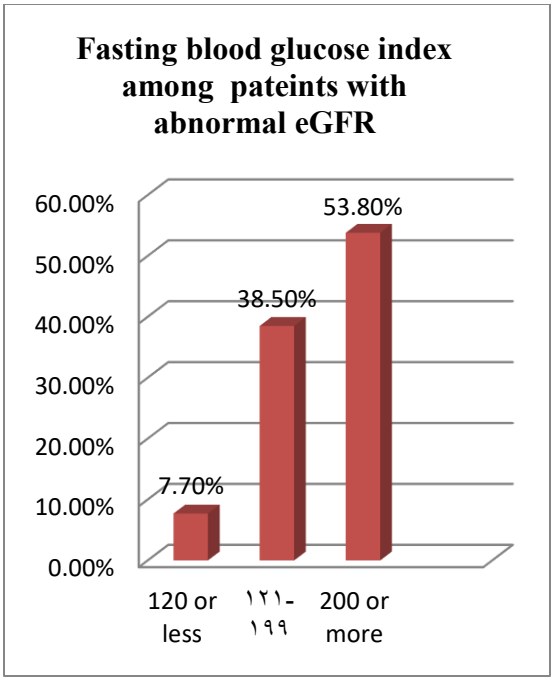

Figure (10)shows the distribution of participants who had abnormal eGFR according to the fasting blood glucose level n=13

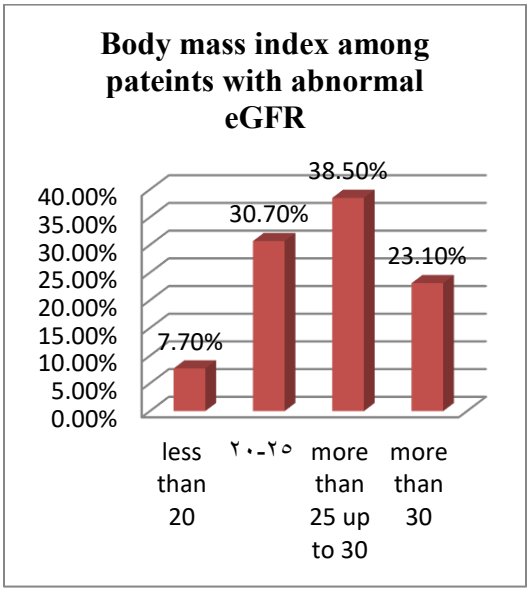

Figure (9) shows the distribution of participants who had abnormal eGFR according to the BMI n=13

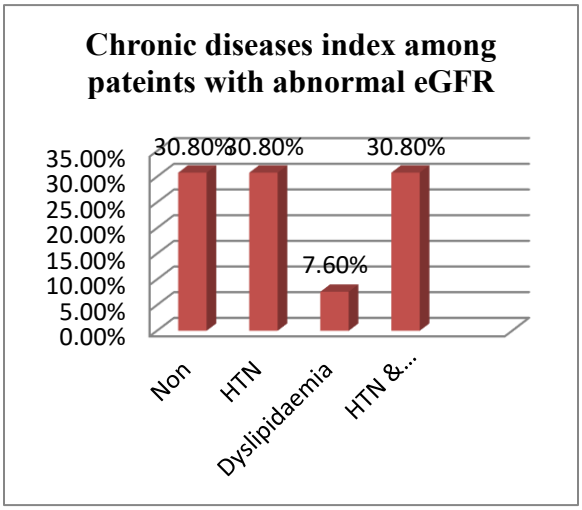

Figure (11)shows the distribution of participants who had abnormal eGFR accordiing to the presence of other chronic diseases. n=13

8% of the participants who have abnormal kidney function (eGFR) are smoker.

Discussion:

Diabetic nephropathy is a well-known complication of DM, early detection is very important because it will affect the consequences of diabetic nephropathy. A cross sectional study was designed to evaluate the renal function among type II diabetic patients using eGFR which is more sensitive than serum creatinine level, also it was found that other biomarkers like neutrophil gelatinase–associated lipocalin (NGAL), cystatin C and kidney injury molecule-1 (KIM-1) are not more useful than eGFR in the assessment of kidney function in diabetic patients.[8]

Although albuminuria is a common biomarker for DKD, the association of normoalbuminuria is not uncommon in DKD but the decline of renal function is slower in normoalbuminuric DKD.[19]

Usually eGFR remains normal while normal albumin excretion or microalbuminuria persists, but it declines progressively after the development of macroalbuminuria.[20]

Other study was made in evaluation of renal biopsy in diabetic nephropathy patients and it was concluded that a complete evaluation of renal pathology in DM could not be made by clinical parameters only, and that the progression of diabetic nephropathy could be accurately predicted by histopathological evaluation.[14] Because in addition to diabetic nephropathy changes other pathological changes were found and the prognosis also was different.

Ischemic lesions are known pathological process for diabetic nephropathy [17], so any other diseases which affect the blood vessels should be consider as risk factors for diabetic nephropathy. Our study demonstrated that, 69% of the participants had abnormal kidney function as well as HTN ±dyslipidaemia.Additionally, a retrospective case study revealed that BMI is positively correlated with diabetic kidney disease and carotid atherosclerotic plaque; however, it is not correlated with diabetic retinopathy. [21]

A retrospective study done by **Yeh and his colleagues** revealed that, increase risk of developing diabetic nephropathy with high blood pressure and the duration of the disease. [13]In our present study 69% of the participants had abnormal kidney function and had DM duration for 10 years or more.

All diabetic complications have the pathologic causes such as vascular pathological changes.[22] So any patient has anyone of the complication will have higher risk to develop diabetic nephropathy. In this study 77% of the participants who had

abnormal kidney function had other DM complications.

Diabetic patients who have chronic kidney diseases either DKD or for other causes, have a higher risk for end stage kidney disease in particular at stage G3b at which eGFR rapidly declines.[23]

A case control study which was done in Nigerian diabetics revealed that prolonged duration of diabetes, hypertension, retinopathy, peripheral neuropathy, left ventricular hypertrophy and poor glycaemic control were the major risk factors for overt nephropathy among Nigerian diabetics. [24] In this study 53.8% of the participants had fasting blood glucose level 200 mg/dl or more, so tight glycemic control may improve the renal function among the diabetic patients.

In general, men appear to be at a higher risk for diabetic microvascular complications (included DKD), while the consequences of macrovascular complications may be greater in women. Whereas, in the absence of diabetes, women have a far lower risk of either micro- or macro-vascular disease compared with men.[25]

Conclusion:

Our current study showed that, 13% of the participants had impaired renal function test (eGFR), 77% of them had other complications of the diabetes, 69% had hypertension ±hyperlipidemia, 69% of them had the diabetes for 10 years or more, 61.6% of them had body mass index (BMI) more than 25 and 53.8% of them had fasting blood glucose of 200 or more mg/dl.

To achieve prevention, early recognition or delaying the progression of diabetic nephropathy frequent screening using sensitive biomarkers like eGFR will be valued; the screening should be more frequent for patients with the risk factors which in this study are presence of other diabetic complications, high blood pressure ± dyslipidemia, and long duration of diabetes, high BMI and poor glycemic control.

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