Diabetic Kidney Disease in Patients Newly Diagnosed with Type-2 Diabetes Mellitus: Incidence and Associations

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ABSTRACT. The global prevalence of type 2 diabetes mellitus (DM) in adults is increasing all over the world. Diabetic kidney disease (DKD) is one of the most common complications of DM. The aim of the present work is to study chronic kidney disease (CKD) in patients newly diagnosed with type 2 DM as regards incidence and associations. This is a comparative cross-sectional study. The study included 153 patients with newly diagnosed type 2 DM over the past six months. DKD was diagnosed if urinary albumin to creatinine ratio >30 mg/g in two out of three morning urine samples collected within three to six months and/or estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m² using 2009 CKD-Epidemiology Collaboration creatinine equation. DKD was present in 45.75% of patients. In our study, 54.9% of patients had microalbuminuria, 39.2% had macroalbuminuria, and 5.9% had severely increased albuminuria. As regards eGFR, 5.2% of patients had eGFR <60 mL/min/1.73 m². Regression analysis showed that increased levels of cholesterol, triglyceride, and glycated hemoglobin were associated with an increased likelihood of developing nephropathy while nonsmoking and elevated high-density lipoprotein cholesterol levels were associated with a reduction in that likelihood. DKD was present in a substantial proportion of our patients at diagnosis. Routine screening for DKD is recommended in all patients early at the onset itself of diagnosis with type 2 DM.

Introduction

The prevalence of diabetes mellitus (DM) increases with age across all regions and income groups.¹ Diabetic kidney disease (DKD) is one of the most common complications of diabetes; prevalence is increasing steeply along with the diabetes epidemic.² It is a leading cause of end-stage kidney disease (ESKD) in developed countries. It is usually a clinical diagnosis made based on the presence of albuminuria and/or reduced estimated glomerular filtration rate (eGFR) in the absence of signs or symptoms of other primary causes of kidney damage.³

We addressed the problem of DKD in patients
with recently diagnosed DM, highlighting the importance of screening programs for DKD early in the course of illness.

**Subjects and Methods**

The aim of the present work is to study chronic kidney disease (CKD) in newly diagnosed patients with type 2 DM as regards incidence and association of DKD with various risk factors, for example, age, duration of diabetes, and lipid profile.

**Study design**

This is a comparative cross-sectional study.

**Place and duration of the study**

The study was conducted on patients attending the outpatient clinic of our hospitals from March 2014 to March 2015.

**Study approval**

Permission was obtained from Research Ethics Committee as a part of Quality Assurance Unit of our university hospitals to conduct this study and to use the facilities in the hospitals.

**Consent**

An informed written consent was obtained from all participants in this research after explanation of the benefits and possible risks of the study and how we will overcome these risks. Privacy of all patients’ data was granted by a special code number for every patient’s file that includes all investigations.

**Study population and sample size**

The study included 153 patients with newly diagnosed type 2 DM.

**Inclusion criteria**

Patients newly diagnosed with type 2 DM (over the past 6 months) regardless of their treatment (oral drugs, insulin, or untreated patients).

**Exclusion criteria**

Excluded in the study were the patients with type 1 DM, patients with type 2 DM with duration more than six months since diagnosis, patients with preexisting renal disease and patients with the following conditions: obstructive uropathy, severe heart failure, liver diseases, cancer, autoimmune diseases, urinary tract infection, pregnant women, and patients using drugs that could alter insulin sensitivity (except antidiabetic drugs) such as hormone replacement therapy, steroids.

All patients were afebrile during the collection of urine.

**Clinical and laboratory assessment**

All patients in the study were subjected to:

a. Thorough history taking and complete physical examination

b. Laboratory investigations including:
   - Urine examination using freshly voided, early morning midstream urine sample
   - Urinary albumin to creatinine ratio (UACR) using a morning urine sample
   - Serum creatinine (SCr) and eGFR calculation
   - Glycated hemoglobin (HbA1c)
   - Fasting blood glucose (FBG)
   - Fasting lipid profile [total cholesterol, density triglyceride (TG), low-density lipoprotein (LDL)-cholesterol and high-density lipoprotein (HDL)-cholesterol].

c. Pelviabdominal ultrasonography

d. Percutaneous renal biopsy (if indicated).

**Definitions**

Patients were considered to have DKD if UACR is increased or if eGFR is reduced in the absence of signs or symptoms of other primary causes of kidney damage. eGFR was considered abnormal if it is less than 60 mL/min/1.73 m² using 2009 CKD-Epidemiology Collaboration (CKD-EPI) creatinine equation. UACR was considered abnormal if ≥30 mg albumin/g creatinine (mg/g). Two of three specimens of UACR collected within a three to six months’ period should be abnormal before considering a patient to have albuminuria.

Hypertension (HTN) was defined as treatment with antihypertensive drugs or, in untreated patients, systolic blood pressure (SBP) ≥140
mm Hg and/or diastolic blood pressure (DBP) ≥ 90 mm Hg following two or more seated BP readings.5

A patient was considered as a current smoker if he/she smoked part or all of a cigarette during the past 30 days using standard National Survey on Drug Use and Health (NSDUH-S) current smoking definition.6

Body mass index (BMI) was defined as weight by height squared (kilogram per square meter). The classification used for BMI was in agreement with that recommended by the World Health Organization (WHO).7

Statistical Analysis

The data were collected, presented, and statistically analyzed with the computer program IBM SPSS Statistics version 23.0 (IBM Corp., Armonk, NY, USA).

Results

We included 153 patients recently diagnosed with type 2 DM over the past six months. Demographic, clinical, and laboratory parameters of our patients are shown in Table 1. Two important points need to be emphasized about our study group; first our group showed female predominance (97 patients; 63.4%), second; our group included a relatively high proportion of patients with HTN (74 patients; 48.4%).

Based on our results, patients were divided into two groups; group 1 (patients without nephropathy) included 83 patients (54.25%) without DKD, and group 2 (patients with nephropathy) included 70 patients (45.75%) with DKD.

In our study group, 62 patients (88.6%) were included based on UACR alone, one patient (1.4%) was included based on eGFR alone and seven patients (10%) were included based on both UACR and eGFR.

Regarding UACR, 84 patients (54.9% of the studied group) had normal to mildly increased albuminuria (A1; normoalbuminuria; UACR 30 mg/g), 60 patients (39.2%) had moderately increased albuminuria (A2; microalbuminuria; UACR 30–300 mg/g) and nine patients (5.9%) had severely increased albuminuria (A3; macroalbuminuria; UACR >300 mg/g).

As regards eGFR, eight patients (5.2%) had eGFR <60 mL/min/1.73 m²; six of these patients had severely increased albuminuria, one had moderately increased albuminuria, and one patient had normal to mildly increased albuminuria.

Comparing both groups, there was no statistically significant difference regarding age or

| Table 1. Clinical and laboratory parameters of the studied group. |
|-------------------|------------------|
| Age (years)       | 49.1 (45–54.0)   |
| DM duration (ms)  | 3.5 (±1.4)       |
| Age at onset (years) | 48.7 (±6.7)     |
| Sex               |                  |
| Male              | 56 (36.6%)       |
| Female            | 97 (63.4%)       |
| BMI (kg/m²)       |                  |
| 18.5–24.9         | 24 (15.7%)       |
| 25–29.9           | 32 (20.9%)       |
| 30–34.9           | 53 (34.6%)       |
| ≥35               | 44 (28.8%)       |
| HTN               | 74 (48.4%)       |
| SBP (mm Hg)       | 137.9 (±21.3)    |
| DBP (mm Hg)       | 86.6 (±13.5)     |
| Current smokers   | 42 (27.5%)       |
| Cholesterol (mg/dL) | 176.6 (±55.3)  |
| TG (mg/dL)        | 141 (97.0–189.0) |
| LDL-c (mg/dL)     | 99.6 (59.7–133.0)|
| HDL-c (mg/dL)     | 43.3 (±13.8)     |
| FBG (mg/dL)       | 199.8 (±65.8)    |
| HbA1c (%)         | 8.6 (±2.3)       |
| SCr (mg/dL)       | 0.9 (±0.3)       |
| ACR (mg/g)        | 25 (11–90)       |
| eGFR (mL/min)     | 84.9 (±16.9)     |

Data are the means (±SD), n (%) or median (IQR). SD: Standard deviation, DM: Diabetes mellitus, BMI: Body mass index, HTN: Hypertension, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, TG: Triglyceride, LDL-c: Low-density lipoprotein cholesterol, HDL-c: High-density lipoprotein cholesterol, FBG: Fasting blood glucose, HbA1c: Glycated hemoglobin, SCr: Serum creatinine, ACR: Albumin/creatinine ratio, eGFR: Estimated glomerular filtration rate.
DM duration. On the other hand, group 2 showed significantly higher proportion of patients with HTN, current smokers; with significantly older age at onset of DM. SBP, DBP and BMI were higher in group 2 (Table 2). As regards laboratory parameters, group 2 showed significantly higher levels of cholesterol, FBG, TG, LDL-cholesterol, HbA1c, and SCR and significantly lower HDL-cholesterol and eGFR (Table 3).

After adjustment for age, sex, SCR, diabetes duration, and smoking status as recommended by the WHO,\(^7\) odds ratios (95% confidence interval) [ORs (95% CI)] for development of nephropathy were higher in patients with overweight [6.608 (1.417–30.821)], obese [10.723 (2.506–45.889)] and severe obesity [4.524 (0.953–21.482)] versus normal weight. Factors closely related to BMI such as HTN, dyslipidemia, and hyperglycemia were not considered confounding, and adjustments for these factors were therefore not made.

HTN was present in 74 patients (48.4%) out of which 46 patients (30.1% of the study population) were unaware of their illness, while 66 patients (43.1% of the study sample) had BP ≥140/90; which is a low control rate.

A stepwise binary logistic regression analysis was performed and showed that increased levels of cholesterol, TG, and HbA1c were associated with an increased likelihood of developing nephropathy, while nonsmoking and increasing HDL-cholesterol levels were associated with a reduction in the likelihood of developing nephropathy.

Our study showed that DKD was present in 45.75% of our studied group of recently diagnosed patients with type 2 DM. Microalbuminuria, macroalbuminuria and low eGFR was present in 39.2%, 5.9%, and 5.2% of patients, respectively. Independent predictors of DKD were increased levels of cholesterol, TG, and HbA1c. Nonsmoking status and higher HDL-cholesterol levels were factors associated with a reduction in the risk of developing nephropathy (Table 4).

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### Table 2. Comparison between group 1 and group 2 as regards demographic and clinical parameters.

| Parameter                      | Groups                  | Tests of significance | Test statistic | P       |
|--------------------------------|-------------------------|-----------------------|----------------|---------|
|                                | Group 1                 | Group 2               |                |         |
| Age (years)                    | 50.0 (42.3–53.0)        | 49.0 (45.1–55.0)      | Z\(_{MW}\)=−1.199 | 0.230   |
| DM duration (months)           | 3.6 (±1.5)              | 3.4 (±1.3)            | t=−1.011       | 0.314   |
| Age at onset of DM (years)     | 47.7 (±7.1)             | 49.9 (±6.2)           | t=2.035        | 0.044*  |
| Gender                         |                         |                       |                |         |
| Female                         | 59 (71.1%)              | 38 (54.3%)            | \(\chi^2\)\(_{ChS}\)=4.618 | 0.032*  |
| Male                           | 24 (28.9%)              | 32 (45.7%)            |                |         |
| Current smokers                |                         |                       | \(\chi^2\)\(_{ChS}\)=18.217 | <0.001* |
| No                             | 72 (86.7%)              | 39 (55.7%)            |                |         |
| Yes                            | 11 (13.3%)              | 31 (44.3%)            |                |         |
| HTN                            |                         |                       |                |         |
| No                             | 56 (67.5%)              | 23 (32.9%)            | \(\chi^2\)\(_{ChS}\)=18.217 | <0.001* |
| Yes                            | 27 (32.5%)              | 47 (67.1%)            |                |         |
| SBP (mm Hg)                    | 134.7 (±18.2)           | 141.8 (±24.0)         | t=−2.027       | 0.045*  |
| DBP (mm Hg)                    | 84.3 (±11.5)            | 89.2 (±15.1)          | t=−2.214       | 0.029*  |
| BMI (Kg/m\(^2\))              |                         |                       | \(\chi^2\)\(_{ChS}\)=18.783 | <0.001* |
| 18.5–24.9                      | 21 (25.3%)              | 3 (4.3%)              |                |         |
| 25–29.9                        | 14 (16.9%)              | 18 (25.7%)            |                |         |
| 30–34.9                        | 19 (22.9%)              | 34 (48.6%)            |                |         |
| ≥35                            | 29 (34.9)               | 15 (21.4%)            |                |         |

Data are the means (±SD), n (%) or median (interquartile range). *Significant at P<0.05. BMI: Body mass index, DBP: Diastolic blood pressure, DM: Diabetes mellitus, HTN: Hypertension, SBP: Systolic blood pressure, \(t\): Independent samples \(t\)-test, \(\chi^2\)\(_{ChS}\): Pearson’s Chi-square test, Z\(_{MW}\): Mann–Whitney test, SD: Standard deviation.
Over the last several years, the global prevalence of type 2 DM has reached epidemic proportions fuelled by the global rise in the prevalence of obesity and unhealthy lifestyles.\(^8\) Due to the growing number of patients with type 2 DM worldwide including Egypt (7.5 million patients with DM in 2013),\(^8\) the magnitude of the problem including prevalence and risk factors should be addressed in our locality especially in newly diagnosed patients in whom complications, including DKD, are not uncommonly present even at the time of diagnosis.

A study in Egypt conducted by Farahat et al\(^9\) evaluated 234 participants with type 2 DM and showed that the overall prevalence of microalbuminuria and macroalbuminuria was 34.2% and 12.8%, respectively. He used a single measure of UACR and excluded patients with severe renal disease (Scr \(\geq 2\) mg/dL). The study was not restricted to patients recently diagnosed with type 2 DM.

Al-Homrany and Abdelmoneim\(^10\) showed that about 54.3% of patients with type 2 DM attending a primary care center, had proteinuria. Khan et al\(^11\) found that 19.6% of patients had microalbuminuria. AlFehaid\(^12\) found that microalbuminuria was found in 37.4%. Al-Salman et al\(^13\) found that the prevalence of microalbuminuria and macroalbuminuria were 22% and 12.5%, respectively.

### Discussion

### Table 3. Comparison between both groups as regards laboratory parameters.

| Parameter     | Group 1                   | Group 2                   | Tests of significance |
|---------------|---------------------------|---------------------------|-----------------------|
| Cholesterol (mg/dL) | 162.3 (±45.1)             | 193.5 (±61.5)             | \(t=−3.511\) 0.001*  |
| TG (mg/dL)    | 108.0 (87.0–149.0)        | 170.0 (130.0–239.0)       | \(Z_{MW}=5.087\) <0.001* |
| LDL-c (mg/dL) | 82.4 (55.0–120.0)         | 106.8 (80.4–152.0)        | \(Z_{MW}=2.866\) 0.004* |
| HDL-c (mg/dL) | 46.4 (±12.5)              | 39.6 (±14.4)              | \(t=3.148\) 0.002*  |
| FBG (mg/dL)   | 174.7 (±48.5)             | 229.7 (±71.3)             | \(t=−5.475\) <0.001* |
| HbA1c (%)     | 7.9 (±2.0)                | 9.5 (±2.5)                | \(t=−4.273\) <0.001* |
| Serum Cr. (mg/dL) | 0.85 (±0.11)            | 1.01 (±0.44)              | \(t=−2.868\) 0.005*  |
| eGFR (mL/min/1.73 m\(^2\)) | 88.6 (±13.7)   | 80.6 (±19.3)              | \(t=2.985\) 0.003*  |

Data are the means (±SD), n (%) or median (interquartile range).

*Significant at \(P<0.05\), ACR: Albumin/creatinine ratio, eGFR: Estimated glomerular filtration rate, FBG: Fasting blood glucose, HbA1c: Glycated hemoglobin, HDL-c: High-density lipoprotein cholesterol, LDL-c: Low-density lipoprotein cholesterol, S. Cr: Serum creatinine, \(t\): Independent samples \(t\)-test, TG: Triglyceride, \(Z_{MW}\): Mann–Whitney test, SD: Standard deviation.

### Table 4. Binary logistic regression predicting the occurrence of nephropathy.

| Chi-square test \(\chi^2\) | Nagelkerke \(R^2\) | Percentage accuracy in classification | Variables | Coefficients | SE | \(P\) | OR | 95% CI for OR |
|-----------------------------|----------------------|--------------------------------------|-----------|--------------|----|------|----|----------------|
| 59.411                      | <0.001*              | 0.430                                | Cholesterol | 0.004        | 0.009 | 1.010 | 1.003–1.018    |
|                             |                      |                                      | TG        | 0.003        | 0.010 | 1.008 | 1.002–1.014    |
|                             |                      |                                      | HDL-c     | 0.016        | 0.006 | 0.956 | 0.926–0.987    |
|                             |                      |                                      | HbA1c     | 0.094        | 0.022 | 1.241 | 1.031–1.493    |
|                             |                      |                                      | Non smoking | 0.469        | 0.001 | 0.219 | 0.088–0.550    |
|                             |                      |                                      | Constant  | 1.176        | 0.079 | 0.127 |                |

*Significant at \(P<0.05\), CI: Confidence interval, HbA1c: Glycated hemoglobin, HDL-c: High density lipoprotein cholesterol, OR: Odds ratio, SE: Standard error of unstandardized coefficients, TG: Triglyceride.
5.8%, respectively. Another study showed a higher prevalence of albuminuria (42.5%) using similar criteria to our study. Al-Adsani 

showed that the prevalence rates of proteinuria, microalbuminuria, and macroalbuminuria were 43.5%, 27.3%, and 16.2%, respectively. Harzallah et al. found that nephropathy was present in 13% of patients. However, the aforementioned studies were not restricted to patients newly diagnosed with type 2 DM.

Some studies addressed the incidence/prevalence of DKD in patients with recently diagnosed type 2 DM. The prevalence of microalbuminuria was 54.09% in a study from India which is higher than 19% found in another study from the same region. Another study showed that microalbuminuria was present in 30% of patients in a cohort of 50 patients from Pakistan. There was variation in the method of detecting albuminuria; some used dipstick test, while others used 24 h urinary collection or a single measure of UACR.

In the USA, up to 41.7% of adults with previously undiagnosed DM had CKD. This rate is higher than that reported for the United Kingdom Prospective Diabetes Study (UKPDS) population, wherein the prevalence was 25 and 5% for microalbuminuria and macroalbuminuria, respectively.

Studies conducted in Asian countries reported an alarmingly high prevalence of DKD. The prevalence in European countries is variable; for example, the prevalence of microalbuminuria was 26.9% in Hungary, while albuminuria was present in 20% of patients after five years’ follow-up according to a study based on the Swedish National Diabetes Register.

As regards risk factors for the development of DKD, many studies showed older age was a significant predictor of albuminuria after adjustment of other confounders. On the other hand, other studies found that microalbuminuria was not related to age. These variations are probably related to the varied distribution of patients’ ages in the different studies. Regarding the duration of DM, many studies - in contrast to our work - found nephropathy/microalbuminuria are related to the duration of DM. Fewer studies reported no significant correlation between microalbuminuria and the duration of diabetes. This conflicting observation may be the result of the difficulty in dating the onset of diabetes. In many countries, DM goes undetected for a long period, and newly diagnosed patients with diabetes sometimes present with well-established complications as shown in the present study. In addition, our study was restricted to newly diagnosed patients.

Regarding age at onset of DM, it was reportedly not a significant marker for the development of microalbuminuria, according to the larger UKPDS study at the six-year follow-up. However, a classic example for the effect of younger age at diagnosis of DM is a high prevalence of CKD and ESKD among Pima Indians. This discrepancy might have resulted from small study sample and difficulty in dating the onset of DM.

As regards relation to sex, our finding was similar to other studies that showed that male were at increased risk for albuminuria. Other studies found that microalbuminuria was more common in females, while some studies found no significant difference. The recommended UACR of 30 mg/gm to detect microalbuminuria does not account for sex or racial differences in creatinine excretion. Studies that used a single UACR found that the prevalence of microalbuminuria was significantly lower among the men compared with women. This is probably because urine creatinine concentrations were lower in female. No significant difference in the prevalence of microalbuminuria between men and women was noted when sex-specific UACR cut points sex-specific cut points (≥17 mg/g in men and ≥25 mg/g in women) were used. In our study, though we used the same detection limit for male and female, male sex was found to be a risk factor for the development of nephropathy (though not by regression analysis). This may be explained by our adoption of the current practice of using multiple measurements for UACR rather than a single one.

It is now appreciated that different risk factors
are associated with patients following albuminuric and nonalbuminuric pathway to renal impairment with more females following the nonalbuminuric pathway.\textsuperscript{36}

As regards the effect of obesity, and in agreement with our results, obesity was associated with increased urinary albumin excretion (UAE) in many studies.\textsuperscript{22,24,37} In contrast, Thakkar et al\textsuperscript{17} failed to show any correlation between increased BMI and microalbuminuria in their study on newly diagnosed patient with DM. Some earlier studies showed similar results.\textsuperscript{30,38} This may be due to the confounding variables like duration of diabetes and glycemic control that would have played a major role in the occurrence of microalbuminuria.

Some studies found that HTN is found in about one-third of patients with type 2 DM at the time of diagnosis.\textsuperscript{39} Similar to our study, elevated SBP was associated with established albuminuria, in several studies.\textsuperscript{15,22,40,41} DBP was a predictor for albuminuria in other studies.\textsuperscript{30,37}

Regarding relationship of DKD to abnormalities in lipid profile, many studies found an association between abnormal lipid profile and increased UAE,\textsuperscript{42-44} while few studies found no association.\textsuperscript{45}

As regards relation of nephropathy to glycemic control, many studies found statistically significant correlation between the prevalence of nephropathy and increased HbA1c.\textsuperscript{12,17,27,29,37}

The large differences, observed in the prevalence of nephropathy as well as differences in risk factors for DKD among different studies including our study could be attributed to the differences in study design, methodologies adopted for defining the disease, differences in ethnicity, patient selection, and the failure to control for potentially confounding variables.

There are certain limitations that need to be addressed in the present study. The first limitation is that our study included patients from outpatient clinic of a university hospital with possible referral bias, resulting in possibly higher prevalence of DKD.

The second limitation is the small sample size of the study; which might be due to the fact that many of patients with type 2 DM are managed at the level of primary or secondary health care; especially newly diagnosed patients and that most patients referred to our clinic were patients with complications; usually with long-standing disease. Although this may affect the prevalence of DKD, it should not affect factors associated with DKD.

The third limitation is that no information on renin–angiotensin aldosterone system (RAS) blocking agents was available in this study. Information on RAS blocking agents would have been of interest since this has an impact on both albuminuria and renal function.

Being a cross-sectional study with small sample size and possible selection bias, findings of our study need to be carefully reviewed before considering it generalizable to a general population with type 2 DM. A population-based study is warranted to confirm our findings.

\textbf{Conflict of interest:} None declared.

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