

Original article

Comprehensive Evaluation of the Relationship Between Predictors Including Type 2 Diabetes and Diabetic Kidney Disease: A Cross-Sectional Study from Benghazi, Libya

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Abstract

Diabetic kidney disease is prevalent among diabetic patients worldwide and in Libya. Thus, the study aims to evaluate the relationship between type 2 diabetes, other predictors, and diabetic kidney disease (DKD). In the cross-sectional study, the data were collected from a total of 382 type 2 diabetic patients treated in the Benghazi diabetic clinic. The data were collected through a written Questionnaire for the time period from January to June 2026. SPSS version 25 was used for data analysis, which included descriptive analysis and Poisson regression. The Results indicate that the regular screening of renal function had a statistically significant relationship with DKD (p-value = 0.000, PR=2.767, 95% CI 1.672 to 4.579). Additionally, smoking e-cigarettes had a relationship to DKD compared to nonsmokers (reference) (p-value = 0.000); smoking shisha had a relationship to DKD compared to nonsmokers (reference) (p-value = 0.000). Moreover, the Body Mass Index variable is related to DKD (p-value = 0.042, PR=1.018, 95%CI 1.001 to 1.036). However, HBA1C and the history of HTN were not statistically significantly related to DKD. The research hypothesis is partially supported. The independent variables (marital status, family history of diabetes, working at a high temperature, BMI, smoking, caffeine consumption, and other complications of diabetes) are related to DKD. However, the other independent variables are not related to DKD. It is recommended for health educators to encourage diabetic patients to adhere to a healthy lifestyle and to regularly check renal function to decrease the risk of development and progression of DKD.

Keywords. Diabetic Kidney Disease, Type 2 Diabetes, Cross-Sectional Study, Poisson Regression, Lifestyle Variables.

Introduction

Type 2 diabetes mellitus is a chronic endocrine disease that leads to hyperglycemia, since there is resistance from the peripheral tissues to insulin. Chronic kidney disease is defined as damage to the kidney and a decline in the estimated glomerular filtration rate (eGFR) for at least three consecutive months. Diabetic kidney disease is defined as damage to the kidney that leads to chronic kidney disease due to uncontrolled diabetes [1]. Additionally, kidney diseases usually affect the nephrons, which leads to the damaged kidney being unable to eliminate waste products. Consequently, this leads to electrolyte disturbances, renal hypertension, muscle weakness, arrhythmia, weakness in the bones, and further damage to the kidney in patients who do not adhere to a healthy lifestyle and renal dietary restrictions [2]. Furthermore, diabetes can damage renal blood vessels, which consequently leads to a decrease in renal blood flow and kidney damage. Also, diabetes can lead to glomerular damage, which leads to leakage of albumin and albuminuria.

In addition to that, diabetes can damage urinary bladder nerves, which causes pressure on the kidney and kidney damage. Besides, diabetes can cause urinary tract infection, since diabetes causes hyperglycemia, which leads to increased urinary excretion of glucose, which is a good environment for bacterial growth. Finally, uncontrolled diabetes can cause renal failure [1]. Therefore, diabetic patients are recommended to adhere to a healthy lifestyle to decrease the risk of DKD and adhere to screening (renal function tests) to early detect kidney damage and prevent the progression of kidney damage to renal failure [1]. Moreover, the prevalence of diabetic kidney disease as early kidney damage (microalbuminuria) in Libya is over 40% according to previous studies published in Libya [3].

Although two previous studies stated that type 2 diabetes had no statistically significant impact on renal function biomarkers [4, 5], other studies have indicated that type 2 diabetes had a statistically significant effect on renal function biomarkers and increases the risk of diabetic kidney disease [3, 6-10]. One study indicated that age did not have a statistically significant association with DKD [7]. Other studies have indicated that age had a statistically significant relationship to DKD [5, 6, 8-10]. Several studies have shown that the duration of diabetes had a statistically significant relationship to DKD [6-10]. Additionally, many studies have proved that smoking had a statistically significant association with DKD [5, 10]. Though, one study indicated that BMI did not have a statistically significant relationship to DKD [7]. Other studies have shown that BMI had a statistically significant relationship to DKD [6, 10]. Many studies have stated that hypertension had a statistically significant association with DKD [8-10]. Also, many studies have indicated that diabetic retinopathy had a statistically significant relationship to DKD [8-9].

Despite many studies in Libya having investigated the effect of type 2 diabetes on kidney function, these studies lack a comprehensive evaluation of socioeconomic and socio-demographic characteristics, lifestyle factors, medical history factors, and knowledge as predictors of diabetic kidney disease. Thus, the study is the first study in Libya to comprehensively evaluate the predictors of diabetic kidney disease, which include socioeconomic and socio-demographic characteristics, lifestyle factors, medical history, biomarkers, and health awareness knowledge. The study

is significant for diabetic patients, health care providers, and the public, since all of them will learn how diabetic patients can be protected against diabetic kidney disease.

Methods

Study Design

A cross-sectional study was conducted to evaluate the effect of type 2 diabetes on renal function. The risks (independent variables) and the outcome (Diabetic kidney disease) were collected from the participants of the study at one point in time (at the same time).

Sampling Procedure, Sample Size and Power Calculation

Since the randomization process of the sampling is almost impossible in Libya [11] the sampling procedure was convenience sampling. In order to calculate the sample size, the population size for type 2 diabetic patients treated in Benghazi Diabetic Clinic was used, which is 65000. Additionally, the confidence level was set at 95%. Furthermore, the population proportion was assigned as 50% since it is unknown. Moreover, the margin of error was assigned as 5%. Thus, the sample size was 382. Finally, the total sample size (target sample size) required for the cross-sectional study is 382 (it is suitable for descriptive analysis and univariate analysis of Poisson regression), which is different from the total sample size that is required for the final model of the Poisson regression (according to the rule of 10).

Study Population

382 diabetic patients were included in the study. The inclusion criteria for participants in the study include patients diagnosed with type 2 diabetes and treated at Benghazi Diabetic Clinic from January to June 2026, of both genders and any age. The exclusion criteria include patients with type 1 diabetes, prediabetes, gestational diabetes, and known non-diabetic kidney disease.

Data Collection and Management:

A written questionnaire was used to collect data from the participants in the study. The data were collected from Type 2 diabetic patients treated in Benghazi Diabetic Clinic from January to June 2026.

The Data Collected Include

The data collection instrument consisted of five major sections. The first section gathered sociodemographic and socioeconomic characteristics, including participants' age, gender, duration of diabetes, marital status, educational level, employment status, occupation, income level, and place of residence. The second section assessed lifestyle-related factors, including smoking status, adherence to a diabetic diet, dietary habits, number of daily meals, renal diet frequency, daily consumption of coffee and milk tea, daily water intake, frequency of fast-food consumption, sleep disturbance status, physical activity, and body mass index (BMI). The third section focused on medical history and clinical characteristics, including the presence of kidney problems, adherence to renal function testing, family history of diabetes and kidney disease, symptoms of kidney damage, hypertension status, the presence of complications other than diabetic nephropathy, current diabetes treatment, use of medications for blood pressure and kidney function regulation, and the use of other medications. The fourth section collected laboratory data, including glycated haemoglobin (HbA1c), blood urea, serum creatinine, and urine albumin-to-creatinine ratio (ACR). The final section evaluated participants' awareness of kidney disease, assessing their knowledge regarding the causes of kidney disease and preventive measures that individuals with diabetes should adopt to protect against diabetic kidney complications. Some of these variables are considered potential confounders, as the biological plausibility states that these variables are related to both renal diseases and diabetes, which include BMI, smoking, and hypertension [12]. The reasons for these variables to be part of the study are to adjust for them by Poisson regression during data analysis. At the same time, these variables are independent predictors of kidney disease [12]. To avoid subjective bias, the height and weight were measured objectively for each diabetic patient in the study. The Body Mass Index (BMI) was computed from the height in meters and the weight in kilograms (weight in kilograms/ height in meters x height in meters) [13] by SPSS as part of data manipulation before beginning data analysis.

Additionally, the physical activity was measured objectively in order to avoid subjective bias. In accordance with the type, the duration, and the frequency of the physical activity, the Metabolic Equivalent of Task (MET) was calculated to measure the intensity of physical activity [14]. MET-minutes= MET for the specific exercise x duration of exercise in minutes x frequency of exercise in days/week. MET-minutes were calculated by the Omni calculator [15]. The participants with MET-minutes/week less than 560 were classified as low-intensity exercise, while participants with 560 MET-minutes/week or higher were classified as moderate-to-vigorous intensity exercise [14]. Furthermore, the dietary habits were measured quantitatively using a frequency questionnaire to avoid self-report bias. The renal diet frequency Questionnaire includes 18 questions. All types of food included in the renal diet questionnaire should be avoided or consumed in moderate amounts by diabetic patients with kidney disease. The total score of 18 questions in the renal diet questionnaire was calculated to form a single continuous variable.

Moreover, the biomarkers were collected from the medical files of the patients to avoid self-report bias and recall bias. In addition, HBA1C is defined as the average blood glucose concentration for 3 months. It is measured as a percentage [16].

Diabetic patients with less than 7% are considered diabetic patients with controlled diabetes. Diabetic patients with 7% to 7.9% HbA1c are considered fair. Diabetic patients with HbA1C of 8% or higher are considered diabetic patients with uncontrolled diabetes [17]. Fasting blood glucose level is defined as the blood glucose level in the fasting state, and it is measured in mg/dl [16]. A fasting blood glucose level of 126 mg/dl or higher is considered uncontrolled diabetes, and a fasting blood glucose level of higher than 180 mg/dl is considered hyperglycemia [18].

Fasting blood glucose and HbA1c levels were collected from the medical files of diabetic patients to evaluate whether they are predictive of renal disease. Besides, the urine albumin-to-creatinine ratio was used as an indicator of kidney damage for levels of 3 mg/mmol or higher [5]. Furthermore, the estimated glomerular filtration rate (eGFR) (assessment of renal function by examining the ability of the kidney to filter creatinine) was calculated from serum creatinine according to the 2021 CKD-EPI creatinine equation [5]. eGFR was computed by SPSS using the following formula for men: $142 \times (\text{Serum creatinine}/0.9)^{-0.302} \times 0.9938^{\text{age}}$ [5]. For women, the formula is $142 \times (\text{Serum creatinine}/0.7)^{-0.241} \times 0.9938^{\text{age}} \times 1.012$ [13]. eGFR is measured as ml/min/1.73 m² [5]. According to the eGFR and urine albumin creatinine ratio (eGFR is less than 60 ml/min/1.73 m² or urine albumin creatinine ratio at level 3 mg/mmol or higher), the diabetic patients were classified into diabetic patients with kidney disease and diabetic patients without kidney disease [9]. Finally, for the knowledge questions that assess the awareness of diabetic patients about the causes of renal disease and how to be protected against renal disease, the total score of the 6 knowledge questions was calculated to form a single continuous variable.

Data Analysis

SPSS version 25 was used for data analysis. First, the participants with missing renal biomarkers or HbA1C were excluded from the data analysis. Secondly, the data were entered manually into SPSS. Then, the data were cleaned in SPSS to ensure the findings of the study were accurate. After that, the descriptive statistics analysis was done by cross-tabulation between the diabetic kidney disease status variable (dependent variable) and socioeconomic and sociodemographic variables to calculate frequencies and percentages. The cross-tabulation was done since all the sociodemographic variables, socioeconomic variables, and outcome variable were categorical variables. To determine which statistical test to use for the inferential analysis, the prevalence of diabetic kidney disease was calculated (prevalence=20.4%). Thus, Poisson regression with a robust standard error was performed, since the prevalence of diabetic kidney disease is higher than 10%. Besides, all categorical variables were recoded as dummy variables. Moreover, the assumptions for the Poisson regression, which included the rule of 10 and multicollinearity, were tested before starting the inferential analysis. According to the rule of 10, there was a violation of the assumption, since the required sample size is 470, which is much higher than the sample size (330) (the sample size for the final model of Poisson regression was 330 (not 382) since there are 52 missing values due to listwise deletion, and missing values with the dependent variable of the study) included in the final model.

To detect and avoid multicollinearity in the study, multicollinearity was tested by computing the variance inflation factor (VIF). VIF higher than 5 indicates multicollinearity. The variables that were dropped from the study due to multicollinearity were metabolic equivalent task, employment status, personal water in the workplace, diabetic diet, and dietary description variables. Also, to filter out inaccurate and unreliable variables, a purposeful selection method was used, which included univariate analysis, multivariable analysis, and the final model. Omnibus P-values with values higher than 0.20 were used to determine which independent variables were insignificant for the univariate analysis. For the multivariable analysis, any independent variable, continuous or with at least one dummy variable, with a p-value less than 0.05, was considered significant and included in the final model. Also, the clinically and theoretically significant variables and the variables omitted from being included in the multivariable analysis were included in the final model. The statistical tools used included the prevalence ratio, which was used to evaluate whether there is an association between each independent variable and an outcome variable. Also, the prevalence ratio with values other than one indicates the relationship. Finally, other statistical tools used included the P value (less than 0.05 is significant) and the 95% confidence interval ranges (significant results when the CI range does not pass through 1).

Pretest or Pilot Study

The pilot study was conducted in January 2026 to evaluate the reliability and validity of the Questionnaire. An unweighted Cohen kappa test was used for the nominal categorical variables, while weighted Cohen's kappa was used for the ordinal categorical variables. Intraclass correlation coefficient test-retest reliability was used for the continuous variables. For the nominal categorical variable, all variables in the questionnaire were reliable (kappa = 0.75 or higher) and had statistically significant agreement (p values=0.000), with the lowest value of Cohen kappa (0.831), which indicates almost perfect agreement for using Angiotensin converting enzyme inhibitor (ACE inhibitor) medication variable. For ordinal categorical variables, all variables in the questionnaire were reliable (kappa = 0.75 or higher) and had statistically significant agreement (p values=0.000) with the sleep disturbance status variable had the lowest value of Cohen kappa (0.966) with p value=0.000 which indicates almost perfect agreement and statistically significant agreement. For continuous variables, all variables have perfect ICC reliability (ICC=1). Thus, the questionnaire in the study is reliable.

Compliance with Ethical Principles

An approval was obtained from Benghazi Diabetic Clinic to collect data from diabetic patients treated in the clinic in order to collect data. The ethical considerations adhering to the Declaration of Helsinki 1964 to engage participants in the study were followed, which include voluntary participation, informed consent, anonymity, and confidentiality.

Results

Sociodemographic Characteristics of The Participants

First, 29.2% of the patients in the age groups 60 to 74 years old and 75 years old and older had diabetic kidney disease (DKD). Secondly, 25% of the female patients had diabetic kidney disease. Additionally, 26.7% of the patients with a duration of diabetes of 15 years or more had diabetic kidney disease. In addition to that, 33.3% of the separated patients had diabetic kidney disease. Furthermore, 25.3% of illiterate patients and 28.6% of patients with a high school degree had DKD. Moreover, 27.6% of the unemployed had DKD. Besides, 21.7% of patients with an income ranging from 1000 LD to less than 2000 LD had DKD. Finally, 23% of the patients with a family history of diabetes and 22.2% of the patients with a family history of kidney disease had DKD. Also, of the total sample size of 382, the sample size for descriptive analysis of the sociodemographic characteristics was only 372 since there are 10 missing values in the outcome variable (Diabetes Kidney Disease Status). See (Table 1) for a summary of findings.

Table 1. Descriptive analysis for sociodemographic characteristics (N=372)

Variable	Diabetes without Kidney Disease		Diabetic Kidney Disease (DKD)	
	Count (N)	Percentage (%)	Count (N)	Percentage (%)
Age				
Less than 40 years old	82	89.1%	10	10.9%
40 to 59 years old	144	78.3%	40	21.7%
60 to 74 years old	51	70.8%	21	29.2%
75 years old and older	17	70.8%	7	29.2%
Gender				
Male	132	84.6%	24	15.4%
Female	162	75%	54	25%
Duration of Diabetes				
0 to 4 years	70	87.5%	10	12.5%
5 to 9 years	68	81.9%	15	18.1%
10 to 14 years	60	76.9%	18	23.1%
15 years or more	96	73.3%	35	26.7%
Marital Status				
Married	212	77.4%	62	22.6%
Single	49	89.1%	6	10.9%
Divorced	14	87.5%	2	12.5%
Widowed	17	70.8%	7	29.2%
Separated	2	66.7%	1	33.3%
Educational Level				
Illiterate	56	74.7%	19	25.3%
Primary or middle school	101	78.3%	28	21.7%
High School	20	71.4%	8	28.6%
Diploma	68	84%	13	16%
University Level	43	84.3%	8	15.7%
Post Graduate	6	75%	2	25%
Employment Status				
Housewife	29	87.9%	4	12.1%
Unemployed	110	72.4%	42	27.6%
Governmental Employed	114	83.8%	22	16.2%
Private Sector Employed	29	80.6%	7	19.4%
Retired	12	80%	3	20%
Monthly Family Income in Libyan Dinar				
Less than 1000 LD	132	80%	33	20%
1000 to Less than 2000 LD	123	78.3%	34	21.7%
2000 to Less than 3500 LD	34	79.1%	9	20.9%

3500 to 5000 LD	5	83.3%	1	16.7%
Higher than 5000 LD	0	0%	1	100%
Family History of Diabetes				
No	92	76.7%	28	23.3%
Yes	161	77%	48	23%
Not Sure	41	95.3%	2	4.7%
Family History of Kidney Disease				
No	242	77.3%	71	22.7%
Yes	14	77.8%	4	22.2%
Not Sure	38	92.7%	3	7.3%

Prevalence of Diabetic Kidney Disease

According to the subjective response from diabetic patients, 6.3% of them had diabetic kidney disease. However, 20.4% of diabetic patients had diabetic kidney disease according to the Renal Biomarkers results. See (Table 2) for a summary of findings.

Table 2. Prevalence of DKD subjectively and according to the renal biomarkers

Variable	YES		NO	
	Counts (N)	Percentage (%)	Counts (N)	Percentage (%)
Subjective DKD (N=382)	24	6.3%	358	93.7%
DKD according to the renal biomarkers (N=372)	78	20.4%	294	77%

Final model for Poisson regression with robust standard:

First, the predictors had relationship (prevalence ratio is not 1) with Dependent variable (DKD) compared to their references with statistical significant relationship detected (p value less than 0.05 and 95% Confidence Interval does not pass through 1) were included, single patients dummy variable compared to separated (reference) (p value=0.000), divorced patients dummy variable compared to separated (reference) (p value=0.000), married dummy variable compared to separated (reference) (p value=0.000), never working at a high temperature dummy variable compare to mostly (reference) (p value = 0.042, Prevalence ratio=0.317, 95% CI 0.104 to 0.961), family history of diabetes dummy variable compared to not sure (reference) (p values = 0.001, prevalence ratio =14.078, 95% CI 2.865 to 69.172), no family history of diabetes compared to not sure (reference) (P value=0.001, PR=15.622, 95% CI 3.016 to 80.91), E cigarette dummy variable compared to nonsmokers (reference) (p value= 0.000), shisha smokers dummy variable compared to nonsmokers (reference) (p value= 0.000), none complication dummy variable compared to more than one complication (reference) (p value=0.004, PR=0.363, 95% CI 0.181 to 0.726), eye complication dummy variable compared to more than one complication (reference) (p value= 0.001, prevalence ratio=0.344, 95% CI 0.185 to 0.640), peripheral neuropathy dummy variables compared to more than one complication (reference) (p value =0.000), foot complication dummy variable compared to more than one complication (reference) (p value=0.004, prevalence ratio= 0.147, 95% CI 0.040 to 0.540), consumption of coffee more than 4 cups per day dummy variable compared to non-consumption of coffee (reference) (p value=0.000), and none regular screening of renal function dummy variable compared to the regular screening of renal function (reference) (p value=0.000, PR=2.767, 95% CI 1.672 to 4.579). The only continuous variable that had a relationship (prevalence ratio is not 1) to a Dependent variable (DKD), with a statistically significant relationship (p-value less than 0.05 and 95% Confidence Interval does not pass through 1), is the Body Mass Index variable (BMI) (p-value = 0.042, PR=1.018, 95%CI 1.001 to 1.036). Otherwise, all other independent variables did not have a statistically significant relationship observed with DKD (p-values are greater than 0.050). Also, the sample size for the final model of Poisson regression was 330 (not 382), since there are 52 missing values due to listwise deletion and missing values with the dependent variable of the study. See (Table 3) for a summary of findings

Table 3. The significant results for the Poisson regression analysis (N=330)

Variable	Adjusted Prevalence Ratio (PR)	P value	95% Confidence Interval Range
Married compared to Separated	3.21×10^{10}	0.000	1.27×10^{10} to 8.07×10^{10}
Singles compared to separated	2.59×10^{10}	0.000	7.35×10^9 to 9.11×10^{10}
Divorced compared to separated	2.56×10^{10}	0.000	4.05×10^9 to 1.62×10^{11}
Family history of diabetes compared to unsure	14.078	0.001	2.865 to 69.17
No family history of diabetes compared to unsure	15.622	0.001	3.016 to 80.91
No other complications compared to multiple	0.363	0.004	0.181 to 0.726
Eye complications compared to multiple	0.344	0.001	0.185 to 0.640
Foot complications compared to multiple	0.147	0.004	0.040 to 0.540
Peripheral neuropathy compared to multiple	2.47×10^{-11}	0.000	7.75×10^{-12} to 7.88×10^{-11}

No screening for renal function compared to yes	2.767	0.000	1.672 to 4.579
Never working in high temperature vs mostly	0.317	0.042	0.104 to 0.961
Body Mass Index	1.018	0.042	1.001 to 1.036
Shisha smokers compared to non-smokers	4.68×10^{-11}	0.000	1.2×10^{-11} to 1.82×10^{-10}
E-cigarettes: E-cigarette smokers compared to non-smokers	2.20×10^{-10}	0.000	1.76×10^{-11} to 2.75×10^{-9}
More than 4 cups of coffee and tea intake with sugar and milk compared to none	1.85×10^{-10}	0.000	1.97×10^{-11} to 1.73×10^{-9}

Discussion

The prevalence of DKD among diabetic patients is 20.4%, which is in agreement with a previous study [19]. The prevalence of DKD, subjectively, is 6.3%, which is far from the prevalence of DKD according to the renal biomarkers. It is sensible, since the subjective questions in the questionnaire always lead to subjective bias [20]. Thus, the prevalence of DKD according to the renal biomarkers is used as a dependent variable in the study. It is reasonable that being married, single, and divorced have a relationship with DKD compared to being separated (all p-values = 0.000). The findings are in agreement with the general knowledge about the topic, since separation due to marital conflicts leads to instability compared to being married, single, and divorced [21].

It is sensible to have a family history of diabetes (p values = 0.001, prevalence ratio = 14.078, 95% CI 2.865 to 69.172), and not to have a family history of diabetes (P value = 0.001, PR = 15.622, 95% CI 3.016 to 80.91) had relationship to the DKD compared to not sure to have family history of diabetes, since diabetic patients regardless of family history of diabetes status are at risk of DKD, which is in agreement with a previous study [22]. Thus, Health educators should recommend that diabetic patients, regardless of their family history of diabetes, adhere to a healthy lifestyle to decrease the risk of DKD. It is justifiable that never working at a high temperature had a relationship to DKD compared to mostly working at high temperatures (p-value = 0.042, PR = 0.317, 95% CI 0.104 to 0.961), since working at a high temperature causes dehydration and kidney damage, which is in agreement with a previous study [23]. Thus, health educators should encourage diabetics to avoid working in high temperatures or to have a source of clean water in the workplace to decrease the risk of DKD.

However, age did not have a relationship with DKD, which is in disagreement with the previous studies [5, 6, 8-10]. Additionally, the duration of diabetes did not have a relationship with DKD, which is in disagreement with the previous studies [6-10]. Furthermore, the educational levels did not have a relationship with DKD, which is in disagreement with a previous study [24]. On the other hand, it is logical to adhere to regular screening of renal function to have a relationship with DKD (p-value = 0.000, PR = 2.767, 95% CI 1.672 to 4.579), since regular screening of renal function leads to early detection of kidney disease and decreases the risk of the progression of kidney damage to renal failure, which is in agreement with a previous study [25]. Thus, health educators should recommend that diabetic patients undergo regular screening of renal function to decrease the risk of renal failure. On the other hand, HbA1C is not related to DKD (P value = 0.889, PR = 1.009, 95% CI 0.888 to 1.147), which is in agreement with the two previous studies [4, 5]. But other studies have indicated that HbA1C is related to DKD [3, 6-10]. However, it is logical that smoking e-cigarettes has a relationship to DKD compared to nonsmokers (reference) (p-value = 0.000), and smoking shisha has a relationship to DKD compared to nonsmokers (reference) (p-value = 0.000), since smoking increases the risk of DKD according to the scientific knowledge about the topic and previous studies [5, 10]. Thus, it is recommended for health educators to encourage diabetic patients to avoid smoking e-cigarettes and shisha to decrease the risk of DKD.

Additionally, the Body Mass Index variable (BMI) is related to DKD (p-value = 0.042, PR = 1.018, 95% CI 1.001 to 1.036). It is justifiable, since overweight and obesity increase the risk of DKD according to general knowledge about the topic and previous studies [6, 10]. Thus, it is recommended for health educators to encourage diabetic patients to adhere to a healthy lifestyle and decrease their weight to decrease the risk of DKD. Furthermore, the consumption of more than 4 cups of coffee with milk and sweets is associated with DKD compared to non-consumption of coffee (p-value = 0.000). It is fair, since the consumption of coffee with sweets and milk leads to further progression of DKD, according to scientific knowledge of the topic [26]. Thus, it is recommended for health educators to encourage diabetic patients to decrease the consumption of coffee with milk and sweets, and, if it is necessary, to consume black coffee without milk and sweets in order to decrease the risk of progression of DKD. However, the Renal diet has no relationship with DKD (p-value = 0.368, PR = 1.012, 95% CI 0.986 to 1.038), which is in disagreement with the scientific knowledge about the topic and a previous study [27]. On the other side, eye complications are related to DKD compared to more than one complication (p value = 0.001, prevalence ratio = 0.344, 95% CI 0.185 to 0.640), peripheral neuropathy complication is related to DKD compared to more than one complication (p value = 0.000), foot complications are related to DKD compared to more than one complication (p value = 0.004, prevalence ratio = 0.147, 95% CI 0.040 to 0.540).

It is sensible since increasing the number of diabetic complications can be an indicator of uncontrolled diabetes and DKD according to previous studies [8, 9, 28]. Thus, the health educators should recommend that diabetic patients adhere to a healthy lifestyle for HbA1C to be in the controlled range to decrease the risk of diabetic complications, including DKD. However, hypertension has no relationship with DKD (p-value = 0.204, PR = 0.688, 95% CI 0.386 to 1.226), which is in disagreement with the general knowledge about the topic and the previous studies [8-10, 29]. In my opinion, the history of hypertension has no relationship with DKD since the history of hypertension was collected from the patients (not medical

files), convenience sampling in the study, low sample size (violation of the rule of 10 for the final model of the Poisson regression analysis), which all increases the risk of bias. Additionally, the health awareness about the DKD total score is not related to DKD (p -value = 0.867, $PR=0.986$, 95% CI 0.839 to 1.159), which is in disagreement with general knowledge about the topic and a previous study [24]. Otherwise, the other independent variables are not related to DKD.

As the study is a cross-sectional study design, the causal relationship cannot be determined. The study has many limitations. First of all, according to the rule of 10, the required sample size for Poisson regression is 470, while the sample size in the final model is only 330 out of 382, which led to a decrease in statistical power and the large numbers of the Prevalence Ratio and 95% CI for some variables. Since randomization is almost impossible in developing countries like Libya due to many factors, the sampling procedure was convenience sampling, which might expose the study to selection bias. Since the data collection of the cross-sectional study design is to collect the risks and the outcome at the same time and at one point in time, temporality could not be preserved. Since a single HBA1C was collected from the medical files, it might not be enough to provide us with an accurate result as a predictor of diabetic kidney disease. Finally, the medical history information, which included diabetic complications, history of hypertension, and drug history, was self-reported by the participants (not taken from the medical files), which might lead to the study being subjected to information bias.

Conclusion

In the study, the variables related to DKD include marital status, working in high temperatures, family history of diabetes, regular checks for renal function, smoking status, BMI, consumption of coffee, and other complications of diabetes. However, HBA1C and history of hypertension and other independent variables are not related to DKD. It is recommended for health educators to encourage diabetic patients to adhere to a healthy lifestyle, to regularly check renal function, to avoid smoking e-cigarettes and smoking shisha, to decrease their weight, to avoid drinking coffee with sugar and milk, and to avoid working at a high temperature or to have a clean source of water in the workplace to decrease the risk of DKD or decrease the progression of DKD. Finally, future studies about the topic are recommended since it is the first study to comprehensively evaluate the predictors of DKD in Libya.

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Conflict Of Interest

There is no conflict of interest declared by authors.

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