

Research Article

# The prevalence and risk factors of chronic kidney disease among type 2 diabetes mellitus follow-up patients at Debre Berhan Referral Hospital, Central Ethiopia

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## Abstract

**Background:** Chronic kidney disease is a progressive loss in renal function that is more accepted as global public health importance and its magnitude is overgrowing in the least developed countries like Ethiopia. No data was found in Debre Birhan Central Ethiopia on the magnitude of chronic kidney disease among type 2 diabetes patients.

**Methods:** Institution-based cross-sectional study was conducted among 327 at Debre Berhan Referral Hospital from March to June 2019 in Adult ( $\geq 18$  years) type 2 diabetes follow-up patients who volunteered to give informed written consent were included in the study. Systematic random sampling was used. Data were collected by interviews using structured and pre-tested questionnaires. Descriptive statistics of the continuous and categorical variables were done. The bi-variable and multivariable logistic regression was done to show the net effect of explanatory variables on chronic renal disease.

**Results:** A total of 327 study participants were involved in the final analysis. The Prevalence of CKD among type 2 diabetic patients was 15.9%. A significant association was found with age  $> 60$  years [AOR 3.5 (95% CI 1.8-6.8)], alcoholic patients [AOR 2.4 (95% CI 1.2-5.1)], glycated hemoglobin levels above 7% [AOR 2.5 (95% CI 1.5-4.1)], higher level of LDL greater than 100 g/dl [AOR 2.7 (95% CI 1.9-4)] and lower level of HDL [AOR 2.9 (95% CI 1.4-6)].

**Conclusion:** The magnitude of chronic kidney disease among type 2 diabetic follow-up patients was 15.9%. Estimated GFR should be determined for diabetic patients at regular intervals of time for earlier diagnosis of chronic kidney disease.

## Introduction

Chronic kidney disease (CKD) is a progressive loss of renal function over three months or years [1]. Clinical practice guidelines define chronic kidney diseases like kidney damage or glomerular filtration rate below 60 mL/min per 1.73 m<sup>2</sup> for 3 months or longer and proposed a

classification scheme based on glomerular filtration rate [2]. Kidneys can be damaged from a mechanical injury or a disease like diabetes or increased blood pressure. Once kidneys' glomerular membrane is damaged, they cannot correctly filter blood and remove other toxic end products, which are usually associated with a reduction in glomerular filtration rate (GFR) and proteinuria [3].

### More Information

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**Keywords:** Chronic kidney disease; Magnitude; Risk factors; Debre Berhan

**Abbreviations:** CKD: Chronic Kidney Disease; BP: Blood Pressure; BMI: Body Mass Index; CVD: Cardiovascular Disease; EDBP: Elevated Diastolic Blood Pressure; DM: Diabetes Mellitus; eGFR: estimated Glomerular Filtration Rate; ESRD: End-Stage Renal Disease; GFR: Glomerular Filtration Rate; KDIGO: Kidney Disease Improving Global Outcome; ESBP: Elevated Systolic Blood Pressure





Globally, in 2017, 1.2 million people died from CKD. The global all-age mortality rate from CKD increased by 41.5%. The global all-age Prevalence of CKD has increased by 29.3% since 1990. Many regions of the world, predominantly Oceania, sub-Saharan Africa and Latin America had a higher burden of CKD, which is considerably higher than expected for development [4].

CKD is increasingly recognized as a global public health problem and a key determinant of poor health outcomes, leading to end-stage kidney disease and increased cardiovascular disease. The risk of cardiovascular mortality, renal failure, kidney disease progression, acute kidney injury, decreased cognitive ability, reduce immune response, anemia, bone fractures, and hospitalizations are higher among patients with CKD than those with normal renal function [5,6].

CKD is highly prevalent and a significant public health problem among type 2 diabetes mellitus (T2DM) next to cardiovascular complications. Patients with type 2 diabetes have a higher chance of repeated hospital admission and, finally, premature death [7].

According to the 2010 Global Burden of Disease study, CKD was ranked 27<sup>th</sup> in the list of causes of the total number of global deaths in 1990 (age-standardized annual death rate of 15.7 per 100 000) but increased to 18<sup>th</sup> in 2010 (yearly death rate 16.3 per 100 000) [8].

Significant risk factors for the development and progression of CKD are diabetes mellitus (DM) and uncontrolled hypertension. Due to DM and hypertension, CKD affects nearly 5% - 7% of the population worldwide and is more common in the least developed countries and outnumbered people [9]. Different studies in many countries showed that CKD affects 10% - 16% of the adult population worldwide [10]. Studies in the Turkish population indicated that the Prevalence of CKD is 15.7% [11].

Despite the global threat of CKD, the problem is not well understood, mainly in underdeveloped countries [12]. With an older population, a sedentary lifestyle, and rapid urban growth, the burden of non-communicable diseases in the low-and middle-income countries cannot be underestimated. It has been anticipated that by 2030, >70% of patients with end-stage renal disease will be in developing countries like Sub-Saharan Africa (SSA) [13].

In many underdeveloped countries, 9.1% - 29.9% and 13% - 21% of the cases of ESRD are caused by diabetes mellitus and uncontrolled hypertension, respectively [14]. Uncontrolled hypertension affects 25% of the adult population in SSA and is the cause of chronic renal failure in 21% of patients on renal replacement therapy in South Africa. The Prevalence of diabetic nephropathy is measured to be 23.8% in Zambia, 14% - 16% in South Africa, 12.4% in Egypt, 9% in Sudan and 6.1% in Ethiopia [15].

Many studies showed that most diabetic kidney disease progresses through the years. Nevertheless, most diabetes patients had slow progression to chronicity, and a decrease in renal function, some patients with diabetes will go for a short period to end-stage. Many risk factors contribute to a rapid decline in renal function in diabetes patients, like smoking habits, increased glycated hemoglobin levels, obesity, elevated systolic blood pressure, and pulse pressure [16].

Healthcare costs or expenditures for type 2 diabetes with CKD care follow-up, care, and hospital visits will increase as the stage and progression increase. Healthcare costs related to progressors had \$674 healthcare cost increments for normal baseline eGFR, \$947. [17].

The Prevalence of diabetes is rising rapidly in the least developed countries like Ethiopia [18]. Comparably, CKD will increase even if studies did not show the exact magnitude, particularly in the study area, Debre Berhan. Therefore, this study aimed to assess the magnitude of CKD and associated risk factors among diabetes patients attending Debre Berhan Referral Hospital, Central Ethiopia.

## Methods and materials

Population, Study Setting, and study design: Debre Berhan is the capital city of North Shoa, one of the 13 zones of the Amhara regional state located 130 KM northeast of Addis Ababa, Ethiopia. The foundation of the town was traced back to the regime of Atse Zereyakob. There are one public and one private hospital, three public health centers, five health posts, and 20 private clinics regarding health services in the town. Debre Berhan Referral Hospital is the only public hospital in the city, and it is a zonal referral hospital serving 3 to 5 million population in the zone as a referral center [8]. According to the 2019 registration book for Diabetic follow-up clinics, type 2 diabetic follow-up patients in the Debre Berhan referral hospital were 995.

A cross-sectional study was conducted from March to June 2019 among 327 types 2 diabetes follow-up patients who visited the diabetic follow-up clinic of Debre Berhan Referral Hospital. All Adult ( $\geq 18$  years) type 2 diabetic follow-up patients who visited the hospital during the data collection period were included. Nevertheless, diabetic patients who were severely ill, not cooperative, having difficulty hearing, and having visual impairment were excluded.

### Sample size determination

We determined the sample size using a single population proportion by considering 26.1% CKD prevalence in southwest Ethiopia [10], assumptions of 5% sampling error, and a 95% level confidence level. After adding a 10% non-response rate, the final sample size was 327.



## Sampling technique and procedure

According to Diabetic follow-up clinic data in 2019 report 995 types' two diabetic patients had to follow up at Debre Berhan referral hospital. By taking their medical registration book as a sampling frame, we systematically selected the required sample size every three intervals from the total 995 types 2 people with diabetes follow-up patients ( $995/327 = 3$ ).

## Variables of the study

**Outcome variable:** Chronic kidney disease.

## Predictor variables

Social and demographic elements: Age of participants, sex of participants, religion, level of education, occupation type, and marital status. behavioral and Clinical characteristics: smoking, alcohol drinking, Blood pressure, reference diastolic blood pressure, reference systolic blood pressure, types of medications, duration on medications, types of medications, and dyslipidemia, Biochemical characteristics: Total cholesterol, Triglycerides, Low-Density Lipoprotein (LDL), High-Density Lipoprotein (HDL), glycated hemoglobin.

## Data collection tools

Data were collected by 5 nurses' working in diabetic clinics after the participants agreed to oral informed consent. Blood pressure was taken by nurses using a validated upper arm aneroid sphygmomanometer and stethoscope. Blood pressure was measured after the patient rests comfortably for at least five minutes, not ingested caffeine or smoked cigarettes, and engaged in physical activity for at least 30 minutes. Systolic BP  $\geq 140$  mmHg and/or diastolic BP  $\geq 90$  mmHg or current antihypertensive medication use were used to define hypertension [5]. Considering their present fasting blood glucose (FBG) level, participants were classified as with good glycemic control (FBG  $< 150$  mg/dl) and poor glycemic control (FBG  $\geq 150$  mg/dl) [7].

Laboratory technicians collected blood samples, and biochemical tests were carried out. Fasting venous blood (5 milliliters) was collected with a standard venipuncture technique to separate serum. Mindray BS-200 (Shenzhen Mindray Bio-Medical Electronics Co. Ltd, China) analyzer was used for biochemical analysis. Serum glucose, creatinine, and urea level were measured using the enzymatic glucose oxidase, kinetic alkaline picrate, and enzymatic glutamate-dehydrogenase (GLDH) methods, respectively. The estimated glomerular filtration rate (eGFR) was estimated using factors including serum creatinine (mg/dl), age and gender of participants considering the CKD Epidemiology Collaboration (CKD-EPI) equation. CKD was defined incorporating both eGFR. Patients having CKD were further classified into the following stages according to the Kidney Disease:

Kidney Disease Improving Global Outcomes (KDIGO) classification system:

Stage 1: eGFR  $\geq 90$  ml/min/1.73 m<sup>2</sup>, stage 2: eGFR 60-89 ml/min/1.73 m<sup>2</sup>, stage 3: eGFR of 30-59 ml/min/1.73 m<sup>2</sup>, stage 4: eGFR of 15-29 ml/min/1.73 m<sup>2</sup> and stage 5 (kidney failure): eGFR of  $< 15$  ml/min/1.73 m<sup>2</sup> [6].

## Data quality assurance

To assure the quality of the data one-day training was given to data collectors and supervisors before data collection. A pre-test was conducted on 5% of the sample size in Petros specialized hospital before the actual data collection process. The questionnaire was carefully designed and the English version was used for data collection. Before the actual data collection time, the questionnaire was checked for clarity and completeness. During data collection, the supervisor monitored the data collection process by checking the completeness of the data and correcting the site of data collection. The principal investigator checked the data for its completeness during data entry and the cleaning process.

## Data processing and analysis

The collected data were checked for completeness, coded, and then entered into Epi-Data Version 4.2.1 and then exported to SPSS version 24 for analysis. Descriptive statistics were used to describe the study participants about relevant variables. To determine the actual predictors of chronic kidney disease, binary logistic regressions were applied. The variables found to have a *p* - value of  $< 0.2$  with the outcome variable at bivariable analysis were entered into multivariate analysis. Moreover, the variables which have significant association was identified based on *p* - values  $< 0.05$  and AOR (adjusted odds ratio), with 95% CI to measure the strength of the associations. Finally, we presented the study results through tables, figures and text.

## Results

### Socio-demographic characteristics

Three hundred twenty-seven diabetic patients were fulfilling's inclusion criteria given a response rate of 100%. The mean age of the participants was  $53 \pm 17$  years, and their mean Diabetic follows up period was 8 years. Above half of the study subjects were females, and above 90% of them were living in urban (Table 1).

### Clinical and biochemical characteristics

The clinical characteristics of the participants showed that 257 (78.6%) of them were in the follow-up duration of below ten years of age. Regarding their blood pressure measurement, in nearly half of the study subjects, systolic blood pressure was below 130 mmHg. Their lipid profile analysis showed that three-fourths of the study participants' HDL level was less than 60 g/dl. Besides this, they showed that nearly two-thirds of the study participant's total cholesterol level was less than 200 g/dl (Table 2).



**Table 1:** Showing socio-demographic and behavioral characteristics of type 2 diabetic follow-up patients at Debre Berhan referral hospital, Debre Berhan, Ethiopia 2019 (n = 327).

Variables	Characteristics	Freq.	%
Age	< 60	243	74.3
	> 60	79	25.7
Sex	Male	141	43.1
	Female	186	56.9
Residence	Urban	305	93.3
	Rural	22	6.7
Family history of Dm	Yes	85	26
	No	242	74
Smoking	Yes	29	8.9
	No	298	91.1
Alcoholic	Yes	82	24.1
	No	245	74.9

DM: Diabetes Mellitus

**Table 2:** Showing clinical and biochemical characteristics of type 2 diabetic follow-up patients at Debre Berhan referral hospital, Debre Berhan, Ethiopia 2019 (n = 327).

Variables	Characteristics	Freq.	%
Serum HbA1c	< 7	98	30
	> 7	229	70
Systolic BP	< 130	175	53.5
	> 130	152	46.5
Diastolic BP	< 80	211	64.5
	> 80	116	35.5
Serum Creatinine	< 1.2 mg/dl	295	90.2
	> 1.2 mg/dl	32	9.8
Total cholesterol	< 200 mg/dl	209	63.9
	> 200 mg/dl	118	36.1
Triglyceride	< 100 mg/dl	189	57.8
	> 100 mg/dl	138	42.2
LDL	< 100 mg/dl	134	41.3
	> 100 mg/dl	193	58.7
HDL	< 60 mg/dl	274	83.8
	> 60 mg/dl	53	16.2

BP: Blood Pressure; HbA1c: Glycated Hemoglobin; HDL: High-Density Lipoprotein; LDL: Low-Density Lipoprotein.

### The magnitude of CKD

In our study prevalence of CKD was 15.9% (95% CI: 13% - 21%). Of those study participants, 52(15.9%) develop renal impairment (eGFR < 60 mL/min/1.73 m<sup>2</sup>). Of this 32 (9.8%) of participants eGFR was between 30-59.9 mL/min/1.73 m<sup>2</sup>, 12 (3.7%) 15-29.9 mL/min/1.73 m<sup>2</sup> and 8 (2.4%) was < 15 mL/min/1.73 m<sup>2</sup> (Table 3).

### Associated factors of CKD among diabetes patients

In the bivariate analysis, older age, obesity, increased systolic blood pressure (SBP), increased diastolic blood pressure, smoking history, alcohol drinking, an elevated level of low-density lipoprotein, low level of high-density lipoprotein and a higher level of glycated hemoglobin level were with *p* - value < 0.25 in bi-variable logistic regression analysis. Then those variables were entered into the multivariable logistic regression model for further analysis and adjustment.

Variables that showed significant association in the multivariable logistic regression model were older age,

alcohol drinking history, LDL level above 100 g/dl, HDL level less than 60g/dl, and glycated hemoglobin level > 7%. CKD.

The odds of CKD among type 2 DM patients aged > 60 years were 3.5 times higher compared with those ≤ 60 years of age [AOR: 3.5 (95% CI 1.8-6.8), *p* = 0.001]. Likewise, alcoholic patients were 2.4 times higher to develop CKD than those nonalcoholic drinkers [AOR: 2.4 (95% CI 1.2-5.1), *p* = 0.027]. Similarly, glycemic control is one of the crucial components of diabetic patients to prevent complications. As a result, patients with glycated hemoglobin levels above 7% were 2.5 times more likely to have chronic kidney disease than their counterparts [AOR: 2.5 (95% CI 1.5-4.1), *p* = 0.01]. Also, diabetic type 2 clients with a higher level of LDL greater than 100 g/dl were 2.7 more likely to develop CKD than those with LDL < 100 g/dl were [AOR: 2.7 (95% CI 1.9-4), *p* = 0.01] and lower level of HDL was associated with CKD than the counterparts [AOR: 2.9 (95% CI 1.4-6), *p* = 0.01] (Table 4).

### Discussion

The results of this study demonstrated two things. First, has assessed the Prevalence of CKD Second, it tried to assess its risk factors among type 2 diabetic follow-up patients at Debre Berhan Referral Hospital using an estimated glomerular filtration rate (eGFR) based on CKD-EPI guideline [18].

In this study, the prevalence of CKD among type 2 diabetic follow-up patients was 52 (15.9%) based on their estimated GFR (eGFR < 60 mL/min/1.73 m<sup>2</sup>). All of the participants were type 2 DM patients. One hundred ninety-nine (60.9%), 76 (23.9%), 32 (9.8%), 12 (3.7%) and 8 (2.4) DM patients had an estimated GFR of ≥ 90 ml/min/1.73 m<sup>2</sup> (stage 1), 60-89.9 ml/min/1.73 m<sup>2</sup> (stage 2), 30-59.9 ml/min/1.73 m<sup>2</sup> (stage 3) and < 15 ml/min/1.73 m<sup>2</sup> (stage 5), respectively (Table 3).

However, when comparing our results to those of older studies, in this study prevalence of CKD was lower than the studies conducted in Gondar (21.8%) [3], Jimma (26.1%) [10], Mekele (22.1%) [1], Southern Ethiopia (18.2%) [7], Spain (27.9%) [17], Netherlands (28%) [19], Mediterranean area (34.1%) [2], USA (39.6%) [15] and Japan (42.3%) (Ohta, Babazono, Uchigata, & Iwamoto, 2010). This difference in CKD prevalence might be because of the differences in case mix (some of the studies included type 1 and type 2 DM patients

**Table 3:** Prevalence and stages of CKD among type 2 diabetic follow-up patients at Debre Berhan referral hospital, Debre Berhan, Ethiopia 2019 (n = 327).

Stage	Description	eGFR (ml/min/1.73m <sup>2</sup> )	Number (%)
1	Normal eGFR	≥ 90	199 (60.9)
2	Slightly decreased eGFR	60-89.9	76 (23.2)
3	Moderately decreased eGFR	30-59.9	32 (9.8)
4	Severely decrease eGFR	15-29.9	12 (3.7)
5	Kidney failure	< 15	8 (2.4)
	Total		327 (100)

eGFR: estimated Glomerular Filtration Rate; CKD: Chronic Kidney Disease.



**Table 4:** Bivariate and multivariable logistic regression analysis of CKD among type 2 Diabetic follow-up patients attending Debre Berhan Referral hospitals, Ethiopia, 2019 (n = 327).

Variables	characteristics	CKD				COR	AOR 95% CI
		Yes = 52		No = 275			
		N	%	N	%		
Age	≤ 60	25	48	218	79.3	1	1
	> 60	27	52	57	20.7	4.1 (2.2-7.7)	3.5 (1.8-6.8) ***
Smoking history	Yes	7	13.5	22	8	1.8 (0.7-4.4)	0.8 (0.3-2.4) 0.7
	No	45	86.5	253	92	1	1
Alcoholic history	Yes	22	42.3	60	21.8	2.6 (1.4-4.9)	2.4 (1.2-5.1) *
	No	30	57.7	215	78.2	1	1
Systolic BP	< 130 mmHg	21	40.4	154	56	1	1
	≥ 130 mmHg	31	59.6	121	44	1.9 (1-3.4)	0.9 (0.6-1.4)0.4
Diastolic BP	< 80 mmHg	28	53.8	183	66.5	1	1
	≥ 80 mmHg	24	46.2	92	33.5	1.7 (0.9-3.1)	2.2 (0.6-3.3)0.7
LDL	< 100 g/dl	12	23	122	44.4	1	1
	≥ 100 g/dl	40	77	153	55.6	2.7 (1.3-5.3)	2.7 (1.9-4) **
HDL	< 60 g/dl	35	67.3	237	86.2	2.5 (1.3-5)	2.9 (1.4-6) **
	≥ 60 g/dl	17	32.7	38	13.8	1	1
HbA1c	< 7%	10	19.2	88	32	1	1
	≥ 7%	42	80.8	187	68	2 (0.9-4.1)	2.5 (1.5-4.1) **

**Note:** \*Statistically significant with  $p$  value  $\leq 0.05$ ; \*\*Statistically significant with  $p$  value  $\leq 0.01$ ; \*\*\*Statistically significant with  $p$  value  $\leq 0.001$   
 AOR: Adjusted Odds Ratio, BP: Blood Pressure; CKD: Chronic Kidney Disease; COR: Crude Odds Ratio; HDL: High-Density Lipoprotein; LDL: Low-Density Lipoprotein; N: Number

but others included only type 2 DM patients), creatinine, and albumin assays sample size, and ethnic variations [3]. However, this finding is more significant than studies done in England at 6% [16], Spain at 6.8% [14] and Leon at 9.1% [12]. This might be due to the time difference, and these studies were carried out among a healthy population.

In this study, Age differences were a significant association with CKD. Participants aged greater than 60 years had a significant association with CKD than those aged less than 60 [AOR 3.5 (95% CI, 1.8-6.8)]. This is consistent with what has been found in previous studies Jimma [10], Gondar [3], Southern Ethiopia [7], Tigray [1], Thailand [9] and Spain [14].

According to this study, alcohol drinking was a significant risk factor for CKD. Diabetic patients who drink alcohol had 2.4 times more likely to develop CKD than those who did not drink [AOR 2.4 (95% CI, 1.2-5.1)]. This was in agreement with other related studies done in Syria [20] and Thailand ngsathit, et al. [9].

A further novel finding of this study also demonstrated that diabetic patients with Low-Density Lipoprotein (LDL) greater than 100 Grams per DL (g/dl) had a more significant association with CKD than those with LDL value less than 100 g/dl [AOR 2.7 (95% CI, 1.9-4)]. This result ties well with the previous study conducted in Spain [4].

Furthermore, in this study, we also found that High-Density Lipoprotein (HDL) was a significant risk factor for CKD. Patients whose HDL values are less than 60 g/dl are significantly associated with CKD than those HDL values greater than 60 g/dl [AOR 2.9 (95% CI, 1.4-6)]. Overall these findings are similar to those reported by studies conducted in Spain [4] and Chinese [21].

This study found a significant association between CKD and glycated hemoglobin levels greater than 7% [AOR 2.5 (95% CI 1.5-4.1)]. This result is consistent with other studies done in various areas of Southern Taiwan [11], Spain [4] and Chinese [21].

In this study, contrary to the findings of other studies, we did not find a statistical association between Systolic and diastolic blood pressures with CKD. However, it was associated with bivariate analysis [COR 1.88 (95% CI 1.03-3.4)]. Other similar studies reported as Systolic BP > 140 mmHg was an independent risk factor for CKD [3,21]. The inconsistency might be the differences in the study area of high altitude. A few sample sizes may affect the statistical tool to show the association between systolic BP and CKD. High systolic BP is associated with CKD due to poor renal hypo-perfusion by narrowing renal blood vessels, pointing to the need for prevention [3].

## Conclusion

According to this study, the Prevalence of chronic kidney disease among Diabetic follow-up patients was considered moderate. Older age, alcohol drinking, LDL greater than 100 g/dl, HDL less than 60 g/dl and glycated hemoglobin level greater than 7% were significant factors of CKD. A clear upcoming intervention that aims at prevalence and associated factors is essential after this finding. Estimated GFR should be determined for DM patients at regular intervals of time for earlier diagnosis of chronic kidney disease to take an appropriate intervention.

## Ethics approval

We obtained ethical clearance from the Research and Ethical Review Committee of the College of Health Sciences,



Debre Berhan University. A permission letter was also taken from the Debre Berhan referral hospital and Outpatient coordinator. To safeguard the confidentiality of the study participants' information, anonymous typing was used for the name of the participants and any identifier was not transcribed on the questionnaire. Data were collected after written consent had been obtained from each participant.

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## Data availability

Data supporting these findings are contained within the manuscript and will share upon request to the corresponding author.

## Authors' contributions

All authors made a substantial contribution to the concept and design of the work, data analysis, drafting or revising the article, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work.

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