

ORIGINAL ARTICLE

Prevalence and associated factors of diabetic nephropathy at Tikur Anbessa Comprehensive Specialized University Hospital, Addis Ababa, Ethiopia

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ABSTRACT

Introduction: Given the global prevalence of diabetes, diabetic nephropathy and its consequences are among the major causes of morbidity and mortality in diabetic populations. However, the prevalence and determinants of diabetic nephropathy in Ethiopia are little studied, and were the main objectives of this study.

Methods: A cross-sectional study design was followed among 340 randomly selected diabetic patients attending the national diabetes referral clinics at the diabetes centre of Tikur Anbessa Specialized Hospital, Addis Ababa, using an interviewer-administered structured questionnaire. A total of 340 patients were involved, of whom 200 (59%) were females and 256 (75%) had type 2 diabetes mellitus. Urine and blood samples were drawn from the study population and the corresponding biochemical analyses were conducted at the Ethiopian Public Health Research Institute.

Results: The mean age of the participants was 51.6 years (range 18–94 years). The median duration of their diabetes was 11 years (range 1–40 years). Forty-eight percent of the patients were hypertensive. Only half of the hypertensive cases (53%) were using angiotensin-converting enzyme inhibitors, either alone or in combination with other anti-hypertensive medicines. Eighty-two percent of the participants had poorly controlled diabetes, with glycated haemoglobin >7%. None was using Sodium-glucose cotransporter 2 (SGLT2) inhibitors or glucagon-like peptide agonists. Some (109, 32%) of the participants were diagnosed with diabetic nephropathy in addition to reduced estimated glomerular filtration rate and albuminuria. Age, dyslipidaemia, educational status, presence of diabetic retinopathy, and elevated triglyceride levels were found to be significant predictors of the condition ($P < 0.05$).

Conclusions: Diabetic nephropathy was present in nearly one-third of the diabetics in the study population. The management of diabetes with renoprotective agents, such as renin-angiotensin-aldosterone system inhibitors and SGLT2 inhibitors, are likely to be very important in this context.

Keywords: diabetes mellitus; nephropathy; end-stage kidney disease; CKD.

INTRODUCTION

Diabetes is a major global public health problem [1]. It affected 463 million individuals in 2019 [2]. In Africa, around 19 million peoples are living with the condition [1]. According to a national prevalence study, in Ethiopia around 3.2% and 9.1% of the population are living with diabetes and impaired fasting glucose, respectively [3].

Diabetes mellitus has been associated with different chronic complications, which are classified as vascular and non-vascular [4]. One of the microvascular complications, diabetic nephropathy (DN), is the leading cause of end-stage kidney disease worldwide [4,5], and is strongly associated with diabetic retinopathy, especially in type 1 diabetic patients [9].

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Microvascular complications of diabetes are related to the duration of the disease and the degree of hyperglycaemia [4,6]. Other factors, such as cigarette smoking, genetics, dyslipidaemia and high blood pressure, contribute to the progression of these complications [4,6]. Patients with diabetic nephropathy have a higher mortality and morbidity than those without these complications [7]. Poor glycaemic control is associated with the development of microvascular complications [8].

The macrovascular complications of diabetes are coronary artery disease, peripheral arterial disease, and cerebrovascular disease [5]; they are also strongly associated with diabetic nephropathy [7,10]. Indeed, the common cause of morbidity in patients with diabetic nephropathy is cardiovascular diseases (CVD) [10]. The risk factors for CVD, including hypertension (HTN), dyslipidaemia, smoking and albuminuria, also affect the progression of kidney disease [10].

Diabetic nephropathy is clinically characterized by a progressive increment in protein excretion and deterioration of the estimated glomerular filtration rate [7]. Overall, diabetic nephropathy occurs in 20–40% of all diabetics [7]. The prevalences of DN in type 1 and type 2 diabetics are between 25–40% and 30–50%, respectively [11]. After 15 years, approximately one-third of diabetics showed microalbuminuria and less than half develop overt nephropathy [7]. The steps in the progression of diabetic nephropathy from microalbuminuria to overt nephropathy are not the same for type 1 and type 2 diabetics [7]. The condition also varies in people according to racial background [12].

The development and progression of diabetic nephropathy are associated with glycaemic control [8,13]. In the Diabetes Control and Complications Trial, patients assigned to the intensive treatment arm had a lower rate of development of albuminuria and progression to advanced chronic kidney disease (CKD) [8]. In the UK Prospective Diabetes Study, in newly diagnosed type 2 diabetic patients, good glycaemic control led to reduced albuminuria and doubling of creatinine [13].

Angiotensin-converting enzyme inhibitors (ACEIs) reduced the risk of progression to end-stage renal disease and mortality in type 1 diabetic patients [14]. ACEIs can also prevent the development of microalbuminuria in hypertensive patients with type 2 diabetes [14]. Blood pressure should be kept below 130/80 mmHg in diabetic patients with albuminuria and CKD [5,15,16].

Reduced progression of diabetic nephropathy was observed with the use of SGLT2 inhibitors in recently reported trials [17]. These inhibitors – empagliflozin, dapagliflozin and canagliflozin – have favourable cardiovascular outcomes [17]. In the CREDENCE trial, with participants with

relatively wide eGFR, canagliflozin showed better renal and cardiovascular outcomes [18]. GLP agonists, such as liraglutide, also showed better renal outcome in type 2 DM patients [19].

A study conducted in our hospital showed that glycaemic control of patients with diabetes was poor [20]. The burden of microvascular complications, including diabetic nephropathy, was therefore expected to be high. There have been only relatively few studies of the prevalence of DN conducted in Ethiopia. The prospective cross-sectional study reported here examined the prevalence of diabetic nephropathy in patients subject to follow-up at the national diabetic referral centre in Addis Ababa.

METHODS

The study was conducted at the Tikur Anbessa Comprehensive Specialised Hospital (TASH), in Addis Ababa, which hosts a national endocrine referral clinic. It is the only specialized clinic in the country for comprehensive diabetes care. The study was conducted from 1 May to 30 July 2019, to determine the prevalence and associated risk factors of diabetic nephropathy in diabetic patients attending the national diabetic referral clinic. All diabetic patients, aged 18 and above who came to the clinic during this period, were invited to participate in the study. Those who gave consent were included. Potential participants with mental health problems, hearing impairments, who were unable to provide appropriate information, were unwilling to participate in the study, or were pregnant or suffered from gestational diabetes were excluded.

The required sample size for this study was determined using a single population proportion formula, on the basis of the prevalence indicated in a recent study that assessed the prevalence of diabetic nephropathy in diabetic patients in sub-Saharan Africa. The pooled overall prevalence of DN was found to be 35.3% for the subcontinent, whereas in sub-group analyses the prevalence in eastern Africa was 29.7% [21]. Thus, the present study considered the latter prevalence for sample size determination (that is, $P = 0.297$). Additionally, assuming a 5% marginal error and 95% confidence level and a non-response rate of 5%, the estimated. The optimum minimum population sample size as 340. A systematic random sampling technique was used to select patients. Currently, there are about 3,200 diabetic patients who are registered and have a regular follow-up at the diabetic clinic in the study. Patients had appointments at intervals of three to four months. Nearly 70% of these patients receive medication and consultations through limited, government-based health insurance. Overall, 20–25% of patients' medical expenses were covered by their employers. Few patients buy medications themselves. The

diabetic clinics provide services three days per week, mainly on Mondays and Wednesdays, but some patients with gestational diabetes mellitus and foot ulcers have follow-up on Tuesdays and Fridays, respectively. On average, about 200 patients are treated per week, representing 800 monthly. Based on the decision to collect data over the course of three months, the sampling interval was determined by dividing the expected number of diabetic patients per three months (2,400) into the sample size (340), which gives a sampling interval of 7. Thus, every seventh patient coming to the clinic for a follow-up service was interviewed until the target sample size was reached.

Respondents were recruited at the diabetes follow-up clinic; consent was obtained for participation, and then demographic data were obtained using a well-structured questionnaire. Patient chart review and anthropometric measurements were recorded by trained nurses. The questionnaire was prepared in English and translated into the commonly spoken local language, Amharic, and then translated back into English to check for consistency. The serum levels of total cholesterol, HDL-cholesterol, LDL-cholesterol and triglyceride levels were measured using a COBAS INTEGRA 400 analyser (Roche Diagnostics, Mannheim, Germany) at the Ethiopian Public Health Institute. Triglycerides and total TC were evaluated with an enzymatic colourimetric method and HDL-c and LDL-c were analysed by a homogeneous enzymatic colorimetric method.

Urine albumin, measured by albuminsticx, was reported as the following six values: negative, trace, 1+, 2+, 3+ and 4+ (corresponding to albumin levels of “undetectable” or <10 mg/dL, 10–29 mg/dL, 30–99 mg/dL, 100–299 mg/dL, 300–999 mg/dL, and 1000 mg/dL or greater, respectively). The data collection process was supervised by the authors, and the data were checked daily for completeness and accuracy.

The study was conducted after obtaining ethical approval from the ethical review committee of the Department of Internal Medicine (Addis Ababa University). Informed consent was obtained from each respondent who participated in the study. A detailed explanation of the objectives, purpose and benefits of the study was given to the respondents, all of whose responses were kept confidential.

Data analysis

The collected data were cleaned, checked for completeness, compiled and analysed. Standard descriptive methods (reporting means/percentages and standard deviations) were used to record results. The significance for the association between dependent and independent variables was carried out using a chi-squared test where necessary.

Variables that showed significant association on bivariate analyses were fitted into a multivariable logistic regression model. All statistical tests were two-sided and significance was set at a P value of <0.05.

Diabetic nephropathy is defined as a reduction in kidney function, usually with an estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m², and kidney damage, usually by estimation of albuminuria >30 mg/dL [7,22]. Chronic kidney disease is defined as abnormalities of kidney structure or function, is present for three months, which was classified based on cause, GFR reduction, and urinary albumin.

RESULTS

The mean age of the participants was 51.6 years, ranging from 18 to 94 years; nearly one-third of the sample were older than 60 years; 69% were females. About 63% of the study population earned a monthly income below the national average per capita (that is, US\$772.3 per annum for the year 2018, according to the World Bank, which is equivalent to 2,070 Ethiopian birrs monthly). About two-thirds of them had received secondary education and above (Table 1).

Table 1. Socio-economic characteristics of participants.

Characteristics	N	%
Age group (years)		
<35	61	17.9
36–50	99	29.1
51–65	116	34.1
>65	64	18.8
Sex		
Male	140	41.2
Female	200	58.8
Individual monthly income (Eth. birr)		
<500	48	14.1
500–1,000	83	24.4
1,000–2,000	84	24.7
2,000–4,000	86	25.3
>4,000	39	11.5
Marital status		
Married	210	61.8
Single	64	18.8
Divorced	20	5.9
Widowed	46	13.5
Education		
No formal education	35	10.3
Primary education	73	21.5
Secondary education	121	35.6
>Secondary education	111	32.6

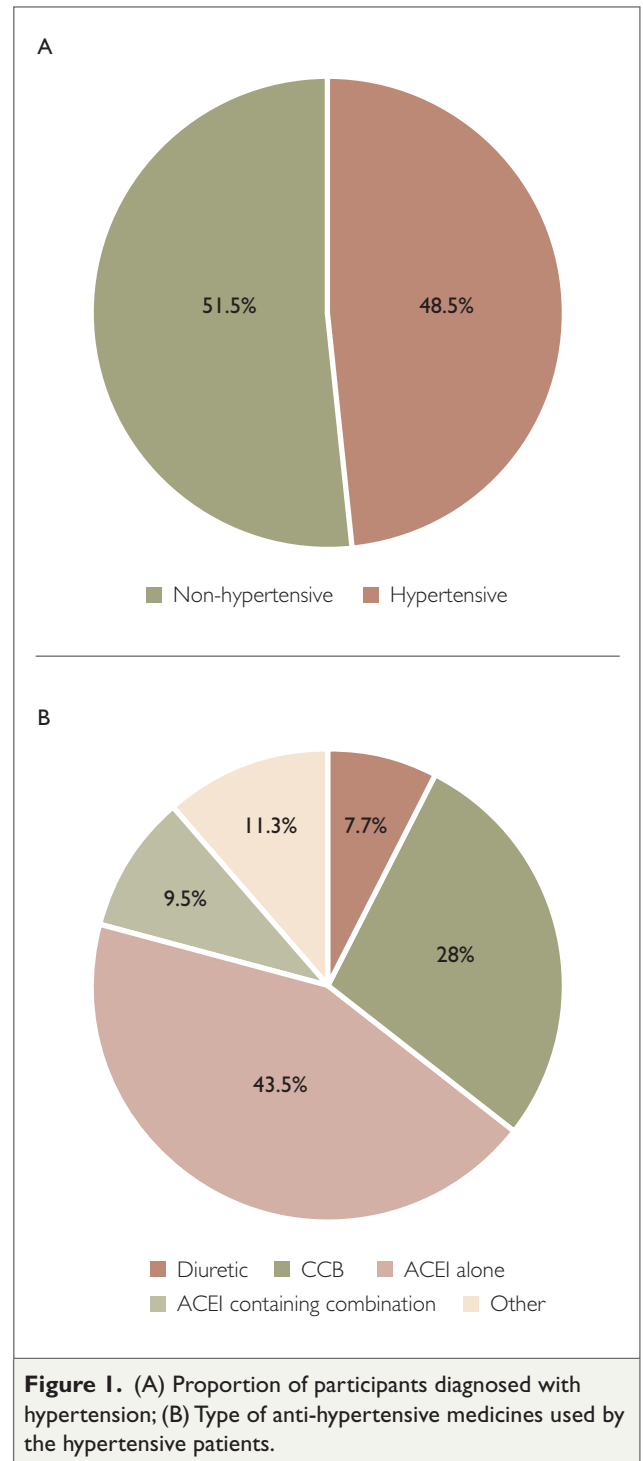
The majority of the participants (75%) were type 2 diabetics. The median duration of their condition was 11 years, ranging from 1 to 40 years. In 51% of cases, the duration of diabetes was more than 10 years. Metformin was used to manage their diabetes either alone or in combination with either sulfonylurea (SU) or insulin by 55% of participants. Likewise, insulin was used by 60% of the study population (Table 2). None of these patients reported the use of dipeptidyl peptidase-4 (DPP-4) inhibitors, sodium-glucose co-transporter 2 (SGLT2) inhibitors or GLP-1 agonists.

Nearly half (48.5%) of the participants were found to be hypertensive, and half of those cases (53%) had been using ACEIs either alone or in combination with other categories of anti-hypertensive medication (Figure 1), whereas only a single case was using angiotensin receptor blocker (ARB).

Among 231 patients (68%) screened for retinopathy in the preceding year, 74 (32%) were found to have diabetic retinopathy in a mild to severe degree (Figure 2).

Table 2. Clinical and anthropometric characteristics of the participants.		
Characteristics	N	%
History of smoking		
Current smoker	10	2.9
Ex-smoker	15	4.4
Non-smoker	315	92.1
Type of diabetes		
Type 1	84	24.7
Type 2	256	75.3
Duration of diabetes (years)		
<5	88	25.9
6–10	79	23.2
11–15	54	15.9
>15	119	35.0
Medications in use		
Type 1 NPH	37	10.9
NPH & regular insulin	47	13.8
Type 2 Metformin	91	26.8
NPH insulin	50	14.7
SU & metformin	29	8.5
Metformin & NPH insulin	68	20.0
Others	18	5.3
Body mass index (kg/m²)		
<18.5	25	7.3
18.5–24.9	126	36.8
>25.0	189	55.3

Abbreviations: SU, Sulfonylurea; NPH, neutral protamine Hagedorn; CCB, calcium channel blockers; ACEI, angiotensin-converting enzyme inhibitors.



Biochemical characteristics of the participants

In 82% of the study population, glycated haemoglobin level was above the acceptable cut-off (>7%). Half of the participants demonstrated elevated triglyceride levels. Furthermore, 40% of the study group reported that they had lipid disorder, and all of those cases are currently using lipid-lowering agents. However, the biochemical result indicates that dyslipidaemia was reported in about three-quarters (77%) of the participants as defined by any abnormality in either of the lipid profiles (TC, LDL, HDL or TG) (Table 3).

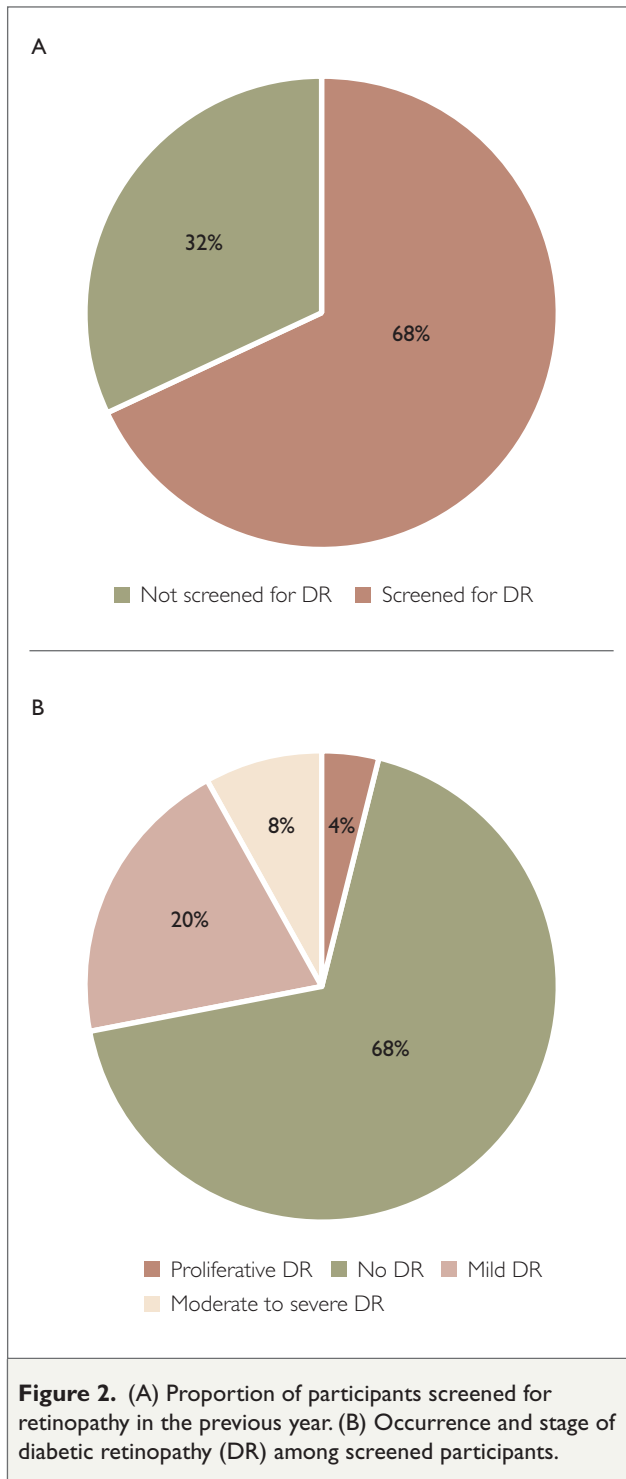


Table 3. Biochemical characteristics of the participants.

Characteristics	N	%
Glycated haemoglobin		
<7%	61	17.9
>7%	279	82.1
Dyslipidaemia (biochemical result)		
Yes	263	77.4
No	77	22.6
Dyslipidaemia (patient history)		
Yes	137	40.0
No	203	60.0
Cholesterol total (mg/dL)		
<200	282	82.9
>200	58	17.1
Low-density lipoprotein (mg/dL)		
<100	224	65.9
>100	116	34.1
High-density lipoprotein (mg/dL)		
Male <40	72	21.2
>40	68	20.0
Female <60	146	42.9
>60	54	15.9
Triglyceride (mg/dL)		
<150	177	52.1
>150	163	47.9
eGFR (mL/min/1.73 m²)		
>90	204	60.0
60–89	107	31.5
45–59	19	5.6
30–44	8	2.4
15–29	2	0.6
<15	0	0
Body mass index (kg/m²)		
<18.5	25	7.3
18.5–24.9	126	36.8
>25.0	189	55.3

In respect of the two indicators of nephropathy, 40% of the sample had mild to severely decreased eGFR and a quarter of them fell into categories of moderate to severely increased albuminuria (Table 3). About 32% of the study population were diagnosed for diabetic nephropathy with a stage of moderate to severely increased risk of CKD, using a composite measure of eGFR and albuminuria categories as presented in Figure 3. The prevalence of DN at a stage of moderate to severely increased risk of CKD using a composite measure of eGFR and albuminuria categories in

type 1 diabetics and type 2 diabetics was 23.8% and 34%, respectively (Table 5).

Comparison of various variables with respect to type 1 and type 2 diabetes mellitus

Age, BMI and triglyceride levels were significantly higher among type 2 diabetics, whereas mean eGFR was significantly higher in type 1. Glycaemic control in both groups was poor (glycated haemoglobin > 7%); however, the mean glycated haemoglobin was relatively higher in type 1 cases (Table 4).

A				Persistent albuminuria categories		
				Description and range		
				A1	A2	A3
				Normal to mildly increased	Moderately increased	Severely increased
				< 30 mg/g < 3 mg/mmol	30–300 mg/g 3–30 mg/mmol	> 300 mg/g > 30 mg/mmol
GFR categories (ml/min/1.73 m ²) Description and range	G1	Normal or high	≥ 90			
	G2	Mildly decreased	60–89			
	G3a	Mildly to moderately decreased	45–59			
	G3b	Moderately to severely decreased	30–44			
	G4	Severely decreased	15–29			
	G5	Kidney failure	< 15			

Figure 3. (A) KDIGO classification of CKD.

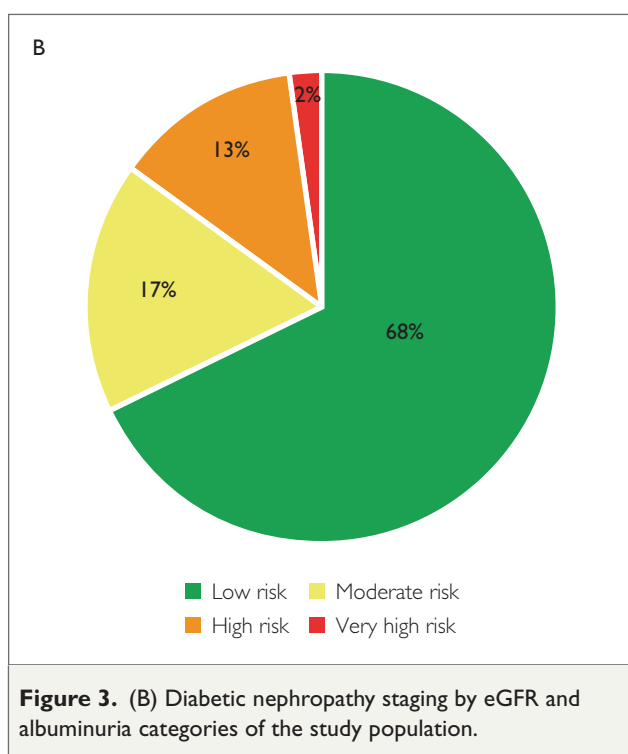


Figure 3. (B) Diabetic nephropathy staging by eGFR and albuminuria categories of the study population.

Dyslipidaemia was found in 81.2% of type 2 diabetic patients as compared to 65.5% of type 1 cases ($P < 0.05$). Triglyceride levels were significantly higher than the desired cut-off for those with type 2 than with type 1 (Table 5).

Sixty percent of type 2 diabetics were hypertensive whereas the prevalence was significantly lower in type 1 cases (20%). There was no significant difference between groups in respect of monthly income. However, a significantly

higher proportion of type 1 diabetics (82%) had attended education at secondary and higher levels.

The number of participants who were overweight and obese was significantly higher in type 2 (62%) than type 1 (32%) cases. The estimate of eGFR (>90 mL/min/1.73 m²) was significantly higher in type 1 diabetics (Table 6). However, no significant association was observed with respect to albuminuria, diabetic retinopathy and total cholesterol.

Among participants screened for diabetic retinopathy, 32% presented with the condition in various stages (20% in mild and 12% in moderate to severe form). The latter condition was significantly associated with advanced age (Table 6). Three-quarters of the study population with moderate and severe diabetic retinopathy had eGFR <60 mL/min/1.73 m².

Bivariate and multivariate analysis of factors associated with diabetic nephropathy

In the bivariate analysis, DN was significantly associated with age, diabetic retinopathy, triglyceride level, dyslipidemia, eGFR and albuminuria. Diabetic patients with reduced eGFR (<60 mL/min/1.73 m²) and with increased albuminuria had an odds chance of being presented with diabetic nephropathy of 4 and 11 times greater probability, respectively (Table 7).

In multivariate analysis, after adjusting for other factors, the only variables that were associated were educational status, presence of diabetic retinopathy and elevated triglyceride level. Diabetic patients with hypertriglyceridemia (≥ 150

Table 4. Lipid and glycaemic control between type 1 (n = 84) and type 2 (n = 256) diabetic patients.

Characteristic	Type of diabetes mellitus		P value
	Type 1	Type 2	
Age (years)	34.0 ± 13.1	57.4 ± 12.9	0.001
Body mass index (kg/m ²)	23.3 ± 4.3	26.8 ± 5.6	0.001
Duration of diabetes (years)	15.5 ± 7.5	12.1 ± 9.3	0.001
Total cholesterol (mg/dL)	168.2 ± 41.1	163.8 ± 44.7	0.371
LDL cholesterol (mg/dL)	90.9 ± 34.0	85.7 ± 39.0	0.322
HDL cholesterol (mg/dL)	50.4 ± 15.1	41.1 ± 11.9	0.001
Male	48.3 ± 16.0	38.8 ± 12.2	
Female	51.9 ± 14.4	42.7 ± 11.2	
Triglyceride (mg/dL)	134.9 ± 88.6	183.9 ± 125.1	0.001
TC:HDL ratio	3.6 ± 1.3	4.2 ± 1.6	0.001
Glycated haemoglobin (%)	9.3 ± 1.9	8.7 ± 5.2	0.001
eGFR (mL/min/1.73 m ²)	107.4 ± 24.6	88.8 ± 20.3	0.001

Abbreviations: Non-parametric Mann–Whitney test; results presented as mean ± standard deviation; LDL, low-density lipoproteins; HDL, high-density lipoproteins; eGFR, estimated glomerular filtration rate.

mg/dL) were 3.64 times more likely to develop DN. Similarly, those with diabetic retinopathy had a five times greater chance of being associated with DN (Table 7).

DISCUSSION

About 63% of the study population earned a monthly income below the per capita national average. This will create a problem of obtaining appropriate medications. Studies elsewhere show that monthly household income is inversely related to diabetic nephropathy prevalence rate. [23]

The median duration of diabetes was 11 years, with a longer history seen in type 1 diabetic patients (ranging from 1 to 40 years). Poor glycaemic control is associated with microvascular complications including diabetic nephropathy. Glycated haemoglobin greater than 7% was found in four out of five participants. Patient, physician and healthcare-related factors might contribute to poor glycaemic control, which in this study was defined by glycated haemoglobin greater than 7% and was not associated with diabetic nephropathy. This may indicate that other factors are better predictors than glycaemic control for DN. No one in the study population was using agents with renoprotective potential such as SGLT2 inhibitors. This may be related to the lack of availability of these agents in the hospital and their associated cost, which may not be affordable by the majority of patients.

Only half of the hypertensive cases (53%) had been using ACEIs, which are widely available in Ethiopia, either alone or in combination with other categories of anti-hypertensives medicines. There is a lack of prescription of these

agents in these circumstances. ACE inhibitors or ARBs have been found to delay the progress of diabetic nephropathy.

Dyslipidaemia was found in three-quarters of the participants even though only 40% of them were taking lipid-lowering agents. Although statins are widely available and affordable, the low use of these lipid-lowering agents indicates a lack of routine lipid assessment and management in this population.

Regarding the two indicators of nephropathy, 40% of the participants had mild to severely reduced eGFR and a quarter of them demonstrated moderate to severely increased albuminuria. About 32% of the study population were diagnosed with diabetic nephropathy corresponding to moderate to severely increased risk on the basis of a composite measure of eGFR and albuminuria. Cases of advanced CKD with eGFR <30 mL/min/1.73 m² were relatively few in this group, which may be due to increased CVD-associated death or some patients may only continue their renal clinic follow-up.

The prevalence of diabetic kidney disease in Africa ranges from 11% in Tunisia to 83.7% in Tanzania [21]. Proteinuria was found in 5.3% of diabetic patients in South Africa and in 53.1% in Cameroon [21]. Diabetic nephropathy using GFR criteria was seen in 4.6% of patients in Tanzania and 43.1% in Nigeria [21].

A study in Butajira in southern Ethiopia recorded 18.2% and 23.8% of diabetic patients with eGFR < 60 mL/min/1.73 m², based on MDRD and Cockcroft-Gault equation [24]. In the same study, 0.9% of patients had eGFR < 30 mL/min/1.73 m² [24]. In a systematic review conducted in Ethiopia, the prevalence of diabetic nephropathy

Table 5. Association of variables in respect of type 1 (n = 84) and type 2 (n = 256) diabetes.

Characteristic	Type of diabetes		P value
	Type 1 N (%)	Type 2 N (%)	
Glycated haemoglobin			
<7%	4 (4.8)	57 (22.3)	0.001
>7%	80 (95.2)	199 (77.7)	
Dyslipidaemia (biochemical result)			
No	29 (34.5)	48 (18.8)	0.004
Yes	55 (65.5)	208 (81.2)	
Dyslipidaemia (patient history)			
Yes	11 (13.1)	126 (49.2)	0.001
No	73 (86.9)	130 (50.8)	
Cholesterol total (mg/dL)			
<200	66 (78.6)	216 (84.4)	0.289
≥200	18 (21.4)	40 (15.6)	
High density lipoprotein (mg/dL)			
<40	63 (75.0)	128 (50.0)	0.001
≥40	21 (25.0)	128 (50.0)	
Triglyceride (mg/dL)			
<150	58 (69.0)	119 (46.5)	0.001
≥150	26 (31.0)	137 (53.5)	
Diagnosed with hypertension			
No	67 (79.8)	107 (41.8)	0.001
Yes	17 (20.2)	149 (58.2)	
Monthly income (Eth. birr)			
≤2,000	53 (63.1)	162 (63.3)	1.00
>2,000	31 (36.9)	94 (36.7)	
Education status			
Below secondary	15 (17.9)	93 (36.3)	0.003
Secondary & above	69 (82.1)	163 (63.7)	
Duration of diabetes (yr)			
≤10	27 (32.1)	140 (54.7)	0.001
>10	57 (67.9)	116 (45.3)	
BMI class (kg/m²)			
<25	52 (62.7)	98 (38.3)	0.001
≥25	31 (37.3)	158 (61.7)	
Diabetic nephropathy			
No	64 (76.2)	169 (66.0)	0.076
Yes	20 (23.8)	87 (34.0)	
Diabetic retinopathy (DR)			
No DR	37 (67.3)	121 (68.4)	0.083
Mild DR	15 (27.3)	31 (17.5)	
Moderate to severe DR	3 (5.4)	25 (14.1)	
eGFR (mL/min/1.73 m²)			
≥90	65 (77.4)	139 (54.3)	0.002
60–89	14 (16.7)	93 (36.3)	
45–59	4 (4.8)	15 (5.9)	
<45	1 (1.2)	9 (3.5)	
Albuminuria (mg/dL)			
<30	68 (81.0)	189 (73.8)	0.374
30–300	7 (8.3)	33 (12.9)	
>300	9 (10.7)	34 (13.3)	

Table 6. Association of variables with severity of diabetic retinopathy.

Variables	Diabetic retinopathy (DR) status			P value
	No DR N (%)	Mild DR N (%)	Moderate to severe DR N (%)	
Age (yr)				
≤35	28 (17.7)	7 (15.2)	1 (3.6)	0.012
36–50	45 (28.5)	19 (41.3)	5 (17.9)	
51–65	60 (38.0)	12 (26.1)	10 (35.7)	
>65	25 (15.8)	8 (17.4)	12 (42.9)	
eGFR (mL/min/1.73 m²)				
<60	149 (94.3)	38 (82.6)	21 (75.0)	0.004
≥60	9 (5.7)	8 (17.4)	7 (25.0)	
Albumin level in urine				
Normoalbuminuric	128 (81.0)	33 (71.7)	21 (75.0)	0.007
Microalbuminuria	18 (11.4)	1 (2.2)	4 (14.3)	
Macroalbuminuria	12 (7.6)	12 (26.1)	3 (10.7)	
Duration of diabetes (yr)				
≤10	79 (50.0)	16 (34.8)	1 (3.6)	0.001
>10	79 (50.0)	30 (65.2)	27 (96.4)	
Age (yr) †	51.07 + 14.85 ^a	50.60 + 17.75 ^a	63.80 + 16.32 ^b	0.001
Duration of diabetes (yr) †	12.37 + 7.70 ^a	16.04 + 9.60 ^b	21.96 + 8.65 ^c	0.001
eGFR (mL/min/1.73 m²) †	94.11 + 21.02 ^a	92.49 + 27.11 ^a	78.47 + 19.42 ^b	0.003

Chi-squared test of association; †non-parametric ANOVA (Kruskal–Wallis test) given by mean ± SD where different superscript letters across the row represent statistically significant differences.

was estimated to range from 15.7% to 32% [25]. A study performed in Gonder, a city in northern Ethiopia, in 1997, recorded the frequency of microalbuminuria in type 1 and type 2 diabetic patients as 32% and 37%, respectively [26]. Macroalbuminuria was observed in 15% of type 1 and 20% of type 2 diabetics [26].

Despite poor glycaemic control as seen in both type 1 and type 2 diabetics, mean eGFR was significantly higher in type 1 cases. This may be associated with the longer duration of diabetes and the number of additional risk factors in type 2 diabetics. The better educational status recorded in type 1 diabetics may have affected their health-seeking behaviour.

The principal determinants of diabetic nephropathy worldwide are advanced age, male gender, smoking, low level of physical activity, high cholesterol, hypertension, and duration of DM over 10 years [4,5]. In northern Ethiopia, a case-control study showed that the major determinants of DM nephropathy were age, weight, poor glycaemic control, systolic blood pressure and non-adherence to self-monitoring glucose [27]. In Gonder, the major predictors of DM nephropathy were systolic hypertension and the duration of diabetes [26]. In southern Ethiopia, the major risk factors were greater age, longer duration of diabetes, family history of kidney disease, and poor glucose control [24]. In

our study, in the bivariate analysis, diabetic nephropathy was significantly associated with age, diabetic retinopathy, triglyceride level, dyslipidaemia, eGFR and albuminuria.

In the multivariate analysis, after adjusting for other factors, the only variables that were associated significantly with diabetic nephropathy were educational status, the presence of diabetic retinopathy and elevated triglyceride levels. Diabetic patients with hypertriglyceridemia (>150 mg/dL) are 3.64 times more likely to develop DN. Patients with diabetic retinopathy had a 5-times greater chance of presenting with diabetic nephropathy.

One of the limitations of this study is that we quantified albuminuria using an albumin dipstick, which may have low sensitivity and be prone to operator-dependent results. Another limitation is that we assessed albuminuria just once, which may overestimate the prevalence of diabetic nephropathy.

CONCLUSIONS

Diabetic nephropathy was present in nearly one-third of the diabetic patients we examined. Age, educational status, dyslipidaemia, the presence of diabetic retinopathy and elevated triglyceride levels were significant predictors of the

Table 7. Logistic regression analysis of factors associated with diabetic nephropathy.

Variables	Prevalence of		Bivariate analysis		Multivariate analysis	
	No DN N (%)	DN N (%)	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Age (yr)						
≤50	121 (51.9)	39 (36.4)	1			
>50	112 (48.1)	68 (63.6)	1.884 (1.177, 3.014)	0.008		
Education						
<Secondary	67 (28.8)	41 (38.3)	1			
≥Secondary	166 (71.2)	66 (61.7)	0.65 (0.401, 1.052)	0.079	0.320 (0.133, 0.774)	0.011
Type of diabetes						
Type 1	64 (27.5)	20 (18.7)	1			
Type 2	169 (72.5)	87 (81.3)	1.647 (0.936, 2.898)	0.081		
Diabetic retinopathy						
Absent	121 (74.7)	37 (52.9)	1			
Present	41 (25.3)	33 (47.1)	2.632 (1.462, 4.739)	0.001	5.321 (1.910, 14.822)	0.001
Triglyceride (mg/dL)						
<150	136 (58.4)	41 (38.3)	1			
≥150	97 (41.6)	66 (61.7)	2.257 (1.412, 3.607)	0.001	3.636 (1.261, 10.484)	0.017
Dyslipidaemia						
Absent	148 (63.5)	55 (51.4)	0.607 (0.382, 0.966)	0.034		
Present	85 (36.5)	52 (48.6)	1			
Hypertension						
Absent	125 (53.6)	49 (45.8)	1			
Present	108 (46.4)	58 (54.2)	1.370 (0.865, 2.169)	0.179		
Glycated haemoglobin (%)						
<7	44 (18.9)	17 (15.9)	1			
≥7	189 (81.1)	90 (84.1)	1.23 (0.667, 2.276)	0.504		
eGFR (mL/min/1.73 m²)						
<60	233 (100)	78 (72.9)	3.984 (3.289, 4.831)	0.001		
≥60	0 (0)	107 (27.1)	1			
Albuminuria						
No albuminuria	233 (100)	24 (22.4)	1			
Albuminuria	0 (0)	83 (77.6)	10.75 (7.30, 15.625)	0.001		

Abbreviation: OR, odds ratio.

condition. We found that half of the diabetic patients were hypertensive; however, the use of ACEIs and ARBs was less than optimal. Despite SGLT2 inhibitors and GLP-1 agonists able to confer renoprotective advantage, none of the patients was on these drugs. Therefore, any intervention that promotes the availability of renoprotective agents, including health insurance, could provide benefits in the circumstances reported here.

Because of the known association between cardiovascular disease and diabetic nephropathy, we recommend further studies and interventions to mitigate their combined effect.

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Conflicts of interest

The authors have none to report.

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