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Prevalence, patterns, and determinants of vascular complications of type 2 diabetes in a teaching hospital in Addis Ababa, Ethiopia: a retrospective study

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Abstract

Background Patients with type 2 diabetes mellitus (T2D) have an increased risk of vascular complications. Despite the rise in the prevalence of T2D and its complications throughout the globe, there is a paucity of data regarding the prevalence and determinants of vascular complications of T2D in Ethiopia. Hence, this study aimed to assess the prevalence, patterns, and determinants of the microvascular and macrovascular complications of T2D among adult patients attending a teaching hospital in Addis Ababa, Ethiopia.

Methods A retrospective study was done by reviewing the electronic health records of adult patients with T2D attending the general medical and endocrine referral clinics of Yekatit 12 Hospital Medical College, Addis Ababa, Ethiopia, from June 1, 2023, to November 30, 2023. Statistical Package for Social Sciences (SPSS), version 25, was used to analyze the data. Descriptive analysis was used to summarize the sociodemographic, clinical, and laboratory profiles as well as the patterns of vascular complications of T2D. Bivariate and multivariate logistic regression models were fitted, and the crude odds ratio (COR) and adjusted odds ratio (AOR), together with the 95% confidence interval (CI), were computed to identify the determinants of microvascular and macrovascular complications of T2D.

Results A total of 272 patients with T2D were included in this study; 50.5% were females, and the mean (± standard deviation) age was 56.3 ± 12.8 years. The majority of patients (62.5%) had diabetes for ≥ 5 years. More than half (51.5%) had poor glycemic control with glycated haemoglobin (HbA1c) value of ≥ 7%. The overall prevalence of vascular complications was 39%. The prevalence of microvascular complications was 23.5%, the most common being neuropathy (11.8%), and the prevalence of macrovascular complications was 21%, the most common being coronary artery disease (12.1%). The determinants of microvascular complications were age ≥ 60 years (AOR = 2.25, 95% CI: 1.17, 4.33), diabetes duration of ≥ 5 years (5–10 years [AOR = 3.13, 95% CI: 1.37, 7.18], and > 10 years [AOR = 3.88, 95% CI: 1.66, 9.06], and HbA1c value of ≥ 7% (AOR = 2.21, 95% CI: 1.14, 4.28). The odds of developing macrovascular complications were higher with diabetes duration of ≥ 5 to 10 years (AOR = 2.89, 95% CI: 1.37, 6.12) as compared with diabetes duration of < 5 years.

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Conclusions This study demonstrated a high prevalence of microvascular and macrovascular complications in adult patients with T2D. Older age, prolonged duration of diabetes, and poor glycemic control were identified as the determinants for the development of microvascular complications of T2D, while prolonged duration of diabetes was the determining factor for the development of macrovascular complications. Hence, targeted initiatives are required to enhance the prevention and early detection of vascular complications of T2D in resource-limited countries like Ethiopia.

Keywords Type 2 diabetes, Vascular complications, Microvascular complications, Macrovascular complications, Ethiopia

Introduction

According to the International Diabetes Federation report in 2021, an estimated 537 million adults aged 20–79 years, representing 10.5% of the world's population, were living with diabetes mellitus, and this was predicted to increase to 643 million (11.3%) by 2030 and to 783 million (12.2%) by 2045 [1]. A systematic analysis of the Global Burden of Disease study in 2015 indicated that diabetes mellitus, together with respiratory disorders, cancer, and cardiovascular disease (CVD), was responsible for over 80% of all early deaths from non-communicable diseases [2].

Patients with type 2 diabetes mellitus (T2D) are more likely to develop microvascular complications (retinopathy, nephropathy, and neuropathy) and macrovascular complications (stroke, coronary artery disease [CAD], and peripheral arterial disease [PAD]) [3, 4]. Based on data from the DISCOVER study program, with 38 participating countries, the crude prevalence of microvascular and macrovascular complications of T2D was 18.8% and 12.7%, respectively [5]. According to this study, the most common macrovascular complications were CAD (8.2%), heart failure (3.3%), and stroke (2.2%), while the most common microvascular complications were peripheral neuropathy (7.7%), chronic kidney disease (5.0%), and albuminuria (4.3%) [5]. Based on the World Health Organization (WHO) mortality database in 108 selected countries between 2000 and 2016, there was a report of 1,904,787 diabetes-related deaths that were attributed to vascular complications (26.8%) [6].

According to a systemic review and meta-analysis that included studies primarily from east African nations, adult T2D populations in Africa had significant rates of diabetic peripheral neuropathy (38%) and retinopathy (32%) [7]. According to a study conducted in Kenya, the overall prevalence of microvascular complications of diabetes was 36.6%, peripheral neuropathy being the most prevalent, affecting 27.4% of the patients [8]. Another study conducted in Sudan revealed that 45.9% of T2D patients had any of the microvascular complications, nephropathy being the most common, with a prevalence rate of 38.8% [9].

Ethiopia is currently facing an increasing challenge from non-communicable disease, including diabetes, and according to the national WHO steps survey conducted in 2015, 3.2% of people had diabetes [10, 11]. According to different studies done in Ethiopia, a significant number of T2D patients had vascular complications. A cross-sectional study of 1,158 patients with T2D from 10 general hospitals in the Tigray region found that 54% had at least one vascular complication, the most common being retinopathy (22.6), and the others being nephropathy (19.2%), and peripheral neuropathy (11.4%) [12]. A retrospective cohort study conducted at Felege Hiwot Referral Hospital reported that the prevalence of vascular complications in T2D was 23.3% [13], and a cross-sectional study of 335 T2D patients in Dessie town hospitals found that 37.9% had microvascular complications (37.9%), the most common being retinopathy (24.8%) [14].

Factors such as poor glycaemic control, old age, and prolonged duration of diabetes were consistently reported to be associated with vascular complications of T2D. A prospective hospital-based study in India showed that the risk of complications of T2D significantly increased with patients' age, duration of diabetes, fasting blood glucose (FBG) and low-density lipoprotein cholesterol (LDL-C) levels [15]. A study done in the Kingdom of Saudi Arabia revealed that increasing age, longer duration of diabetes, and higher glycated hemoglobin (HbA1c) values were found to be predictors of vascular complications of T2D [16]. A study done at a tertiary care hospital in Sri Lanka showed that age>60 years, duration of diabetes for >10 years, and HbA1c value of >7% were risk factors for microvascular complications, while age>60 years was the only risk factor for macrovascular complications [17]. A cross-sectional study in Dessie Town hospitals found that age 60–87 years, diabetes duration for >5 years, and high blood pressure (BP) were all strong predictors of developing microvascular complications of T2D [14].

Despite the rise in the prevalence of T2D and its complications throughout the globe, there is a paucity of data regarding the prevalence and determinants of vascular complications of T2D in Ethiopia, with poor attention given to the macrovascular complications. Hence, this study aimed to assess the prevalence, patterns, and determinants of microvascular and macrovascular

complications of T2D among patients attending a teaching hospital in Addis Ababa, Ethiopia.

Methods and materials

Study design, area, and period

This was a retrospective study on the prevalence, patterns, and determinants of vascular complications among adult T2D patients attending the general medical and endocrine referral clinics of Yekatit 12 Hospital Medical College from June 1, 2023, to November 30, 2023. The data were collected by reviewing the patients' electronic health records (EHRs). Yekatit 12 Hospital Medical College is one of the largest public teaching hospitals in Addis Ababa, Ethiopia, providing both academic and clinical services. It has eight medical education programs, 40 medical services, and more than 300 expert doctors. The hospital has different specialty and subspecialty clinics, one of which is the endocrine subspecialty clinic, where most of the patients with endocrine disorders, including diabetic patients with uncontrolled glycaemia and complications, are followed by endocrinologists twice a week.

Source and study population

All adult patients (≥18 years old) with T2D who were on follow-up at the public hospitals in Addis Ababa, Ethiopia, were the source population. All patients with T2D who were on follow-up at the general medical and endocrine referral clinics of Yekatit 12 Hospital Medical College, Addis Ababa, Ethiopia, in the study period were the study population.

Sample size and sampling technique

The sample size (n) was determined by using the following single population proportion formula, considering a 23.3% proportion (p) of vascular complications of T2D from a previous study [13], a 95% confidence level of $Z\alpha/2=1.96$, and a 5% margin of error (d).

$n = [(Z_{\alpha/2})^2 \times p\ (1-p)]/d^2 = [(1.96)^2 \times 0.23\ (1-0.23)]/(0.05)^2 = 272$.

The minimum sample size was calculated to be 272, and by adding 10% for the probability of getting incomplete data, the final sample size was 299. All patients with T2D who have been on follow-up at Yekatit 12 Hospital Medical College and who fulfilled the eligibility criteria were included in the study via convenience sampling technique.

Study variables

The dependent variables were the prevalence of microvascular and macrovascular complications of T2D. Independent variables were sociodemographic data (age, sex, and marital status), medical history (duration of diabetes, types of medications, presence of hypertension [HTN], presence of dyslipidemia), clinical characteristics (systolic BP, diastolic BP, and body mass index [BMI]), and laboratory findings (FBG, HbA1c, LDL-C, creatinine, dipstick proteinuria, and 24-hour urine protein).

Eligibility criteria

All T2D adult patients (≥18 years old) who were attending the general medical and endocrine referral clinics of Yekatit 12 Hospital Medical College, Addis Ababa, Ethiopia, during the study period with complete documentation of essential data were eligible to be included in the study. Patients who were diagnosed with type 1 diabetes or gestational diabetes were excluded from the study.

Data collection method

A well-structured data abstraction tool was used to extract patients' data from their EHRs. Data collection was done by three general practitioners, who were trained by the principal investigator on how to extract data from the EHRs. Sociodemographic data, medical history, clinical characteristics, and laboratory findings were all extracted from EHRs and documented in the data abstraction forms.

Data quality control technique

The quality of the data was ensured through training of the data collectors, close supervision, and prompt feedback. To verify the completeness of the data abstraction form, a pre-test was conducted among 5% of the patients in the study area. The data were checked for clarity, completeness, accuracy, and missing values, and appropriate corrections were made by the principal investigator.

Data processing, interpretation, and analysis

Statistical Package for Social Sciences (SPSS), version 25, was used to enter and analyze the data. Descriptive analysis was used to summarize the sociodemographic, clinical and laboratory profiles as well as the patterns of vascular complications of T2D. Continuous variables were presented as mean ± standard deviation (SD) when normally distributed or median with interquartile range (IQR) when not normally distributed. Categorical variables were presented as frequencies and percentages. Bivariate and multivariate logistic regression models were fitted, and the crude odds ratio (COR) and adjusted odds ratio (AOR), together with the 95% confidence interval (CI), were computed to identify the determinants of vascular complications of T2D. The model assumptions were fulfilled based on the Hosmer-Lemeshow test, where the *P* values were 0.620 and 0.082 in the multivariate logistic regression analyses used to identify the determinants of microvascular and macrovascular complications of T2D, respectively. Those variables with a *P* value < 0.25 in the bivariate logistic analyses were subsequently used in the

multivariate analyses, and a two-tailed *P* value < 0.05 was regarded as statistically significant.

Operational definitions

Microvascular complication was defined by the presence of one or more of the complications, namely, nephropathy, retinopathy, or peripheral neuropathy, due to known or newly diagnosed T2D [4].

Macrovascular complication was defined by the presence of one or more of the complications, namely, CAD, stroke, or PAD, due to known or newly diagnosed T2D [4].

Diabetic nephropathy was defined by persistent albuminuria or proteinuria for at least three months and a progressive decline in renal function in patients with diabetes, with co-existing retinopathy and no evidence of alternative kidney disease [18].

Diabetic retinopathy was defined based on the results of a dilated eye examination performed by an ophthalmologist, with findings ranging from mild non-proliferative abnormalities or increased numbers of microaneurysms to the formation of new blood vessels on the retina and posterior surface of the vitreous [19].

Diabetic neuropathy was defined by the presence of symptoms and/or signs of peripheral nerve disease (sensory symptoms like numbness or burning pain and/or decreased sensation predominantly in the toes or feet) in patients with diabetes after exclusion of other causes [20].

CAD was defined by the presence of clinical (angina pectoris or anginal equivalents) and imaging (electrocardiogram, and/or echocardiography) evidences of myocardial ischaemia or infarction [21].

Stroke (cerebrovascular disease) was defined by the presence of a neurological deficit due to an acute focal injury of the central nervous system by a vascular cause, including cerebral infarction, intracerebral hemorrhage, and subarachnoid hemorrhage, all of which were confirmed by brain imaging [22].

PAD was defined by the presence of narrowing of peripheral arteries due to atherosclerosis diagnosed by clinical examination and arterial Doppler ultrasound [23].

Glycemic control level was defined by HbA 1c level; good glycemic control was defined by HbA1c value of <7%, and poor glycemic control was defined by HbA1c value of ≥7% [24].

HTN was defined by systolic BP ≥ 130 mmHg or diastolic BP ≥ 80 mmHg [25], or a previous diagnosis of HTN.

Target LDL-C level was defined by an LDL-C level of <70 mg/dL for T2D patients who were ≥40 years old and on statin for the primary prevention of CVD, and an LDL-C level of <55 mg/dL for those who were on statin for the secondary prevention of CVD events after developing CVD at any age [25].

Dyslipidemia was defined by any of the following abnormalities: Total cholesterol ≥ 200 mg/dL; an LDL-C ≥ 130 mg/dL; triglycerides ≥ 150 mg/dL; high-density lipoprotein cholesterol (HDL-C) ≤ 40 mg/dL in males and ≤ 50 mg/dL in females [26] or a previous diagnosis of dyslipidemia.

Results

Socio-demographic and clinical characteristics of T2D patients

There were a total of 289 adult patients with a diagnosis of T2D in the study period, and of these, 272 (94.1%) were eligible and included for analysis, and female patients accounted for 50.5%. The mean (± SD) age was 56.3 ± 12.8 years, with an age range from 30 to 92 years, and 42.6% were elderly (≥60 years old). Most of the patients (86%) were married. The majority of patients (62.5%) had diabetes for ≥5 years. There was a high prevalence of HTN (73.2%) among patients with T2D, and 51.8% had dyslipidemia. The mean (± SD) systolic BP and diastolic BP were 130 ± 18.6 and 76.5 ± 10.8 mmHg, respectively. Of all patients, 26.5% had obesity (BMI ≥ 30 kg/m2) [Table 1].

Laboratory findings of T2D patients

The median (IQR) FBG level was 129 (112–151) mg/dl; the mean HbA1c (±SD) value was 7.7 ± 1.9%; and more than half (51.5%) had poor glycemic control (HbA1c value of ≥7%). The median (IQR) serum creatinine value was 0.73 (0.56–0.90); and 10.3% had renal impairment (estimated glomerular filtration rate [eGFR] < 60 mL/min/1.73m2 using the CKD-EPI equation). Only 10.7% of the patients had proteinuria on dipstick urine examination, and 9.9% had a determination of 24-hour urine protein with a median (IQR) value of 481.4 (345–979) mg/24 hours. The median (IQR) LDL-C value was 78.0 (58.6–98.0) mg/dL, and of 212 patients for whom statins were prescribed with clear indications, 72.2% had met target LDL-C values [Table 1].

Prescription patterns for T2D patients

Regarding the prescription patterns of anti-diabetic regimens for T2D patients, the most commonly prescribed medications were oral anti-diabetic agents (56.2%), followed by a combination of insulin and oral anti-diabetic agents, and the least prescribed was insulin. Many of the patients (83.1%) were on statins. However, there were few patients (6.2%) that were potential candidates but were not prescribed with statins. Less than half (46%) of the patients used ACEIs or ARBs, and 29.8% of them were taking aspirin [Fig. 1].

Table 1 Socio-demographic, clinical, and laboratory profiles of T2D patients attending Yekatit 12 Hospital Medical College, Addis Ababa, Ethiopia, from June 1, 2023, to November 30, 2023

Characteristics	Category	Frequency (*N*)	Percentage (%)
Age (years)	≥60	116	42.6
	<60	156	57.4
Sex	Female	137	50.4
	Male	135	49.6
Marital status	Unmarried	12	14.0
	Married	234	86.0
Duration of diabetes (years)	>10	79	29.0
	5–10	91	33.5
	<5	102	37.5
BMI category (kg/m^2)	≥30	72	26.5
	<30	200	73.5
HTN	Yes	199	73.2
	No	73	26.8
Dyslipidemia	Yes	141	51.8
	No	131	48.2
HbA1c (%)	≥7	140	51.5
	<7	132	48.5
LDL-C in target (*n*=212)	Yes	153	72.2
	No	59	27.8
eGFR (mL/min/1.73m2)	<60	28	10.3
	≥60	244	89.7
Dipstick proteinuria	Yes	29	10.7
	No	243	89.3

BMI, body mass index; eGFR, estimated glomerular filtration rate; HbA1c, glycated hemoglobin; HTN, hypertension; LDL-C, low-density lipoprotein cholesterol; T2D, type 2 diabetes

Prevalence and patterns of vascular complications of T2D

Of 272 patients with T2D, 39% had at least one of the microvascular and/or macrovascular complications, and 5.5% had both microvascular and macrovascular complications. Of all patients, 23.5% had at least one of the microvascular complications, the most common being neuropathy (11.8%). Of all patients, 21% had at least one of the macrovascular complications, the most common being CAD (12.1%) [Fig. 2].

Determinants of microvascular complications of T2D

In the bivariate regression analysis, age≥60 years (COR=2.44, 95% CI: 1.37, 4.32, *P* value=0.002), being unmarried (COR=2.15, 95% CI: 1.04, 4.45, *P* value=0.040), diabetes duration of 5–10 years (COR=3.48, 95% CI: 1.57, 7.75, *P* value=0.002) or >10 years (COR=5.34, 95% CI: 2.41, 11.84, *P* value<0.001), HbA1c value of ≥7% (COR=2.57, 95% CI: 1.42, 4.65, *P* value=0.002), and systolic BP (COR=1.02, 95% CI: 1.01, 1.04, *P* value=0.009) were factors significantly associated with microvascular complications of T2D [Table 2].

In the multivariate regression analysis, age≥60 years, diabetes duration of ≥5 years, and HbA1c value of ≥7% were the determinants of microvascular complications of T2D. The odds of developing microvascular complications were 2.25 times higher among T2D patients with the age of ≥60 years compared to those with the age of <60 years (AOR=2.25, 95% CI: 1.17, 4.33, *P* value=0.015). The odds of developing microvascular complications were 3.13 times higher among T2D patients with diabetes duration of 5–10 years (AOR=3.13, 95% CI: 1.37–7.18, *P* value=0.007) and 3.88 times higher in those with diabetes duration>10 years (AOR=3.88, 95% CI: 1.66, 9.06, *P* value=0.002) compared to those with diabetes duration<5 years. The odds of developing microvascular complications were 2.21 times higher among T2D patients with a HbA1c value of ≥7% as compared with those with HbA1c value of <7% (AOR=2.21, 95% CI: 1.14, 4.28, *P* value=0.019) [Table 2].

Determinants of macrovascular complications of T2D

In the bivariate logistic regression analysis, being unmarried (COR=2.25, 95% CI: 1.07, 4.74, *P* value=0.034) and diabetes duration of 5–10 years (COR=2.89, 95% CI: 1.38, 6.03, *P* value=0.005) were significantly associated with the development of macrovascular complications of T2D. In the multivariate analysis, the duration of diabetes was the determining factor for the development of macrovascular complications. The odds of developing macrovascular complications were 2.89 times higher in T2D patients with diabetes duration of 5–10 years as compared with those with diabetes duration of <5 years (AOR=2.89, 95% CI: 1.37, 6.12, *P* value=0.005) [Table 3].

Discussion

The socio-demographic characteristics of T2D patients observed in this study had similarities with those in other studies. Of 272 T2D patients in this study, about half (50.4%) were females, and the mean age of the patients was 56.3±12.8 years. In line with these findings, the Middle East and Africa (MEA) cohort of the 3-year prospective DISCOVER study revealed that nearly half (47.5%) were females, and the mean age of patients was 54.3±10.8 years [27]. Likewise, similar trends were seen in a study done in Tikur Anbessa Specialized Hospital (TASH), where the mean age of patients was 58±11.2 years, albeit with a slight female predominance (57%) [28]. This implies that T2D mainly affects middle-aged individuals without a remarkable gender predilection.

There was a high prevalence of HTN (73.2%) among patients with T2D in this study, which was consistent with that of the study done at TASH, where HTN was seen in 69% of T2D patients [28]. However, the prevalence of HTN in the present study was much higher than that of the studies done in a tertiary hospital in northeast

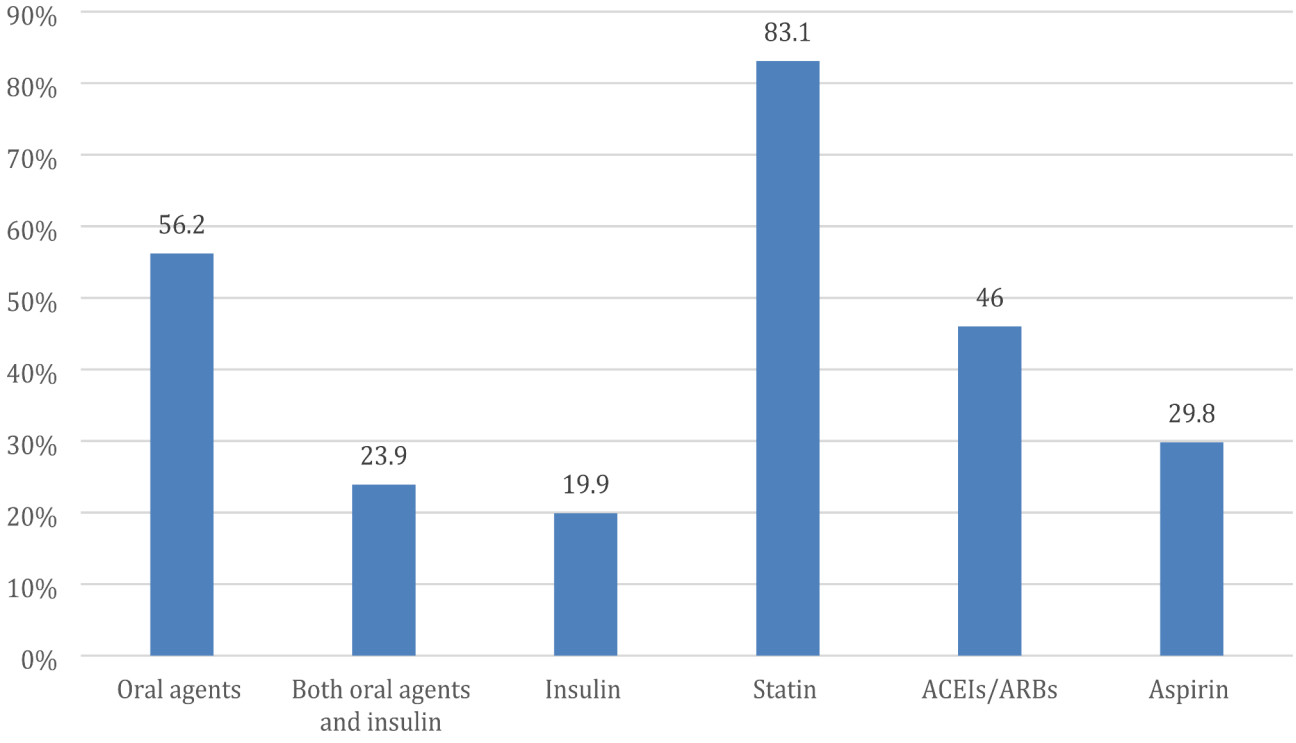

Fig. 1 Prescription patterns of anti-diabetic agents and other medications for T2D patients attending Yekatit 12 Hospital Medical College, Addis Ababa, Ethiopia, from June 1, 2023, to November 30, 2023. ACEis, angiotensin-converting enzyme inhibitors; ARBs, angiotensin receptor blockers

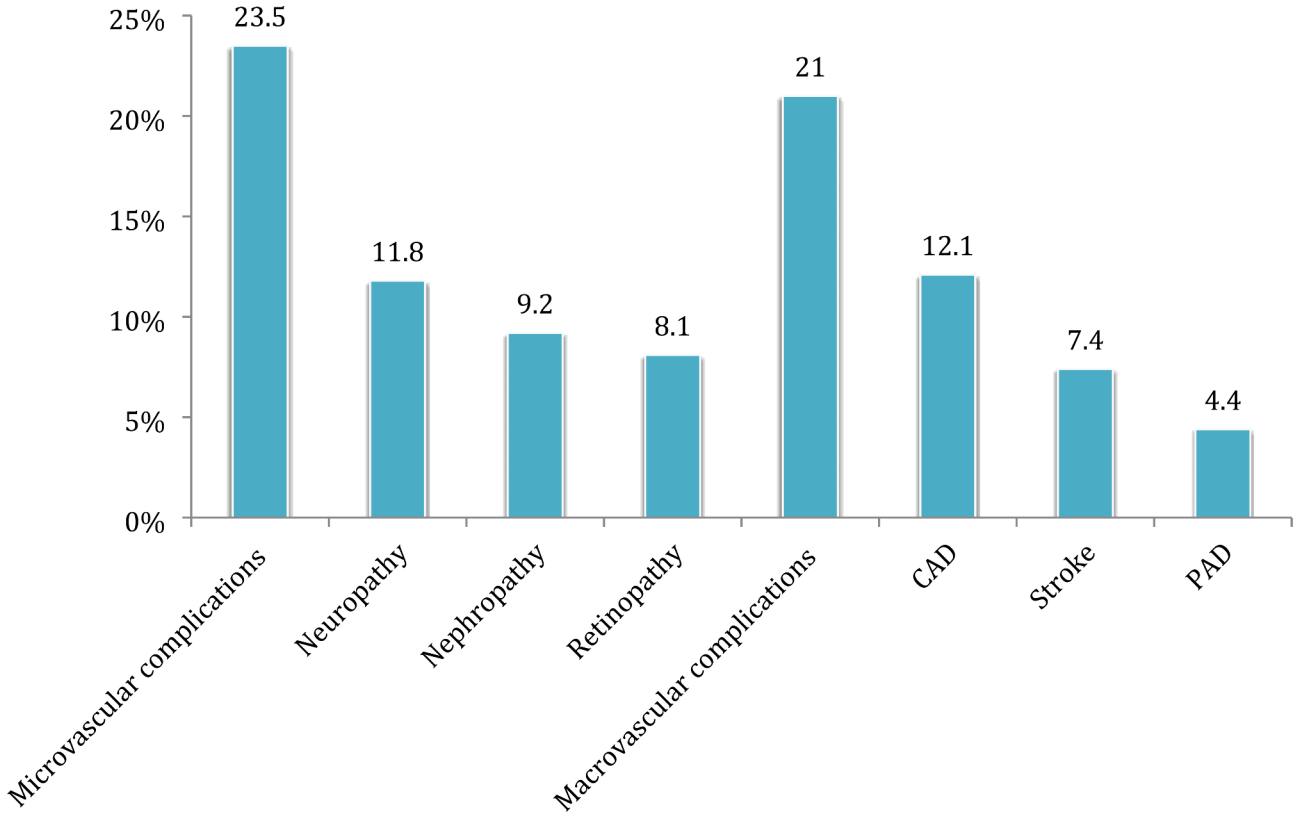

Fig. 2 Patterns of vascular complications of T2D among patients attending Yekatit 12 Hospital Medical College, Addis Ababa, Ethiopia, from June 1, 2023, to November 30, 2023. CAD, coronary artery disease; PAD, peripheral arterial disease

Table 2 Bivariate and multivariate regression analysis to identify the determinants of microvascular complications of T2D among patients attending Yekatit 12 Hospital Medical College, Addis Ababa, Ethiopia, from June 1, 2023, to November 30, 2023

Characteristics	Microvascular complications		Bivariate analysis		Multivariate analysis	
	Yes	No	COR	95% CI	AOR	95% CI
Age (years)						
≥60	38	78	2.44	(1.37, 4.32)*	2.25	(1.17, 4.33)*
<60	26	130	1		1	
Marital status						
Unmarried	14	24	2.15	(1.04, 4.45)*	2.19	(0.99, 4.89)
Married	50	184	1		1	
Duration of diabetes						
>10	29	50	5.34	(2.41, 11.84)*	3.88	(1.66, 9.06)*
5–10	25	66	3.48	(1.57, 7.75)*	3.13	(1.37, 7.18)*
<5	10	92	1		1	
HbA1c						
≥7%	44	96	2.57	(1.42, 4.65)*	2.21	(1.14, 4.28)*
<7%	20	112	1		1	
BMI (kg/m^2)			1.04	(0.98, 1.09)	1.02	(0.96, 1.09)
Systolic BP (mmHg)			1.02	(1.01, 1.04)*	1.01	(0.99, 1.03)
Diastolic BP (mmHg)			0.62	(0.35, 1.09)	1.011	(0.98, 1.05)

*P value < 0.05. AOR, adjusted odds ratio; BMI, body mass index; BP, blood pressure; CI, confidence interval; COR, crude odds ratio; HbA1c, glycated hemoglobin; T2D, type 2 diabetes

Table 3 Bivariate and multivariate regression analysis to identify the determinants of macrovascular complications of T2D among patients attending Yekatit 12 Hospital Medical College, Addis Ababa, Ethiopia, from June 1, 2023, to November 30, 2023

Characteristics	Macrovascular complications		Bivariate analysis		Multivariate analysis	
	Yes	No	COR	95% CI	AOR	95% CI
Marital status						
Unmarried	13	25	2.25	(1.07, 4.74)*	2.10	(0.98, 4.53)
Married	44	190	1		1	
Duration of diabetes						
>10	17	62	1.88	(0.85, 4.14)	2.06	(0.92, 4.61)
5–10	27	64	2.89	(1.38, 6.03)*	2.89	(1.37, 6.12)*
<5	13	89	1		1	
Systolic BP (mmHg)			0.98	(0.96, 1.00)	0.98	(0.96, 1.00)

*P value < 0.05. AOR, adjusted odds ratio; BP, blood pressure; CI, confidence interval; COR, crude odds ratio; T2D, type 2 diabetes

Ethiopia (43.3%) [29] and Jimma University Specialized Hospital (24.9%) [30], both of which included type 1 and type 2 diabetes. The higher proportion of HTN among T2D patients in the present study as compared to the latter studies might be due to differences in the patients' characteristics, mainly the type of diabetes.

In this study, more than half of the patients with T2D (51.5%) had poor glycemic control, and the majority (56.2%) were prescribed oral antidiabetic agents, whereas in the study from Dessie Town hospitals, most T2D patients (85.7%) had poor glycemic control, and the majority (66.6%) were prescribed oral antidiabetic agents [14]. Similarly, in a study from TASH, 69.1% of T2D patients had poor glycemic control, and the most commonly used antidiabetic treatment regimen was the combination of metformin and insulin, prescribed for 37.5% of the patients [28]. This underscores the presence of an unmet need of glyacemic control among T2D patients and the need to optimize the prescription of anti-diabetic regimens along with diabetes education on drug adherence and lifestyle changes.

In the current study, 39% had at least one microvascular or macrovascular complication of T2D, and this figure was lower than that reported in a single-center retrospective study from Cameroon (70%) [31] and 10 general hospitals in the Tigray region (54%) [12], but it was higher than the finding reported from the studies done in Felege Hiwot Hospital (23.3%) [13] and University of Gondar Referral Hospital (28%) [32]. The wide variations in the prevalence of vascular complications of T2D in these studies might be explained by differences in the underlying sociodemographic and clinical characteristics of the patients as well as the diagnostic modalities used to detect the complications.

The prevalence of microvascular complications of T2D (23.5%) in the present study was lower than that

reported in studies from other countries, including the USA (77%) [33], Brazil (41.6%) [34], China (57.5%) [35], India (48%) [36], Ghana (35.3%) [37], and Nigeria (50%) [38]. It was also lower than findings from local studies conducted in various regions of Ethiopia, including Dessie Town hospitals (37.9%) [14], Gurage zone (61%) [39], and Jimma University Hospital (41.5%) [40], though it was higher than that of the study done at the University of Gondar Hospital (20.4%) [41]. Neuropathy (11.8%) was the most common microvascular complication in the current study, followed by nephropathy, and the least common was retinopathy. A similar pattern was observed in studies from India and Nigeria, though with a higher prevalence rate of neuropathy seen in 37% and 69.6% of the patients, respectively [36, 38]. The wide variations in the prevalence of the microvascular complications of T2D among these studies may be explained by the heterogeneity of patient characteristics and differences in the screening methods used to diagnose these complications.

The prevalence of macrovascular complications of T2D in this study was 21%, which was higher than that of the studies from Saudi Arabia (12.1%) [16], Sri Lanka (13.7%) [17], but lower than that of the studies from South India (29.7%) [42], Yemen (25.4%) [43], and South Africa (56%) [44]. CAD (12.1%) was the leading macrovascular complication in the present study, consistent with that of the studies from Sri Lanka (10.6%) [17], South India (15.1%) [42], and Yemen (17.8%) [43]. The present study found that PAD (4.4%) was the least common macrovascular complication; however, it was the commonest macrovascular complication according to studies done in South India (15.1%) [42], Tigray (9%) [12], and TASH (5.8%) [45]. The lowest prevalence rate of PAD in the present study may be explained by the unavailability of the ankle-brachial index, the first-line diagnostic test for PAD, contributing to a lower rate of screening and diagnosis.

The present study revealed that age≥60 years, diabetes duration of >5 years, and HbA1c value of ≥7% were significantly associated with microvascular complications of T2D, and this was consistent with the findings of the studies done in Dessie Town hospitals, Ethiopia [14], Sri Lanka [17], and a tertiary health care hospital in India [36]. Likewise, poor glycemic control and longer duration of diabetes in a study from Saudi Arabia [16] and increasing age and duration of diabetes in a study from Nigeria [39] were strongly associated with the development of microvascular complications. Hypertension and dyslipidemia were not associated with microvascular complications in the present study unlike the other studies from Dessie town and Gurage zone hospitals in Ethiopia [14, 39]. Therefore, T2D patients with older age, prolonged duration of diabetes, and/or poor glycemic control require close monitoring for the prevention and early detection of microvascular complications.

Diabetes duration of 5–10 years was significantly associated with the development of macrovascular complications of T2D in the present study, which was consistent with the studies from Saudi Arabia [16] and Yemen [43]. Unlike the present study, poor glycemic control was associated with a higher prevalence of macrovascular complications in a study from Saudi Arabia [16], and age was strongly associated with the overall prevalence of macrovascular complications in studies from Yemen [43] and Sri Lanka [17]. The present study highlights the importance of diabetes duration, more than glycemic control, as a determining factor for the development of macrovascular complications. Hence, a very low threshold is required to screen T2D patients for macrovascular complications starting from the time of diagnosis of T2D, with particular emphasis on those with a prolonged diabetes duration.

There are certain limitations to this study. First, the accuracy of the EHRs of the patients might affect the reliability of the results of this study. Second, the prevalence of some vascular complications, particularly diabetic neuropathy and PAD, might be underestimated in the current study due to the limited access or unavailability of screening methods like monofilament testing and the ankle-brachial index. Finally, because of the cross-sectional nature of the study, a definite causal relationship between the determining factors and the vascular complications of T2D cannot be established.

Conclusions

This study demonstrated a high prevalence of microvascular and macrovascular complications in patients with T2D. Older age, prolonged duration of diabetes, and poor glycemic control were identified as the determinants for the development of microvascular complications of T2D, while prolonged duration of diabetes was the determining factor for the development of macrovascular complications. Hence, targeted initiatives are required to enhance the prevention and early detection of vascular complications of T2D in resource-limited countries like Ethiopia.

Abbreviations

BMI	Body mass index
BP	Blood pressure
CAD	Coronary artery disease
CVD	Cardiovascular disease
FBG	Fasting blood glucose
HbA1c	Glycated hemoglobin
HTN	Hypertension
LDL-C	Low-density lipoprotein cholesterol
PAD	Peripheral artery disease
SD	Standard deviation
T2D	Type 2 diabetes mellitus
WHO	World Health Organization

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Author contributions
GS was involved in the conceptualization and design of the study, data analysis, and edition of the manuscript. HA, HZ, and AW were involved in the conceptualization of the study, data analysis, and drafting of the initial manuscript. BL was involved in the data analysis and edition of the manuscript. The authors read and approved the final manuscript.

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Data availability
All data generated or analyzed in this study are included in this manuscript.

Declarations

Ethics approval and consent to participate
The Institutional Review Board of Yekatit 12 Hospital Medical College (Ref No. RPO/474/23) granted ethical approval to conduct this study and waived the need for consent because only anonymized patients' data were collected retrospectively from EHRs.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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