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Research Article

Prevalence of Diabetic Retinopathy and Associated Factors among Type 2 Diabetes Patients at Tikur Anbessa Hospital, Ethiopia

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ABSTRACT

Background: Diabetic retinopathy is a complication of type 2 diabetes resulting from long-term accumulated damage to retinal blood vessels. It is one of the leading causes of preventable blindness in adults with type 2 diabetes. The purpose of this study was to assess the prevalence of diabetic retinopathy and associated factors among type 2 diabetes patients visiting Tikur Anbessa Hospital in Addis Ababa, Ethiopia.

Methods: A cross-sectional study was conducted from March to April 2018. Data was collected using semi-structured questionnaire and direct eye examination with Topcon Retinal Camera. Data was analyzed using SPSS for Windows version 22. Logistic regression models were used to identify predictors of diabetic retinopathy. Statistical significance was determined using odds ratio with 95% confidence interval.

Result: A total of 191 type 2 diabetes patients, mean age of 57 ± 10.1 years, participated in this study. From this, 98 (51.3%) had diabetic retinopathy. Multiple logistic regression model revealed that male were about 11 times (AOR=11.248, 95%CI=1.816, 69.689) more likely to have diabetic retinopathy. Participants who visited diabetes clinic every month were about 37 times (AOR=0.027, 95%CI=0.003, 0.0253), those with HbA1c ≤ 7% were 10 times (AOR=0.099, 95%CI=0.020, 0.485), and those without comorbid hypertension were 31.3 times (AOR=0.032, 95%CI=0.006, 0.167) less likely to have diabetic retinopathy. There was a 1.13 times increase in prevalence of diabetic retinopathy for a 1 year increase in the type 2 diabetes duration (AOR=1.126, 95%CI=1.022, 1.242).

Conclusion: Our study showed the prevalence of diabetic retinopathy was 51.3%. Male sex, clinic visits every 6 months, longer duration of diabetes, HbA1c>7%, and comorbid hypertension were independently associated with diabetic retinopathy. Timely screening for diabetic retinopathy and continuous diabetes self-management education are warranted.

Keywords: Diabetic retinopathy; Type 2 diabetes; Diabetes complication; Comorbidity

INTRODUCTION

Diabetes mellitus is a complex metabolic disorder characterized by hyperglycemia that results from defects in insulin secretion, insulin action, or both [1]. In 2017, there were 451 million adult people with DM globally, a prevalence expected to rise dramatically in the coming decades [2]. Studies have shown that sub-Saharan African countries, including Ethiopia, are experiencing a surge in the prevalence of DM resulting from rapid demographic, sociocultural, and economic transitions [3,4]. Based on a national survey, researchers have recently reported a DM prevalence of 3.2% (3.5% males and 3.0% females) in Ethiopia [5]. Type 2 diabetes-a global epidemic of our century-accounts for more than 90-95% of DM disease [6].

If not treated properly, type 2 diabetes leads to a number of macrovascular and microvascular complications that cause end-organ damages such as kidney failure, blindness, amputation, stroke, and coronary heart disease [7]. Diabetic retinopathy is one of the common microvascular complications of type 2

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diabetes. Clinically, diabetic retinopathy is classified as non-proliferative (NPDR) and proliferative (PDR) stages [8]. The NPDR is the early stage of the disease symptoms will be mild, moderate, or sever. In NPDR, the blood vessels in the retina are weakened which results in the formation of tiny bulges called microaneurysms that may leak fluid into the retina. This leakage may lead to swelling of the macula. The PDR, on the other hand, is the more advanced form of the disease. In PDR, microvascular pathology with capillary closure in the retina leads to hypoxia of tissue. There will be growth of new fragile blood vessels in the retina and into the vitreous humour, the gel-like fluid that fills back of the eye. The new blood vessel may leak blood into the vitreous humour leading to clouding of vision.

Diabetic retinopathy is the leading cause preventable blindness [9]. From 1990 to 2020 diabetic retinopathy also ranked as the fifth most common cause of moderate to severe vision impairment [10]. The International Diabetes Federation (IDF) also reported that diabetic retinopathy is the leading cause of blindness in working-age adults and affects over one-third of the 425 million adults (20-79 years old) with diabetes [11]. Type 2 diabetes patients with severe diabetic retinopathy are at increased risk of having other diabetes-related complications including nephropathy [12,13], stroke [14,15], and cardiovascular diseases [13,15] that increase morbidity and mortality in the diabetes population.

A study has shown that retinopathy was 34.6% prevalent in population with type 2 diabetes compared to 8.8% in those without diabetes [16]. Based on a pooled analysis of multiple studies with similar methodologies and ophthalmologic definitions, researchers have reported 35.36% and 7.24% of age-standardized global prevalence of any diabetic retinopathy and PDR respectively [17]. Nevertheless, the prevalence of diabetic retinopathy in type 2 diabetes greatly varies from country to country. For instance, the reported prevalence was 28.5% in the United States [18], 9.6% in India [19], 36.2% in Armenia [20], 8.1% in Beijing, China [21], 14.9% in Spain [22], 28.3% in the United Kingdom [23], 23.2% in Japan [24], and 64.1% in Iran [25]. A systematic review reported that the prevalence of diabetic retinopathy in population-based studies range from 30.2 to 31.6% and the prevalence in clinic-based studies range from 7.0 to 62.4% in Africa [26].

There are potential risk factors for the development of diabetic retinopathy. Studies have indicated that longer diabetes duration [16-18,20-22], higher hemoglobin A_1c [16-19,22], higher blood pressure [16-18,21,22], and higher fasting blood glucose [19,21] were associated with presence of diabetic retinopathy. Studies have also shown that higher prevalence of diabetic retinopathy was associated with increasing age [19,20,22,23], being under insulin treatment [18,20,22], body mass index and creatinine clearance rate [21], higher blood monocyte count [19], estimated glomerular filtration rate (eGFR) less than 60 ml/min/1.73 m^3 [22], and male gender compared with female [18,23]. Furthermore, some studies have reported that lower serum cholesterol [16], black race compared to white [18], and lower socioeconomic status [24] were associated with increased risk of diabetic retinopathy.

Establishing a comprehensive understanding of the magnitude of diabetic retinopathy in the patient population informs policies related to preventive and treatment interventions. Regular screening for diabetic retinopathy risk factors, glycemic control, and prompt diagnosis are important strategies to prevent or limit the progression of diabetic retinopathy [27]. However, there is paucity of studies addressing the prevalence of diabetic retinopathy and underlying risk factors in Ethiopia. Only a couple of studies so far attempted to assess the prevalence of diabetic retinopathy in pocket areas of southwest and southern part of this country [28,29]. But, we know little about the prevalence of diabetic retinopathy and factors associated to it in Addis Ababa, the capital city of Ethiopia. The purpose of this study was, therefore, to assess the prevalence of diabetic retinopathy and associated factors among type 2 diabetes adult patients on treatment follow up at Tikur Anbessa Hospital in Addis Ababa, Ethiopia.

MATERIAL AND METHODS

Study design

The study was an institution-based cross-sectional design in nature and data collection was conducted from March to April 2018. A total of 192 adults with type 2 diabetes were recruited from the list of outpatients attending the Diabetes Centre of Tikur Anbessa Hospital using a systematic sampling method. The Diabetes Center of Tikur Anbessa Hospital is the major referral center for diabetes treatment in Ethiopia. The sample size was determined in advance based on the assumption of 95% confidence interval, 13% expected prevalence of diabetes retinopathy [29], and a 5% margin of error. The inclusion criteria were patients with type 2 diabetes according to the World Health Organization (WHO) criteria [30] and on stable anti-diabetic medication. Patients who were critically ill and consequently unable to give an informed consent for participation were excluded from the study. The study protocol was reviewed and approved by the Institutional Review Board of the College of Health Sciences at Addis Ababa University. Permission to carry out the study was obtained from authorities in the study setting and informed consent was acquired from each participant. Generally, the study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Measurement

Data was collected using semi-structured questionnaire and direct eye emanation with Topcon Retinal Camera. The questionnaire was developed by the researchers for face-to-face individual interview. It consisted of four parts: sociodemographic (8 items), treatment-related (4 items), diabetes care utilization (3 items), and check list for clinical data extraction (9 items). The clinical data were extracted from patients' medical records using the checklists. The questionnaire was reviewed by clinicians in diabetes care in order to ensure its content validity.

The retinal photographs were taken with Topcon camera in a well darken room. Then, using the photographic images diabetic

retinopathy was classified as present (yes) or absent (no) for each eye separately. The classification was performed by the first author of this article, a nurse had training in diabetes retinopathy screening and had long years of experience in the use of Topcon retinal camera. The performance was audited by a consultant physician with previous training and experience in diabetes retinopathy screening using Topcon camera. The following characterizes were used to determine the presence of diabetes retinopathy. Mild NPDR with occasional microaneurysms or haemorrhages; moderate NPDR with moderate intraretinal haemorrhages, soft exudates, and occasional intraretinal microvascular anomalies; severe NPDR with numerous peripheral retinal haemorrhages and/or moderate intraretinal microvascular anomalies and/or definite venous bleedings; PDR with new vessels on the disc or elsewhere on the retinal; and macular oedema diagnosed from the presence of hard exudates within one disc diameter of the foveola [31-33].

Data processing and analysis

All data were entered into SPSS version 22 for Windows and cleaned, checked for missing values and inconsistency, and then analyzed. Frequency distributions were computed for sociodemographic and clinical variables. Then, these variables were cross-tabulated with the dichotomized outcomes of diabetes retinopathy (yes/no). Categorical variables were compared using Chi-Square (X^2) test of association. Comparison of continues variables between groups were performed using independent sample t-test for normally distributed variable-diabetes duration in years. Simple logistic regression followed by multiple logistic regression analysis was conducted to identify the predictors of diabetes retinopathy in the study population. Variables were entered into the multiple logistic regression model if their *p*-value was <0.25 in simple logistic regression analysis [34]. A *p*-value below 0.05 and 95% confidence interval were used to evaluate the statistical significance association between the predictor's variables and diabetes retinopathy.

RESULTS

Sociodemographic and clinical characteristics of the study participants

From a total of 192 type 2 diabetes patients recruited into the study, 191 participated while one has refused participation, yielding the response rate of 99.4%. From the total 191 participants, 98 (51.3%) had diabetes retinopathy.

Table 1: Sociodemographic and clinical characteristics of study participants on diabetes retinopathy (N=191).

Variables	Overall n (%)	Diabetes Retinopathy, n (%)		
		No	Yes	Test of difference
Age: (Mean ± SD=57.2 ± 10.1)				
36-45	25 (13.1)	13 (52.0)	12 (48.0)	X^2=6.12, df=2, *p*=0.047
46-55	61 (31.9)	37 (60.7)	24 (39.3)	
≥ 56	105 (55.0)	43 (41.0)	62 (59.0)	
Sex:				
Male	77 (40.3)	30 (39.0)	47 (61.0)	X^2=4.89, df=1, *p*=0.027
Female	114 (59.7)	63 (55.3)	51 (44.7)	
Educational level:				
No education	23 (12.0)	11 (47.8)	12 (52.2)	X^2=0.72, df=3, *p*=0.87
Primary school	51 (26.7)	25 (49.0)	26 (51.0)	
Secondary school	56 (29.3)	25 (44.6)	31 (55.4)	
Diploma and above	61 (31.9)	32 (52.5)	29 (47.5)	
Occupation:				
Government employee	36 (18.8)	19 (52.8)	17 (47.2)	X^2=2.35, df=2, *p*=0.31
Non-government employee	40 (20.9)	23 (57.5)	17 (42.5)	
No job	115 (60.2)	51 (44.3)	64 (55.7)	
Residence place:				
Urban	171 (89.5)	87 (50.9)	84 (49.10)	X^2=3.12, df=1, *p*=0.077
Rural	20 (10.5)	6 (30.0)	14 (70.0)	
Diabetes duration, y, Mean ± SD	12.33 ± 10.3	9.3 ± 8.8	15.1 ± 10.9	*t*=-4.047, *p*=0.000
Hypertension:				
No	85 (44.5)	63 (74.1)	22 (25.9)	X^2=39.64, df=1, *p*=0.000
Yes	106 (55.5)	30 (28.3)	76 (71.7)	
Chronic kidney disease:				
No	155 (81.2)	77 (49.7)	78 (50.3)	X^2=0.32, df=1, *p*=0.571
Yes	36 (18.8)	16 (44.4)	20 (55.6)	
Glycemia (HbA1c):				
≤ 7%	55 (57.9)	36 (65.5)	19 (34.5)	X^2=10.07, df=1, *p*=0.002
>7%	40 (42.1)	13 (32.5)	27 (67.5)	

Body mass index (BMI):				
18.5-24.5 Kg/m^2	60 (32.3)	33 (55.0)	27 (45.0)	X^2=3.54, df=2, p=0.170
25-30 Kg/m^2	80 (43.0)	40 (50.0)	40 (50.0)	
>30 Kg/m^2	46 (24.7)	17 (37.0)	29 (63.0)	
Treatment modality:				
Insulin	9 (4.7)	4 (44.4)	5 (55.6)	X^2=1.96, df=2, p=0.375
Oral antiglycemic	137 (71.9)	71 (51.8)	66 (48.2)	
Both	45 (23.6)	18 (40.0)	27 (60.0)	
Frequency of clinic visit:				
Every month	43 (22.6)	29 (67.4)	14 (32.6)	X^2=9.12, df=2, p=0.010
Every 3 months	72 (37.9)	34 (47.2)	38 (52.8)	
Every 6 month	75 (39.5)	29 (38.7)	46 (61.3)	
Attend diabetes education:				
No	92 (48.2)	41 (44.6)	51 (55.4)	X^2=1.21, df=1, p=0.271
Yes	99 (51.8)	52 (52.5)	47 (47.5)	

As shown in Table 1, the mean age of the participants in this study was57.0 ± 10.1 years. The majority of the participants were 56 and above years old (n=105, 55%), female (n=114, 59.7%), had educational level of professional diploma and above (n=61, 31.9%), urban dwellers (n=171, 89.5%), had no job (n=115, 60.2%), hypertensive (n=106, 55.5%), had no chronic kidney disease (n=155, 81.2%), had BMI from 25 to 30 Kg/m^2 (n=80, 43%), on oral antiglycemic medications (n=137, 71.9%), visited diabetes clinic every 6 months (n=75, 39.5%).

Table 1 also shows X^2 and independent sample *t*-tests of associations. Accordingly, participant's age, sex, diabetes duration in years, hypertension, HbA1c, and clinic visits every 6 months had statistically significant association with the occurrence of diabetes retinopathy. The findings show that participants who were 56 years old and above compared to those below 56 years old (X^2 (2, 191)=6.12, p=0.047), male compared to female (X^2 (1, 191)=4.89, p=0.027), hypertensive patients compared to those who had no hypertension (X^2 (1, 191)=39.64, p<0.001), participants who had HbA1c >7% compared to those who had ≤ 7% (X^2 (1, 95)=10.07, p=0.002), and participants who visited diabetes clinic every 6 months compared to those who visited either every month or every 3 months (X^2 (2, 190)=9.12, p=0.01) were more likely to develop diabetes retinopathy. Moreover, participants who were without diabetes retinopathy had less years lived with diabetes (M=9.3 ± 8.8) compared to those who had retinopathy (M=15.1 ± 10.9), t(188)=-4.47, p<0.001.

Predictors of diabetes retinopathy

To control for potential confounders all variables with *p*-value less than 0.25 in the initial simple logistic regression analysis were entered into the multiple logistic regression models.

Table 2: Multiple logistic regression analysis of factors associated with diabetes retinopathy (N=191).

Variables	Diabetes retinopathy n (%)		Cruds Odds Ratio (95%CI)	Adjusted Odds Ratio (95% CI)
	No	Yes		
Sex:				
Male	30(32.3)	47(48.0)	1.935(1.075,3.485)*	11.248(1.816,69.689)*
Female	63(67.7)	51(52.0)	1	1
Age:				
36-45	13(14.0)	12(12.2)	0.640(0.267,1.537)	3.913(0.365,41.943)
46-55	37(39.8)	24(24.5)	0.450(0.236,0.857)	1.410(0.225,8.859)
≥ 56	43(46.2)	62(63.3)	1	1
Residence place:				
Urban	87(93.5)	84(85.7)	0.414(0.152,1.127)	0.582(0.061,5.575)

Rural	6(6.5)	14(14.3)	1	1
Occupation:				
Government employee	19(20.4)	17(17.3)	0.713(0.337,1.510)	1.112(0.136,9.083)
Non-government employee	23(24.7)	17(17.3)	0.589(0.285,1.218)	1.509(0.242,9.400)
No Job	51(54.8)	64(65.3)	1	1
Frequency of clinic visit:				
Every month	29(31.5)	14(14.3)	0.304(0.138,0.670)*	0.027(0.003,0.253)*
Every 3 months	34(37.0)	38(38.8)	0.705(0.366,1.358)	0.643(0.125,3.319)
Every 6 months	29(31.5)	46(46.9)	1	1
Diabetes duration, years			1.078(1.035,1.123)*	1.126(1.022,1.242)*
Glycemia (HbA1c):				
≤ 7	36(65.5)	19(34.5)	0.254(0.107,0.603)*	0.099(0.020,0.485)*
>7	13(32.5)	27(67.5)	1	1
Body mass Index:				
18.5-24.9	33(36.7)	27(28.1)	0.480(0.219,1.052)	1.102(0.098,12.419)
25-30	40(44.4)	40(41.7)	0.586(0.279,1.231)	0.850(0.105,6.870)
>30	17(18.9)	29(30.2)	1	1
Hypertension:				
No	63(67.7)	22(22.4)	0.138(0.072,0.262)*	0.032(0.006,0.167)*
Yes	30(32.3)	76(77.6)	1	1

*p <0.05, **p<0.01

Table 2 shows crudes odds ratio (COR) for simple logistic regression analysis and adjusted odds ratio (AOR) for multiple logistic regression analysis both with corresponding 95% confidence intervals and the reference values represented with 1. After adjusting for other covariates, male type 2 diabetes compared to female were more than 11 times (AOR=11.248, 95%CI=1.816-69.689) likely to have diabetic retinopathy. Participants who visited diabetes clinic every month for follow up care were about 37 times less likely (AOR=0.027, 95%CI=0.003, 0.253) to have diabetic retinopathy compared to those who visited clinic every 6 months. There was a 1.13 times increase in the presence of diabetic retinopathy for a 1 year increase in the duration lived with type 2 diabetes (AOR=1.126, 95%CI=1.022, 1.242). Participants with HbA1c of 7% and below were about 10 times less likely (AOR=0.099, 95%CI=0.020, 0.485) to have diabetic retinopathy compared to those who had HbA1c of more than 7%. Participants who had no comorbid hypertension were 31.3 times less likely (AOR=0.032, 95%CI=0.006, 0.167) to have diabetic retinopathy compared to those with comorbid hypertension. The other covariate including age, residence place, occupation, and BMI were not statistically significant predictors of diabetic retinopathy in this study.

DISCUSSION

This study identified that diabetic retinopathy was 51.3% prevalent among the enrolled type 2 diabetes patients. This finding is higher than the prevalence previously reported from Arbaminch [29] and Jimma [28] in Ethiopia and from other parts of the world [18-24]. However, our finding is lower than the one reported from Bahol in Iran [25]. These discrepancies may result from variations among the studies in sample size and sampling techniques, methods used to screen for diabetic retinopathy, diabetes duration, HbA1c values, and health seeking behaviors of Type 2 diabetes patients.

This study also revealed that participants sex, frequency of clinic visits for follow up care, HbA1c, diabetes duration, and comorbid hypertension were important predictors of diabetic retinopathy. The likelihood of having diabetic retinopathy was higher for male compared to female type 2 diabetes patients. Our finding in this regard corroborate with the findings of studies reported from other parts of the world [18,23]. This may be linked to the differences in needs and barriers to diabetes self-management among men and women with diabetes mellitus [35,36]. Though HbA1c would be expected as a main way for sex difference in prevalence of diabetic retinopathy, our study demonstrated sex difference existed even after controlling for HbA1c. This implies the need for gender-sensitive diabetes care and further locally tailored further study to see if there a link between the development of diabetic retinopathy and diabetes self-management juxtaposed with gender.

Our study identified that a more frequent visit to diabetes clinic has a protective effect against the development of diabetic retinopathy. Subjects who visited diabetes clinic every month were less likely to have diabetes retinopathy compared to those who visited every 6 months. A more frequent clinic visit might have contributed to improvement in HbA1c values. This finding corroborates with the findings of an earlier study that reported that the development of diabetic retinopathy was associated with irregular attendance of diabetes clinic in Yemen [37]. This is worrisome in that most diabetes patients in the study setting are appointed for follow up visit every 6 months and above usually due to high case load and they come from distant places. However, this may contribute to poor glycemic control and development of complications including diabetic retinopathy. Thus, creating a mechanism to shorten the appointment time is important to enhance glycemic control and prevention of complications.

Similar with previous research findings reported from other settings [18,20-22], our study revealed that the risk to have diabetic retinopathy among type 2 diabetes increases with the duration of the disease, higher HbA1c (>7%), and presence comorbid hypertension. Therefore, early diagnoses of diabetes and diabetic retinopathy, and continuous diabetes self-management education can improve the control of these risk factors.

Strength and limitation of the study

There are important strengths of the present study. This is the first study to investigate the prevalence of diabetes retinopathy and associated factors in Addis Ababa, Ethiopia. The use of cross-sectional design also provided sufficiently large sample size. Nevertheless, this study also has some limitations. The lack of data for HbA1c on almost half of the participants is a major limitation since HbA1c is likely the main factor determining diabetic retinopathy and won't be adjusted for whom it was missing in this study. Cross-sectional studies by their nature don't provide researchers with the ability to infer causality. The use of self-report and review of patient's medical record for data collection can be subjects to recall bias and missing data. These researchers encountered the latter related to the number of recorded HbA1c. We were able to obtain HbA1c values only for 95 participants in this study. This is an important limitation of our study.

CONCLUSION

In conclusion, our study demonstrated that diabetes retinopathy was prevalent in more than half of the participating type 2 diabetes patients. Male sex, frequency of visit to diabetes clinic, longer duration of diabetes, higher HbA1c level, and presence of comorbid hypertension were independently associated with the presence of diabetes retinopathy. Our findings imply the need for increased efforts by policy makers and health professionals in Ethiopia to improve the practice of timely screening of diabetes retinopathy and the control of factors associated with diabetes retinopathy in type 2 diabetes patients. Continuous diabetes self-management education can improve the control risk factors for the development of diabetes retinopathy.

Data availability

The data used to support the findings of this study are restricted by the IRB of the College of Health Sciences at Addis Ababa University in order to protect patient privacy. Data are available from the corresponding author for researchers who meet the criteria for access to confidential data.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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