Journal of Diabetes & Metabolism

OPEN ACCESS Freely available online

Research Article

Prevalence of Diabetic Retinopathy and Associated Risk Factors among Adult Diabetes Attending at Debre Tabor General Hospital, Northwest Ethiopia

Getasew Alemu Mersha[1]*, Yezinash Addis Alimaw[1], Mikias Mered Tilahun[1], TarkegnCheklie Zeleke[1], Asamere Tsegaw Woredekal[2]

[1]Department of Optometry, School of Medicine, University of Gondar, Comprehensive Specialized Hospital, Gondar, Ethiopia; [2]Department of Ophthalmology, School of Medicine, University of Gondar Comprehensive Specialized Hospital, Gondar, Ethiopia

ABSTRACT

Aim: To assess the prevalence of diabetic retinopathy and its associated risk factors among adult diabetes at Debre Tabor General Hospital, Debre Tabor, Northwest, Ethiopia.

Methodology: A cross sectional study was conducted at Debre Tabor General Hospital from June 29-August 28, 2020. A systematic random sampling technique was employed to select study participants. Interviewer based semi-structured questioner, document review and physical examination were applied to collect the data. Labeling of diabetic retinopathy was done based on the Proposed International Clinical Diabetic Retinopathy and Severity Scale. Only the eye with the higher grade of retinopathy for each participant was included.

Result: A total of 306 participants completed the study with a response rate of 97.7%. The median duration of diabetes was 4 (Range=7) years. The prevalence of diabetic retinopathy was 31.4% (95% Confidence Interval: 26.1%-36.3%). Low family monthly income (Adjusted Odds Ratio=7.4, 95% Confidence Interval 2.4-22.9), longer duration of diabetes (Adjusted Odds Ratio=27, 95% Confidence Interval 11.5-63.6) and poor glycemic control (Adjusted Odds Ratio=3.2, 95%Confidence Interval 1.5-6.7) were significantly associated with diabetic retinopathy.

Conclusion and Recommendation: The prevalence of diabetic retinopathy washigh. Coordinated early screening of diabetic retinopathy in all adult diabetes was recommended.

Keywords: Diabetes Mellitus; Diabetic retinopathy; Prevalence; Ethiopia

INTRODUCTION

Statement of the problem

Diabetic retinopathy is a long term and specific microvascular complication of diabetes, characterized by changes in small blood vessels of the retina, these include changes in vascular permeability, capillary microaneurysms, capillary degeneration, and excessive formation of new blood vessels (neovascularization) [1,2]. Most patients are asymptomatic, yet some patients may experience major visual changes including blurred, spotty and double vision [3].

If left untreated, diabetic retinopathy progresses from its milder abnormalities, to its sight threatening conditions such as growth of new blood vessels over the retina and towards the posterior vitreous and swelling of the highly light sensitive portion of the retina (macula) from leaky blood vessels and ultimately leads to clouding of vision and significant visual impairment [1].

Globally, the prevalence of diabetic retinopathy among adult diabetes is estimated to be 27.0% [4]. Based on a systematic review the prevalence of diabetic retinopathy in Africa is reported to be 31.6% [5]. The national prevalence of diabetic retinopathy in Ethiopia is reported to be 19.48% [3].

Out of 139 million visual impaired worldwide 3.7 (1.9%) million were visually impaired due to DR [6]. Visual impairment as a result of DR has a significant impact on patients' quality of life, and can compromise their ability to manage their disease successfully, which can in turn have a positive impact on the incidence of

***Corresponding to**: Getasew Alemu Mersha, Department of Optometry, School of Medicine, University of Gondar, Comprehensive Specialized Hospital, Gondar, Ethiopia, Tel: +251932823935; Fax number: +251-058-114 1240; E-mail: gechopta12@gmail.com

Received: September 17, 2020; **Accepted:** May 18, 2021; **Published:** May 25, 2021

Citation: Mersha GA, Alimaw YA, Tilahun MM, Zeleke TC, Woredekal AT (2021) Prevalence of Diabetic Retinopathy and Associated Risk Factors among Adult Diabetes Attending at Debre Tabor General Hospital, Northwest Ethiopia. J Diabetes Metab. 12:872.

other diabetic complications and negative impact on overall life expectancy and productivity [7].

The major risk factors for the development DR in DM patients are hyperlipidemia, obesity, puberty, longer diabetes duration, and poor glycemic and blood pressure control [8-10]. Complete understanding of the magnitude of DR in the patient population is crucial to design policies for prevention and timely treatment of the disease.

The risk of DR to sight can be greatly reduced by good blood glucose and blood pressure control, effective screening and timely laser treatment, intraocular injection of steroids and antivascular endothelial growth-factor agents and intraocular surgery [2,11]. The epidemiology and risk factors of DR has been well described in developed nations and a few numbers of studies have been attempted in the developing nations as well.

However, there is paucity of studies addressing the prevalence of diabetic retinopathy and underlying risk factors in Ethiopia particularly, in the study area. The purpose of this study is, therefore, to assess the prevalence of DR and associated factors among adult diabetes patients attending at Debre Tabor General Hospital Northwest, Ethiopia.

MATERIALS AND METHODS

Study design and period

A hospital based cross sectional study was conducted at Debre Tabor General Hospital from June 29/2020 to August 28/2020. The hospital is located in Debre Tabor town, the capital city of South Gondar Zone of the Amhara National Regional State, and it is located 667 km from Addis Ababa. According to the Debre Tabor Hospital Planning and Information Department, the hospital is providing preventive and curative health care services for about ~2.7 million people in the zone and nearby districts and has a capacity of 250 beds for inpatient services in five disciplines and 12 outpatient departments (OPDs) [12]. The hospital has specialty chronic illness clinics where patients with specific chronic diseases are referred for follow-up. On average around 22 DM patients are visited in the two diabetic clinics per day during the working hours and general practitioners, internists and nurses are involved in the clinical service of diabetes patients. A secondary eye care service is given in the hospital with three optometrists, two ophthalmic nurses, one cataract surgeon and one ophthalmologist.

All adult diabetes patients of age ≥18 years visiting the diabetic clinic in DTGH during the study period were included. Patient with pregnancy induced diabetes (gestational diabetes), patients who were severely ill: unable to be sit and examined with slit lamp indirect ophthalmoscopy and patient with media opacity: obscuring the view of their retina were excluded from the study.

The sample size was determined based on a single population proportion formula by taking 13% prevalence from a similar study in Arba Minch [13], 95% CI, 4% margin of error and 15% non-response rate. Accordingly, the final computed sample size was 306. A systematic random sampling technique was applied to select study participants: there are around 700 diabetic patients who visit the diabetic clinic over 40 normal working days. Based on the decision to collect data in 2 months a sampling interval "k" was determined by dividing the expected number of DM patients to the sample size 313 which was approximately 2. Then every other diabetes patient was approached for the study.

Ethical clearance was obtained from University of Gondar, College of Medicine and Health Sciences, School of Medicine ethical review committee. Moreover, permission to conduct the study in the hospital was obtained from Chief Executive Officer and Medical Director Offices of the hospital. Oral informed consent was obtained from each study participants after explaining the purpose of the study. All in all, the study was conducted in line with the Ethical Principle of the Declaration of Helsinki.

Data collection procedures and quality control

Semi-structured interviewer-administered questionnaire, document review and ocular examinations were used to collect data. The questionnaire consisted of 4 sections: Socio-demographic and economic variables (6 items), Behavioural measurements (14 items),diabetic follow up and eye checkup (5 items) and Checklist for clinical data extraction (7 items). Data quality was ensured through pre-testing the questioner on 5% of the sample before the actual data collection period and training of the data collectors. Each day during the data collection 5% of the data was cross checked for completeness by the principal investigator (Table 1).

Table 1: Socio-demographic and economic characteristics of study participants at Debre Tabor General Hospital, Northwest Ethiopia, 2020 (n=306).

Variable	Frequency	Percent
Gender		
Male	166	54.2
Female	140	45.8
Age (Years)		
18-27	56	18
28-37	49	16
38-47	54	17.6
≥48	147	48
Marital status		
Single	103	33.7
Married	203	66.3
Educational status		
No formal education	171	55.9
Primary and secondary school	64	20.9
Collage and above	71	23.2
Occupational status		
Government employee	55	18
Retired	23	7.5
House wife	43	14
Farmer	90	29.4
Other	47	15.4
No job	48	15.7
Residence		
Urban	193	63.1
Rural	113	36.9
Family monthly income (Ethiopian Birr)***		
≤ 2000	110	35.9
2001-3577	43	14.1
3578-6500	79	25.8
≥6501	74	24.2

n=Sample Size
***Income is categorized based on quartile classification.

Retinal examination was carried out with a 90 diopter of Volk lens with slit lamp biomicroscope by a trained senior optometrist after the pupillary dilation was done using 1% tropicamide eye drop on both eyes. Participants with complexity and/ or sight threatening retinopathy were double seen by a senior ophthalmologist working in the hospital. An eye with the highest grade of diabetic retinopathy was referred to label DR. Labeling of DR was done based on the Proposed International Clinical Diabetic Retinopathy and Diabetic Macular Edema Disease Severity Scales [14,15].

Data processing and analysis

After data was entered into EPI INFO 7 and exported to SPSS version 20 for analysis. The descriptive statistics was summarized and presented using summary statistics such as frequency tables. The model was checked by Hosmer and Lemeshow goodness of fit test. Binary logistic regression was used to identify candidate variables. Variables with p-value<0.2 in binary logistic regression, were entered into a multivariable logistic regression model. Variables having p-values <0.05 were considered as statistically significant.

RESULTS

Socio demographic characteristics of study participants

A total of 306 participants completed the study with a response rate of 97.7%. The median age of the respondents was 45 (IQR=30) years. Majority of the participants were male 166 (54.2%), were married 203 (66.3%), had no formal education 171 (55.9%), were farmer 90 (29.4%) and urban dweller 193 (63.1%). The median family monthly income of the respondents was 3577 Ethiopian Birr (ETB) (IQR=4500 Ethiopian Birr) (Table 2).

Table 2: Clinical and behavioral characteristics of study participants at Debre Tabor General Hospital Northwest Ethiopia, 2020 (n=306).

Variable	Frequency	Percent
BMI		
≤24.99	277	74.2
25-29.9	54	17.6
≥30	25	8.2
Type of DM		
Type I	163	53.3
Type II	143	46.7
Duration of DM (in years)		
< 10	230	75.2
≥10	76	24.8
Glycemic control		
Good control	155	50.7
Poor control	151	49.3
Mode of treatment		
Insulin alone	171	55.9
Tablet	106	34.6
Combined	29	9.5
Drinking status		
Non drinker	193	63.1
Moderate drinker	91	29.7
Heavy drinker	22	7.2
Physical activity		
Physical inactivity	54	17.6
Low physical activity	81	26.5
Moderate physical activity	171	55.9
n=Sample Size		

Clinical and behavioral characteristics of study participants

The median duration of diabetes was 4 (IQR=7) years the maximum duration of diabetes was 40 years and the minimum was 3 months in this study. The mean and median level of FBS was 150mg/dl (IQR=88). In this study, most of the participants were type I DM 163 (53.3%), had a good glycemic control 155(50.7%), used insulin alone as a treatment modality 171 (55.9%) (Table 2).

Systemic comorbidity, follow up and awareness of the participants

From the total participants, 93 (30.4%) had hypertension as a comorbidity, 228 (74.5%) visited the DM clinic every month, 72 (23.5%) had family history of DM, 126 (41.2%) had no prior eye exam and only 80 (58.8%) had awareness about diabetic retinopathy (Table 3).

Table 3: Systemic comorbidity, frequency of visit and awareness characteristics of study participants at Debre Tabor General Hospital, Northwest Ethiopia, 2020 (n=306).

Variables	Frequency	Percent
Hypertension		
Yes	93	30.4
No	213	69.6
Frequency of DM clinic visit		
Every month	228	74.5
Every two months	78	25.5
Family history of DM		
Yes	72	23.5
No	234	76.5
History of eye exam		
Yes	180	58.8
No	126	41.2
Awareness of DR		
Yes	80	26.1
No	226	73.9
n=Sample Size		

Prevalence of diabetic retinopathy among participants

Among the total study participants, the prevalence of diabetic retinopathy was found to be 96 (31. 4%).Of the total participants, 54 (17.6%) had NPDR, 6 (2%) had PDR and 36 (11.8%) had Diabetic Maculopathy.

Factors associated with diabetic retinopathy among diabetes

From bivariable logistic regression analysis, age, occupational status, family monthly income, duration of diabetes, glycemic control, hypertension and family history of diabetes were statistically and significantly associated with diabetic retinopathy. However, in a multivariable logistic regression analysis only family monthly income, duration of diabetes and glycemic control were remained significantly associated with diabetic retinopathy.

Regarding family monthly income of the study participants, those who had an income of <200 ETB were 7.4 times (AOR=7.4,

95% CI: 2.38-22.89) more likely to develop diabetic retinopathy compared to those who had income of >6500 ETB.

Participants who had a duration of 10 and above years were nearly 27 times (AOR=26.98, 95% CI: 11.45-63.62) more likely to develop diabetic retinopathy as compared to those who had a duration of less than 10 years.

Participants who had a poor glycemic control were about 3.17 times (AOR=3.17, 95%CI: 1.50-6.68) more likely to have diabetic retinopathy compared to those who had a good glycemic control (Table 4).

However, factors such as age, gender, marital status, educational status, occupational status, residence physical activity, alcohol drinking status, BMI, family history of diabetes, types of diabetes, mode of treatment, frequency of diabetes clinic visit, and having awareness about diabetic retinopathy had no association with diabetic retinopathy.

DISCUSSION

The prevalence of diabetic retinopathy among adult diabetes attending at Debre Tabor General Hospital, Northwest, Ethiopia

Table 4: Bivariable and multivariable logistic regression analysis of factors associated with diabetic retinopathy among adult diabetes at Debre Tabor General Hospital, Northwest Ethiopia, August 2020(n = 306)

Variable	Diabetic Retinopathy n (%)		COR (95 %CI)	AOR (95 %CI)
	Yes	No		
Age (Years)				
18-27	9 (16.1%)	47(83.9%)	1	1
28-37	14 (28.6%)	35 (71.4%)	2.09 (0.81-5.38)	1.87 (0.48-7.39)
38-47	18(33.3%)	36 (66.7%)	2.61 (1.05-6.49)	1.32 (0.30-5.72)
≥48	55 (37.4%)	92 (62.6%)	2.88 (1.42-6.86)*	2.03 (0.48-8.48)
Occupational status				
Government employee	14 (25.5%)	41 (74.5%)	1	1
Retired	12 (52.2%)	11 (47.8)	3.19 (1.15-8.85)*	0.82 (0.18-3.75)
House wife	16 (37.2%)	27 (62.8%)	1.74 (0.73-4.13)	0.68 (0.18-2.49)
Farmer	33 (36.7%)	57 (63.3%)	1.70 (0.81-3.56)	1.21 (0.41-3.59)
Other	10 (21.3%	37 (78.7%)	0.79 (0.31-1.99)	0.44 (0.11-1.72)
No job	11 (22.9%)	37 (77.1%)	0.87 (0.35-2.15)	0.55 (0.13-2.31)
Family monthly income (ETB)				
≤ 2000	47 (42.7%)	63 (57.3%)	4.78 (2.23-10.27)**	7.4 (2.38-22.89)**
2001-3577	16 (37.2%)	27 (62.8%)	3.79 (1.53-9.41)	3.79 (1.06-14.18)
3578-6500	23 (29.1%)	56 (70.9%)	2.63 (1.15-5.99)	3.80 (1.2-12.03)
≥6501	10 (13.5%)	64 (86.5%)	1	1
Duration of DM				
<10 years	33(14.3%)	197 (85.7%)	1	1
≥10 years	63 (82.9%)	13(17.1%)	28.9(14.34-58.36)**	27(11.45-63.62)**
Glycemic control				
Good control	30 (19.4%)	125 (80.6%)	1	1
Poor control	66 (43.7%)	85 (56.3%)	3.24 (1.94-5.40)**	3.17 (1.50-6.68)**
Body Mass Index				
≤24.99	69 (30.4%)	158 (69.6%)	1	1
25-29.9	15 (27.8%)	39 (72.2%)	0.88 (0.46-1.70)	0.70 (0.25-1.91)
≥30	12 (48.0%)	13 (52.0%)	2.11 (0.92-4.87)	0.66 (0.17-2.52)
Hypertension				
Yes	37 (39.8%)	56 (60.2%)	1.73 (1.03-2.88)*	1.67 (0.66-4.20)
No	59 (27.7%)	154 (72.3%)	1	1
Family history of DM				
Yes	36 (50.0%)	36 (50.0%)	2.90 (1.68-5.01)**	1.44 (0.60-3.42)
No	60 (25.6%)	174 (74.4%)	1	1
History of eye check up				
Yes	62 (34.4%)	118 (65.6%)	1	
No	34 (27.0%)	92 (73.0%)	0.70 (0.43-1.16)	1.31 (0.59-2.39)
Physical activity				
Physical inactivity	20 (37.0%)	34 (63.0%)	1.60 (0.84-3.05)	0.90 (0.32-2.51)
Low physical activity	30 (37.0%)	51 (60.0%)	1.60 (0.91-2.80)	1.37 (0.56-2.35)
Moderate physical activity	46 (26.9%)	125 (73.1%)	1	

n=Sample Size. ETB- Ethiopian Birr. * P-value <0.05 **P-value<0.001. Hosmer and Lemeshow Test=0.186

was found to be 31.40% (95% CI: 26.1%-36.3%). This finding was in line with the findings of studies conducted in United Kingdom (UK) [16] 28.50, China [17] (27.9%) Bangladesh [18] (36.10%), Nigeria [19] (26.20%), Zimbabwe [20] (28.40%) and Tanzania [21] (27.90%).

However, our finding was higher than the findings reported from USA [22] (14.70%), New Zealand [23] (22.50%), Spain [24] (14.90%), Slovakia [25] (15.50%), and Pakistan [26] (17.00%), Saudi Arabia [27] (16.00%), Egypt [28] (24.00%) and Uganda [29] (19.00%) Arba Minch [13] (13.00%), Gondar [30] 17.00%) and Bahir Dar [31] (25.50%). The discrepancy might be to the difference in the study population characteristics, sample size, inclusion criteria and methods of screening DR. For instance, studies in USA, Slovakia, Spain, Pakistan, Saudi, Egypt and Bahir Dar were only on type 2 diabetes, while our study included both types of diabetes, excluding type 1 diabetes may lower the actual prevalence of DR. Studies in New Zealand, Arba Minch, Gondar and Bahir Dar used the patients' medical folder to screen DR, reviewing the patient's medical folder results in lower prevalence of the disease since, not all diabetes are examined for their eyes in the absence of symptoms and complete recording of findings may not be available. Additionally, the difference in life style and health seeking behavior in the study settings may also be responsible for the difference.

On the other hand, this finding is lower than the study done in Pittsburgh USA [32] (44.0%), India [33] (60.9%), Cameroon [34] (40.3%), Zambia [35] (52.0%), Sudan [7] (82.6%), Jimma [36] (41.1%) and Addis Abeba[37] (51.1%). These variations could be attributed to the difference in the nature of study population, study settings and duration of diabetes. The study population in Pittsburgh USA were inpatient diabetes, who might have already encountered more systemic comorbidities, which increase the prevalence of DR. Participants in the Indian, Cameroonian, and Sudanese study were diabetes patients who were linked to Ophthalmology clinic for evaluation, and or patients who had been already on follow up in the retina clinic, assessing the prevalence in these setting could result in a high figure of DR. Similarly, the Jimman and Addis Abeban studies were at the referral centers, where patients with severe cases of diabetes and comorbidities are referred result in high prevalence of DR. Moreover, the median duration of diabetes in Addis Abeban study was 15 years which is longer than the median duration of diabetes in this study which was 4 years, this could also contribute to the difference in the prevalence of diabetic retinopathy.

This study also demonstrated that, low family monthly income, longer duration of diabetes and poor glycemic control were important risk factors of diabetic retinopathy. The likely hood of having diabetic retinopathy was high among participants who had an average monthly income of 2000 and below. This finding is in accordance with the finding of studies in India [38] and Sudan [39] which identified a low monthly income was a significant factor associated with the presence of diabetic retinopathy.

The possible reason for the association could be, participants with low monthly income may have constraints to cover their transportation, investigation and medication related costs hence, they might not be able stick with their follow up schedule and taking medications all the time. Besides, they may not be able to prioritize their diets to be taken, and this makes diabetes self-management even more challenging. All these factors are interrelated and may lead to poor glycemic control in turn linked to diabetic complications including diabetic retinopathy.

Our finding demonstrated that, the likely hood of developing diabetic retinopathy was high for participants with longer duration of diabetes (≥10 years) and this is consistent with what has been found previously in Arba Minch, Jimma and around the world [13,20,24-26,40,41] that longer duration diabetes was associated with the development of diabetic retinopathy. This might be due the fact that, in diabetes there are abnormalities in energy production which are thought to be the major contributor to the development of diabetic complications like diabetic retinopathy, and these abnormalities are considered to occur late in the development of the disease [1]. Moreover, this might be due to the widening of retinal vasculature along with the long duration of diabetes, which is a sub clinical marker of endothelial dysfunction which ultimately leads to diabetic retinopathy [2].

Our study also indicated that participants who had a poor glycemic control had an increased risk of developing diabetic retinopathy compared to those who had a good glycemic control. In this regard, our finding is similar with the findings previously reported in China [17], Bangladesh [18], Iraq [42], India [33], and Jimma [40]. Hyperglycemia instigates a cascade of events leading to retinal vascular endothelial dysfunction eventually leads to development of diabetic retinopathy [2]. High glucose level in the endothelial cells create an energetic imbalance and switching these cells to a demanding energy production from fatty acids and amino acids this will increase the oxidative stress to the endothelial cells and may lead diabetic complications like diabetic retinopathy. Moreover, during hyperglycemia, uncontrolled energy production inhibits the antioxidant capacity of the endothelial cells and this could be linked to diabetic complications including diabetic retinopathy.

Themain limitation of our study include: it was a single center and hospital based study, the patients recruited into our study may not be representative of the overall population with diabetes, and this affects the generalizability of our finding, the cross sectional nature of our study, did not allow us to identify the important predictors of diabetic retinopathy.

CONCLUSION

The prevalence of diabetic retinopathy was high compared to the global and national prevalence of diabetic retinopathy in Ethiopia. Low monthly income, longer duration of diabetes and poor glycemic control were found to be independently and significantly associated with the presence of diabetic retinopathy in this study. Therefore, it is better to embark a coordinated early diabetic retinopathy in the hospital. It is also equally important to draw more attentions and increase effort in provision of affordable and accessible health care service for diabetes patients, here by reduce devastating consequences of the disease.

REFERENCES

1. Forbes JM, Cooper ME. Mechanisms of diabetic complications. Physiol Rev. 2013;93:137-188.
2. Melbourne RVE. Diabetic retinopathy. Diabetes Care. 2010;21:22.
3. Fite RO, Lake EA, Hanfore LK. Diabetic retinopathy in Ethiopia: A systematic review and meta-analysis. Diabetes Metab Syndr. 2019;13:1885-1891.
4. Thomas R, Halim S, Gurudas S, Sivaprasad S, Owens D. IDF Diabetes Atlas: A review of studies utilising retinal photography on the global prevalence of diabetes related retinopathy between 2015 and 2018.

Diabetes Res Clin Pract. 2019:107840.

5. Burgess P, MacCormick I, Harding S, Bastawrous A, Beare N, Garner P. Epidemiology of diabetic retinopathy and maculopathy in Africa: a systematic review.Diabet Med. 2013;30:399-412.

6. Leasher JL, Bourne RR, Flaxman SR, Jonas JB, Keeffe J, Naidoo K, et al. Global estimates on the number of people blind or visually impaired by diabetic retinopathy: a meta-analysis from 1990 to 2010. Diabetes Care. 2016;39:1643-1649.

7. Elwali ES, Almobarak AO, Hassan MA, Mahmooud AA, Awadalla H, Ahmed MH. Frequency of diabetic retinopathy and associated risk factors in Khartoum, Sudan: population based study. Int J Ophthalmol. 2017;10:948.

8. Jonas JB, Sabanayagam C. Epidemiology and Risk Factors for Diabetic Retinopathy.Diabetic Retinopathy and Cardiovascular Disease. 27: Karger Publishers; 2019;27:20-37.

9. Ting DSW, Cheung GCM, Wong TY. Diabetic retinopathy: global prevalence, major risk factors, screening practices and public health challenges: a review. Clin Exp Ophthalmol. 2016;44(4):260-277.

10. Yau JW, Rogers SL, Kawasaki R, Lamoureux EL, Kowalski JW, Bek T, et al. Global prevalence and major risk factors of diabetic retinopathy. Diabetes Care. 2012;35:556-564.

11. Njeri LN. Prevalence of diabetic retinopathy and barriers to uptake of diabetic retinopathy screening at Embu Provincial General Hospital, Central Kenya. 2012.

12. Debre Tabor General Hospital. Summary and StatisticalAnnual Report of The Hospital, 2019: Information and Planning Office, Debre Tabor, Ethiopia: Debre Tabor General Hospital (DTGH); 2020.

13. Chisha Y, Terefe W, Assefa H, Lakew S. Prevalence and factors associated with diabetic retinopathy among diabetic patients at Arbaminch General Hospital, Ethiopia: Cross sectional study. PloS One. 2017;12:171-987.

14. Solomon SD, Goldberg MF. ETDRS Grading of Diabetic Retinopathy: Still the Gold Standard? Ophthalmic Res. 2019;62:185-190.

15. Wilkinson C, Ferris III FL, Klein RE, Lee PP, Agardh CD, Davis M, et al. Proposed international clinical diabetic retinopathy and diabetic macular edema disease severity scales. Ophthalmology. 2003;110:1677-1682.

16. Mathur R, Bhaskaran K, Edwards E, Lee H, Chaturvedi N, Smeeth L, et al. Population trends in the 10-year incidence and prevalence of diabetic retinopathy in the UK: a cohort study in the Clinical Practice Research Datalink 2004–2014. BMJ Open. 2017;7:14444.

17. Cui Y, Zhang M, Zhang L, Zhang L, Kuang J, Zhang G, et al. Prevalence and risk factors for diabetic retinopathy in a cross-sectional population-based study from rural southern China: Dongguan Eye Study. BMJ Open. 2019;9:235-286.

18. Billah MM, Rahim MA, Rahman MA, Mitra P, Chowdhury TA, Hossan ME, et al. Pattern and Risk Factors of Diabetic Retinopathy among Type 2 Diabetic Patients: Experience in a Tertiary Care Hospital. J Medicine. 2016;17:17-20.

19. Kizor-Akaraiwe NN, Ezegwui IR, Oguego N, Uche NJ, Asimadu IN, Shiweobi J. Prevalence, awareness and determinants of diabetic retinopathy in a screening centre in Nigeria. J Community Health. 2016;41:767-771.

20. Machingura PI, Macheka B, Mukona M, Mateveke K, Okwanga PN, Gomo E. Prevalence and risk factors associated with retinopathy in diabetic patients at Parirenyatwa Hospital outpatients' clinic in Harare, Zimbabwe. Archives of Medical and Biomedical Research. 2017;3:104-111.

21. Cleland CR, Burton MJ, Hall C, Hall A, Courtright P, Makupa WU, et al. Diabetic retinopathy in Tanzania: prevalence and risk factors at entry into a regional screening programme. TM & IH. 2016;21(3):417-426.

22. Shah A. Prevalence of Diabetic Retinopathy in the United States, 2011–2014. Value in Health. 2016;19:199.

23. Chang LY, Lee AC, Sue W. Prevalence of diabetic retinopathy at first presentation to the retinal screening service in the greater Wellington region of New Zealand 2006-2015, and implications for models of retinal screening. NZMJAX. 2017;130:78.

24. López M, Cos FX, Álvarez-Guisasola F, Fuster E. Prevalence of diabetic retinopathy and its relationship with glomerular filtration rate and other risk factors in patients with type 2 diabetes mellitus in Spain. DM2 HOPE study. J Clinical Translational Endocrinology. 2017;9:61-65.

25. Ondrejkova M, Jackuliak P, Martinka E, Mokan M, Foley J, Fabkova J, et al. Prevalence and epidemiological characteristics of patients with diabetic retinopathy in Slovakia: 12-month results from the DIARET SK study. Plos One. 2019;14:223788.

26. Sultan S, Fawwad A, Siyal NA, Butt A, Khokar AR, Basit A. Frequency and risk factors of diabetic retinopathy in patients with type 2 diabetes presenting at a tertiary care hospital. Int J Diabetes Dev Ctries. 2020;40:87-92.

27. Alharthi AS, Almutairi MZK, Alswat AHK, Wagdani HAA, Ghamdi AA. Prevalence and Potential Risk Factors of Diabetic Retinopathy among Type 2 Diabetics Patients in Diabetic Center, Taif City, KSA. Egypt J Hosp Med. 2018;70(9):1455-1463.

28. Fahmy HL, Khalifa WA, Sharaf M, Soliman AM, Ahmed SM, Abdelazeem K. Diabetic Retinopathy and Major Risk Factors Among Type 2 Diabetic Patients Attending Assiut University Hospitals: a cross sectional study. J Med Sci Clin Res. 2016;4:11782-11790.

29. Magan T, Pouncey A, Gadhvi K, Katta M, Posner M, Davey C. Prevalence and severity of diabetic retinopathy in patients attending the endocrinology diabetes clinic at Mulago Hospital in Uganda. Diabetes Res ClinPract. 2019;152:65-70.

30. Fasil A, Biadgo B, Abebe M. Glycemic control and diabetes complications among diabetes mellitus patients attending at University of Gondar Hospital, Northwest Ethiopia. Diabetes MetabSyndrObes: Targets Ther. 2019;12:75.

31. Lebeta R, Argaw Z, Walle B. Prevalence of diabetic complications and its associated factors among diabetes mellitus patients attending diabetes mellitus clinics; institution based cross sectional study. Am J Health Res. 2017;5:38.

32. Kovarik JJ, Eller AW, Willard LA, Ding J, Johnston JM, Waxman EL. Prevalence of undiagnosed diabetic retinopathy among inpatients with diabetes: the diabetic retinopathy inpatient study (DRIPS). BMJ Open Diabetes Res Care. 2016;4:164.

33. Narsaiah C, Manoj P, Raju AG. Study on Awareness and Assessment of Diabetic Retinopathy in Diabetic Patients Attending Ophthalmology Clinic at a Tertiary Care Hospital, Telangana State. J Contemp MedSci. 2019;6:9-13.

34. Jingi AM, Noubiap JJN, Ellong A, Bigna JJR, Mvogo CE. Epidemiology and treatment outcomes of diabetic retinopathy in a diabetic population from Cameroon. BMC Ophthalmology. 2014;14:1-5.

35. Lewis AD, Hogg RE, Chandran M, Musonda L, North L, Chakravarthy U, et al. Prevalence of diabetic retinopathy and visual impairment in patients with diabetes mellitus in Zambia through the implementation of a mobile diabetic retinopathy screening project in the Copperbelt province: a cross-sectional study. Eye. 2018;32:1201-1208.

36. Sharew G, Ilako D, Kimani K, Gelaw Y. Prevalence of diabetic

retinopathy in Jimma University Hospital, Southwest Ethiopia. Ethiop Med J. 2013;51:105-113.

37. Shibru T, Aga F, Boka A. Prevalence of Diabetic Retinopathy and Associated Factors among Type 2 Diabetes Patients at Tikur Anbessa Hospital Adis Abeba Ethiopia: a cross sectional study. J Diabetes Metab. 2019;10: 2155-6156.

38. Mannam M, Nalluri L, Pingili R, Sudagani J, Kilaru N. Assessment of Drug Utilization Pattern, Prevalence and Risk Factors for the Development of Diabetic Retinopathy among Type 2 Diabetic Patients in A South Indian Tertiary Care Hospital: A cross-sectional observational study. Int J Pharm Sci Res. 2020;11(2):2383-2398.

39. Abrahim MKM. Social risk factors of Diabetic Retinopathy among Sudanese diabetic patients in Khartoum-Sudan: hospital based cross-sectional study. J Public Health Epidemiol. 2017;5:301-304.

40. Sharew G, Ilako D, Kimani K, Gelaw Y. Prevalence of diabetic retinopathy in Jimma University Hospital, Southwest Ethiopia. Ethiop Med J. 2013;51(2):105.

41. Kovarik JJ, Eller AW, Willard LA, Ding J, Johnston JM, Waxman EL. Prevalence of undiagnosed diabetic retinopathy among inpatients with diabetes: the diabetic retinopathy inpatient study (DRIPS). BMJ Open Diabetes Res Care. 2016;4.

42. Tawfeeq AS. Prevalence and risk factors of diabetic retinopathy among Iraqi patients with type 2 diabetes mellitus. Iraqi J Med. 2015;28:17-21.