



Original Research Article

PREDICTORS OF LATE PRESENTATION OF DIABETIC RETINOPATHY: A MISSED OPPORTUNITY FOR HEALTH SYSTEMS IN PAKISTAN

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ABSTRACT

Background

Diabetic retinopathy is one of the most common complications of diabetes which can lead to visual impairment or even blindness. However, early detection and prompt treatment can reduce the risk of visual impairment significantly. Therefore, it is important to detect the socioeconomic predictors of late presentation of diabetic retinopathy which was the objective of this study.

Methods

A cross sectional study was conducted in Retina department of Al- Shifa Trust Eye Hospital for duration of four months. All patients diagnosed with diabetic retinopathy for the first time were inducted and data was collected through an interview-based questionnaire. Classification into stages was done based on system developed by American Academy of Ophthalmology. Multivariable logistic regression was conducted to identify predictors of late presentation of diabetic retinopathy.

Results

Out of total sample (n= 243), 170 (70%) presented with vision threatening diabetic retinopathy. Final multivariate analysis demonstrated that patient registration category, and area of residence were the two statistically significant predictors of late presentation (VTDR) of disease. Patients who were registered in free (non-paying) category of the hospital had a 21.9 times higher risk of presenting with VTDR as compared to privately (fully paying) registered patients.

Conclusion

Socioeconomic variables were found to be statistically significant predictors of late presentation of diabetic retinopathy. Therefore, targeted services should be provided to the socioeconomically deprived people

Key words: Diabetic retinopathy, Late presentation, Diabetes, Developing countries, Predictor

Author's Contribution:

1 Conception, study design data collection & processing, critical review.2 & 4 conception & study design, data collection and processing.3-4 Data analysis and/or interpretation. Drafting of manuscript, critical review

INTRODUCTION

Diabetes mellitus is a global health concern, defined by ICD-11 as 'A metabolic disorder with heterogeneous etiologies which is characterized by chronic hyperglycemia and disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both.' The prevalence estimates place the figure to be around 9.3% (463 million people) of the global adult population aged 20-79 years [1]. According to the world health organization (WHO) global report on diabetes 2016 [2], the disease was responsible for 1.5 million deaths in 2012 alone, while the international diabetes federation (IDF) diabetes atlas (9th edition), reported 4.2 million deaths in 2019 [3]. It also described the disease prevalence in various countries, with Pakistan has shown a huge increase from the previously reported 7.5 million adult diabetics (20-79 years) in 2017 to 19.4 million people.

The global economic burden associated with the disease was estimated to be around 1.3 trillion USD in 2015 and is projected to rise to 2.2 trillion USD in 2030, in a 'baseline scenario' where only urbanization and demography are assumed to be the cause of change [4].

Diabetic retinopathy (DR) is the most common microvascular complication associated with the disease and is the 5th leading cause of blindness worldwide in people aged 50 years or older [5]. In Pakistan, the prevalence varies widely between provinces, with a pooled prevalence of 28.78% (variation of 10.6% - 91.3%) [6]. It is also the most common presentation at a retina clinic in the country's largest city [7].

Diabetic retinopathy may lead to decreased vision by maculopathy, which can occur at any stage of the disease, or complications of Proliferative disease (PDR), including vitreous hemorrhage, retinal detachment, neovascular glaucoma, and the probability increases with the duration of diabetes [8]. Other risk factors include poor glycaemic control [9], arterial hypertension, hyperlipidemia, and obesity [10] among others. Furthermore, there is evidence that HbA1c variation can also increase the risk of retinopathy progression [11].

Prevention strategies remain an important part of treatment to reduce the disease burden and stop progression in the early stages, with a consequent decrease in vision-threatening sequelae. Studies have shown a clear benefit of early intervention and the use of anti-VEGF drugs [12] and lasers [13] for the management of the disease.

However, there are many hurdles and challenges in the developing world where there are scarce eye care centers, lack of eye care providers, lack of a referral system, and absence of a national diabetes screening program, to name a few. Local studies have shown the importance of regional screening in the timely management of the disease and the need for patient education [14].

With the increasing prevalence of diabetic retinopathy in Pakistan, and the IDF report highlighting the number of undiagnosed cases, it is imperative to detect and treat patients in a cost-effective manner as early as possible in the course of the disease. To this end, factors responsible for late presentation should be elucidated in the hopes of eliminating the problem. The objectives of this study were to determine the stage of DR in patients presenting to the outpatient department (OPD) of Al-Shifa Trust Eye Hospital (ASTEH), Rawalpindi, Pakistan, and also to socioeconomic predictors of late presentation of the patient.

MATERIALS AND METHODOLOGY

It was a cross-sectional study to assess patients with diabetic retinopathy and evaluate predictors related to late presentation of Diabetic retinopathy. The study was conducted at the retina department of Al-Shifa Trust Eye Hospital, Rawalpindi, Pakistan. ASTEH is a tertiary eye care center with subspecialty clinics. Approval from the IRB committee of the Pakistan Institute of Ophthalmology was obtained. All patients

presenting to the Retina department from July to October, 2020 and diagnosed with DR were included in this study. Patients with DR in one or both eyes on their very first visit to other tertiary eye care centers were also included. The sample size was not pre-decided to include all patients visiting the retina department of ASTEH during the given period. Patients who had received prior laser treatments or Anti-VEGF drugs anywhere were not included.

Data Collection Procedure

Data were collected from the patients themselves unless they were very elderly or unable to understand English, Urdu, or Punjabi. In such cases, the data were taken from their attendants who were asked to inquire the patient regarding any questions the attendant was not confident in answering. Data were collected from patients after detailed ophthalmic examination including Objective and Subjective Refraction followed by an Anterior Segment examination with Slit lamp biomicroscope. Pupillary mydriasis was achieved with Tropicamide 1% and dilated funduscopy was done with a Slit-lamp biomicroscope using a 78D lens by a consultant ophthalmologist. An indirect Ophthalmoscope with a 20D lens was used in cases where required. Diagnosis of DR was based on the international system of classification developed by the American Academy of Ophthalmology (Table 1). Verbal informed consent was taken and data were collected based on a structured questionnaire. The data collection tool was translated into the Urdu language to increase the convenience for patients and to increase the uniformity of questions posed to the respondents.

Table 1: Classification of Diabetic Retinopathy

Disease severity level	Findings observed upon dilated ophthalmoscopy
No apparent retinopathy	No abnormalities detected
Mild Non-Proliferative Diabetic Retinopathy (NPDR)	Microaneurysms only
Moderate NPDR	More than just microaneurysms but less than the criteria of severe NPDR
Severe NPDR	Any of the following and no signs of proliferative retinopathy • More than 20 intraretinal hemorrhages in each of four quadrants • Definite venous beading in two or more quadrants • Prominent intraretinal microvascular abnormalities (IRMA) in one or more quadrants
Early PDR	Neovessels with criteria not met for high risk PDR
High Risk PDR	New vessels on or within one disc diameter of the optic disc (NVD) $\geq$ standard photograph 10A (about one-quarter to one-third disc area), with or without vitreous or preretinal hemorrhage; or vitreous and/or preretinal hemorrhage accompanied by new vessels, either NVD $<$ standard photograph 10A or new vessels elsewhere (NVE) $\geq$ one quarter disc area

Study Variables

Two main outcome variables were being investigated. The first variable was the Stage of DR based on the international classification of DR as described above. The second variable included Grades of DR based on its effect on visual functions and potential. The disease was classified into Vision threatening DR (VTDR)

which included Proliferative DR of any severity, CSME, and Advanced diabetic eye disease (ADED). All other stages were grouped into non-vision threatening DR (NVTDR).

Statistical Analysis

All the analysis was carried out in Statistical Package for Social Sciences (SPSS) version 20. Rigorous data cleaning was carried out on the complete data set before the final analysis. Data analysis was done at the individual patient level using data from the worst-seeing eye and conducted in two phases; descriptive analysis followed by inferential statistics. Descriptive statistics were generated for all variables. Categorical data were presented in the form of frequencies and percentages. Mean along with standard deviation and ranges were reported for continuous variables. Furthermore, mean and standard deviation were reported in inferential analysis for all continuous variables (homogenous and heterogeneous). A significance level of 5% was used for all inferential statistics. Logistic regression (forced entry method) was used for the univariable as well as multivariable analysis. Initially, the unadjusted odds ratio was calculated for all variables. Afterward, variables depicting statistical significance in univariable analysis were added in the final model for multivariable analysis to calculate the adjusted odds ratio.

RESULT

There were 243 patients included in the final analysis at the end of the study period, 129 males and 114 females, with a mean age of 57.4 ± 8.3 years. Of these individuals, 161 (66.3%) were from urban, and 81 (33.3%) were from rural areas. Monthly income varied from Rs.5000 to Rs.65000, with the mean being Rs.18,400 $\pm 11,184.25$. On the other hand, monthly expenditure data were available for 241 individuals, ranging from Rs.5000 to Rs.70,000, with a mean of Rs.25,834.02 $\pm 15,526.23$.

Presenting complaints that lead to the consultation included decreased visual acuity in 228 (93.8%) individuals, cataracts in 18 (7.4%), watering in 21 (8.6%), pain in 15 (6.2%), monocular diplopia in 12 (4.9%), itching in 8 (3.3%), while 3 (1.2%) individuals came for a routine check-up and 8 (3.3%) due to other complaints. The mean duration of complaints was 7.63 ± 11.44 months.

Of systemic disease, 4 individuals had no prior history of diabetes, while the rest of the individuals had the disease since 0.5 to 408 months, with a mean of 121.73 ± 71.85 months. Of those with the disease, 4 individuals were not taking any medicines, 113 were taking insulin and 114 were on oral medications and 8 were on diet management alone.

Hypertension was present in 152 individuals (62.6%); however, 18 (7.4%) people did not know of their status. Only 50 (20.6%) people reported smoking. Spectacle wear was reported by 126 (51.9%) individuals, whereas 63 (25.9%) reported having past ocular surgery, and only 5 (2.1%) individuals reported having prior ocular trauma. Family history of vision loss was reported by 13 (5.3%) individuals only, of which 3 (1.2%) were due to trauma, 2 (0.8%) due to glaucoma, 3 (1.2%) due to DR, 1 (0.4%) due to corneal opacity, and 4 (1.6%) due to other causes.

When asked about the time and place of the previous consultation, 128 participants responded, having a mean interval of 6.86 ± 11.39 months. Of these individuals, 47 (19.3%) had gone to a government eye hospital, 67 (27.6%) to a private eye setup, 3 (1.2%) to an optician, 6 (2.5%) to screening camps, and 5 (2.1%) to general physicians.

The mean time between the onset of symptoms and first contact with eye care was 3.975 ± 6.68 months, with a maximum of 42 months. The reason for the delayed presentation was asked and the majority of 168 (69.1%) individuals did not consider the decrease in vision to be a significant problem. Moreover, 24 (9.9%) individuals reported having transport issues, 51 (21%) reported financial issues, and 39 (16%) reported the non-availability of attendants to be the cause. Health-related delays and other causes were reported by 6 (2.5%) and 33 (13.6%) individuals respectively.

Awareness about diabetes and its complications were assessed, and 100 (41.2%) individuals were aware of the disease potentially affecting the eyes. The harmful effects on other organs were asked and 54 (22.2%) were aware of the effects on the heart, 95 (39.1%) were aware of its role in kidney damage, 61 (25.1%) were aware of effects on the brain, 19 were aware of the effects on gums (7.8%), and 132 (54.3%) were aware of its effects on pain sensation. 43 (17.7%) individuals did not know of any effects, whereas 47 (19.3%) reported other effects.

Public transport was used by the majority of 134 (55.1%) individuals, private transport by 19 (7.8%), personal transport by 81 (33.3%) people, whereas 9 (3.7%) used various means. The mean time to reach the hospital was 2.935 ± 2.32 hours, ranging from 0.2 to 12 hours. The mean time spent in the hospital was 3.372 ± 1.89 hours, ranging from 0.5 to 24 hours. Hospital expenditure ranged from Rs. 20 to 12000, with a mean of Rs. 2158.12 ± 1729.46 . Only 37 individuals reported not having any attendants with them during their time in the hospital. Eleven (4.5%) individuals reported having an associate in the hospital who helped them through the process.

On examination, right eye visual acuity with mild visual impairment (WHO criteria: 6/12-6/18) was present in 60 (24.6%) individuals, while moderate visual impairment (WHO criteria: 6/18-6/60) was present in 71 (29.2%) people. Visual acuity of CF or worse was present in 72 (29.6%) individuals. The remaining (16.4%) had a VA of 6/9 or better. The left eye visual impairment was mild in 46 (18.9%) individuals, moderate in 79 (32.5%), and CF or worse in 81 (33.3%) people. The rest of the individuals (15.2%) had a VA of 6/9 or better. Thus, the total eyes with mild and moderate impairment were 106 (21.8%) and 150 (30.8%) respectively, while 153 (31.4%) eyes had a VA of CF or worse. The remaining 77 (15.8%) eyes had a VA of 6/9 or better.

On fundus examination, 67 individuals had NVD in at least 1 eye, of which 20 had abnormalities less than, and 33 had more than the standard photograph 10A, while 9 had associated vitreous hemorrhage. Data for the remaining 5 individuals were not available. At least 32 people had NVE in at least 1 eye, with 22 individuals having an area less than, and 10 having more than $\frac{1}{2}$ disc area. Only 87 (35.8%) individuals had CSME. 21 (8.6%) people had Moderate-severe PDR, 41 (16.8%) had high-risk PDR and 46 (18.9%) had an advanced diabetic eye disease. The total number of patients with VTDR was 170 (70%). Finally, Logistic regression was used to predict late presentation as a function of VTDR (Table 3).

Table 2: Stage and duration of diabetes

Stage	Duration (years)				Total
	< 5	5-10	11-15	> 15	
Mild NPDR	24	11	7	4	46 + 1
Moderate NPDR	4	23	11	4	42 + 1
Severe NPDR	7	20	11	7	45
Early PDR	1	5	8	7	21
High-risk PDR	8	13	13	6	40 + 1
ADED	8	16	13	8	45 + 1

Table 3: Logistic regression for VTDR

Predictors	Unadjusted OR				Adjusted OR		
	OR	95% C.I. for OR	P value		OR	95% C.I. for OR	P value
Patient registration category							
Zakat/charity	32.7	6.9,156.6	<0.001		21.9	4.7,110.5	<0.001
Subsidized	14.1	3.2,66.4	<0.001		14.2	2.4,69.1	0.001
Private	1				1		
Education							
No education	5.5	1.1,19.9	0.014		2.8	0.3,14.6	0.181
Primary/middle school	2.8	0.2,11.8			1.1	0.1,11.1	0.466
Secondary/higher secondary school	2.4	0.520,8.000			1.8	0.2,8.7	0.593
Graduation or higher	1				1		
Income (Rs.)							
Less than 10,000	25.0	1.0, 520.4	0.038				
10,000 – 20,000	9.7	0.6,87.2			Not used in the multivariate analysis as data were available for 65 people only		
20,001 – 30,000	17.5	1.3,250.8	0.035				
30,001 – 40,000	1.7	0.4,37.8					
Greater than 40,000	1						
Residence							
Urban	1						
Rural	3.7	1.4,6.7	0.001		2.2	1.0,5.2	0.05
Time to reach (hrs)							
0-1.99	1						
2-3.99	2.9	1.7,4.1	0.014		1.9	0.5,3.9	0.324
4-5.99	2.1	0.9,4.6	0.050		1.1	0.9,2.2	0.729
6-7.99	1.4	0.0,4.3			0.4	0.1,2.1	0.435
8-9.99	3.5	0.2,31.5			1.5	0.9,13.6	0.781
≥10	3.5	0.2,31.5			1.9	0.9,15.1	0.731

Cox and Snell R square: 0.169, Nagelkerke R square: 0.240

Adjusted for Patient category, Education level, residence, and time to reach the hospital.

DISCUSSION

At the end of the study period, data were available for 243 patients, of whom income data were present for only 65 individuals. VTDR was defined as having CSME, PDR, or ADED. This was used as a marker for late presentation, after a thorough ocular examination. Various causes of late presentation were recorded, including personal, health, finance, and transport-related factors. In the final logistic analysis, factors that have an inherent relationship with VTDR were not included as it was a marker of late presentation. Multivariate analysis was significant for the class of patients presenting to the hospital and their residence, which are indirect markers of socioeconomic status.

There are various reasons for late presentation in developing countries. A recent study in south India showed that the majority of patients presented late as 'their eyes were normal at the time', which shows a lack of an understanding of the asymptomatic nature of the disease until very late in the course. Also reported were delays related to financial issues and the non-availability of attendants [15]. This is in line with our study in which 69.1% did not consider the visual loss to be significant, and another 21% had financial problems, whereas 16% had no attendants to accompany them. However, our study did not show any association between distance traveled and age with the late presentation, unlike the former study. Also scheduled follow-up times were not recorded.

Awareness about diabetes and its complications among the masses is limited in low-resource countries. A local study in Punjab, Pakistan showed that only 36% were aware of diabetes is associated with blurred vision, and 31.2% were aware of the complications to the eye [16]. This figure may have been slightly overestimated to 41.2% in our study, as patients were presenting to an eye hospital with ocular complaints. Previous studies have also shown socioeconomic status to be associated with diabetes and an increase in mortality [17-18]. Some have highlighted social deprivation [19] as a risk factor for late presentation, which is in line with our study. However, we did not use socioeconomic scoring or index calculators. Instead, indirect markers were analyzed including the class of patients presenting to the hospital, their residence, and income, the latter of which was not used in the multivariable analysis of our study, as data for income was available for 65 individuals only. Univariate analysis shows a trend that lower income is associated with VTDR, along with lower education levels, rural residence, and the time taken to reach the hospital. However, distance from the hospital was not a significant factor in our univariate model, and in the final multivariate analysis, only the patient category and residence were significant, both of which are indirect markers of socioeconomic status.

As low socioeconomic status is associated with a higher prevalence of diabetes, there is an increased risk of VTDR in this group, which might have influenced our analysis. However, the duration of diabetes was not included in the final logistic regression as it is an independent risk factor for VTDR and it would not be accurate in assessing the cause of late presentation.

Systemic illnesses have been shown to influence retinopathy progression. Hypertension, nephropathy, and non-healing ulcers are associated with diabetic retinopathy progression, and a risk score can help predict retinopathy [20]. Such scoring methods may be helpful in our setup especially where people present late and with NVTDR progression. Of note, however, is that our study did not record the progression of NVTDR to VTDR as this was a cross-sectional study.

CONCLUSION

Socioeconomic status and residence appear to be important predicting variables for the presentation of VTDR, which was used as a marker of late presentation in our study. Awareness about diabetes and its complications is lacking among the masses, and there appears to be a lack of initiative on behalf of the patients to present early despite visual symptoms, until late in the disease.

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FUTURE STUDIES

Future studies should have fixed follow-up dates to accurately calculate the delay in presentation in days and assess the progression of NVTDR to VTDR in those presenting late. HbA1c levels should be measured and other causes of delays should be inquired in detail. Finally, socioeconomic scoring using valid indices may be used for a more accurate prediction.

REFERENCES

1. Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N, Colagiuri S, Guariguata L, Motala AA, Ogurtsova K, Shaw JE. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas. *Diabetes research and clinical practice*. 2019 Nov 1;157:107843.
2. Roglic, G. (2016). WHO Global report on diabetes: A summary. *International Journal of Noncommunicable Diseases*, 1(1), 3.
3. World Health Organization. ((2016World Health diabetes. Global report on .
.Organization<https://apps.who.int/iris/handle/10665/204871>
4. International Diabetes Federation. *IDF Diabetes Atlas, 9th edn*. Brussels, Belgium: 2019. Available at: <https://www.diabetesatlas.org>
5. Bommer C, Sagalova V, Heeseemann E, Manne-Goehler J, Atun R, Bärnighausen T, Davies J, Vollmer S. Global economic burden of diabetes in adults: projections from 2015 to 2030. *Diabetes care*. 2018 May 1;41(5):963-70.
6. Steinmetz JD, Bourne RR, Briant PS, Flaxman SR, Taylor HR, Jonas JB, Abdoli AA, Abrha WA, Abualhasan A, Abu-Gharbieh EG, Adal TG. Causes of blindness and vision impairment in 2020 and trends over 30 years, and prevalence of avoidable blindness in relation to VISION 2020: the Right to Sight: an analysis for the Global Burden of Disease Study. *The Lancet Global Health*. 2021 Feb 1;9(2):e144-60.
7. Mumtaz SN, Fahim MF, Arslan M, Shaikh SA, Kazi U, Memon MS. Prevalence of diabetic retinopathy in Pakistan; A systematic review. *Pakistan journal of medical sciences*. 2018 Mar;34(2):493.
8. Khan A, Riaz Q, Soomro F, Qidwai U, Qazi U. Frequency and patterns of eye diseases in retina clinic of a tertiary care hospital in Karachi. *Pakistan Journal of Ophthalmology*. 2011 Sep 30;27(3).
9. Nentwich MM, Ulbig MW. Diabetic retinopathy-ocular complications of diabetes mellitus. *World journal of diabetes*. 2015 Apr 15;6(3):489.
10. Nathan DM, DCCT/Edic Research Group. The diabetes control and complications trial/epidemiology of diabetes interventions and complications study at 30 years: overview. *Diabetes care*. 2014 Jan 1;37(1):9-16.
11. Atchison E, Barkmeier A. The role of systemic risk factors in diabetic retinopathy. *Current ophthalmology reports*. 2016 Jun 1;4(2):84-9.

12. Park SP. Long-term HbA1c variability and the progression of diabetic retinopathy in patients with type 2 diabetes. *Investigative Ophthalmology & Visual Science*. 2019 Jul 22;60(9):1073-.
13. Siddiqui MR. New Perspectives in the Management of Diabetic Macular Edema. *Pakistan Journal of Ophthalmology*. 2014 Sep 30;30(3).
14. Chappelov AV, Tan K, Waheed NK, Kaiser PK. Panretinal photocoagulation for proliferative diabetic retinopathy: pattern scan laser versus argon laser. *American journal of ophthalmology*. 2012 Jan 1;153(1):137-42.
15. Nizamani NB, Talpur KI, Awan F, Khanzada MA, Memon MN. Results of a community-based screening programme for diabetic retinopathy and childhood blindness in district Hyderabad, Pakistan. *BMJ open ophthalmology*. 2017 Dec 1;2(1):e000099.
16. Vengadesan N, Ahmad M, Sindal MD, Sengupta S. Delayed follow-up in patients with diabetic retinopathy in South India: social factors and impact on disease progression. *Indian journal of ophthalmology*. 2017 May;65(5):376.
17. Fateen S. Awareness about Diabetes Mellitus in Rural Population of Punjab.
18. Kyrou I, Tsigos C, Mavrogianni C, Cardon G, Van Stappen V, Latomme J, Kivelä J, Wikström K, Tsochev K, Nanasi A, Semanova C. Sociodemographic and lifestyle-related risk factors for identifying vulnerable groups for type 2 diabetes: a narrative review with emphasis on data from Europe. *BMC endocrine disorders*. 2020 Mar;20(1):1-3.
19. Saydah S, Lochner K. Socioeconomic status and risk of diabetes-related mortality in the US. *Public health reports*. 2010 May;125(3):377-88.
20. Lane M, Mathewson PA, Sharma HE, Palmer H, Shah P, Nightingale P, Tsaloumas MD, Denniston AK. Social deprivation as a risk factor for late presentation of proliferative diabetic retinopathy. *Clinical ophthalmology (Auckland, NZ)*. 2015;9:347.
21. Nwanyanwu KH, Talwar N, Gardner TW, Wrobel JS, Herman WH, Stein JD. Predicting development of proliferative diabetic retinopathy. *Diabetes care*. 2013 Jun 1;36(6):1562-8.



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