ORIGINAL ARTICLE

Factors Associated with Delayed Eye Examination Among Diabetic Patients: A Cross-Sectional Study

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ABSTRACT

Background: Failure to get an eye exam early is a major obstacle in preventing and detecting diabetic eye diseases. This study aimed to assess the prevalence of undergoing delayed eye examination and to identify other demographic, clinical, and healthcare-related factors associated with such delayed eye examination among diabetic patients. **Methods:** A cross-sectional analytical study was conducted in the Diabetes Clinic and Ophthalmology Department of a tertiary care teaching hospital between January and June, 2022, enrolling 80 diabetic patients. A structured questionnaire and clinical data collection form were used to collect data on socio-demographic characteristics, diabetes related factors, awareness about diabetic eye disease, and healthcare accessibility factors. A chi-square test was performed to see if there were any associations between potential predictors and delayed eye examination, and a multivariable logistic regression analysis was conducted. **Results:** 51(63.8%) participants had a delayed eye examination, while 29(36.3%) had a timely eye examination. A total of 45(56.3%) participants had poor awareness of the diabetic eye complications. There was a significant association between treatment modality and delayed examination (p=0.029) and a borderline association between dyslipidemia and delayed examination (p=0.050). Multivariable analysis showed that insulin therapy was independently associated with delayed eye examination (AOR=5.94, 95% CI: 1.31–26.91, p=0.021). **Conclusion:** Diabetic patients were more likely to be late for their eye exams, reflecting a lack of preventive diabetic eye care. Awareness and referral systems should be improved for early detection. Multi-center research is needed to assess strategies to improve screening adherence.

Keywords: Diabetes Mellitus; Diabetic Retinopathy; Health Services Accessibility; Risk Factors; Vision Screening.

INTRODUCTION

Diabetes mellitus is a growing worldwide health problem and its prevalence is increasing causing a significant burden of related chronic complications such as diabetic retinopathy (DR) which is the most common preventable loss of sight in working age people [1]. In the early stages, there are no obvious retinal changes, but persistent hyperglycemia causes retinal microvascular damage as the result of oxidative stress, inflammation, and endothelial dysfunction that leads to progressive changes in the retina [2]. Recent studies have shown that early detection of diabetic eye disease and timely intervention greatly decrease the risk of vision-threatening diabetic eye disease, and enhance long-term visual outcomes [3]. Although there are established guidelines for regular eye screening, many diabetic patients are not getting timely eye screenings, especially in low- and middle-income countries where access to healthcare, awareness, and referral are weak [4].

Multiple factors have been shown to affect the delays in diabetic retinopathy screening, as evidenced by systematic reviews which have identified poor knowledge of diabetic eye complications, lack of referral by a health care professional, socioeconomic limitations, and distance to health care facilities [5]. In addition, duration of diabetes, glycemic control, hypertension, and dyslipidemia are risk factors for ocular complications, highlighting the need for regular eye monitoring [6]. While retinal imaging, tele-ophthalmology, and artificial intelligence-based screening strategies have enhanced early detection, these tools are dependent on patient engagement and timely use of eye care services [7]. In developing health care systems, there remains a gap between diabetes care and eye care that remains a missed opportunity for the prevention of avoidable blindness [8].

The rationale for this study is based on the lack of evidence on the factors associated with delay for diabetic patients undergoing eye examination in a tertiary health care setting. Knowledge of the demographic, clinical, awareness, and healthcare accessibility factors can help in formulating specific strategies for better diabetic eye screening practices. Hence, the present study aimed to determine the prevalence of delayed eye examination in diabetic patients. It also aimed to find demographic, clinical, and health access factors that are associated with delayed ophthalmological assessment.

METHODOLOGY

The analytical cross-sectional study was conducted in diabetic patients attending the Diabetes Clinic, Ophthalmology Department in a tertiary care teaching hospital in Karachi, between January 2022 and June 2022. The number of diabetic patients enrolled was 80 through a consecutive sampling technique. The required sample size was calculated using PASS Power Analysis and Sample Size Software (NCSS, LLC, Kaysville, Utah, USA) [9]. The sample size was calculated using the formula $n = Z^2 P(1-P)/e^2$, where *n* represents the required sample size, Z is the standard normal deviate corresponding to the confidence level, P is the estimated prevalence, and e is the absolute precision. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies.

Patient interviews and review of medical records were used to collect data using a structured questionnaire and a clinical data collection form. The questionnaire was formulated based on the literature and incorporated the following items: sociodemographic data, diabetes history, type of diabetes treatment, glycemic control (HbA1c if available), comorbidities, previous ophthalmological referral, knowledge about diabetic eye complications, and factors related to access to healthcare. A pre-established scoring system was used to determine awareness of diabetic eye disease. Patients ≥ 18 years of age with confirmed DM who attended the study departments and had information available about previous eye examinations were selected. Patients with incomplete clinical data, non-diabetic eye diseases that interfered with the eye exam, heavy eye trauma/surgery in the past, or those who were unable to provide accurate information were excluded.

The main outcome was delayed eye examination, which was defined as not having an eye examination within the recommended screening interval since a diagnosis of diabetes or clinical indication for it. The participants were divided into two groups: timely and delayed examination, and demographic, clinical, awareness-related, and healthcare factors were evaluated that may be associated with delayed examination. SPSS version 26.0 (Released 2019; IBM Corp., Armonk, NY, USA; RRID: SCR_016479) was used for data analysis. Variables were described as continuous mean ± standard deviation (SD) or median (interquartile range (IQR)), and categorical (frequencies and percentages).

The Chi-square test and the appropriate parametric or non-parametric tests were used to study the association of potential predictors and delayed eye examination. Variables with clinical significance or association were entered into a multivariable logistic regression analysis to determine independent predictors. Odds Ratios (ORs) with 95% confidence intervals (CIs) are presented and $p < 0.05$ was regarded as statistically significant. Study approval (LT/0014/2022) was acquired from the institutional head committee prior to the start of the study. Informed consent was obtained and patient information was kept confidential throughout the study.

RESULTS

The socio-demographic characteristics of the study participants are presented in **Table I**. The average age of the participants was 54.4 ± 11.2 years. The study population was dominated by males 47(58.8%) and females 33(41.2%). A total of 51(63.8%) were from urban areas, while 29 (36.2%) were from rural areas. Secondary education was the most prevalent 32(40.0%), followed by graduate or higher education 18(22.5%), primary education 16(20.0%), and no formal education 14(17.5%). Employment status revealed that 30(37.5%) participants were employed, 25(31.3%) were housewives, and 25(31.2%) were retired or unemployed.

Table I: Socio-demographic Characteristics of Study Participants (N=80)

Variable	Category	n (%)
Age (years), mean ± SD	—	54.4 ± 11.2
Gender	Male	47 (58.8)
	Female	33 (41.2)
Residence	Urban	51 (63.8)
	Rural	29 (36.2)
Educational status	No formal education	14 (17.5)
	Primary education	16 (20.0)
	Secondary education	32 (40.0)
	Graduate or above	18 (22.5)
Employment status	Employed	30 (37.5)
	Unemployed	25 (31.3)
	Housewife/retired	25 (31.2)

The clinical features and the symptoms of the participants related to diabetes are summarized in **Table II**. Most of the patients 72(90.0%) had type 2 diabetes mellitus (DM), and 8(10.0%) had type 1 diabetes mellitus (DM). For duration of diabetes, 31 persons (38.7%) had diabetes for more than 10 years, 24(30.0%) for 5-10 years, and 25(31.3%) for less than 5 years. The most frequently used treatment modality was oral antidiabetic drugs 34(42.5%), followed by combination therapy 29(36.2%), and insulin therapy 17 (21.3%). 47(58.7%) participants had poor glycemic control, and 35(43.8%) participants had hypertension and dyslipidemia, respectively.

Table II: Diabetes-Related Clinical Characteristics of Study Participants (N=80)

Variable	Category	n (%)
Type of diabetes	Type 1 diabetes	8 (10.0)
	Type 2 diabetes	72 (90.0)
Duration of diabetes	<5 years	25 (31.3)
	5–10 years	24 (30.0)
	>10 years	31 (38.7)
Treatment modality	Oral antidiabetic drugs	34 (42.5)
	Insulin therapy	17 (21.3)
	Combination therapy	29 (36.2)
HbA1c status	Good control (<7%)	33 (41.3)
	Poor control (≥7%)	47 (58.7)
Hypertension	Present	35 (43.8)
	Absent	45 (56.2)
Dyslipidemia	Present	35 (43.8)
	Absent	45 (56.2)

The results of the eye examination and information about diabetic eye complications are summarized in **Table III**. A total of 51(63.8%) of the respondents were observed to have their eye examination delayed, while 29(36.3%) had a timely eye examination. The overall mean awareness score was 2.31 ± 1.57, of whom 45(56.3%) had poor awareness, 29(36.2%) had moderate awareness, and 6(7.5%) had good awareness. 36(45.0%) of the patients reported having awareness that diabetes may affect vision, and 34(42.5%) knew about diabetic retinopathy. 32 patients (40.0%) received counseling for diabetic eye complications.

Table III: Eye Examination Status and Awareness Regarding Diabetic Eye Disease Among Participants (N=80)

Variable	Category	n (%)
Eye examination status	Timely examination	29 (36.3)
	Delayed examination	51 (63.8)
Awareness score	Mean ± SD	2.31 ± 1.57
Awareness level	Poor (0–2)	45 (56.3)
	Moderate (3–4)	29 (36.2)
	Good (5)	6 (7.5)
Aware diabetes affects vision	Yes	36 (45.0)
	No	44 (55.0)
Heard about diabetic retinopathy	Yes	34 (42.5)
	No	46 (57.5)
Received diabetic eye counseling	Yes	32 (40.0)
	No	48 (60.0)

The healthcare-related factors that may affect eye examination are shown in **Table IV**. 33(41.3%) reported being referred by their doctor for eye care, while 47(58.7%) said they were not referred. As for diabetes follow-up, 28(35.0%) reported regular follow-up, 32(40.0%) occasional, and 20(25.0%) rare. 35(43.8%) participants reported financial barriers as an issue with access to eye care, and 20(25.0%) participants reported transportation- or distance-related barriers.

Table IV: Healthcare-Related Factors and Barriers Among Study Participants (N=80)

Variable	Category	n (%)
Previous physician referral	Yes	33 (41.3)
	No	47 (58.7)
Diabetes follow-up pattern	Regular	28 (35.0)
	Occasional	32 (40.0)
	Rarely	20 (25.0)
Financial barrier	Yes	35 (43.8)
	No	45 (56.2)
Distance/travel barrier	Yes	20 (25.0)
	No	60 (75.0)

There was a statistically significant association between delayed examination and potential demographic, clinical, awareness-related, and healthcare factors (p=0.029), with the highest eye examination delays observed among the patients who were taking oral antidiabetic drugs (25(73.5%)) and insulin therapy (13 (76.5%)). The 27 patients who were examined later were more likely to have dyslipidemia than 8 of the patients who were examined on time (p=0.050).

There was no statistically significant difference in the frequencies of poor glycemic control, poor awareness, lack of physician referral, and financial barriers between the delayed examination cases, as shown in **Table V**.

Table V: Factors Associated with Delayed Eye Examination Among Diabetic Patients(N=80)

Variable	Delayed Examination n (%)	p-value
Male gender	30 (63.8)	0.96
Rural residence	20 (69.0)	0.46
Diabetes duration >10 years	23 (74.2)	0.14
Oral antidiabetic therapy	25 (73.5)	**0.029**
Insulin therapy	13 (76.5)	
Combination therapy	13 (44.8)	
Poor HbA1c control	34 (72.3)	0.095
Hypertension	24 (68.6)	0.39
Dyslipidemia	27 (77.1)	**0.050**
Poor awareness level	33 (73.3)	0.080
No physician referral	34 (72.3)	0.090
Financial barrier	18 (51.4)	0.074

The distribution pattern of delayed eye examination across different demographic, clinical, and healthcare-related factors among diabetic patients is shown in **Figure 1**. More delayed assessment was noted in groups with insulin therapy, dyslipidaemia, long duration of diabetes mellitus, and poor diabetes control.

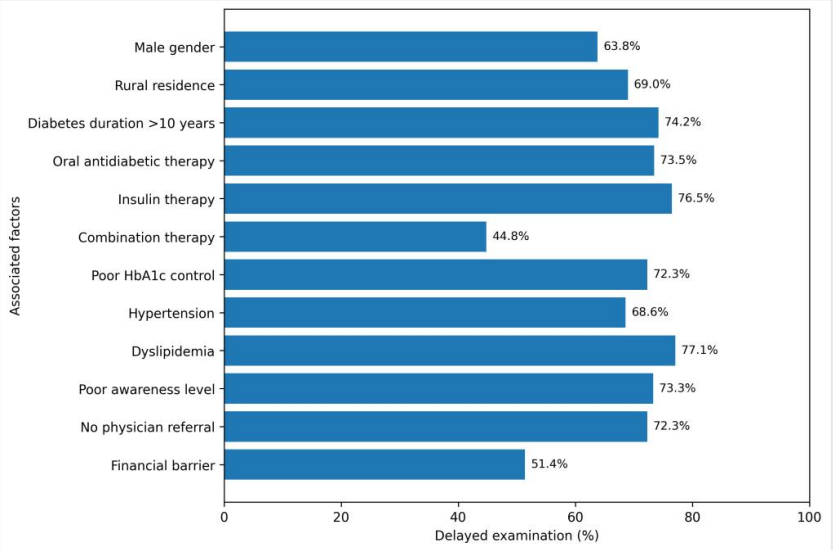


Figure 1: Factors Associated with Delayed Eye Examination Among Diabetic Patients.

Multivariable logistic regression was used to determine factors independently associated with delay to eye examination and results are shown in **Table VI**. The association of insulin therapy with delayed eye examination remained significant after adjustment for potentially confounding factors (AOR=5.94, 95% CI: 1.31–26.91, p=0.021). Dyslipidemia (AOR=2.87, 95% CI: 0.94–8.76) and poor glycemic control (AOR=2.41, 95% CI: 0.79–7.34) were associated with higher odds, but not statistically significant. Likewise, insufficient awareness and no physician referral showed associations with delayed exam but were not found to be independent statistically significant predictors in the final model.

Table VI: Multivariable Logistic Regression Analysis for Predictors of Delayed Eye Examination

Predictor	Adjusted OR	95% CI	p-value
Insulin therapy	5.94	1.31–26.91	0.021
Oral therapy	3.11	0.89–10.91	0.076
Dyslipidemia	2.87	0.94–8.76	0.063
Poor glycemic control	2.41	0.79–7.34	0.122
Poor awareness score	1.37	0.96–1.95	0.084
No physician referral	1.89	0.68–5.26	0.220
Financial barrier	0.36	0.13–1.06	0.065

The study findings demonstrated a considerable gap in diabetic eye care, with delayed ophthalmological assessment being a common issue among diabetic patients. Delayed examination was associated with multiple patient-related, clinical, and healthcare-related factors, including limited awareness, inadequate referral practices, and barriers affecting access to eye care services.

DISCUSSION

The ability to detect retinal problems early and manage them appropriately makes diabetic eye screening one of the most important methods of preventing unnecessary visual loss. The present study showed that there was a significant gap between diabetes care and ophthalmological services, as observed for delayed eye examination in 51(63.8%) diabetic patients. In low- and middle-income countries (LMICs), there are similar issues with delayed attendance for diabetic eye screening (DES), which is a significant barrier to high-quality diabetic retinopathy prevention [10]. Inadequate awareness, poor referral patterns, and availability of health services have been other important factors associated with low uptake of diabetic retinopathy screening identified by previous systematic reviews [11].

The rate of delayed examination in our study may be explained by the lack of patient awareness, poor coordination between diabetes clinics and ophthalmology services, and the lack of focus on prevention of eye disease. The mean awareness score in our population was 2.31 ± 1.57, and poor awareness was seen in 45(56.3%) participants. Recent research has shown that inadequate information about DR and the lack of symptoms in early DR is strongly associated with decreased participation in recommended screening [12,13]. In addition, systematic reviews and meta-analyses have demonstrated that structured interventions in education are effective in increasing the knowledge, awareness, and adherence of patients to recommendations for screening for diabetic retinopathy [14].

Other factors that affected ophthalmological assessment in our study included healthcare system-related factors. The physicians' referrals for eye examination were inadequate, as 47(58.7%) of the participants had not been referred by their physicians previously. Diabetic retinopathy screening attendance has been shown consistently in previous studies to be closely associated with non-recommendation of screening by a healthcare provider (HPP) [15]. Further, financial constraints (35(43.8%)) and transportation-related problems (20 (25.0%)) reported in the current study align with those reported from resource-constrained environments, which include indirect costs of care, transportation issues, and poor access to eye-care facilities, all of which have an adverse effect on screening uptake [16]. In recent years, there has been evidence that improving referral systems and embedding eye screening into primary care for diabetes may enhance the provision of eye screening and minimize missed opportunities for early screening [17].

In the present study, clinical characteristics also had a significant impact on screening practices in people with diabetes. Patients with poor glycemic control and dyslipidemia had higher rates of delayed eye exams, and dyslipidemia had an almost statistically significant association in univariate analysis (p=0.050). Longer duration of diabetes, higher levels of HbA1C, hypertension, and lipid abnormalities are known to be factors that exacerbate the risk of DR, and it is important to provide regular ophthalmological monitoring [18]. In addition, insulin use was an independent predictor of delayed examination in our analysis (AOR=5.94, 95% CI: 1.31–26.91, p=0.021), which could be due to the increased

complexity of the disease in insulin users and/or the longer duration of diabetes in these patients. Recent research has identified the need to integrate routine diabetes monitoring with retinal screening, including screening for cardiovascular risk and monitoring of HbA1c, for the early detection of diabetic eye disease [19].

While there has been a significant improvement in the potential for early detection through retinal imaging, tele-ophthalmology, and screening using artificial intelligence, there is a need for patient engagement and readiness of the healthcare system [20]. It has recently been shown that technology-assisted screening methods can increase access to diabetic eye care in LMICs, but poor referral systems, lack of awareness, and lack of follow-up are significant barriers [21]. Hence, a multi-layered approach involving patient education, training of health care providers, implementation of systematic referral systems, and the provision of convenient screening services is needed to enhance practices in diabetic eye examinations. There are a few limitations of this study, such as the cross-sectional design, which does not allow for an assessment of the temporal relationships between associated factors and delayed examination [22]. The sample size of the study is relatively small in a single tertiary health care facility, which may not be generalizable. More large population-based, longitudinal, multicenter studies to continue to examine factors associated with delayed diabetic eye exams and implement interventions to increase screening adherence are recommended.

CONCLUSION

Delayed eye examination was seen among 63.8% of diabetic patients, and limited awareness, lack of good referral practices, and inadequate accessibility of healthcare were identified to be associated with delayed eye examination. The association of the treatment modality and dyslipidemia with delayed ophthalmological assessment was identified. This research underscores the importance of better collaboration between diabetes and eye care providers to further optimize early screening and prevention of diabetic vision complications. Further multicenter longitudinal research is suggested to assess specific interventions to increase adherence to diabetic eye examination.

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