



## AWARENESS AND PRACTICES REGARDING EYE DISEASES AMONG PATIENTS WITH DIABETES

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### Abstract

**Background:** The increasing prevalence of diabetes is leading to a rise in eye diseases, augmenting the risk of sight-threatening complications. This study aimed to evaluate the prevalence, awareness, and practices regarding eye diseases among patients with diabetes in KSA. **Methods:** This was a cross-sectional study among diabetics at two primary healthcare centers in Saudi Arabia, who were selected by convenience sampling. 323 patients with diabetes completed a self-administered questionnaire assessing prevalence, awareness, and practices regarding eye diseases, besides health status and quality of care measures. Descriptive analyses followed by exploratory subgroup analyses and linear regressions were performed to investigate factors associated with awareness and practices. **Results:** While diabetic retinopathy was reported by 40.9% of patients with type 1 diabetes and 9.8% of patients with type 2 diabetes, 35.8% and 12.6% of all participants reported cataract and glaucoma, respectively. Awareness that diabetes could damage the eyes was reported by almost all participants; the majority were also aware of the importance of glycemic control and regular eye examination in preventing eye diseases. In contrast, only 70.5% of participants underwent an eye examination by an ophthalmologist during the past year. Eye examination was associated with better patient awareness. Barriers mentioned by patients revealed a lack of knowledge about screening guidelines, in particular regarding the preventive nature of eye examinations. **Conclusions:** Despite high levels of awareness regarding diabetic eye diseases, a significant proportion of patients with diabetes did not report annual eye examinations. Both healthcare strategic efforts targeting the promotion of regular eye examinations and initiatives aiming at improving knowledge of screening guidelines should be encouraged.

**Keywords:** Diabetes, Ocular complications, Diabetic retinopathy, Awareness, Practices.

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**Introduction:**

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by high levels of blood glucose. It causes damage to different organs and body tissues, such as the heart, nerves, kidneys, eyes, and blood vessels<sup>(1)</sup>. DM is classified into three major types: type 1 diabetes, type 2 diabetes, and gestational diabetes<sup>(2)</sup>. Eye diseases among patients with diabetes are one of the microvascular complications of DM. It can affect 24% of diabetic patients who have had the disease for 10–15 years<sup>(3)</sup>. It is estimated that globally around 35% of all diabetic patients<sup>(4, 5)</sup>. In Saudi Arabia, the prevalence of eye diseases among patients with diabetes was found to be 28%–36% among diabetic patients in studies from different areas of the country<sup>(6-9)</sup>.

Eye diseases among patients with diabetes are the leading cause of avoidable visual impairment and blindness worldwide<sup>(10)</sup>. Diabetes glycemic control is an important factor in eye diseases among patients with diabetes. People with poor glycemic control have a higher risk for eye diseases<sup>(11)</sup>; a study from Australia showed that diabetic patients with poor indicators of glycemic control had three to four times more chances of eye diseases as compared with those with better control<sup>(12)</sup>. The duration of DM is also a significant factor in developing eye diseases. The longer the duration of DM, the higher the risk for eye diseases<sup>(3, 11)</sup>.

The majority of eye diseases with diabetes patients present in late stages due to the silent nature of the disease<sup>(13, 14)</sup>. Hence, screening annually is essential for early detection as it decreases the prevalence of visual impairment and blindness in diabetic patients and allows intervening on time<sup>(9, 14-16)</sup>. Diabetes mellitus is a public burden in Saudi Arabia as 23%–32% of its adult population suffers from the disease<sup>(17-19)</sup>. Saudi Arabia is also among the top 10 countries with the prevalence of eye diseases among patients with diabetes<sup>(20)</sup>.

Additionally, diabetes is associated with macrovascular complications such as cerebrovascular diseases, kidney diseases, neural damage, and eye diseases<sup>(21-23)</sup>. Among microvascular complications, vision loss from diabetic retinopathy<sup>(24, 25)</sup> may be one of the most devastating complications for affected individuals. Currently, with the rising prevalence of diabetes<sup>(26, 27)</sup>, the latter complication emerges as a leading cause of avoidable visual impairment and blindness worldwide<sup>(10)</sup>. Additionally, other eye diseases that may compromise vision, such as cataracts<sup>(25)</sup> and glaucoma<sup>(26)</sup>, appear to increase in prevalence among patients with diabetes<sup>(10, 28)</sup>.

Optimal management of diabetic retinopathy should include annual screening, adequate control

of associated risk factors, and timely treatment<sup>(24)</sup>. Furthermore, a significant element of optimal management, which is often undervalued, is the improvement of awareness and education among diabetic patients<sup>(28, 29)</sup>. Focusing on these parameters could enable actions targeting preventive strategies more effectively. Previous studies assessing awareness and practices regarding eye diseases in patients with diabetes were mainly based in low and middle-income countries, often reporting poor results<sup>(28-43)</sup>. Surprisingly, the association between poor awareness and/or practices and diabetic eye diseases has also been reported in high-income countries<sup>(10, 44-46)</sup>.

Further and broader exploration and improved awareness and practices regarding eye diseases in patients with diabetes in general, not only focusing on diabetic retinopathy, may provide multiple benefits to patients and, consequently, to national healthcare systems. For example, it has been shown that ophthalmologic screening for patients with diabetes is highly cost-effective, compared to routinely provided medical interventions<sup>(47)</sup>. Furthermore, it was demonstrated that patients with diabetes could develop expertise in the everyday management of their condition<sup>(48)</sup>. Finally, it has been reported that improving patient awareness of updated diabetes care recommendations and empowering them drives better diabetes outcomes<sup>(49)</sup>.

In that context, the aims of our study were first to describe eye diseases reported by patients with diabetes, second to assess their awareness and practices related to the prevention of diabetic eye disease, and finally, to investigate potential determinants of patient awareness.

**Methods****Study setting and study population**

This cross-sectional study design was conducted among diabetics at two primary healthcare centers in Saudi Arabia, who were selected by convenience sampling. A total of 323 patients with diabetes with cognitive impairment or gestational diabetes were recruited and completed a self-administered questionnaire assessing prevalence, awareness, and practices regarding eye diseases, besides health status and quality of care measures.

**Study instrument**

Patients' self-reported outcomes harvested by postal questionnaire were considered. The core questionnaire, described in detail elsewhere<sup>(50)</sup>, was enriched with a thematic module entitled "Eyes and diabetes" that investigated eye diseases and treatments, eye examinations by an

ophthalmologist along with their barriers and facilitators, as well as awareness of risk factors and prevention of diabetic eye diseases.

### Statistical analysis

First, descriptive analyses of participants' characteristics and eye-related variables were performed: means (SD) or percentages were computed for continuous or categorical variables respectively, as well as 95% confidence intervals for the prevalence of eye-related variables. Second, exploratory subgroup analyses were performed using the T-test or chi-squared test, as appropriate. Finally, linear regressions were used to explore the association between the awareness score and explanatory variables a priori hypothesized to be associated with awareness: type of diabetes, age, gender, education, duration of diabetes at the time of recruitment, local diabetes association membership, presence of diabetic retinopathy, and

eye examination by an ophthalmologist during the past two years. All analyses were performed using SPSS 23.

### Ethical considerations

This study was approved by the University Ethics Review Committee. Written informed consent was obtained from all study participants before enrolment in the study, and data are being kept confidential and anonymous.

### Results

Table (1) shows the description of the study population. In summary, the mean age of respondents was 66.5 years and 38.7% were women. Whereas the majority (83.3%) reported type 2 diabetes, 57.5% were treated with insulin and/or other anti-diabetic injections. Also, 18.4% were current smokers, and 31% were physically inactive.

**Table (1)** Participants characteristics (n= 323)

	%
<b>Age (years)</b>	Mean (SD) 66.5 (10.6)
<b>Gender</b>	
Male	61.3%
Women	38.7%
<b>Educational level</b>	
Primary	16.0%
Secondary	57.6%
Tertiary	26.4%
<b>Livening status</b>	
Married or living with a partner	65.9%
Living alone	34.1%
<b>Smoking</b>	
Non-smoking	81.6%
Current smoking	18.4%
<b>Physical status</b>	
Physically inactive	31.0%
<b>Type of diabetes</b>	
Type 1	13.6%
Type 2	83.3%
<b>Type of treatment</b>	
Oral antidiabetics	42.6%
Insulin or another antidiabetic injection	57.5%
<b>Self-reported health</b>	
Excellent/very good	14.9%
Good	61.3%
Medium/poor	23.8%

Table (2) eye diseases were widespread among respondents. Besides common visual defects (i.e. myopia, hyperopia, astigmatism, presbyopia) that affected 36.2% of patients, cataract was the most frequently reported eye disease (35.8%). Whereas glaucoma was mentioned by 12.6% of patients,

only 14.2% of patients reported being affected by diabetic retinopathy, a specific microvascular complication of diabetes. However, when looking at the disparity between types of diabetes, it appears that patients with type 1 diabetes reported being considerably more frequently affected by

retinopathy than those with type 2 diabetes (40.9% vs. 9.8%).

For those reporting diabetic retinopathy, this complication was reported to be mainly treated by laser therapy (75.6%), followed by intraocular injection (26.8%), and surgical intervention (19.5%). Up to 16% of patients with type 2 diabetes

reported not being treated for their diabetic retinopathy, while this scenario was not reported by patients with type 1 diabetes. Finally, we observed that multiple eye diseases affected more often patients with type 1 diabetes than patients with type 2 diabetes ( $\geq 3$  diseases: 20.9% vs. 4.7%).

**Table (2):** Prevalence of eye diseases as reported by patients

	All participants (n = 323) %	Type 1 (n = 44) %	Type 2 (n = 269) %
<b>Eye diseases</b>			
Diabetic retinopathy	14.2%	40.9%	9.8%
Cataract	35.8%	40.9%	35.1%
Glaucoma	12.6%	11.4%	12.8%
Age-related macular degeneration	4.7%	4.5%	4.5%
Myopia, hyperopia, astigmatism, presbyopia	36.2%	38.6%	35.5%
Other	2.8%	2.3%	3.0%
No	26.7%	22.7%	27.9%
Do not know	2.5%	2.3%	2.6%
<b>Number of eye diseases reported</b>			
0 disease	27.4%	23.3%	28.7%
1 disease	45.8%	37.2%	46.5%
2 diseases	20.0%	18.6%	20.2%
$\geq 3$ diseases	6.8%	20.9%	4.7%
Treatment for diabetic retinopathy (among patients reporting diabetic retinopathy) <sup>b</sup> (n = 41)	(n = 41)	(n = 15)	(n = 25)
Laser therapy	75.6%	100.0%	60.0%
Eye injection	26.8%	33.3%	24.0%
Surgical intervention	19.5%	26.7%	16.0%
Other	2.4%	0.0%	4.0%
Retinopathy without having had treatment	9.8%	0.0%	16.0%
Do not know	2.4%	0.0%	4.0%

Table (3) shows awareness regarding diabetic eye diseases and how to prevent them, a significant percentage of participants (96.0%) had prior knowledge that diabetes could damage the eyes; in fact, all patients with type 1 diabetes and 95.1% of patients with type 2 diabetes were aware of this risk. Furthermore, the vast majority of patients knew the benefit of maintaining good glycemic control and having regular eye examinations by an

ophthalmologist (98.6% and 97.5%, respectively). In contrast, the benefits of maintaining good blood pressure control and good lipid control were less known, with respectively 91.3% and 85.4% of patients perceiving them as preventive behaviors. Finally, a quarter of the participants answered positively to the item affirming that nothing can be done to prevent diabetic eye diseases, that's the result of "bad luck"

**Table (3):** Patients' awareness about what can be done to prevent the occurrence or deterioration of diabetic eye diseases

	(n)	Expected answer	% of correct answers
Prevention means <sup>a</sup>			
Maintaining good glycemic control	(291)	Yes	98.6%
Having regular eye examinations by an ophthalmologist	(284)	Yes	97.5%
Maintaining good blood pressure control	(288)	Yes	91.3%
Maintaining good lipid control	(274)	Yes	85.4%

	(n)	Expected answer	% of correct answers
Nothing can be done, it is “bad luck”	(236)	No	75.9%
Mean knowledge score [95%CI] <sup>b</sup>	(292)		4.1 [4.0–4.2]

<sup>a</sup> Results for patients having answered at least 3 out of the 5 items

<sup>b</sup> The score was constructed as the sum of the 5 items – for those answering to at least 3 out of 5 items; each correct answer was given 1 point, otherwise 0; range between 0 (= no correct answer) to 5 (= all answers correct)

Table (4) shows frequency of eye examinations. Seven out of ten patients (70.5%) reported having undergone an eye examination by an ophthalmologist during the past 12 months, and 87.0% during the past two years. Moreover, a very small proportion (3.7%) of respondents stated never having seen an ophthalmologist to screen for diabetic eye diseases. Furthermore, the proportion of patients visiting an ophthalmologist during the past two years was higher for patients with type 1 diabetes than for those with type 2 diabetes (95.5% vs. 85.5%).

In addition, whereas retinal photography examination was known by 63.3% of patients, 83.9% of those answering positively to the previous question reported ever having undergone this examination, with or without pupil dilatation. Patients who did not report an eye examination by an ophthalmologist during the past two years (13.0% of the total sample) differed from the rest of the sample on several points, while being similar

regarding age, gender, education level, and type of diabetes.

First, participants who did not report an eye examination during the past two years were less likely to report eye diseases ( $p = 0.001$ ) or take insulin or another antidiabetic injection ( $p < 0.001$ ). Moreover, while they obtained a better disease-specific quality of life score (ADDQoL,  $p = 0.011$ ), the care they reported was less congruent with the Chronic Care Model (PACIC:  $p < 0.001$ ) than patients reporting an eye examination during the past two years. They also were less likely to be members of the local diabetes association ( $p = 0.009$ ) or to be aware of what HbA1c is ( $p < 0.001$ ). Finally, they reported having received globally less preventive care compared to the other respondents; some of these comparisons being statistically significant (HbA1c check:  $p = 0.047$ , foot examination:  $p = 0.003$ , influenza vaccination:  $p = 0.005$ ).

**Table (4):** Comparison of patients visiting, or not, an ophthalmologist during the past 2 years

Visit to an ophthalmologist during the past 2 years	n	Yes (n = 280)	No (n = 42)	p-value <sup>a</sup>
		Mean (SD) or %	Mean or %	
Age	322	66.8 (10.5)	64.7 (11.5)	0.244
Gender	322			
Women		40.0%	31.0%	0.262
Men		60.0%	69.1%	
Education	317			
Primary		14.9%	23.8%	0.172
Secondary		59.6%	45.2%	
Tertiary		25.5%	31.0%	
Type of diabetes <sup>c</sup>	322			
Type 1		15.0%	4.8%	0.153 <sup>c</sup>
Type 2		81.8%	92.9%	
Undetermined		3.2%	2.4%	
Type of treatment	321			
Oral antidiabetic		37.9%	73.2%	<0.001
Insulin or another antidiabetic injection		62.1%	26.8%	
Member of the local diabetes association	321	20.1%	7.1%	0.053 <sup>c</sup>
Number of eye diseases reported	310	1.2 (1.0)	0.6 (0.6)	0.001
HbA1C value <sup>b</sup>	174	7.3 (1.1)	6.8 (0.8)	0.313
ADDQoL global score	322	-1.5 (1.6)	-0.8 (1.1)	0.011
SF-12 PCS	312	43.5 (10.0)	44.8 (9.6)	0.440



Visit to an ophthalmologist during the past 2 years	n	Yes (n = 280)	No (n = 42)	p-value <sup>a</sup>
		Mean (SD) or %	Mean or %	
SF-12 MCS	311	46.4 (11.1)	45.9 (10.2)	0.771
PACIC global score	316	2.8 (1.0)	2.2 (0.8)	<0.001
Stanford self-efficacy score	316	7.8 (1.6)	7.6 (1.9)	0.610
HbA1C awareness	303	91.3%	66.7%	<0.001
HbA1C check <sup>b</sup>	262	99.2%	92.0%	0.047 <sup>c</sup>
Blood pressure measurement	315	99.3%	95.2%	0.087 <sup>c</sup>
Lipid profile	311	97.4%	95.2%	0.349 <sup>c</sup>
Diabetic foot examination	313	68.6%	45.2%	0.003
Microalbuminuria test	283	82.9%	71.1%	0.083
Influenza vaccination	314	67.7%	45.2%	0.005

<sup>a</sup> P-value from t-tests or Chi2/Fisher's exact test

<sup>b</sup> Among HbA1C-aware patients

<sup>c</sup> Calculated with Fisher's exact test

Table (5) shows barriers and facilitators to a regular eye examination, with multiple choice questions, and the reasons for patients to undergo or not a regular eye examination by an ophthalmologist. The three main barriers to undergoing a regular eye examination mentioned by patients not screened during the past 12 months were the fact that they had no visual symptom or vision problem (32.9%), they found it unnecessary because their diabetes was well controlled (30.0%), and they did not get recommendations from their family physician or diabetologist (30.0%).

Conversely, the three main facilitators for visiting regularly an ophthalmologist for eye screening, mentioned by patients regularly screened, were the

fact that healthcare professionals recommended it (54.8%), that they were aware of the importance of regular controls (38.0%) as well as of the risks of diabetes-related affection of the retina (33.8%). The exploratory linear regression analyses investigating the determinants of patients' knowledge about the prevention of diabetic eye diseases revealed that only one variable was associated with the awareness score: eye examination performed during the past two years ( $p = 0.005$ ). No association was found with the seven other variables of the model (age, gender, education, type of diabetes, duration of diabetes at recruitment, member of the local diabetes association, and presence of diabetic retinopathy).

**Table (5):** Barriers and facilitators to regular eye examination by an ophthalmologist <sup>a</sup>

	%	[CI 95%]
<b>Facilitators <sup>b</sup></b>	(n = 305)	
Recommendation of healthcare professionals	54.8%	[49.1%–60.4%]
Recommendation of relatives	2.3%	[0.6%–4.0%]
Feeling obliged to do it	9.8%	[6.5%–13.2%]
Knowledge of its importance	38.0%	[32.6%–43.5%]
Knowledge of the risks of a diabetes-related affection of the retina	33.8%	[28.4%–39.1%]
Knowledge of the treatment options	11.8%	[8.2%–15.4%]
Fear of having their eyes affected	22.3%	[17.6%–27.0%]
Having another eye problem necessitating an ophthalmologic follow-up	14.4%	[10.5%–18.4%]
<b>Barriers <sup>c</sup></b>	(n = 70)	
No recommendation from the family physician or diabetologist	30.0%	[19.0%–41.0%]
No information about diabetic eye diseases	7.1%	[1.0%–13.3%]
No information about retinal screening	2.9%	[–1.1%–6.9%]
No time	10.0%	[2.8%–17.2%]
Financial reasons	4.3%	[–0.6%–9.1%]
Too many other examinations and medical appointments	4.3%	[–0.6%–9.1%]
Fear of the examination, result, or treatment	1.4%	[–1.4%–4.3%]
Fear of losing their driving license	0.0%	-

Discomfort during the examination (eye drops, dilated pupils)	1.4%	[-1.4%–4.3%]
Difficulty in finding an ophthalmologist	4.3%	[-0.6%–9.1%]
Difficulty to go to the ophthalmologist's practice	4.3%	[-0.6%–9.1%]
No symptoms or vision problems	32.9%	[21.6%–44.1%]
Belief that it is not necessary because diabetes is well-controlled	30.0%	[19.0%–41.0%]

<sup>a</sup> Multiple choice questions <sup>b</sup> Results for patients having reported at least one eye examination (no time frame)

<sup>c</sup> Results for patients having not reported an eye examination during the past 12 months

## Discussion

This study explored patients' reported prevalence, awareness, and practices regarding eye diseases among patients with diabetes, as well as barriers and facilitators to regular eye examinations. The results found that eye diseases were frequent, especially among patients with type 1 diabetes. Also noticed that the majority of patients were aware of the positive influence of good glycemic control and regular eye examinations by an ophthalmologist on the prevention of diabetic eye diseases, while the benefits of good blood pressure or good lipid controls were less well known.

Moreover, most participants underwent regular eye examinations by an ophthalmologist, one-third of patients did not visit an ophthalmologist during the last year, mainly because they did not seem to be aware of the importance of preventive examinations. Finally, our exploratory model revealed that regular eye examination was positively associated with patients' awareness of ocular preventive measures. Diabetes with eye diseases has been associated with the development of various eye diseases including primarily retinopathy, but also cataracts and glaucoma<sup>(24-26, 51)</sup>.

More specifically, epidemiological studies have shown that the probability of retinal complications was higher in patients with type 1 than with type 2 diabetes: potentially vision-threatening retinal changes developed over time in up to 50% of patients with type 1 diabetes and 30% of those with type 2 diabetes<sup>(52)</sup>. This study found that diabetic retinopathy, the leading cause of vision loss in adults aged 20–74 years<sup>(53)</sup>, was reported by 40.9% of patients with type 1 diabetes and only 9.8% of patients with type 2 diabetes. Considering that diabetic retinopathy is generally present in about 30% of patients with type 2 diabetes<sup>(13)</sup>, different hypotheses could explain this discrepancy.

One could be that diabetic retinopathy is underestimated because a percentage of patients had no eye examination during the last year. This inconsistency may also simply reflect poor knowledge of diabetic retinopathy status, an issue already shown in other studies<sup>(44, 46)</sup>. Additionally, it has been suggested that the prevalence of retinopathy is likely underestimated in patients'

perceived history of diabetic retinopathy<sup>(54)</sup>. Moreover, considering that the vast majority of participants reporting diabetic retinopathy also reported having received ocular treatment for this condition, we may hypothesize that some participants falsely assume that they only present diabetic retinopathy if treatment is needed; for example, in the presence of proliferative diabetic retinopathy or macular edema, therefore leading patients to under-report simple diabetic retinopathy.

Another explanation might be that patients do not understand well what specialist physicians do and/or say during/after eye examination, and are consequently not well aware of their eye conditions. Correlations between patients and physicians reported annual eye and foot examinations suggest such an explanation<sup>(13)</sup>. The last explanation could be that our sample is not representative of the population of patients with diabetes. We also found that cataract was reported by 35.8% of the participants, and by 40.9% of patients with type 1 diabetes despite the younger mean age of this group (57.4 years for patients with type 1 diabetes vs. 68.1 years for patients with type 2 diabetes).

Epidemiologic studies have demonstrated that cataract is a common cause of visual impairment in patients with diabetes<sup>(56-58)</sup> and that patients with diabetes are 2–5 times more likely to develop cataracts than their non-diabetic counterparts<sup>(59)</sup>. Since cataracts occur at an earlier age in patients with diabetes, it leads to a visual loss with a significant impact on the working population<sup>(25)</sup>. Finally, our results also showed that one in ten patients reported glaucoma; such results are in line with recent evidence suggesting that patients with diabetes are at greater risk of glaucoma<sup>(26)</sup>, although it should be mentioned that the association between diabetes and glaucoma remains controversial for some authors<sup>(52)</sup>. This non-negligible percentage dictates the need for at least a basic glaucoma screening in patients with diabetes during their routine eye examination. In addition, as glaucoma evolves silently, with potentially irreversible and devastating visual loss when untreated, it may be wise to broaden the diabetes education perspective and include all

significant diabetic eye diseases instead of focusing solely on diabetic retinopathy.

In the present study, almost all patients with diabetes were aware that diabetes could damage the eyes. This is consistent with Schmid et al., (2003)<sup>(59)</sup> reported that 96% of Australian patients with diabetes were aware that diabetes could be sight-threatening, and more than 98% of Japanese patients with type 2 diabetes were aware that diabetes could be related to eye damage<sup>(46)</sup>. Interestingly, our exploratory analyses revealed that eye examination by an ophthalmologist during the past 2 years was significantly associated with better awareness regarding diabetic eye diseases. This is not surprising considering that comprehensive eye examinations generally include patients' education regarding ocular complications and guidance about preventive measures. These findings emphasize the need to promote regular examinations by an eye specialist.

### Conclusion

In conclusion, the level of awareness regarding diabetic eye diseases appeared to be relatively high in patients with diabetes, while there is still room for improvement in diabetic eye disease screening practices. Barriers mentioned by patients revealed their lack of knowledge about screening guidelines, in particular regarding the preventive nature of eye examinations. Consequently, diabetes-related ocular screening guidelines for patients and healthcare professionals should be promoted to reduce patients' misconceptions and help them change practices for earlier detection of diseases and, finally, reduce the risk of sight-threatening complications.

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