# Causes of visual impairment and blindness among Yemenis with diabetes: a hospital-based study

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**أسباب ضعف الإبصار والعمى بين اليمنيين المصابين بالسكري: دراسة مرتكزة على المستشفى**

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**الخلاصة:** قام الباحثون بتقييم أسباب الاختلال البصري والعمى في 694 من مرضى السكري الذين يراجعون مركز طب العيون في صنعاء في اليمن منذ عام 2001 حتى 2005 بمراجعة سجلاتهم الطبية. وقد كان متوسط عمر المرضى 53.9 سنة (الانحراف المعياري 11.52 سنة)، وتراوحت الأعمار من 13 حتى 95 سنة، وبلغ عدد الذكور منهم 382 (55٪). وكان لدى 273 مريضاً (39.3٪) مصابين بضعف الإبصار، و109 مصابين بالعمى (15.7٪) وفقاً لتعريف منظمة الصحة العالمية. وكان الساد (الكاتاراكت)، واعتلال الشبكية السكري التكاثري، واعتلال البقعة الشبكية السكري هي الأسباب الرئيسية لضعف الإبصار والعمى. وكان مرضى اعتلال الشبكية السكري التكاثري واعتلال البقعة الشبكية أكثر عرضة للإصابة بضعف الإبصار بدرجة يُعْتَدُّ بها (الاختطار النسبي = 1.99، بفاصلة ثقة مقدارها 95٪: أي من 1.74 إلى 2.28) مقارنة بالمرضى غير المصابين باعتلال الشبكية (الاختطار النسبي 1.84، بفاصلة ثقة مقدارها 95٪: أي من 1.60 إلى 2.13) أو للإصابة بالعمى لدى المرضى غير المصابين باعتلال الشبكية السكري (الاختطار النسبي = 4.69، بفاصلة ثقة مقدارها 95٪: أي من 3.70 إلى 5.95) مقابل المرضى غير المصابين باعتلال الشبكية السكري (الاختطار النسبي = 2.53، بفاصلة ثقة مقدارها 95٪: أي من 1.92 إلى 3.34) على التوالي. مما يدلُّ على أن اعتلال الشبكية السكري يمثل مشكلة من مشاكل الصحة العمومية في اليمن، ويستدعي التحرِّي عنه وتنفيذ برامج توعوية بشأنه على الصعيد الوطني، للحد من اختطار ضعف الإبصار والعمى بين السكريِّين.

ABSTRACT We assessed the causes of visual impairment and blindness in 694 diabetic patients attending our eye centre in Sana'a, Yemen from 2001 to 2005 by review of their medical records. The mean age of the patients was 53.9 (SD 11.52) years, range 13–95 years, and 382 (55%) were males. According to the World Health Organization definitions, 273 (39.3%) patients had visual impairment and 109 (15.7%) were blind. Cataract, proliferative diabetic retinopathy (PDR) and diabetic maculopathy were the main causes of visual impairment and blindness. Patients with PDR and maculopathy were significantly more likely to have visual impairment compared to patients without retinopathy (RR = 1.99, 95% CI: 1.74–2.28 and RR = 1.84, (95% CI: 1.60–2.13 respectively) and be blind (RR = 4.69, 95% CI: 3.70–5.95 and RR = 2.53, 95% CI: 1.92–3.34 respectively). Diabetic retinopathy is a public health problem in Yemen and national screening and educational programmes are highly needed to reduce the risk of visual impairment and blindness among diabetics.

**Causes des déficiences visuelles et de la cécité chez les Yéménites souffrant de diabète : une étude en milieu hospitalier**

RÉSUMÉ Nous avons évalué les causes des déficiences visuelles et de la cécité chez 694 patients diabétiques ayant consulté dans notre centre des soins oculaires à Sanaa (Yémen) entre 2001 et 2005 en examinant leur dossier médical. L'âge moyen des patients était 53,9 ans (E.T. 11,52 ; extrêmes 13-95 ans) et 382 étaient de sexe masculin (55 %). Selon les définitions de l'Organisation mondiale de la Santé, 273 patients (39,3 %) souffraient de déficiences visuelles et 109 étaient atteints de cécité (15,7 %). Les principales causes des déficiences visuelles et de la cécité étaient la cataracte, la rétinopathie diabétique proliférante et la maculopathie diabétique. Les patients atteints de rétinopathie diabétique proliférante et de maculopathie diabétique avaient une probabilité plus forte de souffrir de déficiences visuelles (RR = 1,99 ; IC à 95 % : 1,74–2,28 et RR = 1,84 ; IC à 95 % : 1,60–2,13 respectivement) et de cécité (RR = 4,69, IC à 95 % : 3,70–5,95 et RR = 2,53 ; IC à 95 % : 1,92–3,34 respectivement) par rapport aux patients exempts de rétinopathie. La rétinopathie diabétique représente un problème de santé publique au Yémen et un dépistage national et des programmes d'éducation sont hautement recommandés afin de réduire le risque de déficiences visuelles et de cécité dans la population diabétique.

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## Introduction

In Yemen, diabetes mellitus is a common disease among adult Yemenis with an overall prevalence ranging from 4.6% to 9.7% over the age of 20 years [1,2]. The prevalence of diabetes mellitus, particularly type II diabetes mellitus, is increasing in Middle Eastern countries [3]. Diabetes mellitus is a multiorgan disease and affects many parts of the body, including the eye, leading to visual impairment and blindness [4,5].

The prevalence of visual impairment and blindness due to diabetic retinopathy and diabetic eye complications is on the rise [6]. Diabetic retinopathy is a priority disease in the VISION 20/20 initiative for the global elimination of avoidable blindness and World Health Organisation (WHO) has made prevention of visual impairment and blindness an international priority [7,8]. Most diabetes-associated blindness is due to complications of diabetic retinopathy and diabetic maculopathy [4].

Screening for diabetic retinopathy in patients with diabetes mellitus has been going on in our hospital for approximately 7 years. All patients with diabetes mellitus are examined annually unless they have diabetic retinopathy in which case they are invited for a follow-up examination after 3–6 months. Our eye centre is affiliated with the University of Science and Technology in Sana'a, Yemen, and receives patients who are either referred from diabetic clinics or are self-referred. Eye examination in our eye centre is possible with the latest modern ophthalmic technology. Medical care service such patients is provided at the diabetic centre, which has the facilities to diagnose and manage diabetes mellitus and its systemic complications.

The aim of this study was to assess the causes of visual impairment and blindness in diabetic patients attending the Ibn Al-Haitham Eye Center. Our data will be useful for future comparative studies and to provide baseline information to monitor progress toward the St Vincent targets of reduction of blindness due to diabetic retinopathy [9]. Also from these data, priorities for prevention and treatment can be identified and resources allocated appropriately.

## Methods

A retrospective observational study was performed on the case notes of all patients with type 1 and type 2 diabetes mellitus during 2001–2005 (patients) there were 17 300 patients examined at the centre over this period, 694 (4%) of whom were diabetic. Our field investigators were 2 ophthalmologists and an endocrinologist who have experience in treating diabetic retinopathy and diabetes mellitus.

Diabetes mellitus was defined as having fasting glucose level ≥ 7 mmol/L. If a patient was already taking medicine to control hyperglycaemia, he/she was classified as "previously physician-diagnosed" diabetes [10].

Patients attending our centre have a detailed medical history taken and undergo a thorough clinical examination from the endocrinologist. Laboratory tests include fasting blood sugar, HbA1C, lipid profile, complete blood count and renal function tests.

Patients have a detailed eye examination, which includes best spectacle corrected visual acuity for each eye using a Snellen projection chart. We used the WHO recommended definitions of visual impairment and blindness [11].

- normal vision: visual acuity = 1.0 to 0.3 (6/6–6/18)
- visual impairment: visual acuity = < 0.3 to 0.05 (< 6/18–3/60)
- blindness: visual acuity = < 0.05 (< 3/60)

Best corrected visual acuity used is in the better eye.

The anterior segment of each eye is examined using slit-lamp biomicroscopy (Haag Streit, Switzerland). Ocular muscle movement in all 8 directions, pupillary reflexes and Goldmann applanation tonometry (Zeiss) is also performed. Dilated fundus examination using slit-lamp biomicroscopy (Haag Streit) with +90 Dioptre Volk lens is also performed after instilling 1.0% drops of tropicamide and 2.5% phenylephrine. This enables us to have a stereoscopic view of the retina and its vasculature. Patients with a diagnosis of maculopathy also have fundus flouresceine angiography.

For the classification of diabetic retinopathy, the modified Airlie House classification, as introduced by the Early Treatment Diabetic Retinopathy Study [12], is used, where diabetic retinopathy is classified into non-proliferative diabetic retinopathy (NPDR), proliferative diabetic retinopathy (PDR) and maculopathy. NPDR is further subdivided into mild (microaneurysms confined mainly to the area temporal to the fovea), moderate (vascular changes seen in 1–2 quadrants of the retina), and severe (vascular changes seen in > 2 quadrants). PDR is classified into neovascularization at the disc, neovascularization elsewhere and advanced PDR.

Maculopathy has been defined as:

- exudative: exudates and oedema in the macular region or clinically significant macular oedema (CSMO);
- ischemic: capillary dropout, as shown by fundus fluorescein angiography and;
- mixed: both types together.

CSMO as defined by the Early Treatment Diabetic Retinopathy Study is retinal oedema within 500 μm of the foveal centre, or hard exudates within 500 μm of the foveal centre that may be associated with retinal thickening that is outside the 500 μm limit, or retinal oedema that is 1 disc diameter (DD) or larger, any part of which is within 1 DD of the foveal centre [12,13].

Case notes of patients with visual acuity 3/60–6/18 in the better eye (visual impairment) or < 3/60 (blind) were selected for more extensive chart review to establish the main cause of visual impairment/blindness.

The research and ethical committee of our university eye hospital approved this study. The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975, as revised in 2000.

Descriptive analysis was performed on the data collected using Microsoft *Excel* spreadsheet. For the bivariate analysis, we used *SPSS*, 11.5.

## Results

The records of 694 patients with diabetes mellitus were reviewed for this study. Out of the 694 patients examined, 382 (55.0%) were males. The mean age was 53.9 years (SD = 11.52 years) range 13–95 years. The mean duration of diabetes mellitus was 10.3 (SD = 7.7) years, range 0.2–49 years. With respect to treatment, 5.3% of patients were on diet alone, 62.1% on oral hypoglycaemic medication, 31.4% on insulin injection and 1.2% on both types of treatment (Table 1). According to the WHO definition of blindness mentioned previously, 109 (15.7%) were blind and 273 (39.3%) had visual impairment. The remaining 312 (45.0%) had normal vision (Table 1).

The main causes of visual impairment in decreasing order were: cataract, CSMO, PDR, age-related macular degeneration (ARMD) and glaucoma (Table 2). The main causes of blindness in decreasing order were: cataract, PDR, CSMO, ischaemic maculopathy, ARMD and glaucoma (Table 3). Diabetic retinal complications combined accounted for about half the visual impairment and blindness, 49% and 55% respectively.

Overall, 368 patients (53.0%) had diabetic retinopathy: NPDR was detected in 216 (31.1%), 152 (22.0%) had PDR (Table 4). Mild NPDR accounted for 23.3% (162 patients), moderate NPDR for 4.0% (28 patients) and severe NPDR for 3.7% (26 patients) (Table 4).

Patients with PDR and CSMO were more likely to have visual impairment and blindness compared to patients without retinopathy. The relative risk (RR) for visual impairment in patients with PDR and CSMO was almost 2-fold compared to those with no retinopathy (RR = 1.99; 95% CI: 1.74–2.28, $P < 0.0001$) for PDR, and (RR = 1.84; 95% CI: 1.60–2.13, $P < 0.0001$) for CSMO (Table 5).

Patients with PDR were almost 5 times more likely to be blind and those with CSMO 2.5 time more likely to be blind than those without retinopathy (RR = 4.69; 95% CI:3.7–5.95%, $P < 0.0001$) and (RR = 2.53; 95% CI:1.92–3.34, $P < 0.0001$) respectively.

On the other hand, NPDR had no significant association with visual impairment (RR = 1.03; 95% CI: 0.86–1.22), $P = 0.83$). However, people with NPDR were less likely to be blind than those without diabetic retinopathy (RR = 0.49; 95% CI 0.31–0.77, $P < 0.001$) (Table 5).

Cataract was present in a significant number of cases with diabetes mellitus. Cataract was the main cause of visual impairment and blindness and was diagnosed in 30% . ARMD and glaucoma also contributed to the causes of visual impairment and blindness.

## Discussion

This study determined the causes of visual impairment and blindness among diabetic patients attending our eye centre. We found a high prevalence of visual impairment and blindness due to retinopathy and maculopathy among the diabetic patients presenting to our centre.

CSMO accounted for the majority of diabetic-retinopathy-related visual impairment followed by PDR, while PDR accounted for most of the diabetic-retinopathy-related blindness followed by CSMO. The results show that it is more difficult to preserve vision in patients with macular oedema. However, the introduction of intravitreal bevacizumab and intravitreal triamcinolone, which can treat macular oedema, is likely to change this [14,15].

There were significantly more males than females in this study, which may be because females have less access to eye care services and other medical services in Yemen [16].

Non-retinal ocular abnormalities also contribute to visual loss and should be considered in the management of diabetic patients [17–19]. It is worth noting that 50.2% of our patients were visually impaired and 44.9% blind due to causes other than diabetic retinopathy, mainly cataract, glaucoma and ARMD. Our results are similar to studies in Jordan and France [20,21].

Diabetes mellitus is a common disease in countries of the Eastern Mediterranean Region including Yemen [1–3]. It is documented that the prevalence of diabetes mellitus in middle-aged Asians is 5 times that of a European population [22]. Risk factors, such as impaired glucose tolerance, obesity, hypertension, smoking and hyperlipidaemia, are quite prevalent in the Yemeni population [2] and thus the burden of diabetes mellitus is likely to be significant. With improvements in socioeconomic conditions and the high urban growth rate in Yemen it is likely to rise further [23]. Moreover, the Yemeni population is expected to have higher diabetes mellitus complications because of familial clustering and the high rate of consanguinity, which are genetic risk factors for diabetes mellitus [24,25].

Eye problems among diabetics are significantly higher compared to the general population [18] and studies in our

**Table 1 Characteristics of the patients with diabetes mellitus**

| Variable | Patients with diabetes mellitus | | | |
|---|---|---|---|---|
| | No. ($n$ = 694) | % | 95% CI | $P$-value |
| ***Sex*** | | | | |
| Male | 382 | 55.0 | 2.6 to 17.4 | 0.01 |
| Female | 312 | 45.0 | | |
| ***Age group (years)*** | | | | |
| < 35 | 16 | 2.3 | – | - |
| 35–44 | 108 | 15.6 | 3.26 to 23.34 | 0.294 |
| 45–54 | 232 | 33.4 | 21.57 to 40.63 | 0.02 |
| 55–64 | 196 | 28.2 | 16.22 to 35.58 | 0.049 |
| 65 + | 142 | 20.5 | 8.30 to 28.10 | 0.15 |
| ***Treatment*** | | | | |
| OHA | 431 | 62.1 | 48.25 to 65.35 | < 0.001 |
| Insulin | 218 | 31.4 | 16.61 to 35.59 | |
| Diet only | 37 | 5.3 | – | 0.002 |
| OHA & insulin | 8 | 1.2 | –6.34 to 14.54 | 0.667 |
| ***Duration of diabetes (years)*** | | | | |
| < 5 | 223 | 32.1 | – | - |
| 5–9 | 112 | 16.1 | 6.84 to 25.16 | 0.002 |
| 10–14 | 156 | 22.5 | 0.63 to 18.57 | 0.053 |
| ≥ 15 | 203 | 29.3 | –5.96 to 11.56 | 0.602 |
| ***Best corrected visual acuity in the better eye*** | | | | |
| 6/6 | 102 | 14.7 | – | - |
| 6/9 | 106 | 15.3 | –9.11 to 10.31 | 0.941 |
| 6/12 | 100 | 14.4 | –9.43 to 10.03 | 0.889 |
| 6/18 | 38 | 5.5 | –0.79 to 19.19 | 0.234 |
| 6/24 | 60 | 8.6 | –3.78 to 15.98 | 0.373 |
| 6/36 | 66 | 9.5 | –4.66 to 15.06 | 0.451 |
| 6/60 | 50 | 7.2 | –2.43 to 17.43 | 0.288 |
| 3/60 | 63 | 9.1 | –4.28 to 15.48 | 0.416 |
| 2/60 | 18 | 2.6 | 2.04 to 22.16 | 0.302 |
| 1/60 | 57 | 8.2 | –3.4 to 16.4 | 0.345 |
| Hand movement | 18 | 2.6 | 2.04 to 22.16 | 0.302 |
| Perception of light | 16 | 2.3 | 2.34 to 22.46 | 0.331 |

*CI = confidence interval; OHA = oral hypoglycaemic agent.*

region have shown the same [17,21,26]. The majority of patients come to our centre after years of having diabetes and frequently come because of diabetic complications. Over two-thirds of the study group had had diabetes mellitus for > 5 years and this finding was noted in another study, which reported that Yemeni patients with diabetes do not present early to the ophthalmologist and do not make regular visits [27]. This could explain the large proportion of diabetic retinopathy, visual impairment and blindness among our patients. In a Saudi Arabian study [26], diabetic retinopathy was also associated with the duration of diabetes mellitus.

More patients lose vision because they have not received adequate treatment and in our patients the majority had sought ophthalmological advice too late. Regular visits to medical clinics seem to be a proxy indicator of better primary prevention of eye complications of diabetes mellitus. In a study done in our centre among 228 patients, diabetic retinopathy was found in 41.2% of diabetics in group A (attending clinics regularly) and in 61.4% of diabetics in group B (irregular clinic visits) [27]. In addition, the severity of diabetic retinopathy was positively associated with irregularity of clinic visits; the risk of bilateral blindness and visual impairment were higher in group B and the duration of diabetes and the regularity of

**Table 2 Causes of visual impairment in the patients with diabetes mellitus**

| Cause | No. (*n* = 273) | % |
|---|---|---|
| Cataract | 82 | 30.0 |
| Diabetic retinopathy | | |
| Diabetic maculopathy, CSMO | 77 | 28.2 |
| Proliferative diabetic retinopathy | 49 | 17.9 |
| Diabetic maculopathy, ischaemic | 8 | 2.9 |
| Age-related macular degeneration | 14 | 5.1 |
| Glaucoma | 12 | 4.4 |
| Myopic macular degeneration | 10 | 3.7 |
| Central retinal vein occlusion | 6 | 2.2 |
| Decompensated cornea | 4 | 1.5 |
| Cystoid macular oedema | 4 | 1.5 |
| Retinal dystrophy | 3 | 1.1 |
| Hypertensive retinopathy | 2 | 0.7 |
| Diabetic papillitis | 2 | 0.7 |

*CSMO = clinically significant macular oedema.*

**Table 3 Causes of blindness in the patients in diabetes mellitus**

| Cause | No. (*n*= 109) | % |
|---|---|---|
| Cataract | 32 | 29.4 |
| Diabetic retinopathy | | |
| Diabetic maculopathy, CSMO | 24 | 22.0 |
| Proliferative diabetic retinopathy | 28 | 25.7 |
| Diabetic maculopathy, ischaemic | 8 | 7.3 |
| Glaucoma | 6 | 5.5 |
| Age-Related macular degeneration | 6 | 5.5 |
| Decompensated cornea | 2 | 1.8 |
| Optic disc atrophy | 2 | 1.8 |
| Retinal dystrophy | 1 | 0.9 |

*CSMO = clinically significant macular oedema.*

clinic visits were predictors of diabetic retinopathy [27].

Around 50% of visual impairment and blindness is preventable by early detection and treatment of proliferative retinopathy and macular oedema [28]. This can be done by regular screening [29–32], or the effects of proliferative retinopathy and macular oedema can be slowed with laser photocoagulation [33–35]. The primary risk factor for the development of PDR and maculopathy is lack of diabetes control [36]. However, in Yemen, other specific factors might be related to diabetics and may contribute to the high rate of eye complications, such as a lack of screening facilities, poor patient education, living in remote areas from the capital and the main cities and lacking health insurance. Early detection, laser treatment, intravitreal injection of bevacizumab and triamcinolone are key factors to prevent or decrease the risk of blindness from diabetes mellitus [14,15,34,37,38].

**Table 4 Severity of diabetic retinopathy among the patients with diabetes mellitus**

| Severity of diabetic retinopathy | No. (*n* = 694) | % |
|---|---|---|
| No diabetic retinopathy | 326 | 47.0 |
| Mild NPDR | 162 | 23.3 |
| Moderate NPDR | 28 | 4.0 |
| Severe NPDR | 26 | 3.7 |
| PDR | 152 | 22.0 |

*NPDR = non-proliferative diabetic retinopathy; PDR = proliferative diabetic retinopathy.*

Screening programmes reduce the number of patients losing their vision and a system that calls patients is important in ensuring regular eye examinations [39]. Physicians treating diabetic patients should be educated to refer their patients for early diabetic eye screening. In the United Kingdom, there are 2 models for screening for diabetic retinopathy: a photographic model and an optometrist-based model but neither is applicable to Yemen as there are only 3 optometrists in Yemen and they all work in hospitals, not optician shops [40].

The success of a screening programme can only be judged by a documented decrease in ocular morbidities due to diabetes mellitus over a number of years. The figures in this study need to be revised in few years to find out if our screening has reduced diabetic retinopathy and other complications.

Our study had some limitations and the results should be read with caution. Patients included in this study are not representative of all patients with diabetes mellitus in Yemen, but rather a selected group with diabetic visual problems or concerned diabetic patients perhaps with knowledge of relatives who had diabetic complications. The hospital-based case selection usually introduces health-seeking bias. In addition, a large number of patients were referred by a physician, which may increase the misclassification bias. Another limitation of the study is that we were not able to calculate the prevalence

**Table 5 Relative risk of visual impairment or blindness in the patients with diabetic retinopathies**

| Variable | RR (95% CI) | *P*-value |
|---|---|---|
| ***Visual impairment (VA: 6/24–3/60)*** | | |
| NPDR | 1.03 (0.86–1.22) | 0.83 |
| PDR | 1.99 (1.74–2.28) | < 0.0001 |
| CSMO | 1.84 (1.60–2.13) | < 0.0001 |
| ***Blindness (VA: < 3/60)*** | | |
| NPDR | 0.49 (0.31–0.77) | 0.001 |
| PDR | 4.69 (3.70–5.95) | < 0.0001 |
| CSMO | 2.53 (1.92–3.34) | < 0.0001 |

*Best corrected visual acuity is in the better eye.*
*RR = relative risk; CI = confidence interval.*
*VA = visual acuity; NPDR = non-proliferative diabetic retinopathy; PDR = proliferative diabetic retinopathy; CSMO = clinically significant macular oedema.*

and incidence of visual impairment and blindness due to diabetic retinopathy or the annual rate per year because a large number of our patients come from different governorates of Yemen.

The establishment of a national programme and awareness-raising campaigns to educate both patients and physicians about control of diabetes mellitus and the early detection of diabetic retinopathy is critical. The Prevention of Blindness Programme in the Ministry of Health and Population should address diabetic retinopathy within the VISION 20/20 initiative and proper planning of a public health programme is crucial. This study, although hospital-based, provides information that will be useful for the Prevention of Blindness Programme. The intervention strategies should include primary prevention, prophylactic treatment with laser or intravitreal injections and management of complications of PDR and maculopathy.

## Conclusions

Diabetes mellitus is a common disease in Yemen and diabetic retinopathy is highly prevalent among Yemeni diabetics. Eye care services at an affordable cost should be made available to all patients with diabetes mellitus. Further research is a national priority in order to draft and implement a plan for early detection and treatment of diabetic retinopathy to reduce the risk of visual impairment.

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