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Characteristics of patients with diabetic retinopathy in Gaborone, Botswana

ALASTAIR M. BLAKE[1], HENRY N. MUNBY[1], PEARL M. KATLEGO[2], PEGGY M. SEBUYUYU[2], OATHOKWA NKOMOZANA[2,3], RAPHAEL BANGURE[2], MALCOLM KERR-MUIR[4] and JEREMIAH M. NGONDI[5,6*]
[1]*University of Cambridge School of Clinical Medicine, Addenbrookes Hospital, Cambridge, United Kingdom*
[2]*Department of Ophthalmology, Princess Marina Hospital, Gaborone, Botswana*
[3]*University of Botswana, School of Medicine, Gaborone, Botswana*
[4]*Dept of Ophthalmology, Addenbrookes Hospital, Cambridge, United Kingdom*
[5]*Department of Public Health and Primary Care, University of Cambridge, Cambridge, United Kingdom*
[6]*RTI International, Dar es Salaam, Tanzania*

Abstract
Background: Diabetic retinopathy is a cause of preventable blindness globally and is an increasing public health problem in the developing countries. The Botswana National Screening Programme for diabetic retinopathy was launched in October 2009. We report the descriptive epidemiology of diabetic retinopathy in Botswana.
Methods: The study population comprised patients on the National Diabetic Retinopathy Screening register at Princess Marina Hospital, Gaborone. Prevalence of diabetic retinopathy, maculopathy and visual impairment were estimated. Associations of diabetic retinopathy and explanatory variables were explored using logistic regression.
Results: Of the 1,307 patients screened for diabetic retinopathy between October 2009 and August 2011, 67.9% were female and mean age (standard deviation) was 55.0 (14.1) years. The prevalence of DR and maculopathy was 17.7% (95% CI=15.6–19.9) and 14.7% (95% CI=12.7–16.7), respectively. The prevalence of low vision (presenting visual acuity [VA] ≥3/60 but <6/18 in the better eye) and blindness (presenting VA of <3/60 in the better eye) was 15.0% (95% CI=13.3–18.9) and 1.5% (95% CI=0.83–2.9), respectively. Increasing odds of DR were associated with increasing age (*Ptrend*=0.004), low vision (odds ratio [OR] =2.2; 95% CI=1.6–3.0), blindness (OR=4.6; 95%CI=2.6–8.1) and maculopathy (OR=15.2; 95% CI=10.9–21.3).
Conclusion: Diabetic retinopathy is a common complication of diabetes amongst Batswana patients. Our findings are consistent with prevalence rates in other developing countries and underscore the importance of screening for diabetic retinopathy in developing nations.

Keyword: Diabetic retinopathy, visual impairment, epidemiology, screening programme, Botswana

Introduction

Diabetic retinopathy is an important cause of preventable blindness and accounts for 4.8% of visual impairment globally (Klein *et al.*, 1984; Cheung *et al*., 2010). It is the most frequent cause of new blindness amongst adults aged 20-74 years (Fong *et al.*, 2004). The burden of diabetes retinopathy in developing countries, is now comparable to that in developed countries (Sidibe, 2000; Rema *et al.*, 2005). It is estimated that diabetes retinopathy causes 250,000 cases of visual impairment in Africa alone (Pascolini & Mariotti, 2012). Whilst in developed countries the contribution of diabetes retinopathy to visual impairment is decreasing, due to effective screening and intervention programmes, no such trend is seen in the developing world (Bachmann & Nelson, 1998). Crucially, if retinopathy is detected early, its progression can be ameliorated by managing hypertension (Gillow *et al*., 1999), hyperglycaemia (Klein & DeMets, 1988), hyperlipidaemia (Chew *et al.*, 1996), and in some cases through treatment with laser photocoagulation (The Diabetic Retinopathy Study Research Group, 1981). A systematic review of the prevalence of diabetes retinopathy in Sub-Saharan Africa found that prevalence varied between 15 and 52% (Sidibe, 2000). In Botswana, the epidemiological data relating to diabetic retinopathy is currently limited to a single study of 401 patients in Gaborone which reported a prevalence of 9.2% (Mengesha, 2006).

* Correspondence: E-mail: jngondi@rti.org

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With the burgeoning problem of non-communicable disease in sub-Saharan Africa (Dalal *et al.*, 2011), the association of diabetes retinopathy with different demographic groups is pertinent, and will inform public health interventions to manage this disabling disease. Screening for diabetic retinopathy has been shown to be a cost-effective approach to the prevention diabetic retinopathy-associated blindness in both developed and developing countries (Javitt & Aiello, 1996; Guigui *et al.*, 2011). A national screening program for diabetic retinopathy in Botswana was launched in October 2009. This study therefore, aimed to investigate the descriptive epidemiology of diabetic retinopathy amongst patients with diabetes attending Princess Marina Hospital in Gaborone, Botswana.

Materials and Methods

Study population

Physician-diagnosed patients with Type 1 and Type 2 diabetes were referred to the screening programme, based in Princess Marina Hospital, Gaborone, Botswana. Referral to the programme was national; however, the majority of patients were from the capital city Gaborone and its environs. The National Diabetic Retinopathy screening programme maintains a register of all referrals, which contains demographic and clinical information. An electronic questionnaire was used to obtain age, sex, address, diabetes type, visual acuity measurements, retinopathy and maculopathy grades.

Diabetic retinopathy screening

All patients were examined at Princess Marina Hospital, by ophthalmic nurses, trained in diabetic retinopathy screening and grading, between October 2009 and August 2011. Presenting visual acuity was recorded using a Snellens' Chart. Digital stereoscopic fundus photography (Canon CR-1) was performed after appropriate mydriasis with 1% Tropicamide if required. Patients' images were graded according to UK National Screening Committee protocols (Harding *et al.*, 2003). The minimum criterion for diagnosis of diabetic retinopathy was 'presence of at least one microaneurysm in any field in either eye' (Kohner *et al.*, 1998). For patients attending screening more than once during the study period, only data from their first attendance was used for analysis.

Definition of vision status

The World Health Organization categories of visual impairment were used to define vision status (WHO, 2004). Blindness was defined as presenting visual acuity of less than 3/60 in the better eye. Low vision was defined as presenting visual acuity of less than 6/18 but equal to or greater than 3/60 in the better eye. Normal vision was defined as normal or near-normal visual acuity in the better eye (VA ≥ 6/18). Visual impairment was defined as low vision or blindness.

Data analysis

Data from the manual diabetic retinopathy screening register was entered into a Microsoft® Excel spread-sheet. Personal identifiers removed before data sets were exported into Stata SE 9 (Stata Corporation, College Station, Texas) for analysis. Proportions were used to describe the demographic characteristics of participants and prevalence. The prevalence of diabetic retinopathy and maculopathy were described based on the worst affected eye whilst prevalence of vision status was based on the visual acuity in the better eye. The 95% confidence intervals of the estimates were derived using the binomial exact method and differences in proportions investigated using chi-square tests. Eye level analysis was performed to investigate associations between explanatory factors and diabetic retinopathy. An ordinal outcome of diabetic retinopathy was generated for each eye based on the grading (R0, R1, R2, and R3). Ordinal logistic regression models were fitted using Generalised Linear Latent and Mixed Models

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(GLLAMMs) to account for the non-independence of the eye diabetic retinopathy outcome at the patient level (Rabe-Hesketh *et al.,* 2000). This model allowed for analysis of a polytomous ordinal response on a set of predictors and computed the odds ratios (OR) of having a more severe diabetic retinopathy grade compared to a less severe grade (Hosmer, 2000). Univariate analysis was conducted for each explanatory factor and diabetic retinopathy. It was not appropriate to conduct multivariate analysis due to missing data for various variables in nearly a half of all eyes.

Ethical consideration

The study was conducted as a routine public health practice to inform implementation of diabetic retinopathy screening programme in Botswana. Ethical clearance was obtained from the Health Research Unit at the Botswana Ministry of Health. Personal identifiers were removed from the data set before analyses were undertaken.

Results

Characteristics of the study population

The characteristics of the study population are summarised in Table 1. A total of 1,307 patients attended screening between October 2009 and August 2011. The mean age (standard deviation) was 55.0(14.1) years. Majority of patients were female (67.9%) and had type 2 diabetes (70.1%).

Table 1: Characteristics of the study population (n=1,307)

Characteristics	Response	Number of patients	Percent of patients
Sex	Male	418	32.0
	Female	881	67.4
	Missing data	8	0.6
Age	0-20	37	2.8
	21-30	41	3.1
	31-40	80	6.1
	41-50	269	20.6
	51-60	397	30.4
	61-70	282	21.6
	71+	164	12.5
	Missing data	37	2.8
Diabetes type	1	308	23.6
	2	916	70.1
	Missing data	83	6.4

Prevalence of diabetic retinopathy, maculopathy and vision status

The prevalence of diabetic retinopathy, maculopathy, vision status are described in Table 2. Some patients were excluded from analysis due to missing data: 101(7.7%) diabetic retinopathy ungraded; 39 (3.4%) maculopathy not recorded; and 301(23.0%) visual acuity not recorded. The prevalence of DR and maculopathy was 17.7% (95% CI=15.6–19.9) and 14.7% (95% CI=12.7–16.7), respectively. The prevalence of low vision (presenting visual acuity [VA] ≥3/60 but <6/18 in the better eye) and blindness (presenting VA<3/60 in the better eye) was 15.0% (95% CI=13.3–18.9) and 1.5% (95% CI=0.83–2.9), respectively. The prevalence of diabetic retinopathy, maculopathy and visual impairment increased with age (Figure 1). There was no gender difference in the prevalence of diabetic retinopathy (p-value =0.9), maculopathy (p-value=0.9) or visual impairment (p-value =0.2).

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Table 2: Prevalence of diabetic retinopathy, maculopathy and vision status

Characteristic	No. patients with data	Eye level	Prevalence (%)
Diabetic retinopathy	1,206	Ro	82.3
		R1	13.3
		R2	2.2
		R3	2.1
		Any retinopathy	17.7
Maculopathy	1,258	M1	1.2
		M1a	11.2
		M1b	2.3
		Any maculopathy	14.7
Vision status	1,006	Normal vision	83.5
		Low vision	15.0
		Blindness	1.5

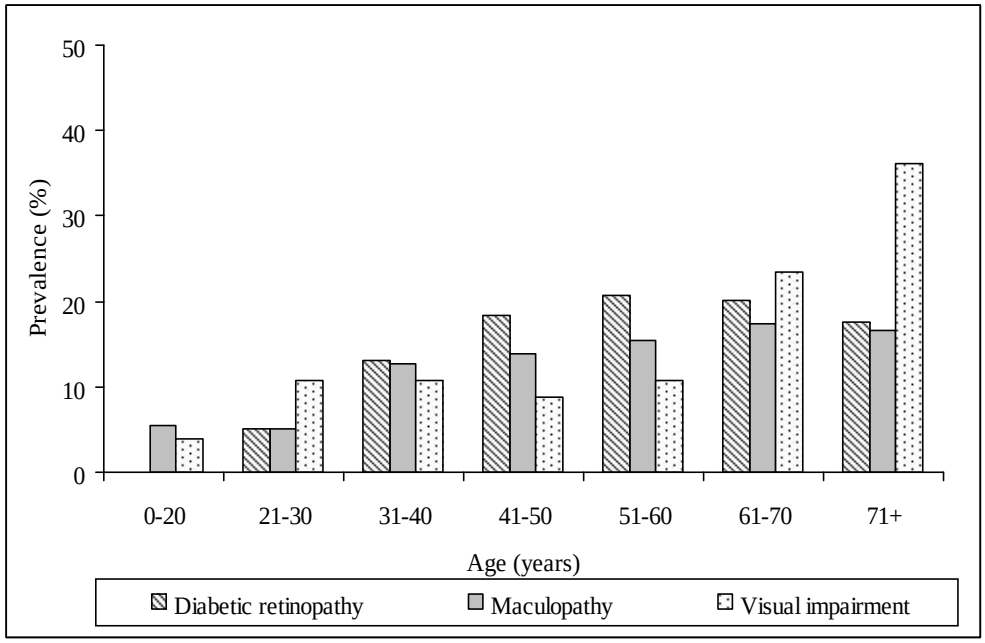

Figure 1: Age specific prevalence of diabetic retinopathy, maculopathy and visual impairment

Associations of diabetic retinopathy and explanatory variables

Univariate ordinal logistic regression analysis of associations between severity of diabetic retinopathy and explanatory variables is shown on Table 3. Factors associated with increased odds of more severe diabetic retinopathy were increasing age (p-value for trend=0.004), low vision (odds ratio [OR] =2.2; 95% CI=1.6–3.0), blindness (OR=4.6; 95%CI=2.6–8.1) and maculopathy (OR=15.2; 95% CI=10.9–21.3). Compared to Type 1, type 2 diabetes was associated with reduced odds of severe diabetic retinopathy (OR=0.7; 95% CI=0.5-0.9).

Discussion

This study describes the descriptive epidemiology of diabetic retinopathy among patients attending screening at Princess Marina Hospital, Botswana. Over two thirds of the patients were female, one in six had diabetic retinopathy, one in seven had maculopathy and one in six had either low vision or blindness. The prevalence of diabetic retinopathy was higher than previous estimates reported by Mengesha *et al.* (2006) among patients with diabetes attending a City

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Council Clinic in Gaborone. Our study investigated patients on the National Diabetic Retinopathy screening register who had been referred from a larger geographical area. The findings suggest that diabetic retinopathy is more widespread than previous estimates and is consistent with other studies in sub Saharan Africa which reported prevalence estimates ranging from 15–52% (Sidibe, 2000). We found a high correlation between diabetic retinopathy and visual impairment and blindness. Although not adjusted for confounding factors, this association suggests that diabetic retinopathy has a substantial impact on the burden of eye disease in Botswana.

Table 3: Associations of diabetic retinopathy (DR) and explanatory variables (eye level analysis)

Explanatory variable		Number of eyes					Prevalence of diabetic retinopathy (%)			Odds Ratio	95% CI	P-*value*
		R0	R1	R2	R3	Total	R1	R2	R3			
Age (years)	≤30	146	2	0	1	149	1%	0%	1%	1.0		
	31-40	129	12	1	1	143	8%	1%	1%	5.2	1.5-18.6	0.011
	41-50	421	59	7	15	502	12%	1%	3%	9.4	2.9-30.3	<0.001
	51-60	594	77	22	12	705	11%	3%	2%	9.2	2.9-29.3	<0.001
	61-70	396	60	6	4	466	13%	1%	1%	8.5	2.6-27.3	<0.001
	71+	206	36	1	0	243	15%	0%	0%	8.4	2.5-27.8	<0.001
Gender	Female	1,301	166	28	22	1,517	11%	2%	1%	1.0		
	Male	646	81	11	11	749	11%	1%	1%	1.0	0-7-1.2	0.740
Diabetes Type	1	440	72	11	10	533	14%	2%	2%	1.0		
	2	1,403	155	26	17	1,601	10%	2%	1%	0.7	0.5-0.9	0.003
Visual impairment category	Normal vision	1,252	145	17	8	1,422	10%	1%	1%	1.0		
	Low vision	226	46	6	13	291	16%	2%	4%	2.2	1.6-3.0	<0.001
	Blindness	38	9	6	5	58	16%	10%	9%	4.6	2.6-8.1	<0.001
Maculopathy	No	1,911	172	26	22	2,131	8%	1%	1%	1.0		
	Yes	46	75	13	11	145	52%	9%	8%	15.2	10.9-21.3	<0.001

Our study was cross sectional, representing patients seen over a two year period and lacks longitudinal follow-up. The value of this study lies in its description of the disease burden and helps to inform the debate about allocation of resources in Sub-Saharan Africa for non-communicable disease. The study has a number of possible limitations. Missing data was a potential source of bias in our prevalence estimates especially for vision status, where 23% of patients did not have visual acuity readings. We do not expect the missing data to have biased the diabetic retinopathy estimates since only 7.7% of patients did not have grading for diabetic retinopathy due to lens opacities, poor patient cooperation and inadequate mydriasis. On the other hand, our study is advantageous in that we studied patients on the National Diabetic Retinopathy screening register who had been referred from across the country and used standard methods for diabetic retinopathy screening and grading by qualified ophthalmic trained nurses. The patients were all referred from diabetes clinics across the country, although the predominance of patients from around the capital and other large cities may reflect the better access to care seen in urban populations. As such, these patients may demonstrate better glycaemic control, either through their better access to care, better patient education, or increased motivation to improve their health. Such access issues are likely to underestimate prevalence since many poorly controlled, or undiagnosed patients are unlikely to present for screening.

As highlighted in previous studies of diabetic retinopathy prevalence, there is paucity of published data for the African region. Comparison of our findings to those previously reported in Sub-Saharan Africa show a wide range of estimated prevalence of diabetic retinopathy from 15-52% (Sidibe, 2000). Methodological and demographic issues may affect the prevalence disparities among African studies. Diagnosis in some studies relied upon direct ophthalmoscopy and in

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others on the interpretation of fundus photographs, with added noise from the inevitable inter-operator variability and technological inconsistencies in sensitivity and specificity.

We suggest further studies to investigate results of follow-up screening, progression of diabetic retinopathy in the screening population and the outcomes of diabetic retinopathy treatment. However, we acknowledge that compliance with annual follow-up for diabetic retinopathy screening is challenging even in developed world countries (Hazin *et al*., 2011) In addition, further studies are required to assess inter-observer reliability among ophthalmic trained nurses in the Botswana diabetic retinopathy screening programme to ensure quality control for image grading (Carmichael *et al.*, 2005).

Our study has important implications for diabetes care provision in Botswana. The increasing prevalence of diabetes mellitus seen in the country is likely to only increase the number of diabetic retinopathy patients and the demand on ophthalmology services. The implications both economically and in quality of life for the country are potentially significant. Further development of the National Screening Program in terms of patient recruitment and healthcare worker training are of some importance. Our results show that diabetic retinopathy is a significant health problem amongst patients with diabetes in Botswana. We also highlight the associated high prevalence of visual impairment and thus the importance of providing high-quality ophthalmic care for these patients and of ensuring all diabetes patients can access diabetic retinopathy screening.

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Conflicts of interest

Nothing to declare.

Author contributions

JMN, AMB, ON, MKM, designed the study; AMB, PMK, PMS, RB compiled data from manual diabetic retinopathy screening records into an electronic register; JMN, AMB, MHN undertook data analysis; AMB, HNM, JMN, drafted the manuscript. All authors reviewed and approved the final version of the manuscript.

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