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Screening in Primary Care for Diabetic Retinopathy, Maculopathy and Visual Loss in South Africa

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Key Words
Diabetes screening · Diabetes complications · Diabetic retinopathy · Diabetic maculopathy · Visual acuity · Teleophthalmology

Abstract
Objective: The aim of the study was to determine the prevalence of diabetic retinopathy, maculopathy and visual loss in primary care patients and to identify associated risk factors. ***Research Design and Methods:*** We conducted a cluster randomised trial at primary care clinics in the Tshwane district in South Africa. Grades of retinopathy and maculopathy (with fundus camera) and visual acuity (Snellen chart) were assessed and, using mobile screening and teleophthalmology, clinical and biochemical testing was conducted to obtain information about glycaemic control and microvascular complications. ***Results:*** The prevalence rates for any retinopathy, preproliferative retinopathy and proliferative retinopathy were 24.9, 19.5 and 5.5%, respectively. The prevalence rates of diabetic maculopathy, observable maculopathy and referable maculopathy were 20.8, 11.8 and 9.0%, respectively. The presence of retinopathy was associated with high body mass index, systolic blood pressure, being on insulin treatment, high HbA1c and the presence of neuropathy. High systolic blood pressure, being on insulin treatment, high HbA1c level and high low-density lipoprotein cholesterol level as well as the presence of albuminuria were significant in predicting any diabetic maculopathy. Laser photocoagulation was given to 8.3% of patients from the mobile unit and 12% of patients were referred to the nearest hospital with an outpatient eye clinic for follow-up treatment of various other eye conditions. Using the WHO categories, the study found that 78.1% of diabetes patients had normal vision, 19.3% were visually impaired and 2.2% were severely impaired or blind. ***Conclusion:*** High prevalence rates for diabetic retinopathy, maculopathy and visual loss were found and associations were identified.

Introduction

South Africa has not escaped the epidemiological transition marked by an increasing prevalence of noncommunicable diseases. The International Diabetes Federation (IDF) in the latest Diabetes Atlas of 2013 estimates that 382 million people worldwide have diabetes, with a global prevalence of 8.3%. This number is set to increase beyond 592 million in less than 25 years [1]. The IDF predicts a 109% increase in the prevalence of diabetes in the next 22 years for Africa, even though the region currently spends less than 1% of the global health expenditure on diabetes. The IDF 2013 report also states that only 8.6%

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of all deaths in Africa are diabetes related, yet more that 76% of these deaths occur in those under the age of 60 years [1]. Approximately 33% of people with diabetes will develop some degree of diabetic retinopathy and this has become the leading cause of blindness in the working population [1].

According to the 2013 IDF report, there is a lack of data on the prevalence of diabetic retinopathy. The current estimate for diabetes prevalence in South Africa is 8.3%, very close to the international prevalence [1]. Various hospital-based and primary-care-based studies have been done in South Africa to estimate the prevalence of diabetic retinopathy. These studies have been summarised in a systematic review, which reports that diabetic retinopathy prevalence ranges from 7.6 to 62.4% [2]. A recent study reported in 2014 a diabetic retinopathy prevalence of 39% at a tertiary diabetes clinic in Durban [3].

The prevalence of any diabetic maculopathy in primary care facilities in South Africa was described in three studies as being 13.1, 15.2 and 31.1% [4]. Clinically significant macular oedema has been reported in three studies as ranging from 8.5 to 10.3% [2].

Only two studies from Cape Town, South Africa, have reported on the prevalence of diabetic retinopathy, maculopathy and visual acuity. A 1997 audit done on the quality of diabetes care at primary care clinics in Cape Town revealed a prevalence of any retinopathy of 55.4%, macular changes in 13.1% and only 12% of patients with normal vision. Cataracts were identified in 5% of diabetic patients [5]. Mash et al. [6] reported in 2007 a prevalence of any retinopathy of 69.3%, any maculopathy of 12.5% and visual acuity of 6/6–6/9 in 32% of diabetic patients.

The aim of the current study was to examine the prevalence of and risk factors associated with diabetic retinopathy, diabetic maculopathy and visual loss in primary care in the Tshwane district of Gauteng province, South Africa. A secondary aim was to describe associations between the above-mentioned outcomes and factors that influence them.

Materials and Methods

Setting and Study Design

We conducted a cluster randomised trial in the Tshwane district of Gauteng province using a mobile unit to visit primary care facilities. Twelve clinics were randomly selected, each representing the following strata within the South African health system: (1) clinics managed by local government; (2) clinics managed by provincial government, and (3) community health centres managed by the provincial government. Data collection took place between July 2010 and March 2012. The main aim of the study was to determine the efficacy of a mobile intervention on glucose control and complication screening. This article reports on the cross-sectional evaluation of screening for diabetes eye complications. Patients in the intervention group were screened in year 1 and patients in the control group were screened in year 2.

Participants

Diabetic patients attending the three strata of primary health care clinics for routine care were invited to participate. Patients were eligible for inclusion in the study if (1) they had type 2 diabetes (unspecified duration) or type 1 diabetes for 5 or more years; (2) they were older than 18 years of age, and (3) they were able to give informed consent.

Ophthalmological Assessment

Best corrected visual acuity was measured with a Snellen chart and categorised as normal (6/4–6/18), visually impaired (<6/18–6/60) or blind (<6/60).

Eyes were dilated (Mydriacyl; 0.5% tropicamide) and retinal photos were taken with a Canon Cr-1 fundus camera, fitted in the mobile unit in a separate eye room. Photographs were assessed daily by an ophthalmologist. Retinopathy and maculopathy were classified according to the Scottish retinopathy grading system of 2003 [7]. The worst or gradable eye was used in the analysis.

Patients found in need of laser photocoagulation treatment were recalled and received laser therapy from a NIDEK Yag YC-1800 laser within a week after their having been identified. The treatment was delivered in the mobile unit on site.

Record Review, Interview and Examinations

One and the same questionnaire was used for each patient interviewed. Patients were examined clinically and a retrospective clinical record review was conducted. Urine and blood samples were collected for tests. Baseline questions and measurements included age, sex, blood pressure, weight and height, duration of diabetes, smoking status, socioeconomic status and history of referrals.

Patients were assessed for foot complaints using a standardised diabetic foot questionnaire, which included the neuropathy symptom score (NSS) [8]. All patients had a foot examination. This included examination with a Semmes-Weinstein 5.07/10-g monofilament; vibration sense with the use of a 128-Hz tuning fork; checking pulses (dorsalis pedis and posterior tibial) and a neurothesiometer (Williams Medical), using 25 Hz as a cut-off point, for peripheral neuropathy.

Cardiovascular symptoms were evaluated with the standardised World Health Organization (WHO)/Rose questionnaire and the intermittent claudication questionnaire [9, 10]. Erectile dysfunction was evaluated using the Sexual Health Inventory for Men (SHIM) questionnaire [11].

Socioeconomic status was assessed by responses to a housing quality index (HQI) questionnaire, validated for the South African context. Questions focused on the type of wall, floor and roof of the house in which the patient resided, whether there was electricity, the type of water supply, where the source of sanitation was located, and what type of sanitation was available for the household [12].

Care received in the 12 months preceding the study was recorded. For the retrospective evaluation of eye care received, any mention of an eye evaluation was recorded, using 'retinopathy',

'cataracts', 'visual acuity' or 'eye problems' as keywords. Patients were also questioned about their knowledge of how regularly a diabetic patient needs to have a foot and eye examination.

Nonfasting blood samples were collected for HbA1c to assess glycaemic control, direct low-density lipoprotein (LDL) cholesterol as a marker of lipid control and serum creatinine as an indicator of renal function in the intervention group. A Micral urine test strip (Accu-chek; intervention group) and a Combi-6 urine test strip (Macherey Nagel) were used to test for albuminuria. All blood samples were analysed by means of a Beckman Coulter Synchron LX® system. Glomerular filtration rate was calculated using the modification of diet in renal disease (MDRD) formula, without ethnicity being taken into account, as recommended by van Deventer et al. [13]. All measurements were taken and data captured by the primary investigator and participating trained medical students from the University of Pretoria.

Data Collection and Analysis

Data were captured in Epidata [14] and analysed using Stata 12 [15]. Descriptive statistics included means and standard deviations for parametric data and medians with 25th and 75th quartiles for nonparametric data, and binomial and multinomial variables as percentages with 95% confidence interval. In order to compare the results of our study with results from the literature, we also grouped data, such as serum creatinine, to values found in the literature [16].

To determine independent associations, variables were selected from the univariate analysis and included as predictors in the model if the p value was <0.25. As we had collected more than one variable for proteinuria and neuropathy, we used one indicator only of a specific complication. Manual backwards stepwise logistic regression was used to select the final model, dropping the variables from the model with the largest p value until we were satisfied with the model. Likelihood ratio testing was not done as sample size changed between the various models. A p value ≤0.05 was considered statistically significant.

All the analyses done in this study were likelihood based. Therefore, valid inferences can be obtained under the assumption of random missingness, implying that the fact that a variable is missing for a patient is unrelated to the outcome that would have been measured for the patient.

Diabetes control parameters were categorised using clinical cut-off points as prescribed by local and international clinical care guidelines. The Society for Endocrinology, Metabolism and Diabetes of South Africa (SEMDSA) provides guidelines for diabetes management. During the study, the 2009 guidelines were applicable, but the LDL cholesterol target was lowered in the 2012 guidelines, which resulted in both cut-off values being reported. [17, 18]. Data from all the screening tools used were classified and analysed as prescribed by the developers. The classification of raised creatinine was based on the cut-off value of >106 μmol/l as reported by Glover et al. [16]. Screening for complications (including the eye evaluations) linked to diabetes took place in the intervention group of the study from June 2010 to March 2011 and in the control group from July 2011 to May 2012.

Ethics Approval

Informed consent was obtained from all patients and clinic health care providers attending or working in the clinics where the study took place. The study was approved by the Faculty of Health Sciences Ethics Committee of the University of Pretoria on April 21, 2010 (protocol No. 61B/2010), by the Tshwane Metropolitan Council on March 2, 2010 and by the Tshwane Metsweding Region Research Ethics Committee on May 18, 2010 (project No. TMREC 2010/19). The study was registered with www.clinicaltrials.gov (NCT01275040).

Results

Sociodemographic Characteristics

We enrolled 599 patients into the trial, of which 457 had eye evaluations. Patients in the intervention arm were screened in round 1 and those in the control arm in round 2. The lower number is explained by the 70% response rate for the second round.

Demographic details can be seen in table 1. Sixty-eight percent of the participants were female and the mean age of the patients was 57.8 years. Patients self-reported whether they were type 1 or type 2 diabetes, whether they were also hypertensive and for how long they had had diabetes. From the last prescription written up in the patient files, patients were grouped as receiving oral agents only, oral agents with insulin, insulin only and diet and exercise alone. Table 1 shows that 70.7% used oral agents only, 9% received insulin and 17.9% used both oral agents and insulin. Only 1.5% did not receive medication for their diabetes diagnosis. The majority of patients had never smoked (76.7%). There was a sex-associated difference in body mass index: the majority of men (40.3%) were overweight, whereas the largest group of women (60.4%) was obese. The study also found that the mean systolic and diastolic blood pressure of patients was 141 and 83 mm Hg, respectively. The blood results indicated that the mean HbA1c was 8.7%, the mean LDL cholesterol was 2.8 mmol/l and the mean creatinine was 70 μmol/l.

Prevalence of Retinopathy, Maculopathy and Other Nondiabetic Lesions

The overall prevalence of retinopathy was found to be 24.9% and that of maculopathy 20.8%. Cataracts were found in 47 patients (10.3%) and drusen maculopathy was found in 16.8% (n = 77) of patients. One patient was also identified with HIV-related retinopathy. Of all the patients evaluated, 8.3% (n = 38) received laser therapy for their retinopathy or maculopathy or both. Twelve percent (n = 55) were referred to the closest hospital with an eye clinic for a follow-up visit with an ophthalmologist. The majority, 79.7% (n = 364), were informed that they needed an eye evaluation in a year's time (table 2).

Table 1. Description of study participants (n = 457) and diabetes control indicators

Sex	
Female	313 (68.5)
Male	144 (31.5)
Diabetes type (self-reported)	
Type 1	18 (3.9)
Type 2	334 (73.1)
Unknown	105 (23.0)
Hypertension (self-reported)	
Yes	356 (77.9)
No	86 (18.8)
Unknown	15 (3.3)
Duration of diabetes (self-reported)	
<5 years	106 (23.2)
5–10 years	132 (28.9)
>10 years	127 (27.8)
Unknown	92 (20.1)
Current treatment	
Oral agents only	323 (70.7)
Insulin only	41 (9.0)
Oral and insulin	82 (17.9)
Diet and exercise	7 (1.5)
Unknown	4 (0.9)
Smoking status (self-reported)	
Current	45 (9.9)
Never	347 (76.6)
Ex-smoker (stopped >1 year ago)	61 (13.5)
Socioeconomic status	
Adequate	372 (81.4)
Inadequate	85 (18.6)
Erectile dysfunction (males, n =137; 9 no response)	
Severe	57 (42.2)
Moderate	21 (15.6)
Mild to moderate	23 (17.0)
Mild	21 (15.6)
No erectile dysfunction	13 (9.6)
Age, years	57.8±10.5 (20–90)
Body mass index	30.8±6.7 (14.3–66.8)
HbA1c, %	8.73±2.3 (4.9–17.3)
Direct LDL cholesterol, mmol/l	2.8±0.97 (0.4–6.4)
Blood pressure, mm Hg	
Systolic	141±23.1 (87–232)
Diastolic	83±13.2 (41–156)
Serum creatinine (n = 280), μmol/l	70±30.3 (26–312)
Median (25th–75th quartile)	63 (54–78)
HbA1c	
≥7%[a]	337/453 (74.4)
Direct LDL cholesterol, mmol/l	
≥2.5[a]	298/453 (65.8)
≥1.8[b]	374/453 (82.6)
Body mass index	
Males	
<25 (normal)	46 (31.9)
25–29 (overweight)	58 (40.3)
≥30 (obese)	39 (27.1)
Unknown	1 (0.7)
Females	
<25 (normal)	39 (12.5)
25–29 (overweight)	83 (26.5)
≥30 (obese)	189 (60.4)
Unknown	2 (0.6)

Values in parentheses represent percentages or ranges. [a] 2009 guidelines; [b] 2012 guidelines.

Visual Acuity

The frequency distribution of visual acuity is shown in table 3. According to the WHO definition, 78.1% (n = 357) had normal vision (≥6/5–6/12), 19.3% (n = 88) were visually impaired (6/18–6/36) and 2.2% (n = 10) were severely visually impaired or blind (≤6/60).

Risk Factor Analysis for Diabetic Retinopathy and Maculopathy

Associations for diabetic retinopathy and maculopathy are shown in tables 4 and 5. For any retinopathy, the following predictors were significant at the $p < 0.05$ level: systolic blood pressure, HbA1c level, LDL cholesterol level, being on insulin treatment, presence of neuropathy (as measured by a neurothesiometer) and the presence of albuminuria using a Micral test strip. In multivariate analysis, three models were tested. Model 1, with the largest number of participants in the model, showed that body mass index, systolic blood pressure, being on insulin treatment, HbA1c level and the presence of neuropathy (as measured by a neurothesiometer) was significant in predicting any diabetic retinopathy.

For any maculopathy, the following predictors were significant at the $p \leq 0.05$ level: systolic blood pressure, HbA1c level, LDL cholesterol level, being on insulin treatment and the presence of albuminuria using a Micral test strip. In multivariate analysis, three models were tested. Model 1, with the largest number of participants in the

Table 2. Prevalence of diabetic retinopathy, diabetic maculopathy, grading of retinopathy and maculopathy, prevalence of other nondiabetes-related eye lesions and final outcomes of evaluations (n = 457)

	n	%	95% confidence interval
Retinopathy			
No retinopathy (R0)	343	75.1	71.1–79.0
Any retinopathy (R1–R4)	114	24.9	21.0–28.9
Preproliferative retinopathy (R1–R2)	89	19.5	15.8–23.1
Proliferative retinopathy (R3–R4)	25	5.5	3.4–7.6
Maculopathy			
No maculopathy (M0)	362	79.2	75.5–83.0
Any maculopathy (M1–M2)	95	20.8	17.1–24.5
Observable maculopathy (M1)	54	11.8	8.9–14.8
Referable maculopathy (M2)	41	9.0	6.3–11.6
Other nondiabetic lesions			
Cataracts	47	10.3	7.5–13.1
Drusen maculopathy	77	16.8	13.4–20.3
Age-related macular degeneration	5	1.1	0.1–2.1
Glaucomatous discs	7	1.5	0.4–2.7
Retinal vein occlusion	6	1.3	0.3–2.4
Retinitis pigmentosa or Stargardt's disease	0	0	
Final outcome			
No action – review eyes within 1 year	364	79.7	75.9–83.4
Refer to mobile unit for laser photocoagulation	38	8.3	5.8–10.9
Refer to hospital outpatient eye clinic for follow-up	55	12.0	9.0–15.0

model, showed that systolic blood pressure, being on insulin treatment, HbA1c level, LDL cholesterol level and the presence of albuminuria using a Micral test were significant in predicting any diabetic maculopathy.

Discussion

Our study reports prevalence rates for diabetic retinopathy, maculopathy and visual acuity for diabetic patients in primary care. To our knowledge, this is the first study reporting on all three of these outcomes in such detail in primary care in South Africa. The prevalence rates for any retinopathy, preproliferative retinopathy and proliferative retinopathy were 24.9, 19.5 and 5.5%, respectively. The prevalence of diabetic maculopathy, observable maculopathy and referable maculopathy was 20.8, 11.8 and 9.0%, respectively. Laser photocoagulation was given to 8.3% of patients from the mobile unit, and 12% of patients were referred to the nearest hospital with an outpatient eye clinic for follow-up treatment of various other eye conditions. On the basis of the WHO categories, the study found that 78.1% of diabetes patients have normal vision, 19.3% were visually impaired and 2.2% were severely impaired or blind.

Table 3. Prevalence of Snellen chart visual acuities according to the better eye of patients with diabetes (n = 457)

Visual acuity[a]	n (%)
Normal vision	
≥6/5 (20/17)	66 (14.4)
6/6 (20/20)	121 (26.5)
6/9 (20/30)	110 (24.1)
6/12 (20/40)	60 (13.1)
Visually impaired	
6/18 (20/60)	52 (11.4)
6/24 (20/80)	20 (4.4)
6/36 (20/120)	16 (3.5)
Severely impaired or blind	
6/60 (20/200)	10 (2.2)
No data	2 (0.4)

[a] US equivalent in parentheses.

Two predictors that this study could not investigate fully were the association between diabetic retinopathy and maculopathy prevalence and the type of diabetes, as well as the duration of diabetes. In our study, patients did not know whether they had type 1 or type 2 diabetes nor

Table 4. Risk factors for the association with diabetic retinopathy in patients with diabetes (n = 457): univariate and multivariate analysis

	OR	95% CI	p value
Univariate regression			
Sex: male vs. female	0.81	0.51–1.26	0.343
Current age (years)	1.00	0.98–1.02	0.959
Body mass index	0.98	0.95–1.01	0.244
Duration: less than 5 years vs. more than 5 years (self-reported)	1.57	0.92–2.70	0.101
Smoking: never smoked vs. current and ever smoked	0.69	0.40–1.17	0.164
Blood pressure (mm Hg)			
Systolic	1.01	1.01–1.02	0.002*
Diastolic	1.01	0.99–1.03	0.220
HbA1c (%)	1.16	1.06–1.27	0.001*
LDL cholesterol (mmol/l)	1.28	1.03–1.59	0.026*
Serum creatinine (μmol/l)	1.01	1.00–1.02	0.038*
Serum creatinine (binary; ≤106 μmol/l vs. >106 μmol/l)	2.33	0.88–6.14	0.088
Visual acuity: normal vs. impaired or blind	1.53	1.11–5.74	0.027*
Insulin vs. no insulin	2.17	1.37–3.43	0.001*
Neuropathy present (neurothesiometer)	2.72	1.14–6.49	0.024*
Neuropathy present (monofilament)	1.13	0.68–1.88	0.643
Protein in the urine, using a urine dipstick (+ vs. –)	1.58	0.71–3.49	0.259
Protein in the urine, using a Micral strip (+ vs. –)	2.26	1.25–2.11	0.000*
Erectile dysfunction (males = 144), SHIM score	0.93	0.77–1.12	0.451
Multivariate regression model 1 (larger data set, n = 397)			
Body mass index	0.96	0.93–0.99	0.043*
Blood pressure: systolic (mm Hg)	1.02	1.01–1.03	0.003*
Insulin vs. no insulin	1.95	1.16–3.27	0.012*
HbA1c (%)	1.13	1.03–1.25	0.014*
Neuropathy present (neurothesiometer)	3.18	1.2–8.47	0.02*
Multivariate regression model 2 (smaller data set, with serum creatinine binary ≤ vs. >106 mg/ml, n = 250)			
Blood pressure: systolic (mm Hg)	1.01	1.00–1.03	0.019*
HbA1c (%)	1.14	1.01–1.28	0.033*
Raised creatinine (>106 μmol/l)	2.72	0.90–8.25	0.077
Neuropathy present (neurothesiometer)	3.95	1.23–12.73	0.021*
Multivariate regression model 3 (smaller data set, with Micral strip, n = 250)			
Blood pressure: systolic (mm Hg)	1.01	1.00–1.03	0.061
HbA1c (%)	1.12	0.99–1.27	0.067
Micral strip (no microalbuminuria, reference category)			
±20 mg/l	0.90	0.35–2.31	0.827
±50 mg/l	2.84	1.28–6.27	0.010*
≥100 mg/l	3.20	1.30–7.86	0.011*
Neuropathy present (neurothesiometer)	3.06	0.93–10.11	0.067

CI = Confidence interval. * p ≤ 0.05.

did they know the duration of their disease. Classification of the patients was difficult because of poor previous history and the absence of systematic records.

Our study found that high systolic blood pressure, HbA1c, LDL cholesterol and insulin treatment are all independent significant predictors of diabetic maculopathy but are also the best predictors for diabetic maculopathy. The role of serum lipids in exudative diabetic maculopathy has been controversial. We found a significant association between LDL cholesterol and diabetic maculopathy, which

Table 5. Risk factors for the association with diabetic maculopathy in patients with diabetes (n = 457): univariate and multivariate analysis

	OR	95% CI	p value
Univariate regression			
Sex: male vs. female	0.99	0.61–1.62	0.987
Current age (years)	0.99	0.98–1.02	0.784
Body mass index	0.99	0.96–1.02	0.572
Duration: less than 5 years vs. more than 5 years (self-reported)	1.63	0.91–2.94	0.102
Smoking: never smoked vs. current and ever smoked	0.79	0.45–1.38	0.413
Blood pressure (mm Hg)			
Systolic	1.02	1.01–1.03	0.002*
Diastolic	1.01	0.99–1.03	0.291
HbA1c (%)	1.17	1.07–1.28	0.001*
LDL cholesterol (mmol/l)	1.69	1.33–2.15	0.000*
Serum creatinine (μmol/l)	1.01	1.00–1.01	0.140
Serum creatinine (binary; ≤106 μmol/l vs. >106 μmol/l)	1.80	0.65–5.00	0.261
Visual acuity: normal vs. impaired or blind	1.88	0.79–4.51	0.156
Insulin vs. no insulin	1.85	1.13–3.01	0.014*
Neuropathy present (neurothesiometer)	1.88	0.74–4.77	0.184
Neuropathy present (monofilament)	1.24	0.73–2.12	0.425
Protein in the urine, using a urine dipstick (+ vs. –)	1.69	0.74–3.83	0.210
Protein in the urine, using a Micral strip (+ vs. –)	2.15	1.17–3.93	0.013*
ED (males = 144), no ED vs. any ED	1.8	0.50–6.54	0.372
Multivariate regression model 1 (larger data set, n = 440)			
Blood pressure: systolic (mm Hg)	1.01	1.00–1.02	0.009*
HbA1c (%)	1.14	1.03–1.26	0.014*
LDL cholesterol (mmol/l)	1.65	1.28–2.13	0.000*
Insulin vs. no insulin	1.58	0.93–2.68	0.090
Multivariate regression model 2 (smaller data set, n = 242)			
Blood pressure: systolic (mm Hg)	1.01	0.99–1.02	0.265
HbA1c (%)	1.09	0.96–1.24	0.188
LDL cholesterol (mmol/l)	1.55	1.11–2.16	0.01*
Serum creatinine (μmol/l)	1.01	1.00–1.02	0.042*
Insulin vs. no insulin	1.43	0.72–2.83	0.306
Multivariate regression model 3 (smaller data set, n = 245)			
Blood pressure: systolic (mm Hg)	1.00	0.99–1.02	0.210
HbA1c (%)	1.09	0.96–1.24	0.164
LDL cholesterol (mmol/l)	1.60	1.15–2.22	0.005*
Micral strip (binary; + vs. –)	2.33	1.22–4.45	0.010*
Multivariate regression model 4 (smaller data set, n = 245)			
Blood pressure: systolic (mm Hg)	1.00	0.99–1.02	0.210
HbA1c (%)	1.09	0.96–1.24	0.164
LDL cholesterol (mmol/l)	1.60	1.15–2.22	0.005*
Micral strip (no microalbuminuria, reference category)			0.0249*
±20 mg/l	0.46	0.60–3.57	0.406
±50 mg/l	2.94	1.28–6.74	0.011*
≥100 mg/l	3.24	1.24–8.51	0.017*

CI = Confidence interval; ED = erectile dysfunction. * p ≤ 0.05.

supports the findings of Chowdhury et al. [19] and Rema et al. [20] that LDL cholesterol is accepted as a risk factor for diabetic maculopathy. According to Klein et al. [21], the Wisconsin Epidemiologic Study of Diabetic Retinopathy was the first to identify an association between elevated serum cholesterol levels and the presence of hard exudates and the ETDRS showed that LDL cholesterol was higher in type 2 diabetic patients with maculopathy compared to those without. Increased maculopathy rates were also seen in those patients with higher baseline cholesterol levels [21]. The Fenofibrate Intervention and Event Lowering in Diabetes (FIELD) trial showed that a 30% reduction in laser requirement was seen following fenofibrate treatment of dyslipidaemia in patients with type 2 diabetes. Atorvastatin therapy in type 2 diabetics has been shown to reduce the severity of hard exudates in clinically significant macular oedema [22, 23]. The 2006 South African treatment guidelines for diabetics seen at primary care level include 10 mg simvastatin for every diabetic patient seen, regardless of lipid profile [24]. Yet, from the prescriptions found in patient files, only 37% of patients were on a lipid-lowering agent. This situation needs to be addressed urgently, as it has been found that statins have an important role to play as a medical adjunct in the management of exudative maculopathy and the need for laser therapy [25].

As the global prevalence of diabetes increases, and with the predicted increase in diabetes in the African region, complications such as diabetic retinopathy will follow suit. In the absence of adequate diabetes care and good metabolic control, the rate of diabetic complications, including retinopathy will continue to rise. In this study, we also explored the effect of teleretinal screening using a mobile unit, linking primary care data collection and tertiary care data interpretation work within the health system. A study carried out in Nairobi, Kenya by Kurij et al. [26] focused on identifying the preferred method for diabetic retinopathy screening by patients in Nairobi. They found that patients prefer teleophthalmology-based screening over the traditional ophthalmologist-based screening. [26]. A study on teleretinal screening in the United States reported that nonmacular diabetic retinopathy was the most common (43.2%) referral diagnosis. Diabetic macular oedema was fifth at 5.6%. [27]. India, another developing country, is also exploring the use of mobile diabetes eye care, because of the size of its diabetic population as well as the distances needed to travel for medical care. A recent review reported that mobile diabetic retinopathy screening and treatment not only provide the care needed but are also popular and effective. Various models are being tested [28]. In our study, following the record review, we found that only 8.2% of diabetic patients in primary care had had any type of eye evaluation and only 6.5% had had their feet checked for complications – this despite the fact that 27.2% of patients reported in a knowledge, attitude and practices survey before the investigations that they knew a diabetic should have an annual eye and foot exam. Using the mobile screening model in a structured way, this can change for diabetic patients, as the debate currently on the screening interval for diabetic retinopathy is not even important, as we first need to establish eye care as part of the routine care received by a diabetic patient at primary care level.

In our study, we found no significant relationship between self-reported erectile dysfunction and diabetic retinopathy ($p = 0.541$) as was reported by Chew et al. [29], but our study also found no association between diabetic maculopathy ($p = 0.372$) and self-reported erectile dysfunction [29]. Our sample size, however, was small and the questionnaires have not yet been validated in this type of setting.

Finally, we would like to agree with the sentiments from the United Kingdom of the president of the Royal College of Ophthalmologists, Prof. Harminder Dua, and the president of the College of Optometrists, David Park, that the need exists for ophthalmologists to take a more active role in community eye care and for increased integration of primary and secondary eye care [30, 31]. This is also true for South Africa, as the population is aging and the need for both general and specialist eye care services is growing. Also, in light of the rising diabetes epidemic, screening at primary care level for eye-related complications will become very important and training should focus on ensuring that the quality of referrals from primary care to tertiary care is improved, so as not to add to already overloaded eye clinics available only at hospital level within the health system. We therefore suggest that all clinics conduct visual acuity screening using a Snellen chart, combined with structured diabetes care with eye evaluations annually.

Strengths

In this study, we explored multiple factors associated with the prevalence of diabetic complications, specifically eye complications. The presence of specific diabetic complications is screened for with the use of multiple techniques, such as a urine dipstick, Micral test strip and serum creatinine to test for the presence of proteinuria. Similarly, neuropathy presence was explored using a standardised questionnaire, a monofilament, tuning fork, presence of pulses and a neurothesiometer.

Limitations

We did not collect data on HIV status. We therefore did not explore the link between HIV and the metabolic syndrome, which can have an even higher effect on diabetes prevalence and its linked complications.

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There are no conflicts of interest.

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