DIABETIC EYE DISEASE: A NATURAL HISTORY STUDY

R. H. TAYLOR[1], H. S. JONES[2], P. M. DODSON[3], A. P. HAMILTON[4] and E. E. KRITZINGER[5]
Birmingham

SUMMARY

In previous studies on diabetic retinopathy it has not been possible to relate risk factors to reduced vision because of the influence of vision-preserving treatment. Demographic data, cardiovascular risk factors and ocular features from the diabetic population of the Seychelles are described. Diabetic retinopathy in this population had not been modified by laser treatment. The population described consists of entirely type 2, maturity onset diabetics. Using a multivariate logistic regression model, the risk factors were deduced for three outcome variables: (1) reduced vision, defined as 6/36 or worse in both eyes; (2) the presence of diabetic retinopathy; and (3) the presence of maculopathy, preproliferative and proliferative retinopathy, grouped as severe retinopathy. Insulin treatment was associated with all outcome variables, duration from diagnosis of diabetes with retinopathy of all forms, and increasing age with reduced vision and severe retinopathy. Hypertensive diabetic patients were twice as likely to have reduced vision as compared with non-hypertensive diabetic individuals.

Diabetic eye disease is a common disorder affecting an unknown number of people world-wide, in which vision is reduced from the effects of cataract and diabetic retinopathy. In the developed world diabetic retinopathy is the leading cause of blind registration under the age of 65 years, accounting for 8 to 10 thousand persons in the UK.[1] Diabetes and its complications are a growing health problem in Europe and elsewhere, and screening programmes have been set up with the aim of reducing the number of blind registrations from diabetic retinopathy.[2,3]

From: [1]Department of Ophthalmology, Royal Hallamshire Hospital, Sheffield; [2]Academic Department, Birmingham and Midland Eye Hospital, Birmingham; [3]Diabetic and Medical Eye Clinic, Birmingham Heartlands Hospital, Birmingham; [4]Moorfields Eye Hospital, London; [5]Birmingham and Midland Eye Hospital, Birmingham, UK.

Correspondence to: Robert H. Taylor, FRCS, FRCOphth, Eye Department, York District General Hospital, Wiggington Road, York YO3 7HE, UK. Tel: +44 (01904) 453938. Fax: +44 (01904) 453397 e-mail.rtaylor@yorkeyes.demon.co.uk.

The prevalence of diabetes mellitus and diabetic retinopathy differs in populations taken from different countries. Type 1 diabetes is rare in patients of African and Asian descent whereas maturity onset diabetes is common (6% Jamaica,[4] 34% Zambia[5] and 15% Nigeria[6]) and positively correlated with increasing age (age-adjusted prevalence rates of 1.4% for African and 2.4% for East Indian Trinidadians[4]) and increasing obesity.[7] In the Nigerian study, it was concluded that efforts should be directed at preventive measures and early identification of high-risk groups.

It is known that focal laser photocoagulation reduces the risk of visual loss from macular oedema by 50%[8] and peripheral scatter laser photocoagulation reduces the risk of visual loss from proliferative disease in high-risk eyes.[9,10] High-risk eyes may be asymptomatic until the disease is advanced and treatment less effective. The screening of asymptomatic patients is therefore of benefit.

The aim of this study was to describe the diabetic population of the Seychelles in terms of visual function and diabetes-related ophthalmic disease. We hoped to identify high-risk groups for diabetic retinopathy and poor vision in order to assist the planning of screening services both in this country and in other developing nations.

SUBJECTS AND METHODS

The population of the Seychelles is approximately 66 000, with 85% of African or mixed descent, 10% Caucasian, 2% Indian and 2% Chinese.[7] Diabetes is common, with an estimated age-standardised prevalence of 4% of the population (3.4% for men and 4.6% for women), rising to 8.8% in males and 13.4% in females at age 55–64 years.[7] There is a strong relationship between diabetes and excess body weight.[7]

Over a period of 1 year, 184 consecutive diabetic patients presenting to the eye clinic in the Seychelles were carefully documented. In addition 199 diabetic

Table I. Summary of information collected

History	Examination
Age	Waist and hip measurement
Sex	Best corrected visual acuity
Race	Intraocular pressure
Diabetes type	Iris
Duration since diabetes first diagnosed	Cataract
	Vitreous
Treatment	Retinopathy
Smoking	Background
Hypertension treatment	Maculopathy
Family history	Preproliferative
Amblyopia	Proliferative
Glaucoma treatment	Advanced
	Age-related macular degeneration
	Advanced field loss from glaucoma
	Other causes of reduced vision

patients were asked to attend screening clinics set up in the districts. The patients seen in the main eye clinic presented either because of visual symptoms or because they were referred for screening by their diabetic physicians. Those seen in the district clinics were asymptomatic.

No patient had received laser treatment prior to the study. Previous to this study, 31 patients had had intracapsular surgery without implantation of an intraocular lens. Surgery was only carried out in those patients with poor vision. In order to approach a true natural situation, the visual function of these patients was assumed to be less than 6/36 pre-operatively.

The information recorded from each patient is displayed in Table I. Each person's ethnicity was based on skin colour, type of hair and the facial characteristics. The number of years on treatment for hypertension was documented and a full smoking history was obtained. For those with a positive family history of diabetes the number of affected first degree relatives, when known, was recorded.

All examinations were carried out by the primary author (R.H.T.). Refracted Snellen visual acuity was recorded in each eye. A Sheridan Gardiner test was used for those unable to recognise letters. Anterior segment examination was at the slit lamp with Goldmann applanation tonometry. For those seen in the district clinics intraocular pressure was measured using a Perkins tonometer and anterior segment assessment made using an indirect ophthalmoscope and 20 dioptre lens. Cataracts were recorded using a simplified grading scale. Brunescence was graded from 1 to 5, white scatter from 1 to 3. In order to simplify the result a significant cataract was taken to be one with greater than or equal to 2 for white scatter or brunescence or, if the patient was aphakic, following cataract surgery, although it is accepted that it is difficult to be precise about the direct effect on vision of any individual cataract.

All retinal examinations were after mydriasis, using indirect ophthalmoscopy and slit lamp biomicroscopy with a condensing or contact lens where appropriate. Macular exudates with significant oedema were recorded as defined by the ETDRS.[8] Ischaemic maculopathy was also documented as present on the basis of reduced vision in the absence of any other demonstrable cause. The presence of arterial and venous changes, intraretinal haemorrhages and intraretinal microvascular anomalies (IRMA) were noted. Cotton wool spots (CWS) were counted where present. The number and site of the new vessels, traction retinal detachment and advanced vitreoretinal changes were recorded. Haemoglobin A_1 estimation and fluorescein angiography were not available for the duration of the study.

RESULTS

Of the 383 patients 70% were female, 52% were hypertensive, 45% had a family history of diabetes, 16% were smokers and 6% were on treatment for glaucoma. In terms of genetic influences, 86% were of African or mixed ethnicity, 8% were Caucasian, 4% Indian and 1% Polynesian. Oral hypoglycaemic agents were being taken by 71% of patients, 11% were being treated with diet alone and 18% were receiving insulin. Further clinical details studied are set out in Table II. All patients were considered to have type 2 diabetes because of age of onset and no evidence of ketosis. Only 17 patients were diagnosed before age 30 years and the youngest was 27 years old at diagnosis. Women had a significantly smaller waist/hip ratio than men. More patients were female; most were hypertensive and overweight.

The ophthalmic examination findings are set out in Table III and the refracted visual acuities in Fig. 1. The causes of reduced vision (6/36 or worse in the better eye) are set out in Table IV. Reduced vision was present in 52 patients, with cataract as the predominant cause followed by maculopathy and traction retinal detachment. Nine of these patients had cataract and maculopathy combining to reduce their vision.

Of the whole population, 28% had diabetic retinopathy, 46% had some form of cataract, 16% had cataract in the better eye enough to reduce the vision to 6/36 or less, and 22% had significant cataract in the worse eye based on cataract grade.

Table II. Continuous data of the population

	n	Mean	Range
Age (years)	383	58	27–83
Duration of diabetes (years)	383	7.8	1–48
Duration of hypertension (years)	198	9.5	1–50
No. of cigarettes per day	63	11.6	1–60
No. of years smoking	63	26.8	2–60
Waist (inches)	255	38.8	30–52
Hips (inches)	255	43.5	34–58
Waist/hip ratio	2.55	0.89	0.71–1.07

Table III. Diabetic retinopathy examination findings

	n (%)
All types	105 (28)
Background	69 (18)
Maculopathy	65 (17) exudates
	42 (11) oedema
	13 (3) ischaemia
	70 (19) total
Preproliferative	24 (6.3) arterial changes
	26 (6.8) venous changes
	17 (4.5) haemorrhages
	11 (3) IRMAs
	17 (4.5) CWS
	47 (12.4) total
Proliferative	12 (3) at disc
	11 (3) elsewhere
	10 (3) traction
	16 (4) total

All figures relate to the more diseased eye.
Not all the denominators are 383, due to the poor view of some retinas as a result of media opacity.

The mean intraocular pressure was 15.4 mmHg (range 0–52 mmHg, standard deviation 4.3). Rubeosis was present in 3 eyes.

STATISTICAL METHODS

Three outcome measures were taken for statistical analysis. First, reduced vision was defined as 6/36 or less in the better eye. This population included some of those who had had cataract surgery (for example if the vision in the non-operated eye was also reduced), in which an assumption of a pre-operative visual acuity of less than 6/36 was made. The second outcome variable was diabetic retinopathy in either eye. Lastly severe retinopathy included the presence of maculopathy, preproliferative or proliferative retinopathy, in either eye.

Data were analysed using the statistical packages MINITAB and GLIM. Initially factors significantly associated with one of the main outcome measures (reduced vision, any diabetic retinopathy, and severe retinopathy) were identified using the chi-squared test for categorical data and the two-sample *t*-test for continuous data. Any variables found to be univariately associated with one of the outcomes were then included in a multivariate logistic regression model to independently assess each variable's effect on this outcome. A stepwise procedure was employed whereby, at each stage, a variable was added to or deleted from the model depending on whether it was or was not significant at the 5% level. This procedure was continued until no more variables could justifiably be added or deleted.

Reduced Vision

Based on the results of the univariate analyses the following variables were tested for significance in the multivariate model: age, insulin therapy, systemic hypertension, duration from the diagnosis of diabetes and age at diagnosis. Using the model, insulin therapy, age and coexistent hypertension were found to be significantly and independently associated with reduced vision. The probability (p) of reduced vision is expressed by the following equation:

$$\ln (p/1-p) = -7.49 + 1.04\ \mathrm{I} + 0.09\ \mathrm{A} + 0.72\ \mathrm{BP}$$

where I is insulin, A is age and BP is blood pressure.

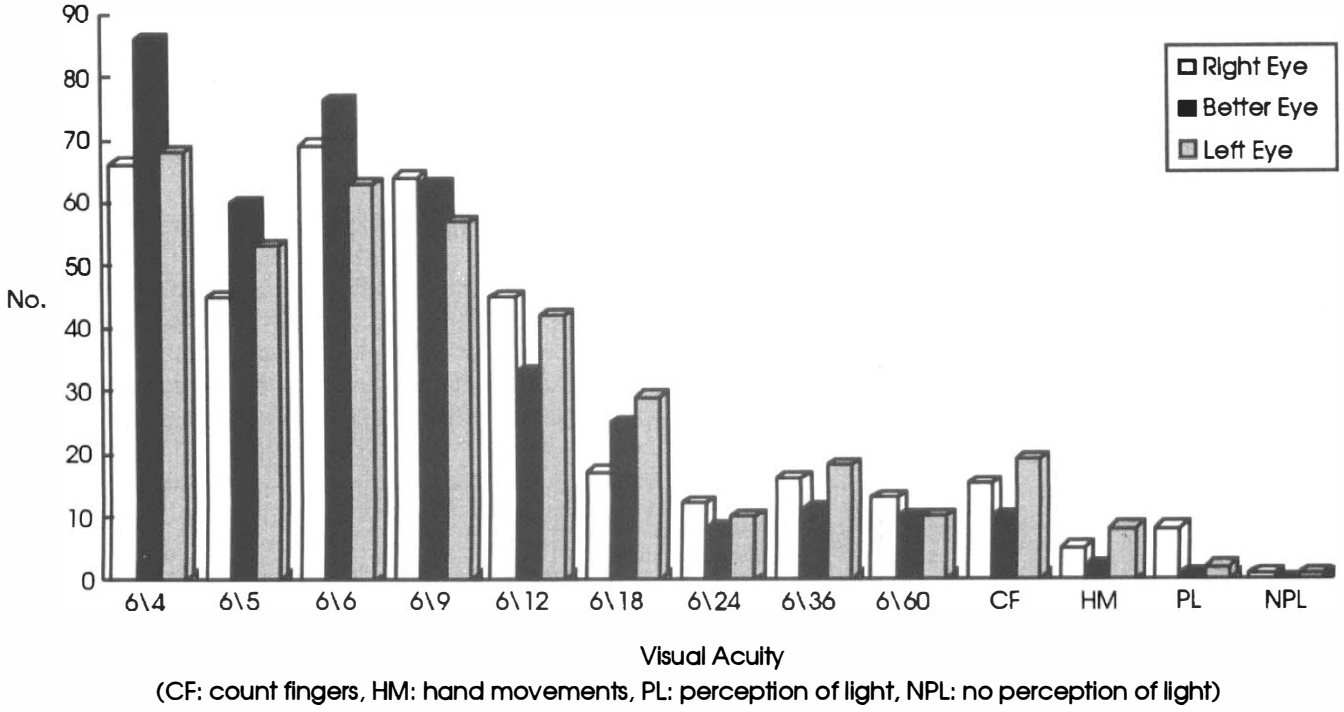

Fig. 1. *Refracted visual acuity of the population.*

Table IV. Causes of reduced vision (52 patients with vision of 6/36 or worse in the better eye had one or more of the following)

	n	%
Cataract	33	63
Diabetic maculopathy	21	40
Traction retinal detachment	9	17
Glaucoma	6	12
Vitreous haemorrhage	3	6
AMD	2	4
Optic atrophy	1	2
Injury/*Toxoplasma* scar	1	2
Both maculopathy and cataract	9	17

AMD, age-related macular degeneration.
NB: Because 17 of these patients had had cataract surgery, it is now known that the second pathology would not have reduced the vision to a level of 6/36 or less. This includes 4 of the cases of maculopathy, 1 of the cases of AMD and 1 case of glaucoma.

Diabetic Retinopathy

One hundred and five patients were found to have diabetic retinopathy. The following variables were tested in the model based on the results of the univariate analysis; where the patient was seen (the clinic as compared with the community), age, duration from the diagnosis of diabetes and insulin treatment. Multivariate associations were with insulin therapy, duration from diagnosis of diabetes and where the patient was seen. In addition the risk of diabetic retinopathy was significantly increased in insulin-treated patients seen in the hospital clinic compared with those seen in the community. The equation expressing the probability of any one person having diabetic retinopathy is:

$$\ln (p/1-p) = -1.56 - 0.36\,P + 1.7\,I - 1.27\,P{\cdot}I + 0.06\,D$$

where P is place (whether seen in the main clinic or in the community), I is insulin and D is duration.

Severe Diabetic Retinopathy

Thirty-six patients had severe diabetic retinopathy. The following variables were tested on the basis of the univariate analysis: where the patient was seen, age, insulin treatment, family history and duration of diabetes. Multivariate associations were with insulin treatment, duration from diagnosis of diabetes, family history, age and place. Again the effect of insulin was modified by place seen.

The multivariate regression model equation for the severe retinopathy category is:

$$\ln (p/1-p) = -3.85 - 0.39\,P + 1.95\,I + 0.05\,D + 0.58\,FH + 0.03\,A - 1.56\,P{\cdot}I$$

where P is place, I is insulin, D is duration and FH family history.

The odds ratios and associated confidence intervals for the outcome variables (reduced vision, any retinopathy in either eye, and the presence of severe retinopathy) are given in Table V.

INTERPRETATION

Reduced Vision

On the basis of the results of the multivariate model, reduced vision was 2.83 times more likely if the patient was treated with insulin, as compared with treatment with diet alone or oral hypoglycaemics. The odds of having reduced vision increased by a multiplicative factor of 1.09 for each year of age; for example, a 40-year-old was 2.46 times more likely to have reduced vision compared with a 30-year-old, all other variables being equal. A patient on treatment for hypertension was twice as likely to have reduced vision than a normotensive one.

Table V. Summary of multivariate logistic regression model

Outcome measures	Risk factors	Odds ratio	Confidence limits
Reduced vision <6/36 in better eye	Insulin therapy	2.83	1.34–5.9
	Increasing age	1.09 per year	1.06–1.13
	Blood pressure	2.05	1.07–3.96
Diabetic retinopathy in either eye	Duration of DM	1.06 per year	1.02–1.1
	Clinic vs community:		
	not on insulin	1.4	0.8–2.5[a]
	on insulin	5.1	1.8–14.9
	Insulin vs other:		
	in clinic	5.5	2.4–12.5
	in community	1.5	0.6–3.7[a]
Significant diabetic retinopathy in either eye	Age	1.03 per year	1.01–1.05
	Duration of DM	1.05 per year	1.01–1.09
	Family history	1.79	1.01–3.15
	Clinic vs community:		
	not on insulin	1.5	0.8–2.8[a]
	on insulin	7.0	2.2–22.4
	Insulin vs other treatment:		
	in clinic	7.0	2.9—16.8
	in community	1.5	0.5–4.1[a]

DM, diabetes mellitus.
Any figure over 1 indicates significance at the 5% level.
[a]Not significant, but included for comparison.

Factors not found to have any influence on reduced vision were smoking, duration from diagnosis of diabetes, race, sex, glaucoma, increased waist or hip measurement, waist/hip ratio or family history.

Diabetic Retinopathy

The odds of having retinopathy increased by a multiplicative factor of 1.06 for each year of duration from the diagnosis of diabetes. For example if a patient had been treated for diabetes for 10 years then their chance of having retinopathy was 1.35 times that of a patient who had had the disease for 5 years. From the equation given earlier, the probability of any given patient having diabetic retinopathy can be calculated. For example, for a patient who had diabetes for a duration of 5 years from diagnosis, who was seen in the eye clinic and was on insulin treatment, the probability of the presence of diabetic retinopathy is 0.61.

The odds ratio for clinic patients was 0.7. This was not significant alone but when this variable interacted with insulin treatment it was significant. For example, a clinic patient on insulin was 5.5 times more likely to have retinopathy than a clinic patient on other modes of treatment, and 5.1 times more likely to have retinopathy than a community patient on insulin.

The factors not found to have any influence on the presence of diabetic retinopathy were smoking, age, race, sex, hypertension, glaucoma, increased waist or hip measurement, wasit/hip ratio, age at diagnosis and family history. There was no negative correlation with glaucoma.

Severe Diabetic Retinopathy

A clinic patient who was receiving insulin was 7 times more likely to have severe diabetic retinopathy than a clinic patient who was on other modes of treatment. A clinic patient was also 7 times more likely to have severe retinopathy than a community patient receiving insulin.

A patient who had a positive family history of diabetes was 1.79 times more likely to have severe retinopathy than a patient with no family history.

The odds of having severe retinopathy increased by a multiplicative factor of 1.05 for each year of duration from the diagnosis of the disease and by a multiplicative factor of 1.03 for each year of age.

Factors not found to have any influence on the presence of severe retinopathy were smoking, race, sex, hypertension, age at diagnosis and increased waist or hip measurement and waist/hip ratio. Furthermore there was no negative correlation with glaucoma.

DISCUSSION

As the diet of developing nations becomes more Westernised and average body weight increases along with increasing age, diabetes and its complications are likely to become increasingly prevalent and a heavy burden on the health service provider.

Comparisons with Other Population Studies

Diabetes is known to be more common in patients of African descent. The population prevalence of diabetes in one study based in the UK was 10.8/1000, of which 6.7/1000 were non-insulin-treated diabetics.[11] This compares with 4% in this Seychelles population. This increased prevalence may in part be due an increased prevalence of obesity in the Seychelles as well as genetic factors.

Characteristics from our sample of the diabetic population of the Seychelles were remarkably consistent with a larger study of 1078 patients[7] in whom 17% of diabetics were on insulin treatment as compared with 18% in our study. The proportion of diabetic patients who were hypertensive was 52.4%[12] – similar to the 51.6% in this study. In a population of black type 2 diabetic patients in the UK, 48.9% were found to be hypertensive.[13]

In our study, 18% of the diabetic patients were insulin treated. This is lower than the figure in other Western diabetic mellitus populations[14] and could reflect differing criteria for conversion to insulin by their physicians or different characteristics of the two populations.

The overall figure of 46% of patients in this population with cataract appears high but is similar to the figure of 40% for Afro-Caribbeans living in Britain.[4] Ethnic factors and diabetes combine to produce this high figure. A potential weakness of the study is the absence of control data for the prevalence of cataract in an age- and sex-matched non-diabetic population.

The overall prevalence of diabetic retinopathy in this population was 28% and is less than the figures from a recent UK study (53%[11]). Our figure is greater than that for diabetic populations reported in Africa.[5,6] It is known that obesity is common in this population (age-standardised rates of body mass index (BMI) >30.0 kg m^{-2} being 4.2% for men and 20.9% for women[7]) and this may have an influence. Proliferative diabetic retinopathy was more common (4%) than the 0.2% in a population of Zambian diabetics,[5] and lower than the figure of 16% for those in Lesotho.[15]

Reduced Vision

Diabetic maculopathy was identified as the cause of reduced vision in 40% of those patients with a visual acuity of less than 6/36. Together with traction retinal detachment and vitreous haemorrhage, complications of diabetic retinopathy accounted for 63% of those patients with a visual acuity of less than 6/36.

The rarity of age-related macular degeneration in this population is also confirmed (see Table IV).

It is interesting that reduced vision was associated with increasing age and not duration from the diagnosis of diabetes. The latter figure is dependent on the time of the diagnosis, and in many cases it may be that diabetes already existed at this date, reducing the likelihood of a significant association.

Definition of High-Risk Groups

High-risk groups for the development of diabetic retinopathy in African or Afro-Caribbean patients have been described as those in older age groups, those with a longer duration of diabetes[5] and insulin-treated patients.[6] In these studies there was no association of diabetic complications and glycaemic control. In other major studies from mixed populations in developed nations the above risk factors were found, and in addition the following: young age at diagnosis,[14] older patients,[16] smoking,[17] high diastolic blood pressure,[14,16,17] male sex,[14] leaner patients,[16] and populations attending a medical centre as opposed to a rural setting.[18]

More advanced diabetic retinopathy was associated with increased age, increased systolic blood pressure and increased fasting glucose concentration in a population of maturity onset diabetics.[16]

In this population, risk factors for reduced vision included insulin therapy and the coexistence of hypertension. Hypertension is not normally associated with vision-damaging retinopathy, but we found that a hypertensive diabetic patient was twice as likely to have reduced vision as a non-hypertensive diabetic patient. Afro-Caribbean diabetics have the highest prevalence of associated hypertension but the lowest prevalence of lipid abnormalities.[19]

Insulin therapy correlated highly with all the outcome variables, and in particular for those attending the clinic, who were over 7 times as likely to have severe retinopathy if on insulin treatment. This significance could indicate poor diabetic control at an earlier time which warranted the conversion to insulin. This is in agreement with recent data showing reduced diabetic complications associated with tight diabetic control.[20] The possibility that either these insulin-treated patients have a more severe form of diabetes or that insulin itself might be an exacerbating factor should be considered.

We have included in our analysis the factor of whether patients were seen in the clinic or in the community. As a significant result was found, this has been reported. It is not implied that such a division of the population would be relevant to other geographic settings.

Duration from the diagnosis of diabetes was significantly associated with diabetic retinopathy, but there was no association of this variable with reduced vision. There is a high risk of diabetic retinopathy being present shortly after diagnosis in type 2 diabetics (quoted at 24%[16]) and this may explain this lack of correlation.

A patient with a positive family history of diabetes was 1.8 times more likely to have severe diabetic retinopathy than one without such a history. This may relate to the inbred nature of the population studied.

It has been postulated that glaucoma protects against the development of diabetic retinopathy by reducing metabolic demand.[21] We found no protective influence from glaucoma, which was present in only 5.7% of the population studied. This low figure may reduce the likelihood of achieving significance.

These patients have now been treated with laser photocoagulation using a portable laser, by an ophthalmologist experienced in treating diabetic retinopathy. This method of organising treatment may be relevant for neighbouring countries planning laser facilities, as such an ophthalmologist may be more appropriate than a general ophthalmologist having to develop the necessary skills on a relatively small number of patients.

CONCLUSION

It is likely that the prevalence of blinding diabetic retinopathy will increase in developing countries as diet becomes more Westernised, average weight increases and people live longer. If a screening programme for diabetic retinopathy is to be envisaged the identification of high-risk groups may be worthwhile. Diabetic retinopathy, in particular diabetic maculopathy, was responsible for reducing the visual performance to a level eligible for partial sight registration (in the UK) in 63% of the patients with reduced vision. The patients most likely to have reduced vision were elderly, hypertensive patients receiving insulin. The patients most likely to have treatable retinopathy were patients seen in a hospital setting, receiving insulin, who had a longer history of diabetes and who had a positive family history. While cataract, infective and nutritional problems are still paramount in many parts of the world, the screening for and treatment of diabetic retinopathy will become of increasing import.

The authors thank the Ministry of Health, Republic of Seychelles, Academic Department of Ophthalmology, University of Birmingham, and the Diabetic and Medical Eye Clinic, Heartlands Hospital, East Birmingham Health Authority, for their assistance.

Key words: Diabetes mellitus, Diabetic retinopathy, Visual loss, Risk factors, Screening.

REFERENCES

1. Kohner EM. The evolution and natural history of diabetic retinopathy. Int Ophthalmol Clin 1978;18: 1–16.

2. WHO/DF Europe. Diabetes care and research in Europe: the Saint Vincent Declaration. Diabetic Med 1990;7:360.
3. WHO/DF Europe. A protocol for screening for diabetic retinopathy in Europe. Diabetic Med 1991;8:263–7.
4. Cruickshank JK, Beevers DG. Ethnic factors in health and disease. London: Butterworth, 1989:289–304.
5. Rolfe M. Diabetic eye disease in central Africa. Diabetologia 1988;31:88–92.
6. Erasmus RT, Alanamu RA, Bojuwoye B, Oluboyo P, Arije A. Diabetic retinopathy in Nigerians: relation to duration of diabetes, type of treatment and degree of control. East Afr Med J 1989;66:248–54.
7. Tappy L, Bovet P, Shamlaye C. Prevalence of diabetes and obesity in the adult population of the Seychelles. Diabetic Med 1991;8:448–52.
8. Early Treatment Diabetic Retinopathy Study Research Group. Treatment techniques and clinical guide-lines for photocoagulation of diabetic macular oedema. ETDRS report no. 2. Ophthalmology 1987;94:761–74.
9. Early Treatment Diabetic Retinopathy Study Research Group. Techniques for scatter and local photocoagulation treatment of diabetic retinopathy. ETDRS report no. 3. Int Ophthalmol Clin 1987;27:254–64.
10. Diabetic Retinopathy Research Group. Photocoagulation treatment of proliferative diabetic retinopathy: the second report of Diabetic Retinopathy Study findings. Ophthalmology 1978;85:81–106.
11. Sparrow JM, McLeod BK, Smith TD, Birch MK, Rosenthal AR. The prevalence of diabetic retinopathy and maculopathy and their risk factors in the non-insulin-treated diabetic patients in an English town. Eye 1993;7:158–63.
12. Tappy L, Bovet P, Jéquier E, Shamlaye C, Darioli R, Burnand B. Relationship of fasting serum insulin concentrations with blood pressure in a representative sample of the adult population of the Seychelles. Int J Obes 1991;15:669–75.
13. Pacy PJ, Dodson P, Beevers M, Fletcher RF, Taylor KG. Prevalence of hypertension in white, black and Asian diabetics in a district hospital diabetic clinic. Diabetic Med 1985;2:125–31.
14. Klein R, Klein BE, Moss SE, Davis MD, De Mets DJ. Prevalence and risk of diabetic retinopathy when age at diagnosis is less than 30 years and 30 years or more: Wisconsin epidemiological study of diabetic retinopathy. Arch Ophthalmol 1984;102:520–32.
15. Gordan YJ, Mokete M. Diabetic retinopathy in Lesotho. Doc Ophthalmol 1981;51:193.
16. Kohner EM, Aldington SJ, Nugent Z. Retinopathy at entry in the United Kingdom Prospective Diabetes Study (UKPDS) of Maturity Onset Diabetes. Diabetes 1987;36 (Suppl 1):42A.
17. Mouton DP, Gill AJ. Prevalence on diabetic retinopathy and evaluation of risk factors: a review of 1005 diabetic clinic patients. S Afr Med J 1988;74:399–402.
18. Kollarits CR, Kriess RD, Das A, Hall AM, Jordan EL, Donovan JR. Diabetic retinopathy and insulin therapy in a rural diabetic population. Am J Ophthalmol 1984;97:709–14.
19. Pacy PJ, Dodson P, Kubicki AJ, Fletcher RF. Differences in lipid and lipoprotein levels in white, black and Asian non-insulin dependent (type 2) diabetics with hypertension. Diabetes Res 1987;4: 187–93.
20. DCCT Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin dependent diabetes mellitus. N Engl J Med 1993;329: 977–1034.
21. Ulbig MR, Hamilton AMP. Factors influencing the natural history of diabetic retinopathy. Eye 1993;7: 242–9.