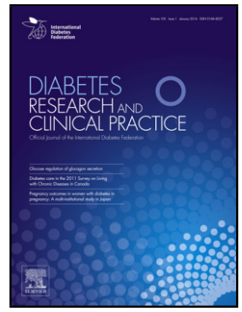
Accepted Manuscript



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PII: S0168-8227(15)00192-8
DOI: http://dx.doi.org/doi:10.1016/j.diabres.2015.04.010
Reference: DIAB 6355

To appear in: *Diabetes Research and Clinical Practice*

Received date: 19-12-2014
Revised date: 27-2-2015
Accepted date: 12-4-2015

Please cite this article as: S. Alemu, A. Dessie, A. Tsegaw, C.C. Patterson, E.H.O. Parry, D.I.W. Phillips, E.R. Trimble, Retinopathy in Type 1 Diabetes Mellitus: major differences between rural and urban dwellers in northwest Ethiopia, *Diabetes Research and Clinical Practice* (2015), http://dx.doi.org/10.1016/j.diabres.2015.04.010

Retinopathy in Type 1 Diabetes Mellitus: major differences between rural and urban dwellers in northwest Ethiopia

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Abstract

Aim: To audit levels of diabetes-related eye disease in Type 1 diabetes mellitus (T1DM) patients in northwest Ethiopia. In particular to establish whether, despite identical clinical goals, major differences between the physically demanding life-style of rural subsistence farmers and the sedentary life-style of urban dwellers would influence the prevalence of diabetes-related eye complications.

Methods: A robust infrastructure for chronic disease management that comprehensively includes all rural dwellers was a pre-requisite for the investigation. A total of 544 T1DM were examined, representing 80% of all T1DM patients under regular review at both the urban and rural clinics and representative of patient age and gender (62.1% male, 37.9% female) of T1DM patients from this region; all were supervised by the same clinical team. Eye examinations were performed for visual acuity, cataract and retinal changes (retinal photography). HbA1c levels and the presence or absence of hypertension were recorded.

Results/Conclusions: Urban and rural groups had similar prevalences of severe visual impairment/blindness (7.0% urban, 5.2% rural) and cataract (7.3% urban, 7.1% rural). By contrast, urban dwellers had a significantly higher prevalence of retinopathy compared to rural patients, 16.1% and 5.0%, respectively (OR 2.9, $p<0.02$, after adjustment for duration, age, gender and hypertension). There was a 3-fold greater prevalence of hypertension in urban patients, whereas HbA1c levels were similar in the two groups. Since diabetic retinopathy is closely associated with microvascular disease and endothelial dysfunction, the possible influences of hypertension to increase and of sustained physical activity to reduce endothelial dysfunction are discussed.

Keywords: retinopathy, maculopathy, cataract, hypertension, rural, Africa

1. Introduction

Relatively little is known about the clinical outcomes of many chronic diseases in the developing countries. Reports from the developing world often include only cases from the urban and peri-urban areas; this is particularly the case for T1DM. T1DM, defined here as diabetes which has been treated continuously with insulin, without remission, from the first clinical presentation, causes visual impairment chiefly through the development of cataract and retinopathy. Although cataracts are seen frequently in patients with type 2 diabetes mellitus (T2DM), they also occur in T1DM; at a global level chronic hyperglycaemia and the duration of diabetes are major aetiological factors for cataract formation [1,2]. Diabetic retinopathy and associated maculopathy are due to microvascular disease in which there is endothelial dysfunction giving rise to leakage of fluid from the retinal capillaries into the perivascular space, retinal oedema, small haemorrhages, and collapse of the capillaries. The resultant retinal ischaemia is associated with the stimulation of growth factors such as VEGF and the development of new fragile blood vessels; this stage, proliferative retinopathy, poses great risks for major bleeds and retinal detachment resulting in significant visual impairment [3]. Hyperglycaemia is a major cause of diabetic retinopathy and stricter blood glucose control is associated with improved outcomes as first shown clearly in the Diabetes Control and Complications trial (DCCT) [4]. Other factors include hypertension [5], and disturbances of lipid metabolism [6]. There is also emerging evidence that diabetic retinopathy is a polygenic disorder, with familial clustering, and different levels of heritability for proliferative and non-proliferative retinopathy [7] Of particular importance in the present context are lifestyle factors and the differences between urban and rural groups, especially the level of physical activity which has been shown to have glucose-independent effects on endothelial function in T1DM [8]. Visual impairment and blindness are handicaps in any society and especially so in regions where access to appropriate clinical services may be limited; in these areas severe visual impairment and blindness are closely associated with poverty.

In order to inform long-term, strategic planning for chronic disease management it is important to have an accurate assessment of the burden of disease in the rural population as well as in those who live in urban and peri-urban areas. In sub-Saharan Africa a large proportion of the population lives in distant rural areas; in Ethiopia, rural dwellers account for 80% of the population. The greatest barrier to accurate data collection from rural dwellers has been the widespread lack of infrastructures for chronic disease management in these people. We will present audit data on eye disease in T1DM as an example of clinical outcomes in a chronic disease from a region in northwest Ethiopia. The region is served by a central referral hospital and a system of multiple, supervised rural health clinics up to 90 km distant. This sustainable, structured approach to chronic disease management has been developed over the past two decades with urban and rural clinics being supervised by the same clinical team.

The chief aim of the audit was to establish whether significant lifestyle differences between urban and rural dwellers were associated with different levels of eye disease, despite identical clinical goals for the two groups.

2. Patients and Methods

2.1.Context: This is the report of an audit carried out to assess the status of diabetes-related eye disease in Gondar and the surrounding area of northwest Ethiopia. Gondar is one of the centres where there has been a remarkable development of infrastructure to manage chronic diseases in a way that effectively includes the rural population. In this region of the Ethiopian northwest the overall direction, ethos, goals and management of both the urban and rural clinical diabetes services, including patient education, have been overseen by the same clinical consultant physician (SA) for more than 20 years. Although the clinical goals have been identical for the two communities there are several differences in living conditions. Rural dwellers, mainly subsistence farmers, have a life-style that is physically demanding in the extreme, have a lower BMI than their urban counterparts [9], and keep close to the traditional diet of unrefined flours, mainly teff and corn, legumes, a limited selection of vegetables and fruits and minimal amounts of animal protein. There are some specific difficulties for rural T1DM patients; thus, it is exceptionally rare for them to have a fridge for insulin storage, money to buy glucose test strips or a watch/clock to tell the time of day. Urban dwellers in this region have a more sedentary life-style compared to the rural population but have kept relatively close to a traditional diet; although some change is occurring, there has been little move to a western-type diet as has happened in other areas of the developing world. Both urban and rural groups are affected by the limited laboratory resources available to monitor their progress; because of these limitations HbA1c, micro-albuminuria and lipids are not measured as a routine. Alterations in disease management are based on the recent clinical history, the presence or absence of hypertension (≥ 140/90 mm Hg) [10] and on fasting blood glucose levels measured at the clinic visit.

2.2. Patient inclusion: A general invitation was given to all patients (urban and rural) to come to the central clinic for assessment of their sight, including retinal photography with a static camera. This report is on 544 T1DM patients who were screened and who represent approximately 80% of all rural T1DM and 80% of all urban T1DM cases followed up on a regular basis at the rural and urban clinics, respectively. They are also representative of their parent groups with respect to age and sex ratio; there is a well-documented preponderance of males, especially in the rural group [9,11].

2.3. Eye examination:

Visual acuity: Tumbling-E Snellen's charts (recommended for those not used to the Roman alphabet) were used to assess visual acuity, starting the examination with the patient at 6m distance from the chart in a well illuminated room. Best corrected visual acuity was measured for both eyes and grading of visual impairment and blindness was done according to the WHO classification system [12] as follows: visual acuity better or

equal to 6/18 – normal; visual acuity less than 6/18 and better than 6/60 – moderate visual impairment; visual acuity less than or equal to 6/60 and better than or equal to counting fingers at 3m – severe visual impairment; visual acuity less than counting fingers at 3m – blindness; the results for the eye with the best corrected visual acuity was recorded.
Cataract: cataract was diagnosed by examination with a slit-lamp microscope.
Retinopathy (and maculopathy): A Top Con TRC-NW65 Non Mydriatic Retinal Camera (Topcon Medical Systems Inc, Oakland, New Jersey) was used for retinal photography. This was carried out under standardised conditions in a darkened room after the eyes were treated with1% Tropicamide (although this camera can operate without mydriasis); two photographs were taken for each eye, one centred on the optic disc and one centred on the macula. Grading of the retinal changes was made using the Diabetic Retinopathy Study guidelines and recorded in six categories: mild, moderate, and severe non-proliferative retinopathy and early, high risk, and advanced proliferative retinopathy [13]. Maculopathy was diagnosed when there were hard exudates on the macula and/or thickening obvious on the two-dimensional fundus pictures. Slit-lamp examination was carried out only if there was evidence of retinopathy or suspicion of cataract not visible to the naked eye. All retinal photography was carried out by a single, highly trained operator, a senior nurse with extensive responsibilities for both patient education and clinical management (AD). Approximately 1 in 2 of all retinal photographs, and 100% of those with complexities were double-read by the same ophthalmic surgeon (AT) who had trained AD.

2.4. HbA1c measurements were made on venous blood, using cartridges containing boronate affinity columns from Bio-Rad, in a Bio-Rad in2it A1c analyser for point-of-care testing, according to the manufacturer's instructions (Bio-Rad Laboratories Inc, Hercules, California). Quality control was carried at least once per day and/or after the analyzer was moved.

2.5. Statistical analyses were performed using SPSS version 21(IBM Corp, Armonk, New York).Baseline results are presented as mean± SD or percentages, and comparisons between groups were made using the t-test or chi-square test/Fisher's exact probability test. Significant associations were further examined using logistic regression analyses, in particular with adjustments for the possible confounding effects of duration of diabetes, age, gender, and hypertension with respect to prevalence of retinopathy and maculopathy. Results were expressed as odds ratios with 95% confidence intervals.

3. Results

3.1.Patient demographics (Table 1):

3.1.1. A total of 544 T1DM patients were screened, this is approximately 80% of the total number of T1DM patients under regular review at both the urban and rural clinics. The average age at the time of screening of urban and rural patients was similar; mean duration of diabetes was significantly longer in urban patients. There was a sex difference in the numbers of T1DM patients attending for assessment (62.1% male, 37.9% female), with the rural patients showing the greater disparity.

3.1.2. *HbA1c*: There was no significant difference in the average HbA1c levels between urban and rural groups (Table 1). In the combined group HbA1c was ≤7% [≤53mmol/mol] in 22.9% patients, 7.1-9.0% [54-75 mmol/mol] in 35.2% patients and ≥ 9.1% [≥76 mmol/mol] in 41.9% patients (not shown).

3.1.3. *Hypertension:* Hypertension was three times more prevalent in urban than in rural patients (Table 1).

3.2. Vision

3.2.1. *Visual acuity* (Table 2): Visual acuity was assessed in 536 of the 544 patients. In those who were tested normal visual acuity was present in 83.7% of urban and 87.6% of rural patients; 7.0% of urban and 5.2% of rural cases (total n=31) had either severe visual impairment or were blind. An accurate result could not be recorded in 8 patients without obvious visual impairment despite the use of tumbling-E Snellen's charts; these patients were totally illiterate.

3.2.2. *Cataract* (Table 3): Cataracts at various levels of development were present in 39 (7.2%) cases. Place of residence (urban/rural) did not affect the prevalence of cataract. Visual impairment in association with cataract: severe visual impairment or blindness on testing, was associated with cataract in 15 cases, 6 of 12 urban and 9 of 19 rural cases (details not shown). Thus in 6 urban and 10 rural cases cataract was not sufficient cause for the severe visual impairment/blindness.

3.2.3. *Retinopathy* and maculopathy(Table 4): Density of the cataract prevented adequate visualisation of the retina in 33 of the 39 cases with cataract; the prevalence of retinopathy and maculopathy visible to the retinal camera (assessable retinopathy) in the remaining 511 patients (168 urban and 343 rural) is shown in Table 4; the total number of patients with retinopathy was 44 and with maculopathy was 32.

3.2.3.1: Prevalence of Retinopathy: As expected, the prevalence of retinopathy increased with duration of diabetes: crude results for 0-5 years, 6-10 years and 11+ years were, 7.1%,18.8% and 34.2% for urban patients ,and 2.0%, 3.5%, and 29.0%, for rural patients for these time periods, respectively. When all cases from the urban and rural groups were investigated (Table 4a), without adjustment for any available confounder, the urban group had significantly more retinopathy than the rural group [OR 3.7 (1.9 - 7.0), p<0.001], after adjustment by logistic regression for duration of diabetes the results remained significant [OR 2.9 (1.5 - 5.6), p=0.002]; after additional adjustment for age, gender and hypertension the difference between urban and rural patients remained significant [OR 2.9 (1.4 – 5.9), p= 0.005]. Gender alone was a non-significant predictor (not shown). [If all cases with dense cataract (retinas not assessable by photography) also had retinopathy, and this is not certain, then there would still be a significant difference between the prevalence in urban and rural cases (20.8% v 10.7%, respectively, p= 0.001, not shown)].

3.2.3.2. Prevalence of Maculopathy (Table 4b): Maculopathy was noted in 32 patients (6.3% of those in whom the retina could be fully assessed). The prevalence of maculopathy in urban cases of T1DM was significantly greater than in rural cases: without adjustment for any available confounder the differences were highly significant [OR 3.2 (1.6 - 6.7), p=0.002; after adjustment by logistic regression analysis to take into account duration of clinical disease the difference remained significant [OR 2.6 (1.2 - 5.6), p=0.01]; after additional adjustment for age, gender and hypertension the difference between urban and rural groups remained significant [OR 2.5 (1.1 - 5.7), p= 0.03]. Gender alone was a non-significant predictor (not shown).
3.2.3.3. Severity of retinopathy: see Table 4c

3.2.4. *Retinopathy and maculopathy, co-morbidity:* No cases of maculopathy were diagnosed in those without identifiable lesions in the rest of the retina; 32 of 44 subjects (72.7%) with retinopathy also had maculopathy.

3.2.5. *Visual impairment in association with retinopathy and maculopathy*: In 2 patients severe visual impairment or blindness was associated with severe retinopathy (n=1), or retinopathy and maculopathy (n=1), in the absence of cataract.

Therefore in patients with severe visual impairment or blindness (n=31), cataract was associated in a total of 15 cases (see above) and retinopathy and/or maculopathy in a further 2 cases. The causes for severe visual problems have not been ascertained with certainty in the remainder (n=14 or 45%).

3.3. *Co-morbidity: Hypertension with retinopathy and maculopathy* (Table 5): Retinas could be assessed in 511 T1DM patients; of these patients 48 were hypertensive and 463 normotensive. There was a highly significant association of hypertension with retinopathy (OR 5.2 [2.5-10.8], p<0.001) and with maculopathy (OR 5.3 [2.3-11.9], p<0.001). When duration of diabetes was introduced as a confounder the association of hypertension with retinopathy (OR 3.3 [1.5 - 7.3], p=0.004) and maculopathy (OR 3.5 [1.5 – 8.5], p=0.004) remained significant: there was no significant difference after additional adjustment for age, gender and residence (urban/rural).

4. Discussion

In Ethiopia more than 80% of the population are rural dwellers. We have previously reported from two centres in western Ethiopia where, although the incidence of T1DM was higher in the urban centres, the total number of cases in the surrounding rural areas was greater by a factor of two because of the great excess in the population numbers of the rural dwellers [9,11]. The T1DM phenotype in many developing countries differs from westernised societies. As in other countries of sub-Saharan Africa, the maximum incidence of T1DM occurs in the 15-34 age group with a peak at the age of 25-29 years, and little diagnosed in the pre-pubertal period [9]. The typical patient presenting with severe symptoms requiring insulin treatment in rural Ethiopia is a young adult who is extremely poor, with evidence of chronic protein-calorie malnutrition, and skeletal disproportions that suggest nutritional problems dating from early childhood; there is a marked male preponderance in rural dwellers [9,11]. Therefore, the urban and rural groups in this audit were representative of their parent groups with respect to relative numbers and sex differences. Even with treatment T1DM patients remain under-weight by western standards, with average BMIs of 18-19 kg/m^2 for urban and 16-17 kg/m^2 for rural cases [9]. In the region around Gondar in the Ethiopian northwest from which the present report comes, the average BMI of treated T1DM patients (urban and rural combined) has increased over the last decade, from 15.9kg/m^2 to 18.3kg/m^2 [14].

The prevalence of cataract was not significantly different between urban and rural T1DM patients. Diabetes, increasing age, hypertension and excessive exposure to sunlight are among the many risk factors for cataract formation. The rural cases had a similar age but less hypertension than the urban cases; however, as subsistence farmers, their exposure to direct sunlight would be greater than for urban cases. Blindness or severe visual impairment was present in 7% urban cases and 5.2% rural cases; cataract could be linked to these visual deficits in approximately half of the affected patients. It is well documented that in contrast to westernised countries where the main cause of blindness and severe visual impairment in diabetes is retinopathy [15], cataract remains the most common cause of blindness and severe visual impairment (35% of all cases) in sub-Saharan Africa [16]. Cataract removal leads to a life-changing transformation in low-income countries where cataract is both a cause and result of poverty [17]. However, cost to the patient, distance to the hospital, and limited knowledge about the service still create barriers to the uptake of the service, especially in rural areas [18]. In those without dense cataract, blindness and severe visual impairment were associated with retinopathy or maculopathy in a further small number of patients, but the cause was unclassified in the remainder (approximately 45%). In a review of prevalence and causes of vision loss in sub-Saharan Africa, unidentified causes accounted for 33% of cases; other causes listed were refractive error, macular degeneration, trachoma, glaucoma, and diabetic retinopathy [16].

In contrast to cataract, the overall prevalence of retinopathy and maculopathy was higher by a factor of three in urban cases compared to rural cases with T1DM; after adjustment for all available confounders (duration of disease, age, gender and hypertension) the differences between urban and rural groups remained highly significant. Retinopathy has long been associated with the microvascular complications of diabetes [19], for which endothelial dysfunction is an important start point. Apart from duration of disease, one of the main risk factors for diabetic retinopathy in T1DM is poor glycaemic control as first shown in the DCCT study. It has not been possible to give a summative history of glycaemic control as carried out in both the DCCT [4] and UKPDS

[20] studies, and thus relate glycaemic control to retinopathy status in individual cases. Although it is important not to attribute too much aetiological weight to a single HbA1c result in a cross-sectional investigation such as this, the similarity of the urban and rural HbA1c results is interesting. Although the average HbA1c levels were above the goal of ≤ 7.0% [≤ 53 mmol/mol], there was no significant difference between the glycaemic control of the urban and rural T1DM groups, despite the specific difficulties of insulin storage and regular blood glucose monitoring for the rural patients. Globally, as a consequence of the DCCT and UKPDS studies, the targets for glycaemic control have been tightened and retinopathy rates have begun to fall [21,22]. The HbA1c levels in the present cross-sectional report were not dissimilar to those found at present in many routine diabetes clinics in westernised countries [19,21,22]. How do the results of the present report compare with previous results from Ethiopia and other African countries? A report published in 1992 from the Ethiopian capital on a mixed urban/rural group of T1DM patients (mainly urban) reported that of the 11.5% of the total group for whom retinal examination was recorded, retinopathy was found in 21.7% of those with disease duration of 0-9 years [23]. A systematic review which included reports from 21 African countries on the prevalence of diabetic retinopathy and maculopathy was undertaken recently [3]. Most of the studies included in the report were set up for specific but disparate reasons making it difficult to compare them with the present study: thus, several did not differentiate between T1DM and T2DM, many investigated a small percentage of the total diabetic group or did not state the percentage assessed for retinopathy and maculopathy, and although rural groups were included in a few studies the outcomes for rural and urban groups were not reported separately [3]. In the major T1DM-only study an urban cohort (n=88) from Soweto (South Africa) has been followed from 1982, with the 20 year follow-up published in 2005; in 1982 their average age was 22 years and duration of diabetes was 3 years [24]. In this group the BMIs were higher (means of 21.7 kg/m^2 and 27.3 kg/m^2 in 1982 and 2002, respectively) and glycated haemoglobin levels higher (means of 10.2% and 11.2% in 1982 and 2002, respectively) than in the group in the present report from Ethiopia. At ten years' follow-up (mean duration of T1DM, 13.6 years) 52% had retinopathy [25]. However, HbA1c levels were lower in the present report from Ethiopia due to the aim for tighter glycaemic control that has become the goal in more recent years, and this is reflected in the lower prevalence of retinopathy. Clearly there are problems in making direct comparisons between cohort and cross-sectional studies. A recent publication from the Wisconsin Diabetes Registry Study [21] reported 6% retinopathy prevalence at 4 years in young T1DM patients with a cumulative mean level of HbA1c 9.1% from the start of the study. An Australian study [22] has reported 12% retinopathy at 8.9 years duration of T1DM with an average HbA1c of 8.5%. There is overlap in the prevalence of retinopathy between the urban group of the present report (who are adults) and those of the Wisconsin and Australian studies (adolescents); in this case caution is needed when comparing retinopathy in adults with that in patients who have had diabetes before and during the pubertal phase of development. Notwithstanding the difficulties in making comparisons with other published groups, it is remarkable that the rural- and urban- living T1DM subjects in the present report, of similar ethnicity and looked after by the same clinical team differ so much with respect to prevalence of retinopathy.

Any discussion of the reasons for the differences between the urban and rural groups must remain speculative because of the cross-sectional nature of the present study. It seems possible that the differences could be related to the development of microvascular disease since it was seen with retinopathy and not with cataract. There are important life-style differences between the urban and rural groups which may contribute to differences in the prevalence of retinopathy. While diet remains similar in the two groups there are major differences in physical activity. Aerobic exercise improves endothelial function in T1DM through glucose-independent mechanisms [8].The rural group of T1DM, consisting mainly of subsistence farmers, have an extremely demanding life-style compared to the urban dwellers. Physical exercise, when sustained in the way experienced by subsistence farmers, is associated with reduced endothelial dysfunction, the initial step in the development of retinopathy; this may also be one reason for the lower levels of hypertension in the rural group [26]. Hypertension, approximately three times more prevalent in the urban than the rural T1DM subjects remained significant after adjustment for duration of diabetes. Hypertension is another glucose-independent factor in the development of endothelial dysfunction and retinopathy [27] and is an important precipitating factor for retinal ischaemia [28]. Prevalence of hypertension throughout the developing world is very variable and associations of hypertension with incomes, household assets, social class or occupation are also very variable even within a single continent [29]. In Northern Ethiopia a recent survey reported that sex- and age-adjusted mean systolic pressure was significantly higher in the urban than the rural population and also showed a positive association between systolic and diastolic pressure with both age and BMI [30]. In the present study the average age of urban and rural T1DM patients was similar. With respect to BMI, we have shown previously that the average BMI of T1DM patients from this region was 2-3 kg/m^2 greater in urban than in rural dwellers [9]; we have also found that the percent body weight as fat is higher in urban than rural cases (16.7% vs 13.8%, $p<0.05$, unpublished results) in a range of BMI where there is a strongly positive association between BMI and blood pressure [30, 31]. Body fat has been shown to have a positive association with insulin resistance and higher blood pressure in south Asians [32]. The total percent body fat in the Ethiopian groups is lower than in south Asians with similar BMI, but the differences in body fat between urban and rural dwellers are of the order of magnitude shown to be significant for blood pressure changes in south Asians [32]. In lean populations relatively small changes in adiposity have a significant impact on blood pressure [33]. Thus, insulin resistance due to increased fat deposits may be one of several metabolic contributors (others as yet unidentified) to the increased blood pressure in the urban T1DM dwellers in northwest Ethiopia [33,34].

In conclusion, retinopathy and maculopathy, complications of diabetes closely linked to microvascular disease, were much lower in T1DM patients who lived in the rural areas of northwest Ethiopia than in urban dwellers; but cataract prevalence, which is not linked to microvascular disease, was similar in the two groups and was found to be the chief cause of blindness or severe visual impairment. It is possible that the lower rates of retinopathy may be linked to the very active life-style of the rural dwellers who are mainly subsistence farmers. Despite enormous problems for insulin storage and regular blood glucose measurement in the rural community, glycaemic control of rural patients with T1DM was similar to that of urban dwellers, and for both groups was comparable to that achieved routinely in clinics of most westernised countries. This audit report, relating differences between rural and urban groups, has been possible only because of the development of a stable, robust infrastructure that permits the effective management of chronic diseases, such as T1DM, in the distant rural communities of Ethiopia. With respect to diabetic retinopathy the audit has revealed outcomes that compare well with outcomes in rich westernised countries.

Conflict of interest

The authors declare that they have no conflict of interest.

Acknowledgements

The authors are grateful to the World Diabetes Association for the donation of the retinal camera and to Professor P Dodson (Birmingham, England) for his help with software used in conjunction with the retinal camera in Gondar. We also are grateful to the Ethiopian Diabetes Association and the Novo Nordisk Foundation for the HbA1c analyser and the kits to carry out the measurements in this report.

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Table 1

T1DM patient demographics

	Urban	Rural
Total number	178	366
Male gender, % (n)	51.1 (91)	67.5 (247)[a]
Age, years	34.6±13.3	34.4±13.1
Duration of illness, years	7.2±6.6	5.4±4.2[a]
HbA1c: % (n)	8.6±2.2 (98)	8.8±2.1(155)
: [mmol/mol]	[71±24]	[72±23]
Hypertensive, % (n)	18.5 (33)	6.0 (22)[a]

Age, duration of illness and HbA1c results given as mean±SD

[a] *p<0.01, urban vs rural*

Table 2

Visual acuity

	Urban	Rural
Total tested, n [a]	172	364
6/6-6/18 (normal), % (n)	83.7% (144)	87.6% (319)
6/24-6/60 (MVI)[b], % (n)	9.3% (16)	7.1% (26)
<6/60 (CF@3m;SVI)[c], % (n)	1.2% (2)	1.6% (6)
<CF@3m (blind), % (n)	5.8% (10)	3.6% (13)

[a] Visual acuity results were not available for 6 urban and 2 rural patients (see text)
[b] MVI, moderate visual impairment
[c] CF@3m, count fingers at 3 metres; SVI, severe visual impairment

Table 3

Prevalence of cataract

	Urban	Rural
Total, n	178	366
Cataract, % (n)	7.3% (13)	7.1% (26)

Table 4 Prevalence of retinopathy and maculopathy in T1DM patients

		Urban	Rural	Odds ratio (95%CI), p
Number of patients [a]		168	343	
(a) Retinopathy ,% (n)		16.1% (27)	5.0% (17)	3.7 (1.9 -7.0), p<0.001[b]
				2.9 (1.5 -5.6), p=0.002[c]
				2.9 (1.4 – 5.9), p=0.005[d]
(b) Maculopathy , % (n)		11.3% (19)	3.8% (13)	3.2 (1.6 - 6.7), p=0.002[b]
				2.6 (1.2 - 5.6), p=0.01[c]
				2.5 (1.1 - 5.7), p=0.03[d]
(c) Severity of retinopathy*:*				
Non proliferative, n:	Mild	9	2	
	Moderate	12	13	
	Severe	2	0	
Proliferative, n:	Early	1	0	
	High risk	0	1	
	Advanced	3	1	

[a] Retinas could be adequately visualised and assessed in 511 T1DM :168 urban, 343 rural
[b]Retinopathy or maculopathy, total groups: without adjustment for any available confounder
[c]Retinopathy or maculopathy, total groups: after adjustment for duration of diabetes
[d]Retinopathy or maculopathy, total groups: after adjustment for duration, age, gender, and hypertension

Table 5

Hypertension: association with retinopathy and maculopathy in T1DM

(Urban and rural patients combined)

	Total[a]	Normotensive	Hypertensive	
Number of patients	511	463	48	OR (95%CI), p
Retinopathy, % (n)	8.6% (44)	6.7% (31)	27.1% (13)	5.2(2.5 -10.8), p<0.001[b]
				3.3(1.5 - 7.3), p=0.004[c]
				1.9(0.8 - 4.7), p=0.18[d]
Maculopathy, % (n)	6.3% (32)	4.8% (22)	20.8% (10)	5.3(2.3 - 11.9), p<0.001[b]
				3.5(1.5 - 8.5), p=0.004[c]
				2.1(0.8 - 5.6), p=0.15[d]

[a] Total number of patients whose retinas could be adequately visualised

[b] Retinopathy or maculopathy: without adjustment for any other available confounder

[c] Retinopathy or maculopathy: after adjustment for duration of diabetes

[d] Retinopathy or maculopathy: after adjustment for duration, age, gender, residence (urban/rural)