ORIGINAL ARTICLE

Diabetic retinopathy and socioeconomic deprivation in Gloucestershire

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Objectives To investigate socioeconomic variations in diabetes prevalence, uptake of screening for diabetic retinopathy, and prevalence of diabetic retinopathy.
Methods The County of Gloucestershire formed the setting of the study. A cross-sectional study of people with diabetes was done on a countywide retinopathy-screening database. Diabetes prevalence with odds ratios, uptake of screening, prevalence of any retinopathy and prevalence of sight-threatening retinopathy at screening were compared for different area deprivation quintiles. Logistic regression was used to adjust for confounding.
Results With each increasing quintile of deprivation, diabetes prevalence increased (odds ratio 0.84), the probability of having been screened for diabetic retinopathy decreased (odds ratio 1.11), and the prevalence of sight-threatening diabetic retinopathy among screened patients increased (odds ratio of 0.98), while the prevalence of non-sight-threatening diabetic retinopathy remained unchanged with each increasing quintile of deprivation.
Conclusion Sight-threatening diabetic retinopathy was associated with socioeconomic deprivation, but non-sight-threatening diabetic retinopathy was not. Uptake of screening was inversely related to socioeconomic deprivation.

INTRODUCTION

Diabetes affects more than 3% of the UK population. Diabetic retinopathy is the leading cause of blindness in the working age group.[1] A national screening programme for detection of sight-threatening diabetic retinopathy (STDR) has been implemented in England.[2,3] The Gloucestershire Diabetic Eye Screening Service (GDESS) is a mobile digital photographic screening programme[4] that was introduced in all 85 general practitioner (GP) practices in Gloucestershire in October 1998.

Gloucestershire has a population of around 606,000, which is on average slightly older than that of England and Wales as a whole, and has small ethnic minority population. The main ethnic groups are Indian/British Indian (0.7%) and black/black British (0.8%). These groups are very localized within the county, with over 50% of Gloucestershire's non-white population based within Gloucester City, and about 20% living in a single electoral ward. The Indices of English deprivation (IED)[5] were developed on behalf of the Office of the Deputy Prime Minister. They measure deprivation for every one of 32,482 Lower Layer Super Output Area (LSOAs) in England using an aggregation of the lowest level at which census data is available. Each LSOA was assigned a score and a rank for 2004. The overall deprivation score is the sum of weighted scores from the following domains: income deprivation; employment deprivation; health deprivation and disability; education skills and training deprivation; barriers to housing and services; crime and living environment deprivation. The variables combine to form an overall score ranking for a given area, relative to others in England. The current study is the first to use quintiles of deprivation for census output areas to compare diabetes and diabetic retinopathy prevalence and screening uptake rates

METHODS

GDESS has offered mobile camera digital photographic diabetic eye screening at each GP practice since 1998. The primary source of data for the study was individual level records from the GDESS database. All 85 GP practices within Gloucestershire provided details of all their diagnosed diabetic patients to populate the GDESS database. The details were verified annually, approximately one month before the mobile unit visited each surgery. The first data set included anonymized data from all patients entered onto the GDESS database, whether or not they had been screened, as at December 2002. The second data set, up to February 2003, comprised only those patients who had been screened for diabetic retinopathy.

The data sets had the following inclusion criteria: aged 16 or over, entered on system up to December 2002 (data set 1) or February 2003 (data set 2), resident in Gloucestershire, registered with a Gloucestershire GP practice and valid diabetic retinopathy screening test result entered (data set 2 only).

Both data sets included retinal screening number, date of birth, age, postcode, census SOA code Index of Multiple deprivation, (based on patient's residential postcode) and whether screened or not screened. Data set 2 also included screening test results (no retinopathy, background retinopathy or STDR) (Table 1).

Table 1 Population samples meeting inclusion criteria

	Count	%	(95% confidence limits)
Data set 1			
Total of people in Gloucestershire meeting inclusion criteria	471,282		
Patients with diabetes	13,284	2.82	(2.8, 2.9)
Patients with diabetes who attended retinal screening	9810	73.85	(73.1, 74.6)
Data set 2			
Number of patients who attended screening	10,312	100.00	
Patients with no retinopathy	6776	65.71	(64.8, 66.6)
Patients with background retinopathy	2150	20.85	(20.1, 21.6)
Patients with sight-threatening retinopathy	1386	13.44	(12.8, 14.1)

Following discussions with Gloucestershire Research and Development Support Unit, it was agreed that ethics committee approval was not required, because the study data were anonymized and the study would not directly impact on patient care.

The population denominator for prevalence estimates was the number of general practice-registered patients aged over 16 who resided within the County. This was calculated for each Census SOA by taking an extract from Exeter system and using a postcode to OA reference file. The Exeter system is the main population database used in general practice in Gloucestershire.

The grading system used by the GDESS team for screening results has been reported[6,7] and is similar to that recommended for use in the National Grading Classification[8] in England. For this study, grades of retinopathy were merged into two levels – STDR, and non-sight-threatening diabetic retinopathy; the latter group consisted of those with background retinopathy. The reason for this is that the sight-threatening retinopathy group are referred to the hospital for ophthalmological opinion, while the non-sight-threatening group with milder retinopathy are not.

Statistical analysis

All analysis was undertaken using SPSS version 15 (SPSS, Chicago, IL, USA).

Data set 1 was used to analyse diabetes prevalence and uptake of screening using an ecological study model.[9] That is, deprivation was measured for the areas in which individuals lived, and not specifically for each individual. Quintiles of overall deprivation[10,11] were calculated by grouping data by Census OA and then sorting IED score.

The following statistics were calculated for each quintile:

(1) Total number with diabetes
(2) Crude diabetes prevalence rate (% of population aged over 16)
(3) Odds ratio for diabetes prevalence (with 95% CI) compared with least deprived quintile

For take-up of screening for diabetic retinopathy, the data was grouped into approximately equal quintiles of population. Total numbers of people screened and the percentage screening coverage was calculated for each deprivation quintile, and compared with most the deprived quintile. In an alternative model we included deprivation as a constant variable (coded 1, 2 3, 4, 5 with increasing deprivation) in a logistic regression model to estimate the trend in outcome for each increase in deprivation quintile; this was adjusted for gender and age (Table 2).

Data set 2 was used to analyse variations in prevalence of any diabetic retinopathy, and of sight-threatening retinopathy, using a cross-sectional analysis of individual level data. Using the ranges of IED score identified in the analysis of screening uptake ranges, data were then grouped into quintiles of equal population with diabetes who had been screened (and had a test result) and the following calculated for each quintile. Logistic regression models were then used for screening uptake.

RESULTS

A total of 13,304 patient records in data set 1 met the inclusion criteria for the study. Of these, 9821 (73.8%) had been screened and 3483 (26.2%) had not (Table 1). The age range was between 15 and 101 years, with a mean age of 64.7 years (standard deviation 15.3 years). Those who had been screened were on average slightly older (mean 65.9 years) than those not screened (mean 61.3 years).

Prevalence of diabetes in the population

A clear difference in diabetes prevalence was shown between the least and most deprived quintiles of socioeconomic deprivation. The least deprived quintile (quintile 1) showed a diabetes prevalence (for age 16 and over) 2.4%, increasing to 2.8% in the next least deprived (quintile 2), and then 3.0 and 3.6% in quintiles 3 and 4, and 3.9% for the most deprived (quintile 5) (Table 2).

Logistic regression analysis, adjusting for gender and five-year age band, showed an odds ratio of 0.84 (95% CI 0.83–0.85), between adjacent pairs of quintiles, i.e. the odds of being diagnosed with diabetes increased by an estimated 16% from the least deprived to the second least deprived quintile, and similarly from quintile 2 to 3, 3 to 4 and 4 to 5 (the most deprived). The odds ratio was significantly different from 1 ($P < 0.001$).

Table 2 Prevalence of diabetes, attendance for screening and type of retinopathy by deprivation quintile

	Least deprived → Most deprived quintiles				
	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Prevalence of diabetes (%)	2.4	2.8	3.0	3.6	3.9
Attendance for screening (%)	76.7	74.3	73.1	70.9	67.4
Presence of any retinopathy (%)	33.3	34.9	34.7	34.2	35.1
Presence of sight-threatening retinopathy (%)	11.9	13.9	14.3	14.4	14.2

Table 3 Probability of attending for diabetic eye screening – adjusted for age and gender

Deprivation quintile	Rate per 1000 screened	DASR per thousand screened	(95% confidence limits)
1 (least deprived)	767	679	(652, 706)
2	743	682	(652, 711)
3	731	603	(571, 636)
4	709	597	(553, 636)
5 (most deprived)	674	580	(530, 630)
All	738	648	(632, 664)

DSAR, Directly age standardized rate

Table 4 Probability of having sight-threatening retinopathy – adjusted for age and gender

Deprivation quintile	Rate per 1000 screened	DASR screened per thousand screened	(95% confidence limits)
1 (least deprived)	119	123	(103, 143)
2	139	136	(111, 163)
3	143	175	(139, 212)
4	144	123	(94, 153)
5 (most deprived)	142	112	(82, 143)
All	134	136	(124, 149)

DSAR, Directly age standardized rate

Screening uptake among those invited for screening

The least deprived quintile (quintile 1) showed a screening uptake of 76.7%, decreasing to 74.3% in the next most deprived (quintile 2); then 73.1 and 70.9% in quintiles 3 and 4, down to 67.4% in quintile 5 (the most deprived) (Table 3).

Logistic regression analysis, (adjusting for gender and five-year age band), showed an odds ratio of 1.11 (95% CI 1.08–1.15), between adjacent pairs of quintiles, i.e. the odds of attending for screening, decreased by an estimated 11% from the least deprived to the second least deprived quintile (quintiles 1 and 2), and similarly from quintile 2 to 3, 3 to 4 and 4 to 5 (the most deprived). The odds ratio was significantly different from 1 ($P < 0.001$).

Prevalence and severity of retinopathy among screened patients

In data set 2, 10,312 patients met the inclusion criteria for analysis of the results of screening tests for diabetic retinopathy (Table 1). This second data set included 491 extra people with diabetes identified in the two months between December 2002 and February 2003. Of these 10,312 patients, 1386 (13.4%) had sight-threatening retinopathy and 2150 (20.8%) had background levels of retinopathy. The remaining 6776 (65.7%) of patients had no retinopathy present. The mean age of age of patients was 66.5 years, this was similar for all grades of retinopathy.

Prevalence of any type of retinopathy in the screened population

The least deprived quintile (quintile 1) showed a prevalence of retinopathy (any type) of 33.3%, which increased to 34.9% in quintile 2 (the next least deprived quintile). In quintiles 3, 4 and 5 (the most deprived) the prevalences of any retinopathy were 34.7, 34.2 and 35.1%, respectively.

Logistic regression analysis, (adjusting for gender and five-year age band), showed an odds ratio of 0.98 (95% CI 0.95–1.02), between adjacent pairs of quintiles, but this was not significantly different from 1 ($P = 0.33$).

Prevalence of sight-threatening retinopathy in the screened population

Among those who attended for screening, the least deprived quintile (quintile 1) had a prevalence of sight-threatening retinopathy of 11.9% (Table 4). In quintiles 2, 3, 4 and 5 (the most deprived) the prevalences were 13.9, 14.3, 14.4 and 14.2%, respectively.

Logistic regression analysis (adjusting for gender and five-year age band), showed an odds ratio of 0.95 for each increase in quintile of deprivation (95% CI 0.90–0.99). The difference in prevalence between the two least deprived quintiles compared with the other three was significantly different from 1 ($P = 0.02$).

Screening uptake among those invited for screening

The least deprived quintile (quintile 1) showed a screening uptake of 76.7%, decreasing to 74.3% in the next most deprived (quintile 2); then 73.1 and 70.9% in quintiles 3 and 4, down to 67.4% in quintile 5 (the most deprived).

DISCUSSION

The study shows that, in Gloucestershire, people living in more deprived areas were more likely to have diabetes, that these people were less likely to be screened for diabetic retinopathy, and that among those who were screened, those living in the most deprived areas were more likely to have sight-threatening retinopathy.

The analysis of overall deprivation variations in diabetes prevalence supports previous research that has indicated a relationship between prevalence of type 2 diabetes and socioeconomic deprivation, although it was not possible to distinguish between type 1 and type 2 diabetes in the current study.

There has been little if any research undertaken into socioeconomic variations in screening for diabetic retinopathy, although one review[12] has indicated the importance of socioeconomic factors in explaining variations in take-up.

Studies in the UK by Litwin *et al.*[13] and Bachmann *et al.*[14] have looked at overall retinopathy, rather than considering different stages of the disease, and studies by Chaturvedi *et al.*[15] and Hanna *et al.*[16] have found significant socioeconomic variations in the prevalence of proliferative diabetic retinopathy. In the classification system used in Gloucestershire, proliferative retinopathy is graded as sight threatening, though this classification also includes maculopathy, moderate to severe non-proliferative retinopathy and advanced retinopathy. This study may have identified important socioeconomic differences in prevalence related to stage of disease that would have been hidden in other studies that used a definition of the disease as either present or absent.

One of the strengths of this study is that the population size of over 10,000 patients with diabetes enabled a robust analysis and comparison between different subgroups. The other main strength of the study relates to the Gloucestershire Screening Service, which provides county-wide coverage with photographic screening and grading of the resulting image sets being undertaken in a consistent and systematic way, in contrast to a number of other previous studies that have used either self-reported questionnaires or data from screening services with incomplete coverage.

There are a number of weaknesses in this study. No data was available for date of diagnosis (to calculate duration of diabetes), ethnicity, blood pressure, obesity, glycaemic control measurement or practice characteristics. Duration of diabetes has been highlighted as one of the key factors affecting the development of diabetic retinopathy.[17,18] Linkage of these screening databases with general practice data on these risk factors is a priority for further research.

A possible factor in the high prevalence of sight-threatening retinopathy in patients aged less than 40 may have been duration of diabetes in type 1 patients. The inclusion criteria for the study included only those patients with a valid test result and excluded those with ungradeable image sets (approximately 3.7% of those screened with the commonest reason[7] for this being cataract). Data for this study were also received in two parts and although there did not appear to have been any significant differences between characteristics of the two populations it would have been preferable and more straightforward to use a single source.

CONCLUSION

This study has demonstrated that socioeconomically disadvantaged groups in Gloucestershire appear less likely to be screened for diabetic retinopathy despite the development of a comprehensive mobile screening service, delivered at every practice within the County. Further research is required around the key factors involved in variations in screening uptake, which could include a questionnaire of non-attenders, and would need to consider reasons for non-attendance, and also examine the importance of other factors such as geographical accessibility.

The higher prevalence of sight-threatening retinopathy among more deprived groups again raises issues around differences in how individuals manage their diabetes, but also possible variations in how effectively diabetes is being managed in primary care. We aim to repeat this study with enhancements to the data set including individual and practice level data in order to provide a greater understanding of the relative importance of these factors.

The National Screening Programme for STDR will be offering annual digital photographic screening to two million people with diabetes and this study has demonstrated that further research is required to understand the reasons for non-attendance in socioeconomically deprived groups with diabetes. The National Screening Programme needs to attract socioeconomically deprived groups to attend, as these people are at the most risk of STDR.

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