ABSTRACT

Background Preventable sight loss is an indicator within the Public Health Outcome Framework 2013–2018 for England. Routinely available optometric data do not permit small area analysis of access inequalities.

Methods Data were extracted from 17,680 General Ophthalmic Services (GOS1) claim forms for eye examinations conducted in Leeds during February and March 2011. The expected number of GOS1 uptake for each lower super output area was based on the GOS1 national annual uptake. A Poisson regression model was used to explore associations in the GOS1 uptake ratio with deprivation and gender.

Results People aged 60 or over or under 16 living in the least deprived quintile are 71 and 23%, respectively, more likely to have an NHS-funded eye examination than someone in that age group in the most deprived quintile, although all are equally entitled. Uptake is higher in the more deprived quintiles among 16–59 year olds, as means tested social benefits are the main eligibility criteria in this age group. There were no statistically significant gender differences in uptake.

Conclusions Interventions are needed to address eye examination uptake inequalities. However, in order to better inform commissioning and planning eye care services more complete data with additional detail are required. GOS1 forms ought to be submitted electronically linked to additional demographic and clinical data to allow public health analysis. Ideally, private eye examination data should also be captured.

Keywords epidemiology, eye disorders, socioeconomics factors

Introduction

Visual impairment affects ~10% of people aged 65–75 and 20% of those aged 75 or older. Estimates of the rate of undetected visual impairment among older people lie between 20 and 50%, with the majority of problems being correctable (i.e. refractive errors or cataracts).

It was estimated that the cost of partial sight and blindness in the adult population in the UK was £22 billion in 2008 (£2.14 billion in direct health-care system costs, £4.34 billion in indirect costs and £15.51 billion due to years of life lost due to morbidity or premature death). With an ageing population, this health burden is expected to increase, with an estimated 31% increase in the number of people blind or partially sighted between 2010 and 2020.

While there is very limited literature exploring inequalities in eye care in the UK, a systematic review of global social inequalities and visual impairment found that:

- women had a higher prevalence of visual impairment and blindness, which was not fully explained by age or by access to services;
- socioeconomic status (SES) measured as higher income, higher educational status or non-manual occupational social class was inversely associated with prevalence of blindness or visual impairment;
- ethnicity and race were associated with visual impairment, although other social determinants of health can be associated;
- geographical inequalities and visual impairment (of the region, nation or continent) were observed to be independently related to income and living in a rural area.
Preventable sight loss has been included as an indicator within the Public Health Outcomes Framework for England, 2013–2016. The indicator is defined in terms of the incidence of Certificates of Vision Impairment issues for glaucoma, age-related macular degeneration, diabetic eye diseases and all causes.

In recognition of the impact of visual impairment, the NHS in England funds eye examinations under a General Ophthalmic Services (GOS1) contract with optometrists, for children, people aged 60 and over, people on low incomes and those suffering from or pre-disposed to eye disease.

Given that the eye examination is a key first step in detecting preventable sight loss, it is important to understand socio-demographic variation and inequalities in accessing such tests (whether funded by the NHS or privately). However, there are a number of important limitations with the routinely available data.

First, no routine data on privately funded eye examinations have been published since 2005/06.

Secondly, the source of routine data on uptake of NHS-funded eye tests is the GOS1 form submitted by optometrists and ophthalmic medical practitioners in order to claim their fee for performing the examination. The claim form is usually submitted as a paper copy and contains limited information required for verification: name, address, date of birth of the patient, under which eligibility criteria is the test provided, whether a prescription or referral was issued as a result of the test and details of the practitioner who performed the test. No information is collected on ethnicity. The form is retained for audit purposes, but in most parts of England there is no data stored electronically. Data routinely available from eye tests in the community are derived by manual extraction from a 2 to 4% sample of GOS1 forms.

Thirdly, GOS1 test data are only reported according to eligibility category. Patient age is not reported even though date of birth is recorded on the GOS1 form, although age-based eligibility criteria may be used as a proxy. If eye tests were requested as per recommended test frequency (http://www.nhs.uk/chq/Pages/1093.aspx?CategoryID=68&SubCategoryID=157), there might have been expected to be 9.17 million NHS-funded eye tests in the 60 or over group in 2012/13, whereas there were 5.48 million GOS1 tests where ‘age over 60’ was recorded as the eligibility criterion (although some of this age group may have been recorded under another eligibility criteria or paid privately).

Fourthly, the lowest geographical levels at which GOS1 data are published is the former Primary Care Trust areas. The address and postcode of the patient is recorded on the GOS1 form, but is not captured for routine data analysis. If available, the post code of residence would provide an indication of the socioeconomic circumstances of the area in which the patient lived.

Thus, while there are limitations with the data recorded by an optometrist on the GOS1 form, data that would be useful for an equity profile of uptake of GOS1 tests are lost from the routinely published data. Therefore, this study aimed to explore the geographical differences of GOS1 uptake at a smaller geographical area across the city of Leeds, utilizing data manually extracted from GOS1 claim forms that are not usually accessible within the routine data.

Methods

Setting
Leeds is a city in the north of England, with a population of 751,485 in the 2011 census (14.9% within Black and minority ethnic groups). 19.3% of localities in Leeds [lower super output areas (LSOAs), each representing ~1500 people] are ranked amongst the 10% most deprived areas of England.

In 2012/13, there were 172,363 NHS-funded eye examinations within Leeds, a rate of 22,961 per 100,000 population [95% confidence interval (CI) 22,866–to 23,056]. This was 7% less than the rate for England of 23,235 per 100,000 (95% CI 23,224–23,246) and for the Yorkshire and the Humber region of 23,913 per 100,000 (95% CI 23,877–23,949). While the rate of NHS sight tests conducted in Leeds has been increasing over time, the uptake rate has been consistently lower than the regional and national rates. This, however, masks different patterns between the eligibility groups, for example the rates of sight tests in the 60 and over and the 0–15 age groups are higher in Leeds than that for England.

Cohort
All GOS1 application forms for an NHS-funded sight test (paper and electronic) conducted in Leeds and submitted to the West Yorkshire Central Services Agency in February and March 2011 were entered onto a database. Checks were made for duplication between paper and electronic versions of the GOS1 form. A census period of 24 January to 28 February 2011 was identified during which all eye examinations performed in Leeds under a GOS1 contract were likely to have been captured by the data entry process. Gender was recorded on the basis of whether a patient was recorded as Mr/Mrs/Miss/Ms or on the basis of first name.

Statistical analysis
The small area analysis was based on LSOAs that are built from groups of neighbouring output areas (census areas).
LSOAs are automatically generated to be as consistent as possible in population size (1000–3000) and characteristics of the component communities in each LSOA.

The outcome calculated was the ratio between the ‘actual uptake’ of GOS1 within an LSOA and the ‘expected GOS1 uptake’ within that LSOA. The ‘actual uptake’ was calculated by using the postcode of residence, detailed on each GOS1 record, mapped to LSOA and so providing the aggregated number of GOS1 claims within each LSOA. The number of claims within each LSOA was aggregated based on the age groups for age at test (16, 16–59 and 60 over).

The ‘expected number of GOS1 uptake’ for each LSOA was based on the 2010/11 GOS1 national annual uptake rate (extrapolated to 5 weeks) applied to mid-year 2011 population estimates for each LSOA. The expected rates were estimated for each of the three age groups by collating the national uptake by reasons for uptake, i.e. age group under 16 (GOS1 uptake reason children 0–15), age group 60 and over (GOS1 uptake reason 60 and over) and age group 16–59 (all other GOS1 uptake reasons).

A GOS1 uptake ratio of an LSOA $>1$ means that the uptake in that area is above that expected nationally, while a uptake ratio of an LSOA $<1$ equates to uptake that is lower than expected nationally in that area.

The geographical variation of the GOS1 uptake ratio across the LSOA areas of Leeds is shown via maps.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Valid n</th>
<th>Under 16</th>
<th>16–59</th>
<th>60 or over</th>
<th>All tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Age</td>
<td>17 680</td>
<td>3978 22.5</td>
<td>4799 27.1</td>
<td>8903 50.4</td>
<td>60 (17, 72)</td>
</tr>
<tr>
<td>Gender</td>
<td>17 507</td>
<td>2104 53.9</td>
<td>2911 61.5</td>
<td>5133 57.9</td>
<td>10 148 58.0</td>
</tr>
<tr>
<td></td>
<td>1802 46.1</td>
<td>1826 38.5</td>
<td>3731 42.1</td>
<td>7359 42.0</td>
<td></td>
</tr>
<tr>
<td>Months since last test</td>
<td>17 530</td>
<td>811 20.7</td>
<td>359 7.5</td>
<td>132 1.5</td>
<td>1302 7.4</td>
</tr>
<tr>
<td>First test</td>
<td>2402 61.2</td>
<td>1727 36.3</td>
<td>5266 59.5</td>
<td>9395 53.6</td>
<td></td>
</tr>
<tr>
<td>&lt;18</td>
<td>472 12.0</td>
<td>1677 35.2</td>
<td>2409 27.2</td>
<td>4558 26.0</td>
<td></td>
</tr>
<tr>
<td>18–29</td>
<td>128 3.3</td>
<td>450 9.5</td>
<td>547 6.2</td>
<td>1125 6.4</td>
<td></td>
</tr>
<tr>
<td>30–41</td>
<td>113 2.9</td>
<td>546 11.5</td>
<td>491 5.6</td>
<td>1150 6.6</td>
<td></td>
</tr>
<tr>
<td>42 and over</td>
<td>17 680</td>
<td>35 0.9</td>
<td>27 0.5</td>
<td>8524 70.9</td>
<td>8586 48.6</td>
</tr>
<tr>
<td>Under 16</td>
<td>3831 97.9</td>
<td>36 0.7</td>
<td>6 0.0</td>
<td>3873 21.9</td>
<td></td>
</tr>
<tr>
<td>Full-time student</td>
<td>6 0.2</td>
<td>654 12.8</td>
<td>6 0.0</td>
<td>666 3.8</td>
<td></td>
</tr>
<tr>
<td>Income support</td>
<td>6 0.2</td>
<td>701 13.7</td>
<td>40 0.3</td>
<td>747 4.2</td>
<td></td>
</tr>
<tr>
<td>Jobseekers allowance</td>
<td>2 0.1</td>
<td>504 9.9</td>
<td>10 0.1</td>
<td>516 2.9</td>
<td></td>
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<tr>
<td>Employment and support allowance</td>
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<td>122 2.4</td>
<td>7 0.1</td>
<td>130 0.7</td>
<td></td>
</tr>
<tr>
<td>Pension credit</td>
<td>3 0.1</td>
<td>25 0.5</td>
<td>1236 10.3</td>
<td>1264 7.1</td>
<td></td>
</tr>
<tr>
<td>Tax credit</td>
<td>11 0.3</td>
<td>1191 23.3</td>
<td>30 0.2</td>
<td>1232 7.0</td>
<td></td>
</tr>
<tr>
<td>HC2 certificate</td>
<td>3 0.1</td>
<td>122 2.4</td>
<td>52 0.4</td>
<td>177 1.0</td>
<td></td>
</tr>
<tr>
<td>Blind/partially sighted</td>
<td>0 0.0</td>
<td>16 0.3</td>
<td>15 0.1</td>
<td>31 0.2</td>
<td></td>
</tr>
<tr>
<td>Diabetes/glaucoma</td>
<td>0 0.0</td>
<td>20 0.4</td>
<td>66 0.5</td>
<td>86 0.5</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>8 0.2</td>
<td>559 11.0</td>
<td>953 7.9</td>
<td>1520 8.6</td>
<td></td>
</tr>
<tr>
<td>Glaucoma</td>
<td>2 0.1</td>
<td>51 1.0</td>
<td>241 2.0</td>
<td>294 1.7</td>
<td></td>
</tr>
<tr>
<td>At risk of glaucoma</td>
<td>1 0.0</td>
<td>33 0.6</td>
<td>49 0.4</td>
<td>83 0.5</td>
<td></td>
</tr>
<tr>
<td>40 plus and relative with glaucoma</td>
<td>5 0.1</td>
<td>932 18.3</td>
<td>754 6.3</td>
<td>1691 9.6</td>
<td></td>
</tr>
<tr>
<td>Complex lenses</td>
<td>1 0.0</td>
<td>108 2.1</td>
<td>34 0.3</td>
<td>143 0.8</td>
<td></td>
</tr>
</tbody>
</table>

*More than one eligibility criterion may be recorded on a GOS1 form. Some of the eligibility criteria recorded were not valid for the age group. It is not possible to distinguish errors due to inaccurate completion of the GOS1 form from errors during data entry.
boundary files for the LSOAs within Leeds were provided by the Digimap service (© Crown Copyright/database right 2013. An Ordnance Survey/EDINA supplied service).

To explore the associations between the GOS1 uptake ratio and gender deprivation, a Poisson regression model was used. The outcome was the number of GOS1 uptakes per LSOA with the expected number of GOS1 uptakes per LSOA as the exposure. Deprivation was measured by the Indices of Multiple Deprivation ranking as at 2010 for each LSOA, with the rankings in Leeds converted to quintiles. Gender was included in the model as the % male within each LSOA and separate Poisson regression models were undertaken for each of the three age groups to explore whether the associations with deprivation differed by age/eligibility criteria.

Results

There were 17,680 GOS1 eye examinations conducted in Leeds during the census period. More examinations were performed for women (58%) and over half (50.4%) of examinations were for people aged 60 years or over (Table 1). The most frequently recorded eligibility criterion for G0S1 was being 60 and over (48.6%). Over half (53.6%) reported as having their previous eye examination within the last 18 months.

The most deprived LSOAs tend to be in the South and East of Leeds (Fig. 1). This is in contrast to the geographical distribution in uptake of eye examinations for the GOS1 particularly for ages 60 and over and under 16 (Fig. 2).

This association between uptake and deprivation in the 60 over age group is confirmed when looking at the uptake ratio by deprivation quintile. The median uptake ratio in the least deprived LSOAs is 62% higher than expected [1.62; interquartile range (IQR) 1.27, 1.94], while it is 14% lower than expected (0.86; IQR 0.65, 1.15) in the most deprived LSOAs in Leeds for those aged 60 and over (Table 2). For the same age group there is a significant association \( (P < 0.001) \) between deprivation quintile and GOS1 uptake, adjusted for gender. For those in the least deprived LSOAs, uptake is 71% more than those in the most deprived LSOAs [incidence rate ratio (IRR) 1.71: 95% CI 1.59, 1.84] (Table 3).

Significant associations between deprivation and uptake were also found in the under-16 group where the least deprived were 23% more likely to have a GOS1 test than the most deprived quintile (Table 3).
Fig. 2 Ratio of LSOA uptake of GOS1 by age group.
The association is reversed for the 16–59 age group (Table 3). For those in the least deprived LSOAs, uptake is 51% less than compared with the most deprived LSOAs adjusted for gender (IRR 0.49; 95% CI 0.45, 0.54).

There were no statistically significant differences in uptake between genders in each of the age groups (Table 3).

**Discussion**

**Main findings of this study**

This analysis has demonstrated significant social class inequalities in uptake of NHS-funded eye examinations among eligible population aged 60 or over and under age 16 years. A person aged 60 or over living in the least deprived quintile is 71% more likely to attend for an eye examination than someone in that age group in the most deprived quintile in Leeds, even though both have the same entitlement. A parent of a child living in an affluent area is 23% more likely to take their under 16-year old child for an eye examination than someone in the most deprived area, even though both have the same entitlement. The higher uptake in the more deprived quintiles within the 16–59 age group is to be expected as 67% of the reasons for GOS1 eligibility recorded for this cohort were related to low income or receipt of means tested social benefits. There were no statistically significant differences in uptake between genders.

**What is already known on this topic**

Research has consistently shown that the public has a limited awareness or understanding of eye health, which is understood almost exclusively in relation to having good or poor sight. Sight is, however, seen as very important and there is a fear of blindness. The generally low awareness of eye health means that most individuals do not attend eye examinations as a preventative measure; attendance is driven predominately by symptom-led demand. Of those who do not have a recent eye examination, the majority typically state that this was because they did not believe there was anything wrong with their eyes. Patel et al. found that the elderly resign themselves to poor vision as a natural consequence of ageing, creating a further barrier to services. Cost of eye examinations does not appear to influence motivation for testing, especially as many in the UK are eligible for an NHS eye examination or because private tests are offered below cost as a way of attracting business. However, the cost of glasses is commonly cited as a reason for not having access to eye examinations, particularly among more deprived groups. Concerns about pressure to buy expensive glasses...
can cause a lack of trust and discourage testing. Qualitative research conducted within the deprived communities of Leeds reported all of these barriers to uptake of eye examinations and hence might explain the patterns observed in the small area GOS1 uptake mapping.

As part of a health needs assessment conducted in the Tower Hamlets area of London, 14 300 valid GOS1 forms were computerized and analysed for a 6-month period in 2009. Uptake was highest among the over 60 and the 5–14 age groups, reflecting eligibility for free eye examination. Geographical proximity to an optometrist was a strong predictor of uptake of NHS eye examinations. Thirteen per cent of people living within 0.1 km of a sight test provider will have a sight test in any 1 year. This level is maintained up to 0.3 km but declines thereafter to 4% among people living 1 km away from an optometrist. The authors commented that attenuation is particularly steep after 0.8 km, roughly equivalent to a 15-min walking time. They therefore suggested that ideally there should be an optometrist within a 15-min walk of every resident. A previous glaucoma equity profile conducted in Leeds showed that there is a clear mismatch between the most deprived LSOAs and the location of optician premises. Thus, lack of an optometrist nearby might explain the lower uptake in deprived areas of Leeds.

As part of a cohort study, people across Britain aged 65 or over were asked when they last had an eye test. Data were collected in 1994/95 at a time when only people in this age group with a low income were eligible for an NHS-funded eye examination (free access for all people aged over 60 was reintroduced in 1999). Half of the respondents in the lowest income group had an eye examination, the same proportion as those in the highest income group. However, respondents with the second lowest level of income were significantly less likely to have had a recent eye test than people in other income brackets. People from homes where the head of household had or was retired from a manual occupation were significantly less likely to have taken a recent eye test than those from ‘non-manual’ households. Those with lower educational attainment tended to have lower uptake, but this difference was not significant.

**What this study adds**

A systematic review on the relationship between SES and access to eye care concluded that there appeared to be an association between SES and access to eye care. However, this was not consistent or well established because the study designs were, frequently, not high quality, and not the most appropriate design to answer the research question. The review noted that there were very few studies on access to sight tests or
optometry services reflecting the scarcity of routinely collected data from most optometry practices: “This is an area of particular importance in the UK as it is the only eye care service which is fee based (i.e. not free at the point of access) for most people; consequently one might expect there to be a close association between SES and access however no studies were found in this systematic review that explored this association” (p. 25). The data reported in this study make a contribution to filling this deficiency. This study demonstrates that there are inequalities in accessing primary eye care, and that such an analysis should influence the commissioning of services. However, in order to better inform the planning of eye care services more complete data with additional detail are required.

**Limitations of this study and recommendations**

The analysis presented here has been limited by the data recorded on the GOS1 form. A key recommendation is that there should be a review of the means and purpose of optometry data capture. All GOS1 claim forms ought to be submitted electronically to allow other localities to conduct their own assessment of need without having to repeat the manual data entry process that was conducted for this study. However, apart from date of birth and postcode derived from deprivation of area of residence, the data recorded on the GOS1 form are of limited value. Other demographic information such as ethnicity could be added as required data fields for claim form submission. Electronic data would also facilitate linkage to clinical data, such as visual acuity and visual fields which are collected as part of the examination, although practice management software might need to be modified to accommodate extraction of the minimum dataset. However, without NHS number and/or National Insurance number (which are rarely filled in, and neither optometrist or patient may easily know) it would be impossible to link to other NHS datasets. As with any routine data collection incomplete, missing or inaccurate information may lead to invalid or spurious conclusions.

Ideally, data from private eye examinations should also be captured for such analyses. Such analyses of primary eye care activity would also be useful to support the interpretation of the Public Health Outcome indicator for preventable sight loss which focuses on outcomes at the end of the eye care pathway.

Future analysis of inequalities in uptake should explore the potential association between distance to an optometrist and uptake in combination with deprivation as each factor may have independent and multiplicative effects on uptake. The Tower Hamlet study21 and our own qualitative research20 have demonstrated that people living in deprived communities are reluctant to travel. However, it is more pertinent to collect travelling distance and ease of utilizing public transport than purely measuring distance as the ‘crow flies’ from home to optometrist and we are currently exploring the practicalities of collating this information for a large number of records systematically.

The Tower Hamlet report21 recommended that some eye services should be re-sited in proximity to need. The current business model for optometry is dependent on sale of optical appliances to subsidize the cost of both NHS and private eye examinations.25 Thus, there are no incentives for optometrists to establish practices in deprived communities. Salaried NHS optometrists located within NHS facilities may be a solution to ensuring geographical access according to need, but may also be a response to public concerns about the trustworthiness of some optometrists. Indeed, even more radical solutions could be considered, with a separation of dispensing of glasses from primary eye care services. Although this would need a complete renegotiation of the GOS contract and a significant uplift in the cost of eye examinations to reflect the withdrawal in subsidy from the sale of glasses.

**Table 3  Incidence rate ratio of uptake of GOS1.**

<table>
<thead>
<tr>
<th></th>
<th>Incidence rate ratio (95% CI)</th>
<th>&lt;16</th>
<th>16–59</th>
<th>60 and over</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deprivation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First quintile (most deprived)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Second quintile</td>
<td>1.09 (0.98, 1.2)</td>
<td>0.77 (0.71, 0.83)</td>
<td>1.24 (1.14, 1.34)</td>
<td></td>
</tr>
<tr>
<td>Third quintile</td>
<td>1.11 (1.23)</td>
<td>0.52 (0.48, 0.57)</td>
<td>1.24 (1.15, 1.35)</td>
<td></td>
</tr>
<tr>
<td>Fourth quintile</td>
<td>1.07 (0.96, 1.19)</td>
<td>0.46 (0.42, 0.5)</td>
<td>1.51 (1.4, 1.62)</td>
<td></td>
</tr>
<tr>
<td>Fifth quintile (least deprived)</td>
<td>1.23 (1.12, 1.36)</td>
<td>0.49 (0.45, 0.54)</td>
<td>1.71 (1.59, 1.84)</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1.001 (0.998, 1.005)</td>
<td>0.998 (0.995, 1.001)</td>
<td>1 (0.998, 1.002)</td>
<td></td>
</tr>
</tbody>
</table>
Acknowledgements

Thanks to Louise Davis and the students who assisted with data entry.

Funding

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Conflict of interest

None declared

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20. Shickle D, Griffin M. Why don't older adults in England go to have their eyes examined? Optimal Physiol Opt 2014;34(4);38–45.