Capture-recapture-adjusted prevalence rates of type 2 diabetes are related to social deprivation

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Summary

We examined the prevalence of type 2 diabetes and social deprivation in one urban district in Liverpool from October 1995 to September 1996 inclusive. This area has a stable Caucasian population of 176,682. Lists were made of all known diabetics attending six different medical points of contact during the year, and were condensed and aggregated to eliminate duplicates. From postcode data, each patient was assigned to residence in one of the 14 electoral wards in the district, for which demographic structure and standardized measures of social deprivation were known (Townsend index).

The crude period prevalences of type 1 and type 2 diabetes were estimated for each ward. Crude prevalence data were then corrected by applying capture-recapture (CR) techniques to the different patient datasets to allow for undercount. The true prevalence (95%CI) of diabetes was 1.5% (1.4–1.5%), or 2585/176,682. The mean age of people with diabetes was not significantly different between electoral wards. The crude period prevalence of type 2 diabetes within individual wards ranged from 0.4% (0.3–0.6%) in the least deprived area to 4.1% (3.6–4.6%) in the most deprived area. The corresponding range of CR-adjusted prevalence rates of type 2 diabetes was from 3.2% (2.8–3.6%) to 6.7% (6.1–7.4%), and there was strong correlation between both crude and CR-adjusted prevalence and social deprivation in each ward ($r = 0.76, p < 0.001$ for crude; and $r = 0.49, p < 0.005$ for CR-adjusted prevalence). There was no correlation between the crude or CR-adjusted period prevalence rates of type 1 diabetes and Townsend index ($r = 0.14, p = NS$). This strong correlation between the prevalence of type 2 diabetes and social deprivation has important implications for the planning of health-care delivery.

Introduction

Previous reports have demonstrated that adults with diabetes mellitus of lower socio-economic status have poorer glycaemic control and greater morbidity and mortality than their less deprived counterparts. A survey from Middlesborough, UK, has also suggested that the prevalence of type 2 (but not type 1) diabetes is increased in areas of social deprivation.

To explore this interaction further, we studied diabetes prevalence in North Liverpool using multiple list sources and capture-recapture (CR) techniques. The CR method was originally developed by zoologists to count wildlife populations and involves capturing, marking, and then releasing a sample of a population. After some time, a further sample is ‘recaptured’ and the total population is estimated from the proportion of marked to unmarked animals in the recaptured sample. The technique has been used in medical epidemiology, by using multiple...
datasets. Patients appearing on more than one list are effectively ‘recaptured’, and statistical techniques are used to calculate total numbers. The technique is well-validated, and has been used in studies of diabetes epidemiology, using datasets such as general practitioner (GP) lists, hospital diabetic clinic registers, and hospital discharge statistics.

In view of the previously mentioned studies suggesting poorer outcome and control of diabetes in areas of lower socio-economic status; we have re-examined the hypothesis that diabetes prevalence itself may relate to social deprivation. We present our results using both standard and CR epidemiological techniques.

**Methods**

The target population for the study was all residents of South Sefton District in North Liverpool with a diagnosis of diabetes, who were alive during the whole study period. South Sefton is an urban area with an estimated mid-year population of 176,682 at the time of the study, based on the 1991 national census.

Six lists of cases were used in the study. They were lists of people with diabetes known to general practitioners in the area, patients attending the Walton Hospital Diabetes Centre, lists of hospital admissions with a diagnosis of diabetes, diabetic patients attending the hospital Diabetic Retinal Clinic, a research list of stroke in-patients with diabetes, and a list of diabetic patients attending the local children’s hospital. The data was collected from all lists over the same calendar year. The information used to create the six lists of patients was: surname, firstname, postcode, date of birth and sex. Type of diabetes was also recorded, and for uncertain cases, the types were defined as follows: type 1 diabetes if patients were 0–29 years at diagnosis of diabetes, and were treated with insulin from diagnosis; type 2 diabetic patients if 30 years old or over at diagnosis, irrespective of treatment.

To analyse the relationship between deprivation and diabetes prevalence, we subdivided the population into those above 30 years of age, and those below. This was because we could not accurately define type of diabetes in many patients, apart from those in the hospital Diabetes Centre list. Analysis of this dataset, however, showed that 91% (2657/2919) of those over 30 years of age had type 2 diabetes by the definition above. As the Diabetes Centre list was liable to select type 1 diabetic patients particularly (due to referral bias), we believe that over 95% of total diabetic patients in the district over 30 years of age, had true type 2 diabetes.

The information collected was entered onto a personal computer using the database software Epi-Info version 6.04. SPSS for Windows and Generalized Linear Interactive Modelling (GLIM) were used for analysis. Cases were matched using the patient identifiers, and in the CR calculations the total population size (n) with 95% CIs was estimated using log-linear modelling. Diabetes prevalence was estimated for each electoral ward from the updated 1991 census figures. As well as crude prevalence, we estimated prevalence by CR after condensing the patient lists into three datasets. These were (a) the GP list, (b) the Diabetes Centre list and the Children’s Hospital list, and (c) the Hospital Admission list, the Diabetic Retinal Clinic list, and the Stroke Database. This combination of lists not only made the calculation simpler, but also made the calculation of people with diabetes more reliable.

The prevalence of diabetes was mapped onto the electoral ward of residence, for which a standard index of social deprivation (Townsend index) was known. The index is based on the percentage of economically active residents aged over 16 years who are employed, the percentage of households with no cars, the percentage of owner-occupied houses, and the percentage of households with more than one person to a room. Other measures of social deprivation such as the Jarman index, the proportion of council housing in each ward, and the proportion of children in receipt of free school meals were not used, as they may not be sufficiently objective in measuring poverty levels.

The study was approved by the Ethics Committee of the Sefton Health Authority. Confidentiality of information was maintained at all times.

**Results**

A total of 2585 known diabetic patients were identified through the six lists. The unadjusted crude prevalence rates in each electoral ward ranged from 0.4% (95%CI 0.3–0.6%) to 4.1% (3.6–4.7%), and capture-recapture adjusted prevalence ranged from 3.0% (2.7–3.4%) to 6.7% (6.1–7.4%). There was a strong positive correlation between deprivation and diabetes prevalence, as measured by Townsend index, and both crude ($r = 0.74, p < 0.001$; variance $r^2 = 0.55$) and CR-adjusted ($r = 0.49, p < 0.005$; variance $r^2 = 0.24$) diabetes prevalence rates (Table 1 and Figure 1) for patients over 30 years of age. The slightly lower significance of the CR prevalence regression line was probably because adequate list data was not available for two wards to calculate prevalence by this method.

We also plotted diabetes prevalence for patients under 30 years of age (predominantly type 1 diabetes), and found no significant correlation with the...
Table 1 Prevalence of Type 2 diabetes (crude and CR-adjusted) and Townsend index of individual electoral wards

<table>
<thead>
<tr>
<th>Electoral ward</th>
<th>Population</th>
<th>Mean age (SD)</th>
<th>Known diabetes</th>
<th>Crude prevalence % (95% CI)</th>
<th>CR-adjusted prevalence % (95% CI)</th>
<th>Townsend index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6062</td>
<td>59 (17)</td>
<td>250</td>
<td>4.1 (3.6–4.6)</td>
<td>6.7 (6.1–7.4)</td>
<td>9.32</td>
</tr>
<tr>
<td>2</td>
<td>7018</td>
<td>60 (19)</td>
<td>186</td>
<td>2.7 (2.3–3.1)</td>
<td>3.9 (3.5–4.4)</td>
<td>6.02</td>
</tr>
<tr>
<td>3</td>
<td>6055</td>
<td>61 (17)</td>
<td>171</td>
<td>2.8 (2.4–3.3)</td>
<td>4.6 (4.1–5.1)</td>
<td>6.01</td>
</tr>
<tr>
<td>4</td>
<td>7376</td>
<td>63 (15)</td>
<td>170</td>
<td>2.3 (2.0–2.7)</td>
<td>3.7 (3.3–4.1)</td>
<td>5.79</td>
</tr>
<tr>
<td>5</td>
<td>5993</td>
<td>60 (21)</td>
<td>191</td>
<td>3.2 (2.8–3.7)</td>
<td>4.9 (4.4–5.5)</td>
<td>5.76</td>
</tr>
<tr>
<td>6</td>
<td>7215</td>
<td>59 (18)</td>
<td>238</td>
<td>3.3 (2.9–3.7)</td>
<td>5.2 (4.7–5.7)</td>
<td>5.45</td>
</tr>
<tr>
<td>7</td>
<td>6863</td>
<td>61 (18)</td>
<td>193</td>
<td>2.8 (2.4–3.2)</td>
<td>5.0 (4.5–5.6)</td>
<td>5.28</td>
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<tr>
<td>8</td>
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<td>64 (19)</td>
<td>180</td>
<td>2.5 (2.1–2.9)</td>
<td>3.9 (3.5–4.4)</td>
<td>4.32</td>
</tr>
<tr>
<td>9</td>
<td>8473</td>
<td>59 (19)</td>
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<td>2.2 (1.9–2.6)</td>
<td>3.8 (3.4–4.3)</td>
<td>0.82</td>
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<td>10</td>
<td>7907</td>
<td>61 (19)</td>
<td>186</td>
<td>2.4 (2.0–2.7)</td>
<td>3.2 (2.8–3.6)</td>
<td>−0.60</td>
</tr>
<tr>
<td>11</td>
<td>8711</td>
<td>58 (18)</td>
<td>209</td>
<td>2.4 (2.1–2.7)</td>
<td>5.2 (4.8–5.7)</td>
<td>−1.22</td>
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<tr>
<td>12</td>
<td>9430</td>
<td>60 (18)</td>
<td>45</td>
<td>0.5 (0.4–0.6)</td>
<td>N/A</td>
<td>−2.18</td>
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<tr>
<td>13</td>
<td>8160</td>
<td>60 (18)</td>
<td>183</td>
<td>2.2 (1.9–2.6)</td>
<td>4.1 (3.7–4.5)</td>
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<td>14</td>
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<td>60 (18)</td>
<td>39</td>
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<td>−3.37</td>
</tr>
</tbody>
</table>

N/A, not appropriate to use CR techniques as the number of cases was too small, with no duplicates between lists.

Figure 1. Correlation between crude and capture-recapture (CR) adjusted prevalence rates of diabetes and Townsend index amongst patients aged >30 years, North Liverpool 1996.

Townsend index, using either crude or CR-adjusted prevalence data ($r=0.14$, $p=NS$).

To check whether the positive correlation of diabetes prevalence with deprivation in patients aged over 30 years was an effect of age, we also calculated mean ages of the diabetic cohorts in each of the wards studied. These were very similar, ranging from 58.3 (17.7) to 63.7 (19.3) years, and there was no significant difference between any ward (Table 1).

Discussion

Our data confirm a strong correlation between social deprivation and the prevalence of type 2 diabetes (but not of type 1 diabetes). Additionally, however, we have used multiple datasets rather than a single district diabetes register together with CR calculations to suggest a significant undercount in our crude prevalence estimates. For more socio-economically privileged areas, this increased type 2 diabetes prevalence by about 0.5% overall, but in more deprived areas the increase was of the order of 2.0% (with high prevalence rates estimates of 5.0–6.0%).

Low socio-economic status is known to be associated with a variety of markers of poor health, including overall mortality. Mortality in diabetes is similarly adversely affected by lowered social class, which may be related to increased rates of cardiovascular risk factors. Studies in Middlesborough, UK, have demonstrated poorer glycaemic control and significantly less insulin usage in deprived as compared with less deprived inner-city areas. Type 2 diabetes prevalence (but not type 1) also appeared to be increased in these areas. Interestingly, similar studies in children with type 1 diabetes have not shown such effects on either frequency of disease or outcome, suggesting that the ‘deprivation effect’ in diabetes affects adults only, presumably those with type 2 disease. Interestingly, a primary-care survey in Bristol has also suggested a relationship of type 2 diabetes prevalence with deprivation. The population was smaller than ours and only crude prevalence was assessed, but nevertheless, this study and that from Middlesborough strongly suggest that our results demonstrate a real effect.

Our data do not give clues as to why type 2 diabetes should be over-represented in socially deprived areas, and further work to clarify this is clearly needed using data from a larger number of geographical areas. The more deprived areas in our
study did not have diabetic populations of older age structure. Other possibilities include more obesity in deprived areas, as well as possible migration of known type 2 diabetic subjects into poorer areas. Interestingly, a study from Newcastle, UK, has shown a positive relationship between glucose intolerance and manual working classes, which was independent of age and measures of adiposity (body mass index and waist-hip ratio). Regardess of the cause, our data (and particularly the high CR prevalence rates) confirm a link between the prevalence of type 2 diabetes and poverty, which is of vital importance in planning current and future provision of diabetes care to differing localities.

Acknowledgements

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References