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Meningococcal disease and social deprivation: a small area geographical study in Gwent, UK

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SUMMARY

Although meningococcal disease is known to be linked to characteristics of individuals associated with social deprivation, there is only limited evidence of a relation with area-based measures of deprivation. In a small area geographical study, we ascertained 295 confirmed or probable cases occurring between 1996 and 1999 in the socially diverse resident population of Gwent Health Authority, equating to an average annual rate of 13·2 per 100 000. Incidence rates of meningococcal disease increased from 8·1 per 100 000 in the least deprived fifth of enumeration districts to 19·8 per 100 000 in the most deprived fifth, a relative risk of 2·4 (95% CI 1·7–3·6). In Poisson regression, the percentage change in the incidence rate arising from a unit change in the enumeration district Townsend score, was 9·4% (95% CI 6·2–12·6%). Strongest associations were found for the under 5 age group, serogroup B disease and with the overcrowding variable component of the Townsend index. Our study quantifies the strength of the relation between meningococcal disease and social deprivation at small area level and provides further evidence of the need for action to reduce health inequalities.

INTRODUCTION

Previous studies in the United Kingdom have provided consistent evidence that meningococcal carriage and the incidence of meningococcal disease are linked to characteristics of individuals that are associated with social deprivation, such as manual social class [1], smoking [2, 3], poor housing conditions [3] and household overcrowding [4]. Despite considerable interest in neighbourhood influences on health [5], little is known regarding the relation between meningococcal disease and geographical area-based measures of social deprivation. One previous study has shown an association with overcrowding aggregated at census electoral ward level, but the analysis was limited to meningococcal meningitis in children less than 5 years of age [6].

Gwent Health Authority situated in SE Wales, population 565 000, is a geographical area of socio-demographic contrasts. To the East are the relatively affluent farming lands of rural Monmouthshire, to the West are the former industrial valleys, with high rates of unemployment and socially deprived communities, and the coastal City of Newport exhibits many features of inner-city deprivation. In view of these substantial variations in socio-economic status within Gwent and the lack of published studies investigating small area variations in meningococcal disease, the aim of this paper was to quantify the ecological relation between meningococcal disease and social deprivation at the smallest census geographical area level, the enumeration district, in Gwent.

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Table 1. *Number (%) of cases by age group and serogroup*

Age group (years)	Unconfirmed n (%)	B n (%)	C n (%)	Not typed n (%)	Totals
Under 1	44 (60·3)	18 (24·7)	6 (8·2)	5 (6·8)	73
1–4	45 (41·7)	45 (41·7)	12 (11·1)	6 (5·6)	108
5–9	23 (60·5)	7 (18·4)	4 (10·5)	4 (10·5)	38
10–14	8 (30·8)	5 (19·2)	11 (42·3)	2 (7·7)	26
15–19	4 (16·7)	11 (45·8)	6 (25·0)	3 (12·5)	24
20+	5 (19·2)	6 (23·1)	12 (46·2)	3 (11·5)	26
Total	129 (43·7)	92 (31·2)	51 (17·3)	23 (7·8)	295

Table 2. *Relative risk of meningococcal disease compared between fifths of the distribution of enumeration district Townsend scores*

Townsend score (fifths)	Number of enumeration districts	Number of cases	Total population	Annual rate per 100 000	Relative risk (95% CI)
Least deprived					
(−8·27 to −3·21)	225	38	116 692	8·1	1·00
(−3·21 to −1·13)	226	46	108 050	10·6	1·3 (0·9–2·0)
(−1·13 to 0·78)	225	54	111 217	12·1	1·5 (1·0–2·3)
(0·78–2·95)	226	63	113 082	13·9	1·7 (1·1–2·6)
Most deprived					
(2·95–9·13)	225	94	118 546	19·8	2·4 (1·7–3·6)
Total	1127	295	567 587	13·0	

METHODS

We defined a case as either a confirmed or probable record of meningococcal disease [7] in a Gwent resident occurring between 1 January 1996 and 31 December 1999. Cases were collated from statutory notification records held by the Consultant in Communicable Disease Control at Gwent Health Authority, clinical notifications and records of contact tracing for close contacts requiring prophylaxis, laboratory reports of *N. meningitidis* isolates and Meningococcal Reference Laboratory PCR reports. CoSurv data were used to validate and expand existing case information. Possible cases [7] were excluded from our case definition.

The full unit postcode, age, sex, serogroup and disease outcome were extracted for each case and entered onto a Microsoft Access 97 database. We linked each case to the enumeration district of residence by postcode using Postpoint Professional in Map Info version 5.5. The accuracy of the postcode was checked using the Post Office Postcode Address File and there were no missing postcodes.

The Townsend social and material deprivation score is calculated using unemployment, car ownership, owner occupation and overcrowding variables derived from the 1991 census [8]. The individual score for each component was standardized to zero mean and unit variance across the 1127 enumeration districts in Gwent. The Townsend score ranged from −8·27 in the least deprived enumeration district to +9·13 in the most deprived. The relation between all cases of meningococcal disease and social deprivation was first explored by dividing the whole range of the Townsend score into five equal ranges and comparing incidence rates between these using the relative risk with 95% confidence intervals (CI) for each successive fifth compared with the least deprived fifth. The population denominator chosen was the Office for National Statistics (ONS) mid-year estimates for 1998.

We quantified the association between all cases and Townsend score using Poisson regression [9] on data from individual enumeration districts. Since ONS population estimates are not available for enumeration districts, denominator populations were obtained from

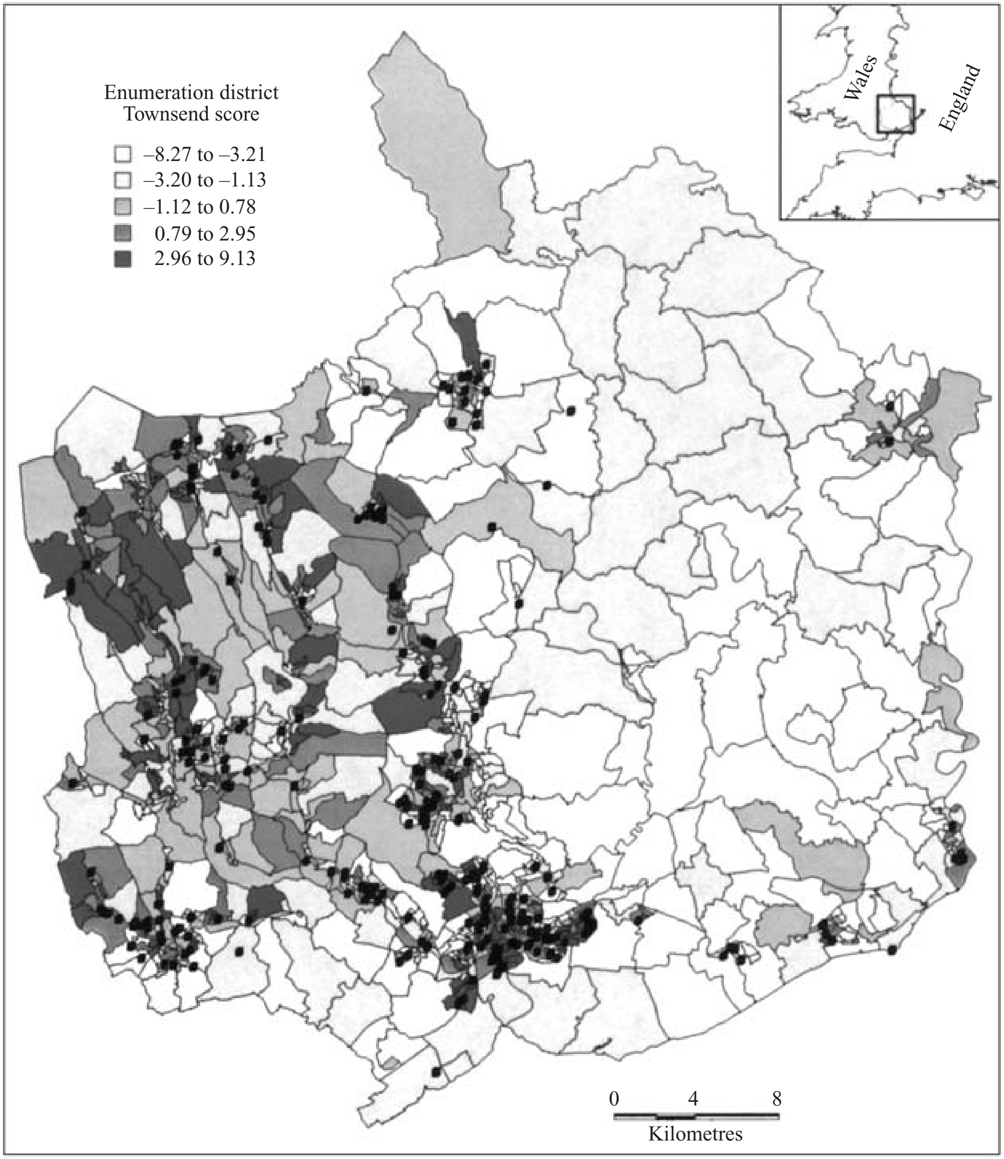

Fig. 1. Map of Gwent to show enumeration district Townsend score and geographical location of cases.

postcode linkage of the Health Authority General Practice age–sex register for April 2000. The magnitude of the effect, defined as the percentage change in the mortality rate arising from a unit change in the Townsend score, was determined. From this the percentage increase in the incidence rate between the median Townsend score in the least deprived fifth and median Townsend score in the most deprived fifth of enumeration districts in Gwent was estimated.

Further Poisson models were estimated to assess whether the associations with deprivation varied between the four individual components of the Townsend index, confirmed and unconfirmed cases, serogroups B and C, and the under 5 and the 5 and over age groups.

All analyses were performed using SPSS version 11.0 and Stata version 6.0.

RESULTS

Over the 4-year period we ascertained and validated 295 confirmed or probable cases. This equates to an annual incidence rate of 13·2 per 100 000. The highest age-specific annual incidence rate was 271·7 per 100 000 in the under 1 age group. Table 1 shows that 166 (56·3 %) of the 295 cases were confirmed. Of these confirmed cases, serogroup B was the most common, accounting for 92 (55·4 %). Serogroup C accounted for 51 (30·7 %) and 23 were confirmed but not typable. A higher proportion of cases was unconfirmed in the under 5 age group than in the over 5s (99/181, 54·7% *vs*. 40/114, 35·1%). Two thirds (68·5%) of serogroup B cases occurred in the under 5 age group, whereas serogroup C cases were more evenly distributed between the age groups. The case fatality rate was 5·8% overall, but 9·1% among confirmed cases.

No cases were reported from 885 (78·5%) of the 1127 enumeration districts in Gwent. One case was reported in 197 (17·5%) enumeration districts, 2 cases in 38 (3·5%), 3 cases in 6 (0·5%) and 4 cases in 1 enumeration district. There were no cases with missing or inaccurate postcodes. Figure 1 shows a chloropleth map of the enumeration district Townsend score, overlaid by the geographical location of the 295 cases. Incidence rates of meningococcal disease increased according to the level of social deprivation (Table 2), from 8·1 per 100 000 in the least deprived fifth of the distribution of the Townsend score to 19·8 per 100 000 in the most deprived fifth, a relative risk of 2·4 (95% CI 1·7–3·6).

Using Poisson regression we found the incidence of meningococcal disease was significantly associated with deprivation. The magnitude of effect was 9·4% (95% CI 6·2–12·6). Over the range of enumeration district Townsend scores in Gwent, this magnitude of effect implies an increase in meningococcal disease incidence from the most deprived to the least deprived enumeration district of 474% (95% CI 283–784%). Model checking found the goodness of fit χ^2 to be non-significant ($P = 1{\cdot}00$) suggesting a good fit of the model to the data. The model including only confirmed cases found almost identical results (magnitude of effect 9·4%, 95% CI 5·2–13·7).

Of the four Townsend variables, overcrowding was most strongly associated with meningococcal disease (magnitude of effect 10·9%, 95% CI 5·4–16·3). Serogroup B (magnitude of effect 13·7%, 95% CI 7·9–19·4) was more strongly associated with the Townsend score than serogroup C (magnitude of effect 5·2%, 95% CI −2·6–12·9). The under 5 age group (magnitude of effect 8·6%, 95% CI 4·7–12·6) was more strongly associated with the Townsend score than the 5 and over group (magnitude of effect 4·2%, 95% CI −1·0–9·4). Model checking also found the goodness of fit χ^2 to be non-significant for all these models suggesting good fits of the models to the data.

DISCUSSION

This population-based ecological study has shown a significant association between meningococcal disease and social deprivation at enumeration district level in Gwent. We found the incidence risk for all cases was 2·4 times higher in the most deprived enumeration districts compared to the least deprived, with an increasing gradient of risk across the fifths of deprivation. Quantified in Poisson regression as the magnitude of effect, we found a substantial 475% (95% CI 283–786%) increase in risk of meningococcal disease across the whole range of enumeration district Townsend deprivation scores. Separate analyses for the individual components of the Townsend index found the strongest association was between meningococcal cases and overcrowding.

Further analysis demonstrated stronger associations with the Townsend score for serogroup B cases than with serogroup C and in the under 5 age group compared with those aged 5 and over. Some care is required in the interpretation of statistical significance in these sub-group results as the numbers of cases are smaller in each model (so that many enumeration districts have no cases) and the imprecision of the estimates of association is greater. Additionally, the reduced power of sub-group analyses may have resulted in associations not reaching conventional statistical significance due to type II error.

One other study has investigated the relation between area based factors and bacterial meningitis, including an analysis of meningococcal meningitis in the under 5 age group [6]. In this geographical study, electoral wards in the former NE Thames region were divided into three Townsend deprivation and three overcrowding (1991 census) groups. Odds ratios for meningococcal meningitis in the under 5 age group were 1·51 (95% CI 0·98–2·33) for the most deprived compared to the least deprived third of wards, and 1·74 (95% CI 1·10–2·77) similarly for overcrowding. Our study included all meningococcal disease for persons at all ages and quantified more precisely the patterns of association by age group and serogroup with measures of social deprivation using the magnitude of effect derived from Poisson regression analysis of data from individual enumeration districts.

Our study showed that the average annual incidence of meningococcal disease for 1996–9 in Gwent, at 13·2 per 100 000, was substantially higher than the equivalent data of 5·1 per 100 000 reported in England and Wales (source: PHLS CDSC, Colindale). Data for Wales over the same time period showed Gwent to have the second highest rate among the five Welsh health authorities, range 5·3–15·5 per 100 000, with an annual average all-Wales rate of 11·2 per 100 000 (source: Co-Surv district data, CDSC Wales).

Enhanced surveillance data reported from the West Midlands for 1996–8 found an incidence of confirmed or probable cases of 8·6 per 100 000, varying from 4·9–12·9 per 100 000 between districts [10]. In a 5-year prospective study in an unspecified English health district with a population of 800 000, Jolly [11] reported 229 confirmed or probable cases of meningococcal disease, equivalent to an annual incidence rate of 5·7 per 100 000. The descriptive epidemiology of data on cases by age group, confirmed serogroups and seasonal trend were similar to our data in both studies [10, 11]. Our study confirms the value of enhanced surveillance by collating multiple sources of data – we ascertained 295 cases, compared to the 275 reported by Co-Surv district data, CDSC Wales. Over the same time period, 1310 cases in Wales were ascertained by Co-Surv district data, CDSC Wales and 1026 by PHLS CDSC, Colindale. Possible reasons for the higher incidence rates in Gwent and Wales might therefore include high case ascertainment and the high levels of social deprivation in Gwent compared to the England and Wales average.

Several potential sources of bias in our study should be considered. Ascertainment bias was minimized by thorough review and cross-checking of multiple sources of information on potential cases of meningococcal disease in a similar fashion to reported methods of enhanced surveillance [10]. All cases had a valid and complete postcode and could be linked to the enumeration district of residence. Since ONS do not publish mid-year enumeration district population estimates, the choice of enumeration district population denominator was either 1991 census data or a download from Gwent Health Authority age–sex patient register for April 2000. Although age–sex registers are prone to inaccuracies such as list inflation and do not count patients not registered with a general practitioner, this population download was a better temporal match to the numerator than the alternative from the 1991 census. Inevitably, in any population-based epidemiological analysis a degree of numerator denominator bias is possible, but is unlikely to have substantially affected the main findings of this study. Seven of the cases clustered in two school-based outbreaks of meningococcal serogroup C infection; in view of a possible violation of the Poisson assumptions of independence in time and space the analysis was repeated excluding these cases with no substantive difference to the results.

Our study offers a baseline position from which to monitor the local effect of the meningococcal serogroup C vaccination campaign. Although the incidence of meningococcal serogroup C disease fell substantially in 2000 [12], uptake in the school vaccination campaign of 1999 in Gwent was 92% in primary schools (range 78–100%) and 90% (range 78–95%) in secondary schools, with lower rates in schools situated within the deprived valleys (source: Gwent Healthcare NHS Trust). Social deprivation has been shown to be linked to low rates of childhood immunisation [13] and future re-assessment of the relation of meningococcal disease with social deprivation should form an important component of the evaluation of the impact of the vaccination policy on reducing health inequality.

Our study highlights the strength of the relation between meningococcal disease and social deprivation measured at small area level in Gwent. Poisson modelling of our data has quantified the substantial magnitude of this relation, made the scale of the public health problem explicit and added to the results of previous work. Our results also add to the increasing body of evidence of inequalities in health at small area level and provide further evidence for the need for action to reduce health inequalities. Further studies to analyse the relation between individual and area-based characteristics and the incidence of meningococcal disease using multilevel modelling are required.

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