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Social deprivation and prevalence of chronic kidney disease in the UK: workload implications for primary care

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Summary

Background: The 'inverse care law' suggests that populations with the poorest health outcomes also tend to have poorer access to high-quality care. The new general practitioner (GP) contract in the UK aimed to reduce variations in care between areas by collecting information on processes and outcomes of chronic disease management. This study investigated whether, despite reductions in inequalities, primary care in deprived areas is still at a disadvantage due to the higher prevalence of chronic diseases, using chronic kidney disease (CKD) as an example.
Methods: Initially, data from a hospital-based cohort of CKD patients were analysed to investigate the clustering of CKD patients across area-level deprivation using a geographical information system that employed kernel density estimation. Data from the Quality and Outcomes Framework were then analysed to explore the burden of CKD and associated non-communicable chronic diseases (NCD) and assess the potential impact on GPs' workload by area-level deprivation.
Results: There was a significant clustering of CKD patients referred to the hospital in the most deprived areas. Both the prevalence of CKD and associated conditions and caseload per GP were significantly higher in deprived areas.
Conclusion: In the most deprived areas, there is an increased burden of major chronic disease and a higher caseload for clinicians. These reflect significant differences in workload for practices in deprived areas, which needs to be addressed.

Introduction

The global burden of non-communicable chronic diseases (NCD) continues to grow and over the next 10 years, total deaths from these diseases are projected to increase by a further 17%.[1] Cardiovascular diseases (CVDs), the world's highest cause of death, are also a major cause of morbidity and mortality in patients with chronic kidney diseases (CKD).[2] Data from the World Health Organization (WHO) show that hypertension, diabetes and obesity are the leading global risk factors for mortality worldwide.[1] Of note, hypertension and diabetes are also the most common underlying cause of CKD and its complications.

There is extensive evidence for the persistence of socio-economic inequalities in the prevalence of NCD: poor access to care, late diagnosis as well as poor outcomes and mortality.[3–9] This has also been the case for CKD affecting the incidence of end-stage renal disease (ESRD) and mortality.[10–14] It has been highlighted in a comprehensive literature review that a rapidly growing number of persons with NCD, particularly living in deprived areas, face many obstacles in coping with their conditions, in a health-care system that often does not meet their needs for effective clinical management, psychological support and information.[15]

In the UK, most patients with NCD are cared for through the National Health Service (NHS) by a comprehensive network of primary care physician [general practitioner (GP)] centres. A given GP practice would provide healthcare for around 8000–10 000 individuals within the community. All UK citizens have to register with a GP. There are consistent reports of large workloads for primary care in socially disadvantaged areas since the establishment of the NHS in the UK, highlighted by Tudor Hart's observation of the 'inverse care law' in more deprived areas in the 1970s.[16]

This descriptive study aimed to explore the distribution of patients with CKD and associated conditions and to investigate socio-economic inequalities at an area level in the UK.

Methods

Study design and setting

We studied the area distribution (post-code) of all CKD patients in Sheffield registered on the Sheffield Kidney Institute (SKI) database ($n = 670$) (Figure 1). Routine UK GP register data, which is publically available, was then used to assess the prevalence of CKD and associated chronic diseases [NCD: diabetes (DM), hypertension (HTN), coronary heart diseases (CHD) and obesity] to assess the workload implications for primary care.

This study obtained ethical approval from the North Sheffield Research Ethics Committee (Ref. No-07/Q2308/24).

Study population and inclusion criteria

In this study, two sets of study population were used: hospital-based CKD patients and patients with major NCD on the primary care centres registered in the area in which hospital CKD patients distributed.

Firstly, we investigated the distribution of hospital-based CKD patients in the community to identify any variation in prevalence in relation to deprivation. The inclusion criteria were $\geqslant$18 years of age and CKD [estimated glomerular filtration rate (eGFR) between 10 and 90 ml/min/1.73 m^2].

Secondly, we investigated the overall prevalence of CKD, DM, HTN, CHD and obesity in primary care based on 2008–09 data from the Quality and Outcomes Framework (QOF). This is a UK primary care management quality evaluation tool.[17]

Study region

Sheffield is a metropolitan borough in South Yorkshire and the fourth largest city in England, which is 368 km^2 in area and has a predominantly White resident population of 513 264. In Sheffield, there were 28 wards based on UK boundary data in 2004. Figure 2 shows the map of Sheffield with the names of the new 28 wards, coded using the Index of Multiple Deprivation (IMD) score 2007. The lightest (light sky colour) and brightest (orange-red colour) colours on the map of Sheffield represent the least deprived and most deprived areas in Sheffield.

Data sources and collection/extraction

Hospital CKD patient data were obtained from two separate data sources: the SKI patients' electronic data system (Proton) and a questionnaire posted to study participants as to ensure accuracy of patients' post codes by cross-checking these data sources.

The patient data in the community (prevalence of CKD, HTN, DM, CHD and obesity at the area level) were extracted from the 2008–09 database of QOF.[18] The QOF website records data on 11 clinical disease areas for the purposes of monitoring GPs' performance.

The data related to GPs' post-codes and the numbers of doctors in each practice centre were collected from the 2009 NHS database.[19] In this study, a data of prevalence of chronic diseases and number of GPs from 91 GP centres in Sheffield were analysed.

Measures of socio-economic status at the area level

Socio-economic status (SES) can be measured at individual and area level, and both have been shown to affect health outcomes. In this study, area-level deprivation based on the IMD score 2007 was used.[20] Note that, in the UK, the IMD 2007 is the government's official measure of multiple deprivations at the small area level, known as lower super output areas, which is commonly used to measure area-level deprivation for public health research in the UK.[21]

A participant's post-code at presentation was used to obtain an IMD score and participants were then classified by quintiles based on IMD score (IMD Q1 = least deprived areas and IMD Q5 = most deprived areas). Similarly, practice post-codes were used to rank them according to the practice IMD score.

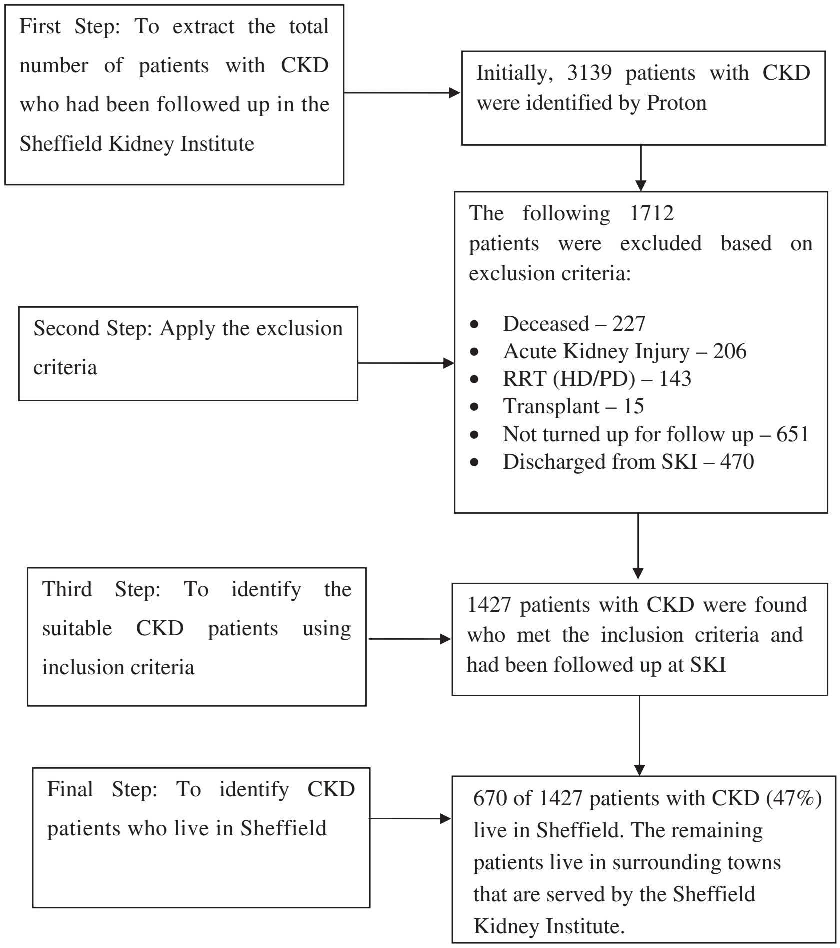


Figure 1. Flow chart to show how CKD patients in Sheffield were identified for this study.

Data analysis

Descriptive analysis

The main descriptive statistical analysis involved the distribution of chronic diseases and GPs workload in terms of caseload per GP across IMD quintiles. Categorical data were described as proportions or percentages.

Geostatistical analysis

Geostatistical methods were used to investigate whether the patterns of distribution of CKD and associated diseases significantly varied across least deprived to most deprived areas by using Geographical Information System (GIS) software (ArcGIS version 9.2). Geostatistics enhance understanding of data by visualizing results.

The post-codes of CKD patients and general practices were geo-coded, i.e. given that Ordnance Survey grid references and two level of analysis were performed; firstly, analysis that allowed visualization of the pattern/distribution of CKD patients and geographical characteristics at the area level including geographical boundary, location of health-care facilities and area-level deprivation and second, geostatistical, clustering analysis using a geographical information system that employed kernel density estimation[22,23] to identify the locations with more cases than expected and visualized diseases occurrence as hot spots on the statistical surface. CKD case density was adjusted with the underlying variation in population density at the area level using the following formula in order to get CKD rates per 10 000 of the population: Kernel density × population density × grid cell size ($0.09\ \text{km} = 300 \times 300\ \text{m}^2/10\,000$).

Two kinds of indexes are applied in order to assess the nature of CKD disease clustering; nearest neighbour index ratio (R) and Moran's *I* coefficient and power evaluation of disease clustering using these two indexes have been tested in the past.[23] Firstly, distribution of CKD diseases is examined by using nearest neighbour analysis based on the average distance (*R*) from each feature to its nearest neighbouring feature. This analysis is an accepted

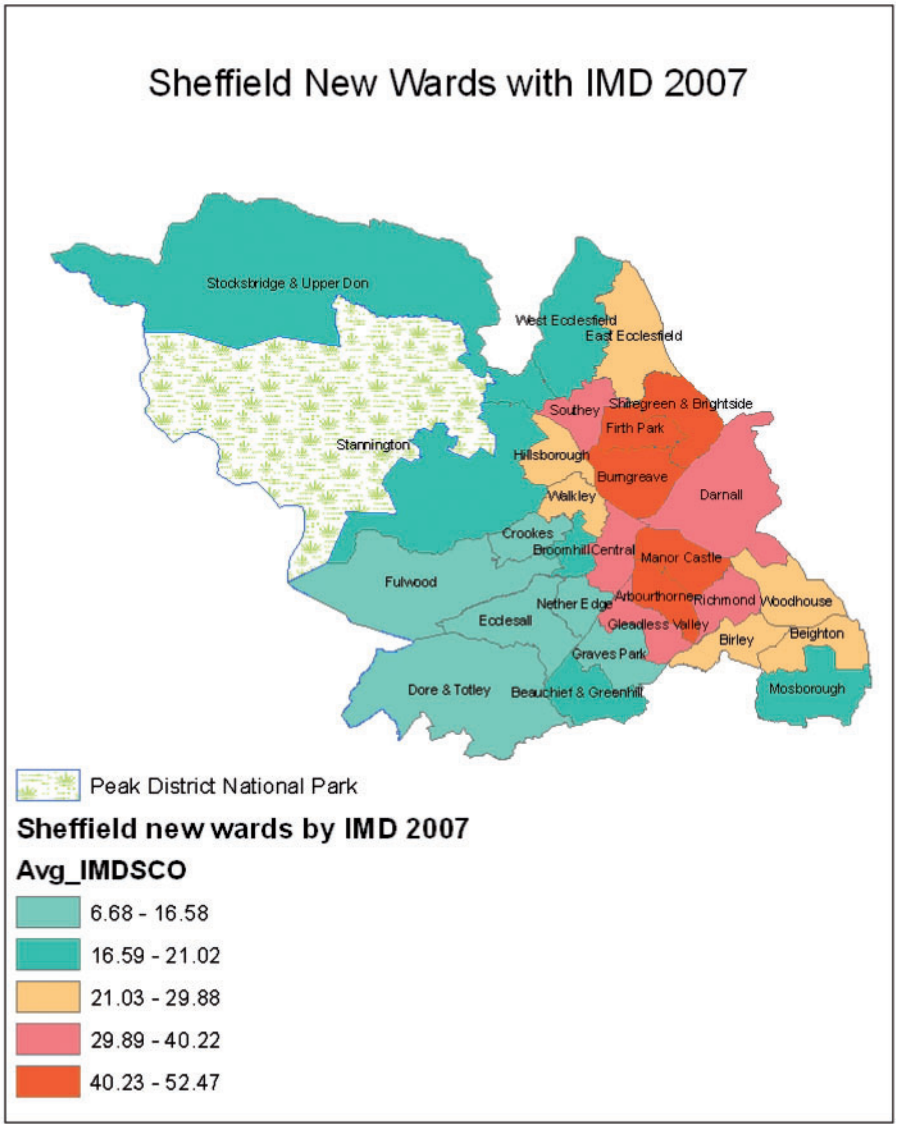


Figure 2. Map of Sheffield with the IMD score 2007 in new wards 2004.

spatial statistical analysis, which was used in the past by environmental scientist to study species distribution.[24] However, there are three different patterns which are possible while using the '*R*' value in nearest neighbour analysis: clustered pattern (*R*, $0 \leqslant R < 0.8$), distributed randomly (*R*, $0.8 \leqslant R < 1.8$) and uniform spacing (*R*, $1.8 \leqslant R \leqslant 2.14$).[24]

Finally, Moran's *I* is a test statistics for spatial autocorrelation. That is, it analyses the degree of dependency among observations spread over a geographic area. If there is any systematic pattern in the spatial distribution of a variable, it is said to be spatially autocorrelated. In other words, Moran's *I* index measure spatial autocorrelation for interval and ratio attributes data. For instance, spatial autocorrelation coefficient helps to measure the proximity of locations (the distance between points) and the similarity of the characteristics of these locations (compare the attributes of point). However, the ranges of Moran's *I* coefficient are between −1 and 1, in which ($0.6 \leqslant I \leqslant 1$) indicates positive spatial autocorrelation (regionalized/clustered), ($-0.6 < I < 0.6$) lack of autocorrelation (random distribution) and ($-1 \leqslant I \leqslant -0.6$) negative autocorrelation (disperse distribution).[23]

Results

Figure 3 shows the geographical distribution and clustering of CKD patients based on IMD quintile. In this study, there was a significant clustering of CKD patients in deprived areas compared to adjacent affluent areas.

Table 1 shows the data from the 10 Sheffield wards with the highest prevalence of CKD based on QOF data. Out of 10, there were six wards (Firth Park, Darnall, Manor Castle, Gleadless Valley, Shiregreen and Brightside and Burngreave) that were known as the most deprived areas (IMD quintiles 4 and 5). It was also found that these areas were within the top 10 when ranked for the prevalence of NCD: diabetes, hypertension, coronary heart disease and obesity.

Figure 4a shows the prevalence of NCD such as CKD, DM, HTN, CHD and obesity in the community across IMD quintiles. There was an increasing trend for the prevalence of all chronic diseases found across IMD quintiles from least deprived to most deprived areas.

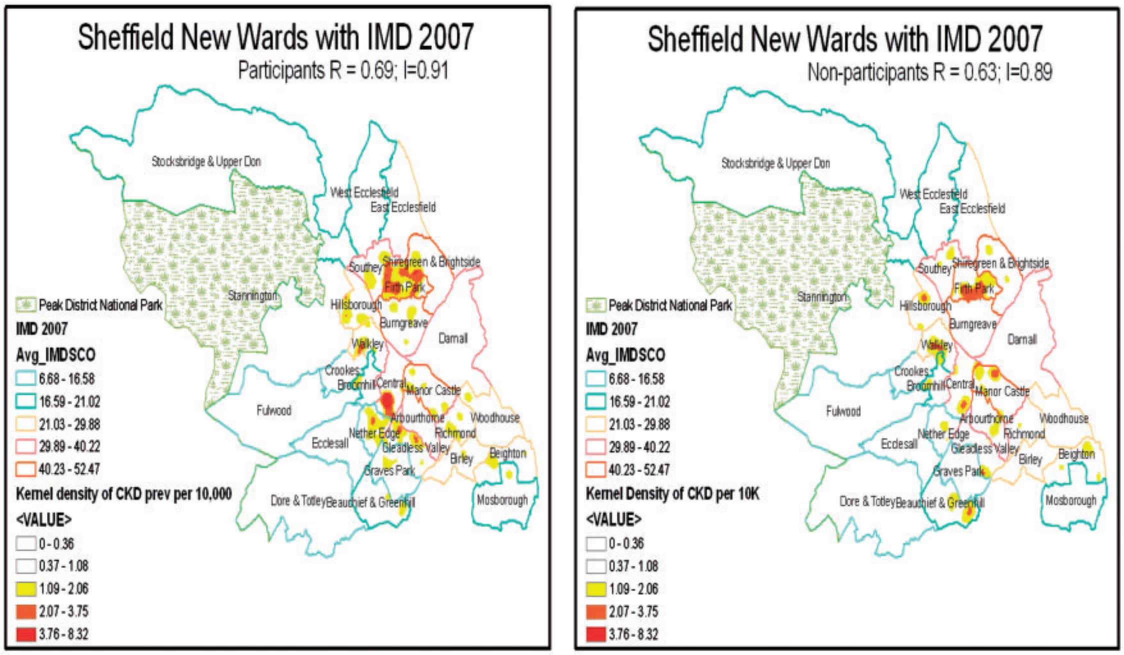


Figure 3. Distribution and Clustering of study CKD patients (using Kernel Density) in Sheffield.

Table 1 Top 10 areas of GP practices with highest prevalence of CKD (per 10 000 of the population) along with other non-communicable chronic diseases (with ranks) in Sheffield

Name of ward	IMD quintiles	CKD prevalence		DM prevalence		Rank of HTN prevalence		CHD prevalence		Obesity prevalence	
		Rank	Prevalence per 10 000	Rank	Prevalence per 10 000	Rank	Prevalence per 10 000	Rank	Prevalence per 10 000	Rank	Prevalence per 10 000
Firth Park	IMD Q5	1	2860	2	2940	2	9490	1	3280	1	6090
Darnall	IMD Q4	2	2580	1	3320	1	9590	2	3120	2	5080
Beauchief and Greenhill	IMD Q2	3	2150	4	2400	3	8660	3	2600	3	4230
Woodhouse	IMD Q3	4	1910	10	1350	19	3380	6	1850	11	2640
Manor castle	IMD Q5	5	1840	6	2170	8	4890	4	2190	4	4210
Gleadless Valley	IMD Q4	6	1780	3	2410	10	4740	5	2160	10	2690
Shiregreen and Brightside	IMD Q5	7	1530	7	1730	6	5500	7	1830	5	4030
Graves Park	IMD Q1	8	1210	13	1190	9	4800	13	1390	15	1840
Burngreave	IMD Q5	9	1210	5	2170	12	4500	9	1590	6	3630
Hillsborough	IMD Q3	10	1110	16	1110	18	3490	16	1310	14	2040

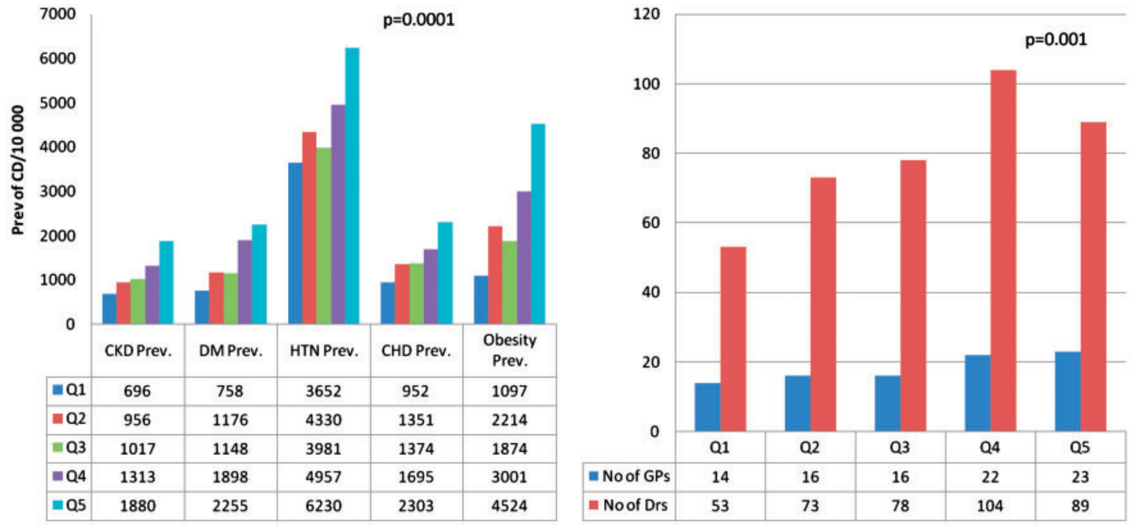


Figure 4. The trend for prevalence of chronic diseases per 10 000 registered patients (Prev of CD/10 000) and the details of total number of health-care services (GP centres) including number of doctors (Drs) working for GP centres across IMD quintiles 2007 in the community.

Table 2 Distribution of ethnicity (White and non-White) across IMD quintile

IMD Quintile	Sheffield total population (*n* = 513 264), *n* (%)	White population (*n* = 474 723), *n* (%)	Non-White population (*n* = 38 541), *n* (%)
Q1	104 117 (20)	97 269 (20)	6848 (18)
Q2	104 811 (20)	101 629 (22)	3182 (8)
Q3	107 669 (21)	104 813 (22)	2856 (7)
Q4	95 593 (19)	82 243 (17)	13 350 (35)
Q5	101 074 (20)	88 769 (19)	12 305 (32)

Table 2 shows the racial distribution of population in each ward. There are a large number of non-White people living in the most deprived areas and fewer in the more affluent areas, with the lowest prevalence in the second- and third-least deprived quintiles. Figures 4b and 5 summarize the findings for the distribution of practices and the caseload per GP by deprivation quintile. Despite the fact that more registered patients were handled by each doctor in the least deprived area, the number of those with NCD showed the opposite trend; there was an increasing trend for dealing of patients with major chronic diseases by each doctor across IMD quintiles from least to most deprived areas. Also of relevance is the fact that the caseload per individual GP is almost twice higher in the most deprived area compared to least deprived areas.

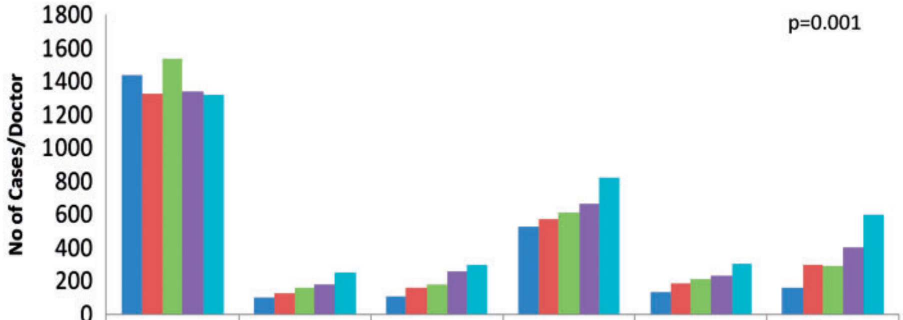
Discussion

Data from a large retrospective cohort of CKD patients at a single tertiary referral centre found that there is clustering of those attending a specialist hospital clinic from the most deprived areas. The data from the hospital-based cohort has fuelled interest to investigate the burden of CKD and its associated conditions (DM, HTN, obesity and CHD) in the community. In Sheffield, of the top 10 wards with the highest prevalence of CKD, six are known to be the most deprived. These six most deprived wards are also in the top 10 when ranked for the prevalence of other major NCD. There was, as expected, an overall significantly increasing trend across IMD quintiles from least to most deprived areas for the prevalence of all these conditions and an associated increased caseload per GP.

Our study confirms previous reports showing evidence for socio-economic inequalities in the prevalence of NCD.[3–6,25] We also found that in Sheffield, the most deprived wards have the highest number of individuals from ethnic minorities.

This is in agreement with most reports highlighting that more people from ethnic minorities live in socially disadvantages areas,[26–30] thus explaining some of the discrepancies in NCD and CKD prevalence since prevalence would be expected to be higher in some ethnic minorities. This is what we observed as both CKD and NCD clustered in the same deprived areas with high prevalence of ethnic minorities.

To our knowledge, this is the first study that investigated the burden of NCD across least deprived to



	Regs. Cases/Dr	CKD Cases/Dr	DM Cases/Dr	HTN Cases/Dr	CHD Cases/Dr	Obesity Cases/Dr
Q1	1440	100	109	526	137	158
Q2	1331	127	157	576	180	295
Q3	1538	156	177	612	211	288
Q4	1344	177	255	666	228	403
Q5	1322	249	298	824	305	598

Figure 5. The number of patients with chronic diseases who have been looked after by each doctor in the Sheffield's ward based on IMD quintiles 2007.

most deprived areas and compares caseload per doctor in the UK. This descriptive study highlights the burden of NCD and the association with area-level deprivation. Similar to our study, across Europe there is significant variation in the size and pattern of socio-economic differences in the prevalence of fatal and non-fatal chronic diseases.[3] In addition, a study based on 22 European countries also reported that there was significantly higher poorer self-assessments of health and increased mortality among the groups of people with lower SES.[31] Also, a number of studies in the USA point to the same discrepancies of healthcare between poor and affluent areas affecting NCD, including CKD and ESRD.[12,32,33]

Area-level socio-economic inequalities in health needs more attention, as a growing number of patients with chronic diseases face many obstacles in both social and medical care in coping with their condition. For example, primary medical care in deprived areas that often does not meet the needs for effective clinical management, psychological support and information causing increasing risk of poor outcomes, disability and mortality. Workload in deprived areas remains as a relevant issue for primary care.[34] Our study also quantifies the mismatch between need (based on prevalence) and supply (based on GP numbers), a potential illustration of the inverse care law even where overall quality of care, crudely measured by QOF data, appears similar.[35,36] In Europe, several studies highlight that GP workload is higher in socially deprived areas, for patients of low SES and elderly patients.[37–39] The majority of these studies measured GPs' workload using either one of the following variables or all: the number of face-to-face contacts with the patient, the number of care episodes per patient and the number of prescriptions per patient. However, none of the studies relates workload directly to disease prevalence. Since a high proportion of workload is directly related to the diagnosis and management of chronic diseases, the variation in prevalence is likely to have a major impact on practice workload.

Limitations of this study

As a descriptive study, this analysis can quantify, but does not explain, the association between area-level deprivation, disease prevalence and GP caseload. Since the study used clinical records and aggregated, practice-level information, the analyses were limited by the availability of information, particularly explanatory factors for prevalence including ethnicity of clinic or GP patients, and age and sex of GP patients. Similarly, the main measure of deprivation was area deprivation, based on post-code, and we did not consider individual deprivation markers such as occupation, education or income. In the absence of individual patient data, the practice post-code linked to IMD scores was used as a proxy for the area deprivation of the practice population.

We did not have information on other measures of workload such as the number of visits or duration of consultations or on individual co-morbidities. We also had limited information on general practice staffing and hours worked that would have given a fuller picture of the human resources available to a practice.

Conclusion

In the most deprived areas, there is an increased burden of major chronic disease and a higher case-load for clinicians. These reflect significant differences in workload for practices in deprived areas, which needs to be addressed.

Conflict of interest: None declared.

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