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Impact of social deprivation on clinical outcomes of adults hospitalised with community-acquired pneumonia in England: a retrospective cohort study

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ABSTRACT

Introduction Socioeconomic deprivation has been associated with an increased incidence of infection and poorer clinical outcomes during influenza pandemics and the COVID-19 pandemic. The aim of this study was to determine the relationship between deprivation and adverse clinical outcomes following hospital admission with community-acquired pneumonia (CAP), specifically 30-day all-cause mortality and non-elective hospital readmission.

Methods Data from the British Thoracic Society national CAP audit on patients admitted to hospital with CAP in England between 1 December 2018 and 31 January 2019 were linked to patient-level Hospital Episode Statistics data and Index of Multiple Deprivation (IMD) scores. Multivariable logistic regression models were used to examine the association between deprivation and (a) 30-day mortality and (b) 30-day readmission with p values for trend reported. Age was examined as a potential effect modifier on the effect of IMD quintile on mortality and subsequent subanalysis in those <65 and ≥65 years was performed.

Results Of 9165 adults admitted with CAP, 24.7% (n=2263) were in the most deprived quintile. No significant trend between deprivation and mortality was observed (p trend=0.38); however, the association between deprivation and mortality differed by age group. In adults aged<65 years, 30-day mortality was highest in the most deprived and lowest in the least deprived quintiles (4.4% vs 2.5%, aOR 1.83, 95% CI 0.84 to 4.0) with a significant trend across groups (p trend=0.04). Thirty-day readmission was highest in the most deprived quintile (17.1%) with a significant p trend across groups (p trend 0.003). Age-adjusted odds of readmission were highest in the most deprived compared with the least deprived (aOR 1.41, 95% CI 1.16 to 1.73).

Conclusions In adults aged<65 years hospitalised with CAP in England, mortality varied inversely with indices of social deprivation. There was also a significant association between deprivation and 30-day readmission. Strategies are required to decrease health inequalities in pneumonia mortality and hospital readmissions associated with deprivation.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Socioeconomic deprivation has been associated with an increased incidence of community-acquired pneumonia (CAP); the relationship with clinical outcomes following pneumonia is much less well defined.

WHAT THIS STUDY ADDS

⇒ This study examines whether clinical outcomes of adults admitted to hospital with CAP differ between deprivation groups. The association between deprivation and mortality differs by age. Mortality is highest in the most deprived quintile in adults under 65 years, but not in those aged≥65 years. Adults living in the most deprived areas are over 40% more likely to be readmitted to hospital following an admission with CAP than those living in the least deprived areas.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Determined public health strategies such as targeting preventative measures in areas of social deprivation may decrease health inequalities in both index admission mortality and subsequent readmission related to CAP.

INTRODUCTION

An association between increasing socioeconomic deprivation and poorer outcomes in non-communicable diseases, such as cardiovascular disease, is well established.[1 2] In addition, socioeconomic deprivation has been associated with an increased incidence of infectious diseases, such as community-acquired pneumonia (CAP).[3 4] A greater preponderance of risk factors that predispose towards pneumonia in persons living in more deprived neighbourhoods, such as increased rates of cigarette smoking, may be one of the reasons for the association with pneumonia incidence. The association of deprivation with clinical outcomes following pneumonia is much less well defined.

In the early months of the COVID-19 pandemic, an association between greater deprivation and increased mortality from COVID-19 was widely reported.[5 6] One of the explanations for this association was possibly the greater risk of exposure to SARS-CoV-2 infection faced by persons in more deprived

neighbourhoods arising from social and structural circumstances such as being less likely to be able to work from home, more likely to use public transport to get to work, more likely to live in crowded housing and more likely to live in multigenerational households.[7] Associations between socioeconomic deprivation and mortality were also observed during the 1918 and 2009 influenza pandemics.[8 9]

Outside of pandemics, pneumonia is a leading cause of death in the UK and worldwide.[10 11] As with COVID-19, any association between deprivation and pneumonia outcomes is likely to reflect the combined effects of disparities in the risk of exposure to infection and risk of mortality. The factors that predispose to each of these two risks may not be similarly evident in persons from more deprived neighbourhoods, and the interventions required to mitigate against these risks may also differ. We sought to better understand the association of socioeconomic deprivation and clinical outcomes from CAP in persons already hospitalised with CAP, hence reducing the influence that may arise from any association between deprivation and risk of exposure to infection.

The British Thoracic Society (BTS) national audit dataset 2018/2019, linked to Hospital Episode Statistics (HES) data, holds patient-level data on adults hospitalised with all-cause CAP in England and their corresponding level of deprivation. This dataset provides a unique opportunity to examine the impact of deprivation on clinical outcomes. Specifically, the aim of this study was to examine whether deprivation was associated with (1) 30-day all-cause mortality or (2) 30-day hospital readmission in adults admitted to hospital in England with radiologically and clinically confirmed CAP.

METHODS

This was a retrospective cohort study of patients admitted to UK NHS (National Health Service) hospitals between 1 December 2018 and 31 January 2019 with a diagnosis of CAP and entered into the BTS national CAP audit. Methodology and findings from the winter 2018/2019 BTS national audit have been reported previously.[12] In brief, cases were identified by participating institutions via ICD-10 (International Classification of Diseases version 10) codes mapping to a primary discharge diagnosis of pneumonia (J12–J18 inclusive) and selected for eligibility against inclusion criteria to confirm a clinical and radiographic diagnosis of CAP. Data were collected retrospectively between 1 February 2019 and 31 May 2019 by clinicians at participating NHS hospital sites and submitted via the online secure BTS audit portal, forming the BTS national audit dataset.

Subsequently, audit cases were matched by NHS Digital at a patient level with data from the corresponding HES admission spell (admitted patient care dataset) via unique patient identifiers. Linked mortality data were obtained via the HES linked Office of National Statistics dataset, forming a linked BTS/HES dataset with enriched outcome data and including deprivation data.

Table 1 Index of Multiple Deprivation quintiles

Quintile group	IMD Score range
1	≤8.49 (least deprived)
2	8.5–3.79
3	13.8–21.35
4	21.36–34.17
5	≥34.18 (most deprived)

Taken from National Perinatal Epidemiology Unit (NPEU) Tools, University of Oxford.[13]

The Nottingham Acute Respiratory Infection Patient and Public Involvement group were involved in reviewing the CAG application for the linked audit dataset and approving analysis arising from it.

Deprivation was measured using Index of Multiple Deprivation (IMD) 2010 scores derived from HES (table 1).[13] Cases were divided from least to most deprived (quintiles 1–5) based on the IMD Score in their lower super output area of residence.[13] Adverse outcomes examined were all-cause mortality within 30 days of index admission to hospital and readmission. Readmission was defined as an emergency admission to any acute NHS hospital in England within 30 days of index discharge in surviving cases, excluding readmissions to hospital within 1 day of index discharge. Severity of index admission CAP was defined as low, moderate or severe by the patient's CURB-65 Score.[14] Data regarding confounders, such as age and presence of comorbidity, are derived from the BTS dataset. This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Statistical analysis

Characteristics of the cohort were described using appropriate summary statistics. Multivariable logistic regression models were used to calculate the adjusted odds of (a) all-cause 30-day mortality and (b) 30-day hospital readmission with increasing deprivation. For categorical variables, we calculated the Wald's test p value for trend by fitting the categorical variables as continuous in the model. The minimal adjustment sets were identified as age only following review of the literature for potential confounders and production of directed acyclic graphs (http://dagitty.net/).[15] Factors existing along an indirect causal pathway of the DAG, such as presence of comorbidity, act as potential explanatory variables for any association between IMD quintile and adverse outcomes.[16 17] Adjustment for these may change the observed result, therefore the primary analysis was adjusted for age only. A secondary analysis including adjustment for comorbidities was performed following peer review.

Based on evidence from the established literature, age was identified as a potential effect modifier on the effect of IMD quintile on mortality.[18] A likelihood ratio test for interaction using binary variables (≥65 vs <65 years; IMD quintiles 1–3 vs 4–5) was performed to assess

the requirement for stratification by age groups. Cases with missing data on IMD quintile were excluded from the analyses. All analyses were performed using STATA V.16.0.

RESULTS

There were 9165 cases available for analysis following exclusion of 128 cases (1.4%) without IMD scores. The highest proportion of patients were in the most deprived quintile (n=2263, 24.7%; table 2). They were younger than patients in the least deprived quintile (median age 71 vs 79 years, respectively). Significant differences in the proportion of patients with c hronic obstructive pulmonary disease (COPD), diabetes, obesity, chronic cardiac, liver and kidney diseases were observed across quintiles. In persons aged≥65 years, the age-adjusted odds of high severity disease on hospital admission increased with deprivation (p trend=0.002); the most deprived were 23% more likely to be admitted with high severity disease than the least deprived (aOR 1.23, 95% CI 1.03 to 1.47).

Mortality

Thirty-day mortality was highest in the least deprived quintile (16.8%) and lowest in quintile 2 (11.6%) (table 3). After adjustment for age, no significant trend between deprivation and mortality was observed (p trend=0.38). In total, 2700 (29.5%) cases were <65 years on admission; mortality was higher is those ≥65 years compared with those <65 years (16.8% vs 3.6%). There was effect modification observed between age and IMD Score on mortality (p interaction 0.03). This is interpreted as the relationship between IMD Score and mortality being different in those ≥65 years compared with those <65 years.

In those aged≥65 years, mortality was highest in the least deprived (20.9%) and lowest in quintile 2 (14.4%). No association between deprivation groups and mortality was observed in this age group (p trend=0.70). In those aged<65 years, morality was highest in the most deprived quintile (n=37, 4.4%) and lowest in the least deprived (n=8, 2.5%). The p trend across groups was significant in the primary age-adjusted analysis (p trend=0.04) suggesting risk of mortality differs with IMD quintile. The point estimates of age-adjusted mortality were higher in the two most deprived quintiles (IMD quintile 4; aOR 1.74, 95% CI 0.78 to 3.88: IMD quintile 5; aOR 1.83, 95% CI 0.84 to 4.0); however, neither reached statistical significance. In a sensitivity analysis adjusting for comorbidity and age, the trend was similar with wide confidence intervals in adjusted ORs and the p trend was no longer significant (p trend=0.09).

Readmission

Data on readmission within 30 days of discharge were available on 8212 cases surviving index admission. The proportion of readmissions was highest in the most deprived quintile and lowest in the least deprived (17.1% vs 14.1% in quintile 1) (table 4). After adjusting for age, a significant p trend across groups was observed (p trend 0.003) suggesting an association between readmission and increased deprivation. Point estimates for age-adjusted readmission in quintiles 2–4 were similar (aOR 1.21, aOR 1.21 and aOR 1.17, respectively). Age-adjusted odds of readmission were highest in the most deprived compared with the least deprived (aOR 1.41, 95% CI 1.16 to 1.73). Results were similar after adjustment for age and comorbidity.

DISCUSSION

The main findings of this study were that in adults hospitalised with CAP in England, the relationship between social deprivation and 30-day mortality differed across social deprivation group in those <65 years, but not in older adults. Adults in the most deprived group are more likely to be readmitted to hospital within 30 days of discharge than those in the least deprived group.

To our knowledge, the only other UK study to investigate the effect of social deprivation on mortality in CAP is a prospective population-based study by Woodward *et al*.[19] That study used Biobank data to estimate the effect of social deprivation on mortality from influenza and pneumonia based on clinical coding data within the context of COVID-19. It differs from our current study which is based on individual patient-level data of confirmed pneumonia managed in hospital. The only other study focused on social deprivation and CAP in hospitalised patients is from the USA.[3] All studies report similar findings; higher levels of social deprivation are associated with a greater risk of fatal disease. Similar to our findings, Woodward *et al* found that adjustment for factors such as body mass index, blood pressure and diabetes attenuated the effects, but the trend remained similar.[19] This suggests that adverse outcomes in CAP are in part due to higher rates of underlying comorbid disease and poorer health indices associated with greater deprivation. Underlying factors associated with deprivation such as differential education levels, low-quality housing and lack of financial security are not adjusted for in either analysis and may be additional explanatory factors in the observed findings.

The interaction of age on the association of deprivation with pneumonia mortality is important. Differences in rates of smoking, alcohol use, nutrition and subsequent comorbidity are well recognised determinants of higher all-cause mortality in more deprived areas, particularly in those aged 45–64 years.[20 21] Consistent with our findings, the effect of social deprivation on all-cause mortality in the UK during the COVID-19 pandemic was marked in the younger age groups with limited differences in those over 85 years of age.[22] A further ecological study examining mortality due to respiratory infections in the West Midlands, the UK, reported the mortality risk in the most deprived was highest in those aged 45–64 years (RR=4.4).[23] An attenuation of the effect of socioeconomic factors on mortality in older populations has been described previously but the mechanism for this effect is unclear.[24] Age-dependent inequalities in smoking, alcohol

Table 2 Cohort demographics by Index of Multiple Deprivation (IMD) quintile

IMD quintile	1 (least deprived), n %	2, n %	3, n %	4, n %	5 (most deprived), n %	P for trend
Number of cases	1423 (15.5)	1638 (17.9)	1878 (20.5)	1963 (21.4)	2263 (24.7)	
Median age (IQR)	79 (67–87)	78 (65–86)	76 (63–86)	74 (59–84)	71 (57–81)	
Gender (male)	693 (48.7)	776 (47.4)	896 (47.7)	927 (47.3)	1093 (48.3)	0.891
Comorbidities						
Cardiac failure	170 (11.9)	173 (10.6)	177 (9.4)	202 (10.3)	218 (9.6)	0.05
Other chronic cardiac disease	423 (29.7)	480 (29.3)	508 (27.1)	506 (25.8)	528 (23.3)	<0.0001
Cerebrovascular disease	130 (9.1)	153 (9.3)	165 (8.8)	184 (9.4)	218 (9.6)	0.59
Liver disease	11 (0.8)	16 (1.0)	30 (1.6)	36 (1.8)	43 (1.9)	0.0008
Chronic kidney disease	153 (10.8)	153 (9.3)	206 (11.0)	202 (10.3)	180 (8.0)	0.02
Malignancy	121 (8.5)	126 (7.7)	134 (7.1)	154 (7.8)	170 (7.5)	0.43
COPD	259 (18.2)	351 (21.4)	426 (22.7)	517 (26.3)	785 (34.7)	<0.0001
Other chronic lung disease	257 (18.1)	251 (15.3)	295 (15.7)	338 (17.2)	359 (15.9)	0.45
Diabetes	204 (14.3)	268 (16.4)	343 (18.3)	357 (18.2)	455 (20.1)	<0.0001
Dementia	168 (11.8)	167 (10.2)	201 (10.7)	229 (11.7)	226 (10.0)	0.35
Body mass index≥40	11 (0.8)	13 (0.8)	13 (0.7)	28 (1.4)	35 (1.5)	0.003
Severity as per CURB-65 Score category						
Low	549 (38.6)	656 (40.0)	745 (39.7)	793 (40.4)	1021 (45.1)	
Moderate	420 (29.5)	485 (29.6)	531 (28.3)	538 (27.4)	563 (24.9)	
Severe	347 (24.4)	382 (23.3)	433 (23.1)	435 (22.2)	467 (20.6)	<0.0001*
Not known	107 (7.5)	115 (7.0)	169 (9.0)	197 (10.0)	212 (9.4)	
High severity disease in persons≥65 years						
n (%)	342/1015 (33.7)	374/1151 (32.5)	427/1249 (34.2)	416/1183 (35.2)	444/1274 (34.9)	2003/5872 (34.1)
Age-adjusted OR (95% CI)	1	0.97 (0.81 to 1.17)	1.07 (0.89 to 1.28)	1.17 (0.98 to 1.40)	1.23 (1.03 to 1.47)	0.002

*P value not for trend—denotes association between the variables.
COPD, chronic obstructive pulmonary disease.

Table 3 Association between deprivation and mortality in the whole cohort and stratified by age group (<65 and ≥65 years)

Quintile	1 (least deprived)	2	3	4	5 (most deprived)	P for trend
Whole cohort (all ages)						
Number of cases	1423	1638	1878	1963	2263	
N (%)	239 (16.8)	190 (11.6)	233 (12.4)	235 (12.0)	286 (12.6)	
OR (95% CI)	1	0.65 (0.53 to 0.80	0.7 (0.58 to 0.85)	0.67 (0.55 to 0.82)	0.72 (0.59 to 0.86)	0.008
Age-adjusted OR (95% CI)	1	0.66 (0.54 to 0.82)	0.76 (0.62 to 0.92)	0.81 (0.66 to 0.99)	0.98 (0.81 to 1.19)	0.38
aOR (95% CI)*	1	0.67 (0.54 to 0.84)	0.76 (0.62 to 0.93)	0.79 (0.64 to 0.96)	0.96 (0.79 to 1.18)	0.61
Age<65 years						
Number of cases	316	393	498	645	848	
n (%)	8 (2.5)	11 (2.8)	14 (2.8)	27 (4.2)	37 (4.4)	
OR (95% CI)	1	1.11 (0.44 to 2.79)	1.11 (0.46 to 2.69)	1.68 (0.75 to 3.75)	1.76 (0.81 to 3.82)	0.04
Age-adjusted OR (95% CI)	1	1.13 (0.45 to 2.85)	1.16 (0.48 to 2.80)	1.74 (0.78 to 3.88)	1.83 (0.84 to 4.0)	0.04
aOR (95% CI)*	1	1.18 (0.45 to 3.10)	1.00 (0.40 to 2.51)	1.45 (0.63 to 3.36)	1.71 (0.75 to 3.86)	0.09
Age≥65 years						
Number of cases	1107	1245	1380	1318	1415	
n (%)	231 (20.9)	179 (14.4)	219 (15.9)	208 (15.8)	249 (17.6)	
OR (95% CI)	1	0.64 (0.51 to 0.79)	0.72 (0.58 to 0.89)	0.71 (0.58 to 0.87)	0.81 (0.66 to 0.99)	0.23
Age-adjusted OR (95% CI)	1	0.65 (0.52 to 0.81)	0.74 (0.60 to 0.91)	0.77 (0.63 to 0.95)	0.95 (0.77 to 1.16)	0.70
aOR (95% CI)*	1	0.66 (0.53 to 0.82)	0.75 (0.61 to 0.93)	0.76 (0.61 to 0.94)	0.93 (0.76 to 1.15)	0.92

The independent variable for each analysis in Index of Multiple Deprivation quintile; 30-day all-cause mortality is the dependent variable. Reference group for all analyses is quintile 1 (the least deprived quintile).
*Adjusted for presence or absence of comorbid diseases as listed in table 2.

Table 4 Association between deprivation and readmission

	Quintile 1 (least deprived)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (most deprived)	P value for trend
Number of cases	1423	1638	1878	1963	2263	
IMD quintile	1	2	3	4	5	P for trend
n (%)	173 (14.1)	243 (16.4)	261 (15.5)	270 (15.2)	347 (17.1)	
OR (95% CI)	1	1.19 (0.96 to 1.47)	1.11 (0.90 to 1.38)	1.09 (0.89 to 1.34)	1.26 (1.03 to 1.53)	0.1
Age-adjusted OR (95% CI)	1	1.21 (0.98 to 1.49)	1.21 (0.98 to 1.49)	1.17 (0.95 to 1.45)	1.41 (1.16 to 1.73)	**0.003**
aOR (95% CI)*	1	1.20 (0.97 to 1.48)	1.15 (0.93 to 1.42)	1.13 (0.91 to 1.39)	1.32 (1.08 to 1.62)	**0.03**

Baseline group for all analysis is quintile 1—the least deprived quintile.
Bold text denotes p values of <0.05.
*Adjusted for presence or absence of comorbid diseases as listed in table 2.

use and housing tenure have been implicated.[24] Influenza vaccine uptake in eligible adults under 65 years of age is lower than in those aged 65 or over[25] and varies by deprivation,[26] potentially strengthening the effect of social deprivation on CAP mortality in younger persons. In older age groups, inequalities due to deprivation may be less important than differences in frailty, comorbidity and social support.[18] Additionally, the IMD score may not adequately reflect individual socioeconomic circumstances of adults residing in care homes, who make up a higher proportion of the older cohort.

To our knowledge, this is the first study to examine the association of readmissions with deprivation following hospitalisation with CAP. Readmission rates following admission to hospital with pneumonia are increasing in the UK; underlying causes for this are unclear.[12] Emergency readmission is associated with a higher risk of death than index admission after adjustment for patient factors.[27] Consistent with our findings, a retrospective cohort study using Medicare data in the USA has shown that residence within a disadvantaged US neighbourhood confers an increased risk of rehospitalisation after an index admission with acute myocardial infarction, pneumonia or heart failure.[28] Results from the UK national COPD audit suggests that the least deprived patients were 11% less likely to be readmitted than the most deprived group following admission with an exacerbation of COPD.[29] Potential explanations for an association between deprivation and all-cause hospital readmission include differences in nutrition, air pollution and access to healthcare.[30] Current smoking is disproportionately present in areas of greater deprivation and smoking status at the time of hospitalisation with pneumonia is associated with increased risk of readmission with recurrent pneumonia.[31] Differences in social support on discharge, particularly access to privately funded care, are also expected to contribute.

Strengths and limitations

The main strength of this study is the use of a large unique dataset of clinician-confirmed CAP derived from linkage of BTS audit and HES datasets containing patient-level data on deprivation, severity and disease outcomes. Selection bias is minimised by the use of routinely collected audit data. Some limitations of this study should be recognised. Inclusion of only hospitalised cases might attenuate differences in healthcare seeking behaviours contributing to variation in healthcare outcomes due to deprivation. Assigned IMD Score is based on lower super output area of residence which may not fully reflect individual patient circumstances, thus introducing misclassification bias. Unmeasured factors associated with deprivation, such lifestyle factors, ethnicity and vaccination status, were not available. Data are restricted to cases from England alone and therefore may not be applicable to devolved nations or internationally. Data used for this analysis date from prior to the COVID-19 pandemic; the effect of social deprivation before and after pandemic may vary but it is difficult to predict the direction or magnitude of this effect.

CONCLUSION

The COVID-19 pandemic has highlighted established health inequalities and led to a recognised need for public health strategies to combat adverse outcomes in deprived areas.[32] Our analysis demonstrates adverse outcomes associated with deprivation are also present in all-cause CAP. Evidence from studies in the USA suggests computerised clinical decision support systems may improve the quality of pneumonia care in underserved areas, providing a further potential target to combat health inequalities.[33] The NHS long-term plan highlighted the burden of admission to hospital with pneumonia on the NHS and called for strategies to reduce this.[34] Determined strategies such as targeting preventative measures, including smoking cessation and vaccine uptake, in areas of social deprivation may decrease health inequalities in both index admission mortality and subsequent readmission related to CAP.

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Competing interests None declared.

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Patient consent for publication Not applicable.

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