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# This divided land: An examination of regional inequalities in exposure to brownfield land and the association with morbidity and mortality in England

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ABSTRACT

This paper is the first empirical examination of the association between brownfield land and spatial inequalities in health. Linear mixed modelling of ward-level data suggests that there is higher exposure and susceptibility to brownfield land in the Northern compared to the Southern regions (with the exception of London); that brownfield exposure has an association with regional inequalities in mortality and morbidity within regions (particularly in the North West); that brownfield has an association with inequalities between regions (particularly between the North West and the South East); but that brownfield land only makes a small independent contribution to the North–South health divide in England. However, brownfield land could be a potentially important and previously overlooked independent environmental determinant of spatial inequalities in health in England.

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## 1. Introduction

### 1.1. Regional inequalities in health

England has some of the largest regional inequalities in health in Europe, particularly between the Northern regions (North West, North East and Yorkshire and the Humber) and those of the South (particularly London and the South East). By way of example, recent data from Public Health England shows that between 2009 and 2011 people in Manchester were more than twice as likely to die early (455 deaths per 100,000) as people living in Wokingham (200 deaths per 100,000) (PHE, 2013). A baby boy born in Manchester can expect to live for 17 fewer years in good health, than a boy born in Richmond in London. Similarly, a baby girl born in Manchester can expect to live for 15 fewer years in good health. The health divide has increased over the past four decades (Hacking et al., 2011), the North of England has persistently had higher all-cause mortality rates than the South of England, with people in the North consistently found to be less healthy than those in the South-across all social classes and amongst men and women (Dorling, 2010). Since 1965, this has amounted to 1.5 million excess premature deaths (CLES, 2014). The scale of the divide is such that the life expectancy gap for women between the North East and North West compared to London and the South East was similar to the gap between the former West Germany and post-communist East Germany in the mid-1990s (Bambra et al., 2014a). There are also significant inequalities in health between areas within the English regions: area-level health is inversely associated with socio-economic disadvantage, resulting in the large inequalities in health between deprived and affluent areas. These within region inequalities in health are larger in the North than in the South and the social gradient is steeper. For example, the local authority with the largest gap in male life expectancy in England is the borough of Stockton-on-Tees in the North East, where the gap between the most and least affluent wards is 16 years (Marmot Indicators, 2012).

### 1.2. Deprivation and regional inequalities in health

Traditionally, most research in health geography has focused on socio-economic explanations of these regional inequalities in health, citing both compositional and contextual factors, particularly the interplay of individual and area-level *socio-economic*

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**Box 1–**Description of data and variables (reproduced from Bambra et al. (2014a, 2014b) under open access)

**Brownfield land data and variables**

Data on the proportion of previously developed land (brownfield) was obtained from the 2009 National Land Use Database (NLUD) available from the Homes and Communities Agency website (2012a). This listed the size and geographic location of brownfield in England– 'previously developed land' (PDL). This classified PDL in England into five categories: "currently in use with permission or allocation for redevelopment" (28%), "derelict land/buildings" (25%), "previously developed vacant land" (22%), "other currently in use with known potential for redevelopment" (18%), and "vacant buildings" (7%). The data was used as released by the Homes and Communities Agency, without additional verification. English local authorities provided the Homes and Communities Agency with data about previously developed sites in their area, and the submitted site-level data was made publically available through yearly revisions of the NLUD between 2001 and 2009 (Homes and Communities Agency, 2012b). Nominally, the submissions related to the situation in each local authority on the 31st of March of a given year, and where a submission was not made, the previous years' data was included in the Homes and Communities agency's release (Homes and Communities Agency, 2012c). A "small number" of local authorities made no submissions (Homes and Communities Agency, 2012c). As such, the category 'no brownfield' may indeed mean no brownfield present or simply be a non-response. Local authorities are required to estimate the percentage of the total that their submission covers (Homes and Communities Agency, 2012c). This is estimated to be between 58% (in the South West) and 82% (in London) of total brownfield, with the dataset covering an average of 72% of brownfield across England. Census Area Statistics (CAS) ward boundaries were downloaded from EDINA UK BORDERS.

**Health data and variables**

Self-reported general health data was obtained from the 2001 Census and calculated as the proportion of 'not good' responses to question: "Over the last twelve months would you say your health has on the whole been… Good? Fairly good? Not good?" Limiting long-term illness data was also obtained from the 2001 Census and calculated as the proportion of positive responses to the question: "Do you have any long-term limiting illness, health problem or disability which limits your daily activities or the work you can do?" All-cause premature mortality data (deaths under age 75) was obtained from the Office for National Statistics for the five year period 1998/9 to 2002/3.

**Physical environment data and variables**

Measures of the physical environment were obtained from the MED-Ix and MED-Class databases developed by Richardson et al. (2010) and Shortt et al. (2011). MED-Ix is a UK index of health-related multiple environmental deprivation, a composite index which contains ward level measures of air pollution, climate temperature, solar UV radiation, proximity to industry, and access to green space. MED-Ix provides a scale of $-2$ to $+3$ (most environmentally deprived). MED-Class is a seven-fold typology based on MED-Ix: London and London-esque (London and other urban centres in England); industrial (spread throughout UK); mediocre green sprawl (spread throughout UK); fair-weather conditions (spread throughout UK); cold, cloudy conurbations (major urban centres of Scotland, Newcastle and urban areas of Northern Ireland); isolated, cold and green (rural Scotland, Northern England, Northern Ireland, and Wales); sunny, clean and green (spread throughout UK). Data downloaded from: http://cresh.org.uk/cresh-themes/environmental-deprivation/medix-and-medclass/

**Demographic and socio-economic data and variables**

Area-level socio-economic deprivation was measured using the well-validated Townsend Index of Deprivation for 2001 (Townsend et al., 1988). This index uses unemployment, private renting, no car ownership, and overcrowding census variables to define material deprivation. Individual-level data relating to demographic and socio-economic variables were all obtained from the 2001 Census. Ethnic composition was calculated as the proportion of white (British, Irish and other White background) adult (aged 16–74) residents. The proportion of the 16–74 year old population of non-professional socio-economic class (intermediate occupations, lower supervisory and technical occupations, semi-routine occupations, routine occupations, never worked, and long-term unemployed) was calculated using the National Statistics socio-economic classification. Educational qualification was measured as the proportion of adults age 16–74 with no qualifications. The proportion of 16–74 year olds who were in full or part-time employment were calculated using the economic activity variable. Housing tenure was calculated as the proportion of owner occupiers (owns outright, owns with a mortgage or loan, or shared ownership). Car ownership was the proportion of the population with no car or van.

**Settlement type data and variables**

Data was obtained from the Office for National Statistics (2004) and is based on the Department for Environment and Rural Affairs' rural/urban classification which defines the urbanity/rurality of different geographies. CASWARDs are classified using a threefold grouping: (1) urban; (2) town & fringe; and (3) village, hamlet or dispersed.

**Regions**

Each CAS ward was assigned to one of nine regions: North East, North West, Yorkshire and Humber, East Midlands, West Midlands, East of England, London, South East and South West. Until 2013, the nine regions all had Government Offices which were administratively and economically important in terms of having some devolved responsibility for the local economy including the allocation of regional development funds, drawing up regional economic strategies, and encouraging inward regional investment (including the receipt of European Union funding). Regional public health groups and Strategic Health Authorities also existed at a regional level and some public health interventions were regionally operated and coordinated. To examine the North–South divide, in common with other research, the North East, North West, and Yorkshire and Humber were merged to be the North whilst the East Midlands, West Midlands, East of England, London, South East and South West were merged to be the South (CLES, 2014).

deprivation. For example, Sloggett and Joshi (1998) observed regional variations in mortality and the North–South differences in mortality remained significant (although small) even after controlling for individual level deprivation. Certainly, there is strong evidence of socio-economic inequalities as over the past 20 years the North has consistently had lower employment rates – of at least 10 percentage points – than the South for both men and women (ONS, 2012; Jenkins and Leaker, 2010). Welfare receipt, ill health related worklessness and poverty rates are also much higher in the North than the South. By way of example, poverty disproportionately affects the North – whilst it has 30% of the population of England it includes 50% of the poorest neighbourhoods (CLES, 2014). Further, the most deprived areas in the South have better health outcomes than equally deprived areas in the North (CLES, 2014). It is often argued that this is related to the economic effects of deindustrialisation as, in the latter part of the 20th century, there were regionally concentrated falls in the demand for labour (most notably in the North East, North West and

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