Health & Place 17 (2011) 1266–1273

Contents lists available at ScienceDirect

Health & Place

journal homepage: www.elsevier.com/locate/healthplace

Area effects on health inequalities: The impact of neighbouring deprivation on mortality

Xin Zhang [a,*], Penny A. Cook [a], Ian Jarman [a], Paulo Lisboa [b]

[a] Centre for Public Health, Liverpool John Moores University, Liverpool L3 2ET, UK
[b] Department of Mathematics and Statistics, Liverpool John Moores University, Liverpool, UK

ARTICLE INFO

Article history:
Received 7 December 2010
Received in revised form
10 May 2011
Accepted 16 May 2011
Available online 30 May 2011

Keywords:
Area effect
Relative deprivation
Principal component analysis
Psychosocial model
Inequality

ABSTRACT

The exact nature of the association between the context of the local area and local health outcomes is unknown. We investigated whether areas geographically close but divergent in terms of deprivation have greater inequality in health than those where deprivation is similar across neighbouring localities. In order to disaggregate the strong correlation between the deprivation of a target area and that of its surrounding areas, we used principal component analysis to create a measure of relative deprivation. Both deprivation ($ß=0.183$, $p<0.001$) and relative deprivation were positively associated with mortality ($ß=0.099$, $p<0.001$), and the effect of relative deprivation was shown to be most pronounced in more affluent segments of the population.

1. Introduction

There is a long history of research showing that material deprivation indicators are important predictors of mortality inequalities (Townsend and Davidson, 1988). Subsequently, the existence of inverse gradients between the socioeconomic status (SES) of populations and the incidence or mortality rates of many health outcomes, such as low birth weight (Krieger et al., 2003; Pattenden et al., 1999), cardiovascular diseases (Avendano et al., 2006; Kaplan and Keil, 1993; Mackenbach et al., 2000), respiratory diseases (Ellison-Loschmann et al., 2007; Prescott et al., 2003) and various cancers (Steenland et al., 2002) have been demonstrated. Since data at the level of an individual are not routinely available, ecological (or contextual) measures of SES are frequently used to aggregate individual socioeconomic data. These ecological analyses have used data grouped at the level of countries, districts, regions and smaller administrative units (e.g. English wards). The extent to which an individual's socioeconomic status on health is driving the association, relative to the effect of place per se, is not clear.

One of the first papers to explicitly examine the area effects on health found that the properties of the socio-physical environment moderated the relationship between low social status and excess mortality (Haan et al., 1987). Since then, there has been considerable debate about the relative importance of people (individual) or place (area) characteristics. It was noted that any associations observed between places and health derive from the population characteristics of the residents in a place, and that there was a need to directly measure those features of local social and physical environment that could promote or inhibit health, a focus that could potentially result in improvements in public health (Macintyre et al. 1993). However, Sloggett and Joshi (1994) reached the opposite conclusion: that there was no evidence that place affects health after controlling for individual-level deprivation of residence. The relationship between place and the local health outcome has been investigated at different levels (e.g. area-level deprivation, individual-level deprivation indicators or individual health data with the area-level deprivation predictor) and at different scales. These have generated inconsistent findings, suggesting there is no single or universal area effect on health in all areas, health outcomes and population groups. A previous literature review concluded that although the area effect cannot be ignored, the effect of area characteristics was relatively small in comparison with the larger effect of individual socioeconomic position (Pickett and Pearl, 2001).

There are two main theories to explain how socioeconomic factors at the individual and the area level act together to influence health. The 'collective resource model' posits that individuals' poverty throughout their life-course is associated with under-investment within the areas in which they live (Stafford and Marmot, 2003). People in less deprived areas acquire more collective resources, which include material and social resources,

* Corresponding author. Tel.: +44 151 231 4517.
E-mail address: arthurgis@gmail.com (X. Zhang).

1353-8292/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.healthplace.2011.05.009

such as public services, recreation facilities, employment opportunities and social support. Even a relatively poor individual may benefit from the effect of living in a less deprived area because of better public services and facilities. Based on this, positive or negative social and environment resources in a local area can influence people's health in a similar direction to their neighbouring areas, in a 'pull-up or pull-down' hypothesis (Boyle et al., 1999, 2004; Gatrell, 1997).

Alternatively, the 'psychosocial model' (Wilkinson, 1997) states that social comparisons lead to worse health in areas surrounded by relatively affluent places, all other factors being equal, thus enhancing existing contrasts in health outcomes. The psychosocial pathway posits that socioeconomic inequality increases an individual's sense of being deprived of status, resulting in frustration, shame and stress, which in turn leads to adverse health consequences (Wilkinson and Pickett, 2006). Although this theory has attracted criticism (e.g. Deaton, 2003; Gravelle et al., 2002), proponents argue that this is one of the explanations for health inequalities remaining in developed nations despite the decline of absolute poverty. Empirical studies provide evidence to support the psychosocial pathway, by examining individual relative deprivation as a predictor of increased risks of mortality, alongside smoking, obesity and mental health services utilisation (Eibner et al., 2004; Eibner and Evans, 2005).

Increasingly, evidence has indicated that the context of the local area in which one lives affects health, but a clear conclusion about the nature of the association between place and the local health outcome is lacking. One method that has been less commonly used to address the conflicting hypotheses is to examine the association between the health outcomes of an area and that of surrounding or adjacent neighbourhoods. In this way the 'place' effect is purely contextual, since inequality between rather than within neighbourhoods is studied.

Using this sort of approach, Ben-Shlomo et al. (1996) and Boyle et al. (1999) were unable to find dominant area effects on health. Typically these studies expressed inequality in deprivation as the variance within areas. However, to test the competing hypotheses of the collective resource and psychosocial models, information on the direction of the inequality is needed, a feature that is lost when using a measure such as variance. There is a recent body of evidence showing that health events are affected by spatial autocorrelation (Lorant et al., 2001; Sridharan et al., 2007). While these suggest that spatial patterns of deprivation may be implicated in the levels of health outcomes, they do not directly address how deprivation inequalities affect health and how to quantify the effects of nearby areas on health. A study that aimed to determine whether the incidence of Type 2 diabetes in small areas (Statistical Output Areas, average population ~200) was associated with deprivation in neighbouring areas, after controlling for the deprivation of the area itself, attempted to examine the contextual effect of the surrounding area by testing the psychosocial versus the pull-up/pull-down hypothesis (Cox et al., 2007). The results are consistent with a pull-up/pull-down model, with types 2 diabetes more common in deprived areas, but lower in deprived areas that are surrounded by relatively less deprived areas. However, a problem with this approach is that an individual area's deprivation is highly correlated to the deprivation of surrounding areas and therefore to health outcomes (i.e. spatial autocorrelation). Maheswaran et al. (2009) used a graph theory methodology to test the hypothesis that if a socioeconomically deprived neighbourhood is situated in a wider deprived area, then that neighbourhood would experience greater adverse effects on mortality compared with a similarly deprived neighbourhood, which is situated in a wider area with generally less deprivation (although not stated explicitly, this was a test of the pull-up/pull-down hypothesis). However, as a methodological paper with data selected for demonstration purposes, this study used only a very small subset of available areas. While not providing convincing results to draw conclusions as to how surrounding areas might affect health, these papers formed the theoretical foundation for future research in this field.

Here we explore whether the socioeconomic conditions of neighbouring localities influence the mortality of a target locality, analysing at the level of a small geographical unit (the Lower Super Output Area, average population ~1500) across the whole of England. We test the hypothesis that areas geographically close but divergent in terms of deprivation will have greater inequality in health than those where deprivation is similar across neighbouring localities. In addition, we report on a method to address the problem of strong correlation between the deprivation of a target area and the relative deprivation of surrounding areas.

2. Methodology

2.1. Data source

2.1.1. The index of multiple deprivations (IMD)

The indices of multiple deprivation (IMD 2007), released by the Department for Communities and Local Government, were used to characterize the degree of deprivation at LSOA level. The IMD comprises several dimensions of deprivation, including income, employment, education and health, which are available separately, or aggregated to provide an overall measure of multiple deprivation, as was used for this study (Noble et al., 2008). There are 32,482 LSOAs in England (a small level geographic area, population of 1500). The North West Public Health Observatory provided data for the 2007 index of multiple deprivation (IMD) scores for each LSOA.

2.2. Adjacent locality deprivation (ALD)

Using IMD scores for each LSOA, the average deprivation scores of neighbouring LSOAs were used to create an adjacent locality deprivation (ALD) index. A spatial analysis tool, neighbourhood contiguous search (NCS), was used to search surrounding localities for each target LSOA and to calculate ALD using ArcGIS 9.1. Then a gravity model approach was employed to weight deprivation scores of adjacent surrounding LSOAs. The influence of every adjacent locality was measured as a function of its population density and the square of the distance between its population-weighted centroid and that for the target area:

$$W_{ij} = \frac{P_i P_j}{D_{ij}^2}$$

where W_{ij} represents the influence of LSOA$_i$ on LSOA$_j$; P_i is the population density of LSOA$_i$; P_j is the population of LSOA$_j$; D_{ij}^2 is the distance squared between LSOA$_i$ and LSOA$_j$.

These weights were multiplied by their respective IMD scores then a mean score was derived from the surrounding locality:

$$\text{ALD}_i = \frac{\sum_j^k I_j W_{ij}}{\sum_j^k W_{ij}}$$

where I_j is the IMD score for LSOA$_j$ and k is the number of adjacent LSOAs.

2.2.1. Directly age-standardised rates (DSR) mortality

All age, all-cause mortality data were provided by the North West Public Health Observatory (NWPHO). Directly age-standardised rates (DSR) mortality from 2001 to 2007 were calculated. DSR mortality weights the age-specific rates observed in a population