



Environmental justice and health: A study of multiple environmental deprivation and geographical inequalities in health in New Zealand

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ABSTRACT

There is an increasing interest in the unequal socio-spatial distribution of environmental 'goods' and 'bads' and the associated implications for geographical inequalities in health. Until recently, research in this area has focused on solitary environmental characteristics and has been hindered by the absence of geographically-specific measures that recognise the multifactorial nature of the physical environment. However, recent work in the United Kingdom has developed an area-level multivariate index of health-related physical environmental deprivation that captures both pathogenic and salutogenic environmental characteristics. Applications of this index have demonstrated that, at the national level, multiple environmental deprivation increased as the degree of income deprivation rose. Further, after adjusting for key confounders, there was a significant association between multiple environmental deprivation and the health outcomes of local residents. In the current study we tested the methods developed in the UK to create the New Zealand Multiple Environmental Deprivation Index (NZ-MEDIX) for small areas across the country ($n = 1860$). We considered whether socially disadvantaged places in New Zealand had higher levels of multiple environmental deprivation, and if environmental disadvantage exerted an influence on health after adjustment for key confounders such as socioeconomic status. We found that although neighbourhoods with higher levels of multiple environmental deprivation tended to have greater social disadvantage, this association was not linear. Further, multiple environmental deprivation tended to exert a modest effect on health that was independent of the age, sex and socioeconomic structure of the population. These findings demonstrate that it is possible to develop an index of multiple environmental deprivation in an alternative national context which has utility in epidemiological investigations.

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Introduction

Health outcomes vary substantially across neighbourhoods with the residents of socioeconomically disadvantaged places tending to have significantly poorer health than those living in more advantaged areas (Thomas, Dorling, & Smith, 2010). It is likely that a component of these geographical differences in health is affected by characteristics of the environments in which people reside. There is an abundance of studies suggesting that area-level attributes are related to health, wellbeing and associated behaviours even after accounting for the variation in individual-level characteristics that occurs between populations residing in different places (Pickett & Pearl, 2001). Nonetheless, the features of places that affect health and health inequalities remain poorly understood. This limitation has been an important impediment for

researchers and policymakers working in the field of health inequalities.

One set of area-level characteristics that may be significant in influencing geographical differences in health are various features of the physical environment. In this context, we define the physical environment as all physical, chemical and biological factors, and exclude social and cultural factors. Many previous studies have used an 'environmental justice' framework to consider firstly whether socially disadvantaged populations are exposed to physical environments that are disadvantageous for health, and secondly the social and political processes that have led to this socio-spatial arrangement. There is a multitude of evidence from countries such as the United States, Canada, Sweden, New Zealand and the UK to demonstrate that low income neighbourhoods tend to have poorer quality physical environments (Brainard, Jones, Bateman, & Lovett, 2002; Brulle & Pellow, 2006; Bullard, 1983; Chaix, et al., 2006; Jerrett, et al., 2001; Pearce & Kingham, 2008). In most countries, environmental characteristics such as air

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pollution, climate, noise, flooding, location of industrial facilities and provision of green space all tend to be distributed to the benefit of more socially advantaged neighbourhoods. Various explanations for the social distribution of environmental goods and bads have been implicated including: the unequal capacity to influence decision making processes such as the investment in environmental infrastructure; historical trends in industrial development, labour markets, suburbanisation and segregation; and economic restructuring including the accompanying organisational shift in the production of pollution (Morello-Frosch, 2002). Given that there is a burgeoning literature documenting the geographical distribution of health-related environmental attributes, it is perhaps surprising that few studies have evaluated the implications of unequal exposure to characteristics of the physical environment for inequalities in health status. A notable exception has been the North American literature considering the role of exposure to air pollution in establishing and maintaining inequalities in pollution-related health outcomes (e.g. Jerrett, et al., 2004). Nonetheless, despite calls in the literature (Evans & Kantrowitz, 2002) there has been less consideration given to detailing the spatial distribution of multiple features of the physical environment, and the health implications of exposure to multiple environmental deprivation. Whilst there are numerous examples of area-level measures that capture multiple dimensions of the social environment, including some that include a physical environment domain, the constituent variables are not selected exclusively for their health relevance. To our knowledge there have been no attempts to develop a health-specific multiple environmental deprivation index. We define multiple environmental deprivation as a concept analogous to multiple socioeconomic deprivation: it relates to the health-damaging confluence of various pathogenic environmental conditions as well as the absence of salutogenic environmental conditions.

In our recent work in the UK we began to address this research niche. We examined how multiple features of the physical environment act simultaneously to influence geographical differences in health. We developed a UK-wide area-level measure of multiple environmental deprivation that was akin to the various measures of the social environment (e.g. the Carstairs Index, the Townsend Index, or the New Zealand Deprivation Index) that summarise key social concepts such as income, unemployment and social class. Rather than measuring the social environment, the newly created index captured a combination of both pathogenic and salutogenic environmental characteristics for small geographical areas (UK Census Area Statistic wards; $n = 10,654$, average population = 5518). The Multiple Environmental Deprivation Index (MEDIX) combined area-level data on the relative levels of exposure to air pollution, cold climate, industrial facilities, green space and UVB radiation into a single value for small geographically-defined populations (see Richardson, Mitchell, Shortt, Pearce, & Dawson (2010) for further details). We appended MEDIX to a measure of area-level social disadvantage and individual-level mortality data and assessed firstly whether multiple environmental deprivation was unequally distributed across areas differentiated in terms of social deprivation, and secondly the extent to which inequalities in mortality in the UK were explained by differential exposure to multiple environmental deprivation. We found firstly that residents of socially disadvantaged places face higher levels of multiple physical environmental deprivation (Pearce, Richardson, Mitchell, & Shortt, 2010). Further, after adjustment for key confounders (age, sex and income deprivation) multiple environmental deprivation had a significant association with health and health inequalities (Mitchell, Richardson, Pearce, & Shortt, 2011). We argued that such measures have significant potential in assisting researchers and policymakers to better understand the role of the

environment in shaping health outcomes. It is therefore useful to test whether it is feasible to apply these new methods in different national contexts. Further, if it is possible to develop measures of multiple environmental deprivation elsewhere then it is important to examine whether environmental disadvantage exhibits a similar socio-spatial arrangement and has associations with health that are consistent with the UK findings.

In the current paper, we test the transferability of our earlier UK research to an alternative national context. We apply methods that are comparable to our UK work to develop a measure of multiple environmental deprivation for small areas across New Zealand. We employ New Zealand as an exemplar comparator because, similar to the UK, it is a country with significant and increasing spatial inequalities in health. Regional inequalities in life expectancy increased by approximately 50% over the 1980s and 1990s (Pearce & Dorling, 2006). Further, the unequal distribution of environmental characteristics that potentially affect health to the disadvantage of deprived communities has been noted. For example, air pollution levels and contaminated sites have been found to be distributed in this way (Pearce & Kingham, 2008; Salmond, Howden-Chapman, Woodward, & Salmond, 1999), although for other environmental characteristics such as beaches and usable green space the opposite social gradient is apparent (Pearce, Witten, Hiscock, & Blakely, 2007; Richardson, Pearce, Mitchell, Day, & Kingham, 2010). To consider whether multiple environmental deprivation is socially and geographically distributed in a similar way to the UK, we examine the relationship between the New Zealand measure and an area-level measure of social disadvantage. We then evaluate whether multiple environmental deprivation is related to health.

Methods

This study was completed in five stages. First, to inform our choice of environmental variables, we reviewed the national and international literatures to identify attributes of the physical environment that were pertinent in influencing health in New Zealand. In the second stage we acquired relevant spatial datasets relating to the physical environment. The relationship of these environmental attributes with health was confirmed in stage three. Fourth, we constructed our index of multiple environmental deprivation and then finally evaluated whether the index was associated with health in New Zealand. We detail the steps taken below.

Stage 1: identifying health-relevant dimensions of environmental deprivation

Given the limited quantity of evidence in New Zealand we drew on a combination of national and international research findings to identify characteristics of the physical environment that were pertinent for explaining geographical differences in health. We augmented our UK-based review of the environment and health literature (Richardson, Mitchell, Shortt, Pearce, & Dawson, 2009) in order to identify additional factors that may have relevance in the New Zealand context. We searched literature databases for health-relevant environmental factors (see Richardson et al. (2009) for more details). For each factor identified, evidence of health effects was appraised based on prevalence of the health outcome(s), rigour of the study design, and the strength of association established. For population health relevance we required that at least 10 percent of the New Zealand population were exposed to each environmental factor; the environmental factors that did not meet this threshold were excluded from our analyses. Four New Zealand-specific factors were identified by our literature review, however none of these satisfied the inclusion criteria and were therefore excluded

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