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Research note: Natural environments and prescribing in England

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HIGHLIGHTS

- All-cause mortality was lower in areas with higher density of natural environment.
- The association was strongest in the most deprived areas.
- Cardiovascular prescribing was positively associated with natural environment.
- Non-significant negative association for anti-depressant prescribing.

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ABSTRACT

Studies using routinely gathered data increasingly show associations between area-level green space and health. However, the environment exposure measures often include only urban green space and there has been limited use of prescribing data as a proxy health indicator. This brief report presents a small-area ecological study of associations between natural environment (including private gardens and water) and the volume and cost of prescribing for cardiovascular conditions and depression in England, with confirmatory analysis using all-cause mortality (in adults aged 15–65 years). Using Besag, York and Molliè (BYM) models to adjust for known confounders and unaccounted-for spatial autocorrelation, we found a statistically significant association of lower mortality in areas with higher area density of natural environment, which was strongest in more deprived areas. There was some evidence of a positive association between cardiovascular prescribing and area density of natural environment, with a non-significant trend towards lower anti-depressant prescribing in areas with higher natural environment density. Apparently beneficial relationships between all cause mortality and natural environment were not observed for prescribing data, but we advocate further exploration focusing on prescribing for mental health and other conditions with plausible links.

1. Introduction

There is broad consensus that exposure to nature is beneficial to human health (Hartig, Mitchell, De Vries, & Frumkin. 2014). Epidemiological studies using routinely gathered datasets have shown beneficial associations betweeen area-level green space exposure and mortality, morbidity and self-reported health (Maas, Verheij, Groenewegen, de Vries, & Spreeuwenberg, 2006; Mitchell & Popham, 2007), mental health (Gascon et al., 2015; White, Alcock, Wheeler, & Depledge, 2013), and health inequalities (Mitchell & Popham, 2008).

In the UK, there are many datasets and indicators that can be used to investigate the health-green space relationship (Park, O'Brien, Roe, Ward Thompson, & Mitchell, 2011). In most cases natural environmental exposure measures have been limited to

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urban green space and usually excluding private gardens, with some exceptions (White et al., 2013). Scope for detailed characterization of the natural environment on a national scale is somewhat limited by the available data. But there is reason to explore more inclusive definitions of natural environments given the growing evidence for health benefits of passive contact with nature (e.g., having a view of nature from your home), gardening (Annerstedt & Währborg, 2011), and some evidence and growing interest in the health benefit of exposure to natural water environments (or 'blue space') (Völker & Kistemann, 2011; Wheeler, White, Stahl-Timmins, & Depledge, 2012).

With respect to health indicators, there has been little analysis of prescribing levels in relation to natural environments. In 2011, national prescribing data were made publically available at general practice level, reporting the amount and cost of prescriptions aggregated by British National Formulary (BNF) code. An early published analysis of medications for diabetes and attention deficit hyperactivity disorder were compared with disease incidence (Rowlingson, Lawson, Taylor, & Diggle, 2013). The authors concluded that data could be mapped for meaningful observation of geographical disparities in the level and associated cost of prescribing. Subsequently, Taylor et al. (2015) reported a significant, albeit weak association, linking a higher volume of street trees with fewer anti-depressant prescriptions across 33 boroughs of London. This, again, provided useful proof of concept evidence with a relatively specific natural environment measure, but was limited to a small number of data points. So further exploration of prescribing data in relation to natural environments is warranted.

The present study selected prescribing data for two condition types, cardiovascular conditions and depression, to explore possible associations with natural environment at small area-level. These were selected given the biologically plausible associations of cardiovascular and mental health with natural environment, which have been shown in some previous studies (outlined above). Moreover, they provide examples of prevalent mental and physical health conditions with considerable associated health service costs. Our specific aims were to: (i) confirm the previously reported area-level green space-all-cause mortality association for England (Mitchell & Popham, 2008) using natural environment indicators that included private gardens and blue space; (ii) explore associations with volume and cost of prescribing for cardiovascular conditions and depression. This work was undertaken as part of the FP7-funded PHENOTYPE project (Nieuwenhuijsen et al., 2014). Ethical approval was granted by the University ethics committee.

2. Methods

2.1. Natural environment exposure

Natural environment exposure was generated from the Generalised Land Use Database (GLUD) 2005 (Communities and Local Government, 2005). The GLUD reports the total area of land use in broad categories, including green space, woodland, farming and agricultural land, residential gardens and water bodies (blue space). These categories were used to generate the primary natural environment exposure indicator, *Green/Blue* (all natural land, including residential gardens and blue space), which was in keeping with the broad definition of natural environment within the PHENOTYPE project. Another exposure indicator, *Green* (including residential gardens, but not blue space), was used for sensitivity analysis to explore the contribution of blue space. Both were negatively correlated with all-cause mortality (*Green/Blue* $r = -.210$, $p < .001$; *Green* $r = -.209$, $p < .001$).

2.2. Prescribing data

All data and associated analyses were performed at Lower Level Super Output Area (LSOA) level, where mean LSOA population size is approximately 1600 people, and mean area size is approximately 88 ha and 1819 ha for urban and rural LSOAs, respectively. Data on the number of items (or volume) and cost of items prescribed for the 12 months of 2011 were downloaded from the Health and Social Care Information Centre (HSCIC) website (http://www.hscic.gov.uk/gpprescribingdata) for two British National Formulary categories (http://www.bnf.org/bnf/index.htm): (i) cardiovascular (2.1–2.13), such as medications for hypertension and heart failure, anti-anginal drugs, anticoagulants, antiplatelet drugs, and lipid-regulating drugs; (ii) antidepressants (4.3). Actual Cost, not the Net Ingredient Cost data were used. Rather than reflecting just the basic price of a drug, Actual Cost includes dispensing costs, fees and discounts.

Data are available at general practice level. To allocate practice level data to LSOAs for analysis with natural environment data, a lookup table was created. It was derived from three years of Hospital Episode Statistics (HES) data, but excluded any LSOA from a practice if it contributed less than 2% of the total practice population. Re-distribution of prescribing data to LSOAs was tested using actual patient addresses that were available in one city (with 55 general practices) and showed good agreement ($r = .897$), suggesting appropriate allocation of data to LSOAs. LSOA population data for 2011 used revised boundaries from the 2011 Census whereas the HES lookup Table used the previous version of LSOA boundaries from the 2001 Census. Only LSOAs that have remained the same, split or been merged were included, which provided a total of 32,250 LSOAs for analysis of prescribing data. The number (or volume) of prescriptions and associated costs per head of LSOA population were used.

2.3. Mortality data

We obtained anonymized, individual mortality records from the UK Office for National Statistics and extracted those aged 15–65 years, approximately equating to the adult working population. The records covered every death registered in England in 2011, with age at death and sex, and linked them to the LSOA of residence based on postcode. Data were used to generate Standardised Mortality Ratios (SMR, all-causes) for each LSOA.

2.4. Confounder variables

A number of other variables were used to adjust for other plausible influences on mortality and morbidity using a similar approach previous green space-mortality analysis (Mitchell & Popham, 2008).

2.4.1. Deprivation

Three sub-domains of the Index of Multiple Deprivation (IMD) used were: income deprivation; education, skills, and training; and living environment, which includes housing condition, lack of central heating, air quality and road traffic accidents (Communities and Local Government, 2010). For stratified analysis, income deprivation tertiles were used, where 1 = least deprived and 3 = most deprived tertile.

2.4.2. Urbanicity

A dichotomous urban/rural classification was used to classify LSOAs as urban (settlements with >10,000 residents) or rural (town and fringe; villages; hamlets and isolated dwellings) (Bibby & Brindley, 2013).