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A neighbourhood level mortality classification of England and Wales, 2006–2009

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ABSTRACT

The paper provides an overview of a neighbourhood level classification of mortality for England and Wales (2006–2009). Standardised mortality ratios for 63 causes of death were calculated for middle super output areas (weighted by prevalence). A *k*-means partitional method was used to classify the data. An eight cluster solution was found to best segment mortality patterns. Clusters mostly differentiated in terms of prevalence, however the importance of neurodegenerative diseases and causes related to unhealthy behaviours were important. The results describe a neighbourhood classification that can be an important tool to help inform policy development, resource allocation and targeting of services.

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1. Introduction

Although health is an individual level outcome, there is long-established evidence of geographical inequalities and patterns in health being found to be independent of individual-level explanatory factors (Diez Roux, 2001; Thomas et al., 2010). Evidence has also shown that neighbourhoods can have an influence on individual health, through mechanisms such as the effects of living in areas of deprivation, geographical influences on social relations or the accessibility to services (Pickett and Pearl, 2001; Riva et al., 2007; Diez Roux, 2001). It is useful to examine the differences in health between places rather than just to assume that space is a passive factor that acts as a container for the existence of individuals who do not interact with people in the areas in which they live (Harris et al., 2005). Assuming any country to be spatially homogenous would restrict our understanding and ignore the geographical patterns that have been found to exist amongst the complex array of health patterns. It is through place that the underlying structure which differentiate the health and death of the population become most visible.

The importance of place provided to incentive for this study to develop novel approaches to measure and summarise the multiple geographies of health. Designing useful small area measurements of health is important for developing and targeting effective policies aimed at improving health. Previous approaches have focused on either geographical or socio-economic measures to group or define areas. These approaches allow the linkage to ecological attributes that help develop our understanding of how health outcomes occur. There has been less consideration of how the health characteristics of small geographical areas could be used to group areas to summarise their geographical patterning.

Geo-demographic classifications have sought to categorise areas in terms of the types of individuals that characterise them (Vickers and Rees, 2007). Their popularity has seen the field develop into a multi-million pound industry with their resulting software tools being used in many commercial and public sector organisations (Harris et al., 2005). There has been less consideration of their application in the field of public health, beyond using geo-demographic classifications to identify population subgroups (Abbas et al., 2009; Nnoaham et al., 2010). This is despite calls for greater focus of such techniques within governmental policy and research in the field of public health (Department of Health, 2005). The few that have tackled the field have been limited in scope. For example, (Shelton et al. (2006)) area classification was conducted at a large geographical scale (parliamentary constituency), resulting in a loss of the wider variation that can be studied between smaller areas due to the coarse geographical areas used. The commercial company CACI have produced the commercial classification 'HealthACORN' as subsidiary of their main classification 'ACORN' however this is no longer available. There is currently no widely available area-based classification of mortality patterns at a small geographical scale.

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Although geographical patterns in mortality have been reported (e.g. Shaw et al., 2008), they are often not disclosed for small geographies due to the small numbers involved when considering specific causes of death (resulting in confidentiality and outlier issues). This has restricted the application of area-based classifications in the field (Abbas et al., 2009). Furthermore with a wide range of causes of death to consider, common patterns and processes found within particular groups of causes can become lost limiting our capacity to understand and analyse such information. The area classification described here addresses these issues through summarising the main patterns into a series of groups and classifying areas into which group they fall (Harris et al., 2005). It allows the discovery of a hidden structure to the data that would be otherwise difficult to see (Everitt et al., 2001). Through describing the structure of the data in a simpler form that retains the most important information, our classification makes these complex geographies of health manageable which improves our understanding about patterns and processes.

Williams et al. (2004) argue, "The drive to tackle health inequalities and the move to localised policy making have increased interest in small area mortality data." (p958). However, research has focused on analysing mortality causes independently of each other. An area classification allows a move away from one-dimensional approaches to a multi-dimensional understanding of the health of areas through summarising the main patterns across a range of variables. Knowing and understanding how causes of death vary and co-associate within an area is important for the effective targeting of policies, resources and location of services (Murray et al., 2006).

This paper details the construction of an area classification of mortality patterns in England and Wales (2006–2009). It draws from a rich database containing mortality data at a low geographical scale across all known causes of death. The results from the study will hopefully provide a useful tool for researchers and policy-makers.

2. Methods

2.1. Data

In England and Wales, it is a legal requirement to report every death. The Office for National Statistics (ONS) collects this information and collates every death into a database (Devis and Rooney, 1999; Griffiths et al., 2005). Access to an anonymised version of the database was granted to the researchers by the ONS 'Microdata Release Panel' (December 2010). The database included records for every death registered between 1981 and 2009 with data on year of death, age at death, sex, cause of death and a geographical location identifier (postcode).

Cause of death is recorded using the International Classification of Diseases (ICD), which was developed to standardise mortality statistics between countries and is updated over time to account for medical advances (Rooney and Smith, 2000; World Health Organisation, 2004). It is filled in by the doctor who last treated the deceased and records the underlying cause of death (Devis and Rooney, 1999; World Health Organisation, 2004). ICD-9 is used for the years 1981–2000 and ICD-10 for 2001–2009. We chose to focus on the time period 2006–2009 to provide enough deaths per geographical unit (MSOA) to give stable estimates, whilst not being too wide temporally to lose accuracy. There were no missing data between 2006 and 2009 for individuals aged above zero (with 30% of deaths for age zero missing).

Data coding through the ICD-10 is based upon a hierarchical classification (Devis and Rooney, 1999). Individual causes of mortality are grouped into broader ICD chapters which reflect their similarities. These ICD chapters are based on diseases of specific organs, pathology, aetiology, as well as more external causes or those related to specific time periods (Griffiths et al., 2005; World Health Organisation, 2004). Within the ICD chapters, causes are grouped by type. At its lowest level, which gives the specific type or site of a particular cause, there are over 14,000 codes (World Health Organisation, 2004). It is important to include a practical number of input variables that maintain the variation and detail in the data.

All deaths were included since no other study has carried an investigation using such small geographical areas. Little is known about how a large range of mortality variables are co-associated with each other. There is also less theoretical basis for just focusing on a few (and hence limiting our ability to describe areas; Voas and Williamson, 2001). Variable selection only included causes that contained at least 0.5% of the total of deaths throughout the study period. This choice was due to statistical reasons, since it gives a figure greater than the number of areas (0.5% deaths was 9955 and there were 7194 areas). Therefore an even distribution would at least provide more than one death in each area, in line with recommendations from the cluster analysis literature (Everitt et al., 2001; Gordon, 1999; Milligan and Cooper, 1987).

Cause of death was coded to three digits using ICD-10. Those causes above the 0.5% threshold were then included in the model. The remaining codes were then combined into relevant categories based upon their ICD-10 groupings to fulfil the same criteria. However, this resulted in four variables that contained 27 ('Disease of the Eye and Adnexa'), 77 ('Disease of the Ear and Mastoid Process'), 160 ('Causes Related to Pregnancy and Childbirth') and 63 ('Conditions Originating in the Perinatal Period') deaths each. The variables were excluded due to their small numbers. Cases with the code U50 ($n=2072$) were not included as these were cases which have been sent to the coroner pending further investigation (Rooney and Smith, 2000). ICD-10 data for data for individuals aged zero were combined into one variable for 'Infant Mortality' as 70% of individuals aged zero had cause of death data missing. The 63 variables chosen are presented in Table 1.

Individual deaths were aggregated using their postcodes to the Middle Super Output Area (MSOA) geographical scale. This was chosen as the geography is designed to be socially homogenous, the areas are similar in terms of population size (mean population size 7200) and their boundaries are designed to be relatively stable over time which is important for the application and dissemination of the classification (Office for National Statistics, 2011). The mean number of deaths per MSOA was 275.

To control for the age and sex make-up of each MSOA, the mortality data were converted into Standardised Mortality Ratios (SMRs). An indirect approach was selected as it is more stable for dealing with small numbers. Population estimates by age and sex at the MSOA level were provided by the ONS. The SMRs were weighted by their prevalence to make them more representative of the actual structure of mortality patterns (rather than each variable being of equal importance).

Data were also collected from the 2011 Census and the ONS for MSOAs to help interpret the area classification. The number of communal establishments in 2011 (e.g. nursing homes, care homes) and the net migration rate for those aged over 65 (2008–2009) were included to explore the role of movements of the elderly, which have been shown to be important previously (Williams et al., 1995). Modelled estimates of the percentage of households in an area with an equivalised income of less than 60% of the median income for England and Wales (2007–2008) was also available to explore the role of social disadvantage (Gregory, 2009).

2.2. Statistical analysis

Cluster analysis is a family of statistical methods used to group a diverse range of heterogeneous cases into a smaller number of more homogenous clusters (Gordon, 1999). Rather than test

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