

Introduction

Spatial variation in the levels of infant and childhood mortality in England and Wales in the 19th century is well-documented. The most detailed spatial analyses of nineteenth century mortality on a large scale used decennial data for the 614 registration districts in England and Wales (Woods and Shelton 1997). Another study, using the same data, explored the spatio-temporal decline of infant mortality and demonstrated different geographical patterns of decline (Gregory 2008). Even though national aggregate measures of infant mortality for England and Wales show a secular decline started at the turn of the twentieth century, the registration district level data indicate that rural areas experienced this decline much earlier –as early as the 1870s and 1880s. These rural declines in infant mortality were only later followed in urban areas, and increasing urbanisation kept national-level rates high until the turn of the century (Woods 1985). However, studies of selected smaller areas have shown that even registration districts can contain considerable variation in the risk of death due to variations in population density, occupational and industrial make-up, environmental hazards and local-disease environments (Garrett *et al* 2001, Garrett and Reid 1994, 1995, Reid 1997).

This paper will use newly generated data for infant mortality for the over c. 2,000 registration sub-districts of England and Wales to illustrate spatial and temporal variation of infant and early childhood mortality for a period from the 1850s to 1911. As described before, registration districts mask considerable differentiation in mortality levels and the use of sub-registration level mortality data will help to obtain a more detailed picture of geographical mortality patterns (see below Figure 1). This paper will also explore differences in the relationship between infant and early childhood mortality over space and time and consider different methods for estimating early childhood mortality (age 1-4) for sub-registration districts. This paper forms a part of a larger project analysing fertility decline in Victorian England and Wales (www.geog.cam.ac.uk/research/projects/victorianfertilitydecline). This project will use the own child method to estimate age-specific fertility rates for sub-registration districts and requires the calculation of early age mortality estimates for the same spatial units.

Data and Methods

The main data sources for this study are the published mortality statistics from the Quarterly, Annual and Decennial Reports of the Registrar General and the individual-level census data from the Integrated Census Microdata (I-CeM) project. This combination of mortality data is necessary because the Registrar General's statistics were not published for the same geographical units throughout the study period, nor did the details published remain the same. From 1869 onwards, deaths under the age of one were published for sub-registration districts in the Quarterly Reports. However, deaths for single years up to the age of five were published annually (up until 1881) and decennially (until 1911) but only on a larger spatial scale – for the registration districts. Therefore estimates of early child mortality for sub-registration districts need to be generated using spatial models of the relationships between infant and child mortality generated at a

registration district level. The individual-level census data for years 1851, 1861, 1881, 1891, 1901 and 1911 allow the calculation of characteristics at both registration district and sub-registration district level. Therefore, population density, different aspects of housing and occupational structure can be used as a set of 'local' factors or environmental conditions influencing the level of early childhood mortality across sub-registration districts in England and Wales.

Our modelling strategy uses ordinary least squares multiple regression models to first estimate the relationship between early childhood mortality (age-specific mortality rates) and a range of contextual variables at registration district level (including infant mortality). We control in the models for non-random spatial dependency through analysis of spatial autocorrelation of residuals (Moran's global I). The final step is to predict sub-registration district level early childhood mortality through the same relationships observed at registration district level. Due to the focus of the broader research project, and the need for childhood mortality data for the five years prior to each census year, we estimate mortality only for these years.

Preliminary Results

The preliminary results for the period 1876-1881 are presented in Figures 2-5. Observed mortality rates mapped on the figures are estimated for every registration district from Decennial Reports (1871-1880). Modelling age-specific mortality rates for sub-registration district for the first five years of life enables us to explore early childhood mortality patterns at a very fine spatial level. We are able to identify the small geographical units, generally urban areas, with high mortality rates. As expected, the model estimation fails to capture some of the registration districts with extremely high or low mortality and therefore the models under- or over-estimate some of these regional mortality rates. Significant predictive factors include population density and occupational structure. However the general geographic pattern is very well captured, particularly for age 1-2, and there is no systematic distribution of residuals. The final paper to be written and presented will extend this analysis from 1851 to 1911, which will allow us to illustrate and analyse the detailed spatial variation in infant early childhood mortality over the course of second half of the nineteenth century. We will also examine changes in the relationship between infant and early child mortality over time and space, and in the additional predictors of early child mortality.

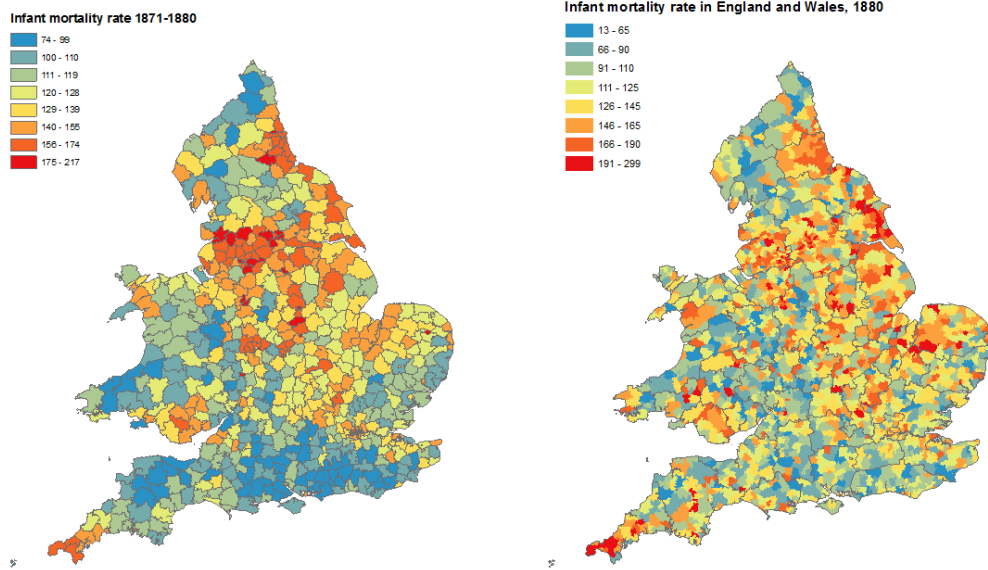


Figure 1. Infant mortality rate in England and Wales – registration district level (1871-1880) and sub-registration district level (1880)

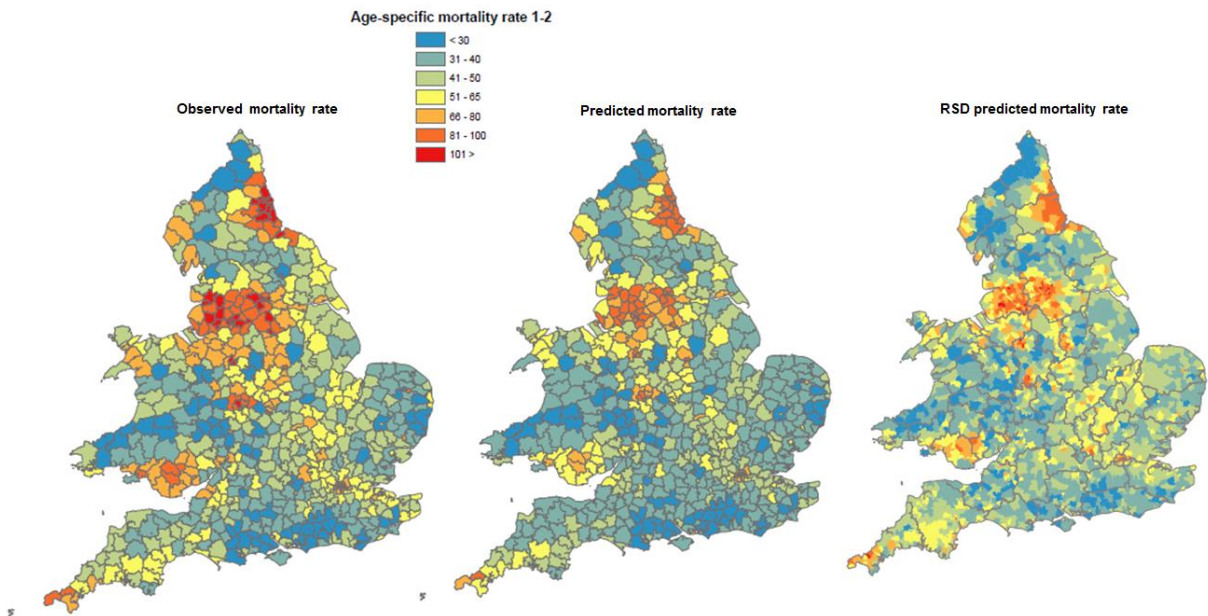


Figure 2. Age-specific mortality rate 1-2 in England and Wales, 1876-1881

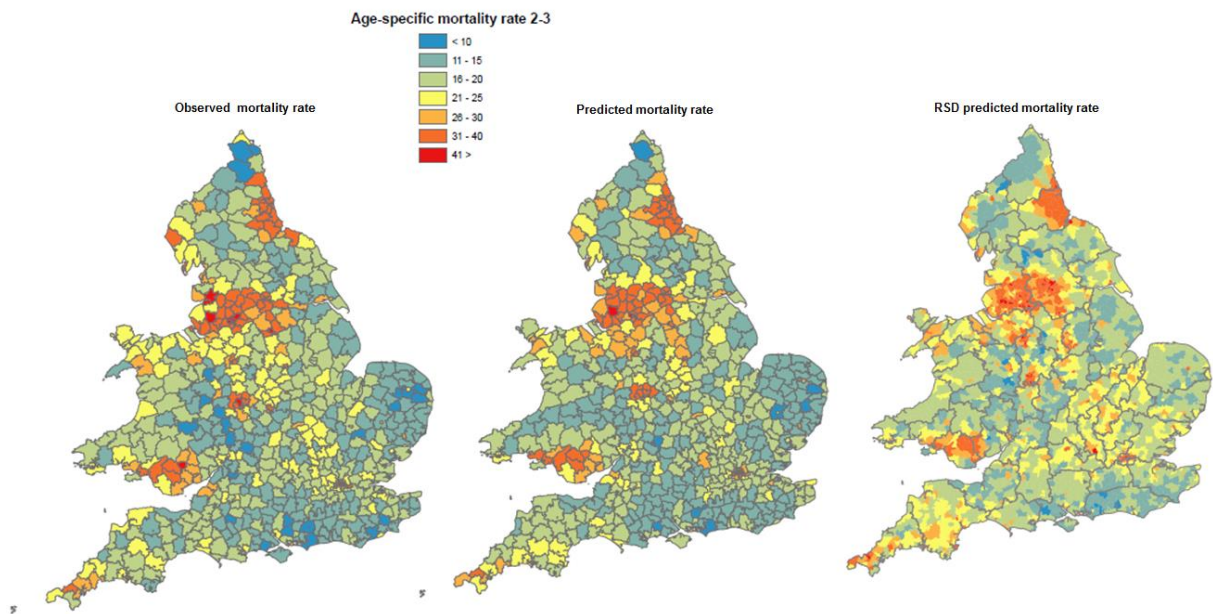


Figure 3. Age-specific mortality rate 2-3 in England and Wales, 1876-1881

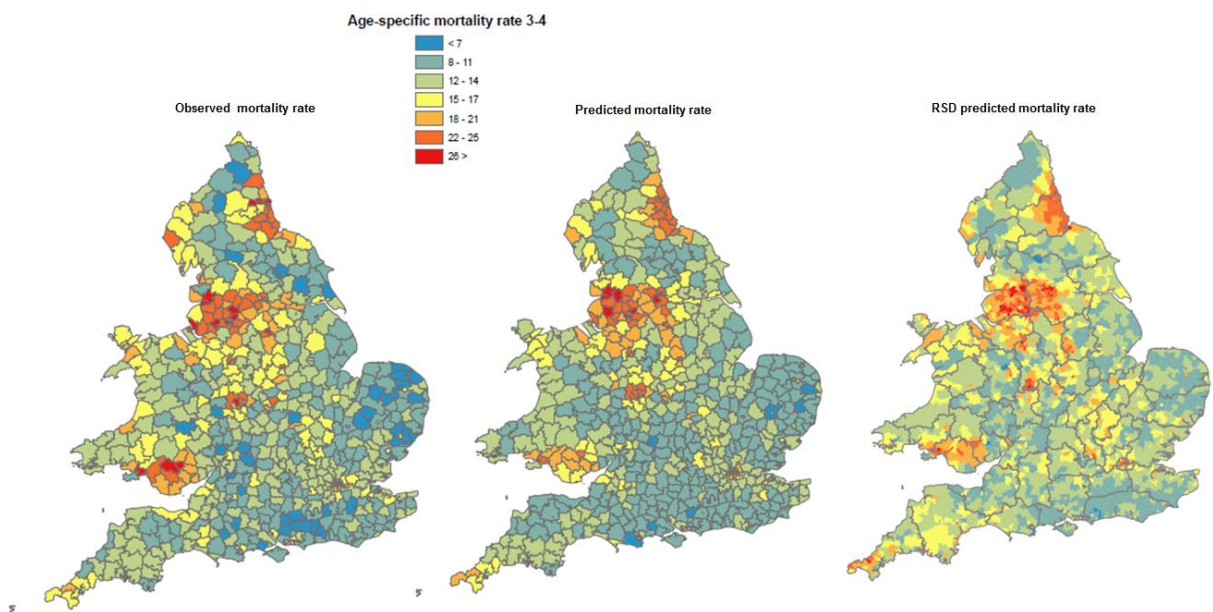


Figure 4. Age-specific mortality rate 3-4 in England and Wales, 1876-1881

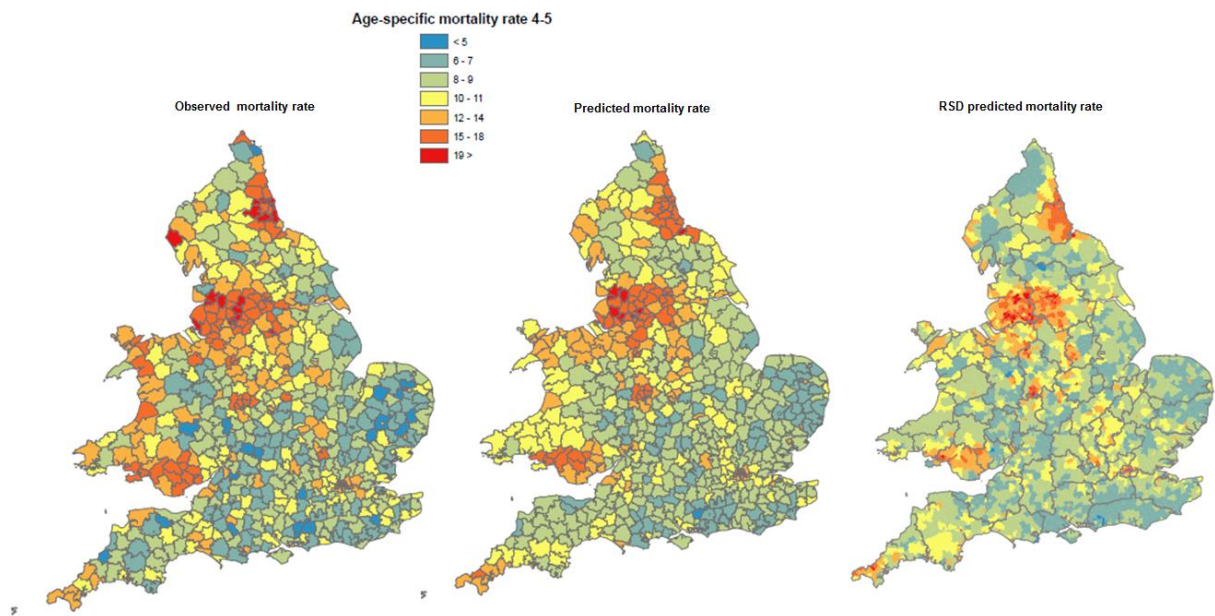


Figure 5. Age-specific mortality rate 4-5 in England and Wales, 1876-1881