Mapping Scotland’s Sickening: Using Lexis Surface Visualisations to compare mortality patterns between populations

# Abstract

# Introduction

This paper will present hundreds of thousands of mortality rates, recorded at over one hundred different ages and over more than sixty years, covering populations in Scotland and those of our nearest neighbours, and selected other populations from across the globe. However it will contain no statistical models, no tables, and very few numbers. It will do this by presenting a series of maps of demographic data, known as Lexis surfaces, which show how something – mortality rates, in this case – varies by both age and by year. Conceptually, Lexis surfaces are to population data as spatial maps are to physical landscapes: in spatial maps, the height of a landscape is shown as a function of both its latitude and its longitude; the Lexis surfaces presented here show mortality as a function of both age and of year. Mortality hazards can be thought to vary continuously over both age and year, much as height varies continuously with both latitude and longitude. And just as it usually makes little sense to try to understand the height of physical landscapes only as a function of their latitude or longitude alone, so this paper will argue that important patterns and features in mortality landscapes are often missed when public health research aims to understand population health, and differences between population, by looking only at how mortality risks vary as a function of age or time alone.

A life expectancy is a common way that many individual age-specific mortality risks are summarised as a function of year alone. Life expectancies are important summary statistics, and show that, on average, one population tends to live less long than another population in a given year. It is known, for example, that the general trend has been for life expectancies to have increased in richer countries for more than a century. (Leon, 2011) Plotting life expectancies against time for many populations can also show how both relative and absolute inequalities can increase despite outcomes improving for everyone, but at a faster rate for some populations than others. For example, life expectancy at birth, for countries submitting data to the Human Mortality Database (HDM) tended to increase faster for females than males for much of the Twentieth Century, leading to a gap in life expectancy by sex opening up until the 1970s, before starting to narrow again in more recent decades, in large part due to falling rates of cardiovascular disease death in men over 60 years of age. (Glei & Horiuchi, 2007; White et al., 2014) Similarly, much of Scotland’s partly deserved status as ‘Sick Man of Europe’ is due to its life expectancy trends improving more slowly than those of European neighbours, rather than falling in absolute terms. (McCartney, Walsh, Whyte, & Collins, 2012; Whyte & Ajetunmobi, 2012)

## Scottish Disadvantage

### Age groups

#### Older Age

#### Younger Age

## Healthy ageing

### Compression of Mortality

### Compression of Morbidity

## Life course

### Life course stages

#### Infancy

#### Adulthood

#### Senescence

### Barker & Critical Period

## Different model types

### Life Expectancies

#### Conditional and Unconditional

#### Period or Cohort

#### Extrapolation if Cohort

### Life course structures

#### Gompertz

#### Gompertz-Makeham

#### Siler

#### Non-Parametric

#### Heligman Pollard

### Drift Models:

#### Lee-Carter

#### Quasi-Spatial (Girosi & King)

## Lexis surfaces

### Concept

### Origins

### Applications

### Variants

## Ways of Reasoning about data

### Reasoning: Inductive, Deductive, Abductive

### Case-based and variable-based

### Lexis surfaces as case-based approach

## Aim

### Use Lexis surfaces to apply case-based reasoning to populations, and population comparisons

### To understand accumulation of Scottish disadvantage over the life course

### To understand additional selected phenomena

# Methods

## Source of data

## Preparation of Data

### Unsmoothed

## Choice of Colour Schemes

### SLP

#### Paired Colour scheme

### CLP

#### Balanced Colour: Magnitude and Colour

# Results

## Lexis Plots of the British Isles

## Comparative Level Plot: Scotland and its Neighbours

## Lexis Plots of other populations

## Comparative Level Plots: Selected Other Populations

# Discussion

## Implications for Practice

### Conclusions regarding Scotland

### Conclusions regarding other countries

## Implications for Research

### Case-based reasoning

### Modelling approaches

### Lexis surfaces in an abductive research workflow

### Interactive Lexis surfaces

## Final summary