# Manuscript

## Opening Page

### *Title.*

Europe’s Demographic Scar: Long-term Mortality Effects of World War One and the 1918 Influenza Outbreak revealed through Contour Plots

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## Abstract

## *Highlights*

## *Keywords*

### 1918 Influenza Pandemic

### Post-war recovery

### Contour plots

### Cohort effects

### Demography

## *Introduction*

## *Material and methods*

## *Theory/calculation*

### *Theory*

### *Calculation*

## *Results*

## *Discussion*

## *Conclusions*

## *Acknowledgements*

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# Notes

## 1918 Flu

### Worst of 20th century

## Main finding

WW1 cohort

cohort born immediately following World War 1 and the 1918 Influenza experienced higher death rates in older age than people born in the years before or since.

The initial dip was equivalent to around five years in most datasets.

Differences between nations

### Sawtooth in some nations (slow recovery?)

### V-shaped in other nations.

### Distinction between v-shaped and sawtooth-shaped recover patterns

#### v-shaped recovery patterns?

##### Faster recovery

##### Western European nations?

#### Sawtooth-shaped recovery patterns?

##### Eastern block countries?

Epigenetic Effects

### 1944 Dutch famine

#### Epigenetic predispositions

#### Obesity, diabetes etc

#### Thrifty metabolisms

#### Morbidity and mortality

## Barker Effect

### What is Barker Effect?

#### A type of cohort effect

#### Interuterine exposure to [?] leads to [?]

#### References?

#### Origins?

#### Challenges to Theory?

### Reasons why consistent with Barker Effect

#### 1918 Flu; interuterine exposure; widespread & lethal pandemic

### Reasons why not consistent with Barker Effect

#### People born quite a few years after 1918 had a similar mortality pattern. Recovery was slow rather than immediate.

The effect persisted for many years in a number of nations, indicating that the effects were not just due to interuterine exposure to influenza, but to broader structural and epidemiological factors.

There is some evidence of a similar, but less severe, cohort effect relating to WW2, suggesting the causes of the cohort patterns are broader than interuterine exposure to infectious disease.

#### Effect of war/destruction more generally?

## Aim of research

### To present complex patterns of mortality from a large number of countries over a very long period of time.

## Contour plots showing age trends

## Problems with standard approaches

### Life expectancy largely dependent on extrapolation assumptions

#### What if there are changes in the fundamentals?

#### Age of death reflects historical demographic patterns and conditions (looking backwards not forwards)

#### Using only expectations it’s not possible to know how typical averages are.

##### Showing variances (upcoming article) provides some indication of this, and could substantively be interpreted as ‘life riskiness’.

##### However, risks are not uniform across the life course.

##### A pair of sharp bimodal spikes may have the same variance as a less sharp unimodal distribution.

## Main areas:

### *Demography*

### *Health*

#### Barker Effect?

### *Statistical visualisation*

## Data used

### population sizes and deaths

### for each of 48 population datasets comprising 40 distinct countries.

#### Counting England & Wales as a single nation.)

### downloaded from the Human Mortality Database,

### Files

#### ‘Deaths\_1x1.txt’

##### Numerator

#### ‘Population.txt’

##### Denominator

## Used to produce numerator and denominator information, respectively, to produce a death rate matrix with age on one axis and year on the other.

### Values calculated simply by dividing age-year specific numbers of deaths (numerator) age-year specific by population size (denominator).

## Age curtailed at 90 years

### Small population size at these ages

### Data imputed beyond 80 years in any case

## Results calculated

### Death rate matrices

#### Age on y axis

#### Year on x axis

### age- and year- specific death rates

### males and females separately and These included both European and non-European countries. Initial years ranged from 1751 (Sweden) to 1992 (Chile). Final years ranged from 2005 to 2009.

### [Total number of observations within each dataset?]

#### Lives

##### From n=19,544,941 (Luxembourg)

##### To 15,705,173,122 (USA)

#### Deaths

##### From n = ? (which country?)

##### To N = ? (Which country?

### For each of the 48 sets of data,

#### Data beyond age 80 largely imputed.

## Details of statistical approach

### Countourplot function

### Lattice package

#### Reference to author

### In order to show trends towards reduced death rates in middle age, a large number of contour lines (100 cuts; default is 7) were used.

#### Something about what contourplots do? [ref to description?]

#### [Ref to lexis plots?]

## Arrays

### Three dimensional data

#### x : year

#### y : age

#### z : mortality rate

## Visualising arrays

### Simplest: Just present the numbers themselves

### Heat maps: substitute numbers for colours

#### Direct: each value is mapped to a unique colour

#### Indirect: numbers categorized (for example by decile), then each category mapped onto a colour

##### Example: <http://esa.un.org/wpp/Model-Life-Tables/figures/lexis-diagrams.htm>

### Contour plots

#### Categorisation and interpolation

#### Number of ‘cuts’ defined first

#### Positions where each cut exists then determined using interpolation procedure

#### Points estimated to have the same value are joined to form lines

### Level plots

#### Areas between cuts are given the same colour

### Isometric plots

#### Terrain plots

## Represent one contour plots as a terrain plot

### Use fig 13.7 as template <http://lmdvr.r-forge.r-project.org/figures/figures.html>

## Reasons why contour plots used

### Compared with heat-map approach

#### Although data are presented discretely, the phenomena are continuous

#### People are born and die at any time of the year, not just at the start of the year and/or at their birthday.

### Rather than level plot

#### Easier to see pattern

#### Cheaper to print & more accessible to colour-blind (black & white)

## Ways of identifying patterns

### the effect of age on mortality

#### Look horizontally across maps

### general trends

#### Consider how contours gradually shift upwards or downwards over time

### Acute trends

#### Look for vertical ‘distortions’ within the maps

### Cohort effects

#### Diagonal patterns

##### running forwards at an equal rate across both the vertical and horizontal axes.

## General trends

## Appendices

### Full series of maps

#### Lower ‘resolution’ contour plots (50 cuts)

### R code

### Acknowledgement of sources

## Table summarizing datasets

### Country

### First observed year

### Last observed year

## Reasons for ‘messiness’ of very old data

### Artefact reasons

#### Small sample size (smaller population size)

#### Less effective data collection

### Genuine reasons

#### Infectious diseases

#### Wars

#### Greater mortality throughout lifecourse

## Sources of data

### Direct

#### Human Mortality Database. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at [www.mortality.org](http://www.mortality.org) or [www.humanmortality.de](http://www.humanmortality.de) (data downloaded on [date]).

### Uses a combination of data from original sources and some imputations.

### Indirect

#### from MANY sources.

### Example, description

#### Present in data from both East Germany and West Germany, despite being collected independently of each other, and subsequently experiencing very different environmental conditions.

## First available year on record

### Records dating back to before 1918

#### Direct and cohort effect observable

### Records after 1918

#### Cohort effect observable

## Identifying origins of cohort effect

### Trace diagonal scars back to age = 0

### points to around about 1919-1920,

#### suggesting that children born soon after WW1 grew into adults who had slightly but noticeably elevated mortality rates at older age.

#### Something that occurred in the first fifth of the Twentieth Century seems to have left a slight demographic tremor that lasted until the start of the 21st century.

## WW2 implications

### Will parallel demographic scars emerge?

## Description of selected countries

### European Countries

#### Western European Nations

##### England & Wales:

Like France, data for these nations are available for a long time period,

and show evidence of both

a turbulent history marked by wars and other major events, and

a significant general improvement in mortality patterns.

Major deleterious events are notable around 1850 and 1890,

in terms of vertical distortions around these years,

but cohort effects relating to these events are harder to gauge.

In terms of death rates,

WW1 appears to have had a much more severe effect than WW2,

with a characteristic spiking up of mortality rates in early adulthood

(noticeably beginning around the age of 18, as should be expected) and carrying on until middle age.

Infant mortality rates are also higher during these years.

A cohort pattern emerges for the 1920 cohort from about the years 1960 onwards.

Any signs that children born at the end of and during WW2

is harder to discern among natural variations in death rates,

though may become clearer to discern in coming years.

##### Spain:

Given the 1918 flu is known as the ‘Spanish Flu’, the contour maps for Spain are surprising in that they lack an obvious WW1 cohort effect in older age.

The primary effects were extremely severe, so it may be that the majority of people weakened in utero by the flu died at birth or in WW2 (when they would have been in their late teens/early 20s).

There is evidence of a substantial cohort effect with an origin around 1900.

There is also some evidence for a cohort effect with an origin around 1940.

(v-shaped notches evident from 1980 onwards in the over 40s at on the 0.005, 0.010, and 0.015 contour lines).

There is also evidence of detrimental cohort effects for a number of cohorts born before 1900, though the data are difficult to disentangle.

##### Italy.

The direct effects of both wars seem to have been particularly severe,

leading to the emergence of ‘mountains’ of high mortality emerging for persons from about the age of 18 to 30.

World War 1, in particular,

also increased mortality rates significantly at almost all ages,

as evident by the near-vertical route taken by many of the contour lines at these ages.

A characteristic v-shaped cohort effect is evident,

first seen in the 0.005 mortality line soon after 1960 and 40 years of age.

The gradient of these contour lines at older ages appears greater after the WW1 cohort than before, suggesting the rate of improvement in general health increased after WW1.

There is some evidence that a smaller WW2 cohort effect,

with an origin around 1940, has started to emerge, as evidenced by a slight dip in the 0.005 contour line around about the year 2000.

However, it may be too early to tell whether this is a genuine cohort effect or just natural variation.

##### France:

As with other data with long-term historic data, there is evidence of a significant general improvement in mortality,

as evidenced by the migration of the 0.005 contour line from the late teens to the over 40s.

There is evidence of a turbulent history marked by a number of events which increased mortality in the population at large,

in particular men in their early 20s.

These include

events around 1850, 1860 and in particular 1870 (Franco-Prussian War).

Each of these were of increasing severity, and leaving noticeable cohort effects,

evidenced by diagonal ripples which are evidence at older ages between around the 1930s to the 1970s.

The primary effect of WW1 was very severe, but

also slightly unusual in that it appears to have two peaks, separated by around three or four years,

as evidenced by the spiked contour patterns at in babies and infants around that time.

This bimodal pattern is to an extent echoed by a double-v shaped cohort effect,

with the contours lines declining not just once but twice, with the second decline more severe than the first.

There is some possible evidence of a WW2 cohort effect, evident of a slight dip in the 0.005 and 0.010 contour lines for people aged more than 40 years and from around 1990 onwards.

#### Eastern Block Nations

##### The Czech Republic

this data also has a noticeable cohort effect dating back to WW1.

Unlike most other European nations, however, this time also seems to have marked a change for the worse in the fundamentals,

with contour lines after this cohort remaining lower than those before for a number of decades,

so that what looks v-shaped for many other affected countries looks more like a saw-tooth for this country.

##### East and West Germany:

Although these data do not date back to WW1 or before, the division of Germany into separately administered East and West German nations has, from a demographic perspective, the upside of demonstrating that the WW1 cohort effects were present even when recorded by two very distinct administrations.

It also provides some evidence of the effects of each nation’s creation on people who lived through the changes, and were born following it.

The longer-term public health effects can be assessed by comparing the trends in contour lines in each dataset, providing

another source of evidence for comparing the effectiveness of ‘communist’ and ‘capitalist’ regimes.

The hardships involved in establishing East Germany can also be inferred, by comparing the shapes of the 0.005 and 0.010 contour lines from around 1990 onwards.

In the case of East Germany,

there is a noticeable and substantial dip, beginning after WW2 and lasting for around 5 years,

suggesting the creation of the regime had a detrimental impact for children born at that time.

For West Germany

no such dip is apparent,

suggesting the experience of West Germans after World War 2 was less turbulent than for East Germans.

### Non-European Countries

#### Anglophone countries

##### USA

##### Canada

###### largely insulated from the effects of both WW1 and WW2,

###### shows no obvious cohort effects.

###### It is possible (remains to be tested formally) that there is a subtle effect, and that the gradient in mortality improvement increased following the 1920 cohort.

#### Non-Anglophone countries

##### Japan

Like the USA, and Canada, Japan largely avoided WW1 and the 1918 Flu,

so there is no obvious cohort effect resulting from this.

However, Japan is unusual

in terms of its rate of development over the course of the 20th Century.

A number of diagonal cohort ripples appear to exist dating back to various points in the first half of the 1900s and perhaps even the late nineteenth century, though the data are not available before 194X.

Although only evident in data from around 2000 onwards, a noticeable cohort effect seems evident from near the end of WW2.

## In this paper, we use contour plots

## 48 sets of records

## from 40 countries to

## produce death rates for all reported years, and

## from birth to 90 years of age.

## , we present this information graphically, revealing a significant cohort effect for people born immediately after the Great War /1918 Influenza pandemic within most European countries. This is consistent with the Barker effect, and indicates that the demographic scars of the pandemic persisted into the 21st century.

## Further research

### To identify duration of cohort effect

### To identify differences between country in terms of years taken to recover, and differences between high and low recovery duration countries

### To attempt to distinguish between effect of pandemic from war more generally.

### To quantify size of mortality effect on average and in a range of countries.

### To identify whether effect begins in exactly the same year in all countries, or whether the start occurred later in some countries than others.

### To repeat the analyses in coming years to see if a similar effect will emerge for WW2 cohort

### To identify possible implications for pensions, medical care etc.

### To review evidence of increased morbidity among this cohort.

### To estimate how many ‘lost years’ have resulted from this cohort effect; also estimate economic costs (and perhaps ‘benefits’ in terms of pensions).

### Why France exhibited a ‘double dip’ primary effect and cohort effect.

### To examine reasons for the mortality differences between the cohorts born during the establishment of East Germany and in West Germany, and to see if East Germans within this cohort also had higher morbidity than West Germans from the same cohort.

## WW1/ Flu left a significant demographic scar in at least [how many?] countries in Europe which were still present into the 21st century.