

Cause of Death Mortality: International Trends by Socio-Economic Group

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Joint work with C. Redondo, D. Blake, K. Dowd, M. Kallestrup-Lamb, C. Rosenskjold

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Outline

- Motivation and long term goals
- Data
- Comparison of US, Denmark and England
- US: deeper dive; cohort effects

Purpose of looking at cause of death data

- What are the key drivers of all-cause mortality?
- How are the key drivers changing over time?
- Which causes of death have high levels of inequality:
 - by education;
 - by affluence?
- Can we point to specific causes of death as responsible for *growing inequality*?
- **Leading to:** insight into mortality underpinning life insurance and pensions



- Medical advances
- Health spending
- Public health initiatives
- Individual risk factors:
 - Controllable
 - e.g. smoking, diet, exercise, alcohol, sun, drugs, hygiene, risky sex, stress, environment...
 - leading to cohort effects and inequality
 - Not (easily) controllable
 - e.g. genetic, affluence, education, character/personality traits, ...

Cause of death data for:

- US (males and females)
 - by education level: low (\leq high school); high
- Denmark (males only):
 - by education level: low; medium; high (cohorts $>$ 1920 only)
 - by individual affluence: 10 deciles
- England (males and females)
 - by small area *income deprivation*: 10 deciles
 - by region: 9 areas



Cause of Death Groupings

US1.1	Infectious diseases excl. HIV/AIDS	US 1.2	HIV/AIDS
1	Infectious diseases	2	Cancer: mouth, gullet, stomach
3	Cancer: gut, rectum	4.1	Cancer: larynx
4.2	Cancer: trachea	4.3	Cancer: lung, bronchus
5	Cancer: breast	6.1	Cancer: uterus, cervix
6.2	Cancer: ovary	6.3	Cancer: other female genital
7.1	Cancer: prostate	7.2	Cancer: other male genital
8	Cancer: skin, bones and certain organs	9	Cancer: lymphatic
10	Benign tumours	11	Diseases: blood
12	Diabetes	13	Mental illness
14.1	Diseases of nervous system excl. Alzh.	14.2	Alzheimers
15	Blood pressure + rheumatic fever	16	Ischaemic heart diseases
17	Other heart diseases	18	Diseases: cerebrovascular
19	Diseases: circulatory	20	Diseases: lungs, breathing
21	Diseases: digestive (excl. alcohol: 27)	22	Diseases: urine, kidney,...
23	Diseases: skin, bone, tissue	24(DU)	Senility without mental illness
25	Road/other accidents	26	Other causes
27	Alcohol → liver disease	28	Suicide
29	Accidental Poisonings		

Detail ⇒ able to separate causes with and without significant risk factors or inequality

- US

- Deaths subdivided into 30 CoD groups
- Single ages 40-89 and *born between 1914 and 1970*
- Single years 1989-2015

- Denmark

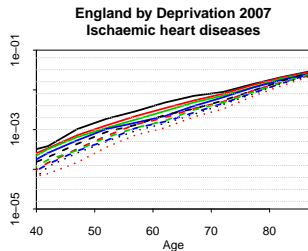
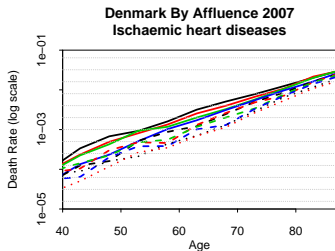
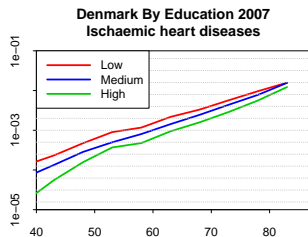
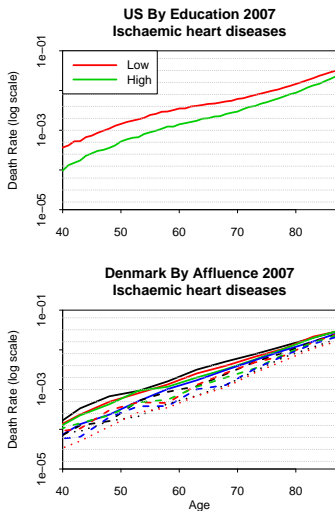
- 29 CoD groups
- Age groups 31-35, 36-40, ..., 91-95
- Five-year blocks 1985-89, 1990-94, 1995-99, 2000-2004, 2005-2009

- England

- 34 CoD groups
- Age groups 20-24, 25-29, ..., 85-89
- Single years 2001-2016



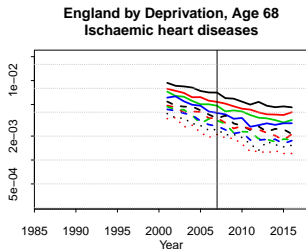
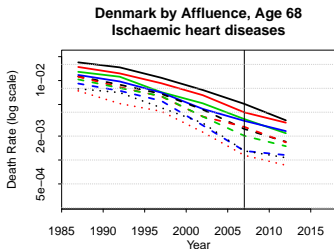
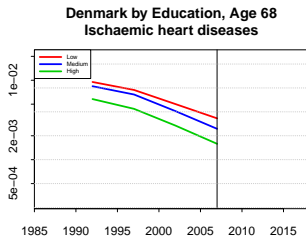
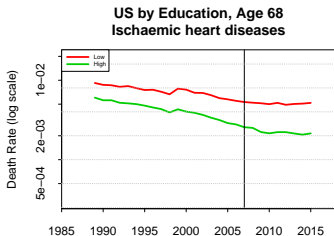
Multi-Country: Year 2007, Males, Ischaemic Heart Disease



US: slightly wider than Denmark

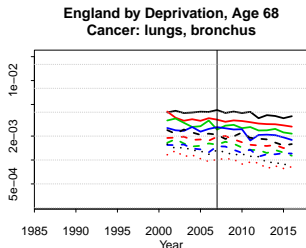
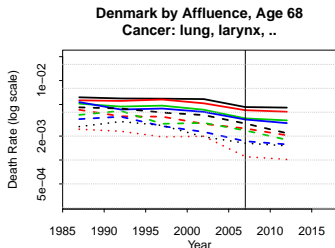
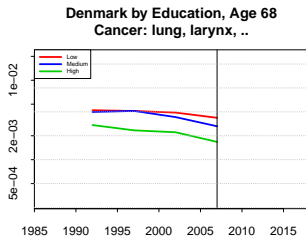
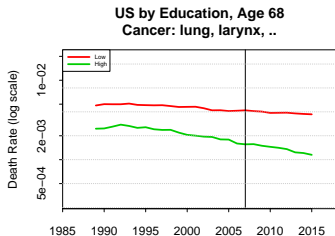
England similar to Denmark but higher

Multi-Country: Age 68, Males, Ischaemic Heart Disease



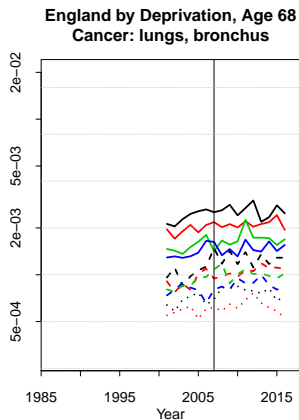
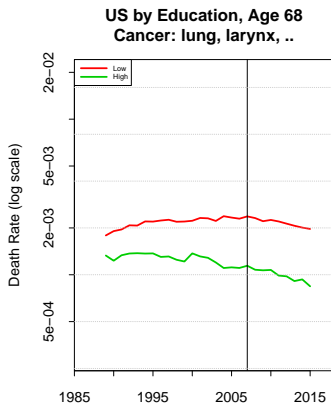
Significant improvements, but not throughout

Multi-Country: Age 68, Males, Lung Cancer



Significant inequality; improvements might be driven by smoking prevalence

Multi-Country: Age 68, Females, Lung Cancer

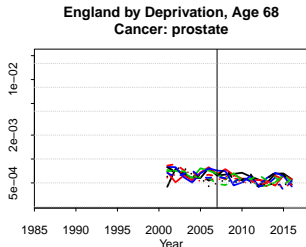
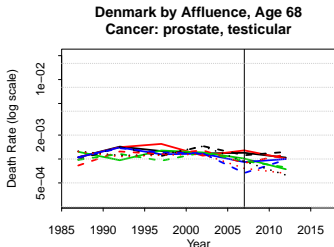
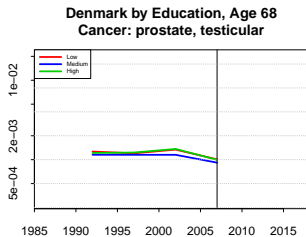
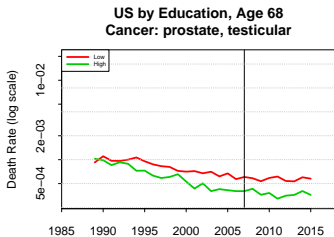


Significant inequality; deterioration driven by smoking prevalence

Impact of Controllable Risk Factors

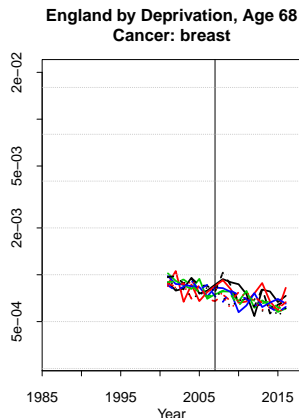
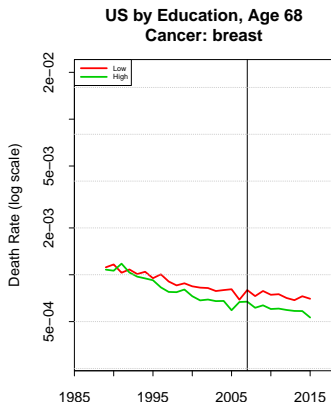
- Risk factors (controllable and not controllable)
⇒
Impact on cause of death rates
- **Some risk factors ⇒ big impact on some causes**
e.g. smoking → lung cancer
e.g. several risk factors → ischaemic heart disease
⇒ significant inequality gaps
- **Some causes of death:**
no known (significant) controllable risk factors
e.g. prostate cancer, breast cancer

Multi-Country: Age 68, Males, Prostate Cancer



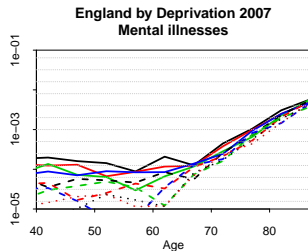
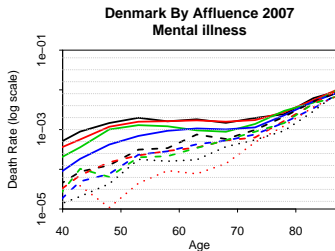
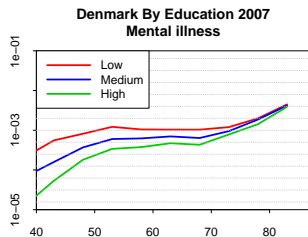
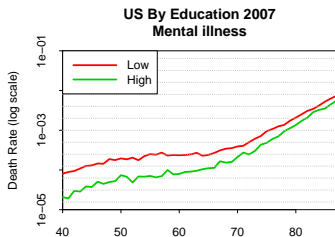
No controllable risk factors; US improvements; DK vs US genetic factors?

Multi-Country: Age 68, Females, Breast Cancer



No controllable risk factors; US inequalities; England equality (?)

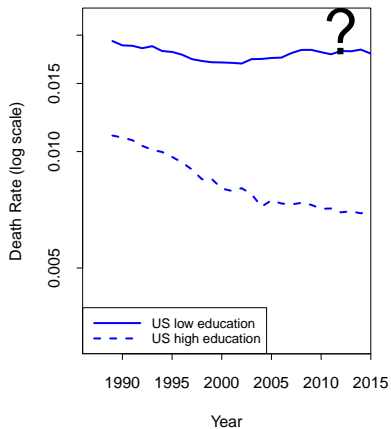
Variation in Reporting Practice: e.g. Mental Illness



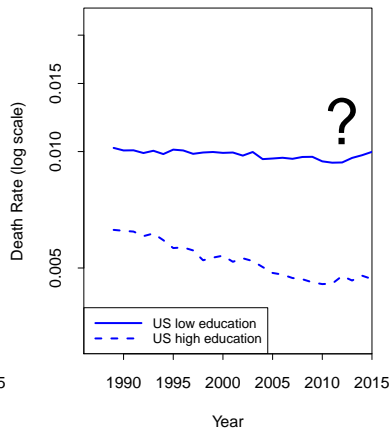
Alcohol & drug abuse; mental disorders; → vascular dementia
Reporting practice (??) ⇒ Denmark >> US >> England

US Males Age 60: Stagnation

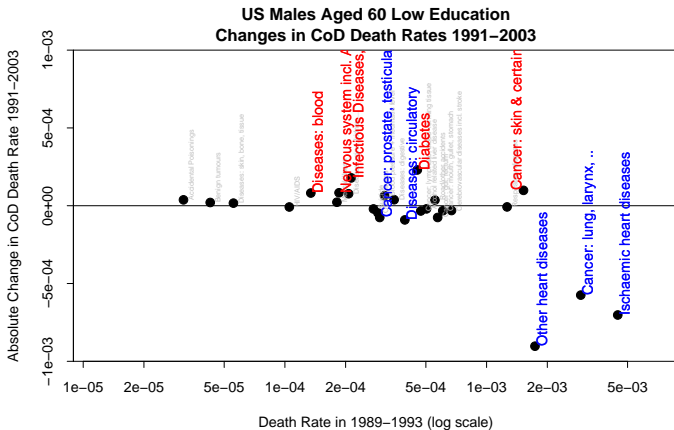
Males, Age 60, All Cause Mortality



Females, Age 60, All Cause Mortality



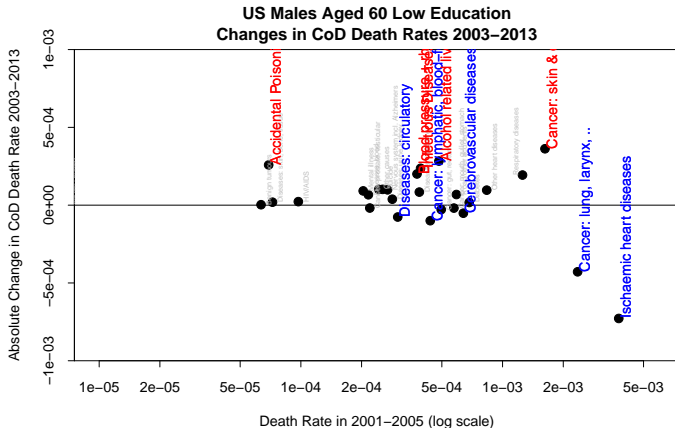
US Drivers of Change 1991-2003, Males Age 60 Low Education: Absolute changes in mortality



Three big gains, many small “losers”

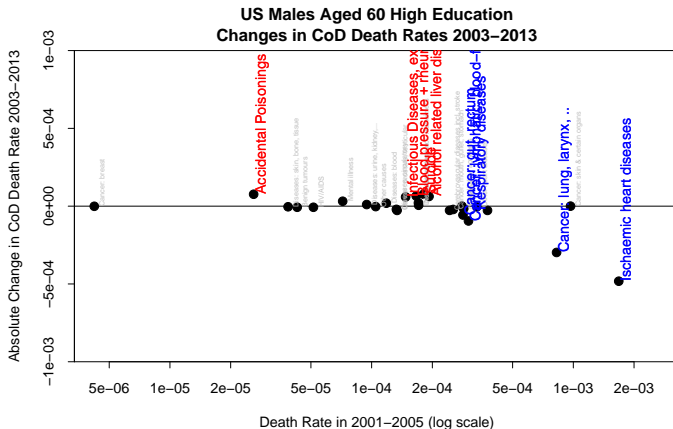
Other heart disease: gains mainly due to 1998 ICD change

US Drivers of Change 2003-2013, Males Age 60 Low Education: Absolute changes in mortality



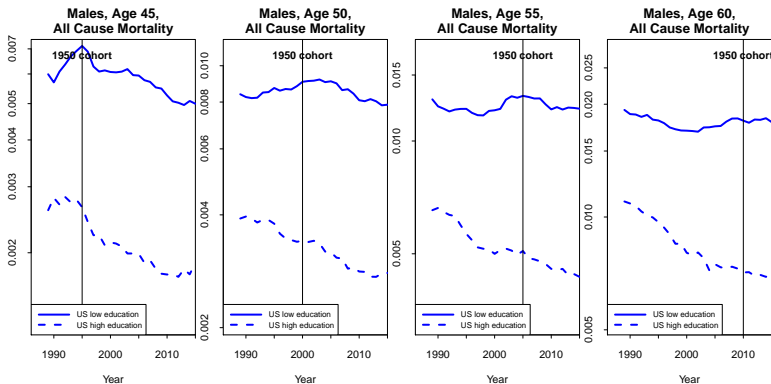
Some continued gains, but several more substantial losers: no single “bad” CoD

US Drivers of Change 2003-2013, Males Age 60 High Education: Absolute changes in mortality



More modest gainers, but no significant losers

US Males: A Possible Cohort Effect



Cohort effect: cohorts born around 1950 have poorer mortality than those born before or after.

Suggests: Weakens the hypothesis that the situation is generally bad for low educated males.

Identifying Cohort Effects

Modelling approach:

- Model death rates for individual causes of death
- Step 1: estimate age and period effects

$$\log m(\text{CoD}, t, x) = \sum \text{age effect} \times \text{period effect}$$

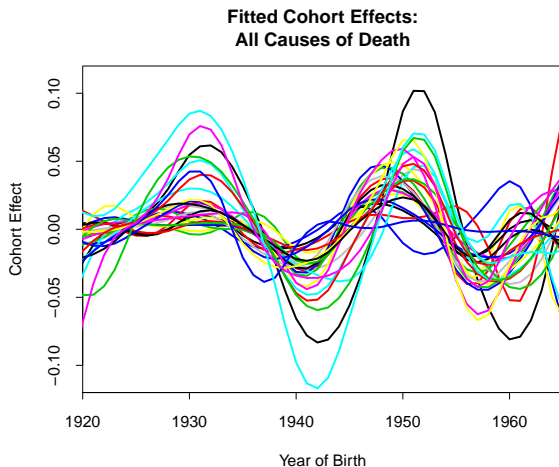
- Step 2: estimate CoD-specific cohort effect

$$\log m(\text{CoD}, t, x) = \sum \text{age effect} \times \text{period effect} \\ + \text{cohort effect}$$

- Cohort effects capture heterogeneity in the underlying population:
e.g. smoking prevalence

Cohort Effects: Low Educated Males

All causes of death in one plot



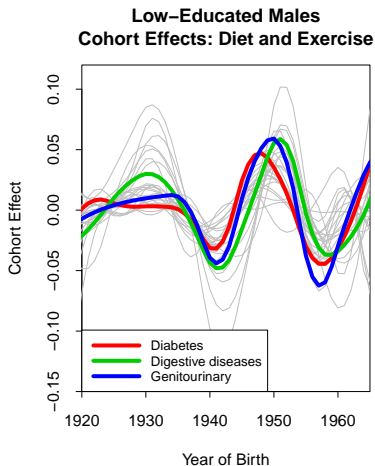
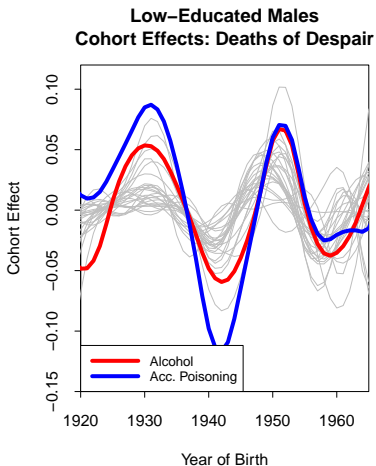
Very messy! Different underlying risk factors.

Drivers of Mortality

- Medical advances
- Health spending
- Public health initiatives
- Individual risk factors:
 - **Controllable**
e.g. smoking, diet, exercise, alcohol, sun, drugs, hygiene, risky sex, stress, environment...
leading to cohort effects, and socio-economic differences
 - Not (easily) controllable
e.g. genetic, affluence, education, character/personality traits, ...

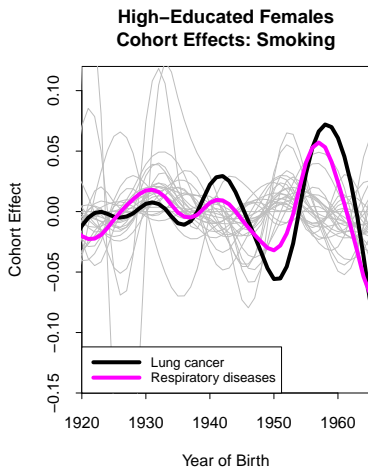
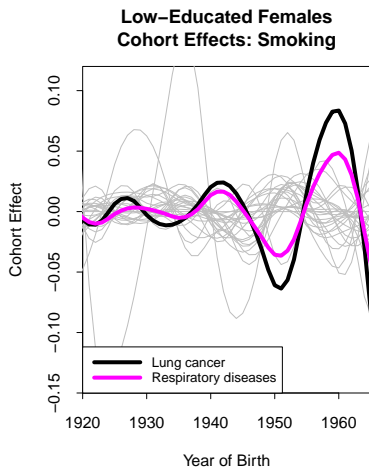
Cohort Effects: Low Educated Males

Specific causes of death



Common risk factor \Rightarrow similar cohort effect

Identifying Cohort Effects



1960 peak consistent with known smoking prevalence for females by cohort

Note: age-period effects can absorb steady trends in prevalence

Summary

- Work in progress!
- Cause of death data can provide insight into all cause mortality
 - time trends
 - inequality between groups
 - growing inequality
- US, England, Denmark
 - Many similarities
 - Some differences
 - No controllable risk factors ⇒
Wider US inequality gap: accessible healthcare
- The US slow down is complex
Partly due to a 1940-50's cohort effect
- Shape of cohort effect varies by cause of death
linked to different underlying risk factors by cohort



Thank You!

Questions?

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W: www.macs.hw.ac.uk/~andrewc/ARCResources



The Actuarial Research Centre (ARC)

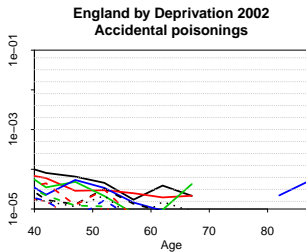
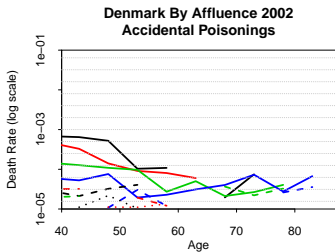
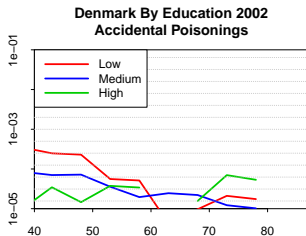
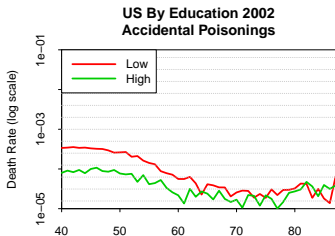
A gateway to global actuarial research

The Actuarial Research Centre (ARC) is the Institute and Faculty of Actuaries' (IFoA) network of actuarial researchers around the world. The ARC seeks to deliver cutting-edge research programmes that address some of the significant, global challenges in actuarial science, through a partnership of the actuarial profession, the academic community and practitioners.

The 'Modelling, Measurement and Management of Longevity and Morbidity Risk' research programme is being funded by the ARC, the SoA and the CIA.

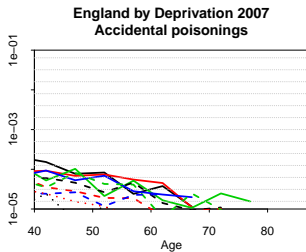
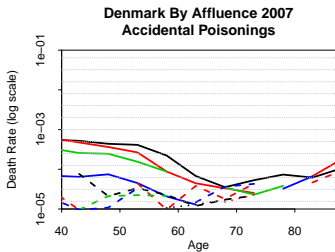
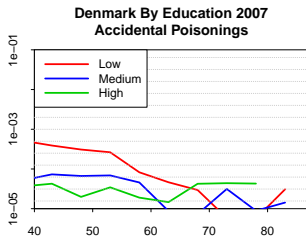
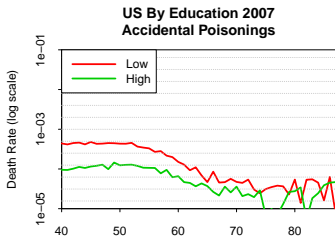
www.actuaries.org.uk/arc

Deaths of Despair: A Growing Problem? 2002/07/12

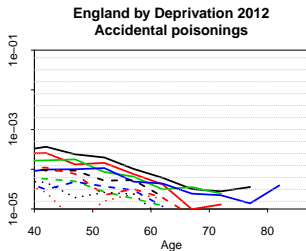
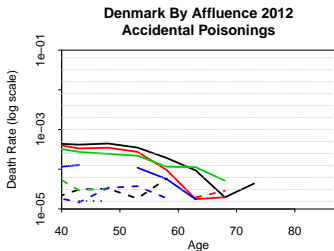
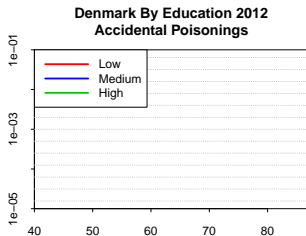
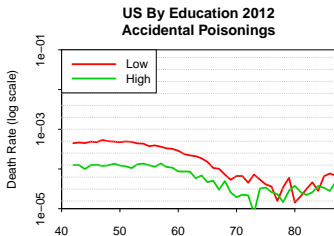


US, Denmark: significant

Deaths of Despair: A Growing Problem? 2002/07/12



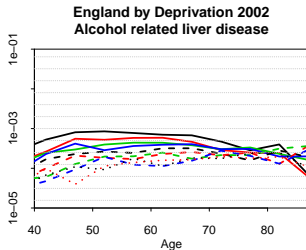
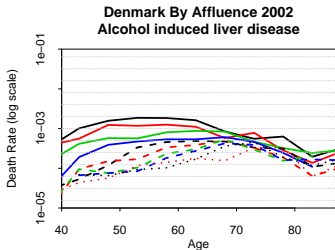
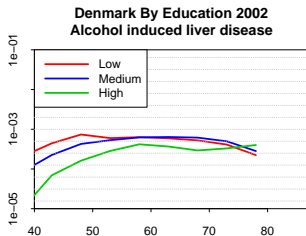
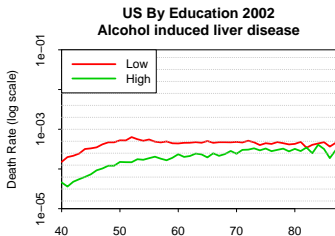
Deaths of Despair: A Growing Problem? 2002/07/12



Growth: England > US > DK

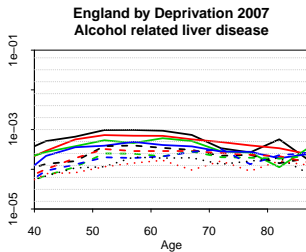
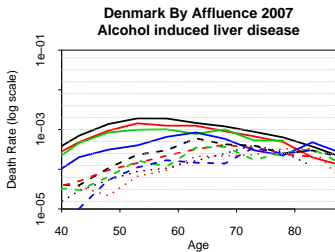
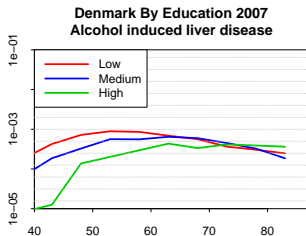
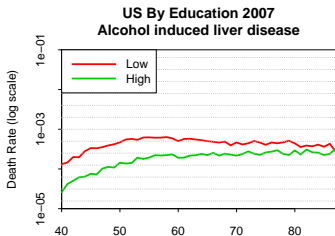
US: evidence of a cohort effect

Deaths of Despair: A Growing Problem? 2002/07/12

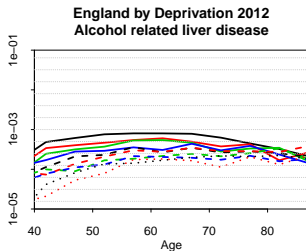
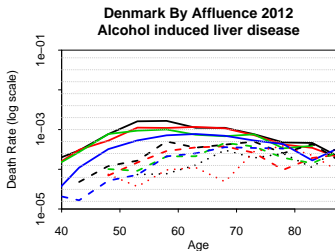
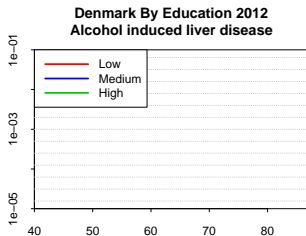
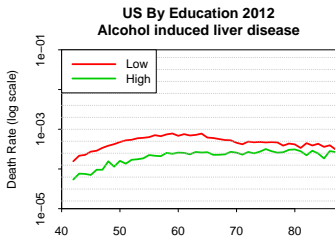


Affluence a much bigger driver

Deaths of Despair: A Growing Problem? 2002/07/12

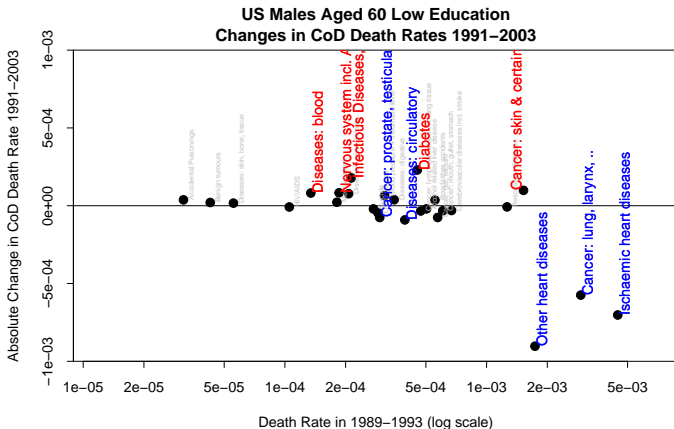


Deaths of Despair: A Growing Problem? 2002/07/12



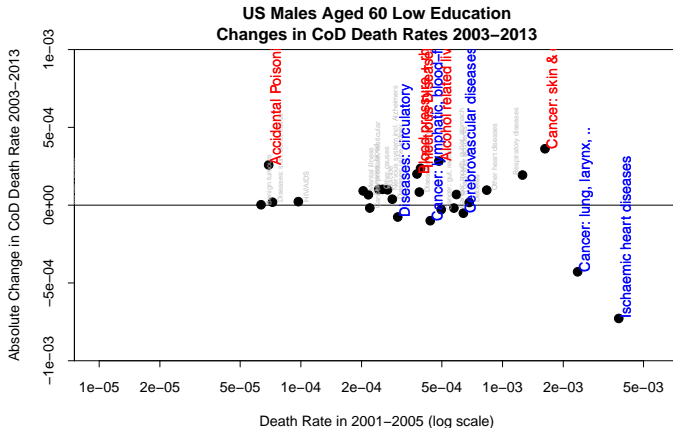
US: possible cohort effect

US Drivers of Change 1991-2003, Males Age 60 Low Education: Absolute changes in mortality



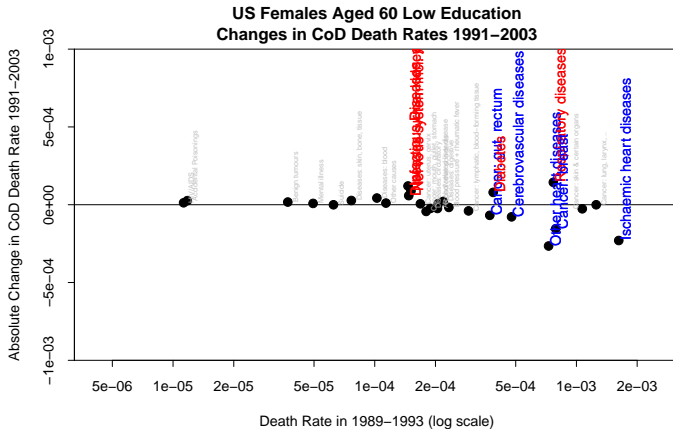
Three big gains, many small “losers”
Other heart disease: gains mainly due to 1998 ICD change

US Drivers of Change 2003-2013, Males Age 60 Low Education: Absolute changes in mortality



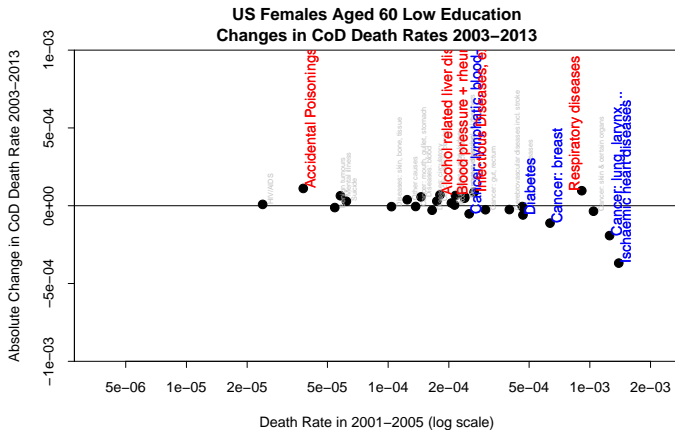
Some continued gains, but several more substantial losers: no single “bad” CoD

US Drivers of Change 1991-2003, Females Age 60 Low Education: Absolute changes in mortality



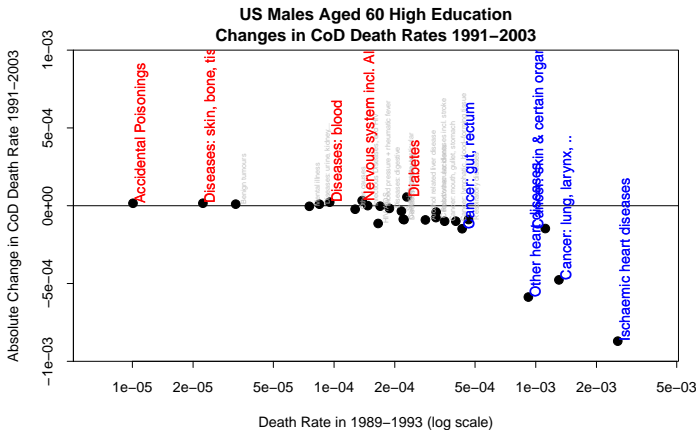
Much smaller improvements than males

US Drivers of Change 2003-2013, Females Age 60 Low Education: Absolute changes in mortality



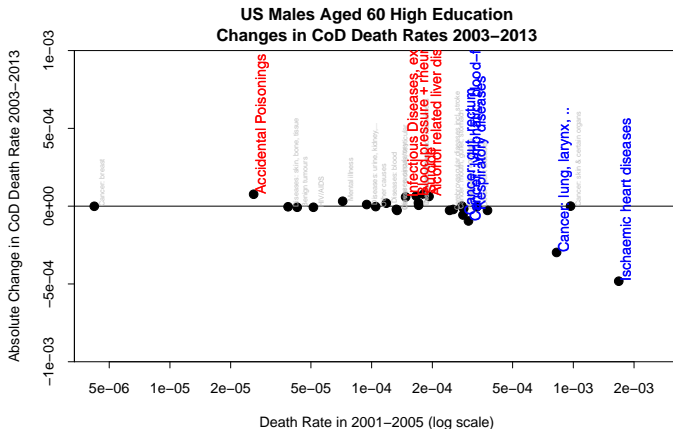
Some cancer progress

US Drivers of Change 1991-2003, Males Age 60 High Education: Absolute changes in mortality



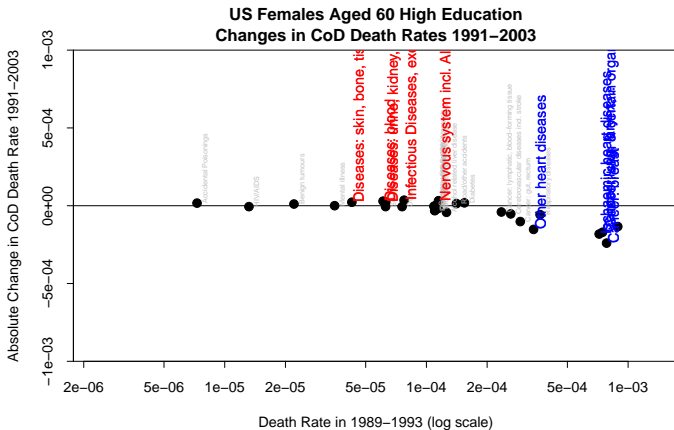
Same three big gains, but many fewer losers

US Drivers of Change 2003-2013, Males Age 60 High Education: Absolute changes in mortality



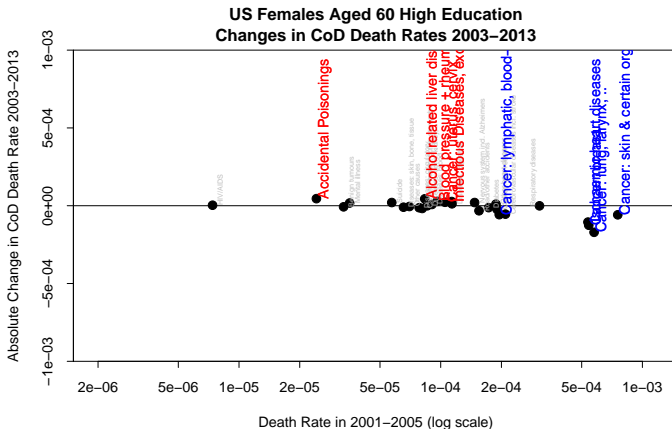
More modest gains, but still no significant losers

US Drivers of Change 1991-2003, Females Age 60 High Education: Absolute changes in mortality



Much smaller improvements than males

US Drivers of Change 2003-2013, Females Age 60 High Education: Absolute changes in mortality



Some cancer progress