Socio-Economic Differences in Mortality by Cause of Death

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

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Outline

- Danish data by:
  - affluence
  - education
- US by education group
- Comparison: Denmark vs US
- English data: early stages
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?
- Can we point to specific causes of death as responsible for growing inequality?
- Beware of
  - changes in ICD classification of deaths (1998-99)
  - drift in how deaths are classified
  - changing education levels (grade inflation)
- Insight into mortality underpinning life insurance and pensions
Danish Data: Cairns et al. (2017)

- Statistics Denmark National Register Database

- Key data (amongst others) for each individual:
  - Date of birth (⇒ age)
  - Date of death
  - Wealth
  - Income
  - Affluence = Wealth + 15 × Income
  - Education
  - Cause of Death
## Education and Affluence Levels

### Education (Denmark)

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low education</td>
<td>Primary and lower secondary education</td>
</tr>
<tr>
<td>Medium education</td>
<td>Upper secondary education</td>
</tr>
<tr>
<td>High education</td>
<td>Tertiary education</td>
</tr>
</tbody>
</table>

(No education data for cohorts born before 1922.)

### Affluence

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low affluence decile</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>High affluence decile</td>
</tr>
</tbody>
</table>
Age Standardised Death Rates, Age Group 55-64

Age Standardised Mortality Rates per 1000 Ages 55–64 by Affluence

Age Standardised Mortality Rates per 1000 Ages 55–64 by Education
Causes of Death Data – Health Inequalities

- Deaths subdivided into 29 CoD groups
- Age groups 31-35, 36-40, ..., 91-95
- Compare affluence groups
- Compare education groups
<table>
<thead>
<tr>
<th></th>
<th>Infectious diseases incl. tuberculosis</th>
<th></th>
<th>Cancer: mouth, gullet, stomach</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Cancer: gut, rectum</td>
<td>4</td>
<td>Cancer: lung, larynx, ..</td>
</tr>
<tr>
<td>5</td>
<td>Cancer: breast</td>
<td>6</td>
<td>Cancer: uterus, cervix</td>
</tr>
<tr>
<td>7</td>
<td>Cancer: prostate, testicular</td>
<td>8</td>
<td>Cancer: bones, skin</td>
</tr>
<tr>
<td>9</td>
<td>Cancer: lymphatic, blood-forming tissue</td>
<td>10</td>
<td>Benign tumours</td>
</tr>
<tr>
<td>11</td>
<td>Diseases: blood</td>
<td>12</td>
<td>Diabetes</td>
</tr>
<tr>
<td>13</td>
<td>Mental illness</td>
<td>14</td>
<td>Meningitis + nervous system (Alzh.)</td>
</tr>
<tr>
<td>15</td>
<td>Blood pressure + rheumatic fever</td>
<td>16</td>
<td>Ischaemic heart diseases</td>
</tr>
<tr>
<td>17</td>
<td>Other heart diseases</td>
<td>18</td>
<td>Diseases: cerebrovascular</td>
</tr>
<tr>
<td>19</td>
<td>Diseases: circulatory</td>
<td>20</td>
<td>Diseases: lungs, breathing</td>
</tr>
<tr>
<td>21</td>
<td>Diseases: digestive</td>
<td>22</td>
<td>Diseases: urine, kidney,...</td>
</tr>
<tr>
<td>23</td>
<td>Diseases: skin, bone, tissue</td>
<td>24</td>
<td>Senility without mental illness</td>
</tr>
<tr>
<td>25</td>
<td>Road/other accidents</td>
<td>26</td>
<td>Other causes</td>
</tr>
<tr>
<td>27</td>
<td>Alcohol → liver disease</td>
<td>28</td>
<td>Suicide</td>
</tr>
<tr>
<td>29</td>
<td>Accidental Poisonings</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Denmark – Affluence – Top 10 CoD

**Ages 71-75; Years 2005-2009**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Least Affluent</th>
<th>Most Affluent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ischaemic heart</td>
<td>Skin/bone cancer</td>
</tr>
<tr>
<td>2</td>
<td>Respiratory</td>
<td>Ischaemic heart</td>
</tr>
<tr>
<td>3</td>
<td>Lung cancer etc.</td>
<td>Prostate cancer</td>
</tr>
<tr>
<td>4</td>
<td>Skin/bone cancer</td>
<td>Respiratory</td>
</tr>
<tr>
<td>5</td>
<td>Other</td>
<td>Lung cancer etc.</td>
</tr>
<tr>
<td>6</td>
<td>Cerebrovascular</td>
<td>Cerebrovascular</td>
</tr>
<tr>
<td>7</td>
<td>Other heart</td>
<td>Other</td>
</tr>
<tr>
<td>8</td>
<td>Diabetes</td>
<td>Gut cancer</td>
</tr>
<tr>
<td>9</td>
<td>Gut cancer</td>
<td>Other heart</td>
</tr>
<tr>
<td>10</td>
<td>Prostate cancer</td>
<td>Alzheimers etc.</td>
</tr>
</tbody>
</table>

**Prostate: almost no inequality**
High levels of mortality inequality
Denmark: Cause of Death Data 2005-2009

Danish Males by Education
Diabetes

Danish Males by Affluence
Diabetes

Affluence ⇒ much wider
Very large differences in middle ages.
Many causes of death have known risk factors or drivers
e.g. smoking, diet, healthy lifestyle etc.
⇒ clear socio-economic differences

Biggest differences at ages < 60

Affluence ⇒ stronger predictor than education
(sometimes very much stronger)

Other diseases do not have strong differences:
Danish Males by Education
Cancer: prostate, testicular

Danish Males by Affluence
Cancer: prostate, testicular

Death Rate (log scale)

Age Group

Death Rate (log scale)

Age Group
Some causes of death have no obvious link to lifestyle/affluence/education
e.g. Prostate Cancer
CancerUK: Prostate cancer is not clearly linked to any preventable risk factors.
Possible unavoidable risk factors: genetic; race
But Affluence ⇒ inequalities
Possible explanations (a very non-expert view)
- onset is not dependent on lifestyle/affluence/education
- BUT less affluent/educated ⇒
  - later diagnosis
  - engage less well with treatment process
  - unhelpful environment
  - genetic/racial
US Education Data

Data sources:

- Human Mortality Database (aggregate exposures)
- CDC individual deaths records
- Current Population Survey (CPS) → population education levels
**US Education Data**

- Males and Females (2)
- Single ages 40-89 (50)
- Single years 1989-2015 (27)
- Causes of death (30) (Danish 29 + HIV/AIDS)
- Low (≤ high school) & high (≥ some college) education level (2)

Note 1: further separation of high into (a) < bachelors degree and (b) ≥ bachelors degree was found to be unreliable.
Note 2: HMD’s Human Cause of Death Database ⇒ All ages (5’s), 1999-2013 BUT no education subdivision
US Education Data: 2000 and 2015

Note 1: some improvements above age 60
Note 2: widening gap
Recall: Denmark ⇒ very narrow gap
US wider gap: health insurance inequalities; genetic/racial
Improvements
Widening gap
Widening gap
Some worsening, some improving
US Education Data

Widening gap, some improvements
Improvements possibly linked to smoking prevalence

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US Education Data

Year 2000
Diseases: lungs, breathing

Year 2015
Diseases: lungs, breathing

Widening gap
Modest improvements

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Socio-Economic Differences in Mortality by Cause of Death
US Education Data

Case & Deaton (2015) ⇒ Deaths of Despair
US Education Data

Year 2000
Other heart diseases

Year 2015
Other heart diseases

Widening gap
Modest improvements for high education
Mixed picture

US Education Data

Year 2000
Road/other accidents

Year 2015
Road/other accidents

CoD Death Rate

Low Edu
High

Year

Mixed picture

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US Education Data

Case & Deaton (2015) ⇒ Deaths of Despair

Year 2000
Accidental Poisonings

Year 2015
Accidental Poisonings

CoD Death Rate

45 50 55 60 65 70 75
1e−05 1e−04 1e−03 1e−02 1e−01

Low Edu
High

Year 45 50 55 60 65 70 75
1e−05 1e−04 1e−03 1e−02 1e−01

Low Edu
High

Case & Deaton (2015) ⇒ Deaths of Despair
US Education Data

Case & Deaton (2015) ⇒ Deaths of Despair

\[ \text{Year 2000 Suicide} \]

\[ \text{Year 2015 Suicide} \]

CoD Death Rate

Low Edu  High

Year

0.01 0.02 0.03 0.04 0.05 0.001 0.0001

45 50 55 60 65 70 75
US Drivers of Change 1991-2013, Males Age 63

Males, Age 63, All Cause Mortality

Year
Death Rate (log scale)
0.010 0.015 0.020 0.025
US low education
US high education

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Socio-Economic Differences in Mortality by Cause of Death
US Drivers of Change 1991-2013, Males Age 63

*Big gains in three causes*

*Offset by modest deterioration in many causes*
US Drivers of Change 1991-2013, Males Age 63

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Socio-Economic Differences in Mortality by Cause of Death
US versus Denmark, Males Age 63 / 61-65

Males, Age 63, All Cause Mortality

- US: wider inequality gap
- But can’t point to one or two big drivers

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Socio-Economic Differences in Mortality by Cause of Death
US versus Denmark, Males Age 63 / 61-65

Males, Age 63, Ischaemic heart diseases

Year

Death Rate (log scale)

1e−05 5e−05 5e−04 5e−03

●


ICD-9 ICD-10

Denmark low education
Denmark medium education
Denmark high education
US low education
US high education

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Socio-Economic Differences in Mortality by Cause of Death
US versus Denmark, Males Age 63 / 61-65

Males, Age 63, Other heart diseases

Year

Death Rate (log scale)

ICD−9 ICD−10

Denmark low education
Denmark medium education
Denmark high education
US low education
US high education

Denmark not impacted by IMD change???
US versus Denmark, Males Age 63 / 61-65

Males, Age 63, Diseases: lungs, breathing

Death Rate (log scale)

Year

10^{-5} to 10^{-3}

ICD-9

ICD-10

Denmark low education

Denmark medium education

Denmark high education

US low education

US high education

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Socio-Economic Differences in Mortality by Cause of Death
US versus Denmark, Males Age 63 / 61-65

Males, Age 63, Diabetes

Death Rate (log scale)

Year


1e−05 5e−05 5e−04 5e−03

● ● ●

● ●

Males, Age 63, Diabetes

ICD−9 ICD−10

Denmark low education

Denmark medium education

Denmark high education

US low education

US high education

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37 / 42
Wider US gap: access to healthcare post-diagnosis + genetic/racial???

No preventable risk factors, but Denmark much higher???

Potentially genetic/racial???
Further remarks

- Need to factor in changing levels of educational attainment
- Can we link smoking prevalence to e.g. lung cancer mortality?
- Working on obtaining English data by socio-economic × geographic groups and cause of death
- Built from small geographical areas rather than individual records.
Summary

- Affluence better than education for all CoD if you have the data
- Impact of affluence/education varies with CoD
- Significant levels of inequality for most of the big CoD’s
- Impact of education varies between countries (e.g. different health systems)
- Work in progress!

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Thank You!

Questions?

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