The Significance of Education for Mortality Compression in the United States

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This research was supported by a research grant from the National Institute of Child Health and Human Development (R01 HD053696, P.I.: R. A. Hummer), a training grant from NICHD (5 T32 HD007081), and infrastructure grants from NICHD (R24 HD042849) and the National Institute on Aging (P30 AG17265).
Background

- Growing interest in whether mortality has become increasingly compressed
- Is there a biologically determined upper-limit to the human lifespan?
- Assumption: Temporal and national variability in mortality compression is due to socioeconomic development.
- If we extend this logic, then socioeconomic differentials in mortality compression should exist within a single nation in a given period.
Research Questions

• Are there educational differentials in mortality compression?

• Given women's lower mortality and smaller educational gradient, how do men and women differ in mortality compression?

• We hypothesize that mortality will be more compressed as education increases.

• We also hypothesize that highly educated women experience the greatest degree of mortality compression of all sex-education groups.
Data

• The Health and Retirement Study (HRS)
  – Nationally representative sample of the U.S. civilian, non-institutionalized population ages 51 and above and their spouses
  – Longitudinal survey began in 1992

• Sample restrictions in our analyses:
  – Survey years: 1992-2004
  – Native born respondents ages 50+ without missing education data
Measures

- Dependent variable: whether death occurred (from any cause) during a calendar year

- Independent variables:
  - Exact age on January 1st
  - Sex (1 = Male, 0 = Female)
  - Education in years: 0-11 years, 12 years, and 13 years or more
Methods: Life Tables

• Sex-education specific life tables derived from statistical models of the risk of death
• Sex-specific mortality models were estimated that included exact age and education group
• Gompertz models were assumed for both men and women, and education was allowed to interact with age

\[
\ln m_m(x) = \beta_{m0} + \beta_{m1} \text{Age}_x + \beta_{m2} \text{Ed}<12 + \beta_{m3} \text{Ed}12 + \beta_{m4} \text{Age}^{*}\text{Ed}<12 + \beta_{m5} \text{Age}^{*}\text{Ed}12
\]

\[
\ln m_f(x) = \beta_{f0} + \beta_{f1} \text{AGE}_x + \beta_{f2} \text{Ed}<12 + \beta_{f3} \text{Ed}12 + \beta_{f4} \text{Age}^{*}\text{Ed}<12 + \beta_{f5} \text{Age}^{*}\text{Ed}12
\]

where,

\[
m(x) = \lim_{\Delta \to 0} \frac{P(x + x + n)}{n}
\]
Methods: Rectangularization

- We follow the approach recently introduced by Cheung, et al. (2005)

  - Modal age of death: The age corresponding to the largest value in the $l(x)$ series of the life table ($M$)

  - Mortality compression: The standard deviation above the modal age of death ($SD(M+)$) and ages of death within plus or minus 3 standard deviations of the modal age of death ($M+/\pm 3SD(M+)$)

  - “Verticalization”: The verticality of the right-hand tail of the survival curve. This is a right angle with a range of $0^\circ$ to $90^\circ$ (i.e., smaller values = more vertical, larger values = less vertical).
## Results

Table 1. Number of Deaths by Sex and Education, HRS, 1992-2004

<table>
<thead>
<tr>
<th>Total</th>
<th>Ages 90+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
</tr>
<tr>
<td>0-11 Years</td>
<td>1,413</td>
</tr>
<tr>
<td>12 Years</td>
<td>854</td>
</tr>
<tr>
<td>13+ Years</td>
<td>849</td>
</tr>
</tbody>
</table>

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Results

Figure 1. Survival Curves (lx) for Men and Women Ages 50+ by Education, Health and Retirement Study, 1992-2004

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Figure 2. Number of deaths (dx) for Men and Women Ages 50+ by Education, Health and Retirement Study, 1992-2004

$\delta(x) = \lim_{\Delta t \to 0} \frac{P(x + \Delta t) - P(x)}{\Delta t}$
## Results

### Table 2. Dispersion Around the Modal Age at Death & the Degree of Verticalization by Sex & Education, HRS, 1992-2004

<table>
<thead>
<tr>
<th>Education</th>
<th>0-11 Yrs</th>
<th>12 Yrs</th>
<th>13+ Yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modal age at death</td>
<td>80.65</td>
<td>83.21</td>
<td>85.99</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>8.10</td>
<td>7.48</td>
<td>6.26</td>
</tr>
<tr>
<td>Verticalization</td>
<td>23.74</td>
<td>22.39</td>
<td>20.53</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modal age at death</td>
<td>85.20</td>
<td>88.46</td>
<td>89.77</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>7.07</td>
<td>5.59</td>
<td>4.87</td>
</tr>
<tr>
<td>Verticalization</td>
<td>22.33</td>
<td>19.41</td>
<td>17.58</td>
</tr>
</tbody>
</table>

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Conclusion

- Educated groups have higher modal ages of death than less educated groups.
- Mortality is more compressed among groups with higher levels of education (e.g., smaller standard deviations).
- The right hand tails of the survival curves are more vertical among groups with higher levels of education (e.g., smaller values).
- Women live considerably longer and display more mortality compression than men at all levels of education.
- The group with the greatest compression of mortality is highly educated women.
Conclusion

• Educated populations have greater access to resources which allow them to optimize their health.

• Women are more advantaged than men, especially at higher levels of education.

• Mortality among the socioeconomically advantaged provides a glimpse into the mortality dynamics of the population as a whole in the future.

• We have replicated these results with the National Health Interview Survey Linked Mortality Files (NHIS-LMF).

• Our next step is to use the SPACE program to obtain confidence intervals for the rectangularization measures.