Extending the HMD approach to regional databases - An illustration with the United States Mortality Data Base (USMDB)

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USMDB Overview

• What is the USMDB?
  – A database of detailed and abridged period life table series for 1959-2016 and supporting documentation for the United States as a whole and for:
    • 4 Census regions, 9 Census divisions, the 50 states and D.C.
    • Present-day 50+ state-membership established in 1959

• **Goal of the USMDB:**
  
  To provide detailed mortality data for sub-regional populations of the United States, free of charge, to all persons interested in US geographic variations in longevity.
Methodology

Faithfully replicates HMD methods:

- Collect inputs for each state (create aggregates for Division, Region, National level)
  - Inputs for each state are from centralized (national-level) organizations
  - Homogeneous data
- Compute Lexis Database for each region, determine period exposure-to-risk
- Compute period life tables from exposures-to-risk and deaths
- Recent (2016) update: HMD method version 5 is used
  - Move to version 6 in next (2017) update by adding (recently obtained) births by month for all states.

Exceptions to HMD methods

- Upper/Lower triangle probability assigned to death records w/ missing cohort.
  - Same method used for HMD-USA

The USMDB is computed entirely with in-house-developed R software and has been used to verify the translation/migration of legacy MATLAB HMD routines to R (Tim Riffe, Carl Boe)
Input data

A. From the National Center for Health Statistics (NCHS):
   1. Natality files => births by area, year, and sex
   2. Mortality files => deaths by area, year, sex, and Lexis triangle (full cohort detail from 1989 - present, single year of age before 1989)

B. From the Census Bureau:
   1. Census populations (1960 on) by area, single year of age and sex
   2. July 1st population estimates (1970 on) by area, single year of age and sex - only available age 85+
Restricted access to detailed mortality data via US Census Bureau Federal Statistics Research Data Center.
Incomplete population inputs by year (missing intercensal estimates for 1959-1969), by age-detail (only 5yr age groups for 1971-1979) and for all ages (Open age interval starts at age 85 for intercensal estimates): Also, 1990 Census discarded because of known age-reporting problems
Lexis surface sampling in high-population state: California

Total 2018 CA population: 39.56 million
Lexis surface sampling in low-population state: Alaska

Total 2018 Alaska population: 734,458 - compare w/ Luxembourg population: 599,499 (2017)
# USMDB Results: Snapshot of life table indicators

Low- and high- mortality cases

## 2016: Female

<table>
<thead>
<tr>
<th>Region</th>
<th>q0</th>
<th>e0</th>
<th>e65</th>
<th>e80</th>
<th>l65*</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>0.00375</td>
<td>83.49</td>
<td>22.06</td>
<td>10.80</td>
<td>90,290</td>
</tr>
<tr>
<td>Mississippi</td>
<td>0.00845</td>
<td>77.78</td>
<td>19.25</td>
<td>9.31</td>
<td>81,625</td>
</tr>
<tr>
<td>USA (USMDB)</td>
<td>0.00529</td>
<td>81.38</td>
<td>20.93</td>
<td>10.15</td>
<td>87,569</td>
</tr>
</tbody>
</table>

## 2016: Male

<table>
<thead>
<tr>
<th>Region</th>
<th>q0</th>
<th>e0</th>
<th>e65</th>
<th>e80</th>
<th>l65*</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>0.00458</td>
<td>78.76</td>
<td>19.50</td>
<td>9.45</td>
<td>83,559</td>
</tr>
<tr>
<td>Mississippi</td>
<td>0.00873</td>
<td>71.64</td>
<td>16.23</td>
<td>7.81</td>
<td>70,839</td>
</tr>
<tr>
<td>USA (USMDB)</td>
<td>0.00631</td>
<td>76.34</td>
<td>18.34</td>
<td>8.78</td>
<td>79,821</td>
</tr>
</tbody>
</table>

*Radix = 100,000
Mortality rates: Low mortality case - California (CA)
Mortality rates: High mortality case - Mississippi (MI)
Verifications

• Internal checks (data quality checks on age reporting; consistency of implied migration; age structure of mortality; etc...)

• Comparison with NCHS Decennial life tables (1959-1961 through 1999-2001)

• Comparison with estimates from the Institute for Health Metrics and Evaluation (IHME)
Life expectancy at birth, District of Columbia, USMDB, NCHS, and IHME, 1959-2014

![Graph showing life expectancy at birth for men and women in the District of Columbia from 1959 to 2014. The graph includes data from USMDB, NCHS, and IHME.]
USMDB vs. HMD

Verify USMDB against HMD
- Create USA-level aggregate from USMDB states
- Compare lifetable indicators against HMD

Discrepancies arise from
- Intercensal estimation and age-group fitting: 1959-1979
- Annually revised State pop. estimates 2010-2017
- V.5 vs. V.6 (1945 cohort)
USMDB vs. HMD estimates of $e_x$
Website & Data-products

- **http://usa.mortality.org**
  - Anyone can visit the site.
  - Users must register (ID + password) to access data-products

- Data available: complete (1x1) & abridged (1x5, 1x10, 5x1, 5x5, 5x10) sex-specific lifetables, ages 0-110+, by state, division, region, USA for years 1959-2016
  - CSV and tab-delimited formats
  - No raw inputs, Lexis database, Exposures, raw mortality rates

- Also available, visually interactive map-based diagnostic tool for glancing at life-expectancy \((e_x)\) and mortality rates \((m_x)\) by state
  - [http://shiny.demog.berkeley.edu/hmd/USHMD_MapApp/](http://shiny.demog.berkeley.edu/hmd/USHMD_MapApp/)
  - developed with R-shiny by D. Dukhovnov
Questions

Is it better to use Census population estimates or official intercensal estimates, when available?
- More age detail in Census measurements, but more measurement error?

Validity of HMD methods for high-age mortality patterns in low population states?

How to account for interstate migration?

Future Directions
- Develop more user-driven data visualization for website
- Estimate mortality rates at the US-county level using Bayesian estimation
  - ~3,150 counties, ranging in population from <100 to >1e6
  - Work in progress - funded by NIH grant
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