HMD member-initiated meeting at the 2016 PAA conference
March 30, 2016
Washington D.C.

The Human Mortality Database: a powerful resource of demography

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HMD: General information

Collaboration

Max Planck Institute for Demographic Research (MPIDR)

Department of Demography at the University of California, Berkeley (UCB)

www.mortality.org

HMD Data Resource Profile in the *International Journal of Epidemiology*

http://ije.oxfordjournals.org/content/44/5/1549

Support

Max Planck Society (Germany), National Institute of Aging (USA), Institut national d'études démographiques (France), University of California at Berkeley (USA)

Outline of the presentation

- Reasons for and origins of the HMD
- What HMD does
- Data problems
- Enhancement of the methodology
- HMD-based studies
- Research teams

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Mortality convergence and expectation of convergence before the 1990s

1970s-80s: strong expectation of worldwide mortality convergence.

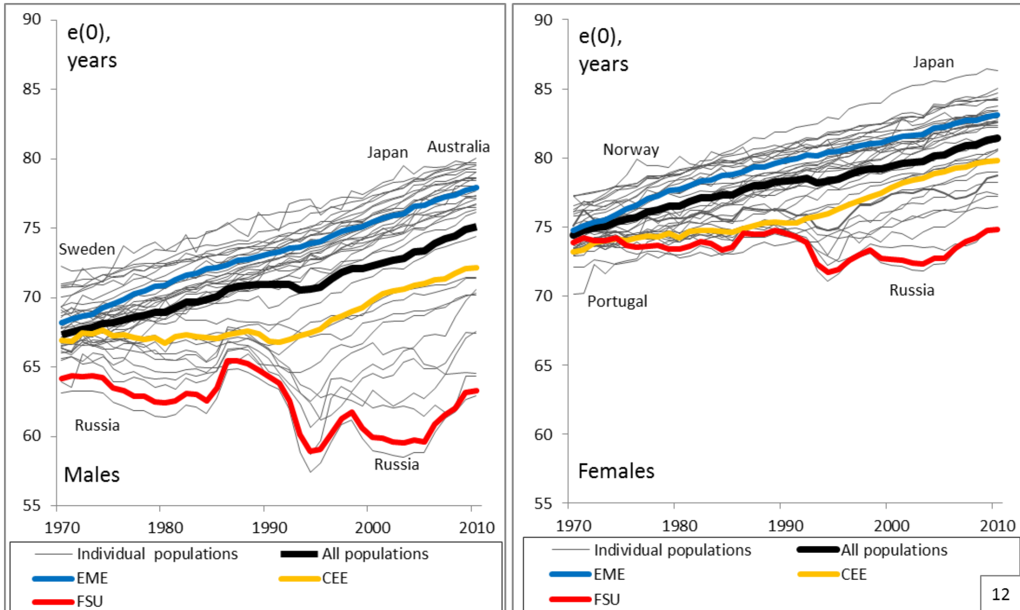
Gross analyses of international mortality trends by Keyfitz, Preston, Schoen, and Flieger suggested a mortality transition process: falling deaths at young ages, greater survival to old age, where people exposed to "degenerative" diseases, difficult to treat or prevent.

→ Expectation of rapid progress in high-mortality countries, via reduced young-age mortality and slower progress or stagnation in countries with already low mortality.

UN Population Division: 2.5 year gain in LEB every 5 years for countries with LEB<62, after which the 5-year gain decreases to 2 years.

New phenomena: mortality divergence and steep progress at advanced ages

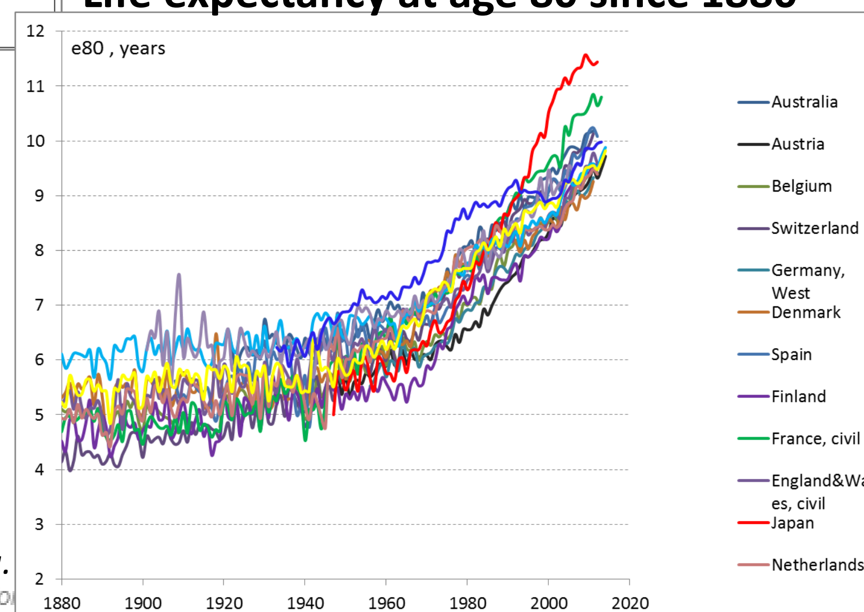
Life expectancy divergence after 1970



Source: Timonin et al, 2015; Barbieri et al. 2015

Life expectancy divergence:
- unexpected health crisis in communist and post-communist countries of the former USSR and CEE;
- unexpected further progress in the established market economies (EME)

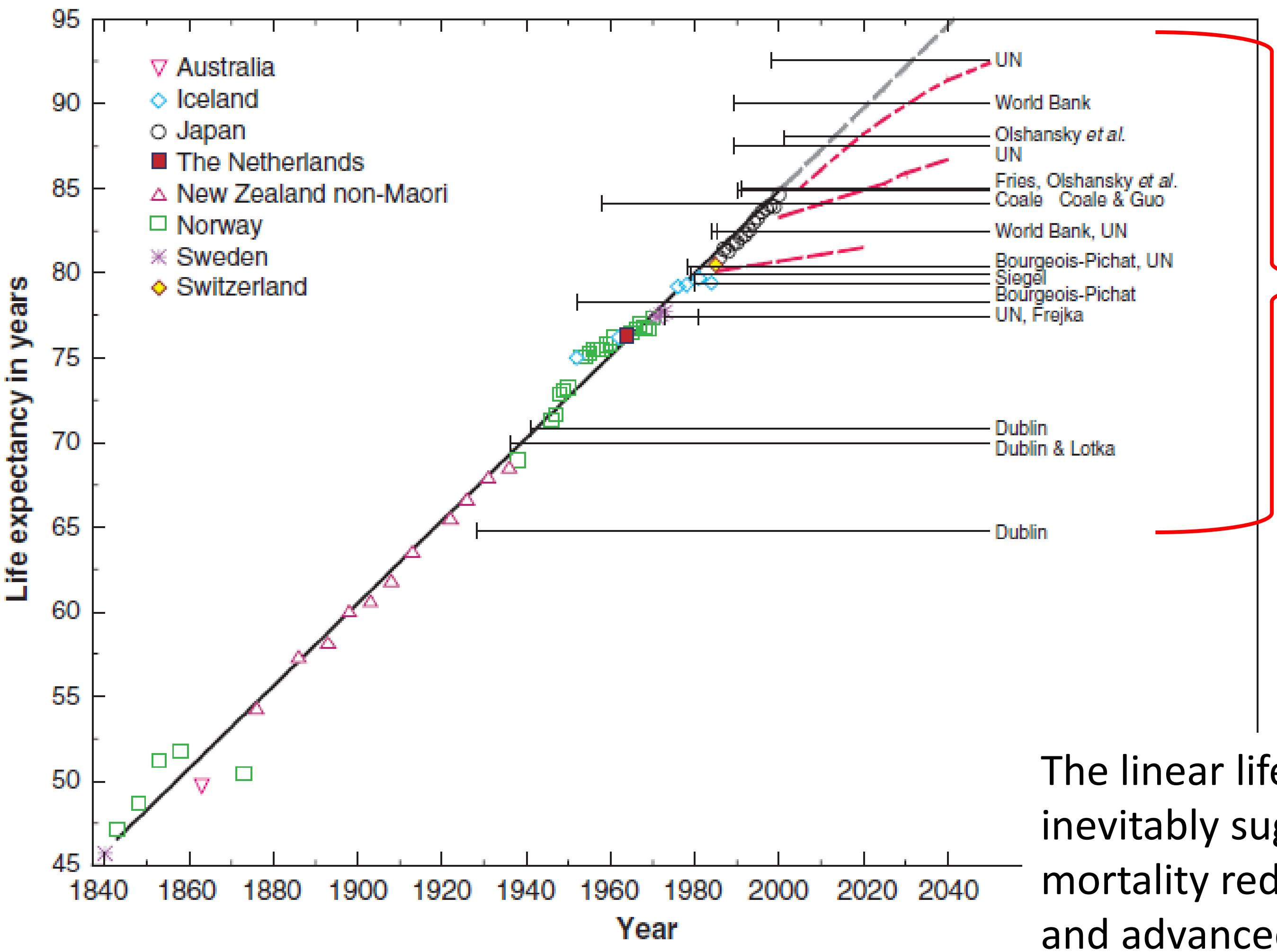
Life expectancy at age 80 since 1880



Success in fight with CVD and other "degenerative" diseases led to spread of mortality reduction toward very old ages.

Source: Built on HMD data.

Discovery of the linear life expectancy increase



Upper limits of life expectancy suggested by researchers in different years

Source: Oeppen and Vaupel, 2002.

The linear life expectancy increase inevitably suggests spread of mortality reduction toward very old and advanced ages.

New data requirements

Questions:
What are the prospects of the longevity rise and population aging?
What are the major components, determinants, and consequences of rising longevity and population aging?

⇓

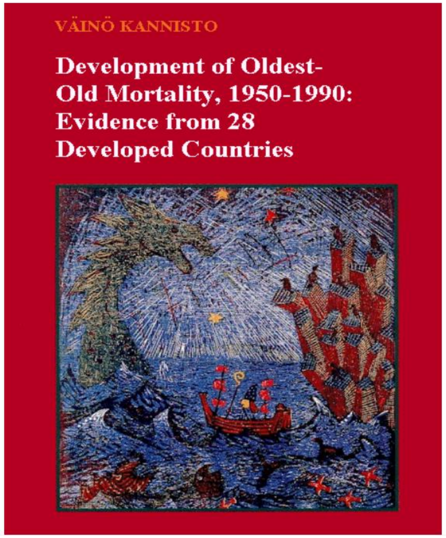
Demography addresses these questions through in-depth analyses and modeling of longevity and survival in human populations with a special emphasis on advanced (frontier) ages.

⇓

Need for data that could reflect historical transformations of the mortality curve and the longevity revolution of the modern era by:
- providing long-term continuous series without gaps or ruptures;
- running up to the highest ages;
- providing fine details according to age, time, and cohort dimensions;
- ensuring sufficient quality and comparability across time and populations.

The international databases of the 1990s did not meet these criteria. HMD does.

1990s: V.Kannisto, R.Thatcher and J.Vaupel begin filling the gap



Development of oldest-old mortality, 1950-1990: Evidence from 28 Developed Countries

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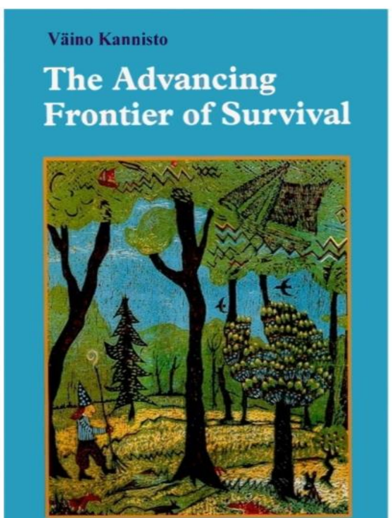

The Advancing Frontier of Survival

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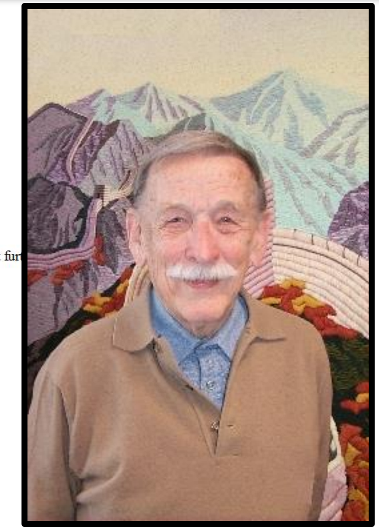

Väinö Kannisto

Roger Thatcher

James W. Vaupel

In 1994-96 Väinö Kannisto produced two books documenting advances in survival and longevity on the basis of data from 28 developed countries.

The books contained numerous and detailed data tables. In 1988-2001 Thatcher, Vaupel and Kannisto published important works on old-age survival, assessment of data quality, and re-estimation of populations aged 80+.

BMD and K-T DB: predecessors of HMD

BERKELEY MORTALITY DATABASE

- Introduction
- Overview
- User Agreement

Data by Country:
- France
- Japan
- Sweden
- United States

home *e-mail*

The Berkeley Mortality Database

Important note: The Berkeley Mortality Database (BMD) has been replaced by a bigger and better project, known as the Human Mortality Database (HMD). HMD data are superior for most purposes, so we are leaving BMD data here on a temporary basis, mostly for comparison purposes. However, some items within the BMD are not yet available within the HMD or elsewhere, including:

1. Japanese cause-of-death data
2. U.S. life tables from the Social Security Administration (SSA)
3. U.S. decennial life tables from National Center for Health Statistics
4. U.S. detailed data by race
5. Swedish period life tables for 1751-1860
6. Swedish cohort life tables

Items 4, 5, and 6 will become available within HMD very soon. Items 2 and 3 will be moved to the Human Lifetable Database, a companion project to the HMD, within a few months. (In addition, we are in the process of updating our copies of the SSA life tables.) At this time, we have no plans to update Item 1, but it will continue to be available here or at some other location in the future.

Welcome! This database was established in 1997 by Prof. John R. Wilmoth of the Department of Demography at the University of California, Berkeley. Construction of the database is supported by a grant from the National Institute on Aging as a means of advancing research on human longevity. Our goal is to assemble a large and detailed collection of mortality data for national populations and to make those data easily accessible to researchers around the world. We are hoping to add data for several more countries over the next few years.

We have tried to provide complete documentation for all data available through this site, although it is a daunting task. Start by reading an Overview of how individual data sets are constructed. More detailed documentation, including sources of the data, is organized by country (follow the links in each section). You are welcome to download and analyze any data posted here. However, before using these data in any way, please read our short User Agreement. Thank you!

Maintained by: Pierre Vachon Last updated: 09/10/2005 18:05:01

The Berkeley Mortality Database launched in 1997 by John R. Wilmoth (Dept. of Demography at UCB). Four countries. Data up to age 110. Single-year divide by age, time, year of birth. Variety of age by time format: 1x1, 5x1, 5x5, …

Kannisto-Thatcher Database on Old Age Mortality
at the Max Planck Institute for Demographic Research

[Methodology | Explanation of data files | Data Map (MS Excel)]

[Introduction | Project Team | Acknowledgements | Contact]

Australia	Austria	Belgium
Canada	Chile	Czech Republic
Denmark	England & Wales	Estonia
Finland	France	Germany
Germany East	Germany West	Hungary
Iceland	Ireland	Italy
Japan	Latvia	Lithuania
Luxemburg	Netherlands	New Zealand
New Zealand (non Maori)	Norway	Poland
Portugal	Scotland	Slovakia
Slovenia	Spain	Sweden
Switzerland	USA	

Analysis Toolkit

[Return to last page | Return to Home Page]

The Kannisto-Thatcher database launched in 2001 MPIDR. 30 countries. Covers ages 80 to 110+. Follows the Kannisto's approach for re-estimation of populations at ages 80+.

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- Data problems
- Enhancement of the methodology
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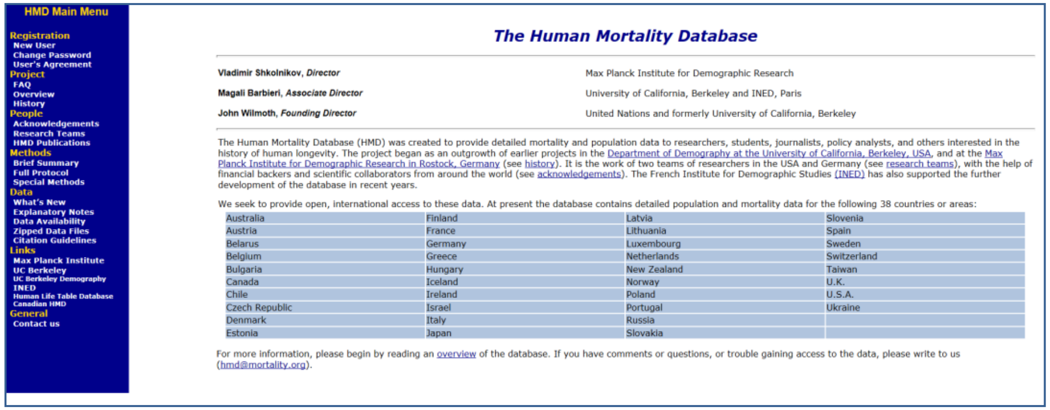
HMD: basic facts



HMD Main Menu

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The Human Mortality Database

Vladimir Shkolnikov, *Director* — Max Planck Institute for Demographic Research

Magali Barbieri, *Associate Director* — University of California, Berkeley and INED, Paris

John Wilmoth, *Founding Director* — United Nations and formerly University of California, Berkeley

The Human Mortality Database (HMD) was created to provide detailed mortality and population data to researchers, students, journalists, policy analysts, and others interested in the history of human longevity. The project began as an outgrowth of earlier projects in the Department of Demography at the University of California, Berkeley, USA, and at the Max Planck Institute for Demographic Research in Rostock, Germany (see history). It is the work of two teams of researchers in the USA and Germany (see research teams), with the help of financial backers and scientific collaborators from around the world (see acknowledgements). The French Institute for Demographic Studies (INED) has also supported the further development of the database in recent years.

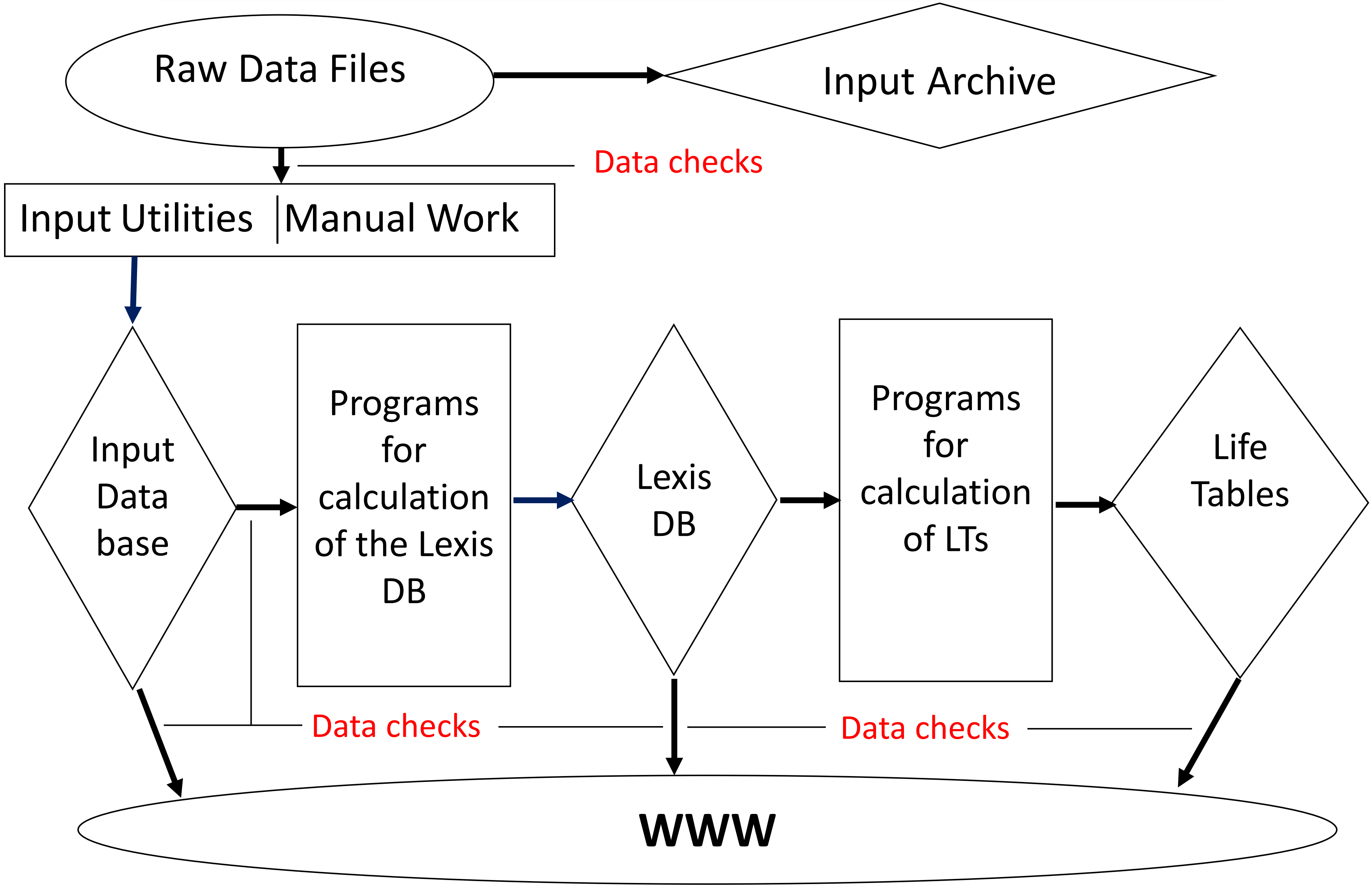
We seek to provide open, international access to these data. At present the database contains detailed population and mortality data for the following 38 countries or areas:

Australia	Finland	Latvia	Slovenia
Austria	France	Lithuania	Spain
Belarus	Germany	Luxembourg	Sweden
Belgium	Greece	Netherlands	Switzerland
Bulgaria	Hungary	New Zealand	Taiwan
Canada	Iceland	Norway	U.K.
Chile	Ireland	Poland	U.S.A.
Czech Republic	Israel	Portugal	Ukraine
Denmark	Italy	Russia	
Estonia	Japan	Slovakia	

For more information, please begin by reading an overview of the database. If you have comments or questions, or trouble gaining access to the data, please write to us (hmd@mortality.org).

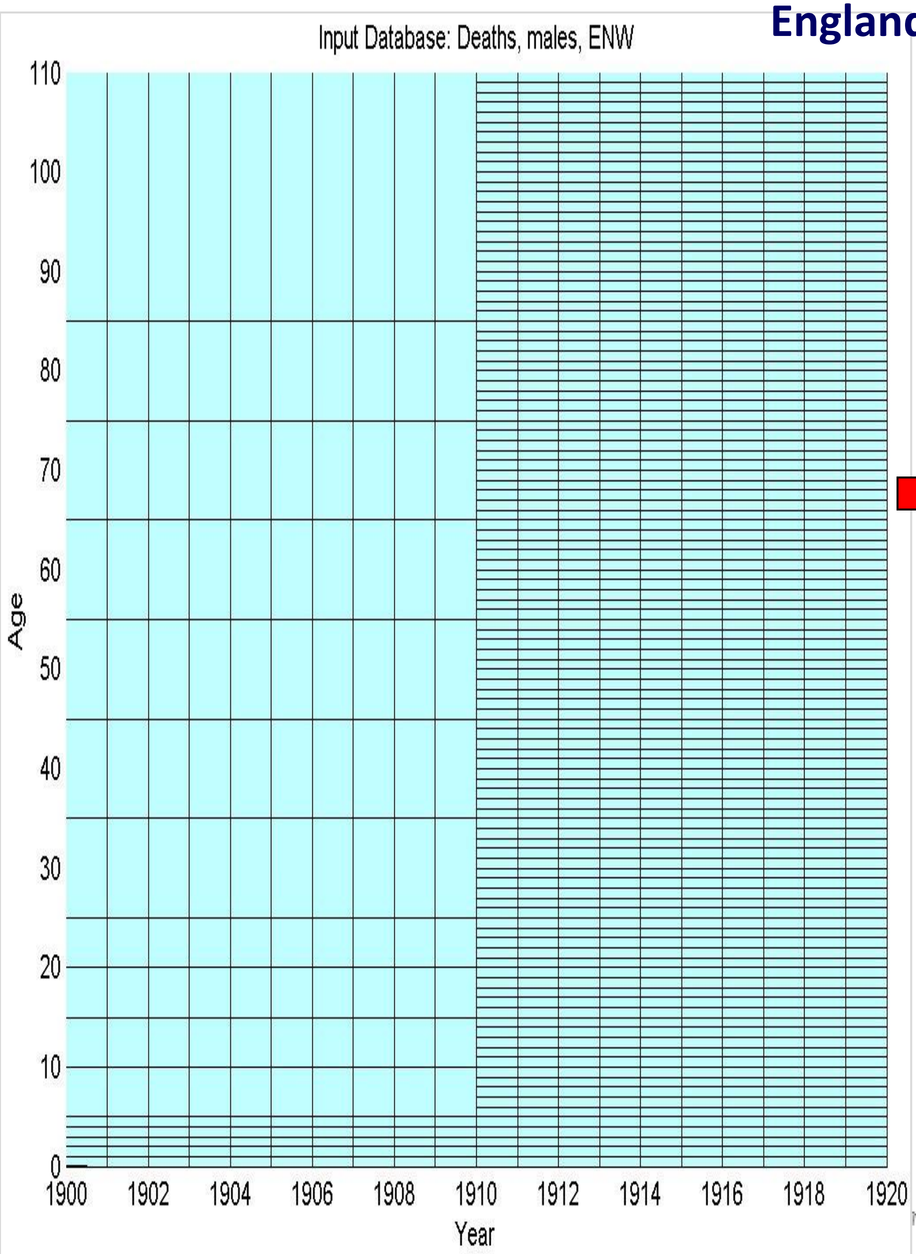
- Work began in autumn 2000
- Launched online in May 2002 with 17 country series
- Now: 38 countries and 8 regions, 30,000+ users
- Comparability across time and space
- Continuous, long-term series without gaps or ruptures
- Data by age, year, cohort, in age-by-time formats 1x1, 5x1, 1x5 etc.
- Uniform data files compatible with stat. packages, research applications, and Excel
- Detailed documentation on origins and quality of the data

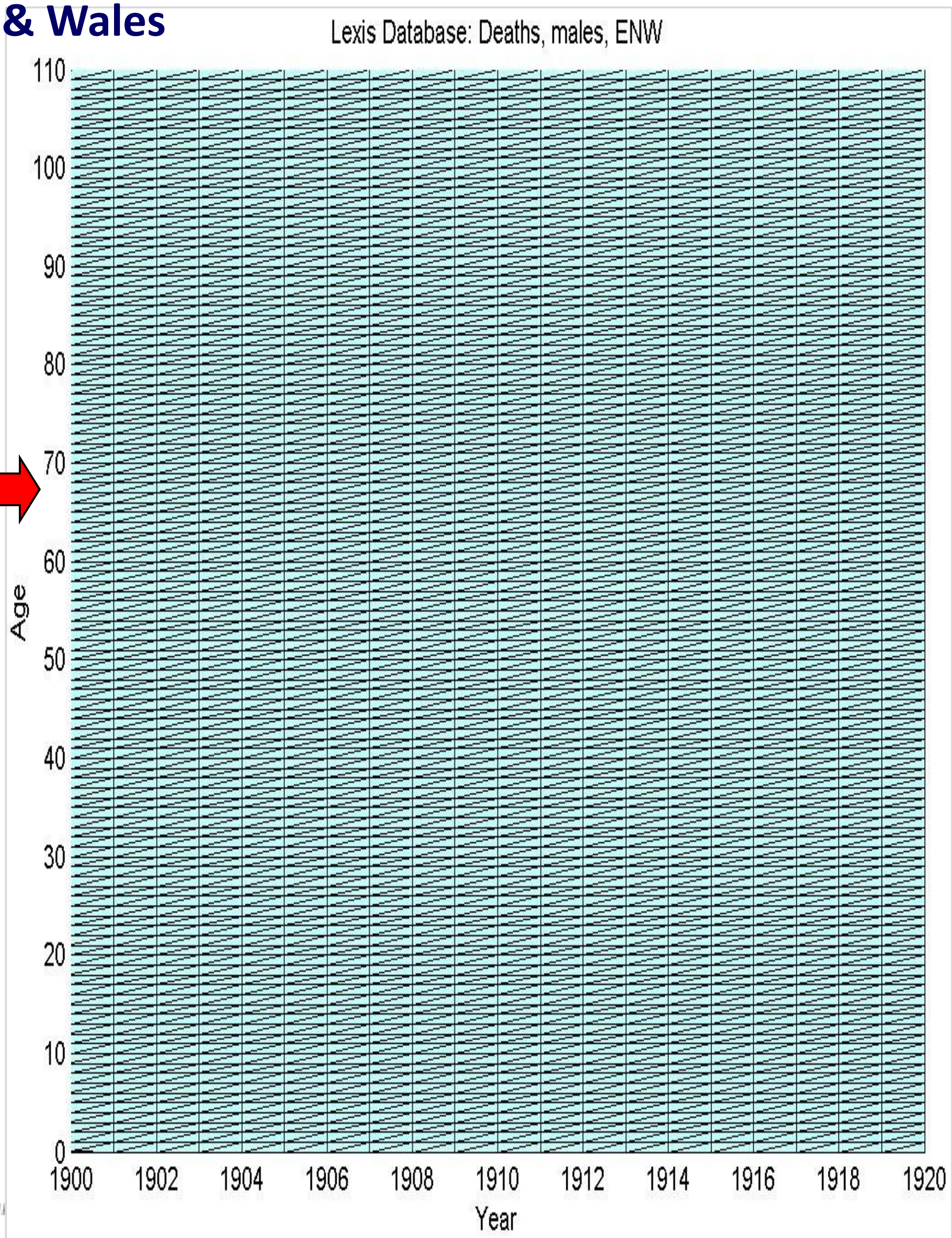
Processing of raw data into Lexis surface in the HMD



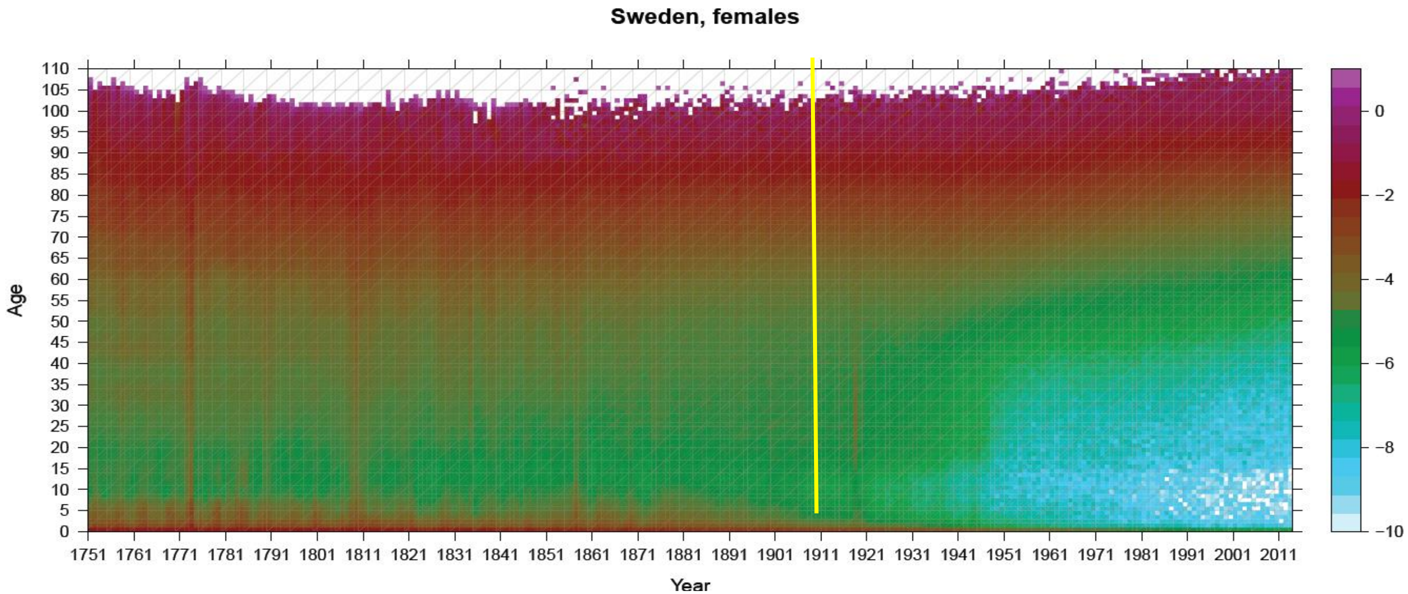
Processing of raw data into Lexis surface in the HMD

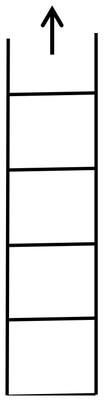
England & Wales

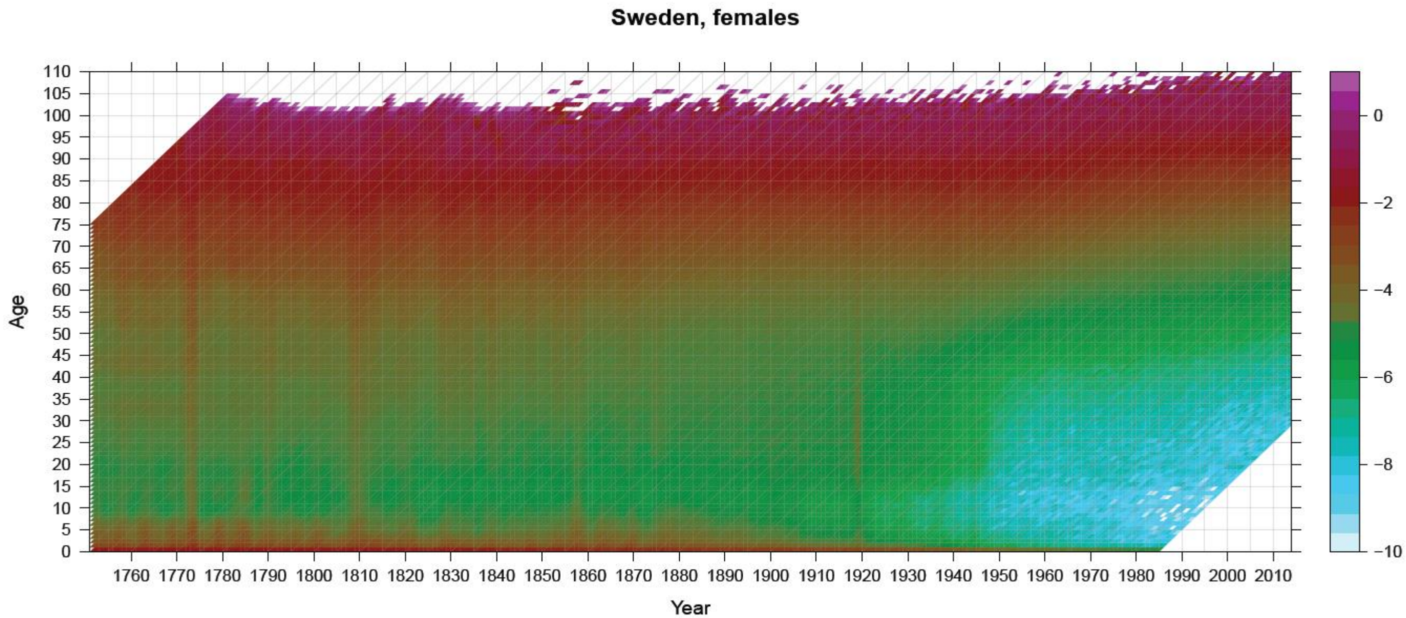


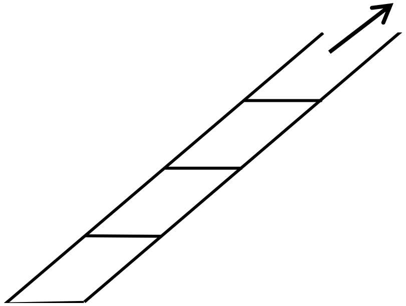


Lexis surfaces of period and cohort mortality



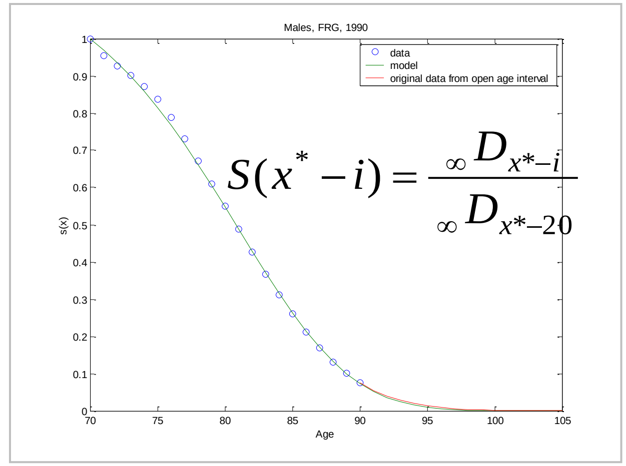






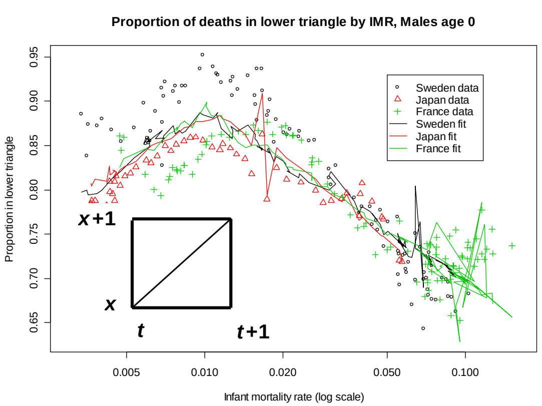
What HMD does for its users. Work behind output data.

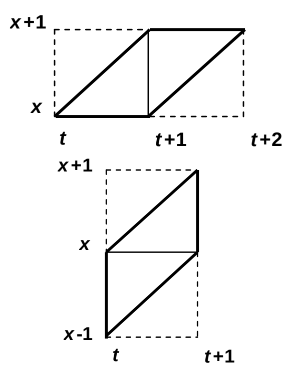
- Collects and provides official raw data for as many countries and years as possible at the highest possible level of detail.
- Analyzes existing evaluations and literature and performs checks to ensure relevance, coverage, completeness, and consistency of the raw data.

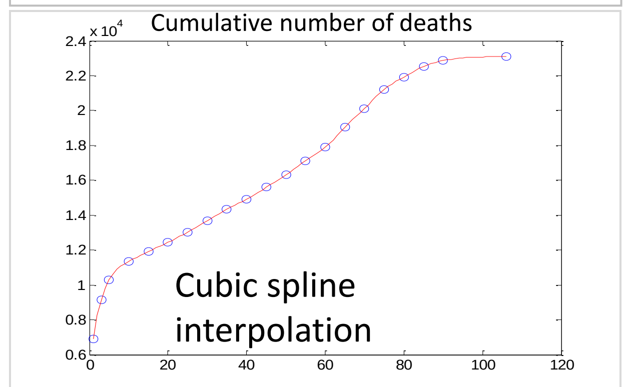


$$S(x^* - i) = \frac{{}_{\infty}D_{x^*-i}}{{}_{\infty}D_{x^*-20}}$$

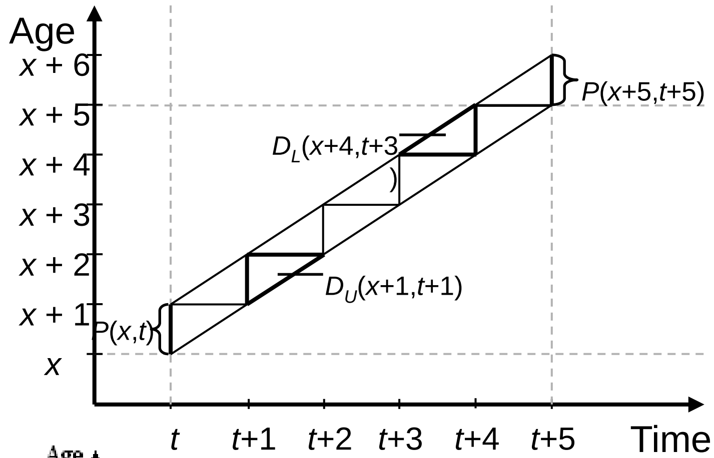
- If needed, splits deaths at unknown age and deaths in open-ended age intervals by single-year ages.
- If needed, splits deaths in 5-yr age groups into single-year age intervals and further splits single-year deaths by birth cohort.



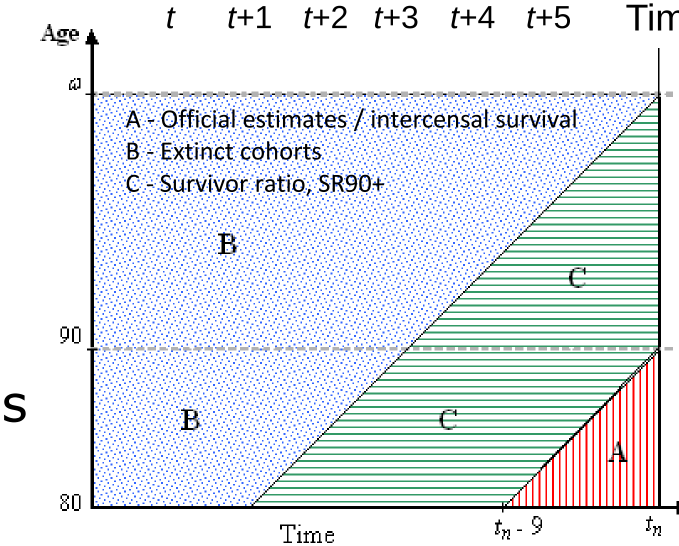




What HMD does for its user.
Work behind the output data (cont.)



- If official annual population estimates are not available or not fully reliable, constructs inter-, post- and pre-censal population estimates.



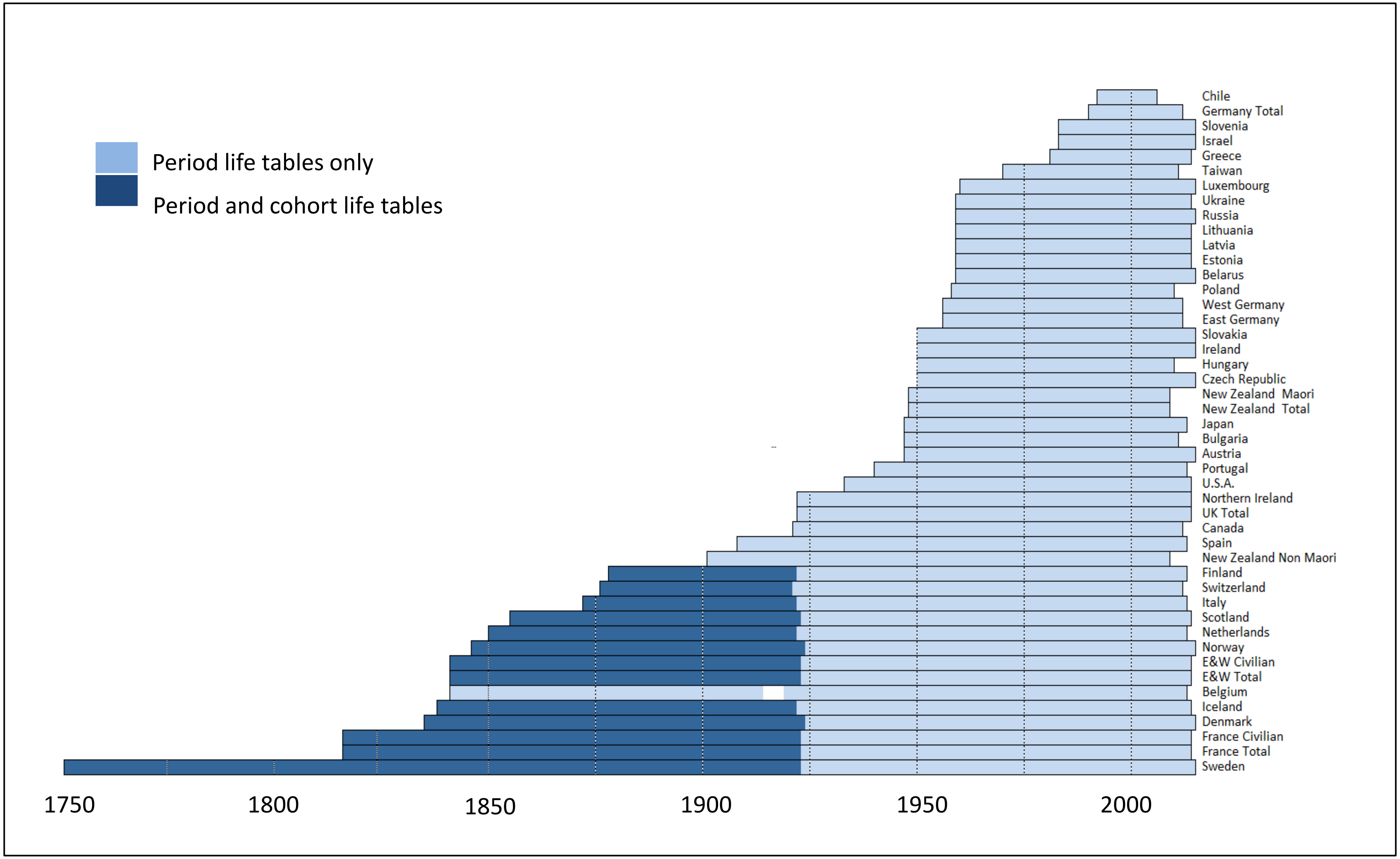
- Constructs more accurate population estimates at ages 80+ by the extinct cohort method combined with the survivor ratio method.

- Computes period and cohort death rates life tables.
- Checks the output data for internal consistency and internal and external plausibility.

What HMD does for its user.
Work behind output data (cont. 2)

- Adjusts for territorial changes, changes of coverage, and population definition.
- Provides data on important regions and sub-populations within countries (e.g. Germany East and Germany West, NZ Maori and NZ non-Maori etc.).
- Provides additional estimates and adjustments for some countries:
    - Constructs mortality and population estimates over war periods for the total (civil + combat) populations.
    - Corrects problems at advanced ages by using additional higher-quality sources.
    - Makes country-specific adjustments to correct inconsistencies in time series.
- Fully describes data origins, sources and highlights quality issues in the country-specific “Background and Documentation” files.
- Provides special warnings pointing at problems which are not treated by the HMD methodology and remain in the output data.

HMD: available data



Period and cohort mortality data series across time and populations

Source: An updated version of the data map by Barbieri et al, 2015

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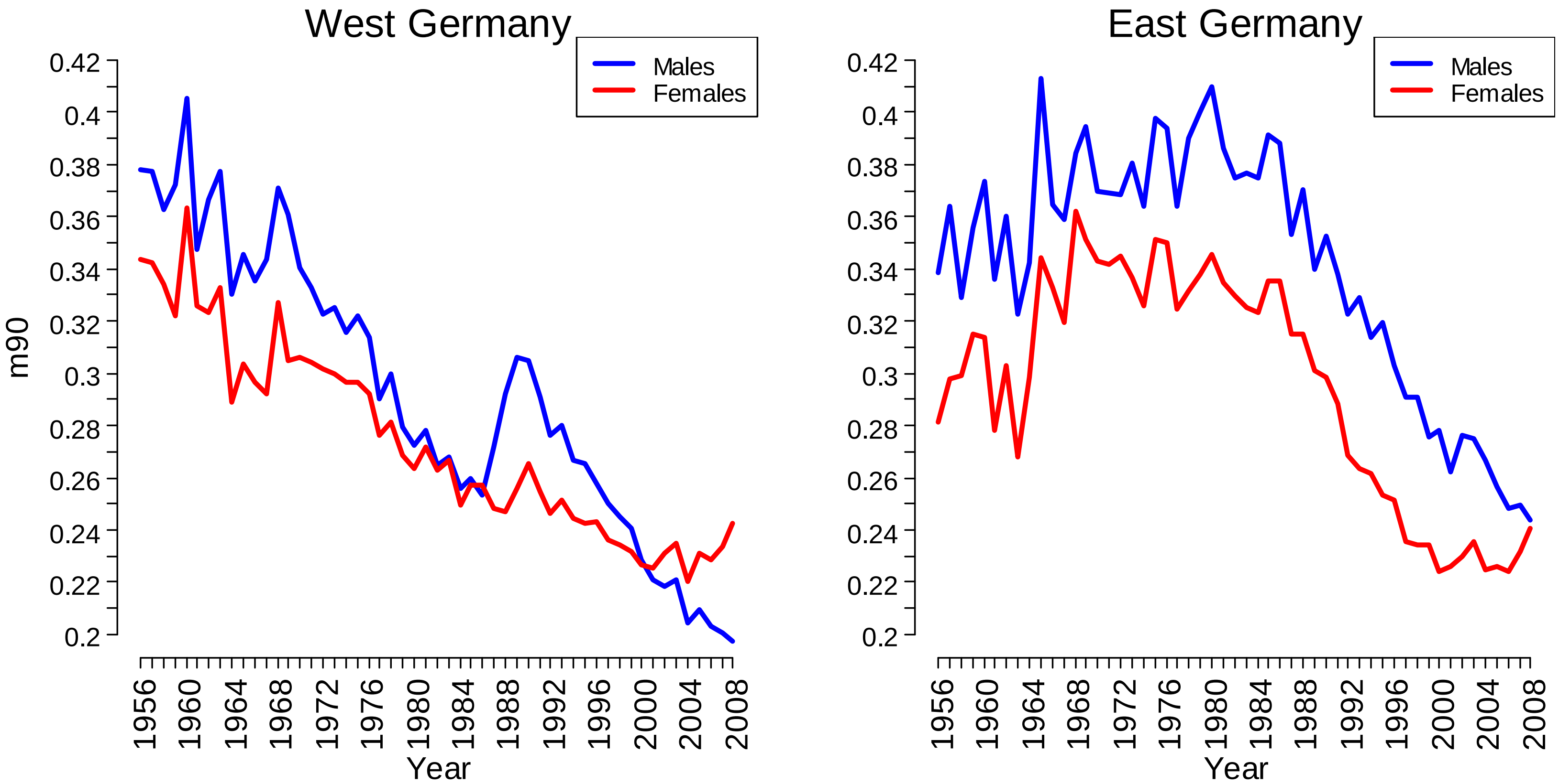
Germany: implausible mortality trends at very old ages

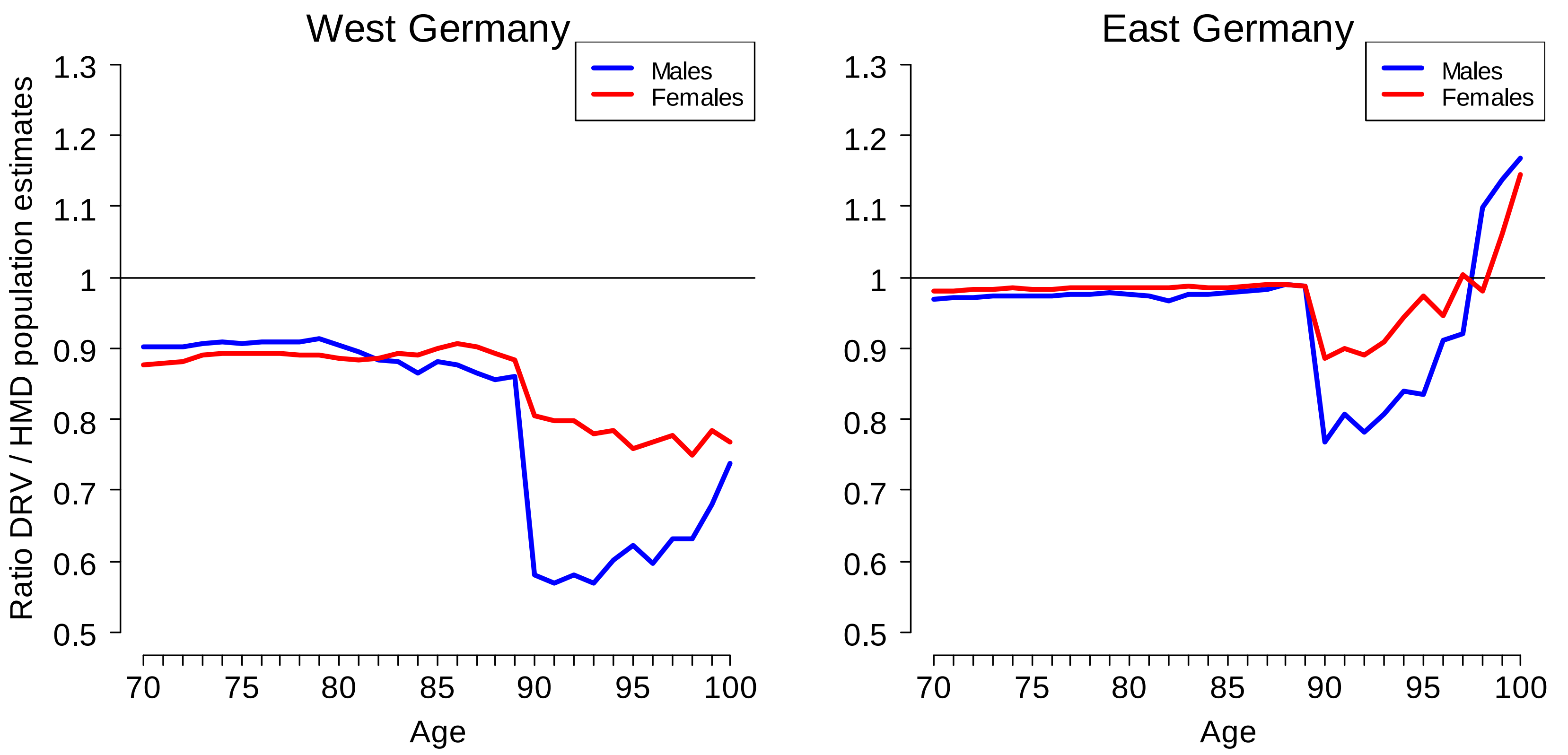


Trends in death rates at ages 90+, calculated from the official population estimates, for West and East Germany, males and females, 1956-2008.

Germany: inflated population denominator at ages 90+

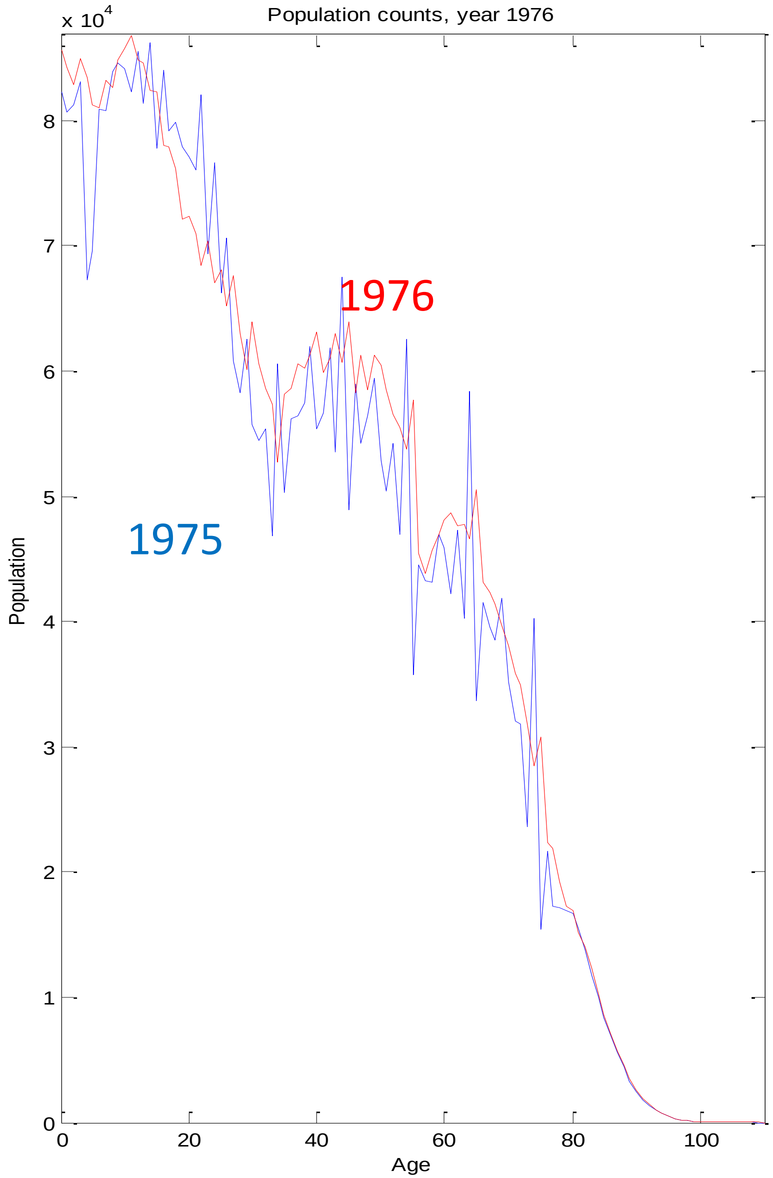
The problem was solved by using estimates of old-age populations by the *Deutscher Rentenversicherung Bund* (DRV) - the German Pension Scheme, and (later on) of the 2011 census.

Ratio of DRV population by age to respective HMD estimates based on the official data, 2009.

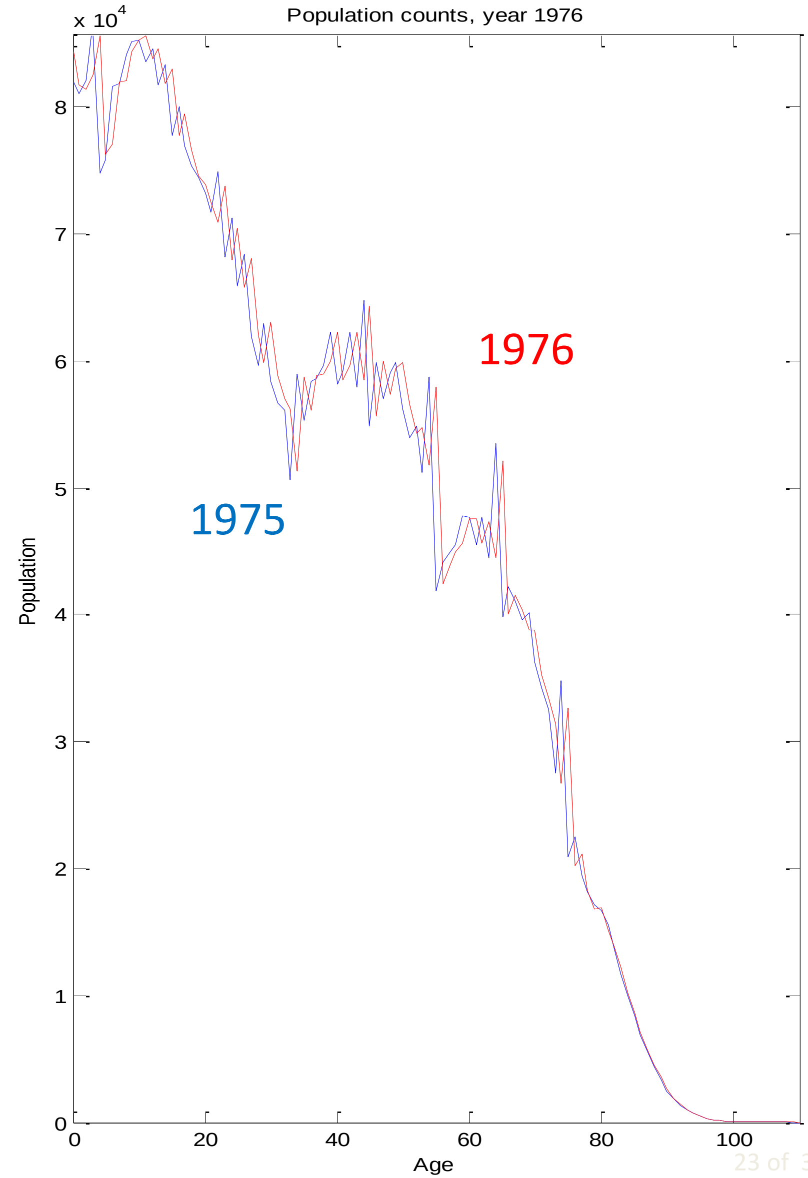


Portugal: correction of population series for the 1970s

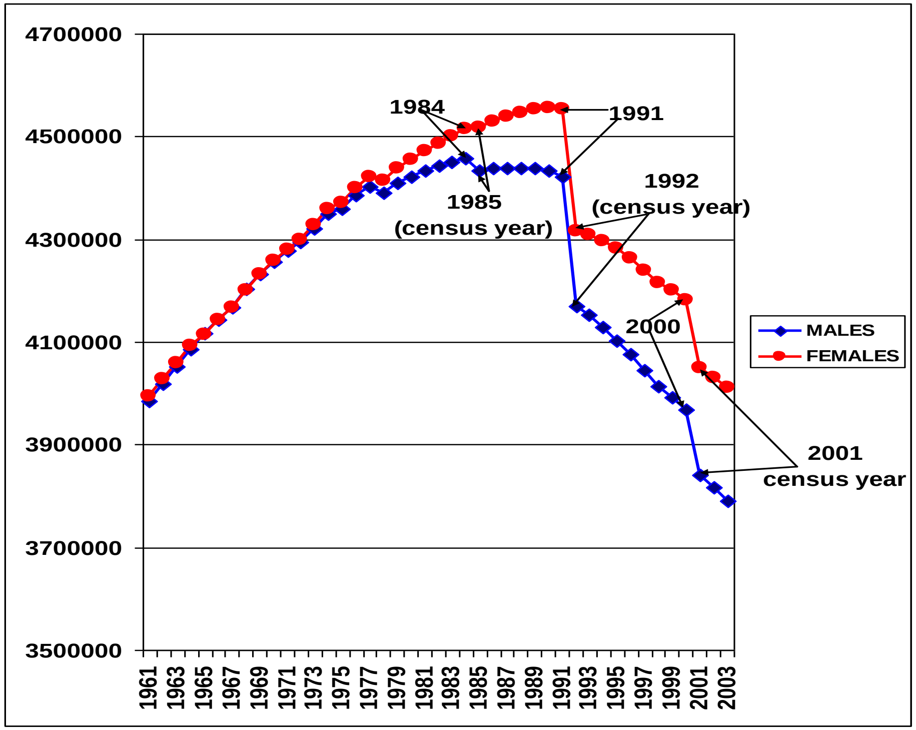
Current population estimates

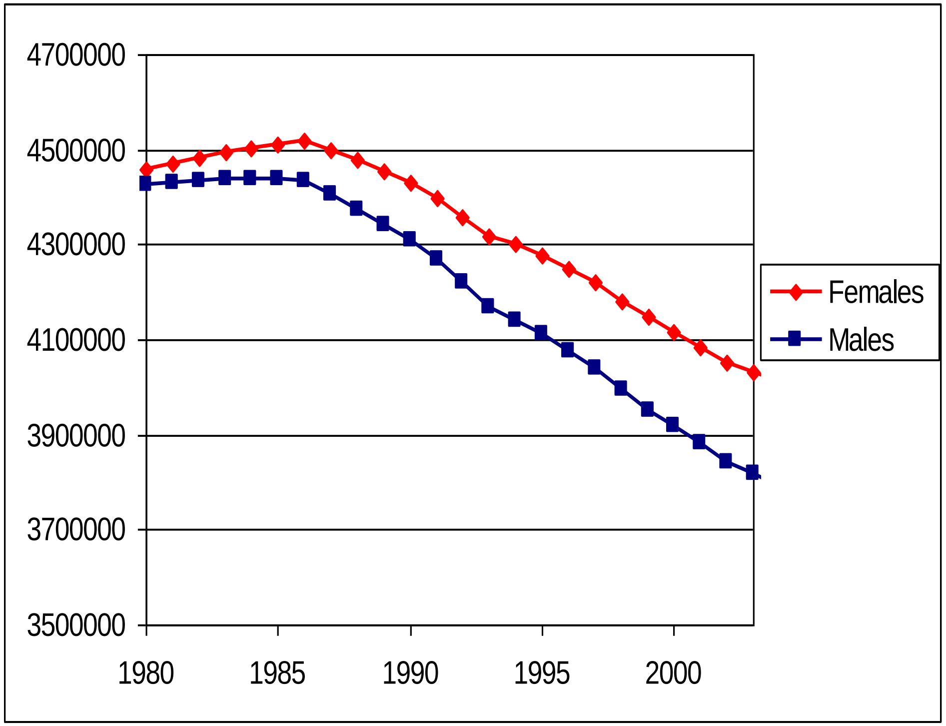


HMD inter-censal estimates



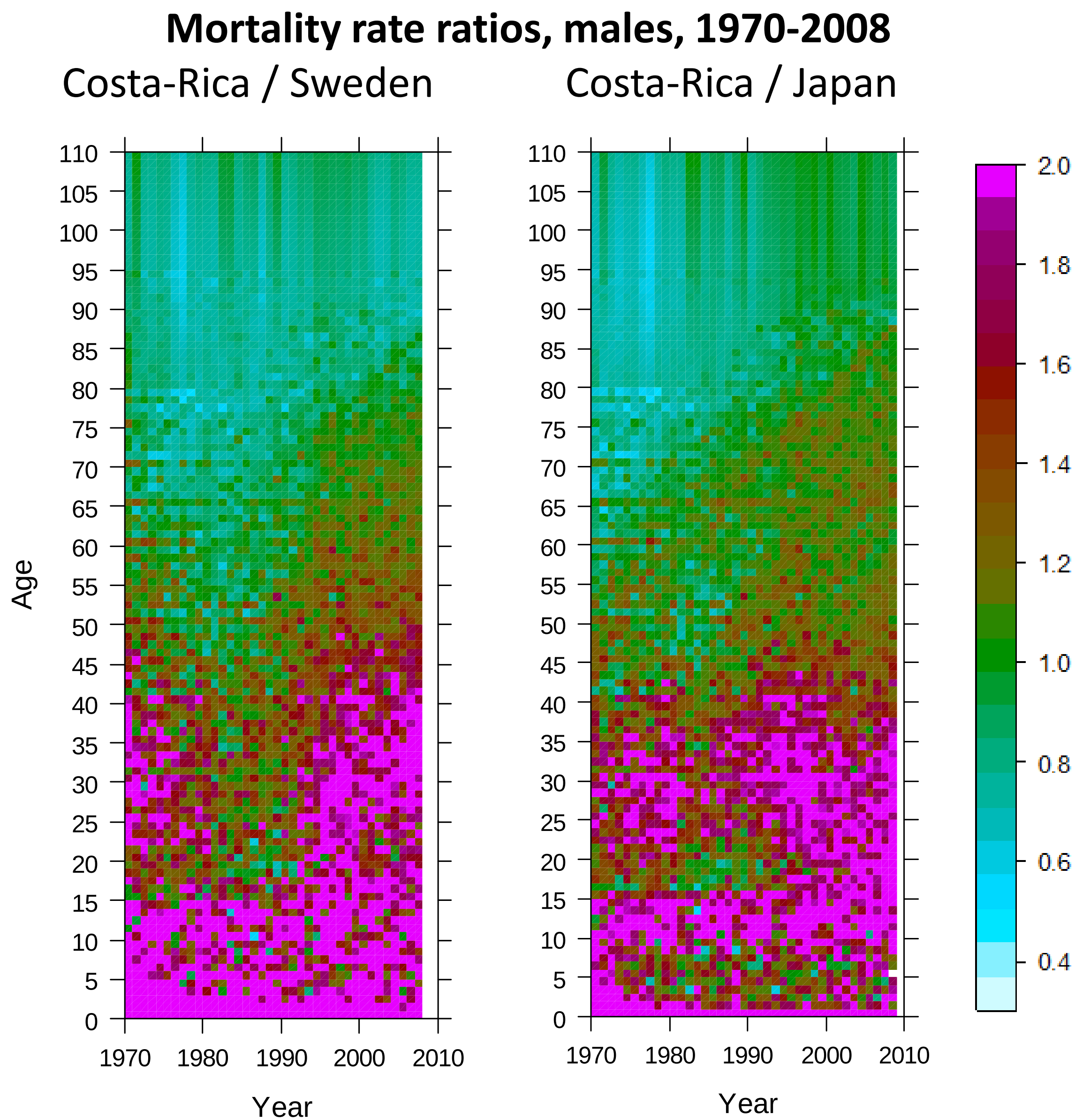
Bulgaria: correction of population series over the 1990s and the 2000s





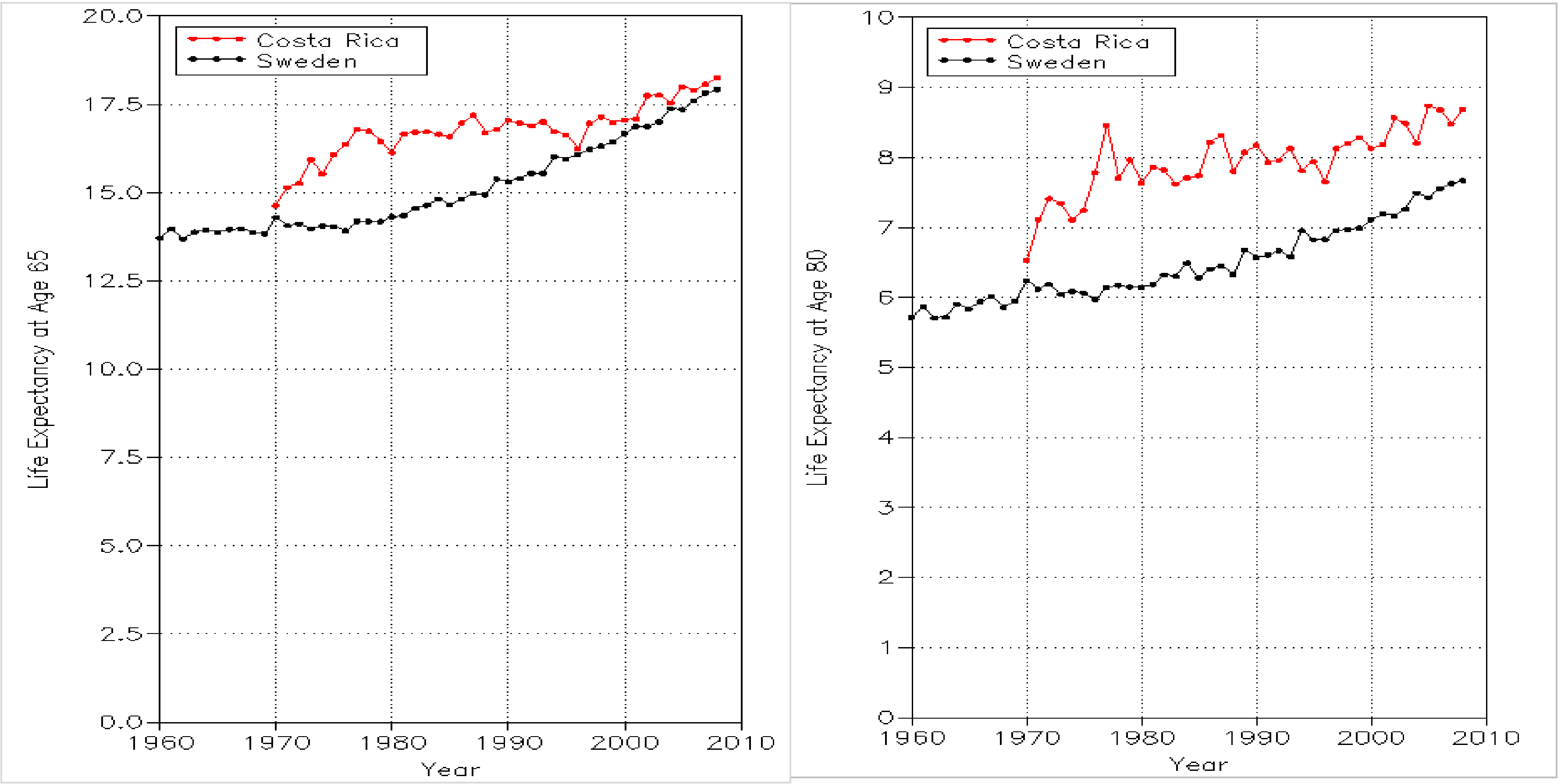
Trends in the total number of males and females. Bulgaria, 1961-2003. Official population estimates (left) and HMD data (right).

An HMD candidate country Costa-Rica. Mortality understatement at old ages



Evidence of age overstatement and age heaping for the whole series

Costa-Rica: overstated life expectancy at ages 65 and 80



Trends in male life expectancy at age 65 (left panel) and age 80 (right panel) in Costa Rica

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Beginning of the HMD Methods Protocol

Draft: October 30, 2000

Methods Protocol for the Core Section

of the Database-That-Has-No-Name

John R. Wilmoth et al.

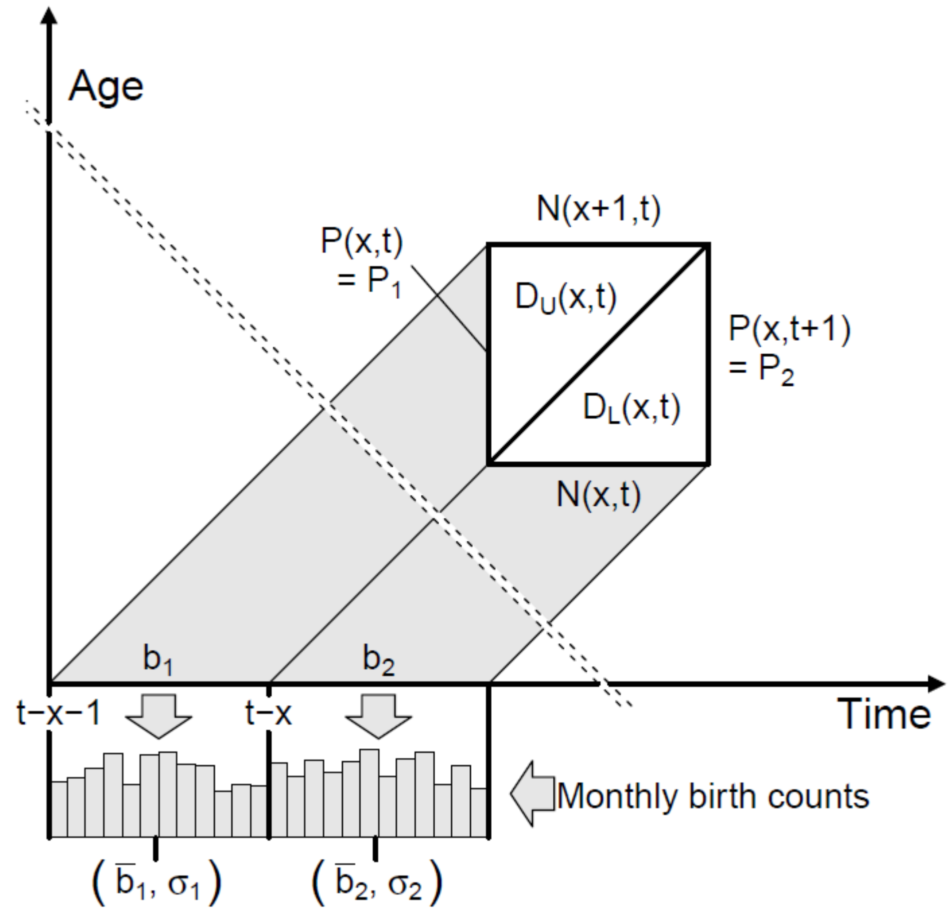
The Database-That-Has-No-Name (DTHNN) is a collaborative project involving researchers at the University of California at Berkeley (United States) and the Max Planck Institute for Demographic Research (Rostock, Germany). When complete, the core section of the database will contain life tables for about 30 advanced industrialized countries (on 4 or 5 continents) and the raw data used in constructing those tables.[1] The raw data generally consist of birth and death counts from vital statistics, plus population counts from periodic censuses.[2] Both general documentation and the individual steps followed in computing mortality rates and constructing life tables are described here. More detailed information – for example, sources of raw data, specific adjustments to raw data, and comments about data quality – will be covered separately in the documentation for each country.

The scope of the present discussion is limited to total mortality and to period life tables based on raw data available in 1-year age categories (or Lexis triangles for deaths, when available). In other words, we will not deal (yet) with the following issues: (1) cohort life tables, (2) raw data in broad (e.g., 5-year) age groups, except for an open category at the highest ages (e.g., ages 100 and above), and (3) causes of death. These topics will be addressed and resolved later on – in future versions of this document and during future discussions.

Revisions of the HMD MP

- **Revisions 1-2 not published**
- **Revision 3 (May 2002)** is the first published version. The fist (published) HMD data were calculated according to the MP v.3
- **Revision 4 (November 2005)**:
  - Changed method for splitting deaths into Lexis triangles;
  - Revised method for splitting open age interval;
  - Revised formula for population exposure;
  - Revised procedure for smoothing M(x).
- **Revision 5 (February 2007)**:
  - Various places through MP, changed "country"/"countries" to "country or area"/"population“;
  - Inaccuracies in some equations corrected;
  - Cubic spline method modified to split VV data.
- **Revision 6 (2016)**:
  - Changed method for calculating population exposures;
  - Changed method for calculating the mean age of infant death;
  - MP re-written in LaTEX
- **Revision 7** – work in progress

MP6: Population exposure accounting for variation in cohort's birthdays



$$E_L(x,t) = s_1 P(x,t+1) + s_2 D_L(x,t)$$

and

$$E_U(x,t) = u_1 P(x,t) - u_2 D_U(x,t)$$

The coefficients s_1, s_2, u_1 and u_2 are calculated using informatic birthdays within annual cohorts, which we approximate using dat males and females combined:

$$s_1 = 1 - \bar{b}_2 \quad (53)$$

$$s_2 = \frac{\bar{b}_2}{2} - \frac{\sigma_2^2}{2(1-\bar{b}_2)} \quad (54)$$

$$u_1 = \bar{b}_1 \quad (55)$$

$$u_2 = \frac{\bar{b}_1}{2} - \frac{\sigma_1^2}{2\bar{b}_1} \quad , \quad (56)$$

MP6: New formula for a_0 accounting for change in infant death distribution at low levels of mortality

Table 1: Andreev-Kingkade formulas for computing a_0 given m_0

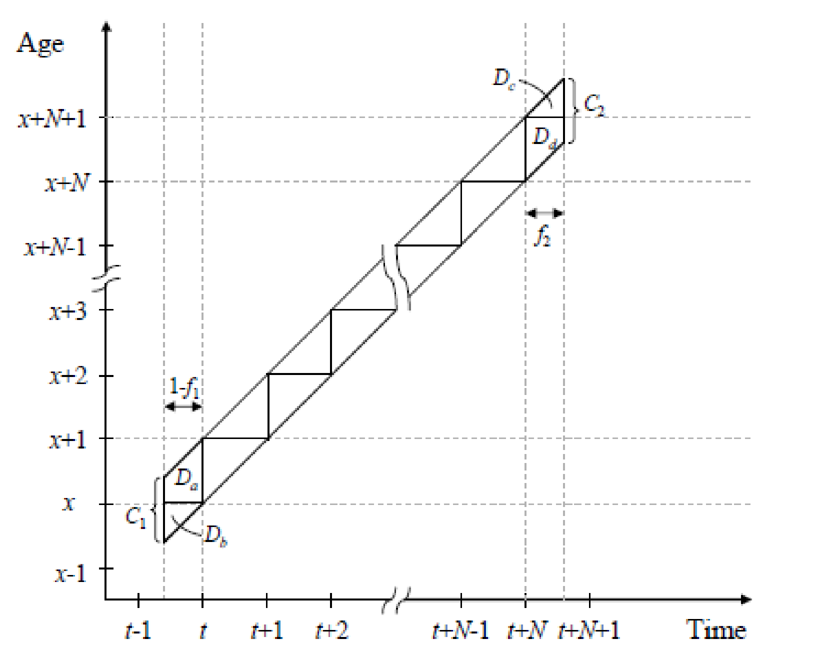
m_0 range	formula: $a_0 = a + b \cdot m_0$
Males	
$[0, 0.0230)$	$0.14929 - 1.99545 \cdot m_0$
$[0.0230, 0.08307)$	$0.02832 + 3.26201 \cdot m_0$
$[0.08307, \infty)$	0.29915
Females	
$[0, 0.01724)$	$0.14903 - 2.05527 \cdot m_0$
$[0.01724, 0.06891)$	$0.04667 + 3.88089 \cdot m_0$
$[0.06891, \infty)$	0.31411

Source: E.Andreev and Kingkade, 2015

Some ideas for MP7

- New inter-censal survival method accounting for uneven migration across time.

Figure 4a: Intercensal survival method: pre-existing cohorts (in general)



$$P(x+n, t+n) = C_1 - (D_a + D_b) + \frac{1 - f_1 + n}{N + 1 - f_1 + f_2} \Delta_x - \sum_{i=0}^{n-1} D_i^{\mathrm{v}}(x, t)$$

- Computation of death rates by Lexis triangles $M(x, t, c)$.

- Reasons for and origins of the HMD
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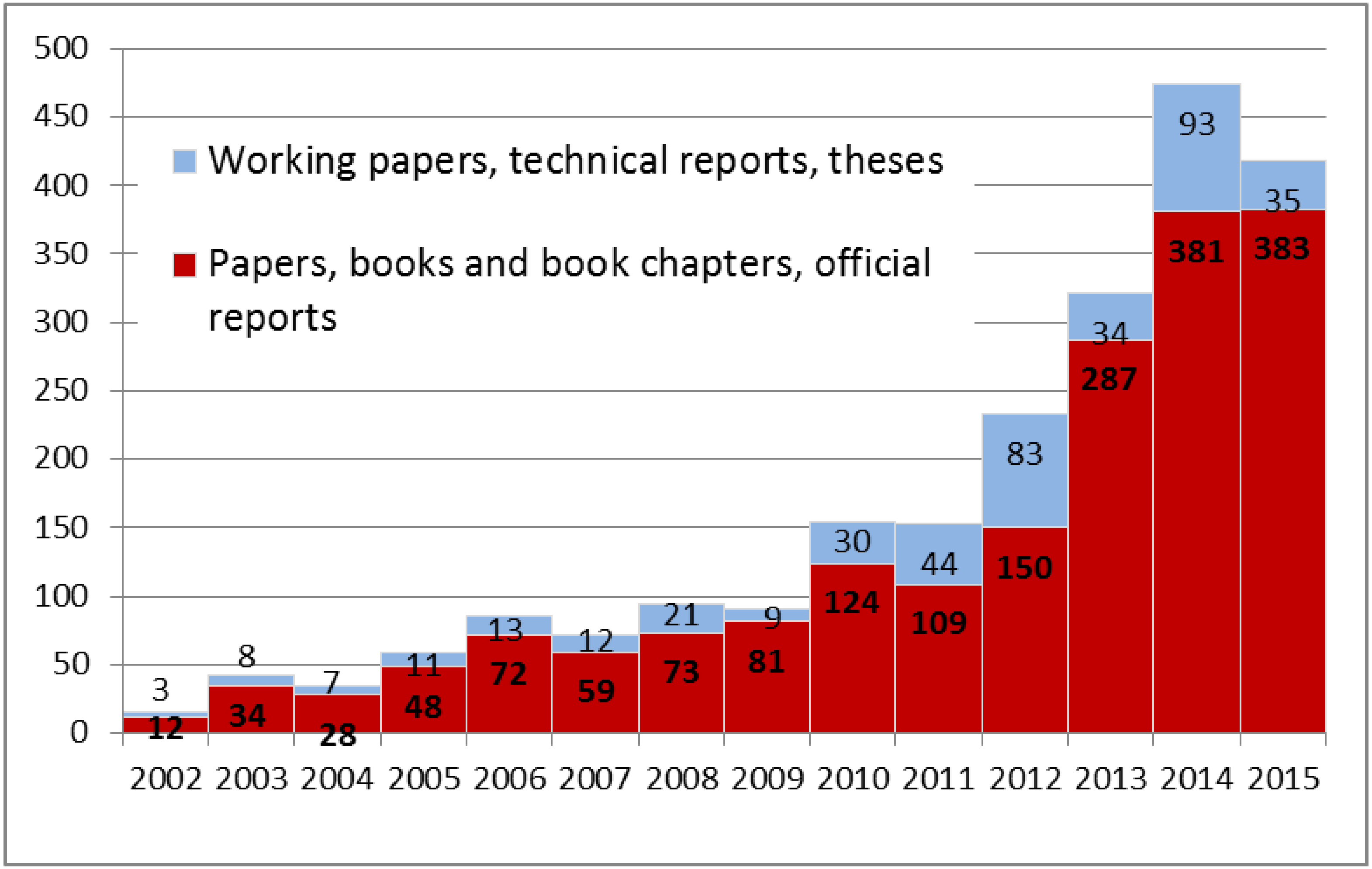
- Enhancement of the methodology
- HMD-based studies
- Research teams

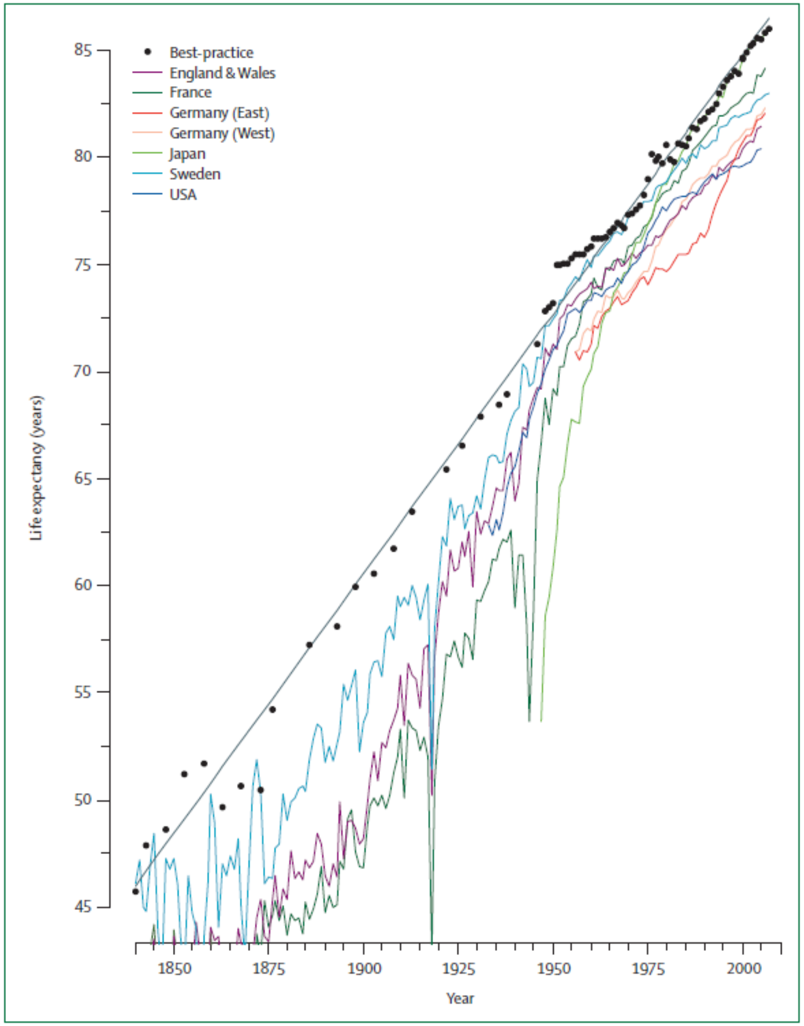
HMD citing



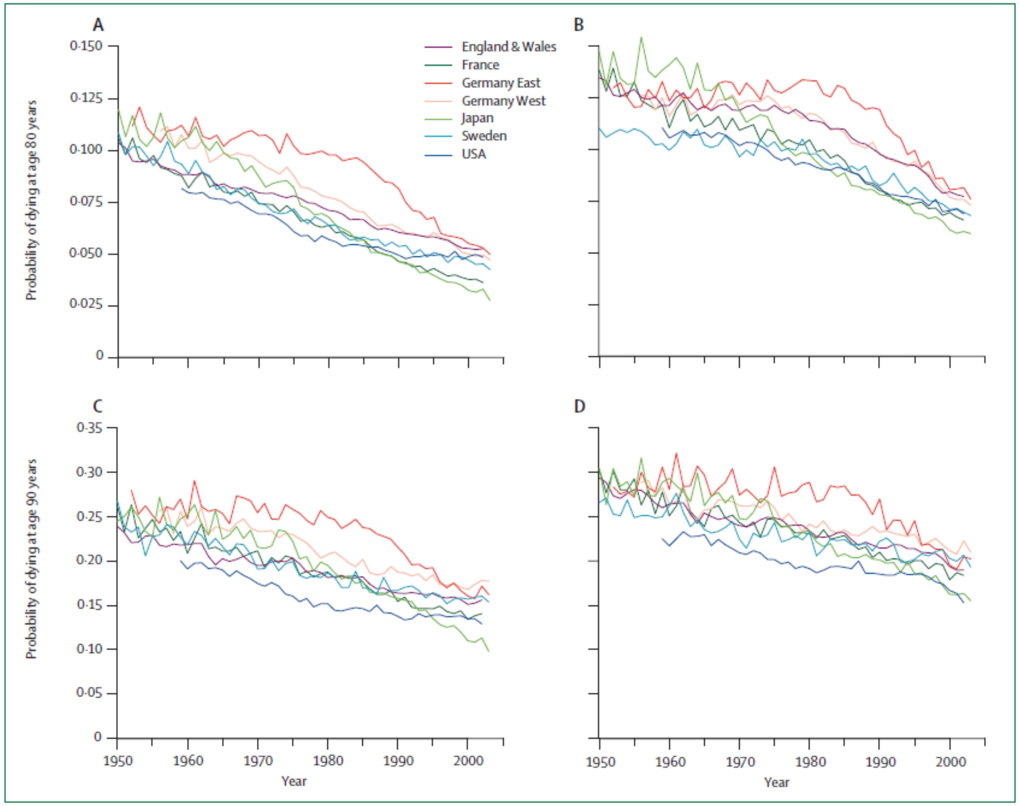
Total 2002-2015:
All items - 2,244
Journal papers - 1,766

Studies on advances in survival with emphasis on old and very ages

The best-practice and country-specific life expectancies since 1846



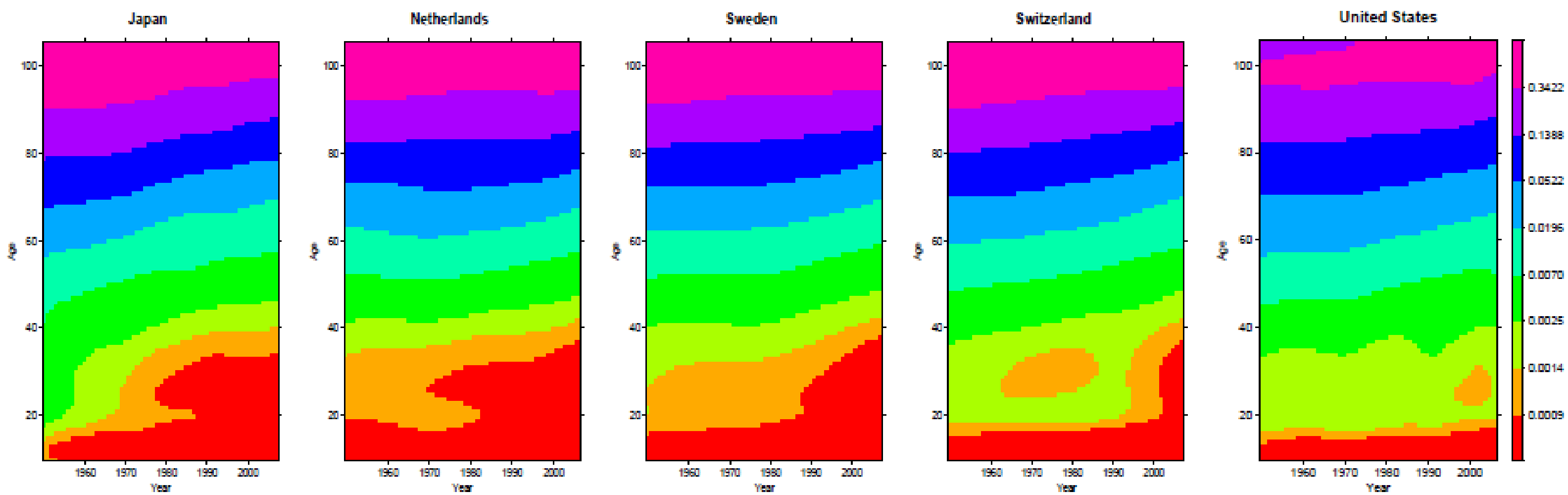
Probabilities of death at ages 80 and 90 since 1950



Source: Christensen, Doblhammer, Rau, Vaupel, 2009

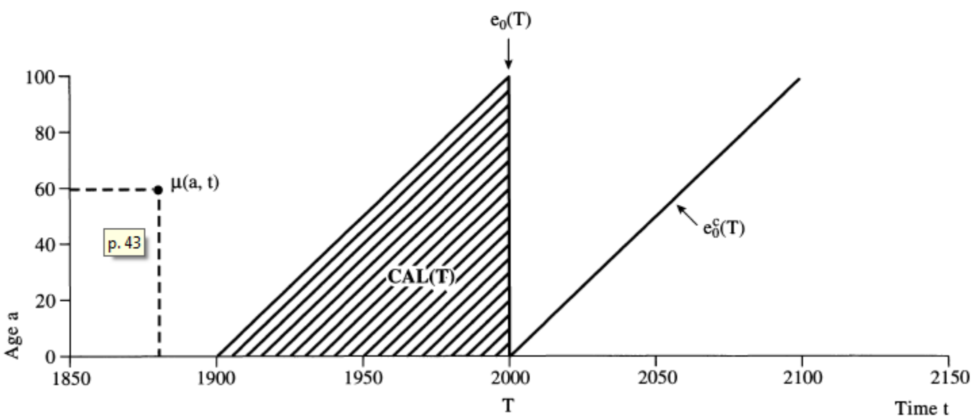
Analyses and measures on mortality surfaces

Smoothed mortality surfaces for selected countries: 1950-2010



Source: Ouellette and Bourbeau, 2011.

Computation of the cross-sectional average length of life (CAL) and of the average cohort life expectancy (ACLE)



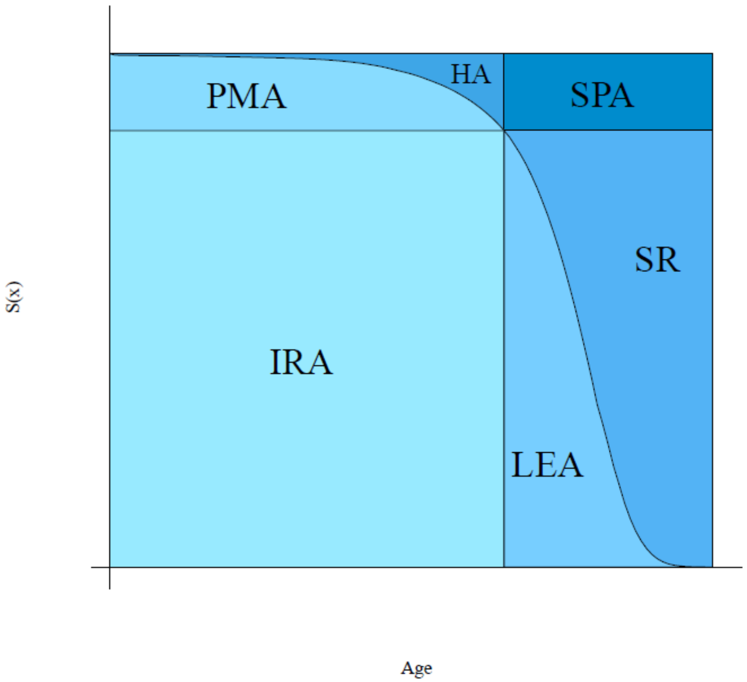
$$CAL(t) = \int_0^{\omega} \ell_c(a, t-a)\,da$$

$$ACLE(t) = \frac{\int_0^{\omega} e_c(0, t-a)\,\ell_c(a, t-a)\,da}{\int_0^{\omega} \ell_c(a, t-a)\,da}$$

Sources: Guillot, 2003; Schoen & Canudas-Romo, 2005.

Measures sensitive to tails of the mortality distribution

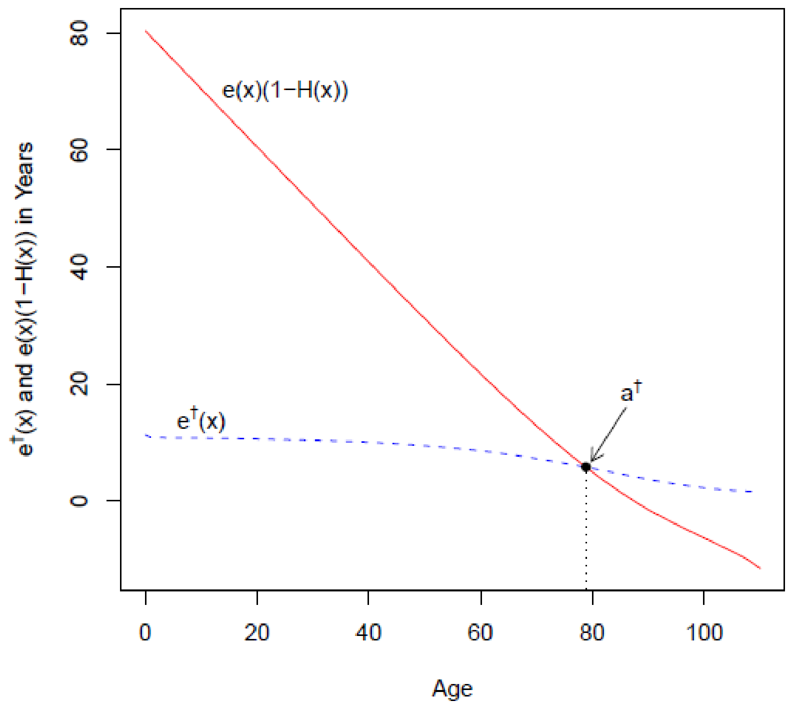
Longevity measures expressing the geometry of the survival curve



IRA – Inner Rectangle Area, PMA-Premature Mortality Area, LEA – Longevity Extension Area, HA – Horizontalization Area, SPA – Shifting Potential Area, SR – Senescence Rectangle

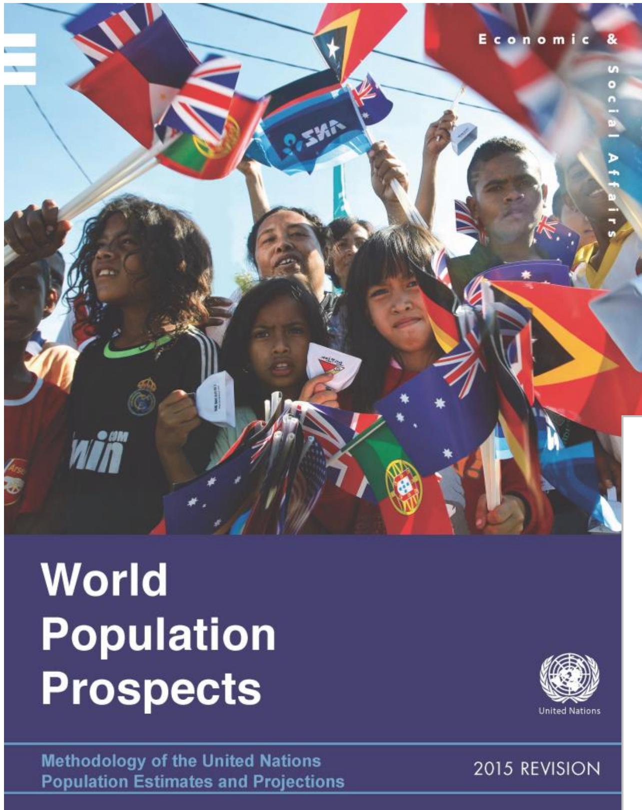
Source: Ebeling and Rau, 2014

A graphical depiction of the calculation of the threshold age $a^\dagger$



Source: Zhang and Vaupel, 2009

Use of HMD data and methods in methods protocols and software



Google Scholar shows 145 citations of the HMD Methods Protocol

Package 'LifeTables'

August 19, 2015

Type Package

Title Two-Parameter HMD Model Life Table System

Depends R (>= 2.10), mclust

Suggests gWidgets, gWidgetsRGtk2, RGtk2

Version 1.0

Date 2015-08-07

Author David J. Sharrow, GUI by Hana Sevcikova

Maintainer David J. Sharrow <dsharrow@uw.edu>

Description Functions supplied in this package will implement discriminant analysis to select an appropriate life table family, select an appropriate alpha level based on a desired life expectancy at birth, produce a model mortality pattern based on family and level as well as plot the results.

License GPL (>= 2)

LazyData yes

NeedsCompilation no

Repository CRAN

Date/Publication 2015-08-19 00:29:08

R topics documented:

LifeTables-package 2
alpha.e0 3
hmd.DA 4
hmd.DA.mx 5
. 7
. 8
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. 12
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16

Package 'demography'

February 19, 2015

Version 1.18

Title Forecasting mortality, fertility, migration and population data

Description Functions for demographic analysis including lifetable calculations; Lee-Carter modelling; functional data analysis of mortality rates, fertility rates, net migration numbers; and stochastic population forecasting.

Depends R (>= 2.15.2), forecast (>= 3.09), rainbow, ftsa, cobs

Imports mgcv, strucchange, RCurl

LazyData yes

ByteCompile TRUE

BugReports https://github.com/robjhyndman/demography/issues

Author Rob J Hyndman with contributions from Heather Booth, Leonie Tickle and John Maindonald.

Maintainer Rob J Hyndman <Rob.Hyndman@monash.edu>

License GPL (>= 2)

URL http://robjhyndman.com/software/demography/

NeedsCompilation no

Repository CRAN

Date/Publication 2014-09-15 07:36:25

R topics documented:

demography-package 2
aus.fert 3
cm.spline 4
coherentfdm 5
combine.demogdata 6
compare.demogdata 7
demogdata 8
extract.ages 10
extract.years 10

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Package 'ROMIplot'

July 15, 2015

Type Package

Title Plots Surfaces of Rates of Mortality Improvement

Version 1.0

Date 2015-07-15

Author Roland Rau, Tim Riffe

Maintainer Roland Rau <roland.rau@gmail.com>

Depends MortalitySmooth, RCurl

Description Provides the possibility to plot Lexis surface maps (heat maps) of rates of mortality improvement. Raw data to be plotted can be read from the Human Mortality Database using code originally written by Tim Riffe. The European Research Council has provided financial support under the European Community's Seventh Framework Programme (FP7/2007-2013) / ERC grant agreement no. 263744.

License GPL-2

NeedsCompilation no

Repository CRAN

Date/Publication 2015-07-15 13:23:31

R topics documented:

ROMIplot-package 2
create.Lexis.matrix 3
readHMDformat 4
ROMI.plot 5

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- Reasons for and origins of the HMD
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- Enhancement of the methodology
- HMD-based studies
- Research teams
  See more on the Research Teams at
  http://www.mortality.org/Public/ResearchTeams.php

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Founding Director,
UCB in 2000, now UN

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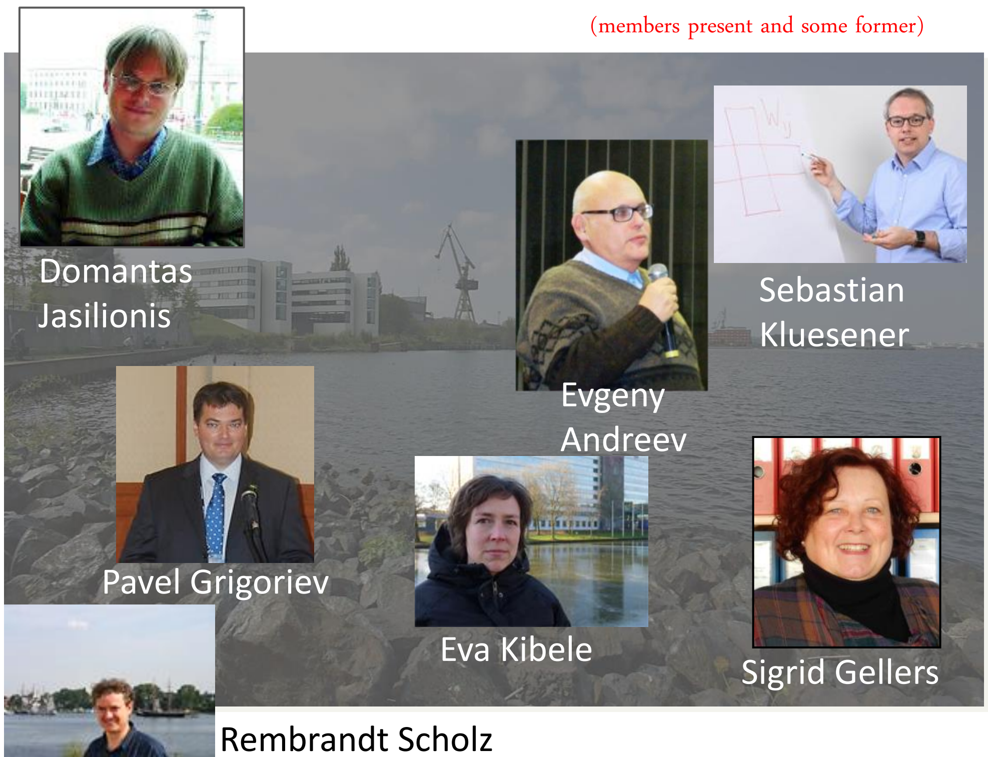
Director, MPIDR

Magali Barbieri
Associate Director,
Head of the UCB Team,
UCB&INED

Dmitry Jdanov
Head of the MPIDR
Team, MPIDR

Max Planck Team

(members present and some former)



Berkeley Team

(members present and some former)