Data and monitoring challenges of sub-national longevity disparities: the case of Portugal

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HMD

MAX PLANCK INSTITUTE FOR DEMOGRAPHIC RESEARCH

WIAS

The Human Mortality Database Project

- International project of the **Max Planck Institute for Demographic Research** (Rostock (Germany), **Department of Demography at the University of California at Berkeley** (USA), and **French Institute for Demographic Studies (INED)** (Paris, France).

- **Started in autumn 2000, launched online in May 2002** with 17 country series (UCB-MPIDR project)

- **Now: a leading data resource on mortality in developed countries → includes 41 countries and 8 regions, 50,000+ users.**

Main advantages:

- Comparability across time and space
- Continuous, long-term series without gaps or ruptures
- Data by age, year, cohort, in age-time formats 1x1, 5x1, 1x5, 5x5 etc.
- Detailed documentation on origins and quality of the data

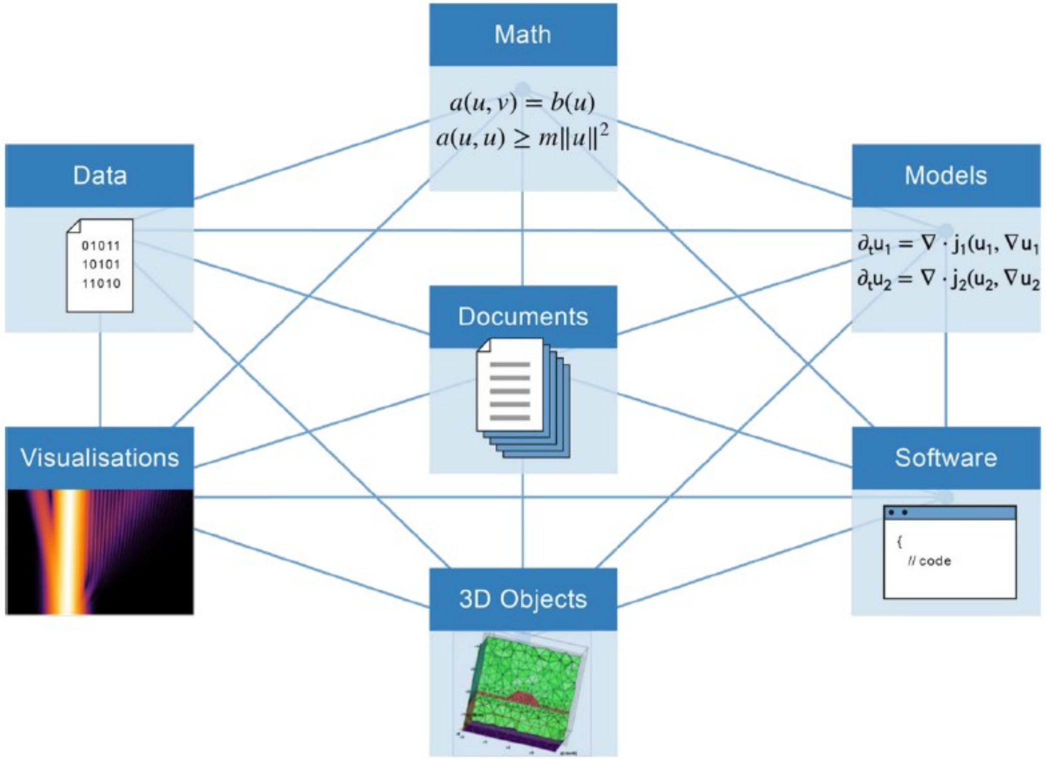
Mathematical Research Data Initiative

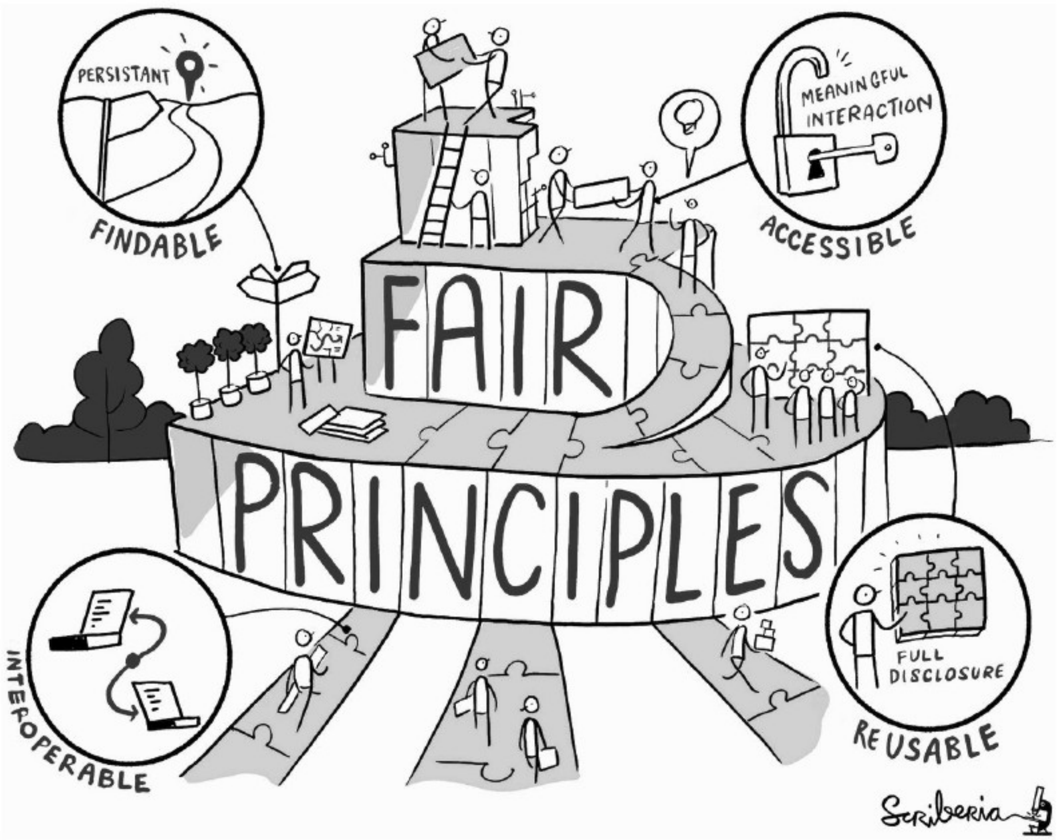
www.mardi4nfdi.de

The consortium in the national research-data infrastructure NFDI to make mathematics FAIR

Funded by the Deutsche Forschungsgemeinschaft (DFG), Project number 460135501. NFDI 29/1 "MaRDI – Mathematische Forschungsdateninitiative"

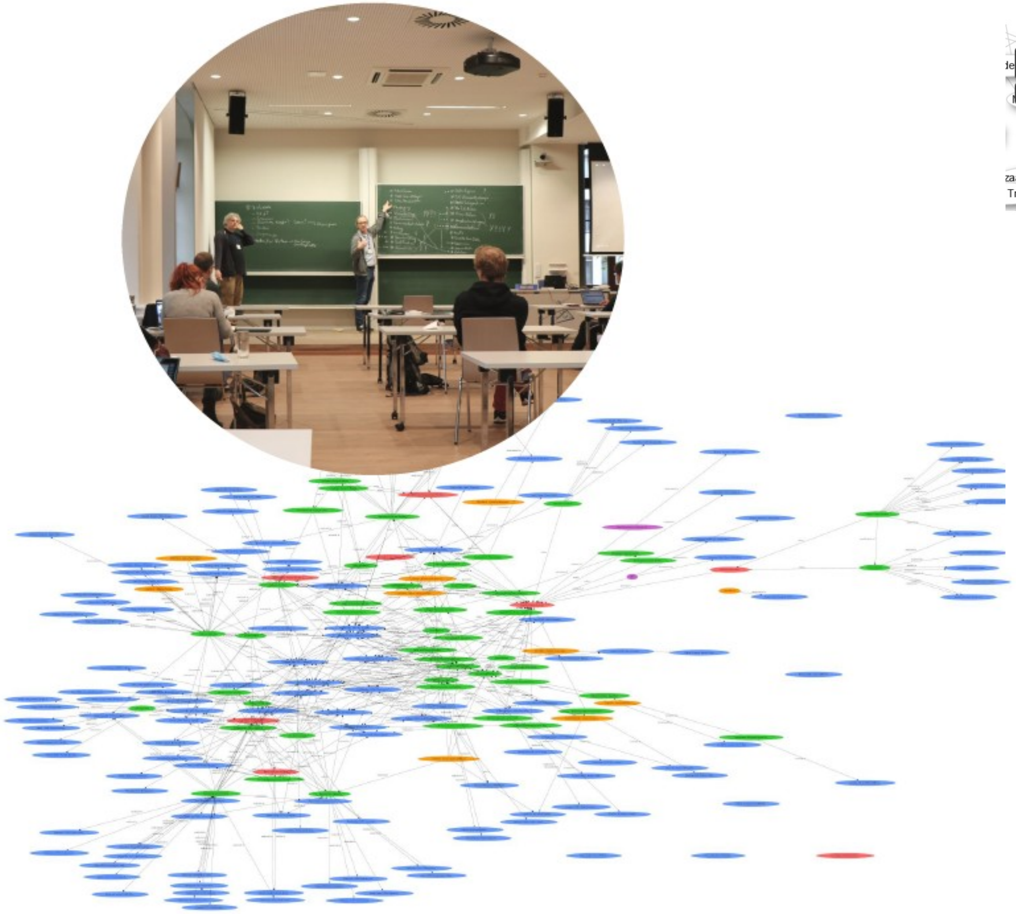
FAIR research data

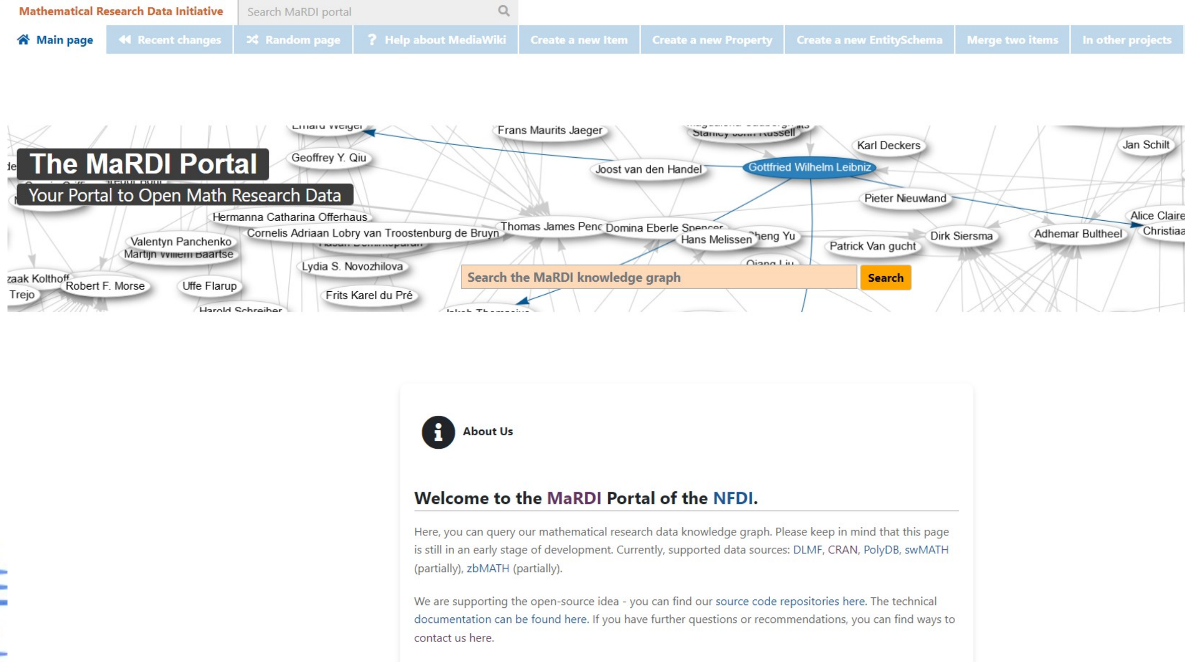




Nathalie Hartl, Elena Wössner, and York Sure-Vetter. Nationale Forschungsdateninfrastruktur (NFDI). Inform. Spektrum, 44(5):370–373, 2021.

Building infrastructure





portal.mardi4nfdi.de

Subnational Mortality Databases

Subnational mortality databases following the model and principles of the Human Mortality Database have been developed by researchers in a number of countries. Some of these databases are more closely related to the HMD than others, in terms of both the people involved and the methods implemented. See below for a short description and link to each database.

The Australian Human Mortality Database (AHMD)

The Australian Human Mortality Database (AHMD) includes historical series of lifetables by sex for the six states and the two territories of mainland Australia for the period from 1971 to 2016.

The AHMD was developed by the Mortality, Ageing and Health research team in the Australian National University School of Demography under the supervision of Vladimir Canudas-Romo and in collaboration with the HMD team.

https://demography.cass.anu.edu.au/research/australian-human-mortality-database

The Canadian Mortality Database/Base de données sur la Longévité Canadienne (CHMD/BDLC)

The Canadian Human Mortality Database (CHMD) is an achievement of the Mortality and Longevity research team at the Department of Demography, Université de Montréal, Canada, under the joint direction of Professors Robert Bourbeau and Nadine Ouellette. The project is carried out in collaboration with demographers at the Human Mortality Database from which it has borrowed its underlying methods, with some adjustments to account for the unique situation of Canada.

The CHMD collects data from the National Statistics Office to compute lifetables for all Canadian provinces and territories after validation and correction where necessary, for all years 1982 through 2019. For comparative purposes, the database lifetables are compared with those produced by governmental organizations, also available for download in the Archives section of the CHMD website.

http://www.bdlc.umontreal.ca/CHMD/index.htm

The French Human Mortality Database

The French Human Mortality Database (FHMD) was created to provide detailed data at the regional and departmental level for metropolitan France to anyone interested in the history of human longevity

- **Australian HMD**
- **Canadian HMD**
- **French HMD** (satellite)
- **Japanese HMD** (independent project)
- **US mortality database**

Longevity and longevity disparities: major dimensions of sustainable development

- **Longevity** [life expectancy] is the key indicator describing social and health aspects of human development.
  [UN Human Development Index]

  → A population health index based on observed age-specific mortality.

  → Long and healthy life for all - an ultimate goal in all policies.

- **Reality - persisting disparities** [by socio-economic status, areas]:

  → all countries, incl. those with strong social systems.

  → no systematic evidence about narrowing disparities
  = obstacle for future sustainable health progress!

Policy relevance of inequalities in health and mortality: Demographic and economic arguments

Mackenbach, Meerding, Kunst (2011):

EVERY YEAR inequality-related losses to health in the EU amount for:

➔ More than 700 thou. avoidable deaths;

➔33 mil. prevalent cases of ill-health.

EVERY YEAR inequality related ECONOMIC losses to health amount:

➔ 1.4% of GDP (or €141 billion) – through avoidable loss of labour productivity.

➔ 5% of the costs of social security systems;

➔ 20% of the costs of healthcare systems.

Longevity disparities across areas

UK ONS traditions in monitoring area-level life expectancy
[Toson & Baker, 2003; Silcocs, 2004].

Small-area characteristics as substitutes of individual characteristics
[deprivation, income, …]???

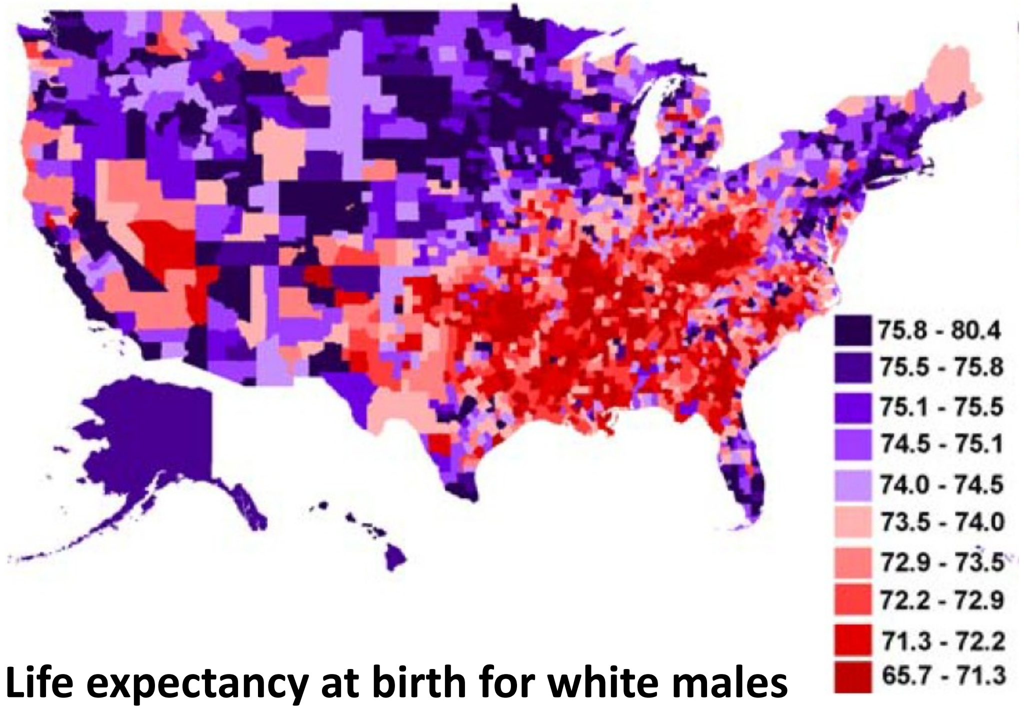
Recent “explosion” of small-area studies (e.g. USA and UK) related to recent slow-downs or reversals in longevity.

Longevity disparities across areas: “Eight Americas” studies

OPEN ACCESS Freely available online PLOS MEDICINE

Eight Americas: Investigating Mortality Disparities across Races, Counties, and Race-Counties in the United States

Christopher J. L. Murray[1,2,3], Sandeep C. Kulkarni[2,4], Catherine Michaud[2,3], Niels Tomijima[3], Maria T. Bulzacchelli[3], Terrell J. Iandiorio[3], Majid Ezzati[1,2*]



Life expectancy at birth for white males

Health Disparities

Eight Americas

New Perspectives on U.S. Health Disparities

Christopher J.L. Murray, MD, PhD, Sandeep Kulkarni, AB, Majid Ezzati, PhD

Am J Prev Med 2005;29(5S1) doi:10.1016/j.amepre.2005.07.031

America	General description	Male life expectan at birth
1	Asians	82.8
2	White low-income rural Northland	76.2
3	Middle America	75.2
4	White poor Appalachia/Mississipi Valley	71.8
5	Western Native Americans	69.4
6	Black middle America	69.6
7	Black poor rural South	67.7
8	Black high-risk urban	66.7

Small area life expectancies: estimation strategies

Direct data approach – maximum real data:

→ Maximal replication of reality!

- In certain situations impossible!

"Mechanical" adjustments:

- Need for aggregation over age groups and/or time intervals.
- Imputing small values instead of zeros.
- Often - smoothing or modelling parts of mortality curves.

Modelling approach

More stable and statistically robust estimates.

Based on estimated parameters from standard mortality schedule or borrowing information from neighbouring or similar areas.

- Arbitrary choice of parameters.
- Risk of overlooking specifics of mortality patterns in some areas
- Not easily understandable for policy makers

Modelling approaches: relational models
TOPALS system

Classical Brass (1974) system: OLS linear relationships between logits of age-specific survival probabilities, baseline mortality level (intercept) and life expectancy.

More sophisticated regression-based models: Poisson or other models - relationships between the "ideal/standard" and observed age-specific mortality in good data settings.

Hierarchical Bayesian models based on prior assumptions i.e. "borrowing information" from similar areas according to age, time, and other characteristics.

TOPALS [de Beer, 2012]
Tool for Projecting Age-specific rates using Linear Splines

Based on a linear spline to estimate the pattern of ratios between the observed probabilities of dying and corresponding probabilities in the standard schedule.

A modified version by Gonzaga and Schmertmann (2016)

Schedule of log mortality rates over ages α=0…99 is the sum of a standard schedule λ* ∈ R100 and a linear spline function:

$$\underset{100x1}{\lambda(\alpha)} = \underset{100x1}{\lambda^*} + \underset{100x7}{B} \underset{7x1}{\alpha}$$

λ is a vector of log rates in a small area; λ* is a standard schedule, B is a matrix of constants with each column linear B-spline basis function. 7 parameters.

Portuguese example:
life expectancy estimation for municipalities

Context:

Small country [10.4 million population in 2022]

7 regions NUTS-2 level: large variability in population size

Max: Norte [3.8m], Min: Azores [239k]

→ Persistently high socioeconomic and mortality disparities

→ Municipality life expectancy gap: 3.69 for males, 2.49 for females

→ **high policy relevance**

Two approaches

Direct data approach

→ 7 municipalities

→1-year-long periods, age-specific

→Chiang's (1984) life table and SE estimation algorithm.

+ inputting national level m0, if municipality m0=0.

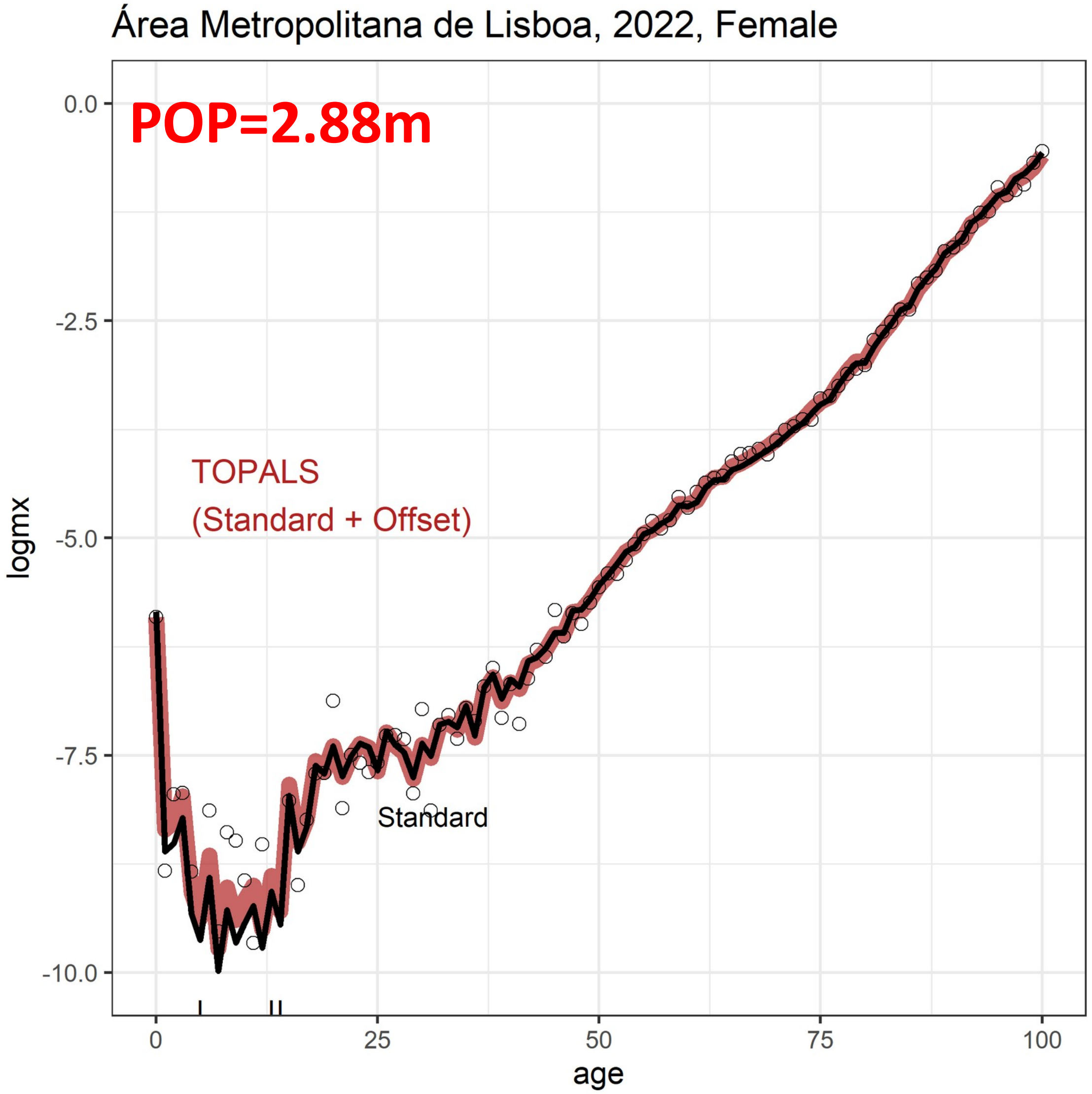
Modelling approach

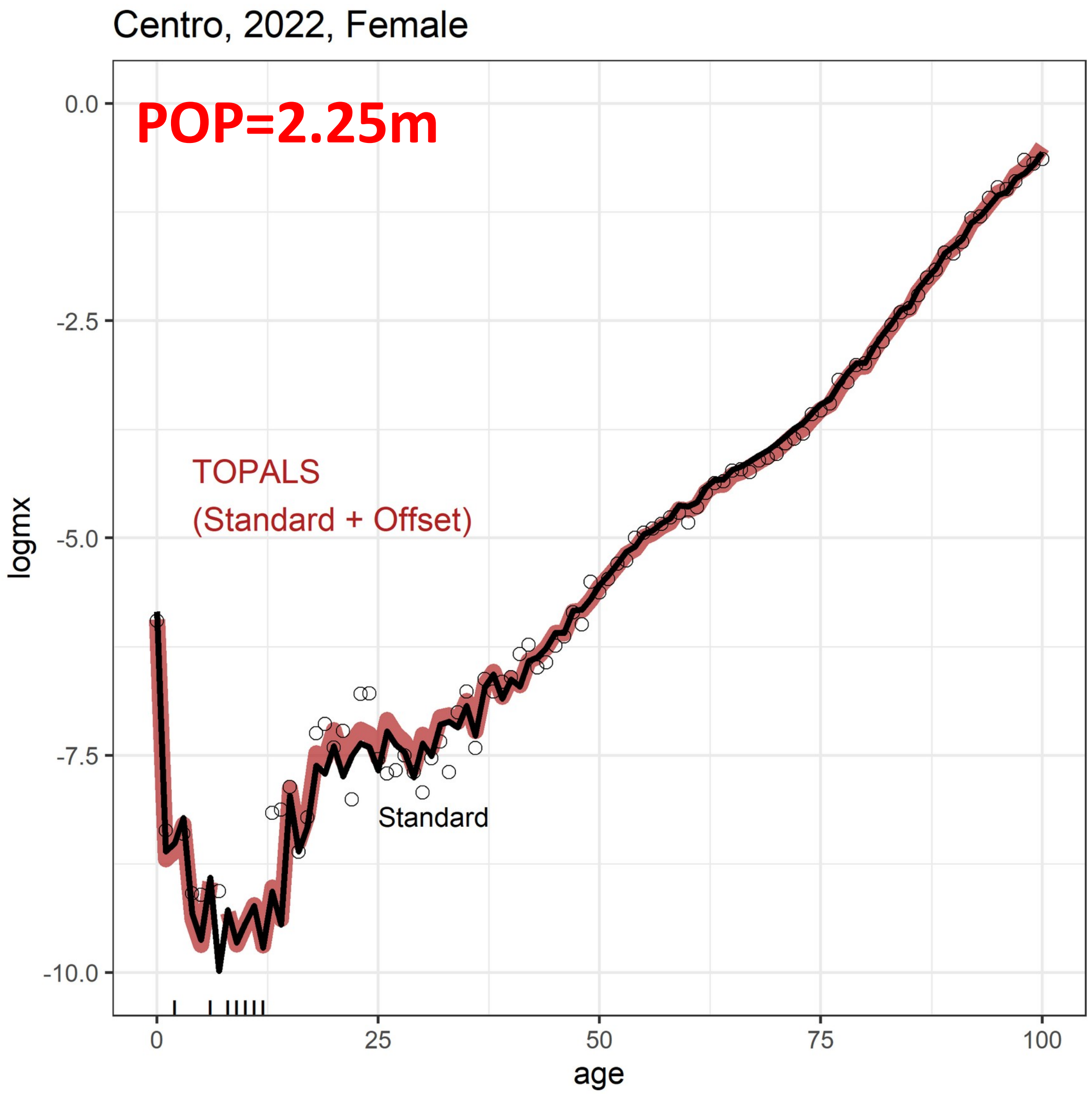
The same aggregation.

Modified TOPALS model [Gonzaga and Schmertmann, 2016].

Standard mortality schedule: national age-specific rates.

TOPALS model:
constructing age-specific mortality profiles





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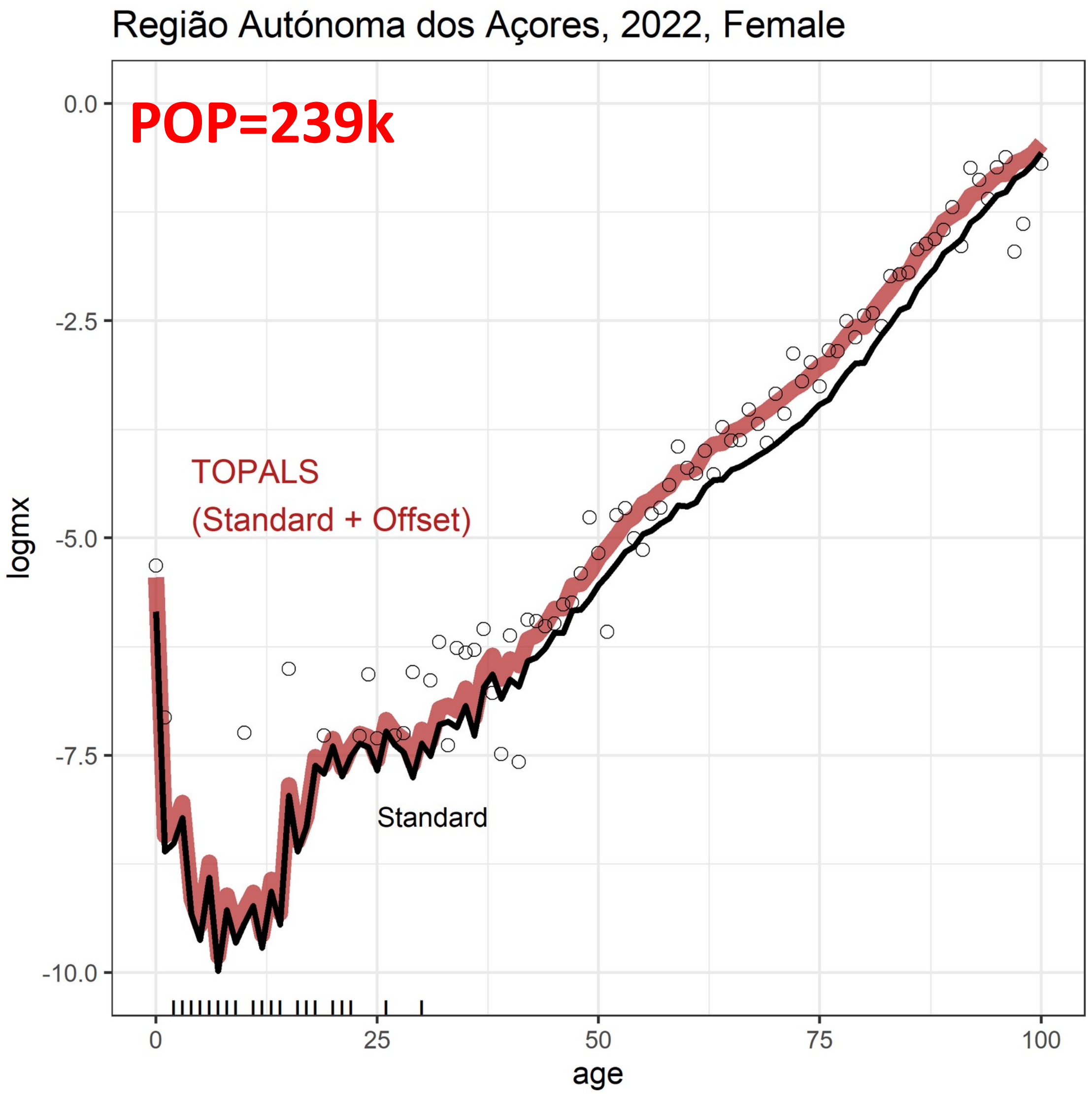

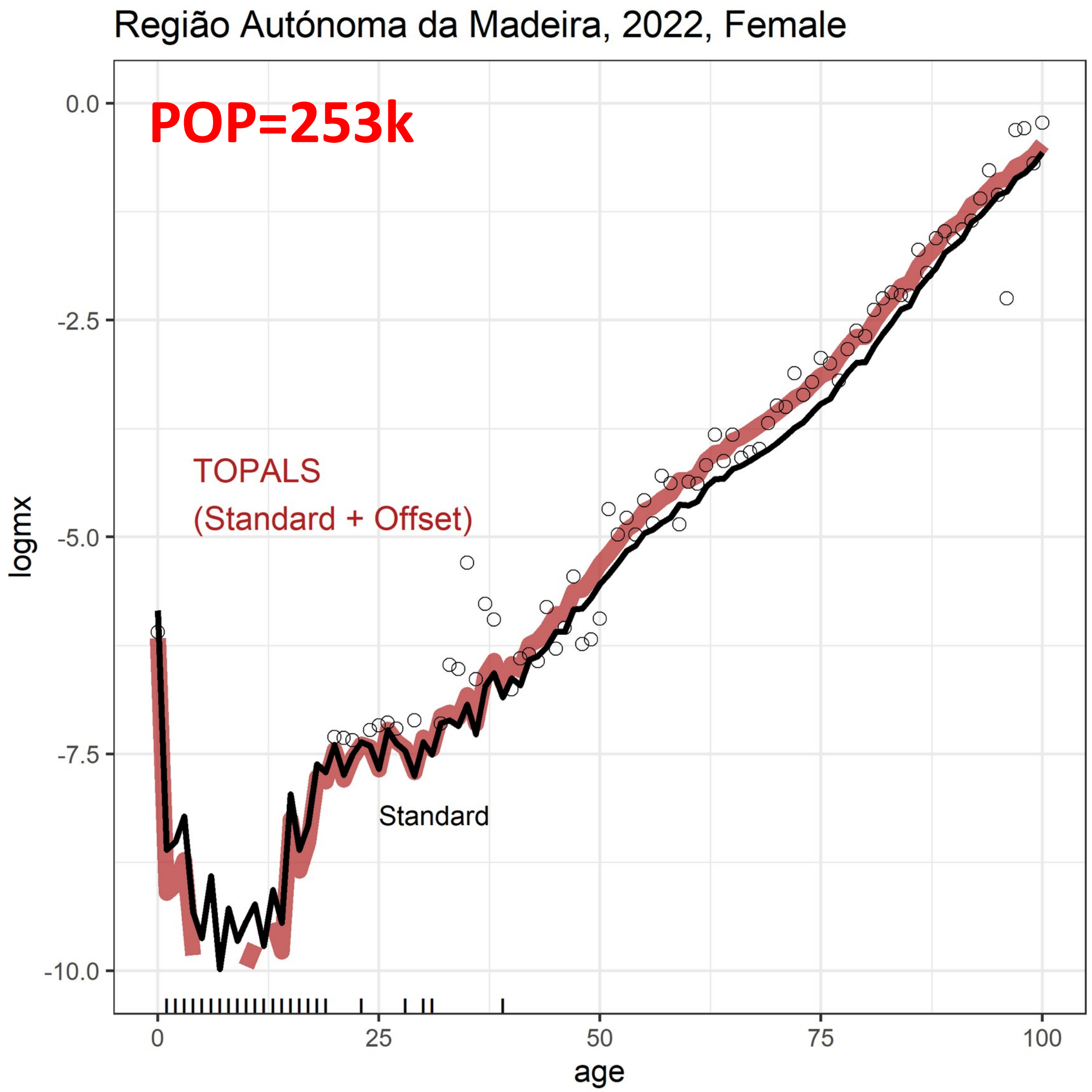

Concluding remarks

Growing importance of mortality data – policy&politics, science, industry.
Future of longevity also depends on longevity inequalities!

Sub-national longevity → high relevance, but estimation challenges persist.

Advantages and limitations of modelling:
→ Risk of arbitrary solutions.
→ Hard to explain to policy makers: experimental statistics?

Ongoing work within the HMD:
→ More experiments with TOPALS standard schedules.
→"Bayes or not Bayes, is this the question?" [Hackenberger, 2019]