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On Mortality of China: Reconstructing the Death-Rate Pattern in Census Years

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FIFTH HMD SYMPOSIUM, BERLIN

Acknowledgements

This is collaborative work between

- Laboratory of Demographic Data, MPIDR
- China Population and Development Research Center (CPDRC)
- National School of Development at Peking University

Mortality Data on China and HMD's Aim

Mortality data on China are available from at least:

- Official reports of the National Bureau of Statistics and the Ministry of Health of China
- United Nations's World Population Prospects (WPP)
- Developing Countries Mortality Database (DCMD)
- Global Burden of Disease (GBD)

WPP, DCMD, GBD apply general methods to a list of countries with similar data format and quality profiles (Murray et al. 2003; Wilmoth et al. 2012; Li and Gerland 2013; Li 2014; Li et al. 2018, 2019).

Given all available data resources, HMD looks for the best possible mortality curve that relies mostly on real data with minimal usage of model-based estimates. The latter are thoroughly documented.

Primary Data Sources for Chinese Mortality

1. National Bureau of Statistics (NBS)
    - Censuses: 1982, 1990, 2000, and 2010
    - Small censuses (1% sample): midway between two consecutive censuses (latest: 2005, 2015)
    - Population Change Survey: annual
2. Ministry of Health of China (MOH)
    - National Maternal and Child Health Surveillance Network
    - Annual reported age- and cause-specific mortality data (since 2006) for selected regions
    - Chinese Center for Disease Control and Prevention (CDC)
        - 161 Data Surveillance Points (DSP), 64 urban, 97 rural (7% sample)
3. Household registration (*Hukou*) system
4. National Citizen ID Information System (NCIIS)

Mortality in Chinese Censuses

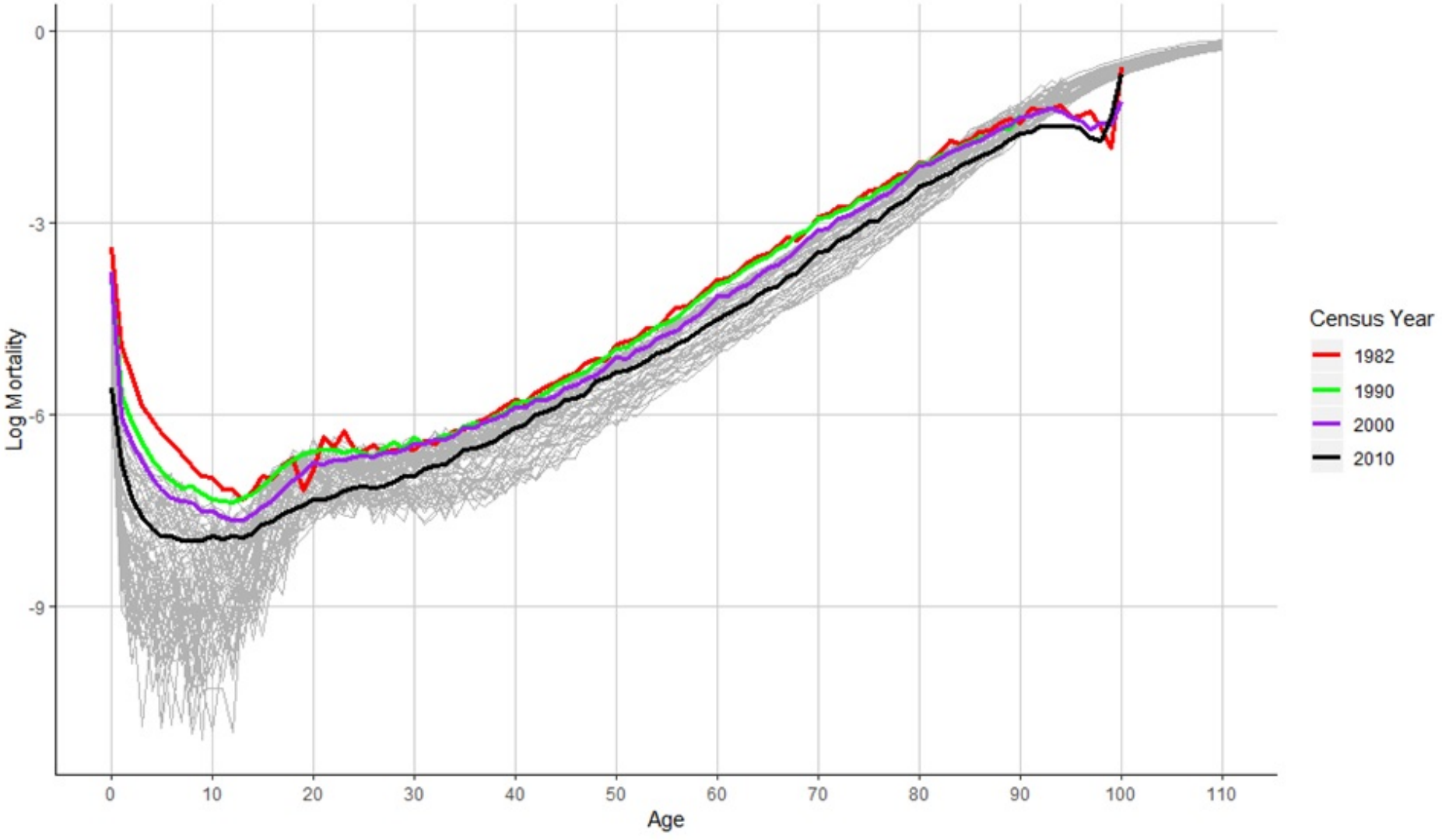
On the positive side:

- Best-quality data source
- Accurate age reporting (in almost all provinces)

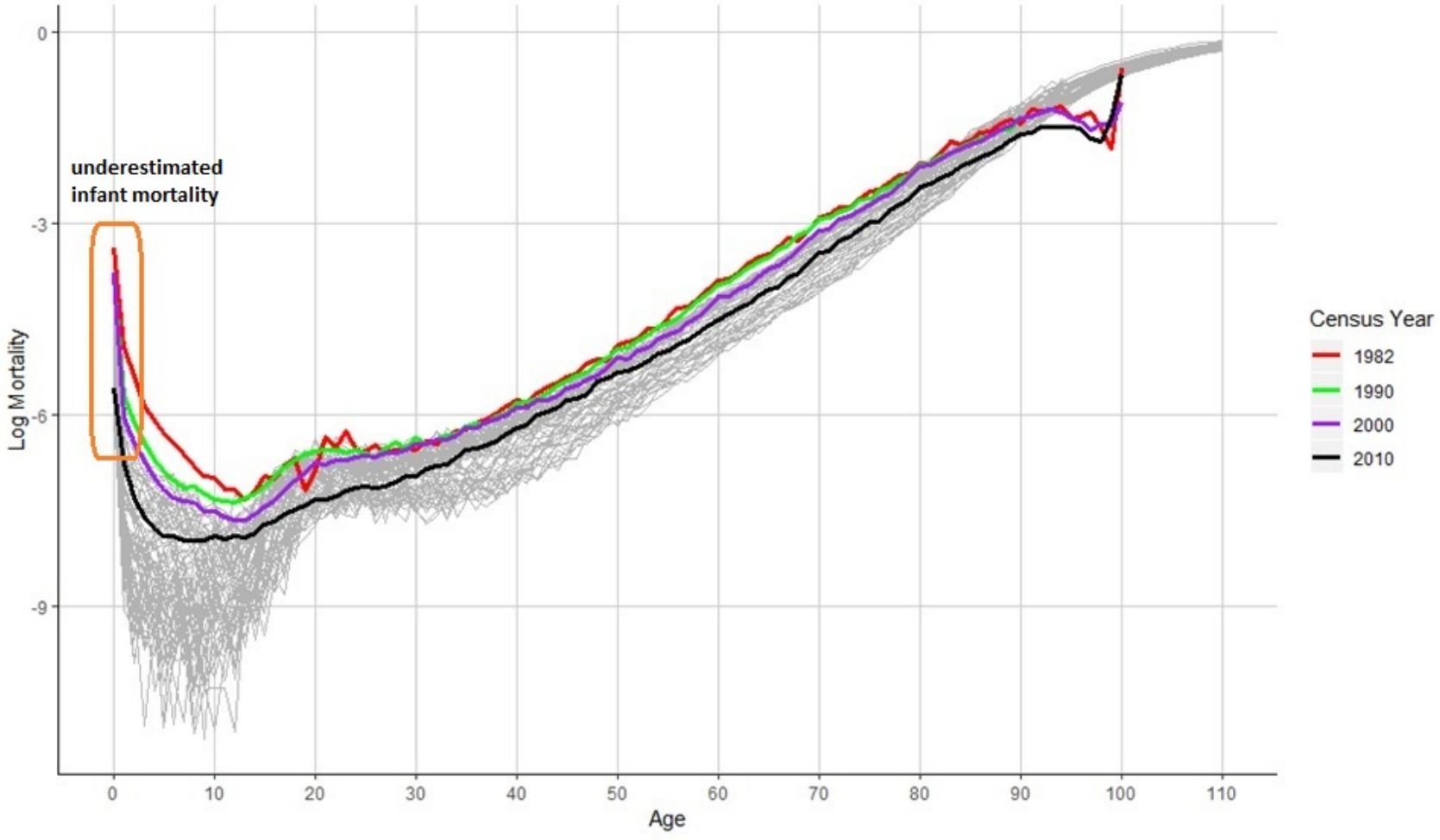
On the negative side

- Possible underreporting of deaths (e.g. at oldest ages)
- Possible population misreporting (e.g. at early and young-adult ages)

Mortality Patterns: CHN Censuses vs SWE 1950+

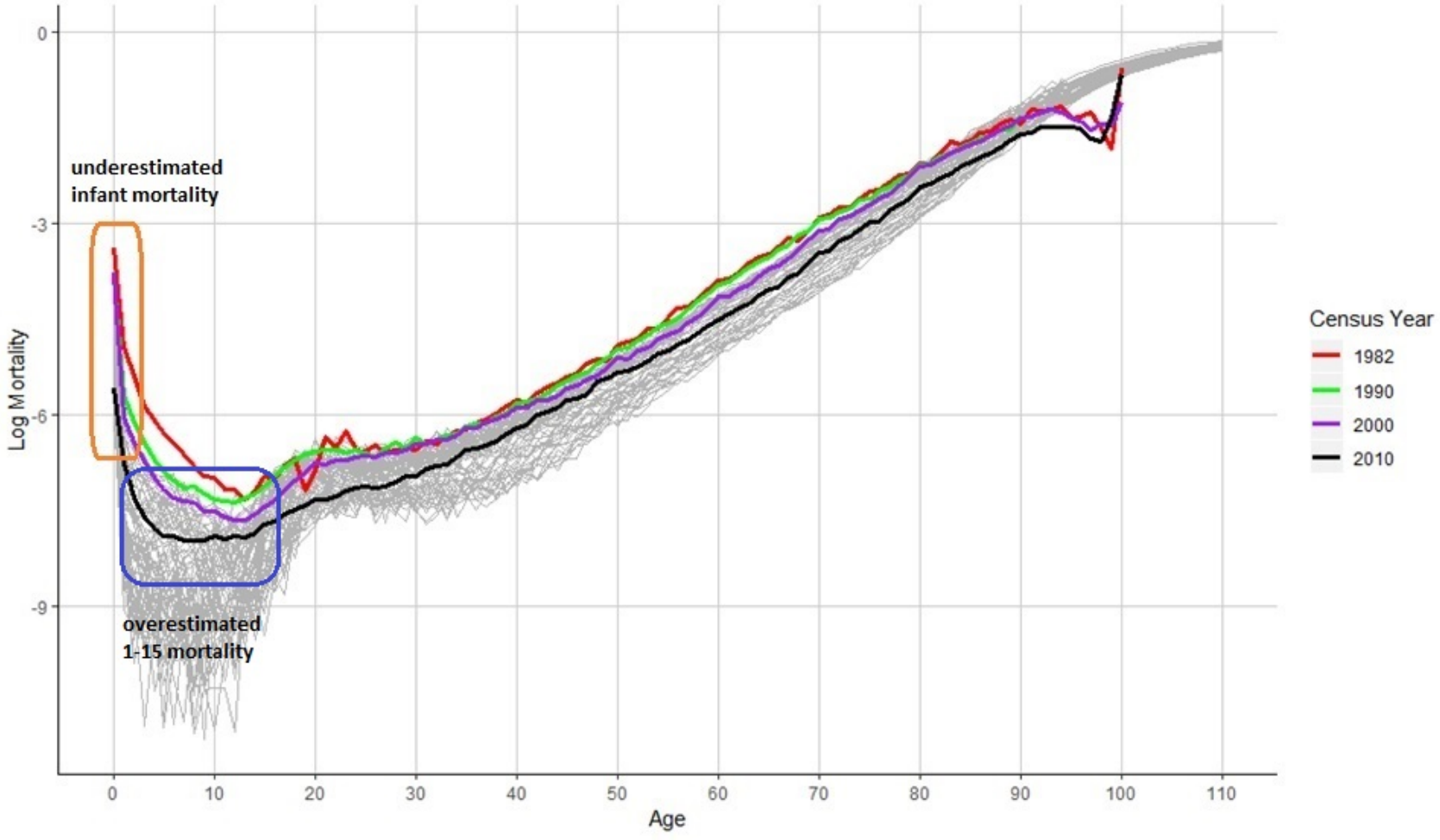


Problem 1: Infant Mortality



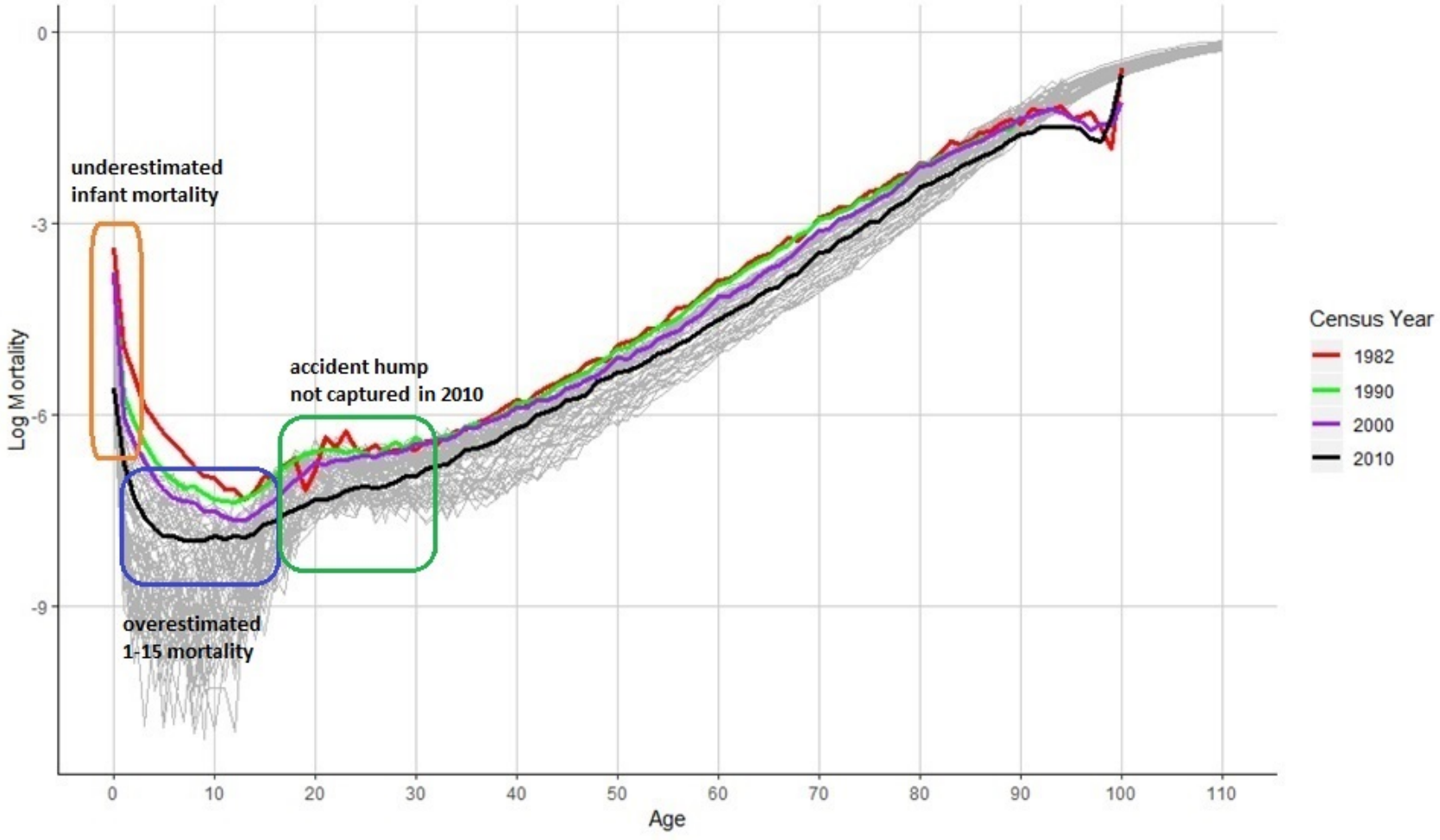
If true, China would have been among world leaders in reducing IMR

Problem 2: Mortality at Ages 1-15



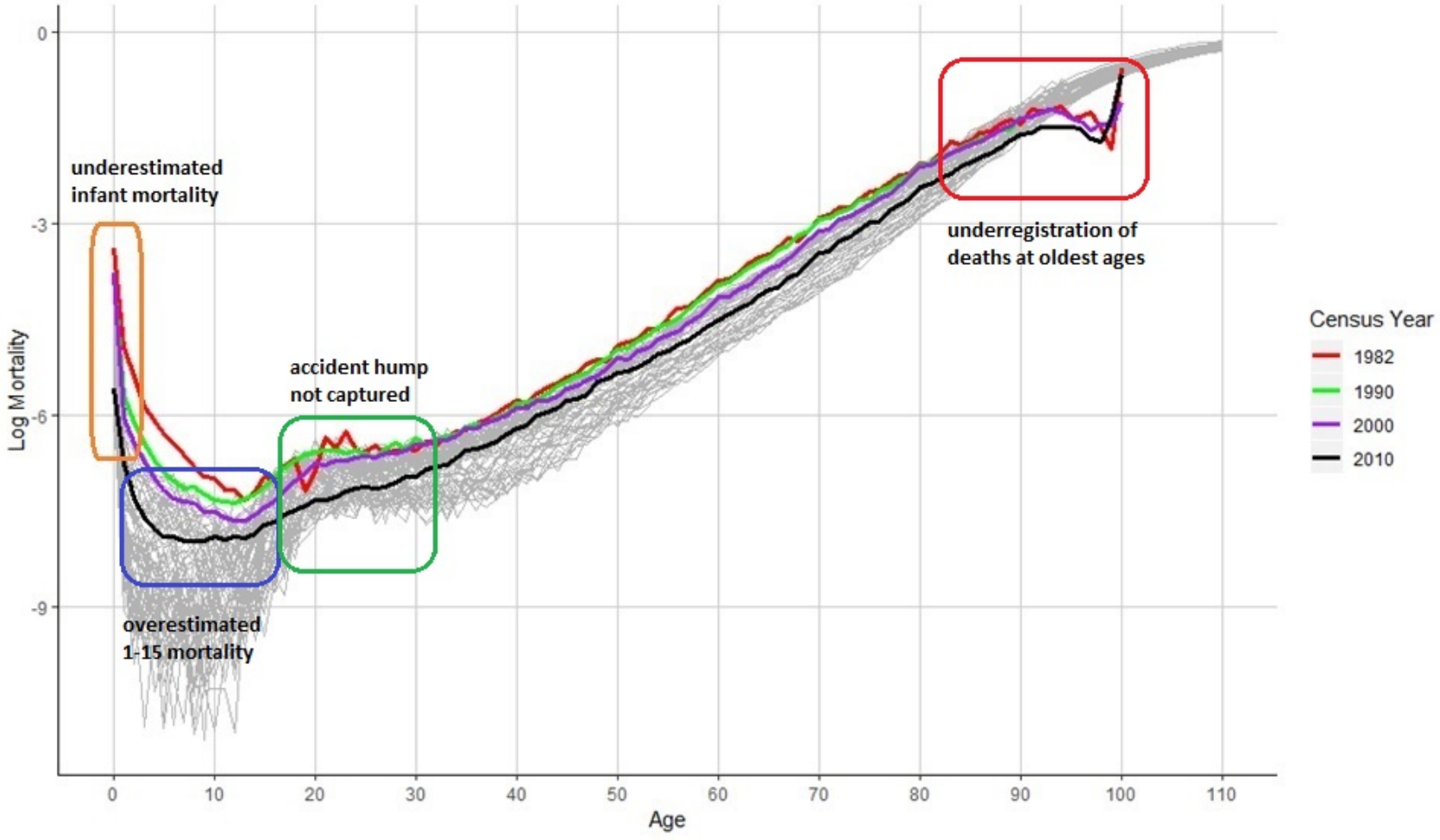
Mortality at ages 1 to 15 seems too high

Problem 3: No Accident Hump



No evidence of an accident-mortality hump between ages 15-40

Problem 4: Old-Age Mortality



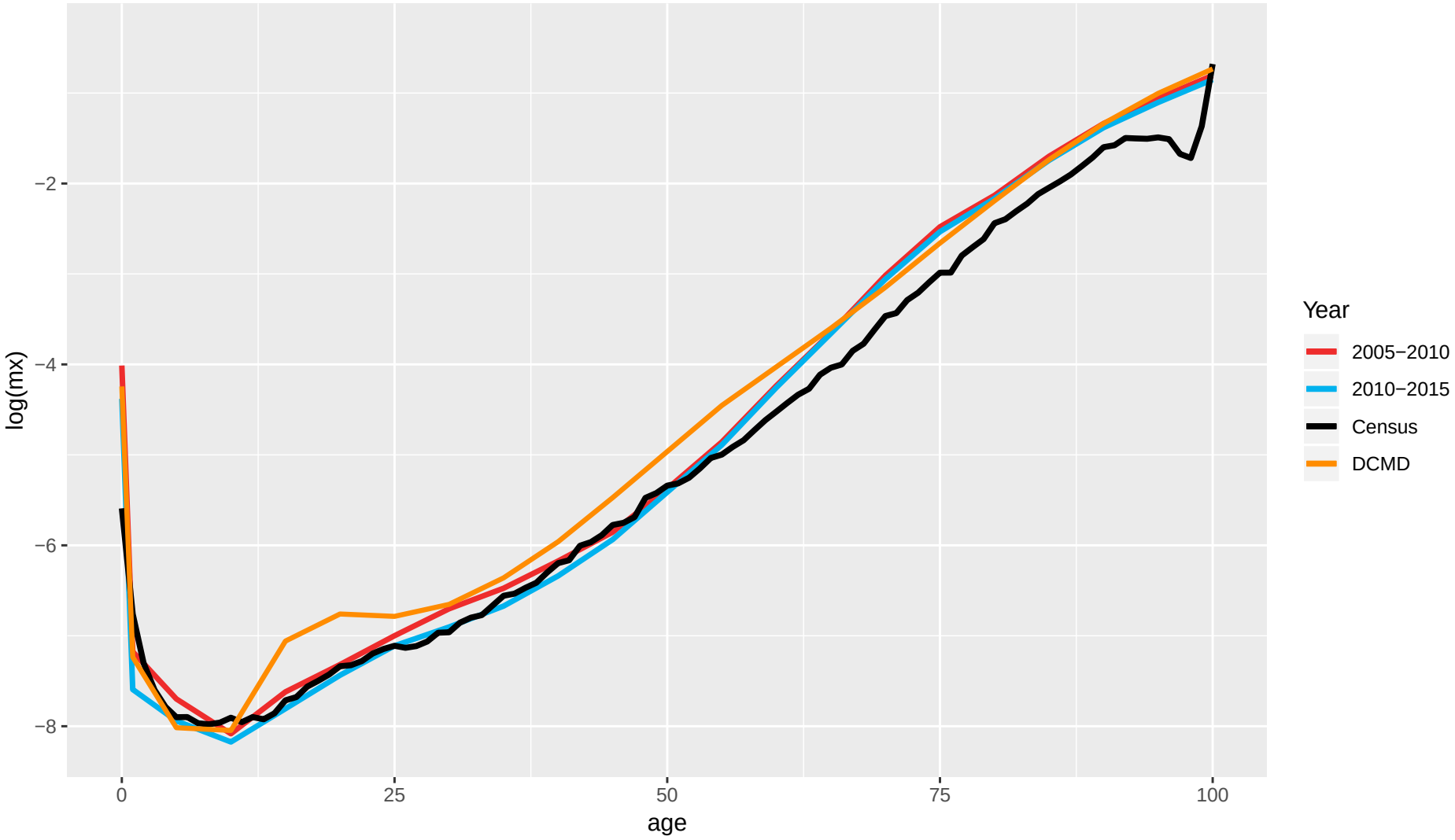
Unexpectedly fast mortality deceleration after 90 and steep increase

Chinese Mortality Estimates and Adjustments

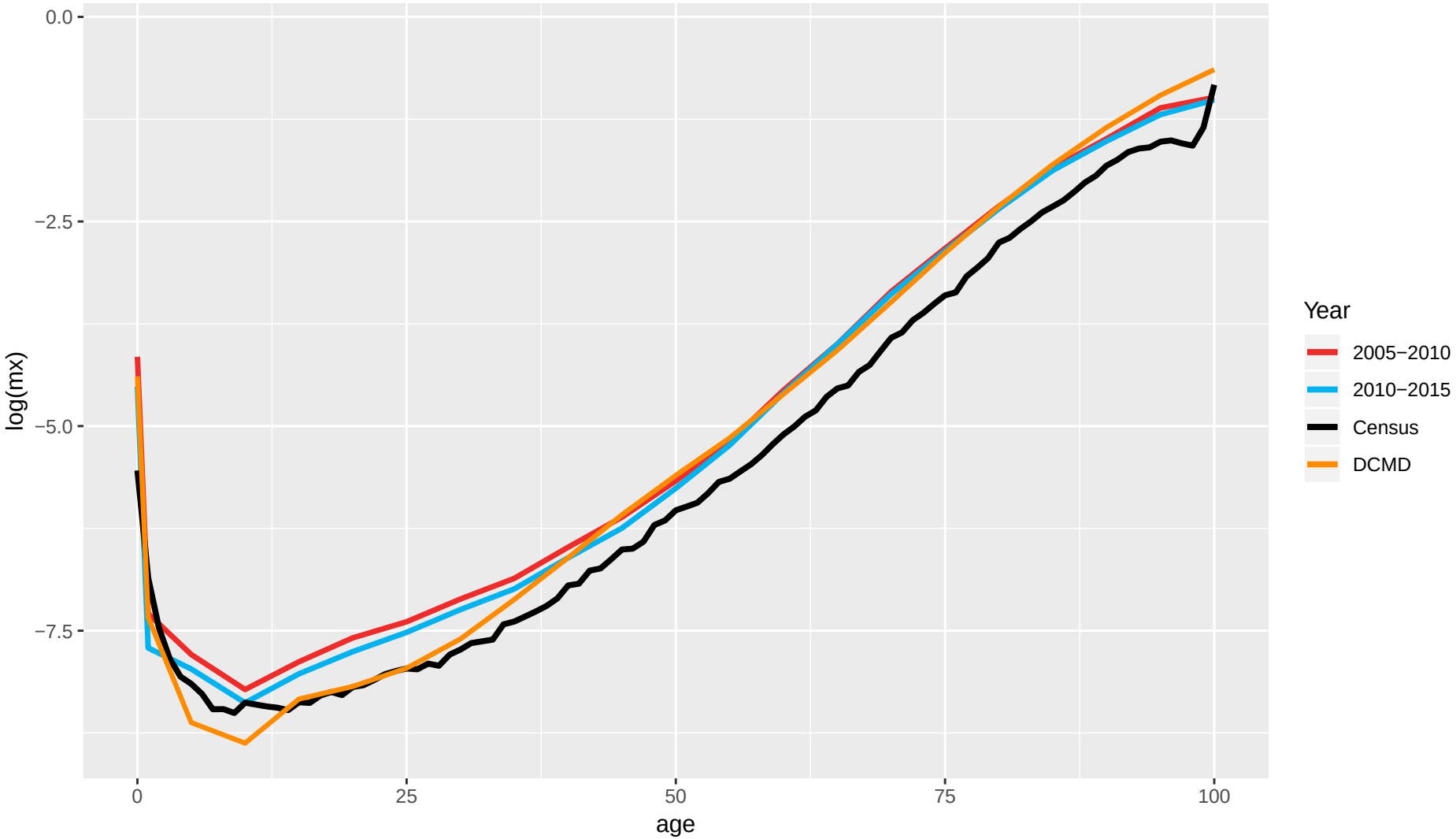
UN's WPP and DCMD

- WPP uses additional data sources to adjust for underreporting:
  - Survey on COD 2004-2005
  - Disease Surveillance Points (DSP) 1991-2015
  - Maternal and Child Mortality Surveillance System 1991-2015
- WPP adjusts official census data for underestimation of child and adult mortality, as well as overestimation of old-age mortality
- DCMD takes official adjustments of infant mortality (NBS) and applies a series of models (Li and Gerland 2013; Li 2014; Li et al. 2018, 2019)

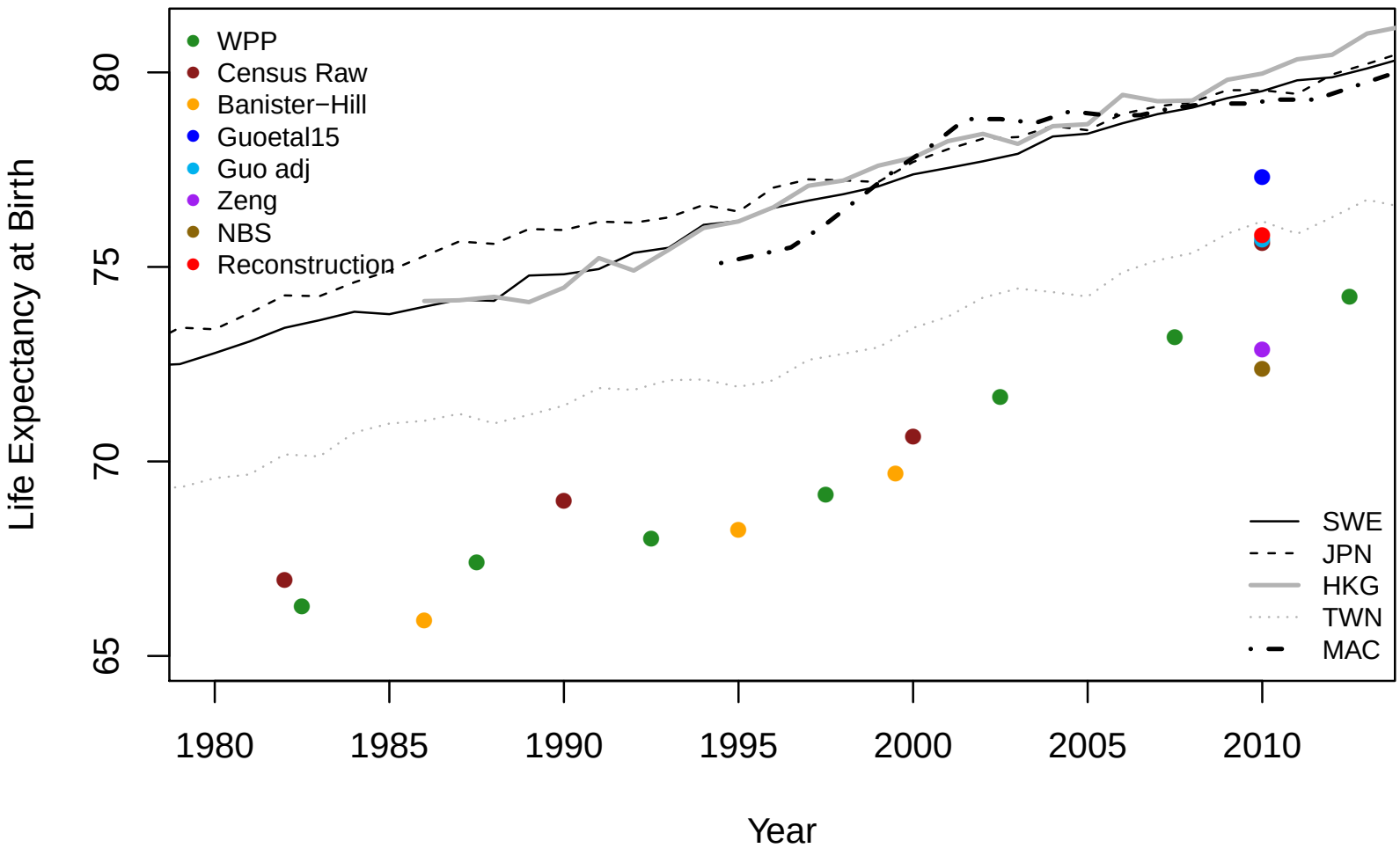
2010 Census vs WPP vs DCMD (males)



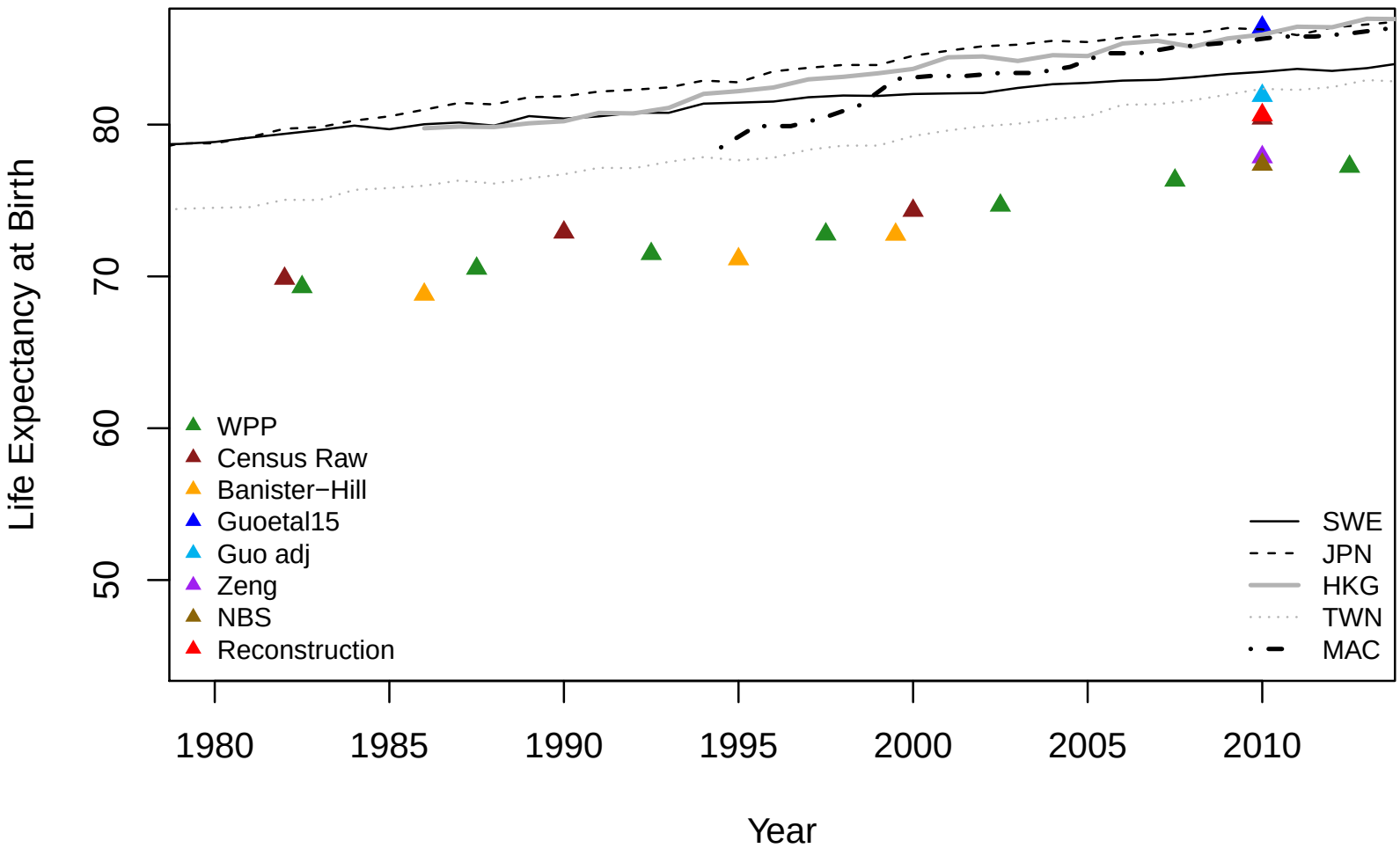
2010 Census vs WPP vs DCMD (females)



More Strategies: e_0 after 1980 (males)



More Strategies: e_0 after 1980 (females)



Motivation for Additional Reconstruction Strategies

At least:

- Revisit infant mortality
- Adjust mortality at ages 1-15
- Reconstruct the mortality hump at young-adult ages
- Adjust old-age mortality

HMD principles:

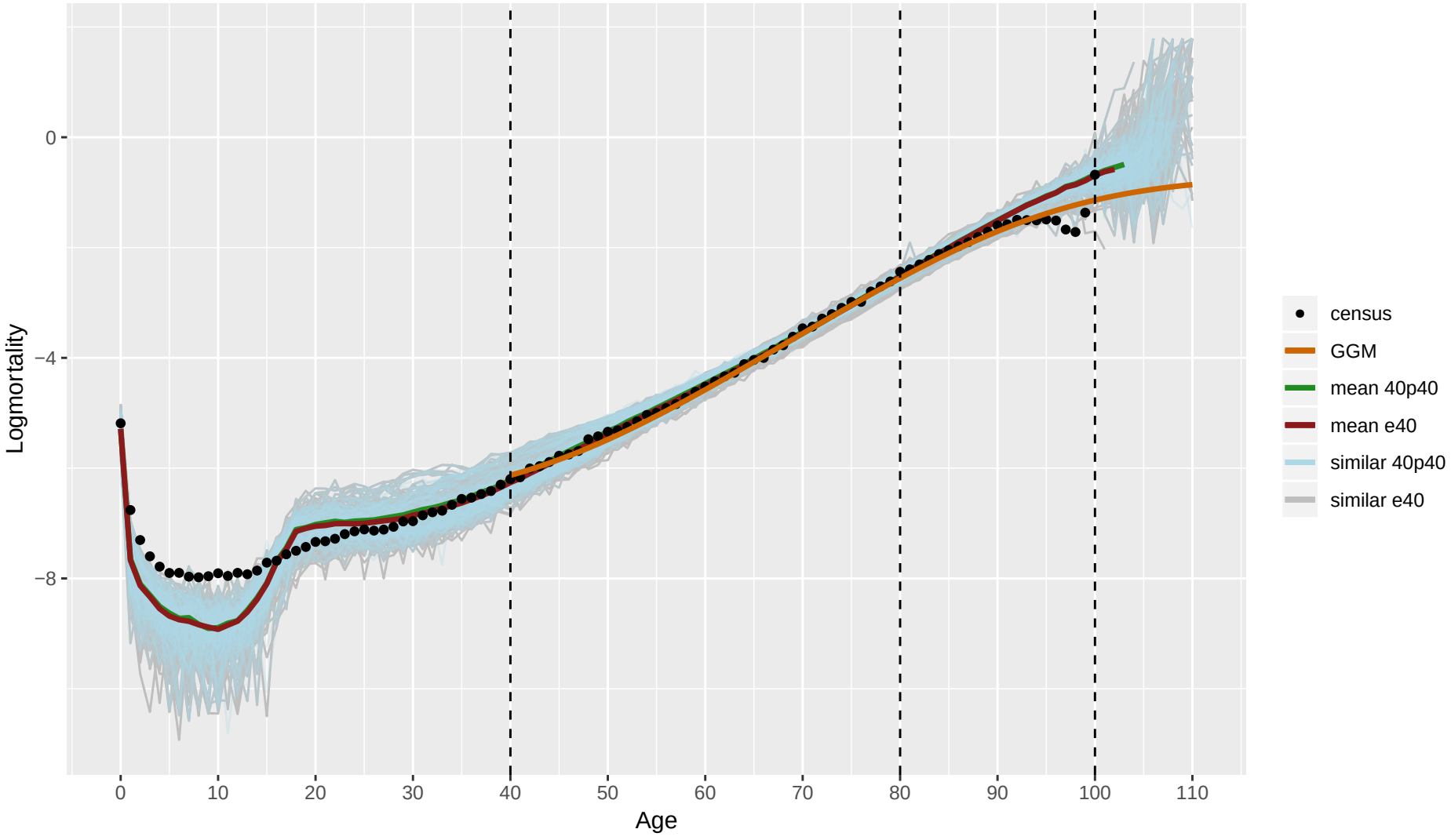
- Maximal use of real data
- Minimal use of methods to adjust real data
- Documentation of all real data adjustments
- Quality tests

Chinese Mortality Reconstruction Procedure

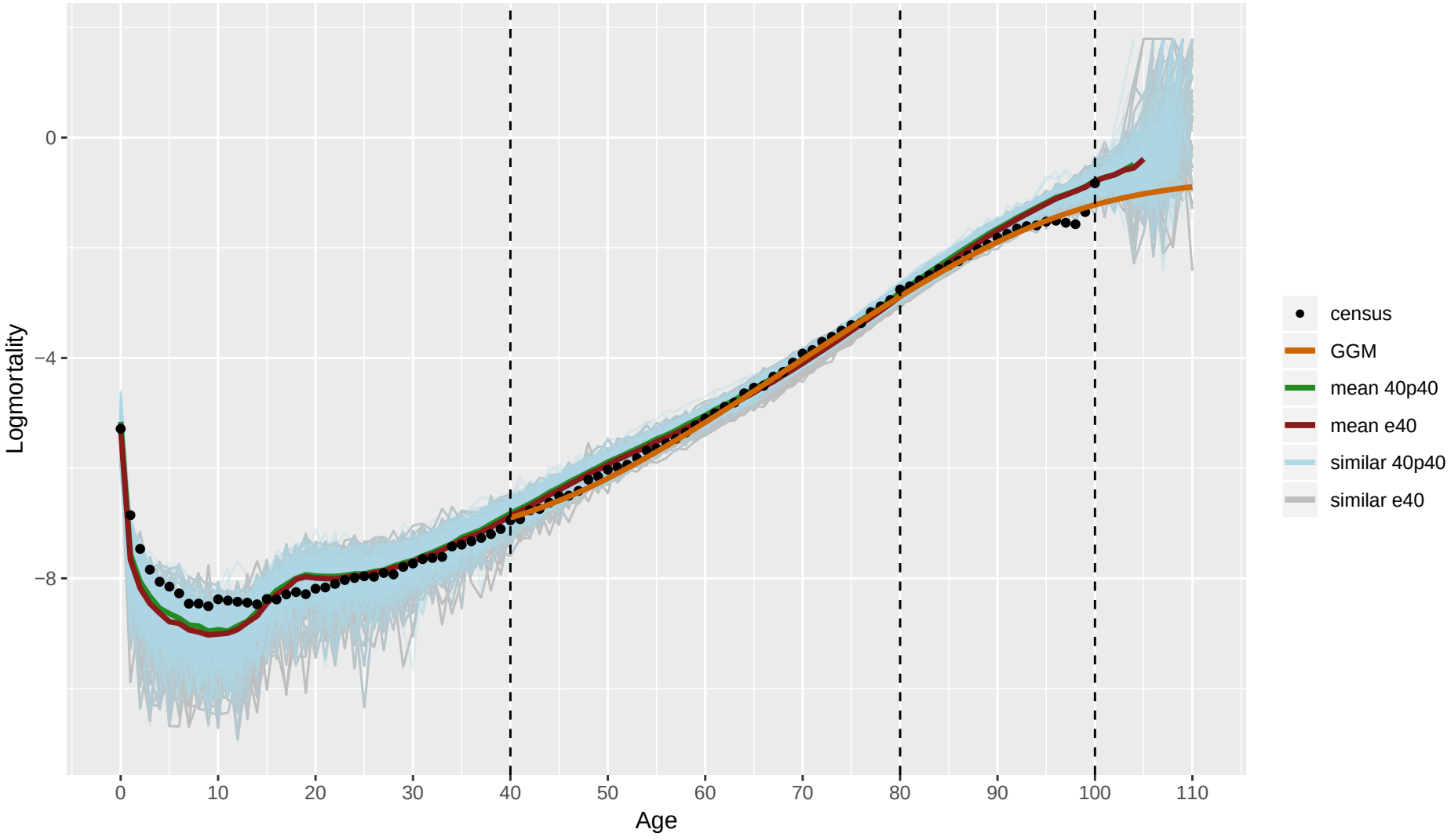
Suggested Mortality Reconstruction Procedure

- Several 'data quality tests' identify the 40-80 age range as the one with acceptable mortality data quality (Banister and Hill 2004, Cai 2013)
- Select HMD populations with similar mortality experience in this age range (2 measures: e_{40} and ${}_{40}p_{40}$) and use their mortality patterns at ages 0-39 to reconstruct the pattern for China at the same part of the age axis
- Calculate the Chinese IMR as mean (or median) of the IMR of the selected HMD populations in the previous step
- Fit a gamma-Gompertz-Makeham (ΓGM) to Chinese data for ages 40+ and use the fit to reconstruct the mortality pattern after age 80

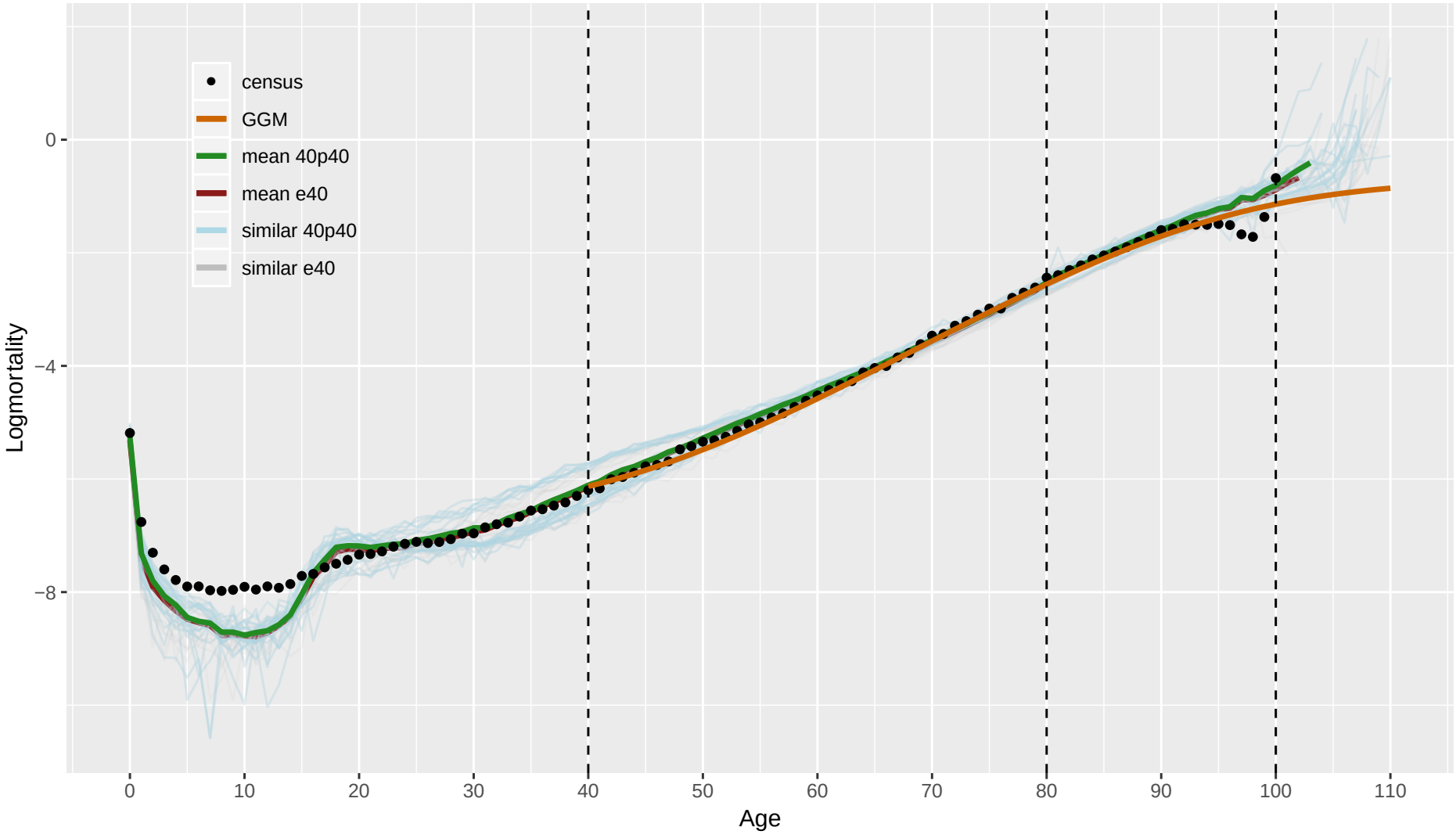
Countries with Similar 40–80 Mortality (males)



Countries with Similar 40–80 Mortality (females)



Asian Countries with Similar 40–80 Mortality (males)



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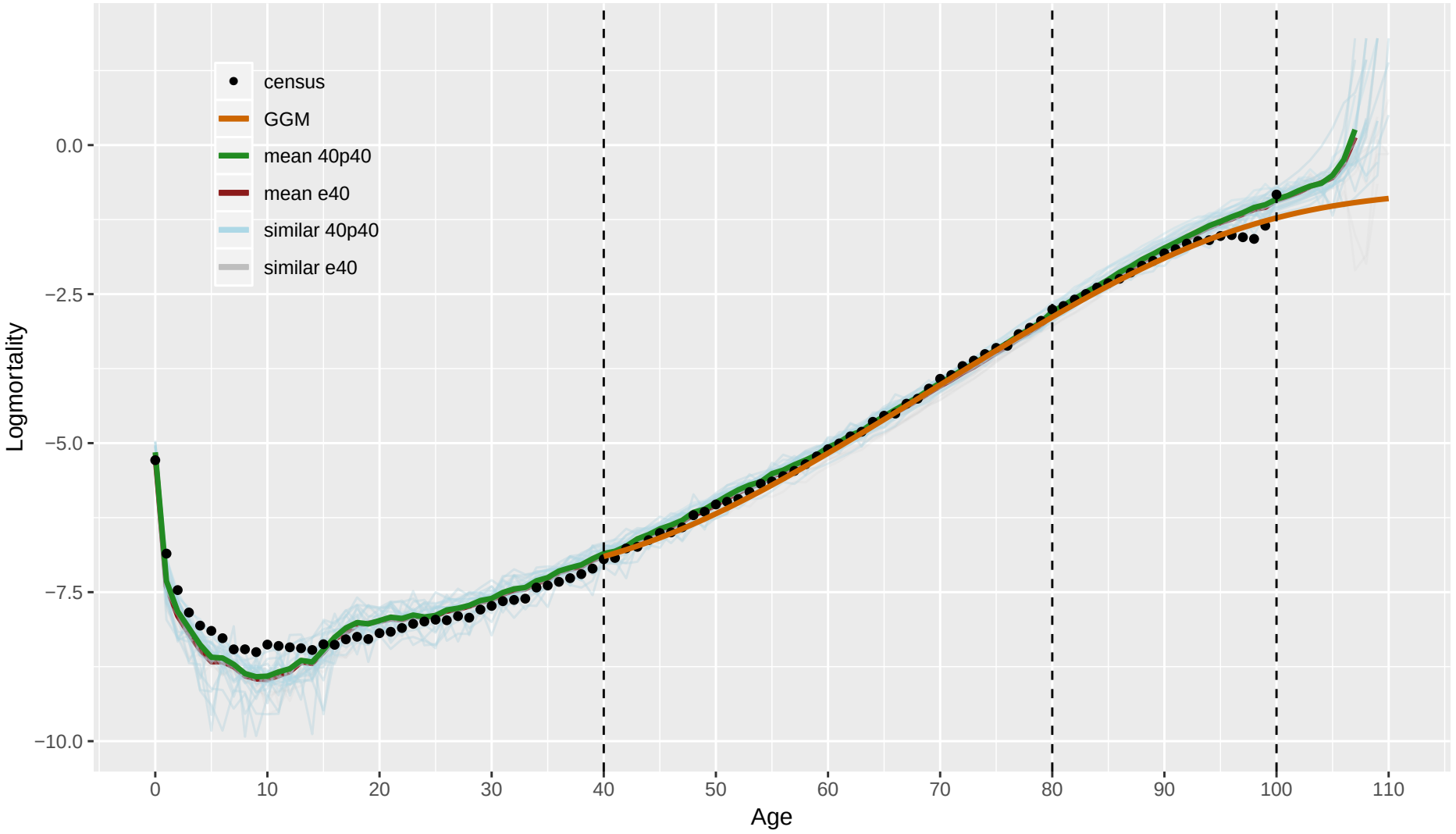
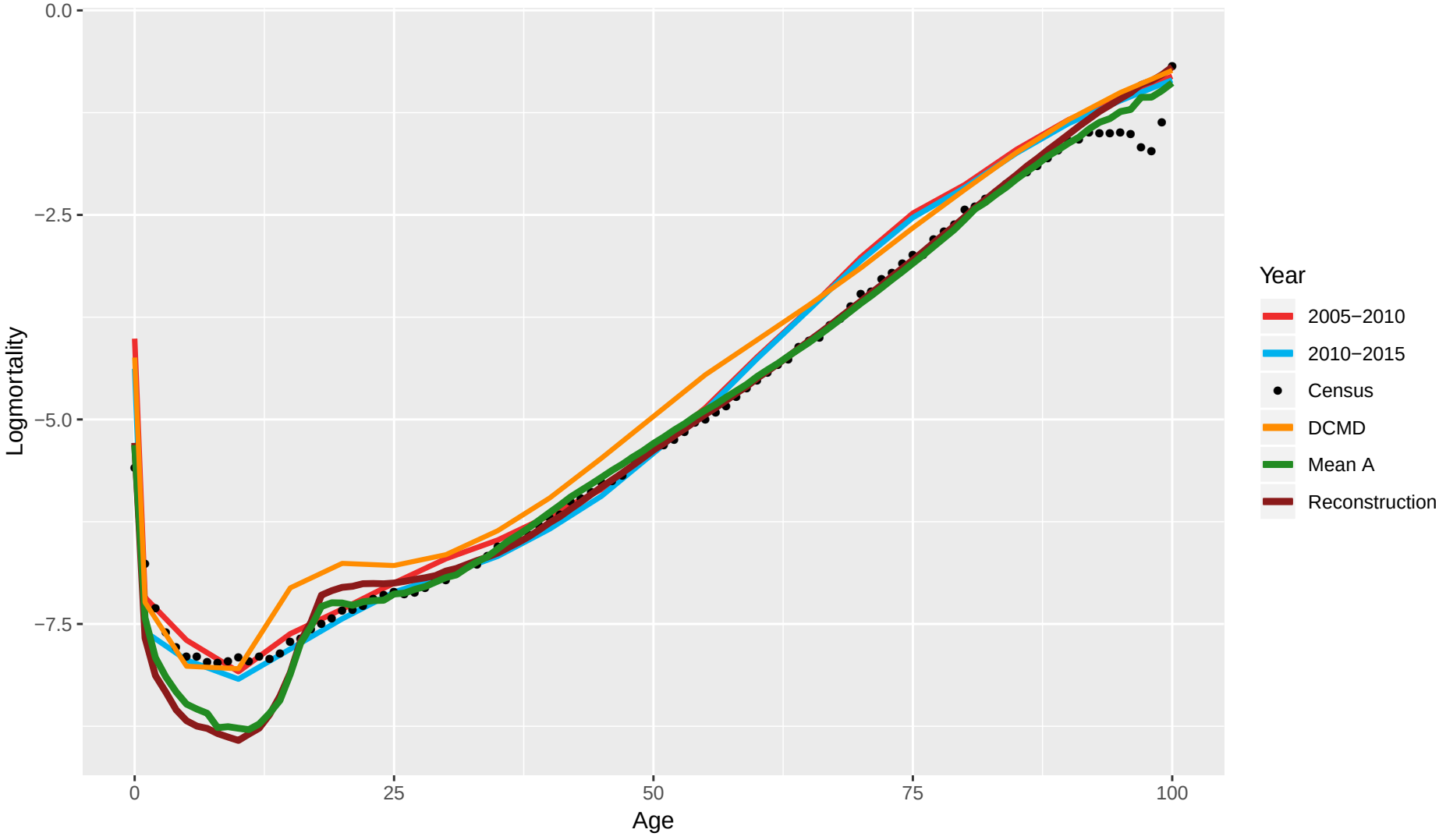
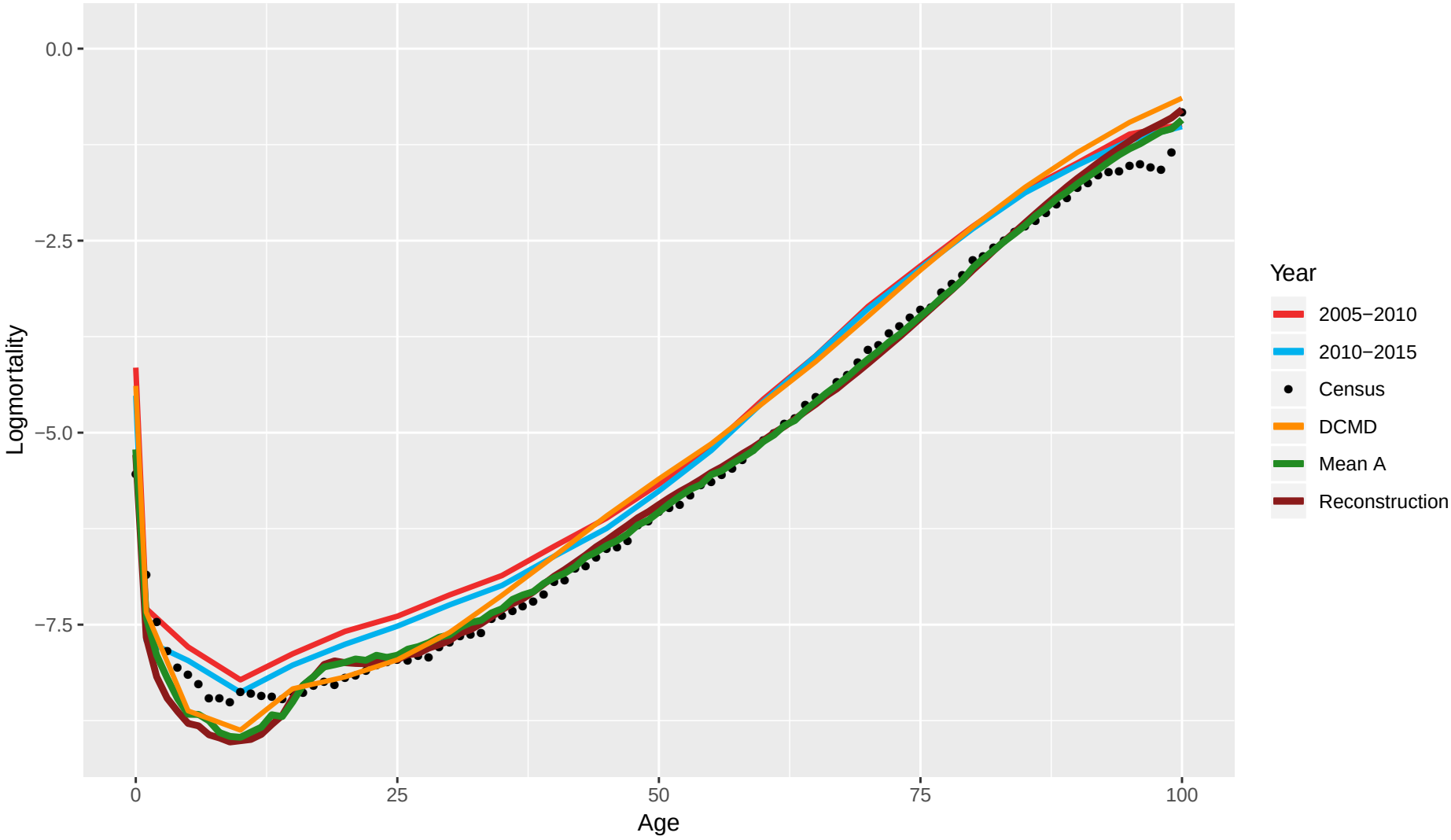


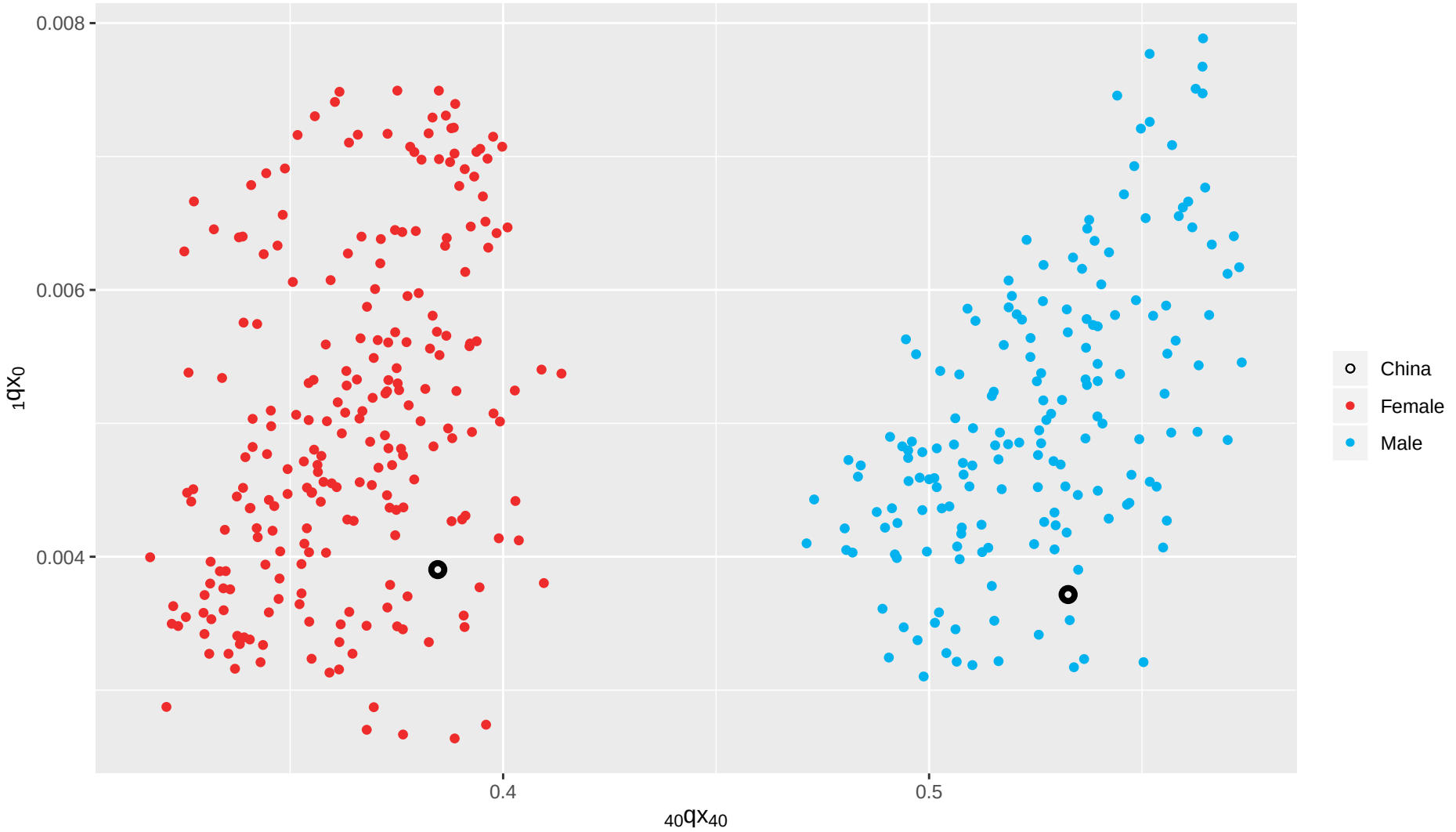
2010 Census vs WPP vs DCMD vs HMD (males)



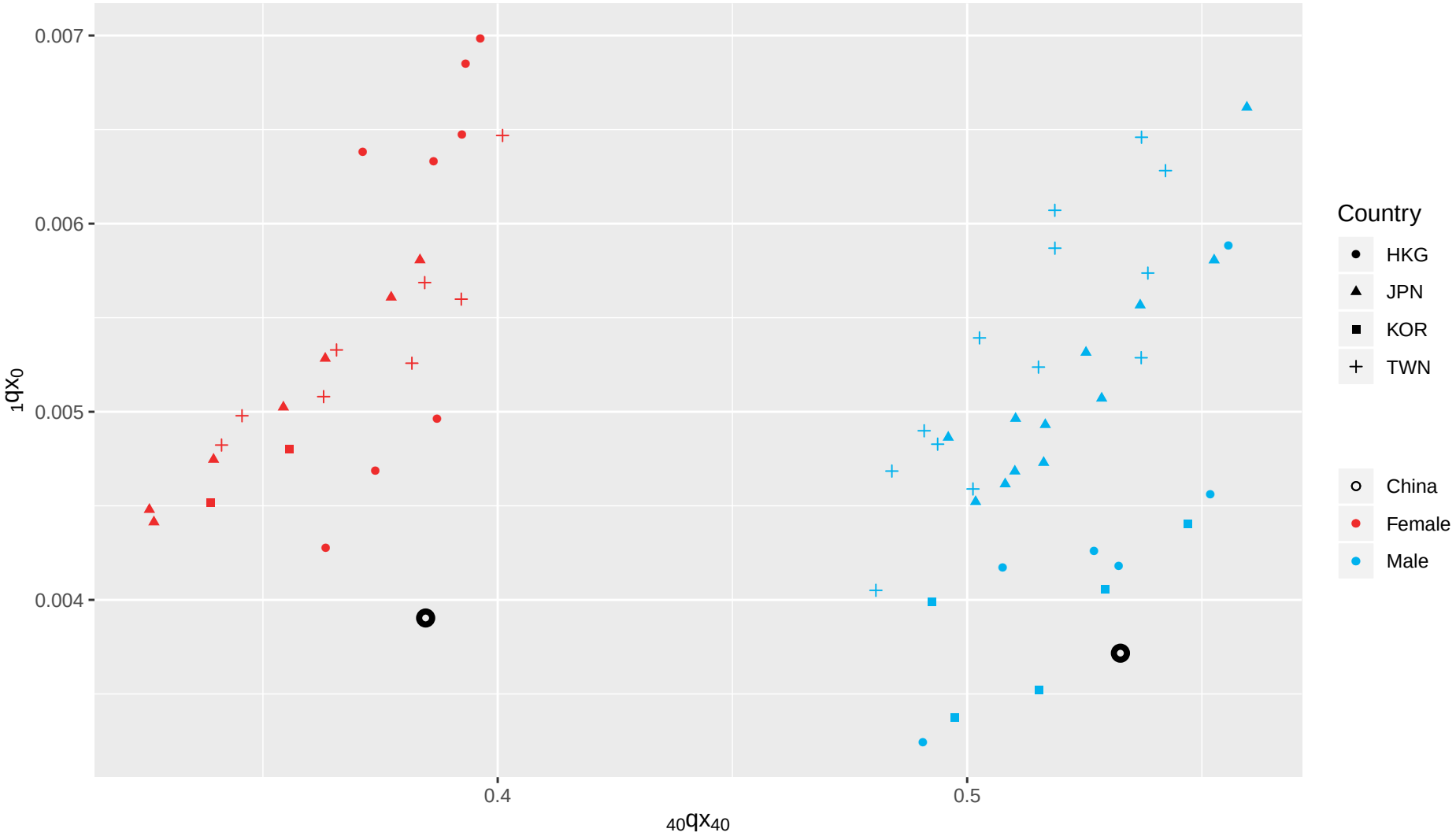
2010 Census vs WPP vs DCMD vs HMD (females)



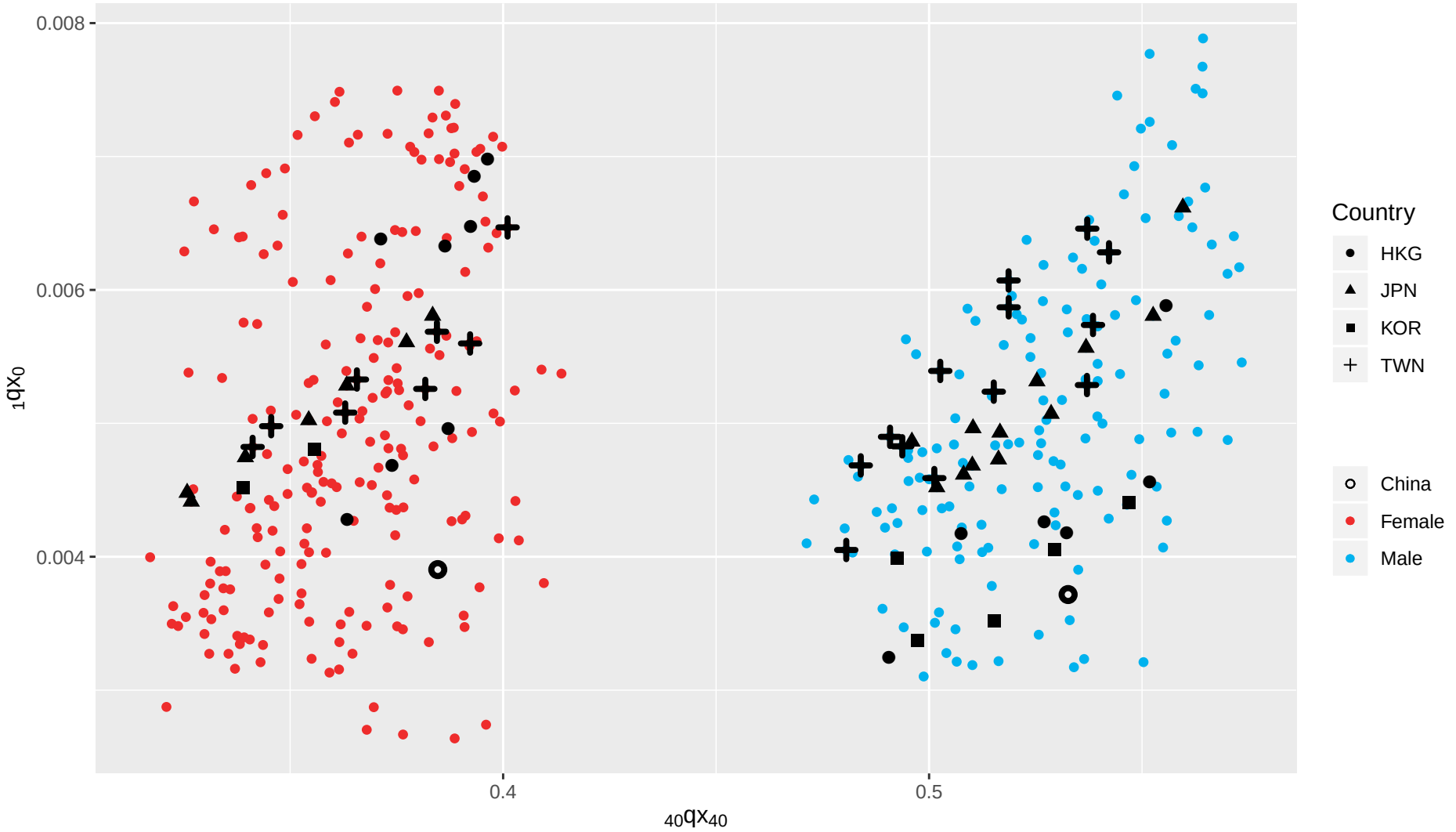
IMR vs ${}_{40}q_{40}$ (HMD)



IMR vs ${}_{40}q_{40}$ (Asia)



IMR vs ${}_{40}q_{40}$ (Asia + rest HMD)



Outcomes and Sidenotes

Life Expectancy in Each Mortality Setting

Hazard	Male	Female
Census	75.11	79.88
Mix	75.28 (75.24 75.33)	80.08 (80.04 80.11)
Red $\sim$e40	75.11 (74.99 75.22)	79.91 (79.83 79.99)
Green $\sim$40p40	74.83 (74.69 74.97)	79.39 (79.23 79.39)
Mix with red tail	75.04 (74.99 75.09)	79.71 (79.67 79.75)

Census-Based and Adjusted Measures (Cai 2013)

Comparison of Infant Mortality Rates, Life Expectancies, China 2000–2010

		Male		Female	
		2000	2010	2000	2010
q_0	Census Raw Data	20.5	4.3	28.4	4.4
	NBS Adjustment	23.9	13.6	33.8	14.3
	GGB	22.7	8.4	33.5	12.5
	MW-GGB	26.5	11.8	16.0	7.3
e_0	Census Raw Data	70.7	75.6	74.3	80.4
	NBS Adjustment	69.6	72.4	73.3	77.4
	GGB	69.7	74.1	72.8	77.4
	MW-GGB	69.8	74.6	74.8	78.4
e_{40}	Census Raw Data	34.6	38.0	38.5	41.6
	GGB	33.9	36.5	37.2	39.5

Data sources:

Census: Census raw data, NBS 2003, 2012.

NBS: Adjusted estimates provided the National Bureau of Statistics (NBS 2012).

MW-GGB: Matched values from Coale and Demeny (1966:83) Regional Model Life Tables West with the GGB estimates of $e40$.

Preliminary Findings

- Acceptable quality of Chinese data at ages 40-80 combined with remarkable regularity of HMD mortality data with the same profile at this age range may serve as a basis for reconstructing patterns at problematic age ranges: 0-39 and 80+
- Perhaps the curve should be adjusted for underreporting: this can push IMR up closer to the NBS adjustment
- Life expectancy resulting from reconstructed death-rate patterns does not differ substantially from the one reported by the census (adjustments for underreporting will certainly change this)
- Different alternatives at ages 80+: use the ΓGM fit (pushed down by data) or the curve resulting from the selected HMD populations with similar 40-80 mortality experience

Final Remarks and Further Steps

Purpose of the presented reconstruction procedure:

- produce a curve / model life table that can be used to validate mortality curves resulting from Census or other data sources, incl. sub-national data series, hospital records, etc.
- identify problematic spots in the data
- estimate the magnitude of the error in each of the problematic spots and the corresponding impact on mortality measures

Further steps:

- Gather and validate as many alternative primary mortality data sources as possible
- Come up with an eventual mortality curve based on max. real data that best reflects the experience of HMD populations with similar mortality at ages where Chinese mortality data are most acceptable.

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Thank you for your attention!

Questions or comments?

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Adjusting the Infant Mortality Rate (IMR)

ASMR Correction (Cai 2013)

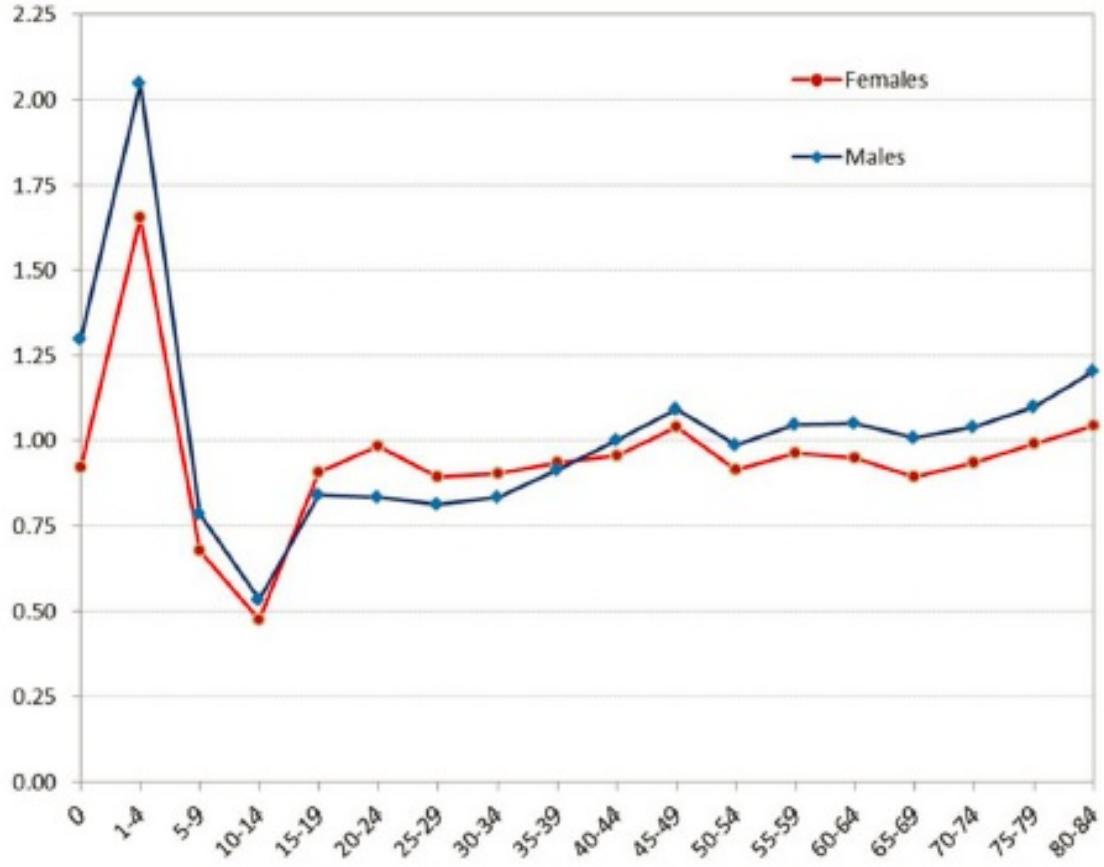
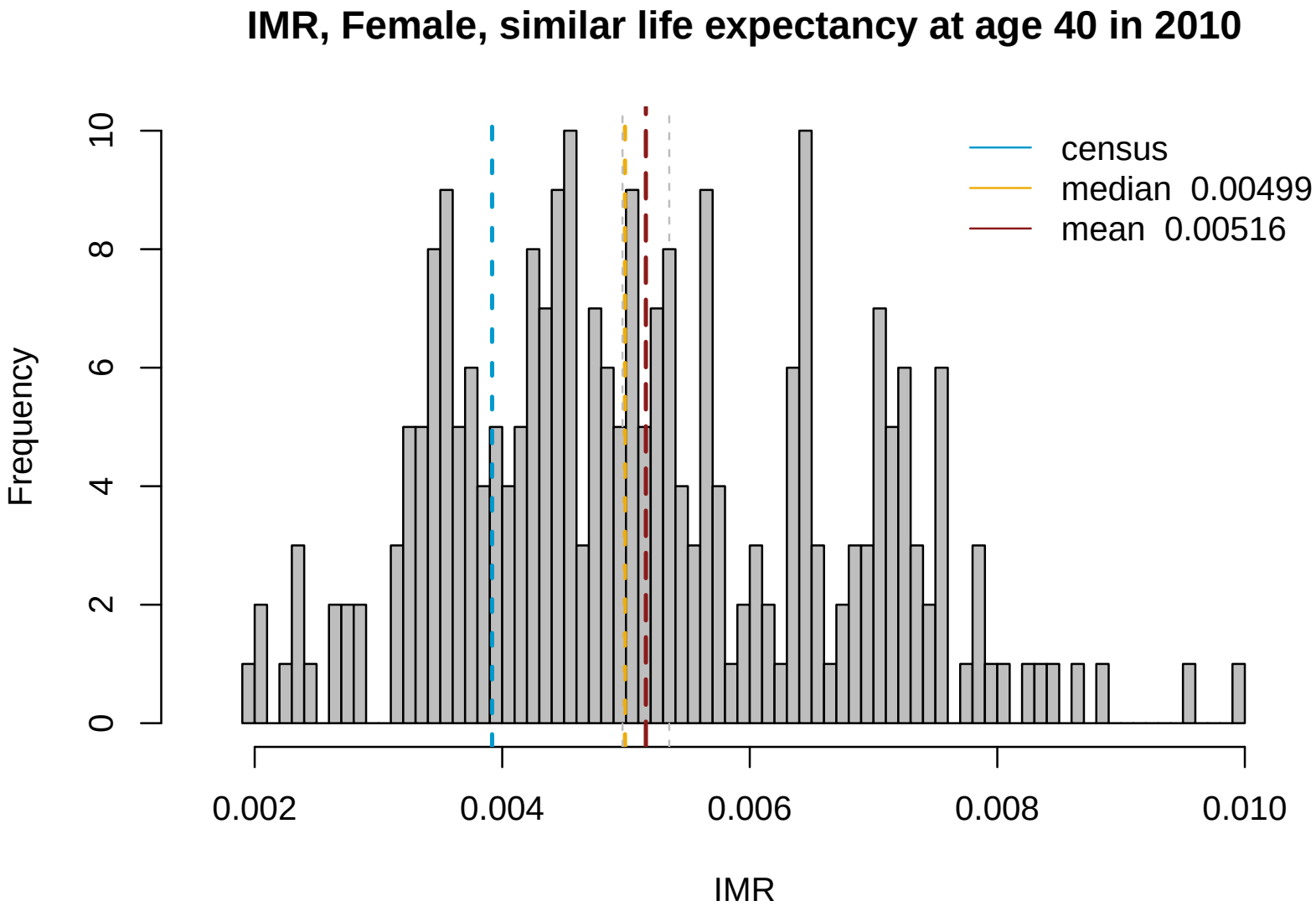


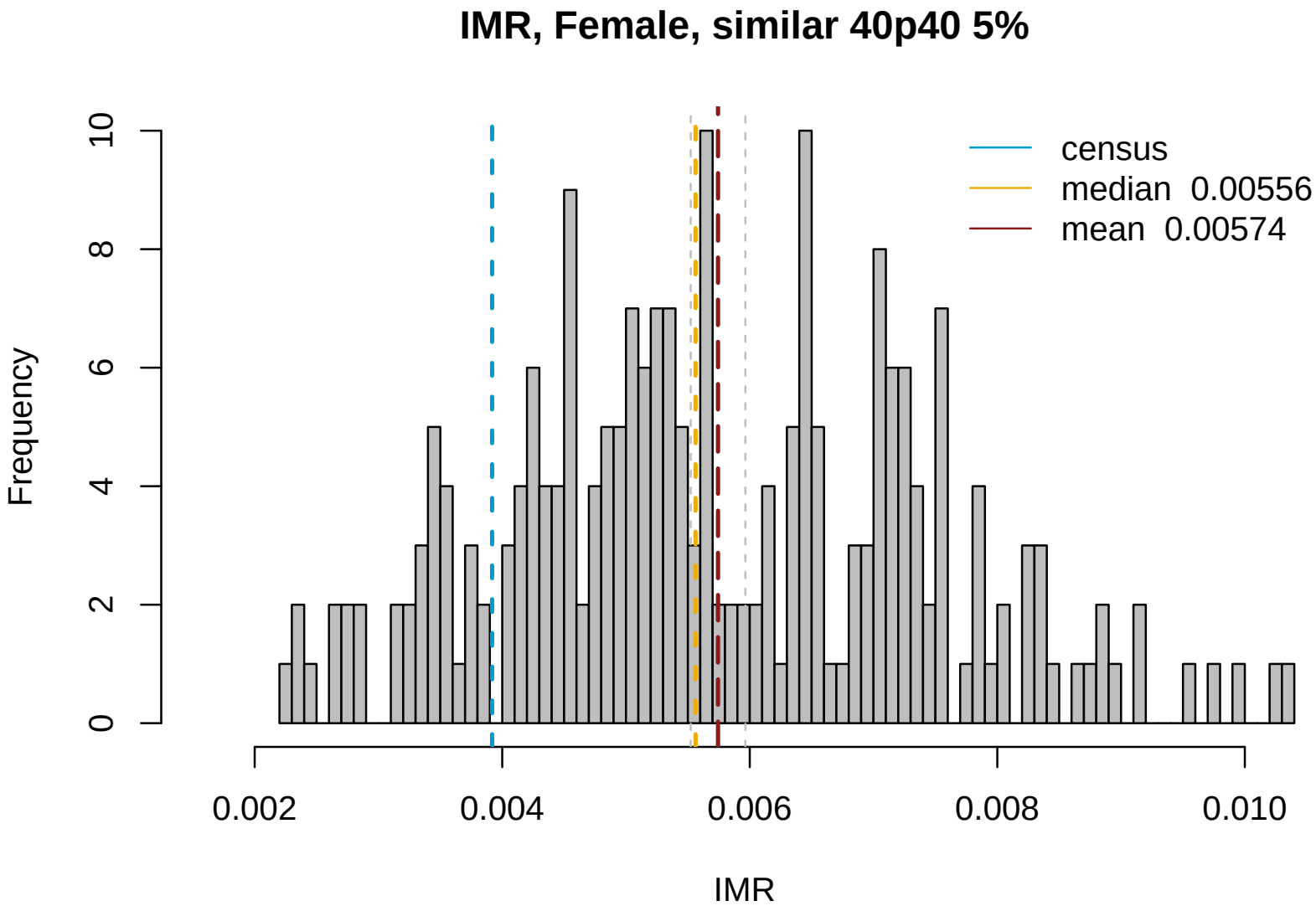
Figure 4. Ratio of Age Specific Mortality Rates: Ministry of Health Registry vs. Census Data, China 2010

Data sources: Age specific mortality rates from China Health Statistical Yearbook (2011) and the 2010 census.

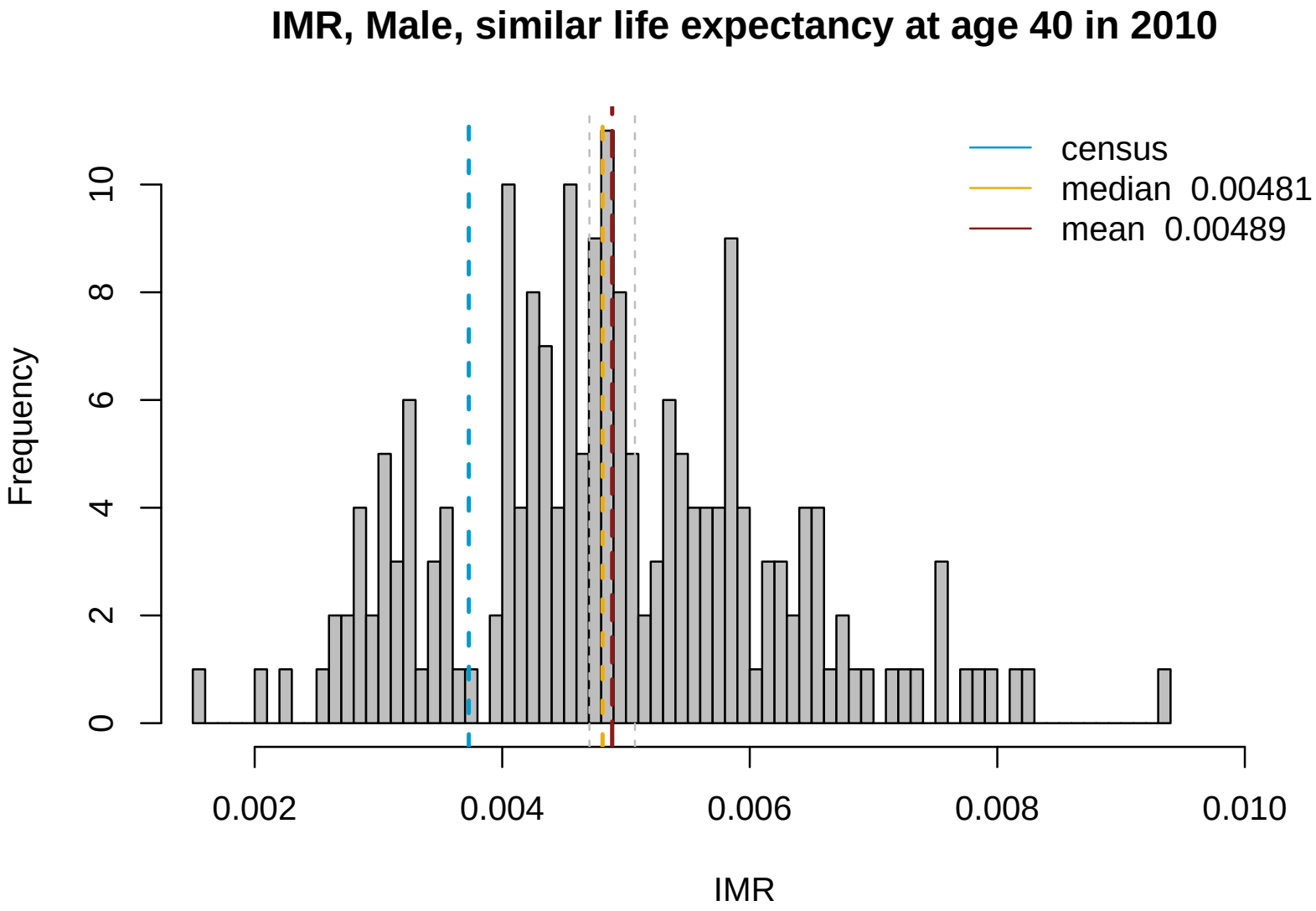
IMR, Females, 2010: HMD Populations with $\sim e_{40}$



IMR, Females, 2010: HMD Populations with $\sim {}_{40}p_{40}$



IMR, Males, 2010: HMD Populations with $\sim e_{40}$



IMR, Males, 2010: HMD Populations with $\sim {}_{40}p_{40}$