Sex Ratio of Mortality Rate Estimation Using a Bayesian Modeling Approach

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Joint Statistical Meetings
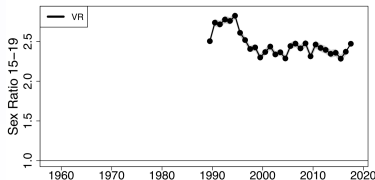Aug 8th, 2021

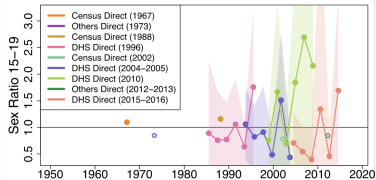King Abdullah University of
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Gender gaps in mortality 15–24

- Mortality rate: probability of dying in a certain age group.
- Mortality sex ratio: ratio of male to female mortality rate.
- Modeling is needed: estimating sex ratios can be challenging because of data quality/availability.
- Aim: estimate trends in sex ratio for age groups 15–24 for 195 countries since 1990 using a statistical model.

Model overview

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Data: 7,313 observations on sex ratio of mortality from age groups 15–24, available from 166 countries.

Model: builds upon the model by Alkema L., et al. 2014.

$$\log(y_{c,t}) \;=\; \log(\Psi_{c,t}) + \Sigma_{c,t},$$

- c and t: country c and year t.
- $y_{c,t}$: observed sex ratio.
- $\Psi_{c,t}$: the true sex ratio of mortality rate.
- $\Sigma_{c,t}$ takes into account <u>known</u> sampling error variance and <u>unknown</u> non-sampling error variance.

Computation: Integrated Nested Laplace Approximations (INLA; Rue H., et al. 2009).

Process model

The true sex ratio $\Psi_{c,t}$ for country c in year t is modeled as:

$$\log(\Psi_{c,t}) = \alpha_c + \Theta_{d[c,t]} + \Phi_{c,t},$$

- α_c: the country-specific random effect for country c, follows a hierarchical normal distribution.
- $\Theta_{d[c,t]}$: the global expected sex ratio for country c in year t evaluated at the dth unique location of the total mortality rate, follows a random walk of order 2 (RW2) model.
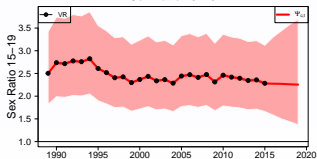- $\Phi_{c,t}$: the year-by-year fluctuation around the global relation, follows a random walk of order 1 (RW1) model.
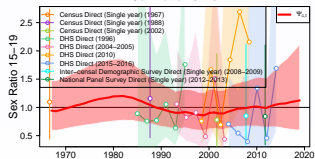
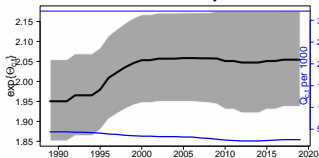# Global expected sex ratios
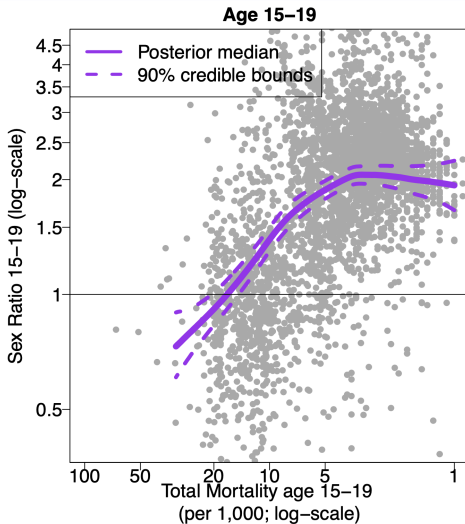
Illustration for country estimates

Summary

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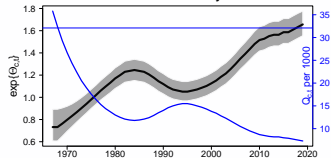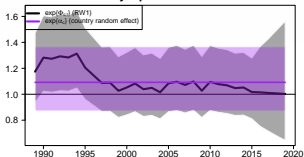
Conclusion

- We estimate trends in sex ratio of mortality for age groups 15–24 for all countries.

- Validation results suggest good model calibration and predictive power.

Collaborators

- Bruno Masquelier, UCLouvain.

- Håvard Rue, KAUST.

- Hernando Ombao, KAUST.

- Leontine Alkema, UMass Amherst.

Reference

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Alkema L, Chao F, You D, Pedersen J, Sawyer CC. National, regional, and global sex ratios of infant, child, and under-5 mortality and identification of countries with outlying ratios: a systematic assessment. The Lancet Global Health. 2014 Sep 1;2(9):e521-30.

Rue H, Martino S, Chopin N. Approximate Bayesian inference for latent Gaussian models by using integrated nested Laplace approximations. Journal of the royal statistical society: Series B (statistical methodology). 2009 Apr;71(2):319-92.