Professor Fengqing Chao's Team Estimating Adult Mortality Rates in 236 Countries Using Bayesian Hierarchical Models

- provided by Qiqi Qiang and Yichang Shi (2025)

The Chinese University of Hong Kong (Shenzhen) — A research team led by Professor Fengqing Chao. She has recently published the work (available here) on computing adult mortality rates in countries with high HIV prevalence using the Bayesian Hierarchical Model (BHM). This work aims to estimate the levels and trends in adult mortality for ages 15-59, i.e. the probability of dying between the ages of 15 and 59 years old, by sex from 1950 to 2023.

It is necessary for countries with high HIV prevalence to monitor the adult mortality rates for disease control and population estimation. It is challenging because most countries lack good civil registration vital systems (CRVS). Therefore, estimating sex-specific mortality in these countries always relies on surveys, which are subject to sampling errors and bias. Moreover, the model life table methods are not able to assess the mortality patterns in countries with high HIV prevalence.

To address the challenging problems, we developed BHMs to estimate the levels and trends in sex-specific adult mortality for ages 15-59 from 1950 to 2023, which aligns with mortality in the ages 15-59 for countries with high HIV prevalence. These models utilize databases of adult mortality from various sources, including CRVS systems, censuses, surveys, and national reports. BHMs enable information sharing across national periods with varying data volumes. This model specifically models the impact of HIV prevalence on adult mortality to capture its nonlinear patterns. It reflects mortality peaks driven by high HIV prevalence while reasonably projecting mortality declines as HIV prevalence decreases and antiretroviral treatment coverage increases. Figure 1 provides an overview of the database preprocessing, database compilation, and the two steps of the Bayesian modelling workflow.

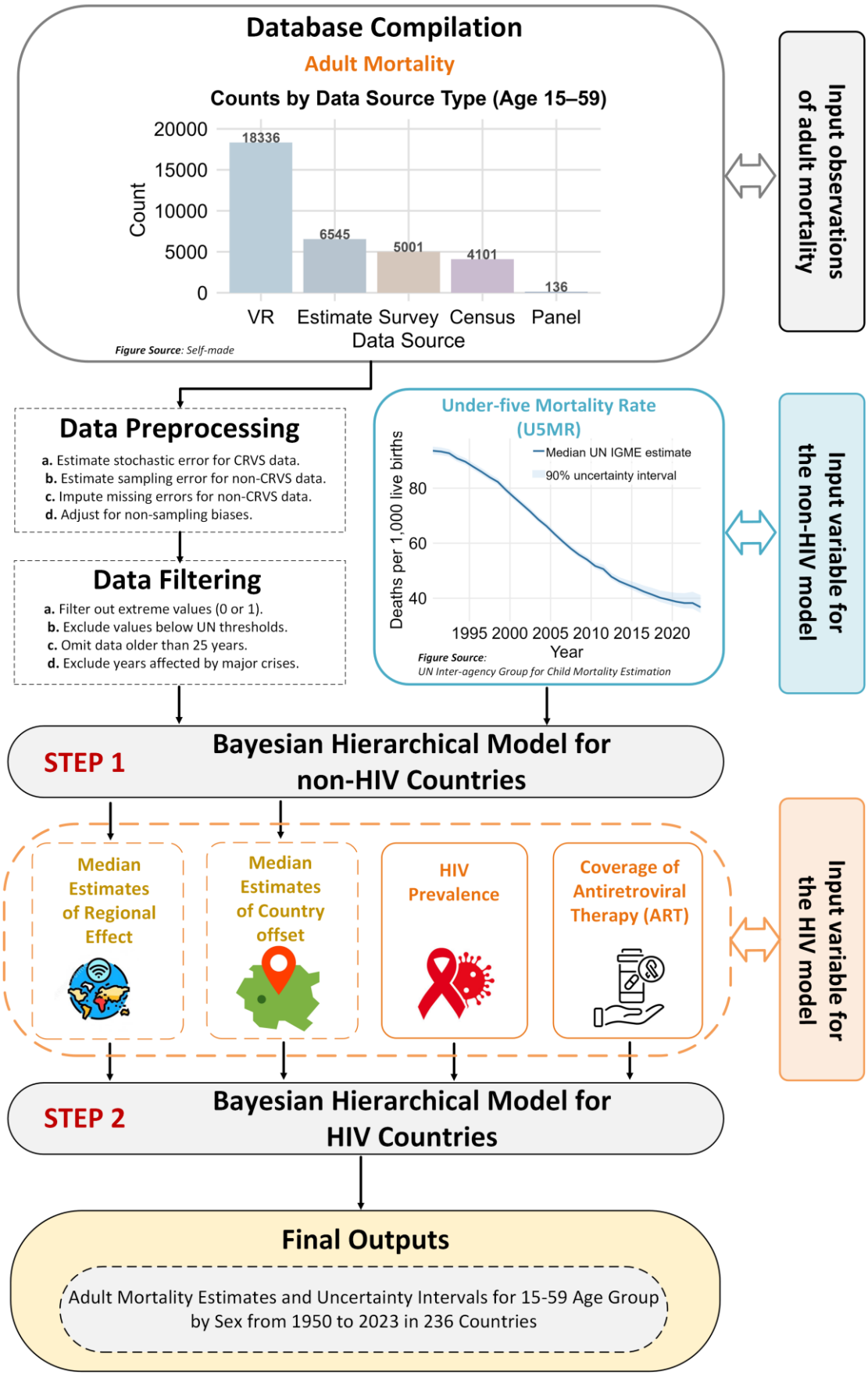

Figure 1: Flowchart of the project.

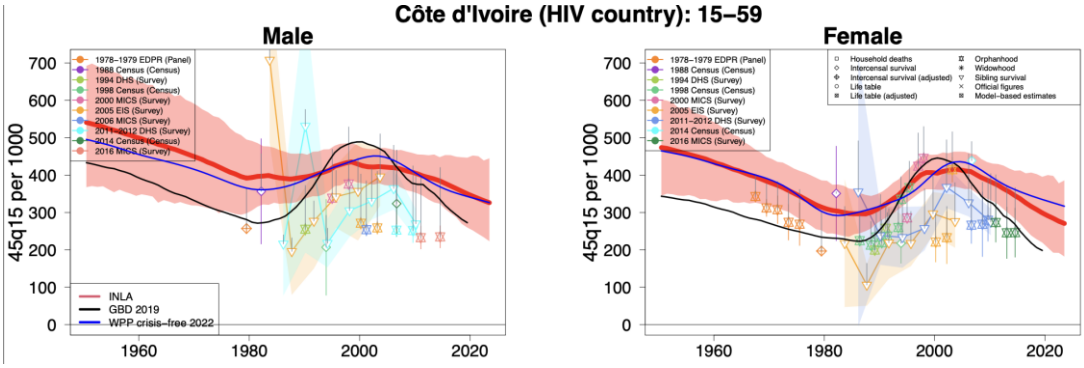

Figure 2: Adult mortality for ages 15-59 model estimates from 1950 to 2023 in Côte d'Ivoire. The curves show the posterior medians. The shades show the 95% uncertainty bounds. Dots are observations used for modelling. Shades and vertical lines around dots are sampling errors. The vertical grey bars at dots shows the bias adjustment done before BHM model fitting. Grey bars are absent for observations if bias adjustment is zero.

Figure 2 shows the model results in Côte d'Ivoire, which had a high HIV prevalence. Since the 1990s, HIV infection rates in HIV countries have begun to rise, a trend reflected in mortality data collected during the same period. After incorporating additional effects related to HIV prevalence and antiretroviral therapy coverage in the second estimation step, the BHM model successfully captured the distinctive hump-shaped mortality pattern primarily driven by HIV prevalence since the 1980s. The model successfully estimated declining mortality trends as HIV prevalence decreased, and antiretroviral treatment coverage increased—primarily due to the model's incorporation of the interaction effect between HIV and antiretroviral therapy.

Main reference for the forementioned work:

Fengqing Chao, Ivan Williams, Lubov Zeifman, Patrick Gerland (2024). Estimating age-sex-specific adult mortality in the World Population Prospects: A Bayesian modelling approach. In *United Nations, Population Division of the Department of Economic and Social Affairs*. [Full report available here]