Under-Five Mortality Estimation: An assessment of Summary Birth History Methods Using Microsimulation

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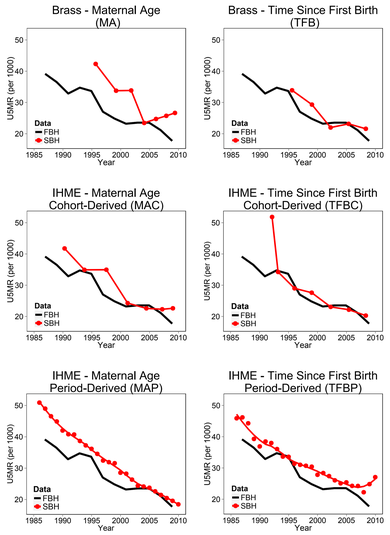
The Summary Birth History Methods



► Figure 1. U5MRs derived indirectly from the six SBH methods under study compared to direct estimates from the 2010 Colombian DHS survey.

► Summary birth histories (SBHs): data collected by asking about women's number of children ever born (CEB) and dead (CD). They don't include the location of births and deaths over time.

► SBH methods: indirect methods that permit to derive under-five mortality rate (U5MR) trends from SBH data. SBH methods approximate the time exposure to the risk of dying by using a proxy as the maternal age or time since first birth.

► Census-based estimates: the SBH approach is essential to produce subnational estimates using census data in countries without comprehensive vital registration systems.

► Two kinds of methods assessed in this study:

1. Classical *Brass* model-based methods.
2. New empirically-based methods developed by the *Institute for Health Metrics and Evaluation (IHME)* using Demographic and Health Surveys (DHS).

► Three categories of IHME methods:

1. *Cohort*-derived methods using the same cohort data than the Brass methods.
2. *Period*-derived methods based on expected time distributions of births and deaths.
3. Combinations of methods through LOESS local regression.

► Two duration proxy variants for each methods:

1. Maternal age (Brass-MA, IHME-MAC and -MAP)
2. Time since first birth (Brass-TFB, IHME-TFBC and -TFBP)

► Research Questions:

1. How robust are the new IHME methods comparing to the classical Brass methods?
2. Do these SBH methods perform the same in all fertility and mortality regimes?
3. Which methods or their combinations should be preferred depending on the available data?

Microsimulation with SOCSIM

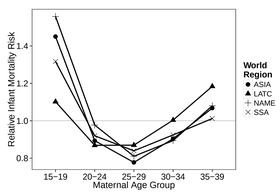
► Demographic microsimulation with SOCSIM: in order to assess them, the six SBH methods under study were applied to simulated birth histories, generated using the SOCSIM program from the Berkeley Demography Lab.

► Country-specific simulations based on UN estimates: the microsimulations were derived from the 1950-2010 fertility and mortality rates from the 2012 Revision of the UN World Population Prospects (WPP). Only the countries without comprehensive death registration were selected. Countries with explicit HIV/AIDS modeling in the WPP (and with peak prevalence rate superior to 5%) were also excluded.

► Four world regions: the 82 resulting countries were divided out according to the regional classification used to developped the IHME methods: **Asia (ASIA), Latin America and the Caribbean (LATC), Northern Africa and Middle-East (NAME), Southern and Eastern Sub-Saharan Africa (SASE), Western and Central Sub-Saharan Africa (SAWC). However, due to the similarity of the results, the two Sub-Saharan regions were considered as one (SSA)**.

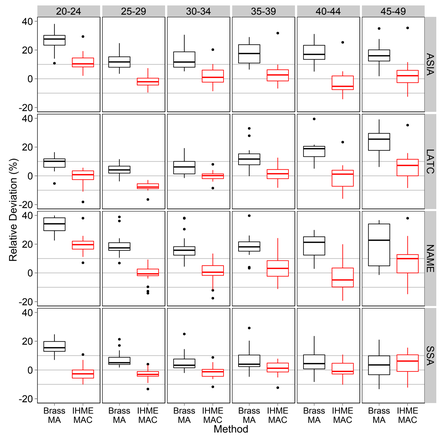
► Regional models of relative infant mortality risks: in order to vary the infant mortality risk by 5-year age groups of mothers in the simulations, four regional models were captured across the 135 DHS datasets collected between 1990 and 2013 in 46 of the 82 selected countries. That was carried on by using a Cox Proportional Hazard Model.

► Assessment strategy: Both indirect and direct (event/exposure procedure for period-specific measures (Moultrie et al., 2013)) estimation methods were applied to the microsimulated birth histories as if the data were collected at the end of 2010. The unbiased and error-free direct estimates were used as gold standard reference to calculate the relative deviation of the SBH estimates.

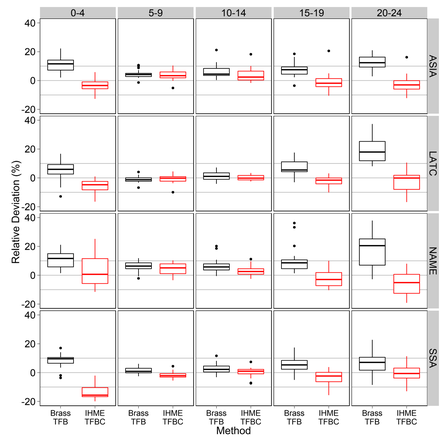


► Figure 2. Models of relative infant mortality risk by 5-year age group of mothers across world regions.

Cohort-Based Methods: Brass vs IHME

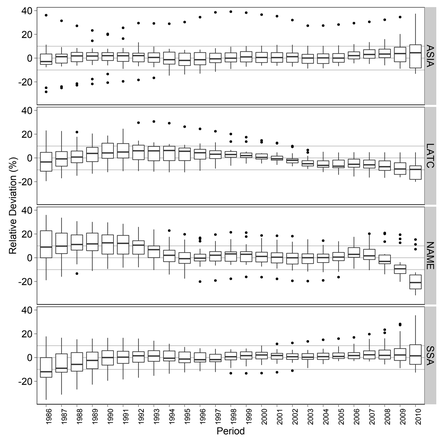


► Figure 3. Relative deviation from gold standard of the U5MR estimates derived from the maternal age variants of the standard Brass (Brass-MA) and IHME cohort-derived (IHME-MAC) methods, and associated with age groups of mothers 20-24 to 45-49 across world regions.

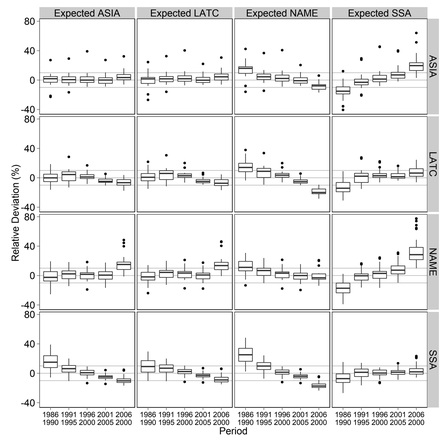


► Figure 4. Relative deviation from gold standard of the U5MR estimates derived from the time since first birth variants of the Brass (Brass-TFB) and IHME cohort-derived methods (IHME-TFBC) methods, and associated with duration groups 0-4 to 20-24 across world regions.

Maternal Age Variant of the IHME Combined Method



► Figure 5. Relative deviation from gold standard of the single-year U5MR estimates derived from the maternal age variant of the IHME combined method (combination of IHME-MAC and -MAP methods) across world regions.



► Figure 6. Relative deviation from gold standard of 5-year period U5MR estimates derived from the maternal age variant of the IHME combined method (combination of IHME-MAC and -MAP methods) using different expected births and deaths time distributions across world regions.

Results

► Figure 3. Maternal age variants of cohort-based methods:

1. The IHME-MAC method shows globally a good performance across world regions with 2% error on average, and 79% of the estimates falling within a 10% deviation interval. The method is particularly robust for the estimates associated with age groups 25-29 to 35-39 (90% of estimates within 10 % deviation), located between 6 and 12 years prior to the data collection.
2. The standard Brass-MA method contrasts with an uniform and positive overestimation growing through older cohorts up to 21 % on average. The estimate of the Brass method that is usually considered the most robust and based on reports from women aged 30-34, is overestimated, on average, by 10% for the set of microsimulations.

► Figure 4. time since first birth of cohort-based methods:

1. Both Brass-TFB and IHME-TFBC methods outperform their maternal age variant counterparts and show a high stability across regions. Respectively, 94% and 97% of the estimates associated with duration groups 5-9 and 10-14 fit within a 10% deviation interval. Including the first estimate associated with duration group 0-4 and located around 2 years prior to survey time, the IHME-TFBC method produces potentially a 15-year trend with a mean deviation approximating zero and 84% of the estimates in a 10% deviation.
2. For both methods, the most recent estimate associated with duration group 0-4 requires further investigation to take into account the effect of the parity/birth order on the mortaliy risk.

► Figure 5 and 6. maternal age variant of the IHME combined method:

1. Figure 5: the combination of the IHME-MAC and -MAP methods is the best possible combination. However, this combined method tends to produce rather mixed results. The mean deviation of 1% is rather good and 76% of the overall estimates fall within a 10% deviation interval (55% for Northern Africa and The Middle-East against (NAME) 89% for Sub-Saharan Africa (SSA)). However, the robust estimates tend to be located in the middle of the trends. By contrast, the older and the most recent estimates are associated with a quite high uncertainty, up to 35% for the two first years prior to data collection.
2. Figure 6 shows the potential impact of the underlying assumption of the IHME-MAP method (within a same region, the time location of births and deaths of a woman of a certain 2-year age group and number of CEB/CD can be generalized across countries and time periods). Asia (ASIA) and Latin America and the Caribbean (LATC) can switch easily their expected time distributions of births and deaths because of their similar stage in their demographic transition. Nonetheless, using these expected time distributions in Sub-saharan countries lead to a strong overestimation of the mortality decline. This misuse of the MAP method is likely to concern regions of Asia, Latin America and the Caribbean as well as Northern Africa and the Middle-EAst that lag behind in the fertility and mortality decline.

Conclusion

1. The maternal age variant of the IHME cohort-derived method (IHME-MAC) outperfoms the standard Brass method (Brass-MA) using the same data, and produces rather robust U5MR trends across different demographic regimes. However, it hardly produces robust estimates within the 5 years prior to the data collection.
2. The time since first birth variant of both Brass and IHME cohort-derived methods (Brass-TFB and IHME-TFBC) perform better than their maternal age counterparts and should be preferred when data are available.
3. The IHME-MAC and -TFBC methods should be preferred to the recommended combinations with the period-derived methods.

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