Supplementary material for the paper "The uneven state-distribution of homici Brazil and their effect on life expectancy, 2000-15"

Authors: José Manuel Aburto (0000-0002-2926-6879), Júlia Calazans, Bernardo L. Queiroz, Shammi Luhar, Vladimir Canudas-Romo

Correspondence to:
José Manuel Aburto
42-43 Park End Street, OX1 1JD Oxford, UK.
Email: jose-manuel.aburto@sociology.ox.ac.uk
Tel: +45 31712122
ORCID: 0000-0002-2926-6879

Section 1. Death Distribution Methods summary

The first step of the study is to assess the quality and adjust the mortality data from states in Brazil. This analysis is done using a series of traditional demographic methods, better known as Death Distribution Methods (Hill, 2017; Hill, You and Choi, 2009). These methods were developed, based on population dynamics equations, to assess the coverage of deaths in relation to the population and the quality of the declaration of information on deaths and population. The methods compare the distribution of deaths by age with the age distribution of the population and provide the age pattern of mortality for a defined period (Hill, 2017; Murray, et.al, 2010; Hill, You and Choi, 2009). There are three main varians for evaluating the quality of mortality data: general growth balance (GGB), synthetic extinct generation (SEG) and the adjusted synthetic extinct generations (SEG-adj). The methods have very strong assumptions: population is closed to migration or subject to very small migration flows, the degree of coverage of deaths is constant by age, the degree of coverage of the population counts is constant by age, and the ages of the living and of deaths are declared without errors. Queiroz, et.al (2020) provides an detailed description of the methods and discuss their applications in different scenarios.

GGB is derived from the basic demographic equilibrium equation, which defines the rate of population growth as the difference between the rate of entry and the rate of exit of the population. This relationship, according to Hill (1987), also occurs for any age segment with open interval x +, and the entries occur as birthdays at ages x. Thus, the difference between the entry rate x + and the population growth rate x + produces a residual estimate of the mortality rate x + (Hill, 1987; Hill, You and Choi, 2009). If the residual mortality estimate can be estimated from two population censuses, and compared with a direct mortality estimate using the death registry, the degree of coverage of the death registry can be estimated and mortality data adjusted (Hill, 1987; Hill, You and Choi, 2009; Murray, et.al, 2010).

SEG uses age-specific growth rates to convert an age distribution of deaths into an age distribution of a population. In a stationary population the deaths observed after a certain age x are equal to the population over the same age x, we have that the deaths of a population over age x provide an estimate of the population over the same age. Age-specific population growth rates are used to adjust the number of deaths in the stationary population for an unstable population. The sum of the number of deaths over age x gives an estimate of the population over age x. The degree of coverage of the death record will be given by the ratio between the deaths estimated by the population above age x and the population observed above age x.

Hill, You and Choi (2009) suggest a combination of the methods of GGB and SEG that can be more robust than the application of the two methods separately. The adjusted method consists of applying the GGB to obtain estimates of the change in census coverage, and using that estimate to adjust one of the demographic censuses (population enumeration) and then apply SEG method with the adjusted population to obtain the degree of coverage of the mortality data.

Although they have some limitations, DDMs provide very robust and consistent results for a series of applications across the globe. For instance, Peralta et al., 2019 applied the methods to evaluate data quality at the sub-national level in Ecuador. Glei, Barbieri and Santamaria-Ulloa (2019) studied the quality of mortality estimates in Costa Rica and compared to other estimates. Wang et al. (2016) shows the application of DDM as part of the procedures of the Global Burden of Diseases and Lima and Queiroz (2014) and Queiroz, et.al (2020) evaluate quality of mortality information for small-areas in Brazil overtime.

References

Bennett, N. G., & Horiuchi, S. (1981). Estimating the completeness of death registration in a closed population. *Population index*, 207-221.

Bennett, N. G., & Horiuchi, S. (1984). Mortality estimation from registered deaths in less developed countries. *Demography*, *21*(2), 217-233.

Glei, D. A., Barbieri, M., & Santamaría-Ulloa, C. (2019). Costa Rican mortality 1950-2013: An evaluation of data quality and trends compared with other countries. *Demographic research*, *40*, 835.

Hill, K. (1987, May). Estimating census and death registration completeness. In *Asian and Pacific population forum/East-West Population Institute, East-West Center* (Vol. 1, No. 3, pp. 8-13). The Asian & Pacific Population Forum.

Hill, K., You, D., & Choi, Y. (2009). Death distribution methods for estimating adult mortality: sensitivity analysis with simulated data errors. *Demographic Research*, *21*, 235-254.

Hill, K (2017). Analytical methods to evaluate the completeness and quality of death registration: current state of knowledge. Population Division Technical Paper, no. 2017/02.

Lima, E. E. C. D.; Queiroz, B. L. Evolution of the deaths registry system in Brazil: associations with changes in the mortality profile, under-registration of death counts, and ill-defined causes of death. Cadernos de Saúde Pública, v. 30, n. 8, p. 1721-1730, 2014.

Murray, C. J., Rajaratnam, J. K., Marcus, J., Laakso, T., & Lopez, A. D. (2010). What can we conclude from death registration? Improved methods for evaluating completeness. *PLoS medicine*, *7*(4).

Peralta, A., Benach, J., Borrell, C., Espinel-Flores, V., Cash-Gibson, L., Queiroz, B. L., & Marí-Dell'Olmo, M. (2019). Evaluation of the mortality registry in Ecuador (2001–2013)–social and geographical inequalities in completeness and quality. *Population health metrics*, *17*(1), 3.

Queiroz, B. L., Lima, E. E., Freire, F. H., & Gonzaga, M. R. (2020). Temporal and spatial trends of adult mortality in small areas of Brazil, 1980–2010. Genus, 76(1), 1-22.

Queiroz, B. L., Gonzaga, M. R., Vasconcelos, A. M., Lopes, B. T., & Abreu, D. M. (2020). Comparative analysis of completeness of death registration, adult mortality and life expectancy at birth in Brazil at the subnational level. Population health metrics, 18(1), 1-15.

Wang H. et al. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the global burden of disease study 2015. Lancet. n. 388, p. 1459-544, 2016.