Annex 5

Methodology for calculations on health inequality across countries

The impact of Global Fund investments during 2023-2029 on inequality in global life expectancy across countries were obtained in two steps: Life expectancy was calculated for each country and year, and investment scenario (Section 1); estimates of life expectancy across countries were transformed into indicators on health inequality across countries (Section 2).

The basic methods for this forward-looking analysis of how Global Fund investments will impact global inequality in life expectancy (LE) between 2023-2029 is adapted from the original retrospective analysis covering 2002 to 2019[1] that was updated to 2021 for this Investment Case. The main data source for the retrospective analysis is the Institute for Health Metrics and Evaluation (IHME) estimates of all-cause and disease-specific mortality by country, age, sex and year in the 2021 Global Burden of Disease (GBD) study.[2]

In contrast to the retrospective analysis, forward analysis is based on mortality rates estimated directly from a simulation of the policy impact in disease-specific epidemiological models. These models generate estimates of the number of deaths by age group for the Investment Case and Constant Coverage at 2023 levels. But they do not make an estimate of future rates of deaths from causes other than HIV, TB and malaria. Therefore, we used all-cause mortality rates from the 2021 GBD study, and assumed the mortality rates from other causes would not change in the period extending to 2029.

[1] Contributions of Declining Mortality, Overall and from HIV, TB and Malaria, to Reduced Health Inequality and Inequity Across Countries. Haacker, Markus. 2023. *Health Policy Plan* 38 (8): 939–48.

[2] Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2021 (GBD 2021) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2022. Available from https://vizhub.healthdata.org/gbd-results/.

Section 1: Estimating life expectancy

Baseline life expectancy used output data from IHME models from the 2021 GBD study on country-, age-, sex- and cause-specific probability of death for the year 2021. In this data, probability of death is available in five-year age intervals, which were converted to single-age annual mortality rates that were assumed to remain constant through 2029. Life expectancy was calculated as the expected duration of life (equivalent to the area underneath the survival curve), applying established methods for this purpose.[3] First, for each country and year, we constructed a survival curve which, for each age, shows the probability of surviving to that age, applying the mortality rate for the respective age bracket for age-specific attrition. The probability of surviving to age *t+1*, P_{t+1} is calculated from the probability of surviving to age t as $P_{t+1} = P_t e^{-m_{S_t}}$ where m_{S_t} is the mortality for age bracket s that contains age t. Life expectancy is then obtained as the expected duration of life for this survival curve, by a procedure that is equivalent to calculating the area under the survival curve.

For the Investment Case and the counterfactual scenario, age-specific mortality profiles by disease were obtained from the impact modeling for HIV, TB and malaria undertaken for the Investment Case, and summed to obtain the combined contribution of HIV, TB and malaria to mortality. The year-on-year change in mortality of HIV, TB and malaria was computed for both scenarios. Then these year-on-year changes were applied to the baseline mortality obtained from the GBD study. In this way, we mapped the model-predicted reductions in mortality expected under each scenario. This allowed us to compare the gain in life expectancy between 2023 and 2029 expected under both scenarios.

Section 2: Estimating health inequality across countries

The analysis of mortality profiles from the impact modeling gives a set of annual estimates of life expectancy across countries. In addition to discussing the distribution of gains informally – e.g., looking at how the gains are distributed across groupings of countries – we estimate the impact of investments on health inequality across countries.

[3] Demography: Measuring and Modelling Population Processes. Preston SH, Heuveline P, Guillot M. 2001. Oxford and Malden MA: Blackwell Publishers.

In this analysis, health inequality is measured by the Gini index applied to life expectancy, with countries weighted by their respective population size.[4,5] The Gini index is equal to zero if life expectancy is the same across all countries; the higher the index, the more uneven life expectancy is distributed across countries. Using the country- and year-specific life expectancy obtained using the methods described in Section 1, we calculate a Gini for 2023 and for 2029 for the counterfactual scenario, as well as the Investment Case scenario. The Gini calculation included all countries for which we had data from the GBD study, but the modeled changes in mortality of HIV, TB and malaria were only in countries supported by the Global Fund. For countries not supported by the Global Fund, we assumed no change in mortality rates of HIV, TB and malaria. We were then able to compare the magnitude of global inequality reduction due to investments in interventions related to HIV, TB and malaria in Global Fund-supported countries under both scenarios.

It should be noted that the Gini index is more commonly applied to income and takes much larger values for comparisons by income levels. This reflects that income differs much more across countries than life expectancy, e.g., gross domestic product (GDP) per capita in 2021 ranged from US$230 (South Sudan) to US$131,000 (Luxembourg) (differing by a factor of 571), while life expectancy ranged from 52.9 years (Central African Republic) to 84.3 years (Japan). However, a poor health outlook and low incomes affect well-being in very different ways, so health inequality and income inequality should not be compared as equal in kind. Depending on the context, we also describe this health inequality as an inequity, to emphasize inequalities across countries that are avoidable and can be mitigated by global action, as evident from the gains achieved in reducing mortality from HIV, TB and malaria over the last two decades.

The Global Fund commissioned a health decision scientist[6] on the faculty of the Health Policy and Management Department at the Harvard T.H. Chan School of Public Health to do this work.

[4] Atkinson, AB. 2013. “Health Inequality, Health Inequity, and Health Spending,” in: Eyal, Nir, Samia A Hurst, Ole F Norheim, Dan Wikler (eds.), 2013, *Inequalities in Health: Concepts, Measures, and Ethics* (Oxford and New York: Oxford University Press).

[5] Wagstaff A, Paci P, van Doorslaer E. 1991. “On the Measurement of Inequalities in Health,” Social Science and Medicine, Vol. 33, No. 5, pp. 545 557.

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