

# Global, regional, national, and selected subnational levels of stillbirths, neonatal, infant, and under-5 mortality, 1980-2015: a systematic analysis for the Global Burden of Disease Study 2015

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Background Established in 2000, Millennium Development Goal 4 (MDG4) catalysed extraordinary political, financial, and social commitments to reduce under-5 mortality by two-thirds between 1990 and 2015. At the country level, the pace of progress in improving child survival has varied markedly, highlighting a crucial need to further examine potential drivers of accelerated or slowed decreases in child mortality. The Global Burden of Disease 2015 Study (GBD 2015) provides an analytical framework to comprehensively assess these trends for under-5 mortality, age-specific and cause-specific mortality among children under 5 years, and stillbirths by geography over time.

Methods Drawing from analytical approaches developed and refined in previous iterations of the GBD study, we generated updated estimates of child mortality by age group (neonatal, post-neonatal, ages 1-4 years, and under 5) for 195 countries and territories and selected subnational geographies, from 1980-2015. We also estimated numbers and rates of stillbirths for these geographies and years. Gaussian process regression with data source adjustments for sampling and non-sampling bias was applied to synthesise input data for under-5 mortality for each geography. Age-specific mortality estimates were generated through a two-stage age-sex splitting process, and stillbirth estimates were produced with a mixed-effects model, which accounted for variable stillbirth definitions and data source-specific biases. For GBD 2015, we did a series of novel analyses to systematically quantify the drivers of trends in child mortality across geographies. First, we assessed observed and expected levels and annualised rates of decrease for under-5 mortality

and stillbirths as they related to the Soci-demographic Index (SDI). Second, we examined the ratio of recorded and expected levels of child mortality, on the basis of SDI, across geographies, as well as differences in recorded and expected annualised rates of change for under-5 mortality. Third, we analysed levels and cause compositions of under-5 mortality, across time and geographies, as they related to rising SDI. Finally, we decomposed the changes in under-5 mortality to changes in SDI at the global level, as well as changes in leading causes of under-5 deaths for countries and territories. We documented each step of the GBD 2015 child mortality estimation process, as well as data sources, in accordance with the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER). Findings Globally, 5.8 million (95% uncertainty interval [UI] 5.7-6.0) children younger than 5 years died in 2015, representing a 52.0% (95% UI 50.7-53.3) decrease in the number of under-5 deaths since 1990. Neonatal deaths and stillbirths fell at a slower pace since 1990, decreasing by 42.4% (41.3-43.6) to 2.6 million (2.6-2.7) neonatal deaths and 47.0% (35.1-57.0) to 2.1 million (1.8-2.5) stillbirths in 2015. Between 1990 and 2015, global under-5 mortality decreased at an annualised rate of decrease of 3.0% (2.6-3.3), falling short of the 4.4% annualised rate of decrease required to achieve MDG4. During this time, 58 countries met or exceeded the pace of progress required to meet MDG4. Between 2000, the year MDG4 was formally enacted, and 2015, 28 additional countries that did not achieve the 4.4% rate of decrease from 1990 met the MDG4 pace of decrease. However, absolute levels of under-5 mortality remained high in many countries, with 11 countries still recording rates exceeding 100 per 1000 livebirths in 2015. Marked decreases in under-5 deaths due to a number of communicable diseases, including lower respiratory infections, diarrhoeal diseases, measles, and malaria, accounted for much of the progress in lowering overall under-5 mortality in low-income countries. Compared with gains achieved for infectious diseases and nutritional deficiencies, the persisting toll of neonatal conditions and congenital anomalies on child survival became evident, especially in low-income and low-middle-income countries. We found sizeable heterogeneities in comparing observed and expected rates of under-5 mortality, as well as differences in observed and expected rates of

change for under-5 mortality. At the global level, we recorded a divergence in observed and expected levels of under-5 mortality starting in 2000, with the observed trend falling much faster than what was expected based on SDI through 2015. Between 2000 and 2015, the world recorded 10.3 million fewer under-5 deaths than expected on the basis of improving SDI alone. Interpretation Gains in child survival have been large, widespread, and in many places in the world, faster than what was anticipated based on improving levels of development. Yet some countries, particularly in sub-Saharan Africa, still had high rates of under-5 mortality in 2015. Unless these countries are able to accelerate reductions in child deaths at an extraordinary pace, their achievement of proposed SDG targets is unlikely. Improving the evidence base on drivers that might hasten the pace of progress for child survival, ranging from cost-effective intervention packages to innovative financing mechanisms, is vital to charting the pathways for ultimately ending preventable child deaths by 2030. Funding Bill & Melinda Gates Foundation. © 2016 The Author(s). Published by Elsevier Ltd. This is an Open Access article under the CC BY license.