

Global, regional, and national progress towards Sustainable Development Goal 3.2 for neonatal and child health: all-cause and cause-specific mortality findings from the Global Burden of Disease Study 2019



GBD 2019 Under-5 Mortality Collaborators*



Summary

Background Sustainable Development Goal 3.2 has targeted elimination of preventable child mortality, reduction of neonatal death to less than 12 per 1000 livebirths, and reduction of death of children younger than 5 years to less than 25 per 1000 livebirths, for each country by 2030. To understand current rates, recent trends, and potential trajectories of child mortality for the next decade, we present the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019 findings for all-cause mortality and cause-specific mortality in children younger than 5 years of age, with multiple scenarios for child mortality in 2030 that include the consideration of potential effects of COVID-19, and a novel framework for quantifying optimal child survival.

Methods We completed all-cause mortality and cause-specific mortality analyses from 204 countries and territories for detailed age groups separately, with aggregated mortality probabilities per 1000 livebirths computed for neonatal mortality rate (NMR) and under-5 mortality rate (U5MR). Scenarios for 2030 represent different potential trajectories, notably including potential effects of the COVID-19 pandemic and the potential impact of improvements preferentially targeting neonatal survival. Optimal child survival metrics were developed by age, sex, and cause of death across all GBD location-years. The first metric is a global optimum and is based on the lowest observed mortality, and the second is a survival potential frontier that is based on stochastic frontier analysis of observed mortality and Healthcare Access and Quality Index.

Findings Global U5MR decreased from 71.2 deaths per 1000 livebirths (95% uncertainty interval [UI] 68.3–74.0) in 2000 to 37.1 (33.2–41.7) in 2019 while global NMR correspondingly declined more slowly from 28.0 deaths per 1000 live births (26.8–29.5) in 2000 to 17.9 (16.3–19.8) in 2019. In 2019, 136 (67%) of 204 countries had a U5MR at or below the SDG 3.2 threshold and 133 (65%) had an NMR at or below the SDG 3.2 threshold, and the reference scenario suggests that by 2030, 154 (75%) of all countries could meet the U5MR targets, and 139 (68%) could meet the NMR targets. Deaths of children younger than 5 years totalled 9.65 million (95% UI 9.05–10.30) in 2000 and 5.05 million (4.27–6.02) in 2019, with the neonatal fraction of these deaths increasing from 39% (3.76 million [95% UI 3.53–4.02]) in 2000 to 48% (2.42 million; 2.06–2.86) in 2019. NMR and U5MR were generally higher in males than in females, although there was no statistically significant difference at the global level. Neonatal disorders remained the leading cause of death in children younger than 5 years in 2019, followed by lower respiratory infections, diarrhoeal diseases, congenital birth defects, and malaria. The global optimum analysis suggests NMR could be reduced to as low as 0.80 (95% UI 0.71–0.86) deaths per 1000 livebirths and U5MR to 1.44 (95% UI 1.27–1.58) deaths per 1000 livebirths, and in 2019, there were as many as 1.87 million (95% UI 1.35–2.58; 37% [95% UI 32–43]) of 5.05 million more deaths of children younger than 5 years than the survival potential frontier.

Interpretation Global child mortality declined by almost half between 2000 and 2019, but progress remains slower in neonates and 65 (32%) of 204 countries, mostly in sub-Saharan Africa and south Asia, are not on track to meet either SDG 3.2 target by 2030. Focused improvements in perinatal and newborn care, continued and expanded delivery of essential interventions such as vaccination and infection prevention, an enhanced focus on equity, continued focus on poverty reduction and education, and investment in strengthening health systems across the development spectrum have the potential to substantially improve U5MR. Given the widespread effects of COVID-19, considerable effort will be required to maintain and accelerate progress.

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*Collaborators listed at the end of the paper

Correspondence to:
Dr Nicholas J Kassebaum,
Department of Health Metrics
Sciences, University of
Washington, 3980 15th Avenue,
Northeast Seattle, WA 98105,
USA
nickjk@uw.edu

Research in context

Evidence before this study

During the Millennium Development Goal (MDG) era (2000–15), numerous organisations comprehensively described global progress in reducing child and neonatal mortality (MDG 4), but the early Sustainable Development Goal (SDG) period has seen few comparable efforts to track progress and none to date have attempted to quantify the preventable portion of child mortality (SDG 3.2). Past preventable mortality analyses have focused on health-care delivery, or were limited to high-income countries and adult populations. The most recent child mortality report from the UN Inter-agency Group for Child Mortality Estimation (UNIGME), published in 2017 for the year 2015, reports on all-cause mortality only. The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) is the only annual assessment of trends in all-cause mortality and cause-specific mortality by detailed age groups for all locations with a population greater than 50 000 people from 1990 to the present that is compliant with the Guidelines for Accurate and Transparent Health Estimates Reporting.

Added value of this study

This analysis presents levels and trends in all-cause and cause-specific neonatal and under-5 mortality from 2000 to 2019. Multiple future health scenarios for child mortality in 2030 were constructed to represent potential trajectories, including the potential impacts of the COVID-19 pandemic and scenarios with targeted improvements in neonatal survival. Additionally, this study presents for the first time all-cause mortality estimates for granular age groups of 0–6 days, 7–27 days, 1–5 months, 6–11 months, 12–23 months, and 2–4 years.

SDG 3.2 explicitly prioritises ending preventable child deaths. Therefore, based on all-cause and cause-specific mortality estimates from GBD 2019, this study introduces a novel, reproducible, and holistic heuristic for quantifying optimal child survival. Within this framework are two complementary cause-specific benchmarks: a global optimum, based on the lowest observed neonatal and under-5 mortality, and a survival potential frontier, based on stochastic frontier analysis of observed mortality and the Healthcare Access and Quality Index. The latter allows for comparing performance between similar countries, and specifically helps those countries with high mortality to establish intermediate goals.

Implications of all the available evidence

The prevention of child deaths accelerated in the MDG era. In the emerging SDG period, progress to prevent child deaths remains slowest in neonates. The study findings highlight regions with potential imbalances in health priorities. The findings can also identify causes of death with the most potential for reduction, and those with the greatest need for resources, expertise, and service delivery, or for basic research into prevention and treatment. To reach the SDG targets by 2030, policy makers must focus on balancing priorities between early newborn care while continuing prenatal and older child health initiatives. Strengthening quality health systems and ensuring effective investment in high-burden countries are imperative in order to scale up interventions. Equally pressing are the needs to examine within-country disparities and pursue integrative action on other determinants of health.

Introduction

Under-5 mortality rate (U5MR) and neonatal mortality rate (NMR) are important indicators reflecting multiple aspects of societal wellbeing such as access to nutrition and food; basic infrastructure such as housing, water, and sanitation; education; agency; financial security; access to preventive and treatment health services; and future human capital. The UN Millennium Development Goals (MDGs) are credited with mobilising global action on child health, and manifested as an unprecedented, accelerated reduction in child mortality and resulted in 58 countries achieving the MDG 4 target of reducing U5MR by two-thirds.^{1,2} Sustainable Development Goal (SDG) 3.2 specifically calls to, “By 2030, end preventable deaths of newborn babies and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1000 live births and under-5 mortality to at least as low as 25 per 1000 live births.”³ The SDG focus on equity was codified here in a shifting from relative global targets, that were mainstays in the MDG agenda, to absolute targets for each country.

The SDG framework aims to build on the successes of the MDG era, albeit with a notably broader lens in which

health (SDG 3) is one of several goals related to healthier lives, wellbeing, and equity.³ Even within SDG 3, the SDG agenda is broader than the MDG agenda, reflecting a growing understanding of the intersectional nature of health outcomes with basic infrastructural considerations such as health system performance, sustainability, and environment. This intersectional perspective is illustrated in the language of initiatives such as the call from the UN Global Strategy for Women’s, Children’s and Adolescents’ Health 2016–2030 to integrate survival, prevention, thriving, and enabling environments,⁴ the Every Newborn Action Plan, the World Bank’s Global Financing Facility for Women, Children and Adolescents, *The Lancet Global Health* Commission on High Quality Health Systems, and the Countdown to 2030.^{5–7} Although this broader focus has not necessarily led to child and neonatal health receiving less investment in development assistance for health (DAH; which, for child and neonatal health, grew by 2.66% from 2015 to 2019 and remained the second largest DAH focus area in 2019), the growth in investment in this period was less than during the period between 2000 and 2015, when DAH for child and neonatal health increased by 314%.⁸

There has not yet been a comprehensive assessment of NMR and U5MR in the SDG era. Selected publications assessed interim progress towards part of SDG 3.2 or provided projections to 2030,^{9–13} but none have been comprehensive with respect to cause, age, trends, geography, and progress towards 2030 targets. The comprehensive nature of the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019 lends itself to a detailed analysis of levels, trends, and drivers of change for specific age groups, causes, and locations. Additionally, there has not been any previous effort, to our knowledge, to empirically explore the concept of preventable mortality in children. Although preventable death has been theoretically defined since the early 2000s, the definitions has usually been through a health-care delivery lens^{14,15} rather than a more holistic lens of preventability that might be interpreted as the intended wording of SDG 3.2. Furthermore, although the Organisation for Economic Co-operation and Development (OECD) and Eurostat convened to provide a more uniform approach to interpreting avoidable deaths in 2019, this was with a singular focus on high-income countries and the adult population.¹⁶

In this study, based on GBD 2019, we have three objectives. First, we aim to present a detailed, comprehensive numerical assessment of progress towards SDG 3.2 targets for all-cause NMR and U5MR at the global, regional, and national level, including a series of scenarios that reflect possible trends over the next decade including the potential effects of the COVID-19 pandemic on young children. Second, we aim to evaluate comparative progress in cause-specific mortality in neonates and children from 2000 to 2019 to highlight successes and potential focus areas for improvement. Third, we aim to better define a holistic focus of preventable mortality by exploring two different measures of optimal child survival that can both inform global progress and provide a benchmark for intermediate progress evaluation in high-mortality settings. In so doing, this study seeks to meet the needs of an expansive, integrative SDG agenda, and to highlight the locations, age groups, and causes of preventable deaths, to inform policy and public health priorities aiming to achieve SDG 3.2. This manuscript was produced as part of the GBD Collaborator Network and in accordance with the GBD Protocol.

Methods

Overview

This study is compliant with the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER;¹⁷ appendix p 9). A brief summary of each component of our study is described below. Extensive methodological details are provided in the appendix (pp 10–86).

Dimensions of the GBD study

GBD 2019 includes all-cause and cause-specific mortality by age and sex for 204 countries and territories, 21 of

which were estimated at the subnational level from 1990 to 2019, inclusive. Results in this study are presented only for countries and territories. All-cause mortality estimation covers six under-5 age groups: 0–6 days (early neonatal), 7–27 days (late neonatal), 1–5 months, 6–11 months, 12–23 months, and 2–4 years. Cause-specific mortality estimates cover four age groups: early neonatal, late neonatal, 28–364 days, and 1–4 years. Although we present all six age groups, we mainly focus on results for the aggregate neonatal age group (<28 days) and the under-5 age group (0–4 years), to best align with the SDG under-5 and neonatal targets. Similarly, we focus on the years 2000, which marks the establishment of the MDGs, 2015, which marks the establishment of the SDGs, and 2019, which is the most recent year of GBD estimates.

Data sources

All-cause mortality data were compiled from 203 of 204 countries and territories ranging from the years 2000 to 2019, for a total of 3097 location-years. Vital registration covered a total of 14889022 global under-5 deaths in this period (appendix p 119). A total of 8000 unique sources were used in estimating cause-specific mortality in GBD 2019. All input data sources for each component of analysis are available for download from the GBD 2019 Data Input Sources Tool.

All-cause mortality estimation and assessment of progress towards SDG 3.2

All-cause mortality estimation closely followed the estimation techniques as described for previous iterations of GBD,^{2,18,19} detailed in the appendix (p 9). Progress towards SDG 3.2 was assessed by examining U5MR and NMR in 2019. NMR is calculated as the probability of death between birth and 28 days and U5MR is calculated as the probability of death between birth and 5 years, and each metric is expressed as the number of deaths per 1000 livebirths. Aggregate mortality probabilities were benchmarked against the SDG thresholds of 25 under-5 deaths per 1000 livebirths and 12 neonatal deaths per 1000 livebirths.

To assess relative progress across age groups, we compared the proportion of under-5 deaths occurring in each age group with the ratio of change in age-specific deaths to change in total under-5 deaths, for the periods 2000–14 and 2015–19. If progress towards SDG 3.2 is equal across age groups, the percentage contribution to progress and the percentage of total deaths would be equal. If the percentage of deaths is greater than the percentage of progress for an age group, then that age group is making slower progress towards the target.

Cause-specific mortality estimation

GBD 2019 includes 369 causes of disease and injury in a mutually exclusive and collectively exhaustive hierarchy

For more on the GBD 2019 Data Input Sources Tool see <http://ghdx.healthdata.org/gbd-2019/data-input-sources>

See Online for appendix

of four levels (appendix p 87). Some conditions only result in fatal burden (eg, sudden infant death syndrome), whereas others cause only disability (eg, scabies); most causes have both fatal and non-fatal burden. Comprehensive methods for cause-specific mortality estimation for GBD have been previously described²⁰ and are detailed in the appendix (p 35). We present most results at level 3 because this level is sufficiently detailed to reflect important cause groupings for the age groups presented in this analysis (eg, neonatal disorders and congenital birth defects), but not so detailed as to obscure important groupings of related conditions.

Scenarios for 2030 and beyond

U5MR and NMR were projected for six scenarios, all computed at the national level, up to 2030 as previously described.²¹ The first three scenarios represent the reference, better-than-reference, and worse-than-reference scenarios, while a fourth represents the 2030 NMR and U5MR in the absence of COVID-19. The remaining two scenarios are intended to assess outcomes for interventions that focus only on specific age groups, to evaluate if opportunity is greater in a particular age group than in others, and to show the limits of achievement when efforts do not consider distinct needs of different age groups. For the first of these age-specific scenarios, neonatal mortality is at the better-than-reference level and remaining under-5 mortality stays at reference level (neonatal scenario), and for the second, mortality for children aged 28–364 days is at the better-than-reference level and neonatal mortality stays at the reference level (child scenario). Many strategies to address neonatal mortality are fundamentally different from strategies targeting older infants and children, so these two scenarios are a broad representation of those differences.

Assessment of optimal survival potential

Our approach to inform an assessment of preventable mortality focused on the quantification of two different measures of optimal child survival based on historical trends. The first measure, what we term the global optimum, represents a universal level at which all additional mortality is theoretically avoidable given current medical knowledge and technology. This is analogous to the GBD method used for estimating global standard life expectancy. The second measure, what we term the survival potential frontier, aims to quantify the amount of mortality that is avoidable given the country's level of Healthcare Access and Quality (HAQ) Index, thereby accounting for the differential resources available for health investment in different locations.

First, we calculated the global optimum for NMR and U5MR based on the aggregate of the lowest observed age-specific and cause-specific mortality rates in locations with populations higher than 10 000 children younger than 5 years (to remove noise associated with small numbers) between 2000 and 2019, scaling them to match

an all-cause mortality minimum that was calculated using the same approach. The scaling step was added to account for potential differences due to small numbers in low-mortality settings or geographical differences in cause assignment that can occur between, for example, subcauses of neonatal disorders. This method is analogous to that used by GBD to calculate a global standard life expectancy for the purposes of calculating years of life lost and therefore can be interpreted to represent the optimum potential for reductions in child mortality based on current technology and health delivery systems.

Second, to help with developing intermediate goals and to evaluate progress in higher-mortality settings, we calculated a survival potential frontier using stochastic frontier analysis²² to evaluate the historical relationship between cause-specific neonatal and under-5 mortality rates and HAQ Index,²³ which is an aggregate metric of health system performance across all age groups combined. The specific formulation of the stochastic frontier analysis is described in detail in the appendix (p 70), but briefly, it uses a spline to estimate the expected lower bound of mortality for a given value of HAQ Index. Stochastic frontier analysis was chosen to quantify system inefficiency because of its flexibility in shape, its assumption of performance possibilities given static system inputs, and the fact that it allows for random effects in the model rather than assuming uniformity of inputs across locations.

All components of the analysis are based on 1000 draws of the posterior distribution of the quantity of interest by age, sex, location, and year. Point estimates are the mean of the draws, and 95% uncertainty intervals (UIs) represent the 2·5th and 97·5th percentiles.

Presentation of results

Results are presented by country, GBD super-region, and Socio-demographic Index (SDI)²⁴ quintile. SDI is a composite index of income per capita, educational attainment, and inverse fertility, and it is used to categorise countries into SDI quintiles: low SDI (ie, low income per capita, low educational attainment, high fertility), low-middle SDI, middle SDI, high-middle SDI, and high SDI. Full results for GBD 2019 are available in an online visualisation at GBD Compare and for download from the GBD Results Tool.

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

All-cause mortality and progress towards SDG 3.2

Over the past two decades, there has been a substantial decrease in global deaths of children younger than 5 years, from 9·65 million (95% UI 9·05–10·30) in 2000,

For more on the **GBD Compare** see <https://vizhub.healthdata.org/gbd-compare>

For more on the **GBD Results Tool** see <http://ghdx.healthdata.org/gbd-results-tool>

SDI regions	Neonatal deaths			NMR			Under-5 deaths			U5MR		
	2000	2015	2019	2019	2030*	2000	2015	2019	2019	2019	2030*	
Global	3760 000 (3530 000-4020 000)	2 820 000 (2 480 000-3 200 000)	2 420 000 (2 060 000-2 860 000)	17.9 (16.3-19.8)	15.4	9650 000 (9050 000-10300 000)	6100 000 (5350 000-6910 000)	5050 000 (4270 000-6020 000)	37.1 (33.2-41.7)	29.6		
Low SDI	1260 000 (1190 000-1340 000)	1190 000 (1030 000-1370 000)	1110 000 (918 000-1340 000)	27.0 (24.0-30.8)	21.4	4010 000 (3780 000-4260 000)	3040 000 (2630 000-3520 000)	2670 000 (2220 000-3240 000)	71.8 (63.3-82.5)	47.0		
Low-middle SDI	1480 000 (1370 000-1600 000)	1020 000 (883 000-1170 000)	841 000 (716 000-985 000)	21.7 (19.7-24.0)	19.1	3390 000 (3140 000-3630 000)	1890 000 (1640 000-2150 000)	1490 000 (1260 000-1750 000)	42.0 (37.8-46.7)	30.3		
Middle SDI	777 000 (724 000-835 000)	479 000 (419 000-546 000)	368 000 (312 000-432 000)	10.1 (9.1-11.2)	16.3	1730 000 (1610 000-1850 000)	912 000 (803 000-1040 000)	686 000 (583 000-810 000)	18.9 (17.1-21.0)	27.3		
High-middle SDI	199 000 (187 000-213 000)	104 000 (94 200-115 000)	78 100 (67 100-90 900)	5.10 (4.71-5.55)	3.30	427 000 (400 000-455 000)	197 000 (180 000-217 000)	150 000 (130 000-172 000)	9.36 (8.66-10.2)	6.12		
High SDI	43 500 (41 600-45 300)	30 500 (29 300-31 700)	26 800 (24 300-29 600)	2.60 (2.51-2.70)	2.57	84 400 (81 000-88 300)	55 800 (54 200-57 600)	48 600 (44 500-53 200)	4.70 (4.56-4.86)	5.02		
GBD super-regions												
Central Europe, eastern Europe, and central Asia	57 800 (54 300-61 800)	39 400 (35 500-43 800)	30 800 (26 400-36 000)	5.88 (5.35-6.52)	4.95	127 000 (119 000-135 000)	77 900 (70 200-86 900)	61 100 (52 200-72 100)	11.5 (10.4-12.8)	9.34		
Central Asia	31 600 (28 300-35 100)	25 400 (21 900-29 400)	20 500 (17 200-24 600)	10.8 (9.62-12.2)	8.99	75 400 (68 200-82 900)	49 300 (42 200-57 700)	39 700 (33 200-48 400)	20.7 (18.3-23.7)	16.2		
Armenia	661 (595-733)	310 (256-378)	230 (181-292)	5.96 (5.04-7.21)	4.46	1290 (1140-1460)	605 (502-732)	452 (357-575)	11.4 (9.55-13.7)	8.90		
Azerbaijan	4450 (3710-5260)	3410 (2860-3990)	2590 (2130-3110)	16.8 (14.8-19.4)	14.0	9530 (8060-11100)	5750 (4760-6910)	4310 (3480-5370)	27.6 (23.2-33.4)	21.5		
Georgia	1060 (892-1250)	376 (308-457)	266 (208-336)	5.79 (4.76-7.10)	4.04	1740 (1480-2040)	669 (553-811)	482 (382-603)	10.2 (8.57-12.5)	7.02		
Kazakhstan	3260 (2790-3780)	2520 (2050-3070)	1970 (1530-2600)	5.60 (4.61-6.88)	4.09	8300 (7250-9410)	5420 (4450-6550)	4330 (3410-5540)	12.1 (10.1-14.7)	8.86		
Kyrgyzstan	1960 (1760-2170)	2060 (1870-2230)	1560 (1360-1790)	10.8 (9.91-11.8)	8.57	4380 (3910-4890)	3290 (3090-3490)	2520 (2210-2870)	17.4 (15.9-19.0)	13.0		
Mongolia	1270 (1120-1430)	990 (836-1170)	773 (633-966)	9.29 (7.86-11.1)	6.89	3400 (3030-3780)	1810 (1550-2120)	1430 (1180-1770)	17.0 (14.5-20.4)	10.2		
Tajikistan	4310 (3650-5070)	4100 (3440-4800)	3730 (3180-4380)	14.7 (13.2-16.4)	11.8	12 500 (11 200-13 900)	9220 (7780-11 000)	8100 (6540-10 000)	32.1 (27.5-37.3)	21.8		
Turkmenistan	2260 (1900-2640)	1870 (1590-2170)	1510 (1290-1770)	13.4 (11.7-15.1)	10.3	5990 (5240-6870)	3620 (3000-4260)	2870 (2380-3480)	25.2 (21.4-29.6)	19.4		
Uzbekistan	12 300 (10 600-14 400)	9760 (7900-11 900)	7900 (6360-10 000)	11.1 (9.25-13.4)	10.0	28 300 (24 700-32 800)	18 900 (15 400-22 900)	15 200 (12 400-19 200)	21.2 (17.8-25.7)	18.2		
Central Europe	8250 (7940-8590)	3720 (3560-3890)	2930 (2340-3670)	2.72 (2.44-3.03)	1.99	16 700 (16 200-17 200)	6990 (6690-7290)	5550 (4520-6800)	5.06 (4.52-5.63)	3.67		
Albania	845 (739-980)	266 (202-345)	217 (150-317)	5.77 (4.39-7.68)	4.81	1760 (1530-2030)	550 (450-676)	451 (344-595)	11.9 (9.94-14.4)	9.15		
Bosnia and Herzegovina	320 (294-344)	138 (125-153)	103 (85-126)	3.95 (3.35-4.67)	3.22	438 (406-471)	191 (173-211)	143 (120-173)	5.41 (4.59-6.39)	4.38		
Bulgaria	534 (487-582)	258 (236-280)	214 (168-271)	3.54 (3.03-4.16)	2.71	1220 (1160-1280)	532 (502-566)	447 (359-556)	7.29 (6.21-8.57)	5.61		
Croatia	236 (220-254)	115 (104-126)	90.5 (67.5-120)	2.56 (2.17-3.02)	1.93	361 (339-383)	181 (165-198)	141 (107-184)	3.95 (3.35-4.67)	2.96		

(Table continues on next page)

	Neonatal deaths			NMR			Under-5 deaths			U5MR		
	2000	2015	2019	2019	2030*	2000	2015	2019	2019	2019	2030*	
(Continued from previous page)												
Czech Republic	236 (215-256)	174 (158-190)	159 (123-201)	1.45 (1.26-1.67)	1.08	483 (454-513)	342 (318-365)	293 (232-369)	2.64 (2.28-3.06)	1.87		
Hungary	572 (530-615)	252 (229-275)	173 (132-224)	2.09 (1.81-2.42)	1.37	1020 (970-1070)	489 (458-521)	336 (262-428)	4.00 (3.46-4.62)	2.80		
Montenegro	77.4 (68.7-86.7)	18.1 (15.4-21.4)	15.1 (12.5-18.3)	2.29 (1.96-2.67)	1.60	116 (104-130)	29.8 (25.5-34.6)	24.9 (20.6-30.0)	3.74 (3.19-4.38)	2.58		
North Macedonia	226 (203-248)	155 (140-170)	123 (99.9-149)	5.52 (4.70-6.49)	4.13	399 (366-434)	239 (215-263)	191 (155-230)	8.51 (7.23-10.0)	6.00		
Poland	1920 (1780-2060)	988 (916-1060)	787 (579-1060)	2.15 (1.84-2.52)	1.36	3530 (3380-3680)	1770 (1680-1850)	1420 (1070-1880)	3.85 (3.29-4.51)	2.60		
Romania	2090 (1920-2260)	884 (815-953)	690 (556-842)	3.98 (3.50-4.60)	3.17	5130 (5010-5260)	1790 (1710-1870)	1420 (1160-1730)	8.03 (7.02-9.33)	5.89		
Serbia	865 (736-1010)	269 (250-291)	196 (154-245)	2.45 (2.08-2.92)	1.47	1590 (1360-1860)	454 (426-486)	334 (263-421)	4.12 (3.51-4.93)	2.42		
Slovakia	266 (243-289)	174 (160-187)	141 (106-186)	2.52 (2.15-2.97)	1.85	533 (502-565)	364 (340-389)	301 (232-390)	5.33 (4.53-6.27)	4.45		
Slovenia	57.9 (53.4-63.0)	31.4 (28.1-35.3)	23.8 (17.9-31.5)	1.26 (1.09-1.46)	0.930	96.1 (88.8-104)	49.4 (44.1-55.4)	38.1 (29.3-49.5)	1.98 (1.70-2.31)	1.43		
Eastern Europe	18000 (17400-18600)	10300 (9920-10600)	7340 (6140-8710)	3.27 (3.02-3.55)	2.41	34500 (33900-35200)	21600 (21000-22200)	15900 (13300-18600)	6.87 (6.26-7.54)	5.29		
Belarus	746 (628-875)	328 (271-394)	244 (188-310)	2.38 (1.99-2.90)	1.51	1510 (1280-1780)	730 (607-884)	562 (437-729)	5.31 (4.44-6.46)	3.64		
Estonia	67.4 (62.2-72.9)	19.7 (17.5-22.1)	15.1 (12.4-18.4)	1.14 (0.980-1.35)	0.710	142 (132-152)	46.0 (40.9-51.5)	35.6 (29.5-43.4)	2.65 (2.27-3.14)	1.64		
Latvia	139 (127-152)	55.4 (50.2-60.3)	41.0 (33.9-49.5)	2.14 (1.86-2.50)	1.54	272 (256-288)	108 (98.3-117)	82.8 (69.3-99.3)	4.21 (3.63-4.95)	3.01		
Lithuania	156 (145-167)	70.8 (63.4-78.3)	48.6 (41.9-56.2)	1.80 (1.65-1.98)	1.20	369 (350-389)	155 (143-168)	110 (93.8-130)	4.00 (3.52-4.62)	2.83		
Moldova	734 (639-847)	374 (304-460)	278 (214-361)	8.64 (7.14-10.7)	6.69	1240 (1090-1430)	536 (438-647)	399 (315-505)	12.2 (10.2-14.7)	8.96		
Russia	12400 (11900-12900)	7040 (6790-7270)	4990 (4010-6050)	3.00 (2.65-3.38)	2.19	24500 (24200-24900)	15200 (15000-15500)	11200 (9190-13400)	6.53 (5.75-7.41)	5.04		
Ukraine	3760 (3460-4080)	2360 (2130-2600)	1720 (1390-2120)	4.45 (3.89-5.12)	3.45	6440 (6110-6770)	4770 (4360-5180)	3500 (2920-4260)	8.76 (7.85-9.73)	7.05		
High income	47600 (46200-49000)	35400 (34300-36500)	31200 (27400-35500)	2.78 (2.70-2.88)	2.39	88900 (88200-89700)	63500 (62700-64400)	55600 (49700-62600)	4.95 (4.78-5.12)	4.14		
Australasia	1060 (1020-1110)	886 (847-927)	794 (677-931)	2.14 (2.03-2.26)	1.77	1980 (1930-2030)	1530 (1480-1580)	1380 (1200-1590)	3.73 (3.53-3.95)	2.96		
Australia	863 (824-902)	710 (680-744)	647 (558-751)	2.08 (1.98-2.18)	1.68	1550 (1510-1590)	1220 (1180-1250)	1110 (973-1260)	3.57 (3.41-3.76)	2.80		
New Zealand	199 (187-212)	175 (165-187)	147 (120-180)	2.46 (2.26-2.68)	2.21	431 (411-452)	313 (296-331)	270 (225-325)	4.53 (4.16-4.95)	3.80		

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	Neonatal deaths			NMR			Under-5 deaths			USMR		
	2000	2015	2019	2019	2030*	2000	2015	2019	2019	2019	2030*	
(Continued from previous page)												
High-income Asia Pacific	3830 (3530-4140)	1730 (1590-1870)	1430 (1290-1590)	1.04 (0.990-1.08)	0.810	9500 (9190-9820)	4440 (4240-4650)	3670 (3350-4000)	2.62 (2.52-2.71)	2.03		
Brunei	36.4 (32.0-41.1)	34.7 (30.8-39.2)	31.9 (24.4-41.7)	4.85 (4.09-5.73)	4.43	70.8 (63.2-79.0)	66.8 (59.4-75.0)	60.2 (46.7-77.5)	9.19 (7.73-10.9)	8.27		
Japan	2100 (1860-2370)	964 (880-1050)	782 (697-880)	0.870 (0.850-0.890)	0.640	5290 (5190-5410)	2740 (2650-2830)	2240 (2060-2450)	2.43 (2.36-2.51)	1.86		
Singapore	957 (86.6-106)	58.8 (44.2-78.8)	50.5 (35.2-71.0)	0.880 (0.770-1.00)	0.650	198 (183-215)	123 (96.5-157)	105 (79.1-140)	1.82 (1.60-2.09)	1.35		
South Korea	1600 (1450-1770)	673 (599-774)	567 (481-658)	1.37 (1.23-1.51)	1.15	3930 (3660-4200)	1500 (1370-1650)	1260 (1100-1450)	3.03 (2.82-3.26)	2.43		
High-income North America	19 900 (18 700-21 000)	16 800 (15 800-17 700)	15 200 (14 000-16 500)	3.61 (3.55-3.67)	3.29	35 400 (35 200-35 700)	29 500 (29 200-29 800)	26 600 (24 600-28 700)	6.32 (6.18-6.47)	5.57		
Canada	1200 (1120-1280)	1220 (1140-1310)	1110 (996-1250)	2.98 (2.86-3.10)	2.66	2040 (2000-2090)	2010 (1960-2060)	1820 (1640-2010)	4.86 (4.67-5.07)	4.23		
Greenland	9.98 (8.5-11.5)	4.92 (3.88-6.22)	4.10 (2.66-6.22)	5.14 (3.74-6.97)	3.78	18.8 (15.9-22.0)	9.09 (7.09-11.6)	7.59 (4.97-11.4)	9.47 (6.85-12.9)	6.69		
USA†	18 700 (17 500-19 800)	15 500 (14 600-16 400)	14 000 (13 000-15 300)	3.67 (3.62-3.73)	3.36	33 400 (33 100-33 600)	27 500 (27 200-27 800)	24 700 (23 000-26 700)	6.46 (6.33-6.60)	5.71		
Southern Latin America	9300 (9060-9520)	6180 (5950-6420)	5240 (4140-6640)	5.38 (5.08-5.72)	4.30	17 100 (16 900-17 300)	11 100 (10 900-11 300)	9370 (7600-11 600)	9.61 (9.09-10.2)	7.59		
Argentina	7380 (7150-7610)	4810 (4590-5020)	4120 (3300-5160)	5.89 (5.70-6.10)	4.67	13 400 (13 200-13 500)	8710 (8580-8840)	7420 (6110-9050)	10.6 (10.3-11.0)	8.37		
Chile	1420 (1360-1500)	1140 (1090-1180)	907 (686-1200)	3.98 (3.41-4.65)	3.31	2840 (2750-2930)	1960 (1880-2030)	1560 (1200-2020)	6.84 (5.87-7.99)	5.44		
Uruguay	493 (442-545)	240 (207-276)	211 (154-286)	4.54 (3.97-5.19)	3.37	884 (818-955)	439 (395-486)	388 (289-516)	8.29 (7.26-9.48)	6.11		
Western Europe	13 500 (13 000-14 000)	9810 (9300-10 300)	8550 (7370-9960)	2.00 (1.91-2.10)	1.61	24 900 (24 700-25 200)	17 000 (16 600-17 300)	14 700 (12 900-16 800)	3.42 (3.29-3.57)	2.69		
Andorra	1.11 (0.900-1.35)	0.585 (0.469-0.729)	0.516 (0.384-0.674)	0.820 (0.690-0.980)	0.540	2.59 (2.06-3.15)	1.30 (1.06-1.62)	1.11 (0.843-1.43)	1.77 (1.48-2.10)	1.16		
Austria	238 (217-257)	186 (170-201)	166 (141-192)	1.90 (1.69-2.10)	1.52	445 (427-463)	307 (294-322)	282 (252-316)	3.22 (3.03-3.42)	2.50		
Belgium	343 (303-387)	258 (222-291)	230 (189-279)	1.89 (1.78-2.01)	1.48	690 (666-715)	480 (457-502)	423 (354-505)	3.48 (3.27-3.71)	2.68		
Cyprus	43.4 (38.7-48.6)	28.7 (24.4-33.3)	27.3 (19.9-36.6)	1.80 (1.42-2.24)	1.31	77.3 (69.6-85.7)	49.3 (42.2-57.1)	47.9 (35.4-63.2)	3.17 (2.52-3.94)	2.32		
Denmark	216 (187-245)	157 (143-171)	145 (118-179)	2.31 (2.12-2.52)	1.90	371 (348-392)	237 (221-255)	218 (179-264)	3.48 (3.20-3.79)	2.73		
Finland	136 (124-149)	65.4 (59.4-71.9)	58.9 (49.3-70.5)	1.18 (1.08-1.29)	0.860	244 (230-258)	125 (117-134)	110 (94.0-130)	2.20 (2.01-2.41)	1.63		
France	2150 (1910-2370)	1740 (1590-1900)	1480 (1270-1720)	2.05 (1.95-2.16)	1.72	4160 (4080-4250)	3110 (3040-3190)	2600 (2280-2960)	3.60 (3.42-3.79)	2.87		
Germany	2110 (1920-2280)	1610 (1490-1730)	1440 (1320-1580)	1.95 (1.88-2.03)	1.64	4120 (4050-4190)	2730 (2660-2790)	2450 (2250-2670)	3.33 (3.21-3.47)	2.63		

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	Neonatal deaths			NMR			Under-5 deaths			U5MR		
	2000	2015	2019	2019	2030*	2000	2015	2019	2019	2019	2030*	
<i>(Continued from previous page)</i>												
Greece	390 (361-416)	242 (223-262)	188 (152-233)	2.17 (1.99-2.38)	1.54	643 (617-671)	484 (459-508)	339 (279-413)	3.85 (3.53-4.21)	2.87		
Iceland	9.77 (8.00-11.8)	6.69 (5.23-8.58)	6.28 (3.84-9.95)	1.45 (1.04-2.00)	1.20	15.9 (13.1-19.0)	10.9 (8.48-13.8)	9.95 (6.21-15.5)	2.31 (1.65-3.20)	1.84		
Ireland	221 (201-241)	157 (141-175)	124 (97.7-157)	2.04 (1.88-2.21)	1.60	385 (364-407)	253 (234-274)	200 (160-249)	3.25 (3.00-3.54)	2.48		
Israel	483 (425-544)	369 (325-413)	331 (265-408)	1.72 (1.65-1.79)	1.27	920 (896-944)	675 (656-696)	609 (508-724)	3.18 (3.06-3.30)	2.37		
Italy	1710 (1510-1890)	982 (906-1050)	770 (680-878)	1.75 (1.69-1.81)	1.20	2980 (2930-3030)	1710 (1670-1750)	1320 (1190-1480)	2.98 (2.88-3.08)	2.14		
Luxembourg	14.0 (11.7-16.5)	9.02 (7.20-11.1)	8.56 (5.35-13.3)	1.32 (0.930-1.83)	1.00	27.3 (23.4-31.9)	16.7 (13.5-20.6)	15.5 (9.89-23.7)	2.42 (1.71-3.38)	1.84		
Malta	19.7 (17.2-22.4)	18.7 (15.2-22.7)	16.3 (10.8-24.0)	3.80 (2.96-4.83)	3.08	31.1 (27.4-35.3)	27.7 (23.1-33.1)	24.7 (16.8-35.7)	5.74 (4.54-7.23)	4.68		
Monaco	0.477 (0.323-0.667)	0.320 (0.229-0.433)	0.287 (0.220-0.367)	1.02 (0.850-1.23)	0.830	1.26 (0.895-1.69)	0.808 (0.606-1.05)	0.727 (0.560-0.925)	2.58 (2.15-3.10)	2.03		
Netherlands	777 (723-828)	425 (383-469)	421 (345-513)	2.27 (2.26-2.49)	1.94	1280 (1240-1310)	674 (653-697)	659 (550-790)	3.72 (3.54-3.91)	2.96		
Norway	155 (145-164)	92.9 (87.3-99.0)	80.1 (68.0-94.5)	1.41 (1.32-1.51)	1.10	284 (272-297)	166 (157-174)	142 (123-164)	2.50 (2.34-2.67)	1.93		
Portugal	405 (363-445)	178 (154-202)	129 (100-166)	1.61 (1.49-1.75)	1.08	841 (802-884)	313 (289-340)	229 (181-286)	2.82 (2.60-3.06)	1.78		
San Marino	0.977 (0.724-1.27)	0.655 (0.493-0.861)	0.606 (0.466-0.773)	1.95 (1.62-2.33)	1.57	1.83 (1.35-2.39)	1.23 (0.928-1.61)	1.13 (0.873-1.44)	3.63 (3.03-4.36)	2.85		
Spain	1090 (983-1200)	760 (680-833)	603 (493-731)	1.63 (1.39-1.86)	1.20	2130 (2090-2170)	1400 (1360-1430)	1130 (996-1290)	2.98 (2.88-3.10)	2.19		
Sweden	193 (182-203)	180 (153-208)	165 (141-191)	1.41 (1.27-1.54)	1.12	357 (341-375)	335 (317-352)	302 (265-345)	2.58 (2.38-2.81)	2.07		
Switzerland	269 (244-294)	263 (242-284)	227 (200-259)	2.57 (2.43-2.72)	2.26	457 (440-475)	375 (358-392)	323 (286-365)	3.66 (3.46-3.88)	3.04		
UK†	2510 (2420-2610)	2070 (1800-2290)	1920 (1590-2310)	2.45 (2.14-2.76)	2.09	4440 (4350-4530)	3470 (3400-3550)	3210 (2810-3660)	4.10 (3.97-4.25)	3.41		
Latin America and Caribbean	181 000 (164 000-198 000)	112 000 (94 800-131 000)	93 900 (74 900-116 000)	9.56 (8.28-11.1)	7.77	397 000 (369 000-427 000)	226 000 (192 000-263 000)	187 000 (149 000-231 000)	19.0 (16.2-22.3)	14.3		
Andean Latin America	22 700 (20 100-25 400)	14 900 (12 400-17 800)	12 600 (9 620-16 300)	9.42 (8.38-10.6)	7.58	56 000 (51 000-61 500)	29 600 (25 000-34 800)	24 900 (19 200-31 900)	18.6 (16.5-21.1)	14.3		
Bolivia	6 710 (5 980-7 470)	5 560 (4 680-6 610)	4 840 (3 880-5 990)	14.8 (12.6-17.7)	12.2	18 300 (16 500-20 100)	11 400 (9 660-13 400)	9 630 (7 800-11 800)	29.5 (25.2-35.1)	22.7		
Ecuador	5 400 (4 430-6 510)	3 050 (2 290-3 990)	2 720 (1 870-3 830)	7.74 (6.19-9.65)	6.22	11 300 (9 570-13 100)	5 980 (4 730-7 430)	5 300 (3 790-7 240)	15.1 (12.7-18.1)	11.5		
Peru	10 600 (9 120-12 200)	6 290 (4 750-8 220)	5 010 (3 550-6 960)	7.61 (6.37-9.11)	5.92	26 400 (23 100-29 700)	12 200 (9 430-15 400)	9 980 (7 070-13 800)	15.1 (12.6-18.1)	11.4		

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	Neonatal deaths				Under-5 deaths				USMR			
	2000	2015	2019	2030*	2000	2015	2019	2030*	2019	2019	2030*	
(Continued from previous page)												
Caribbean	18 100 (16 500–19 800)	17 200 (14 200–20 300)	15 800 (12 300–20 000)	16.5 (15.8–23.3)	44 900 (40 800–49 200)	36 300 (31 000–42 500)	32 000 (26 000–39 000)	38.8 (33.2–45.3)	28.9			
Antigua and Barbuda	13.4 (10.8–16.4)	6.15 (4.56–8.09)	5.34 (3.80–7.37)	4.47 (4.61–6.19)	20.9 (16.9–25.4)	12.2 (9.04–16.2)	10.4 (7.22–14.6)	10.3 (8.61–12.3)	8.97			
The Bahamas	38.0 (31.0–45.1)	28.1 (20.4–39.2)	24.7 (18.5–32.7)	5.32 (4.94–7.62)	80.5 (67.4–94.1)	53.8 (41.1–71.1)	48.2 (37.0–62.2)	11.7 (9.94–14.2)	10.3			
Barbados	40.6 (33.5–48.9)	27.0 (20.5–34.8)	24.7 (17.0–35.3)	7.85 (7.24–10.3)	57.4 (47.5–68.7)	38.0 (29.2–48.6)	34.9 (24.1–49.7)	12.2 (10.2–14.5)	10.9			
Belize	87.6 (76.5–101)	72.9 (60.3–86.7)	69.1 (56.4–83.9)	8.21 (7.97–10.6)	174 (150–202)	124 (101–147)	116 (92.3–144)	15.4 (13.0–18.6)	12.4			
Bermuda	2.43 (1.91–3.08)	1.66 (1.32–2.05)	1.40 (0.971–1.95)	2.31 (2.24–3.28)	4.76 (3.94–5.80)	2.96 (2.39–3.63)	2.44 (1.76–3.34)	4.66 (3.92–5.54)	3.72			
Cuba	608 (553–664)	330 (294–368)	236 (188–291)	1.67 (1.98–2.59)	1260 (1210–1310)	703 (666–741)	503 (409–608)	4.74 (4.12–5.43)	3.40			
Dominica	15.8 (12.6–19.4)	14.6 (11.2–18.6)	13.5 (9.43–18.9)	19.0 (13.6–19.3)	25.8 (20.6–31.5)	23.6 (18.3–30.1)	21.7 (15.3–30.2)	26.0 (21.8–31.0)	29.7			
Dominican Republic	5570 (4700–6490)	4450 (3460–5560)	3910 (2800–5370)	14.8 (14.1–20.2)	10 100 (8860–11 400)	6740 (5430–8290)	5850 (4230–7950)	25.2 (21.1–30.2)	20.4			
Grenada	19.8 (15.0–25.6)	14.1 (10.4–18.9)	12.1 (8.43–17.1)	7.58 (7.26–10.2)	35.4 (27.5–44.3)	23.1 (17.1–30.9)	19.5 (13.6–27.5)	13.8 (11.6–16.5)	11.7			
Guyana	418 (354–490)	241 (179–319)	217 (153–303)	12.7 (12.6–17.9)	692 (606–777)	377 (278–495)	333 (236–462)	23.1 (19.4–27.4)	19.1			
Haiti	8840 (7850–9890)	10 300 (8020–12 900)	9810 (7690–12 200)	24.4 (23.0–36.8)	28 200 (24 900–31 800)	25 400 (21 600–29 900)	22 600 (18 800–27 000)	68.3 (58.7–79.5)	47.8			
Jamaica	732 (578–913)	525 (407–670)	454 (320–627)	11.7 (10.6–15.0)	1010 (807–1240)	656 (513–839)	568 (403–785)	15.7 (13.1–18.7)	13.4			
Puerto Rico	432 (399–467)	150 (133–167)	128 (94.5–171)	4.17 (4.27–5.92)	650 (617–686)	239 (223–258)	197 (148–259)	7.67 (6.52–9.04)	6.49			
Saint Kitts and Nevis	12.2 (10.3–14.5)	8.43 (6.57–10.8)	7.10 (5.55–9.00)	8.77 (8.82–11.9)	18.9 (16.1–22.2)	12.7 (9.88–16.1)	10.7 (8.32–13.6)	15.3 (13.1–17.9)	11.4			
Saint Lucia	38.1 (30.9–46.0)	22.6 (16.5–30.8)	18.9 (12.9–27.1)	9.87 (8.89–12.6)	55.9 (45.5–67.7)	31.4 (22.9–42.9)	26.3 (18.0–37.4)	14.6 (12.2–17.4)	13.0			
Saint Vincent and the Grenadines	35.3 (29.0–41.9)	18.1 (13.8–23.7)	14.8 (10.5–20.5)	8.49 (8.26–11.5)	55.2 (44.3–68.0)	28.4 (21.6–37.3)	23.4 (16.4–32.8)	15.2 (12.8–18.2)	12.5			
Suriname	246 (210–287)	182 (146–224)	155 (109–215)	13.8 (14.1–20.0)	414 (353–481)	281 (228–344)	238 (169–326)	25.7 (21.6–30.6)	20.4			
Trinidad and Tobago	327 (274–393)	185 (140–238)	156 (110–218)	8.84 (8.48–12.1)	478 (397–575)	281 (219–354)	238 (169–329)	15.2 (12.7–18.2)	13.1			
Virgin Islands	14.9 (12.2–17.8)	7.08 (5.50–8.98)	5.90 (4.21–8.11)	3.57 (3.91–5.46)	22.7 (18.8–27.2)	10.6 (8.16–13.3)	8.76 (6.28–12.0)	6.79 (5.74–8.05)	5.26			
Central Latin America	70 000 (61 400–79 900)	40 600 (34 000–48 200)	33 200 (26 400–41 200)	6.02 (6.65–8.47)	143 000 (130 000–157 000)	80 100 (67 100–94 100)	65 400 (50 700–83 700)	14.8 (12.4–17.5)	11.2			
Colombia	13 400 (11 300–15 700)	6610 (5020–8340)	5410 (3660–7660)	5.21 (5.27–8.35)	24 900 (22 000–28 200)	12 500 (9900–15 400)	10 300 (7410–13 900)	12.6 (10.6–15.0)	9.85			
Costa Rica	553 (503–606)	412 (375–452)	338 (242–466)	4.32 (4.33–5.94)	959 (889–1040)	641 (589–695)	532 (388–717)	7.93 (6.76–9.30)	6.59			

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	Neonatal deaths			NMR			Under-5 deaths			U5MR		
	2000	2015	2019	2019	2030*	2000	2015	2019	2019	2030*		
(Continued from previous page)												
El Salvador	1770 (1400-2150)	792 (606-1020)	593 (412-835)	5.26 (4.11-6.59)	3.86	4290 (3730-4950)	1680 (1340-2100)	1240 (896-1690)	10.9 (9.18-13.1)	7.90		
Guatemala	7130 (6170-8200)	3830 (3090-4680)	3440 (2460-4720)	8.35 (7.07-9.86)	6.22	18100 (16000-20300)	10400 (8520-12500)	8870 (6410-12100)	21.7 (18.3-25.8)	14.8		
Honduras	3300 (2790-3850)	2500 (1990-3110)	2180 (1710-2720)	9.33 (7.81-11.1)	7.53	6880 (5900-7990)	4570 (3650-5630)	3970 (3140-4940)	17.2 (14.4-20.5)	12.9		
Mexico	35300 (28000-43400)	19200 (15400-24200)	15700 (12100-20200)	7.44 (6.52-8.53)	6.12	69800 (61700-78900)	37400 (30500-45200)	30300 (24200-37500)	14.4 (12.2-17.1)	11.2		
Nicaragua	1930 (1580-2280)	1070 (823-1360)	860 (653-1100)	6.58 (5.40-8.01)	4.84	4570 (3930-5230)	2350 (1930-2830)	1880 (1530-2300)	14.4 (12.1-17.1)	10.0		
Panama	617 (509-741)	539 (447-646)	490 (355-665)	6.42 (5.39-7.64)	4.98	1430 (1200-1700)	1210 (1000-1440)	1100 (818-1460)	14.5 (12.1-17.3)	11.5		
Venezuela	5990 (5650-6320)	5640 (4850-6590)	4240 (3000-5870)	8.83 (7.42-10.5)	7.64	11700 (11100-12400)	9370 (8140-10800)	7220 (5200-9880)	14.8 (12.4-17.6)	11.8		
Tropical Latin America	70000 (61000-79000)	39600 (32300-47300)	32300 (25500-39700)	9.96 (8.41-11.8)	8.10	154000 (138000-169000)	79800 (66800-95400)	64600 (51300-79200)	19.8 (16.7-23.4)	15.1		
Brazil†	68100 (59200-77200)	38700 (31500-46500)	31600 (24900-38700)	10.1 (8.55-12.0)	8.26	150000 (135000-166000)	77700 (65100-92700)	62800 (49900-77000)	20.0 (16.9-23.7)	15.3		
Paraguay	1900 (1590-2220)	853 (648-1100)	733 (525-1010)	5.80 (4.88-6.90)	4.53	3490 (2950-4040)	2060 (1580-2650)	1770 (1280-2410)	14.0 (11.8-16.6)	12.0		
North Africa and Middle East	298000 (268000-328000)	182000 (159000-210000)	150000 (129000-173000)	12.2 (11.1-13.3)	9.82	682000 (623000-742000)	382000 (333000-442000)	300000 (255000-353000)	24.4 (22.3-26.7)	18.2		
Afghanistan	38900 (32600-45400)	34900 (29100-41100)	37400 (31300-44200)	25.0 (21.6-28.4)	19.5	120000 (108000-133000)	83800 (71000-99000)	81400 (67900-97200)	55.3 (47.9-63.5)	37.2		
Algeria	15600 (12800-18600)	13600 (11200-16100)	10700 (8220-13400)	12.0 (9.83-14.4)	10.4	29400 (25400-33700)	22200 (19000-25900)	17300 (14500-20500)	19.5 (17.0-22.4)	16.0		
Bahrain	64.5 (57.6-72.6)	42.9 (35.9-51.4)	30.7 (24.6-38.7)	2.36 (2.13-2.59)	1.57	158 (142-175)	126 (107-147)	87.3 (69.8-109)	6.53 (5.79-7.36)	5.02		
Egypt	40500 (33400-47600)	15400 (12000-20100)	11800 (8250-16200)	5.55 (4.20-7.20)	3.11	84400 (72600-96300)	47400 (38200-57600)	32600 (24600-42600)	15.3 (12.8-18.3)	8.27		
Iran	33700 (27500-40300)	18000 (15500-20800)	9140 (7440-11100)	6.77 (6.09-7.44)	5.19	60800 (50200-72500)	29100 (25500-33200)	15200 (12700-18400)	11.1 (10.2-12.0)	7.83		
Iraq	22100 (19500-25000)	12300 (9300-16300)	9130 (6610-12800)	9.49 (7.92-11.5)	7.51	40700 (35800-46000)	23000 (18100-29100)	15000 (11000-20700)	15.7 (13.2-18.9)	11.9		
Jordan	2160 (1830-2520)	2070 (1610-2660)	2130 (1570-2930)	8.80 (7.46-10.6)	6.72	3610 (3040-4220)	3540 (2750-4520)	3640 (2680-5010)	15.3 (13.0-18.3)	11.3		
Kuwait	262 (234-292)	369 (324-422)	310 (242-402)	5.09 (4.30-5.99)	4.46	500 (463-545)	659 (599-730)	555 (440-708)	9.18 (7.75-10.8)	8.03		
Lebanon	1050 (813-1330)	684 (497-938)	521 (373-734)	4.82 (4.02-5.89)	3.65	1920 (1510-2420)	1290 (958-1730)	983 (708-1380)	8.99 (7.51-11.0)	6.99		
Libya	1650 (1350-1990)	560 (436-712)	458 (351-583)	5.62 (4.73-6.69)	4.43	3240 (2640-3890)	1470 (1180-1800)	1110 (869-1390)	13.3 (11.4-15.7)	10.4		
Morocco	22200 (17600-27300)	9820 (7510-12500)	6760 (5120-8700)	11.1 (9.74-12.5)	7.92	40800 (33500-48200)	16200 (11700-21900)	11100 (7860-15400)	17.9 (15.0-21.4)	11.9		
Oman	478 (408-553)	504 (445-564)	418 (357-482)	5.38 (4.86-5.90)	4.25	926 (792-1070)	958 (842-1070)	809 (690-937)	10.4 (9.40-11.4)	8.17		

(Table continues on next page)

	Neonatal deaths			NMR			Under-5 deaths			USMR		
	2000	2015	2019	2019	2030*	2000	2015	2019	2019	2019	2030*	
(Continued from previous page)												
Palestine	1720 (1450-2000)	1050 (803-1320)	800 (606-1060)	6.36 (5.38-7.63)	5.67	3750 (3350-4160)	2060 (1620-2580)	1560 (1180-2060)	12.4 (10.5-14.8)	10.1		
Qatar	107 (85.9-133)	127 (103-155)	113 (90.6-144)	4.22 (3.52-5.13)	3.45	199 (165-239)	239 (195-291)	214 (172-274)	8.02 (6.71-9.74)	6.62		
Saudi Arabia	5910 (4690-7240)	1670 (1320-2100)	1200 (950-1520)	2.64 (2.20-3.24)	1.48	13000 (9880-16500)	3830 (3060-4750)	2610 (2070-3300)	5.73 (4.77-7.01)	3.39		
Sudan	43600 (36800-50700)	30700 (24800-37300)	25700 (20600-32500)	21.3 (18.9-24.1)	17.0	124000 (111000-137000)	65100 (51100-81800)	50700 (37300-68600)	41.9 (35.7-50.0)	30.0		
Syria	5300 (4670-5950)	3320 (2850-3830)	1590 (1320-1900)	6.88 (5.72-8.32)	5.92	10800 (10000-11700)	8940 (7980-10100)	3210 (2560-3990)	13.6 (11.7-15.8)	12.0		
Tunisia	3590 (2900-4370)	1610 (1260-2010)	1140 (903-1420)	6.82 (5.73-8.12)	5.33	6140 (5160-7180)	2700 (2170-3290)	1920 (1530-2380)	11.3 (9.49-13.5)	8.45		
Turkey	28200 (23400-33500)	10900 (8610-13800)	8380 (6710-10400)	8.54 (7.15-10.2)	6.62	61200 (51700-71300)	19500 (15500-24300)	15100 (12100-18700)	15.4 (12.9-18.4)	11.4		
United Arab Emirates	305 (269-341)	227 (173-298)	145 (109-197)	2.58 (2.18-3.10)	2.40	587 (532-641)	455 (352-599)	295 (220-399)	4.96 (4.19-5.97)	4.37		
Yemen	30100 (25300-35200)	23900 (19300-29200)	21600 (17700-26000)	22.8 (18.8-27.4)	18.7	75800 (67600-84400)	49200 (40800-58800)	44200 (36700-53100)	46.7 (40.2-54.4)	35.1		
South Asia	1560000 (1410000-1730000)	1110000 (958000-1280000)	899000 (761000-1060000)	26.9 (24.2-30.0)	21.8	3040000 (2780000-3330000)	1760000 (1510000-2020000)	1360000 (1140000-1610000)	40.5 (36.0-46.0)	29.0		
Bangladesh	146000 (130000-163000)	70100 (54500-87600)	52600 (40400-66300)	19.8 (16.4-23.7)	14.2	295000 (267000-325000)	108000 (90000-128000)	77900 (63000-94200)	29.2 (24.9-34.2)	18.4		
Bhutan	796 (661-929)	379 (279-499)	287 (207-393)	20.6 (17.5-24.2)	15.0	1580 (1320-1830)	602 (443-788)	445 (322-602)	31.5 (26.7-36.9)	22.2		
India	1070000 (938000-1220000)	720000 (606000-844000)	558000 (455000-689000)	23.8 (20.1-28.8)	18.8	2130000 (1900000-2380000)	1150000 (970000-1350000)	841000 (692000-1040000)	35.8 (30.2-43.0)	24.6		
Nepal	32500 (28500-36700)	14700 (12000-18000)	11700 (9610-14100)	19.0 (15.6-23.0)	13.5	65900 (59300-73100)	24200 (20500-28600)	18000 (14700-21800)	29.1 (24.8-34.1)	18.9		
Pakistan	309000 (264000-356000)	305000 (246000-374000)	277000 (226000-333000)	41.6 (34.2-50.0)	34.5	552000 (495000-614000)	478000 (395000-569000)	420000 (346000-507000)	63.3 (53.9-74.3)	48.0		
Southeast Asia, east Asia, and Oceania	507000 (471000-543000)	250000 (215000-288000)	194000 (162000-230000)	7.23 (6.29-8.27)	6.17	1280000 (1200000-1380000)	519000 (456000-590000)	405000 (349000-467000)	14.8 (13.2-16.4)	11.7		
East Asia	243000 (222000-263000)	86700 (77800-96600)	59300 (51500-67700)	3.83 (3.37-4.37)	2.89	652000 (594000-717000)	185000 (166000-206000)	136000 (119000-155000)	8.56 (7.52-9.76)	5.89		
China	229000 (208000-249000)	82700 (74000-92300)	56400 (49100-64400)	3.78 (3.31-4.31)	2.77	610000 (556000-666000)	177000 (158000-198000)	131000 (114000-149000)	8.52 (7.45-9.71)	5.70		
North Korea	13100 (9580-18000)	3510 (2720-4470)	2420 (1920-3110)	6.91 (5.74-8.45)	5.85	39200 (25000-69700)	6430 (5000-8140)	4460 (3530-5680)	12.6 (10.5-15.4)	9.55		
Taiwan (province of China)	967 (889-1050)	532 (498-570)	405 (330-497)	2.31 (1.97-2.75)	2.30	2300 (2230-2380)	1030 (988-1080)	815 (672-998)	4.51 (3.85-5.38)	3.98		
Oceania	5900 (5080-6800)	7360 (5910-9040)	7540 (5970-9450)	18.1 (15.2-21.4)	15.4	17400 (15000-20000)	20200 (16300-24700)	19900 (15800-25000)	48.4 (40.7-57.5)	39.0		
American Samoa	12.2 (10.5-14.0)	5.67 (4.58-6.85)	5.14 (3.94-6.47)	4.86 (4.23-5.52)	3.88	24.6 (20.7-28.9)	12.2 (9.61-15.3)	10.8 (7.95-14.4)	10.2 (8.72-12.0)	7.72		
Cook Islands	2.21 (1.71-2.81)	0.412 (0.326-0.519)	0.303 (0.243-0.375)	1.10 (0.930-1.31)	0.940	5.00 (3.87-6.33)	0.942 (0.742-1.20)	0.685 (0.547-0.848)	2.46 (2.06-2.94)	1.98		

(Table continues on next page)

	Neonatal deaths			NMR			Under-5 deaths			U5MR		
	2000	2015	2019	2019	2030*	2000	2015	2019	2019	2019	2030*	
(Continued from previous page)												
Federated States of Micronesia	42.2 (34.0-51.4)	16.4 (12.7-20.5)	13.4 (10.4-16.9)	6.85 (5.72-8.22)	5.05	105 (87.3-125)	35.6 (27.8-44.4)	28.4 (22.1-35.9)	14.5 (12.1-17.4)	10.5		
Fiji	217 (172-272)	198 (152-255)	177 (128-241)	10.0 (8.41-12.0)	8.70	471 (376-590)	432 (338-554)	387 (281-521)	21.7 (18.2-25.9)	18.8		
Guam	20.2 (18.1-22.5)	24.6 (21.6-28.1)	23.6 (18.8-29.6)	7.18 (6.16-8.40)	7.31	41.3 (36.8-46.1)	46.0 (41.5-51.3)	43.9 (35.6-53.7)	13.3 (11.6-15.3)	12.6		
Kiribati	54.1 (44.8-65.3)	48.5 (37.0-63.4)	44.5 (32.3-60.2)	14.6 (12.3-17.5)	12.0	157 (130-190)	116 (88.7-151)	101 (74.0-137)	33.6 (28.1-40.0)	25.4		
Marshall Islands	24.5 (19.7-29.6)	13.9 (11.1-17.6)	11.7 (9.32-15.1)	9.38 (7.84-11.4)	7.74	57.9 (49.9-66.6)	29.2 (23.5-36.5)	24.3 (19.4-31.0)	19.3 (16.2-23.4)	16.9		
Nauru	5.85 (4.75-7.19)	3.71 (2.96-4.61)	3.04 (2.45-3.89)	10.1 (8.44-12.2)	8.58	17.7 (15.2-20.3)	8.94 (7.27-11.0)	7.03 (5.65-8.95)	23.2 (19.5-28.1)	18.7		
Niue	0.415 (0.313-0.540)	0.224 (0.173-0.284)	0.205 (0.160-0.259)	8.12 (6.81-9.68)	6.92	1.01 (0.775-1.28)	0.520 (0.399-0.656)	0.472 (0.367-0.595)	18.6 (15.5-22.2)	15.0		
Northern Mariana Islands	9.67 (7.70-11.8)	2.73 (2.25-3.28)	2.22 (1.82-2.69)	4.40 (3.60-5.29)	3.89	17.5 (14.0-21.3)	6.00 (4.77-7.39)	4.69 (3.68-5.83)	9.11 (7.73-10.7)	8.07		
Palau	3.22 (2.44-4.16)	1.52 (1.15-1.97)	1.15 (0.876-1.53)	6.04 (5.05-7.38)	5.15	7.78 (5.78-10.3)	3.72 (2.82-4.76)	2.77 (2.11-3.66)	14.0 (11.7-17.0)	11.3		
Papua New Guinea	4690 (4010-5470)	6280 (5020-7740)	6530 (5180-8160)	19.6 (16.5-23.3)	16.8	14.400 (12.300-16.700)	17.600 (14.100-21.600)	17.600 (14.000-22.000)	53.8 (45.3-63.9)	43.4		
Samoa	30.9 (21.8-42.2)	24.0 (17.5-32.9)	22.3 (15.8-31.0)	6.28 (5.24-7.52)	5.35	65.1 (47.2-86.9)	49.9 (36.6-67.4)	46.4 (32.8-64.1)	13.2 (11.1-15.9)	11.4		
Solomon Islands	325 (261-398)	272 (216-333)	245 (197-301)	11.5 (9.65-13.8)	9.36	767 (620-935)	593 (474-728)	519 (421-638)	24.6 (20.6-29.4)	19.2		
Tokelau	0.406 (0.322-0.506)	0.139 (0.110-0.176)	0.119 (0.0935-0.149)	3.19 (2.54-3.97)	2.71	0.961 (0.767-1.19)	0.338 (0.265-0.420)	0.286 (0.229-0.351)	7.73 (6.45-9.28)	6.24		
Tonga	26.9 (22.0-32.6)	17.5 (13.5-22.8)	14.5 (10.5-19.7)	6.36 (5.31-7.61)	5.37	56.4 (46.7-67.1)	38.0 (29.4-48.7)	31.4 (22.9-42.3)	13.6 (11.4-16.3)	13.7		
Tuvalu	4.62 (4.00-5.32)	1.70 (1.26-2.22)	1.42 (1.06-1.93)	6.63 (5.51-8.10)	5.65	10.6 (9.00-12.5)	3.50 (2.66-4.52)	2.92 (2.19-3.90)	13.7 (11.4-16.7)	11.0		
Vanuatu	99.6 (78.1-125)	93.4 (75.2-115)	88.3 (70.4-110)	11.6 (9.68-13.8)	9.73	223 (175-277)	201 (163-246)	185 (148-228)	24.4 (20.5-29.2)	20.0		
Southeast Asia	259 000 (233 000-283 000)	156 000 (129 000-187 000)	127 000 (102 000-156 000)	11.6 (9.92-13.6)	9.17	615 000 (563 000-665 000)	314 000 (269 000-367 000)	250 000 (209 000-297 000)	22.6 (20.1-25.6)	16.5		
Cambodia	12 200 (11 100-13 300)	7 330 (5 800-9 240)	6 280 (4 810-8 280)	16.9 (14.4-20.3)	13.1	35 200 (31 600-38 900)	14 200 (11 200-17 800)	11 600 (8 890-15 300)	31.3 (26.5-37.5)	21.6		
Indonesia	115 000 (102 000-129 000)	66 500 (50 800-83 100)	52 400 (40 900-65 500)	13.7 (10.9-17.0)	10.5	260 000 (236 000-283 000)	129 000 (106 000-153 000)	98 900 (80 600-121 000)	25.5 (21.6-30.2)	17.8		
Laos	7 790 (6 960-8 770)	3 960 (3 270-4 670)	3 470 (2 760-4 280)	19.9 (16.9-23.2)	12.8	21 600 (19 600-23 900)	8 680 (7 220-10 300)	7 100 (5 650-8 900)	40.9 (35.0-47.5)	18.8		
Malaysia	2 460 (2 240-2 680)	2 340 (2 060-2 590)	1 910 (1 540-2 330)	3.55 (3.01-4.20)	2.82	4840 (4 720-4 980)	4 270 (4 160-4 380)	3 410 (2 790-4 150)	6.42 (5.43-7.59)	4.91		
Maldives	134 (112-159)	99.9 (76.4-131)	81.9 (60.0-113)	9.58 (8.05-11.5)	8.08	241 (205-283)	169 (131-217)	140 (103-192)	16.2 (13.7-19.4)	13.6		

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	Neonatal deaths			NMR			Under-5 deaths			U5MR		
	2000	2015	2019	2019	2030*	2000	2015	2019	2019	2030*		
(Continued from previous page)												
Mauritius	228 (208-249)	120 (109-132)	104 (77.5-136)	8.07 (6.90-9.39)	6.79	349 (326-372)	192 (177-206)	163 (124-211)	12.6 (10.8-14.7)	10.7		
Myanmar	48 300 (40 000-57 000)	26 600 (21 200-32 400)	22 200 (16 300-28 700)	21.0 (17.3-24.8)	16.2	135 000 (117 000-156 000)	55 000 (43 800-67 900)	42 800 (32 100-56 300)	40.3 (34.3-47.1)	28.6		
Philippines	37 800 (32 500-44 100)	31 200 (21 800-41 700)	27 400 (19 700-36 400)	10.2 (7.91-13.0)	8.59	87 100 (77 600-97 500)	69 000 (55 700-84 400)	60 000 (47 800-73 200)	22.6 (19.0-26.7)	17.5		
Seychelles	13.6 (11.7-15.7)	12.7 (10.5-15.0)	10.7 (8.09-14.0)	7.15 (6.18-8.26)	6.12	20.6 (17.7-23.7)	20.3 (16.8-24.2)	17.3 (13.1-22.6)	11.5 (9.89-13.4)	9.79		
Sri Lanka	3300 (3050-3560)	1750 (1430-2130)	1300 (882-1860)	4.37 (3.46-5.45)	3.16	5880 (5510-6240)	3060 (2560-3630)	2290 (1640-3150)	7.61 (6.38-9.08)	5.38		
Thailand	7780 (6400-9410)	2790 (2380-3230)	2120 (1660-2670)	3.63 (2.99-4.26)	2.39	16 100 (13 800-19 000)	6030 (5510-6560)	4570 (3760-5480)	7.63 (6.84-8.48)	4.97		
Timor-Leste	966 (859-1080)	622 (512-748)	602 (486-741)	15.5 (13.1-18.6)	12.4	3150 (2790-3550)	1340 (1110-1610)	1230 (1000-1520)	32.1 (27.2-38.5)	21.0		
Vietnam	22 200 (19 400-25 200)	12 300 (9830-15 400)	9200 (7010-12 300)	6.83 (5.76-8.27)	5.21	44 300 (39 400-49 800)	22 600 (18 100-28 400)	17 100 (13 000-22 700)	12.4 (10.5-15.0)	9.42		
Sub-Saharan Africa	1120 000 (1 050 000-1 190 000)	1 090 000 (938 000-1 270 000)	1 020 000 (847 000-1 250 000)	27.9 (24.7-31.6)	23.6	4 020 000 (3 790 000-4 270 000)	3 070 000 (2 640 000-3 550 000)	2 680 000 (2 220 000-3 250 000)	74.1 (65.3-85.2)	54.4		
Central sub-Saharan Africa	124 000 (111 000-137 000)	114 000 (98 400-132 000)	100 000 (85 800-120 000)	22.5 (19.8-25.8)	17.7	509 000 (468 000-553 000)	333 000 (289 000-387 000)	260 000 (222 000-310 000)	58.8 (51.7-67.5)	36.5		
Angola	28 700 (25 200-32 100)	26 200 (21 900-31 100)	24 000 (20 100-28 400)	21.7 (19.1-24.5)	16.9	116 000 (105 000-127 000)	73 000 (60 900-85 700)	58 800 (48 100-70 800)	54.2 (46.4-62.9)	33.7		
Central African Republic	7730 (6570-8970)	8060 (6320-10 200)	7770 (6150-9930)	39.3 (33.2-47.4)	35.4	28 300 (24 500-32 100)	26 900 (21 900-32 600)	24 000 (19 200-30 000)	123 (105-146)	95.2		
Congo (Brazzaville)	3400 (2910-3940)	3240 (2770-3770)	2680 (2250-3170)	18.4 (16.0-21.0)	15.3	18.4 (10 900-13 400)	7540 (6410-8770)	5760 (4810-6890)	39.5 (33.7-46.1)	27.8		
DR Congo	81 900 (71 700-93 100)	74 700 (62 800-88 800)	64 700 (53 500-79 500)	22.0 (18.7-26.3)	17.6	346 000 (311 000-385 000)	222 000 (187 000-263 000)	168 000 (141 000-205 000)	57.9 (49.2-69.1)	36.0		
Equatorial Guinea	1090 (886-1300)	795 (589-1060)	683 (492-952)	17.7 (14.8-21.6)	14.4	3710 (3060-4430)	1890 (1420-2500)	1450 (1050-2010)	38.1 (31.9-46.3)	24.2		
Gabon	1140 (921-1380)	797 (594-1070)	680 (487-952)	15.8 (13.2-19.0)	13.5	2940 (2370-3530)	1600 (1200-2110)	1300 (928-1810)	30.1 (25.3-36.4)	21.4		
Eastern sub-Saharan Africa	424 000 (392 000-457 000)	378 000 (317 000-448 000)	353 000 (285 000-439 000)	24.9 (21.6-29.0)	20.6	1 450 000 (1 360 000-1 550 000)	941 000 (794 000-1 110 000)	814 000 (658 000-1 010 000)	58.3 (50.5-68.1)	41.1		
Burundi	10 700 (8930-12 600)	11 100 (9470-12 900)	11 200 (9420-13 400)	24.0 (21.3-27.2)	19.3	43 300 (39 100-47 900)	32 100 (26 600-38 400)	29 700 (23 800-37 400)	65.4 (55.7-77.8)	42.7		
Comoros	934 (763-1130)	553 (439-680)	469 (369-589)	27.9 (23.5-33.8)	22.0	2140 (1770-2560)	1050 (846-1290)	836 (663-1040)	49.8 (42.1-59.9)	35.2		
Djibouti	864 (729-1020)	863 (693-1060)	750 (593-943)	21.2 (17.6-25.8)	17.2	2670 (2260-3130)	2080 (1680-2530)	1670 (1330-2080)	47.0 (39.4-56.9)	34.4		
Eritrea	4510 (3690-5480)	4220 (3180-5620)	3870 (2800-5360)	19.3 (16.1-23.5)	15.7	16 000 (13 300-19 100)	11 300 (8600-14 800)	9400 (6860-12 900)	47.5 (39.8-57.5)	30.7		
Ethiopia	144 000 (130 000-161 000)	110 000 (88 300-135 000)	97 900 (77 200-126 000)	26.6 (22.6-31.6)	21.5	426 000 (387 000-469 000)	229 000 (187 000-277 000)	190 000 (150 000-243 000)	52.4 (44.7-62.4)	34.6		

(Table continues on next page)

	Neonatal deaths				Under-5 deaths				U5MR		
	2000	2015	2019	2030*	2000	2015	2019	2030*	2019	2030*	2030*
	(Continued from previous page)										
Kenya	32 000 (27 700-36 400)	29 200 (23 900-35 100)	26 400 (21 200-32 300)	16.3	99 300 (89 300-111 000)	64 500 (52 900-76 800)	54 100 (43 700-65 700)	40.6 (34.6-47.7)	28.1		
Madagascar	21 400 (18 500-24 600)	21 100 (17 000-25 600)	19 800 (15 900-24 500)	18.7	70 600 (61 900-79 800)	55 100 (45 200-65 800)	48 200 (39 100-59 000)	56.6 (48.1-67.7)	37.3		
Malawi	19 500 (17 900-21 400)	14 700 (12 000-17 900)	13 700 (10 600-17 600)	19.6	80 000 (74 100-86 300)	38 600 (32 000-46 800)	31 800 (24 900-40 800)	59.1 (50.6-70.0)	39.6		
Mozambique	34 600 (31 200-38 300)	30 400 (25 400-36 200)	29 000 (23 700-35 800)	20.2	130 000 (117 000-143 000)	88 900 (74 700-105 000)	76 500 (62 800-93 800)	69.4 (59.0-82.8)	47.0		
Rwanda	11 100 (9 090-13 100)	7 490 (6 050-8 990)	7 030 (5 750-8 640)	15.1	47 000 (42 900-50 900)	18 800 (15 300-23 200)	16 300 (12 600-21 200)	46.6 (39.6-55.8)	28.3		
Somalia	20 800 (17 300-24 700)	25 800 (20 500-32 300)	27 000 (20 900-35 200)	25.2	77 700 (66 700-89 600)	81 300 (65 100-100 000)	80 600 (62 900-104 000)	95.4 (80.8-114)	67.6		
South Sudan	13 200 (11 300-15 100)	13 300 (10 600-16 300)	12 000 (9 670-14 900)	29.7	47 100 (41 100-53 200)	41 400 (33 500-50 200)	33 100 (26 800-40 600)	92.6 (78.9-108)	66.3		
Tanzania	52 100 (46 700-57 900)	52 300 (42 700-63 600)	50 000 (39 300-63 700)	20.0	186 000 (171 000-202 000)	133 000 (110 000-161 000)	118 000 (93 200-150 000)	57.1 (48.9-67.7)	41.8		
Uganda	42 600 (39 500-46 100)	43 000 (36 700-50 200)	40 800 (33 300-50 400)	21.9	163 000 (153 000-174 000)	107 000 (91 600-124 000)	91 700 (75 000-112 000)	58.4 (50.4-68.7)	43.3		
Zambia	14 600 (12 900-16 400)	13 800 (10 900-17 500)	13 100 (9 930-17 300)	17.4	62 300 (56 300-68 700)	36 000 (28 800-44 500)	31 500 (24 200-41 300)	51.8 (44.0-61.8)	35.8		
Southern sub-Saharan Africa	45 700 (40 100-51 300)	41 000 (33 800-49 500)	35 900 (28 600-45 700)	19.9	128 000 (113 000-145 000)	83 800 (69 400-101 000)	70 700 (56 300-89 800)	42.0 (36.3-49.3)	36.0		
Botswana	1 200 (920-1510)	1 070 (796-1430)	1 000 (735-1380)	18.8	33 600 (27 100-40 600)	21 900 (16 300-28 800)	20 000 (14 600-27 500)	41.3 (34.7-49.9)	36.0		
Eswatini	746 (645-857)	557 (458-678)	506 (413-628)	14.8	31 600 (27 800-35 700)	16 800 (13 900-20 300)	14 300 (11 700-17 600)	47.3 (40.4-55.3)	37.7		
Lesotho	2 330 (2 010-2 670)	1 540 (1 070-2 080)	1 350 (919-1 840)	24.7	58 900 (52 300-66 200)	37 500 (30 500-45 500)	30 300 (23 700-37 400)	64.4 (54.9-75.6)	52.8		
Namibia	1 260 (1 100-1 460)	1 100 (845-1 400)	1 020 (767-1 360)	14.3	36 100 (31 100-42 000)	24 800 (19 300-31 800)	22 000 (16 800-29 000)	35.0 (29.6-42.2)	28.4		
South Africa	30 300 (25 700-35 300)	25 300 (20 200-31 800)	21 400 (16 900-27 600)	18.5	80 600 (67 900-94 900)	47 100 (37 600-58 900)	38 500 (30 200-49 400)	36.9 (31.6-43.6)	29.7		
Zimbabwe	9 850 (8 870-10 900)	11 400 (9 280-14 000)	10 500 (8 310-13 500)	22.1	31 600 (28 900-34 600)	26 600 (22 000-31 800)	23 600 (18 600-29 900)	52.4 (45.0-62.0)	45.8		
Western sub-Saharan Africa	522 000 (483 000-563 000)	557 000 (487 000-643 000)	535 000 (448 000-644 000)	27.8	1 930 000 (1 820 000-2 040 000)	1 710 000 (1 490 000-1 960 000)	1 530 000 (1 280 000-1 860 000)	95.3 (84.7-109)	71.1		
Benin	12 300 (10 200-14 900)	15 600 (12 700-18 700)	15 400 (12 600-19 100)	26.8	42 000 (38 800-45 700)	45 700 (39 000-53 300)	42 000 (34 300-51 500)	85.0 (73.8-99.3)	65.9		
Burkina Faso	21 500 (18 400-24 700)	26 000 (20 800-32 200)	26 900 (21 100-34 500)	24.0	99 300 (89 400-109 000)	101 000 (83 800-122 000)	98 800 (78 300-125 000)	109 (93.0-129)	82.5		
Cameroon	20 900 (18 200-24 100)	23 400 (18 200-29 300)	21 700 (17 100-27 000)	18.6	80 000 (72 300-88 000)	75 400 (62 100-89 300)	64 000 (52 500-77 200)	71.7 (61.2-84.0)	48.6		

(Table continues on next page)

	Neonatal deaths			NMR			Under-5 deaths			U5MR		
	2000	2015	2019	2019	2030*	2000	2015	2019	2019	2019	2030*	
(Continued from previous page)												
Cape Verde	226 (189-271)	135 (106-171)	103 (74.3-141)	9.46 (8.16-11.0)	7.65	647 (544-773)	246 (194-309)	187 (135-253)	17.0 (14.7-19.8)	11.6		
Chad	18 200 (16 700-19 700)	23 600 (19 300-28 600)	25 400 (20 800-31 100)	32.2 (27.6-38.0)	26.9	76 600 (70 000-83 900)	84 600 (72 200-99 100)	85 600 (70 400-105 000)	113 (97.0-133)	83.2		
Côte d'Ivoire	35 300 (28 800-42 100)	34 500 (27 600-42 300)	30 400 (24 500-36 900)	34.2 (27.9-41.4)	28.3	101 000 (90 700-112 000)	78 900 (66 800-92 500)	64 800 (54 300-77 100)	73.3 (62.8-85.6)	48.2		
The Gambia	2020 (1 730-2 360)	1 610 (1 210-2 110)	1 410 (1 030-1 920)	19.4 (16.4-23.4)	14.7	5 460 (4 690-6 260)	3 330 (2 550-4 300)	2 710 (1 990-3 680)	37.8 (31.9-45.5)	23.2		
Ghana	24 100 (21 100-27 100)	21 600 (16 800-27 000)	19 800 (14 000-27 000)	23.1 (18.7-28.1)	19.5	66 800 (60 700-72 900)	52 900 (43 200-63 400)	44 300 (33 300-58 400)	52.2 (44.9-60.7)	40.5		
Guinea	17 600 (16 100-19 200)	15 100 (12 000-18 700)	14 600 (11 600-18 200)	30.6 (26.4-35.4)	23.4	61 800 (56 100-67 700)	51 300 (43 000-60 800)	45 400 (36 400-55 800)	97.1 (83.8-112)	67.1		
Guinea-Bissau	2 700 (2 300-3 130)	2 210 (1 770-2 720)	1 980 (1 630-2 330)	31.5 (27.9-35.4)	24.3	8 630 (7 560-9 700)	5 280 (4 280-6 370)	4 430 (3 540-5 420)	71.2 (60.7-83.0)	45.6		
Liberia	5 380 (4 810-6 020)	3 650 (2 820-4 680)	3 220 (2 370-4 420)	23.6 (20.0-28.3)	18.3	21 000 (19 300-22 800)	10 800 (8 520-13 300)	8 280 (6 120-11 200)	60.9 (51.9-72.6)	37.8		
Mali	29 400 (25 300-33 700)	36 400 (29 600-44 400)	38 000 (30 800-47 200)	39.5 (34.2-46.2)	32.0	104 000 (95 300-113 000)	111 000 (94 400-129 000)	110 000 (89 500-135 000)	118 (103-138)	86.2		
Mauritania	3 800 (3 290-4 370)	3 100 (2 610-3 680)	2 610 (2 130-3 270)	23.9 (21.3-26.9)	18.9	9 230 (8 260-10 300)	5 860 (4 790-7 160)	4 660 (3 580-6 100)	42.8 (36.6-50.8)	29.2		
Niger	26 200 (23 100-29 500)	28 300 (23 600-33 800)	30 600 (25 900-36 200)	26.8 (23.6-30.6)	21.1	138 000 (125 000-153 000)	121 000 (101 000-143 000)	120 000 (99 500-147 000)	111 (94.5-131)	71.1		
Nigeria	271 000 (239 000-305 000)	294 000 (247 000-350 000)	277 000 (224 000-346 000)	36.4 (31.7-42.3)	32.0	1 010 000 (936 000-1 080 000)	886 000 (760 000-1 030 000)	773 000 (628 000-957 000)	104 (90.6-120)	78.0		
São Tomé and Príncipe	108 (92.1-125)	71.9 (55.3-91.2)	56.8 (41.0-77.4)	12.1 (10.2-14.3)	9.77	386 (333-441)	160 (124-203)	119 (87.0-161)	25.4 (21.4-30.0)	17.4		
Senegal	13 900 (12 400-15 600)	12 900 (11 200-14 900)	11 700 (9 750-14 100)	25.0 (22.5-27.9)	20.1	43 800 (40 600-47 300)	27 100 (23 400-31 400)	22 800 (18 400-28 600)	49.3 (42.8-57.6)	32.6		
Sierra Leone	10 000 (8 720-11 400)	8 370 (6 630-10 400)	8 030 (6 410-10 100)	28.6 (24.2-33.7)	20.8	39 100 (35 000-43 400)	32 500 (27 600-38 200)	28 100 (22 900-34 300)	102 (88.6-117)	67.7		
Togo	7 270 (6 170-8 540)	6 710 (5 610-7 970)	5 930 (4 770-7 340)	24.9 (21.4-28.8)	19.0	23 700 (20 900-26 600)	18 500 (15 400-22 300)	15 000 (12 000-19 000)	63.2 (53.9-75.3)	41.8		

Count data are given to three significant figures. Data in parentheses are 95% uncertainty intervals. NMR=neonatal mortality rate. U5MR=under-5 mortality rate. SDI=Socio-demographic Index. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study. * Reference scenario. † Subnational analyses are done in these countries and data is available in the appendix (p 109).

Table: Neonatal and under-5 deaths in 2000, 2015, and 2019, by country, GBD region, GBD super-region, and SDI, and at the global level for both sexes combined, and neonatal mortality rate in 2019 with reference scenario for 2030

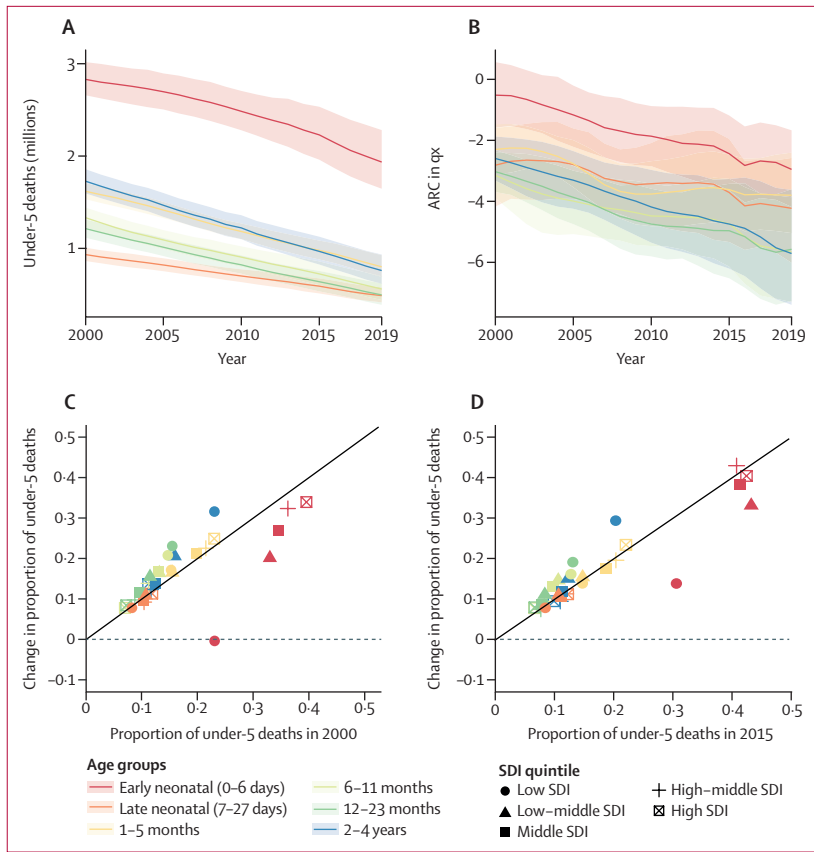


Figure 1: Global all-cause under-5 mortality by age, year, and SDI
 (A) Under-5 deaths (in millions) for 2000–19. (B) ARC in qx for each year between 2000 and 2019. (C) Proportion of under-5 deaths in 2000 compared with the ratio of age-specific to total under-5 absolute change in deaths between 2000 and 2015 by SDI quintile. (D) Proportion of under-5 deaths in 2015 compared to ratio of age-specific to total under-5 absolute change in deaths between 2015 and 2019 by SDI quintile. The shaded areas in panels A and B represent 95% uncertainty intervals. The black line in panels C and D represents line of equivalence, such that points above the line indicate age and SDI groups in which change outpaces overall under-5 mortality change and points below the line indicate age and SDI groups in which change underperforms relative to overall under-5 mortality change. ARC=annualised rate of change. qx=probability of death. SDI=Socio-demographic Index.

to 6·10 million (5·35–6·91) in 2015, and to 5·05 million (4·27–6·02) in 2019 (table). Of these deaths, 3·76 million (95% UI 3·53–4·02; 39%) in 2000, 2·82 million (2·48–3·20; 46%) in 2015, and 2·42 million (2·06–2·86; 48%) in 2019 occurred in neonates (aged <28 days). In each year analysed, the largest share of the global deaths of children younger than 5 years occurred in the sub-Saharan Africa and south Asia super-regions. Although U5MR declined in each successive period in all super-regions, the proportion of global deaths in children younger than 5 years in these two super-regions increased from 73% (7·07 million deaths [95% UI 6·57–7·59]) in 2000 to 80% (4·04 million [3·36–4·86]) deaths in 2019. The share of under-5 deaths also shifted towards lower SDI groups in this period, with the proportion of under-5 deaths in the low SDI quintile increasing from 42% (4·01 million deaths [95% UI 3·78–4·26]) in 2000 to 53% (2·67 million deaths [2·22–3·24]) in 2019.

Global U5MR and NMR both are falling short of SDG targets. Global U5MR declined from 71·2 (95% UI 68·3–74·0) in 1990 to 37·1 (95% UI 33·2–41·7) deaths per 1000 livebirths in 2019, with corresponding changes in NMR from 28·0 (95% UI 26·8–29·5) in 1990 to 17·9 (16·3–19·8) deaths per 1000 livebirths (table). The countries with the highest U5MR in 2019 were Central African Republic, Mali, and Chad, whereas Andorra, Singapore, and Slovenia were found to have the lowest U5MR. As for 2019 neonatal mortality, the highest rate was observed in Pakistan, followed by Mali and Central African Republic. The countries with the lowest 2019 NMR were Andorra, Japan, and Singapore. U5MR and NMR declined in every country between 2000 and 2019, apart from Dominica, Guam, and Northern Mariana Islands (appendix p 311).

We found evidence of accelerated reduction in global U5MR, but the largest number of deaths, as well as the slowest progress, occurred in the early neonatal age group (figure 1A, B). In all SDI quintiles, decline in NMR lagged behind mortality declines in other age groups (figure 1C, D). There is evidence of relative progress in neonatal mortality in the time period between 2015 and 2019, compared with between 2000 and 2015, but early neonatal progress in this more recent time period is still slower than overall under-5 progress in low SDI settings (figure 1D). The proportion of neonatal death broadly increases as SDI increases: in 2019, in the low SDI quintile, 1·11 million (41%) of 2·67 million deaths in children younger than 5 years were neonatal deaths, and in the high SDI quintile 26800 (55%) of 48600 deaths in children younger than 5 years were neonatal deaths (appendix p 120).

In 2015, 128 (63%) of 204 countries already had an U5MR below the SDG 3.2 threshold of 25 deaths of children younger than 5 years per 1000 livebirths (figure 2A). By 2019, eight additional countries—Syria, Uzbekistan, Guatemala, Philippines, Guyana, Nauru, Vanuatu, and Solomon Islands—had a U5MR below this threshold, making a total of 136 (67%; table). In 2015, 126 (62%) of 204 countries had an NMR below the SDG 3.2 threshold of 12 neonatal deaths per 1000 livebirths (figure 2B). By 2019, an additional seven countries—Syria, Iraq, Kyrgyzstan, Uzbekistan, Morocco, Solomon Islands, and Vanuatu—had achieved an NMR below this threshold, making a total of 133 (65%).

Under-5 mortality in each analysed year was somewhat higher in males than in females, although this difference was not statistically significant at the global level (appendix p 99). U5MR declined in both males and females in the periods between 2000 and 2015, and between 2015 and 2019 (appendix p 99). The 2019 male-to-female ratio of U5MR does not change meaningfully with SDI; this ratio ranges from 1·08 in low-middle SDI to 1·18 in high SDI in 2019 (appendix p 99).

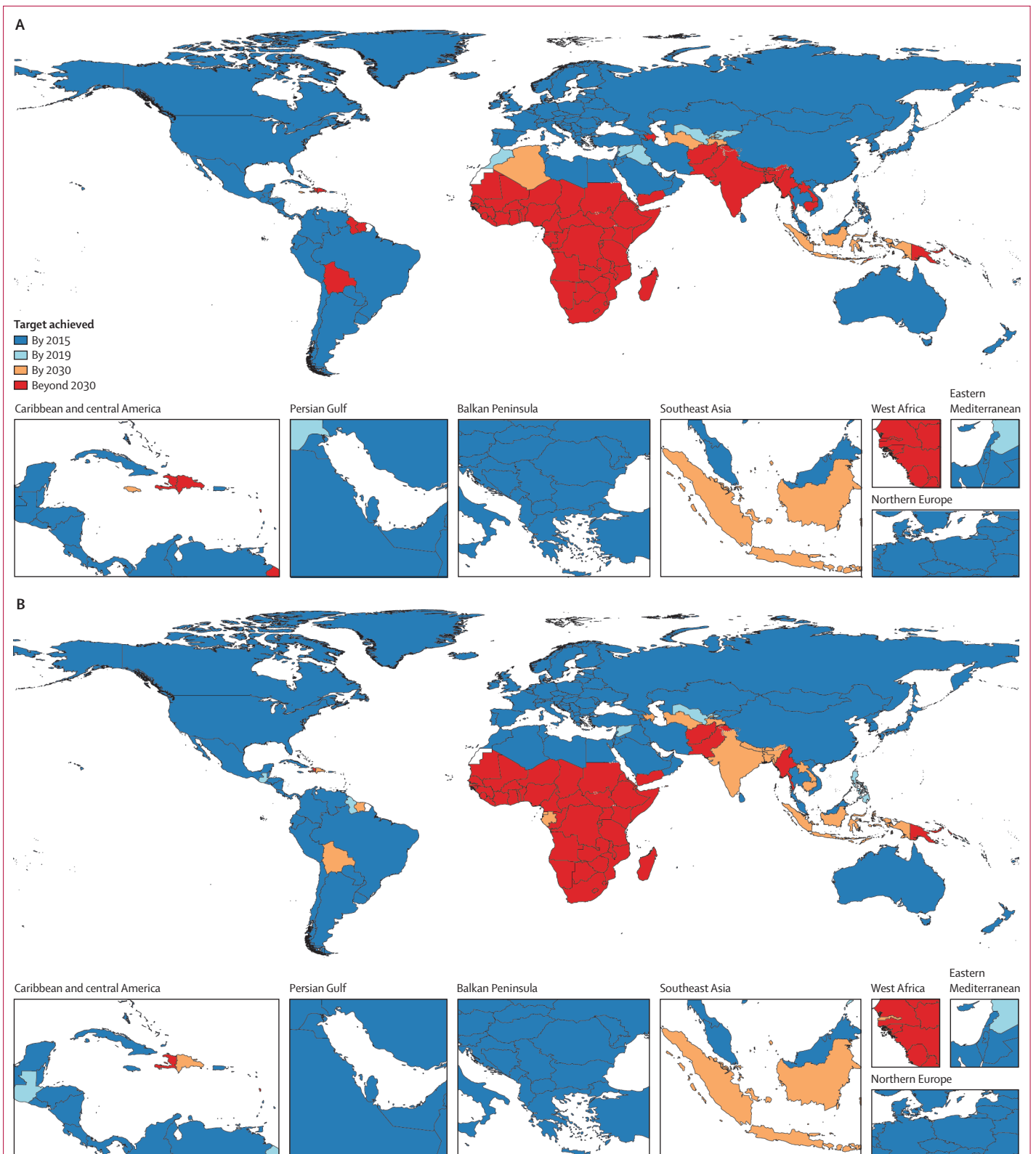


Figure 2: Map of individual countries' progress toward achieving the Sustainable Development Goals 3.2 target of (A) reducing neonatal mortality rate to the threshold of 12 neonatal deaths per 1000 livebirths, and reducing under-5 mortality rate to the threshold of 25 under-5 deaths per 1000 livebirths (B), under the reference scenario

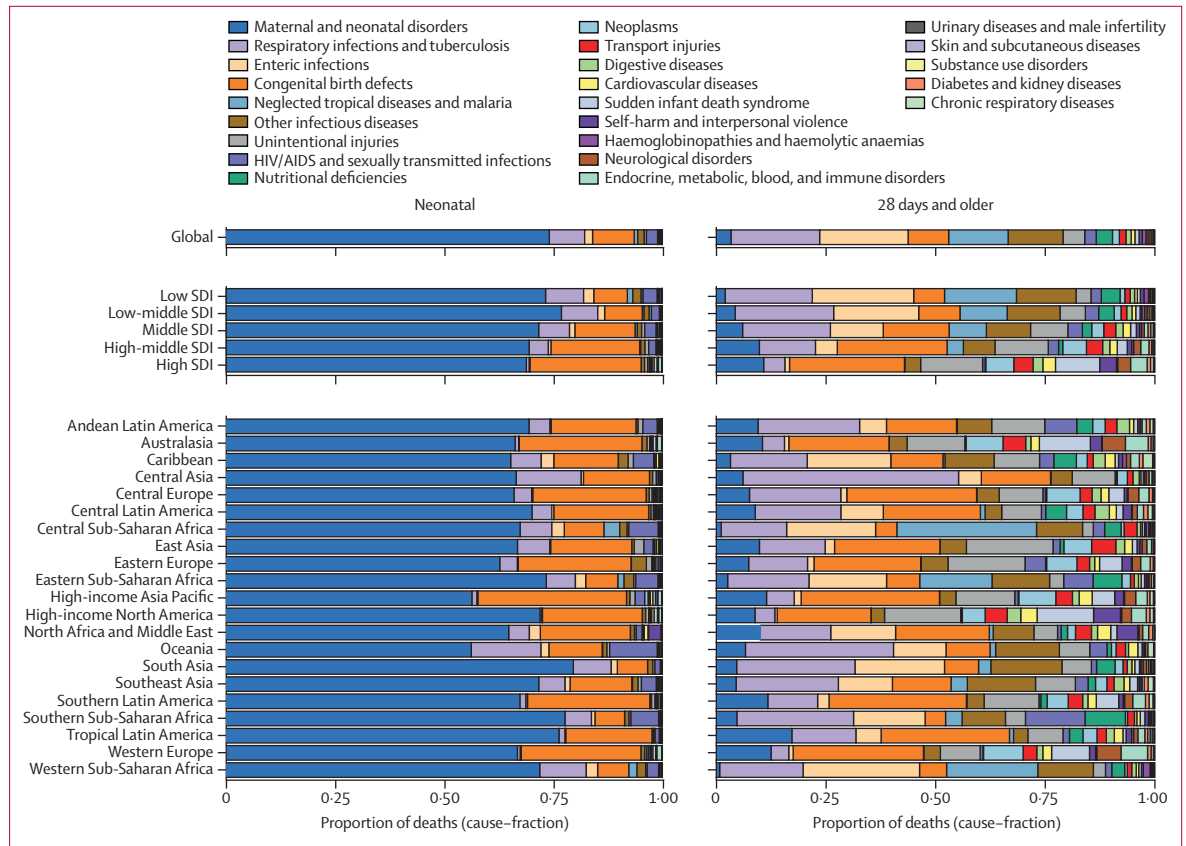


Figure 3: Neonatal and remaining under-5 cause-specific mortality, by region and SDI
 Values presented are cause fractions: the proportion of total age-specific deaths with a particular underlying cause of death. Causes are presented at Level 2 in the hierarchy, with other non-communicable diseases disaggregated to include congenital birth defects, sudden infant death syndrome, haemoglobinopathies and haemolytic anaemias, endocrine, metabolic, blood, and immune disorders, and urinary diseases and male infertility separately. Total under-5 mortality is split at 28 days to include neonatal (<28 days) separately from children between 28 days and 5 years of age. SDI=Socio-demographic Index.

Levels and trends in cause-specific mortality

The leading level 3 causes of global under-5 mortality in 2019 were neonatal disorders, which accounted for 37.3% (95% UI 35.6–38.8) of deaths in children younger than 5 years, followed by lower respiratory infections (13.3% [12.1–14.4]), diarrhoeal diseases (9.9% [8.3–11.6]), congenital birth defects (9.4% [8.0–11.8]), and malaria (7.1% [3.5–12.0]); figure 3; appendix p 100). Leading subcauses of neonatal disorders and congenital birth defects and leading global aetiologies of lower respiratory infections and diarrhoeal disease can be found in the appendix (pp 106, 121).

Of the 15 level 3 causes that accounted for more than 30000 global under-5 deaths in 2019, the greatest reduction in deaths between 2000 and 2015 was observed in measles, which saw a -9.2% (95% UI -10.4 to -8.0) mean annual percentage change (appendix p 129). Measles was followed by protein-energy malnutrition (-6.5% [-8.2 to -4.7]) and HIV/AIDS (-6.0% [-6.9 to -5.0]). Among these same 15 high-mortality causes, and for the period 2015–19, the three with the greatest reduction in deaths were measles

(-11.3% [95% UI -13.7 to -9.0]), HIV/AIDS (-10.2% [-12.3 to -7.8]), and tuberculosis (-7.8 [-9.9 to -5.6]).

In 2019, causes of death varied by age, sex, and SDI (figure 3; appendix p 100). The most common level 3 causes of death in children younger than 5 years were neonatal disorders, lower respiratory infections, and diarrhoeal diseases in the low SDI quintile, and neonatal disorders, congenital birth defects, and sudden infant death syndrome in the high SDI quintile (appendix p 100). The level 3 causes with the largest male-to-female ratio of mortality in the under-5 age group at the global level in 2019 were vascular intestinal disorders (5.99) and inguinal, femoral, and abdominal hernia (2.90), and those with the lowest ratio were gallbladder and biliary diseases (0.29) and pancreatitis (0.29; appendix p 100).

Scenarios for 2030 and beyond

In our reference scenario, by 2030, 154 (75%) of 204 countries are projected to have a U5MR lower than the SDG threshold of 25 under-5 deaths per 1000 livebirths, and 139 (68%) are expected to have an NMR lower than the SDG threshold of 12 neonatal deaths per 1000 livebirths (figure 2, appendix p 93). In the better-than-reference

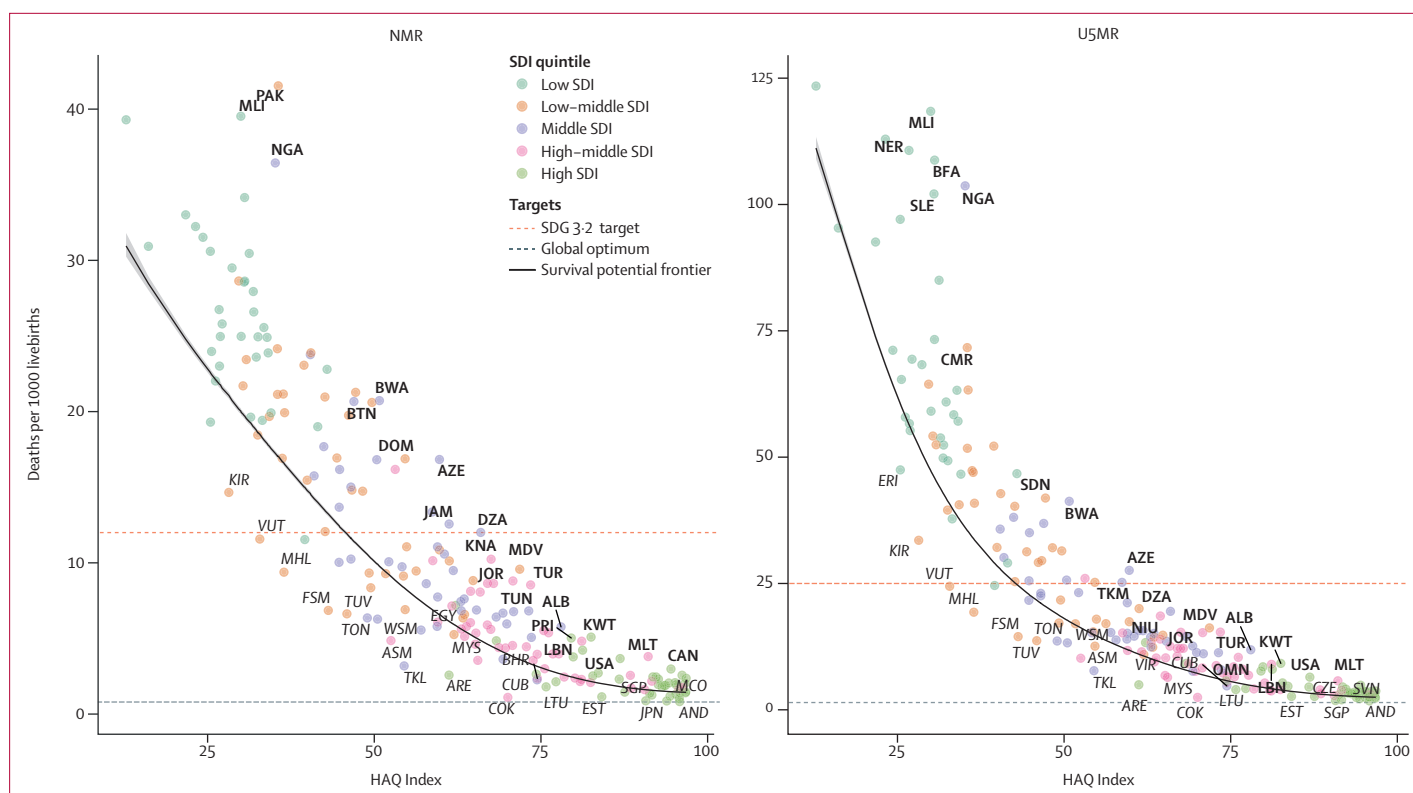


Figure 4: 2019 NMR and U5MR by HAQ Index at the national level

204 countries were analysed, and the colour of each point indicates the SDI quintile that the country belongs to. HAQ Index ranges from 0 (worst) to 100 (best). The survival potential frontier, global optimum, and SDG targets are indicated as lines on the graph. Grey shaded bands represent 95% UIs. Countries are labelled with their ISO3 country code in bold when their ratio to the survival potential frontier is in the highest 10% of all countries and in italics when their ratio to the survival potential frontier is in the lowest 10% of all countries. ISO3 codes and corresponding location names are listed in the appendix (p 11). NMR=neonatal mortality rate. HAQ=Healthcare Access and Quality. SDG=Sustainable Development Goal. SDI=Socio-demographic Index. U5MR=under-5 mortality rate. UI=uncertainty interval.

scenario, 164 (80%) countries would reach the SDG U5MR target, and 145 (71%) countries would reach the SDG NMR target (appendix p 93). In the neonatal scenario, 155 (76%) countries would meet the U5MR target, and in the child scenario, 158 (77%) countries would meet the U5MR target. In the counterfactual scenario without the COVID-19 pandemic, our results suggest 154 (75%) countries would have a U5MR below the SDG threshold and 140 (69%) countries would have an NMR below the SDG threshold by 2030.

Global optimum and survival potential frontier

There were an estimated 9.45 million (95% UI 8.86–10.05) under-5 deaths more than the global optimum in 2000 and 4.85 million (4.09–5.80) more than the global optimum in 2019 (appendix p 130). These deaths represent 98% of all 9.65 million under-5 deaths in 2000 and 96% of all 5.05 million under-5 deaths in 2019. In 2019, only 198 000 (95% UI 169 000–224 000) under-5 deaths worldwide were below the global optimum, and of these 108 000 (93 000–122 000; 55%) were neonatal deaths. Based on this analysis, and on current technology and health delivery systems, the global optimum NMR is 0.80 (95% UI 0.71–0.86) and

the global optimum U5MR is 1.44 (95% UI 1.27–1.58). Sex differences in mortality are similar below the global optimum as compared to overall mortality, with an NMR male-to-female ratio of 1.05 (95% UI 1.00–1.09) and a U5MR male-to-female ratio of 1.12 (95% UI 1.05–1.18).

16 causes of death have a global optimum of zero deaths and are therefore classified as 100% preventable by this framework. With the exceptions of exposure to forces of nature and conflict and terrorism, all of these preventable deaths are infectious conditions. If all countries reduced mortality to the global optimum, the leading level 3 global under-5 causes of death would be neonatal disorders; congenital birth defects; lower respiratory infections; sudden infant death syndrome; and endocrine, metabolic, blood, and immune disorders.

When looking at mortality along the spectrum of HAQ Index, our analysis suggests that in 2000, as many as 1.50 million (95% UI 1.31–1.72) neonatal deaths were above the survival potential frontier, accounting for 40% (95% UI 37–43) of 3.76 million neonatal deaths. In the same year, analysis suggests that 3.94 million (95% UI 3.49–4.40) under-5 deaths were above the survival potential frontier: 41% (95% UI 39–43) of 9.65 million under-5 deaths). In 2019, the number of deaths occurring

above the survival potential frontier was smaller, but the fraction of the overall mortality above the survival potential frontier remained similar: 0·88 million (95% UI 0·62–1·20; 36% [95% UI 30–42]) of 2·42 million neonatal deaths and 1·87 million (1·35–2·58; 37% [32–43]) of 5·05 million under-5 deaths (figure 4). If all 204 countries were to improve performance to meet the survival potential frontier without changing their HAQ Index level from 2019, 143 (70%) would have mortality below the NMR SDG threshold and 149 (73%) would have mortality below the U5MR SDG threshold, and 43 (70%) out of 61 countries not achieving both SDG targets would be from the sub-Saharan Africa super-region. The countries where U5MR lags the most relative to HAQ Index in 2019 are Nigeria, Turkey, Mali, and Maldives. The countries where NMR lags the most relative to HAQ Index in 2019 are Maldives, Turkey, and Azerbaijan. The countries with the most success at preventing under-5 mortality and neonatal mortality relative to their HAQ Index are Cook Islands, United Arab Emirates, and Tokelau (figure 4).

Global under-5 mortality above the survival potential frontier in 2019 consisted of 1·56 million (95% UI 1·11–2·17; 83%) deaths due to communicable, maternal, neonatal, and nutritional (CMNN) diseases, 0·23 million (0·15–0·33; 12%) deaths due to non-communicable diseases, and 0·08 million (0·06–0·11; 5%) deaths due to injuries (appendix p 130). If all regions had mortality rates at their survival potential frontier levels in 2019, the distribution of under-5 deaths would skew slightly towards non-communicable diseases but would not fundamentally change; 2·58 million (95% UI 2·35–2·81; 81%) deaths would be due to CMNN diseases, 0·46 million (0·40–0·52; 15%) deaths would be due to non-communicable diseases, and 0·13 million (0·11–0·15; 4%) deaths would be due to injuries (appendix p 130). Of the 48 level 3 causes that were accountable for more than 5000 global under-5 deaths in 2019, those with the lowest proportion of cause-specific deaths above the survival potential frontier were sudden infant death syndrome (27% [95% UI 15–43]) of SIDS deaths above the survival potential frontier, other malignant neoplasms (28% [21–36]), varicella and herpes zoster (29% [23–36]), and congenital birth defects (30% [23–37]; appendix p 94). Of the same 48 causes, those with the highest proportion of cause-specific deaths above the survival potential frontier were invasive non-typhoidal salmonella, other neglected tropical diseases, haemoglobinopathies and haemolytic anaemias, and malaria, all with over 50% above the survival potential frontier. The leading causes of death overall were also those with the highest above-survival potential frontier mortality rates, and the rank order would remain similar even if all regions had cause-specific mortality rates at their survival potential frontier levels in 2019: 33% of each of neonatal disorders and lower respiratory infections deaths were above the survival potential (neonatal disorders ranked first and lower respiratory

infections ranked second in both observed and expected), while 40% of diarrhoea deaths were above the frontier (ranked third in observed and fourth in expected; appendix p 94).

Discussion

Main findings

Declines of U5MR and NMR have continued to accelerate worldwide. Of 204 countries, our reference scenario suggests that, by 2030, 154 (75%) are likely to meet the U5MR SDG target and 139 (68%) the NMR SDG target. However, the concomitant findings of growing relative inequity and a large remaining proportion of preventable deaths shows there is much more work to be done. If every country were at the global optimum in 2019, global U5MR would have been 1·44 (95% UI 1·27–1·58) deaths per 1000 livebirths and NMR would have been 0·80 (95% UI 0·71–0·86) deaths per 1000 livebirths.

Thankfully, although children have been found to be at risk of developing multisystem inflammatory syndrome²⁵ as result of COVID-19, they appear to be less at risk of severe illness and death. It is important to reiterate, however, how the complex, multisector determinants of health that substantially affect child survival could be negatively affected by COVID-19, an understanding that is likely to continue to evolve in the coming months and years. Risks include,²⁶ but are not limited to, the potential disruption of routine perinatal and clinical care for children, worsened in-facility outcomes due to overburdened medical systems, loss of caretakers from the pandemic impacting child health and wellbeing, suspended vaccination campaigns, financial and economic pressures leading to food insecurity and malnutrition, disruption of supply chains leading to decreased availability of highly active antiretroviral therapy medications for HIV/AIDS, interrupted prevention of mother-to-child transmission programmes, decreased malaria prevention and treatment, and disruption of domestic economies and education systems. Mitigating these risks will require even more focus and attention on an equilibrium strategy for neonatal and child health.

Our analysis suggests the need for a five-pronged strategy to optimise child survival in the SDG era that augments community-based strategies and efforts to address social determinants of health (eg, education, family planning, financial security) that proved effective during the MDG era. The central theme is that, to achieve SDG targets by 2030, investments should strive for equilibrium and overall system strengthening, with a particular focus on inequality, rather than simply shifting attention to individual priorities.

Comprehensive neonatal care

Neonatal deaths comprise an increasing share of global under-5 deaths, indicating a generalised need to improve

neonatal programmes along the entire SDI spectrum. Although not explicitly stated in SDG targets or in our analysis, reductions in stillbirths should also be targeted through comprehensive maternal and neonatal care. Reducing early neonatal mortality, and stillbirth mortality, should start with expansion of community and facility-based strategies targeted towards pregnancy, labour, delivery, and the postnatal period.²⁷ Nepal is an example of a country that explicitly prioritised the neonatal period and integrated community and facility-based approaches, leading to accelerated improvements in neonatal and under-5 mortality.²⁸ The first step is encouraging and supporting facility-based delivery by skilled providers with the training and resources available to perform resuscitative efforts for women and neonates when needed.⁵ Basic activities include skin-to-skin contact, timely breathing assistance for intrapartum asphyxia, chlorhexidine umbilical cord cleansing for sepsis prevention, and early screening for congenital birth defects.⁵ Improvements also need to be made to neonatal care after delivery. Advancements are needed for in-hospital activities such as intensive care for prematurity, advanced resuscitation for intrapartum asphyxia, full support for sepsis beyond antibiotics, breastfeeding education and support, and surgical care for neonatal emergencies and birth defects that have been shown to be associated with improved neonatal survival.^{27,29,30} Postnatal check-ups are also required for prompt diagnosis and treatment of new illnesses that can be life-threatening in young neonates. Crosscutting, longitudinal neonatal care is not possible without augmenting hospital infrastructure, supply chains, and qualified health-care workers, and must be accounted for in national health plans.⁵

Optimising health systems to scale up interventions

Providing technology and supplies alone, without coordinated investment in the strengthening of health systems, will be insufficient for achieving the SDG targets. Moving beyond survival is the cornerstone of the SDGs, which requires enabling environments, as outlined in the UN Global Strategy for Women's, Children's and Adolescents' Health 2016–30 agenda.⁴ Per our analysis, more than 90% of countries have the potential to achieve the SDG targets by optimising their current health systems. Efforts to counter shortages and retain skilled health-care workers, reinforce facility infrastructure and supplies including oxygen,³¹ develop and strengthen referral networks, and expand integrated services⁷ are needed to achieve access and quality of care for improving survival rates for children younger than 5 years, particularly around the time of birth.^{27,29} Liberia is an example of a country that has made important progress in health system strengthening. Despite the odds of civil war and the Ebola virus epidemic, Liberia heavily invested in paying and supervising community health workers, providing medical supply chains to

remote areas, and creating a health information system, leading to better survival.³²

Continued investment and scale-up of community-based initiatives

Community-based strategies such as primary health-care promotion and integrated management of childhood illness³³ are an important pillar of prevention. Successful community activities include vaccination campaigns, insecticide-treated bednets for malaria, and mother-to-child HIV/AIDS transmission prevention.³⁴ Further efforts are required, however, to increase uptake and coverage of additional community-based activities such as ensuring optimal maternal nutrition and iron and folic acid supplementation³⁵ (to target low birthweight and neural tube defects), reducing household air pollution and second-hand smoke, *Haemophilus influenzae* type B and pneumococcal vaccination, and access to antibiotics³⁶ for lower respiratory infections. Similarly, treatment campaigns for diarrhoea such as oral rehydration solution, zinc, and rotavirus vaccines have been successful, but must be accompanied by reductions in malnutrition and improvements in clean water and sanitation to achieve more than 90% reduction in rates of diarrhoea from the 2015 levels.³⁷

Targeting inequity across and within countries

Relative inequity has grown over the 29 years since the first GBD study, with the 51 countries in the Countdown to 2030 initiative in sub-Saharan Africa and south Asia now accounting for 80% of all child mortality and facing stark within-country disparities.^{6,38} Within-country disparities exist throughout the SDI spectrum and are related to race and ethnicity, urban-rural geography, mother's education, and income.³⁴ Global and national achievement of SDG 3.2 will hinge on our collective ability to target inequality both across and within countries.

Progress for the countries in the Countdown to 2030 programme is monitored by key intervention coverage milestones,⁶ but must be met with national ownership and effective international investment. On an international level, the World Bank's Global Financing Facility is an example of a performance-based, country-led mechanism to strengthen health systems and multi-sectoral approaches,⁶ but the promise of this programme has not reached countries like Central African Republic and Chad, which are not only the furthest from achieving the SDG targets with lowest key intervention coverage, but are also cited as receiving the least development assistance funding.³⁹ These countries contrast with countries like Rwanda and Bangladesh. In Rwanda, a revised national health policy successfully aligned international donors to nationally driven goals of comprehensive child health care and health system strengthening, and were associated with a dramatic reduction in under-5 mortality.³² In Bangladesh, the

government partnered with domestic and international non-governmental organisations to target areas of the country most in need with delivering known interventions, performing local effectiveness research, and prioritising women's empowerment.²⁸

Peru and Brazil are examples of middle and high-middle SDI countries that have targeted inequity internally. Peru substantially reduced under-5 mortality by adopting the 2002 Acuerdo Nacional,²⁸ a national health policy targeting extreme poverty that deployed health workers to impoverished communities, completed community-based intervention research to increase perinatal care coverage, and codified collective responsibility for improving health outcomes. Brazil sanctioned governmental conditional cash transfers targeting prenatal care, immunisation, child health check-ups, and nutritional education.²⁸ Although the specific solutions for targeting inequity and marginalised populations vary, the essential component is that the efforts to increase equity must be explicit, sustained, and universal because it is present throughout the world.

Prioritising research into specific causes of child mortality

Many of the leading causes of death are also the source of the most mortality above both the global optimum and the survival potential frontier, include neonatal disorders, congenital birth defects, sudden infant death syndrome, many childhood cancers, and important infections like lower respiratory infections, diarrhoea, and meningitis. These causes are prime targets for additional dedicated primary research on disease mechanisms for effective prevention, detection, and treatment. Sudden infant death syndrome is particularly notable as only 27% of the mortality burden is above the survival potential frontier, it is the top cause of death in older infants and children in the high SDI quintile, and comparatively little is known about its pathophysiology.

This entire analysis draws on the overall strength and rigour of GBD 2019, the only comprehensive analysis of fertility, population, mortality, and outcomes for specific diseases and injuries that currently exists. The UN Inter-agency Group for Child Mortality Estimation last published estimates for 2017¹¹ but has not reported on causes of mortality since 2015,^{12,40} at which time there was broad agreement in the top causes of death globally, but some important differences existed in cause categories that limited our ability to make direct comparisons.

Measuring preventable death with the intersection of HAQ Index and SDG targets has not been explored in previous literature and necessarily extends beyond the scope of the OECD and Eurostat taskforce that only focuses on adult health outcomes.¹⁶ This method is more holistic than previous avertable mortality frameworks such as the Countdown to 2030 report that analysed only a composite coverage index of specific interventions, but did not measure the health system

performance as a whole.⁶ Uses of our preventable mortality analyses include being able to identify the causes with the most potential for improvement (largest proportion above the global optimum or stochastic frontier analysis), the regions with potential imbalances in health priorities (largest ratio above frontier or discrepancies in ratio between neonates and children aged 1–59 months), causes where there are needs for better distributional allocation of resources, expertise, or delivery (those where the frontier is largely flat until decreasing sharply in high HAQ Index settings), and the causes where there is the greatest need for basic research into prevention and treatment (largest proportion below the global optimum). This preventable death framework thus introduces a novel, useful, and potentially powerful tool for developing comprehensive, evidence-based strategies for advancing child survival on multiple fronts.

Limitations

This analysis has several limitations. First, it shares the limitations of the overall GBD analysis,^{20,24} including it being a descriptive study; limitations on data availability because of reporting lags or because of disruptions in settings with conflict, natural disasters, or domestic governance crises; variable data granularity with respect to age, sex, and cause detail; varying quality and completeness of mortality reporting systems; and the core GBD assumption of each death having only a single underlying cause, where, clinically, there is close inter-relatedness of many causes, especially in the very young. Second, our future health scenario analyses are benchmarked against past trends and are ecological in nature. This limits the ability of the analysis to be used for causal inference, and also means it is limited in its ability to capture disruptions that could arise as a consequence of future crises, such as the COVID-19 pandemic. Third, although our framework for preventable mortality is conceptually simple, reproducible, and a powerful tool for tracking context-specific progress, it is also limited by its inherently retrospective nature, its inability to parse competing risks or factors that might influence geographical variability, and that it does not make special consideration for causes like vaccine-preventable diseases that some experts contend are entirely preventable. Finally, the definition of livebirth has varied in countries and over time. Although our study has utilised a large amount of empirical data on death in the under-5 age groups, directly or indirectly measured, such information is based on potentially different definitions of livebirths, thus affecting the accuracy of our results. Although we do account for source specific biases, difference in definitions of livebirths as one of them, in our U5MR estimation process, future model development should be done to explicitly account for the effect of definition of livebirths on the accurate estimation of mortality in the under-5 age groups.

Future directions

Future work is required to measure and understand the direct (severe illness and death) and indirect (determinants of health) effects of COVID-19 on child mortality. First, this work will include collecting data on disruptions in basic childhood health services (eg, vaccines, integrated management of childhood illness, well-child visits), nutritional status (eg, food supply and distribution), perinatal health (eg, maternal and neonatal care), and socioeconomic indicators such as fertility, education, and household income. A second direction is to work towards an integrated framework for women's, maternal, and child health because of the inherent links between the health of mothers and their children. Third, integrating information from prevention and intervention trials into developing future health scenarios is a priority in order to provide information to motivated policy makers as to what their most effective options might be. Fourth, following the momentum of the Institute for Health Metrics and Evaluation's Local Burden of Disease project, developing increasing local estimates of cause-specific and age-specific disease burden is crucial to guide local efforts at improving survival, and assess within-country disparities further.

Achieving SDG 3.2 will require focus on equilibrium, which will involve balancing early newborn care with continuing prenatal and older child health initiatives, strengthening quality health systems, scaling up interventions, addressing within-country disparities, and pursuing integrative action on social determinants of health. All these steps forward promote the SDG agenda of moving beyond mere survival, for the wellbeing of young children worldwide.

Contributors

Katherine R Paulson, Tahiya Alam, Kelly Bienhoff, Molly R Nixon, Simon I Hay, Christopher J L Murray, Haidong Wang, and Nicholas J Kassebaum managed the estimation or publication process. Katherine R Paulson, Aruna M Kamath, and Nicholas J Kassebaum wrote the first draft of the manuscript. Katherine R Paulson, Tahiya Alam, Kelly Bienhoff, Haidong Wang, and Nicholas J Kassebaum had primary responsibility for applying analytical methods to produce estimates. Katherine R Paulson, Aruna M Kamath, Haidong Wang, and Nicholas J Kassebaum had primary responsibility for seeking, cataloguing, extracting, or cleaning data, and designing or coding figures and tables. Please see the appendix (p 71) for individual authors' contributions to the research. All authors had full access to all data in the study and had final responsibility for the decision to submit for publication.

GBD 2019 Under-5 Mortality Collaborators

Katherine R Paulson, Aruna M Kamath, Tahiya Alam, Kelly Bienhoff, Gdiom Gebreheat Abady, Jaffar Abbas, Mohsen Abbasi-Kangevari, Hedayat Abbastabar, Foad Abd-Allah, Sherief M Abd-Elsalam, Amir Abdoli, Aidin Abedi, Hassan Abolhassani, Lucas Guimarães Abreu, Eman Abu-Gharbieh, Niveen M E Abu-Rmeileh, Abdelrahman I Abushouk, Aishatu L Adamu, Oladimeji M Adebayo, Adeyinka Emmanuel Adegbosin, Victor Adekanmbi, Olatunji O Adetokunboh, Daniel Adedayo Adeyinka, Jose C Adsuar, Khashayar Afshari, Mohammad Aghaali, Marcela Agudelo-Botero, Bright Opoku Ahinkorah, Tauseef Ahmad, Keivan Ahmadi, Muktar Beshir Ahmed, Budi Aji, Yonas Akalu, Oluwaseun Oladapo Akinyemi, Addis Aklilu, Ziyad Al-Aly, Khurshid Alam, Fahad Mashhour Alanezi, Turki M Alanzi,

Jacqueline Elizabeth Alcalde-Rabanal, Ayman Al-Eyadhy, Tilahun Ali, Gianfranco Alicandro, Sheikh Mohammad Alif, Vahid Alipour, Hesam Alizade, Syed Mohamed Aljunid, Amir Almasi-Hashiani, Nihad A Almasri, Hesham M Al-Mekhlafi, Jordi Alonso, Rajaa M Al-Raddadi, Khalid A Altirkawi, Arwa Khalid Alumran, Nelson Alvis-Guzman, Nelson J Alvis-Zakzuk, Edward Kwabena Ameyaw, Saeed Amini, Mostafa Amini-Rarani, Arianna Maever L Amit, Dickson A Amugsi, Robert Ancuceanu, Deanna Anderlini, Catalina Liliana Andrei, Fereshteh Ansari, Alireza Ansari-Moghaddam, Carl Abelardo T Antonio, Ernoiz Antriyandarti, Davood Anvari, Raziq Anwer, Muhammad Aqeel, Jalal Arabloo, Morteza Arab-Zozani, Timur Aripov, Johan Årnlöv, Kurnia Dwi Artanti, Afsaneh Arzani, Malke Asaad, Mehran Asadi-Aliabadi, Ali A Asadi-Pooya, Mohammad Asghari Jafarabadi, Seyyed Shamsadin Athari, Seyyede Masoume Athari, Desta Debalkie Atnafu, Alok Atreya, Madhu Sudhan Atteraya, Marcel Ausloos, Asma Tahir Awan, Beatriz Paulina Ayala Quintanilla, Getinet Ayano, Martin Amogre Ayanore, Yared Asmare Aynalem, Samad Azari, Ghasem Azarian, Zelalem Nigussie Azene, Darshan B B, Ebrahim Babae, Ashish D Badiye, Atif Amin Baig, Maciej Banach, Palash Chandra Banik, Suzanne Lyn Barker-Collo, Hiba Jawdat Barqawi, Quique Bassat, Sanjay Basu, Bernhard T Baune, Mohsen Bayati, Neeraj Bedi, Ettore Beghi, Massimiliano Beghi, Michelle L Bell, Salaheddine Bendak, Derrick A Bennett, Isabela M Bensenor, Kidanemariam Berhe, Adam E Berman, Yihienew Mequanint Bezabih, Akshaya Srikanth Bhagavathula, Dinesh Bhandari, Nikha Bhardwaj, Pankaj Bhardwaj, Kritika Bhattacharyya, Suraj Bhattarai, Zulfiqar A Bhutta, Boris Bikbov, Antonio Biondi, Binyam Minuye Birihane, Raaj Kishore Biswas, Somayeh Bohlouli, Nicola Luigi Bragazzi, Alexey V Breusov, Andre R Brunoni, Katrin Burkart, Sharath Burugina Nagaraja, Reinhard Busse, Zahid A Butt, Florentino Luciano Caetano dos Santos, Lucero Cahuana-Hurtado, Paulo Camargos, Luis Alberto Cámera, Rosario Cárdenas, Giulia Carreras, Juan J Carrero, Felix Carvalho, Joao Mauricio Castaldelli-Maia, Carlos A Castañeda-Orjuela, Giulio Castelpietra, Ester Cerin, Jung-Chen Chang, Wagaye Fentahun Chanie, Jaykaran Charan, Souranshu Chatterjee, Soosanna Kumary Chattu, Vijay Kumar Chattu, Sarika Chaturvedi, Simiao Chen, Daniel Youngwhan Cho, Jee-Young Jasmine Choi, Dinh-Toi Chu, Liliana G Ciobanu, Massimo Cirillo, Joao Conde, Vera Marisa Costa, Rosa A S Couto, Berihun Assefa Dachew, Saad M A Dahlawi, Hancheng Dai, Xiaochen Dai, Lalit Dandona, Rakhi Dandona, Parnaz Daneshpajouhnejad, Gary L Darmstadt, Jai K Das, Claudio Alberto Dávila-Cervantes, Adrian C Davis, Kairat Davletov, Fernando Pio De la Hoz, Diego De Leo, Farah Deeba, Edgar Denova-Gutiérrez, Nikolaos Dervenis, Assefa Desalew, Keshab Deuba, Sagnik Dey, Samath Dhamminda Dharmaratne, Sameer Dhingra, Govinda Prasad Dhungana, Diana Dias da Silva, Daniel Diaz, Fariba Dorostkar, Leila Doshmangir, Eleonora Dublinjan, Andre Rodrigues Duraes, Arielle Wilder Eagan, Hisham Atan Edinur, Ferry Efendi, Sahar Eftekharzadeh, Iman El Sayed, Maha El Tantawi, Iffat Elbarazi, Islam Y Elgandy, Shaimaa I El-Jaafary, Amir Emami, Shymaa Enany, Oghenowede Eyawo, Sayeh Ezzikouri, Pawan Sirwan Faris, Farshad Farzadfar, Nazir Fattahi, Nelsensius Klau Fauk, Mehdi Fazlzadeh, Valery L Feigin, Tomas Y Ferede, Seyed-Mohammad Fereshtehnejad, Eduarda Fernandes, Pietro Ferrara, Irina Filip, Florian Fischer, James L Fisher, Nataliya A Foigt, Morenike Oluwatoyin Folayan, Masoud Foroutan, Richard Charles Franklin, Marisa Freitas, Sara D Friedman, Takeshi Fukumoto, Mohamed M Gad, Abhay Motiramji Gaidhane, Shilpa Gaidhane, Santosh Gaihre, Silvano Gallus, Alberto L Garcia-Basteiro, MA Garcia-Gordillo, William M Gardner, Mariana Gaspar Fonseca, Ketema Bizuwork Gebremedhin, Lemma Getacher, Ahmad Ghashghaee, Asadollah Gholamian, Syed Amir Gilani, Tiffany K Gill, Giorgia Giussani, Elena V Gnedovskaya, Myron Anthony Godinho, Amit Goel, Mahaveer Golechha, Philimon N Gona, Sameer Vali Gopalani, Houman Goudarzi, Michal Grivna, Harish Chander Gugnani, Davide Guido, Rafael Alves Guimarães, Rajat Das Gupta, Rajeew Gupta, Nima Hafezi-Nejad,

- Mohammad Rifat Haider, Arvin Haj-Mirzaian, Samer Hamidi, Asif Hanif, Graeme J Hankey, Arief Hargono, Ahmed I Hasaballah, Md Mehedi Hasan, Syed Shahzad Hasan, Amr Hassan, Soheil Hassanipour, Hadi Hassankhani, Rasmus J Havmoeller, Khezra Hayat, Reza Heidari-Soureshjani, Nathaniel J Henry, Claudiu Herteliu, Michael K Hole, Ramesh Holla, Naznin Hossain, Mostafa Hosseini, Mehdi Hosseinzadeh, Mihaela Hostiuc, Sorin Hostiuc, Mowafa Househ, Junjie Huang, Ayesha Humayun, Bing-Fang Hwang, Ivo Iavicoli, Segun Emmanuel Ibitoye, Kevin S Ikuta, Olayinka Stephen Ilesanmi, Irena M Ilic, Milena D Ilic, Sumant Inamdar, Leeberk Raja Inbaraj, Khalid Iqbal, Usman Iqbal, M Mofizul Islam, Sheikh Mohammed Shariful Islam, Hiroyasu Iso, Masao Iwagami, Chidozie C D Iwu, Jalil Jaafari, Kathryn H Jacobsen, Jagnoor Jagnoor, Vardhmaan Jain, Manthan Dilipkumar Janodia, Tahereh Javaheri, Fatemeh Javanmardi, Shubha Jayaram, Achala Upendra Jayatilke, Ensiyeh Jenabi, Ravi Prakash Jha, John S Ji, Oommen John, Jost B Jonas, Tamas Joo, Nitin Joseph, Farahnaz Joukar, Jacek Jerzy Jozwiak, Mikko Jürisson, Ali Kabir, Zubair Kabir, Leila R Kalankesh, Naser Kamyari, Tanuj Kanchan, Neeti Kapoor, Behzad Karami Matin, André Karch, Salah Eddin Karimi, Getinet Kassahun, Gbenga A Kayode, Ali Kazemi Karyani, Laura Kemmer, Nauman Khalid, Rovshan Khalilov, Mohammad Khammarnia, Ejaz Ahmad Khan, Gulfaraz Khan, Maseer Khan, Md Nuruzzaman Khan, Young-Ho Khang, Khaled Khataf, Amir M Khater, Mona M Khater, Maryam Khayamzadeh, Ardeshir Khosravi, Daniel Kim, Young-Eun Kim, Yun Jin Kim, Ruth W Kimokoti, Adnan Kisa, Sezer Kisa, Niranjan Kissoon, Jacek A Kopec, Soewarta Kosen, Parvaiz A Koul, Sindhura Lakshmi Koulmane Laxminarayana, Ai Koyanagi, Kewal Krishan, Vijay Krishnamoorthy, Barthelemy Kuate Defo, Burcu Kucuk Bicer, Vaman Kulkarni, G Anil Kumar, Manasi Kumar, Nithin Kumar, Om P Kurmi, Dian Kusuma, Carlo La Vecchia, Ben Lacey, Ratilal Lalloo, Faris Hasan Lami, Iván Landires, Anders O Larsson, Savita Lasrado, Zohra S Lassi, Paolo Lauriola, Paul H Lee, Shaun Wen Huey Lee, Yo Han Lee, James Leigh, Matilde Leonardi, Sonia Lewycka, Bingyu Li, Shanshan Li, Juan Liang, Lee-Ling Lim, Miteku Andualem Limenih, Ro-Ting Lin, Xuefeng Liu, Rakesh Lodha, Alan D Lopez, Rafael Lozano, Alessandra Lugo, Raimundas Lunevicius, Mark T Mackay, Shilpashree Madhava Kunjathur, Francesca Giulia Magnani, D R Mahadeshwara Prasad, Mina Maheri, Morteza Mahmoudi, Azeem Majeed, Venkatesh Maled, Afshin Maleki, Shokofeh Maleki, Reza Malekzadeh, Ahmad Azam Malik, Deborah Carvalho Malta, Abdullah A Mamun, Borhan Mansouri, Mohammad Ali Mansournia, Gabriel Martinez, Santi Martini, Francisco Rogerlândio Martins-Melo, Seyedeh Zahra Masoumi, Pallab K Maulik, Colm McAlinden, John J McGrath, Carlo Eduardo Medina-Solis, Entezar Mehrabi Nasab, Fabiola Mejia-Rodriguez, Ziad A Memish, Walter Mendoza, Ritesh G Menezes, Endalkachew Worku Mengesha, George A Mensah, Atte Meretoja, Tuomo J Meretoja, Abera M Mersha, Tomislav Mestrovic, Bartosz Miazgowski, Tomasz Miazgowski, Irmira Maria Michalek, Ted R Miller, GK Mini, Mohammad Miri, Andreea Mirica, Erkin M Mirrakhimov, Hamed Mirzaei, Maryam Mirzaei, Babak Moazen, Masoud Moghadaszadeh, Bahram Mohajer, Osama Mohamad, Yousef Mohammad, Seyyede Momeneh Mohammadi, Abdollah Mohammadian-Hafshejani, Shafiu Mohammed, Ali H Mokdad, Mariam Molokhia, Lorenzo Monasta, Stefania Mondello, Mohammad Ali Moni, Catrin E Moore, Ghabad Moradi, Masoud Moradi, Rahmatollah Moradzadeh, Paula Moraga, Lidia Morawska, Shane Douglas Morrison, Jonathan F Mosser, Amin Mousavi Khaneghah, Ghulam Mustafa, Mehdi Naderi, Ahamarshan Jayaraman Nagarajan, Shankar Prasad Nagaraju, Mohsen Naghavi, Behshad Naghshtabrizi, Mukhammad David Naimzada, Vinay Nangia, Sreenivas Narasimha Swamy, Bruno Ramos Nascimento, Muhammad Naveed, Javad Nazari, Rawlance Ndejo, Ionut Negoii, Ruxandra Irina Negoii, Evangelia Nena, Samata Nepal, Henok Biresaw Netsere, Georges Nguefack-Tsague, Josephine W Ngunjiri, Chi Thi Yen Nguyen, Cuong Tat Nguyen, Huong Lan Thi Nguyen, Yeshambel T Nigatu, Samuel Negash Nigussie, Molly R Nixon, Chukwudi A Nnaji, Shuhei Nomura, Nurulamin M Noor, Jean Jacques Noubiap, Virginia Nuñez-Samudio, Vincent Ebuka Nwatah, Bogdan Oancea, Oluwakemi Ololade Odukoya, Felix Akpojene Ogbo, Bolajoko Olubukunola Olusanya, Jacob Olusegun Olusanya, Ahmed Omar Bali, Obinna E Onwujekwe, Alberto Ortiz, Adrian Otoiu, Nikita Otstavnov, Stanislav S Otstavnov, Mayowa O Owolabi, Mahesh P A, Jagadish Rao Padubidri, Smita Pakhale, Keyvan Pakshir, Pramod Kumar Pal, Raffaele Palladino, Adrian Pana, Songhomitra Panda-Jonas, Anamika Pandey, Ashok Pandey, Seithikurippu R Pandi-Perumal, Helena Ullayrtha Pangaribuan, Ana Melisa Pardo-Montaño, Eun-Kee Park, Sangram Kishor Patel, George C Patton, Shrikant Pawar, Hamidreza Pazoki Toroudi, Amy E Peden, Veincent Christian Filipino Pepito, Emmanuel K Peprah, Jeevan Pereira, Jorge Pérez-Gómez, Norberto Perico, Konrad Pesudovs, Thomas Pilgrim, Marina Pinheiro, Michael A Piradov, Meghdad Pirsaeed, James A Platts-Mills, Khem Narayan Pokhrel, Maarten J Postma, Hadi Pourjafar, Sergio I Prada, Sanjay Prakash, Elisabetta Pupillo, Zahiruddin Quazi Syed, Navid Rabiee, Amir Radfar, Ata Rafiee, Alireza Rafiei, Alberto Raggi, Shadi Rahimzadeh, Mohammad Hifz Ur Rahman, Amir Masoud Rahmani, Kiana Ramezanzadeh, Juwel Rana, Chhabi Lal Ranabhat, Sowmya J Rao, Davide Rasella, Prateek Rastogi, Priya Rathi, David Laith Rawaf, Salman Rawaf, Wasiq Faraz Rawasia, Reza Rawassizadeh, Robert C Reiner Jr, Giuseppe Remuzzi, Andre M N Renzaho, Bhageerathy Reshmi, Serge Resnikoff, Negar Rezaei, Nima Rezaei, Aziz Rezapour, Seyed Mohammad Riahi, Daniela Ribeiro, Jennifer Rickard, Leonardo Roeber, Luca Ronfani, Dietrich Rothenbacher, Enrico Rubagotti, Susan Fred Rumisha, Paul MacDaragh Ryan, Basema Saddik, Ehsan Sadeghi, Sahar Saeedi Moghaddam, Rajesh Sagar, Amirhossein Sahebkar, Mohammad Reza Salahshoor, Sana Salehi, Marwa Rashad Salem, Hamideh Salimzadeh, Joshua A Salomon, Yoseph Leonardo Samodra, Abdallah M Samy, Juan Sanabria, Milena M Santric-Milicevic, Sivan Yegnanarayana Iyer Saraswathy, Abdur Razzaque Sarker, Nizal Sarrafzadegan, Arash Sarveazad, Brijesh Sathian, Thirunavukkarasu Sathish, Davide Sattin, Sonia Saxena, Ganesh Kumar Saya, Mete Saylan, Silvia Schiavolin, Markus P Schlaich, David C Schwebel, Falk Schwendicke, Subramanian Senthilkumaran, Sadaf G Sepanlou, Edson Serván-Mori, Feng Sha, Omid Shafaat, Saeed Shahabi, Mohammad Shahbaz, Amira A Shaheen, Izza Shahid, Masood Ali Shaikh, Saeed Shakiba, Ali S Shalash, Mehran Shams-Beyranvand, Mohammed Shannawaz, Kiomars Sharafi, Aziz Sheikh, Sara Sheikhbahaei, Wondimeneh Shibabaw Shiferaw, Mika Shigematsu, Jae Il Shin, Rahman Shiri, Ivy Shiue, Kerem Shuval, Tariq Jamal Siddiqi, Negussie Boti Sidemo, Inga Dora Sigfusdottir, Rannveig Sigurvinsdottir, João Pedro Silva, Jonathan I S Silverberg, Biagio Simonetti, Balbir Bagicha Singh, Jasvinder A Singh, Deepika Singhal, Dhirendra Narain Sinha, Eirini Skiadaraesi, Valentin Yurievich Skryabin, Anna Aleksandrovna Skryabina, David A Sleet, Badr Hasan Sobaih, Mohammad Reza Sobhyieh, Shahin Soltani, Joan B Soriano, Emma Elizabeth Spurlock, Chandrashekhar T Sreeramareddy, Paschalis Steiropoulos, Mark A Stokes, Stefan Stortecy, Mu'awiyah Babale Sufiyan, Rizwan Suliankatchi Abdulkader, Gerhard Sulo, Carolyn B Swope, Bryan L Sykes, Mindy D Szeto, Miklós Szócska, Rafael Tabarés-Seisdedos, Eyayou Girma Tadesse, Amir Taherkhani, Animut Tägele Tamiru, Md Ismail Tareque, Arash Tehrani-Banihashemi, Mohamad-Hani Tamsah, Fisaha Haile Tesfay, Gizachew Assefa Tessema, Zemeni Tadesse Tessema, Kavumpurathu Raman Thankappan, Rekha Thapar, Musliu Adetola Tolani, Marcos Roberto Tovani-Palone, Eugenio Traini, Bach Xuan Tran, Jaya Prasad Tripathy, Giorgos Tsapparellas, Aristidis Tsatsakis, Lorraine Tudor Car, Riaz Uddin, Anayat Ullah, Chukwuma David Umeokonkwo, Brigid Unim, Bhaskaran Unnikrishnan, Era Upadhyay, Muhammad Shariq Usman, Marco Vacante, Maryam Vaezi, Sahel Valadan Tahbaz, Pascual R Valdez, Tommi Juhani Vasankari, Narayanaswamy Venketasubramanian, Madhur Verma, Francesco S Violante, Vasily Vlassov, Bay Vo, Giang Thu Vu, Yohannes Dibaba Wado, Yasir Waheed, Richard G Wamai, Yanping Wang, Yanzhong Wang, Yuan-Pang Wang, Paul Ward, Andrea Werdecker, Ronny Westerman, Nuwan Darshana Wickramasinghe, Lauren B Wilner,

Charles Shey Wiysonge, Ai-Min Wu, Chenkai Wu, Yang Xie, Seyed Hossein Yahyazadeh Jabbari, Kazumasa Yamagishi, Srikanth Yandrapalli, Sanni Yaya, Vahid Yazdi-Feyzabadi, Paul Yip, Naohiro Yonemoto, Seok-Jun Yoon, Mustafa Z Younis, Zabihollah Yousefi, Taraneh Yousefinezehadi, Chuanhua Yu, Sifat Shahana Yusuf, Syed Saoud Zaidi, Sojib Bin Zaman, Mohammad Zamani, Maryam Zamanian, Mikhail Sergeevich Zastrozhin, Anastasia Zastrozhina, Yunquan Zhang, Zhi-Jiang Zhang, Xiu-Ju George Zhao, Arash Ziapour, Simon I Hay, Christopher J L Murray, Haidong Wang, and Nicholas J Kassebaum.

Affiliations

Institute for Health Metrics and Evaluation (K R Paulson MPH, T Alam MPH, K Bienhoff MA, K Burkart PhD, X Dai PhD, Prof L Dandona MD, Prof R Dandona PhD, Prof S D Dharmaratne MD, Prof V L Feigin PhD, W M Gardner AB, K S Ikuta MD, L Kemmer PhD, Prof A D Lopez PhD, Prof R Lozano MD, Prof A H Mokdad PhD, J F Mosser MD, Prof M Naghavi MD, M R Nixon PhD, R C Reiner Jr PhD, E E Spurlock BA, L B Wilner MPH, Prof S I Hay FMedSci, Prof C J L Murray DPhil, H Wang PhD, N J Kassebaum MD), Department of Anesthesiology & Pain Medicine (A M Kamath MD, V Krishnamoorthy MD, N J Kassebaum MD), Department of Health Metrics Sciences, School of Medicine (K Burkart PhD, Prof R Dandona PhD, Prof S D Dharmaratne MD, Prof A D Lopez PhD, Prof R Lozano MD, Prof A H Mokdad PhD, Prof M Naghavi MD, R C Reiner Jr PhD, Prof S I Hay FMedSci, Prof C J L Murray DPhil, H Wang PhD, N J Kassebaum MD), Division of Plastic Surgery (D Y Cho MD), Division of Allergy and Infectious Diseases (K S Ikuta MD), University of Washington, Seattle, WA, USA; Department of Nursing (G G Abady MSc), Adigrat University, Adigrat, Ethiopia; Antai College of Economics (J Abbas PhD), Shanghai Jiao Tong University, Shanghai, China; Social Determinants of Health Research Center (M Abbasi-Kangevari MD), Obesity Research Center (A Haj-Mirzaian MD), Department of Pharmacology (K Ramezanzadeh PharmD), Department of Epidemiology (M Shahbaz MSc), Injury Prevention and Safety Promotion Research Center (T Yousefinezehadi PhD), Shahid Beheshti University of Medical Sciences, Tehran, Iran (M Khayamzadeh MD); Advanced Diagnostic and Interventional Radiology Research Center (H Abbastabar PhD), Research Center for Immunodeficiencies (H Abolhassani PhD, Prof N Rezaei PhD), Department of Pharmacology (K Afshari MD, A Haj-Mirzaian MD), Non-communicable Diseases Research Center (Prof F Farzadfar DSc, B Mohajer MD, N Rezaei PhD, S Saedi Moghaddam MSc), Department of Environmental Health Engineering (M Fazlzadeh PhD, Prof A Maleki PhD), School of Medicine (N Hafezi-Nejad MD), School of Nursing and Midwifery (R Heidari-Soureshjani MSc), Department of Epidemiology and Biostatistics (Prof M Hosseini PhD, M Mansournia PhD), Pediatric Chronic Kidney Disease Research Center (Prof M Hosseini PhD), Health Equity Research Center (A Khosravi PhD), Digestive Diseases Research Institute (Prof R Malekzadeh MD, H Salimzadeh PhD, S G Sepanlou MD), Tehran Heart Center (E Mehrabi Nasab MD), Endocrinology and Metabolism Research Center (N Rezaei PhD), Faculty of Medicine (S Shakiba MD), Tehran University of Medical Sciences, Tehran, Iran; Department of Neurology (Prof F Abd-Allah MD, S I El-Jaafari MD, A Hassan MD), National Hepatology and Tropical Medicine Research Institute (A M Khater MD), Department of Medical Parasitology (M M Khater MD), Cairo University, Cairo, Egypt; Tropical Medicine Department (S M Abd-Elsalam MD), Tanta University, Tanta, Egypt; Department of Parasitology and Mycology (A Abdoli PhD), Jahrom University of Medical Sciences, Jahrom, Iran; Department of Orthopaedic Surgery (A Abedi MD), Department of Radiology (S Salehi MD), University of Southern California, Los Angeles, CA, USA; Department of Laboratory Medicine (H Abolhassani PhD), Karolinska University Hospital, Huddinge, Sweden; Department of Pediatric Dentistry (Prof L G Abreu PhD), Department of Pediatrics (Prof P Camargos PhD), Department of Maternal and Child Nursing and Public Health (Prof D C Malta PhD), Department of Clinical Medicine (Prof B R Nascimento PhD), Clinical Hospital (Prof B R Nascimento PhD), Federal University of Minas Gerais, Belo Horizonte, Brazil; Department of Clinical Sciences

(E Abu-Gharbieh PhD), Clinical Sciences Department (H J Barqawi MPhil), Department of Family and Community Medicine (B Saddik PhD), University of Sharjah, Sharjah, United Arab Emirates; Institute of Community and Public Health (Prof N M Abu-Rmeileh PhD), Birzeit University, Ramallah, Palestine; Harvard Medical School (A I Abushouk MD), Center for Primary Care (S Basu PhD), Department of Global Health and Social Medicine (A W Eagan MSW), Division of Cardiology (I Y Elgendy MD), Division of General Internal Medicine (Prof A Sheikh MD), Harvard University, Boston, MA, USA; Department of Medicine (A I Abushouk MD), Department of Entomology (A M Samy PhD), Neurology Department (Prof A S Shalash PhD), Ain Shams University, Cairo, Egypt; Community Medicine Department (A L Adamu MSc), Bayero University Kano, Kano, Nigeria; Infectious Diseases Epidemiology (A L Adamu MSc), Department of Non-Communicable Disease Epidemiology (M Iwagami PhD), London School of Hygiene & Tropical Medicine, London, UK; College of Medicine (O M Adebayo MD), Department of Health Policy and Management (O O Akinyemi FWACP), Department of Community Medicine (O S Ilesanmi PhD), Department of Medicine (Prof M O Owolabi DrM), University College Hospital, Ibadan, Ibadan, Nigeria; School of Medicine (A E Adegbosin MD), Griffith University, Gold Coast, QLD, Australia; Department of Population Health Sciences (V Adekanmbi PhD), Faculty of Life Sciences and Medicine (M Molokhia PhD), School of Population Health and Environmental Sciences (Y Wang PhD), King's College London, London, UK; Centre of Excellence for Epidemiological Modelling and Analysis (O O Adetokunboh PhD), Stellenbosch University, Stellenbosch, South Africa; Department of Global Health (O O Adetokunboh PhD), Stellenbosch University, Cape Town, South Africa; Department of Community Health and Epidemiology (D A Adeyinka MPH), University of Saskatchewan, Saskatoon, SK, Canada; Department of Public Health (D A Adeyinka MPH), Federal Ministry of Health, Abuja, Nigeria; Sport Science Department (J C Adsuar PhD), University of Extremadura, Badajoz, Spain; Department of Dermatology (K Afshari MD), University of Massachusetts Medical School, Worcester, MA, USA; Department of Epidemiology and Biostatistics (M Aghaali PhD), Qom University of Medical Sciences, Qom, Iran; Center for Policy, Population & Health Research (Prof M Agudelo-Botero PhD), Center of Complexity Sciences (Prof D Diaz PhD), Department of Economic Geography (A M Pardo-Montaña PhD), National Autonomous University of Mexico, Mexico City, Mexico; The Australian Centre for Public and Population Health Research (ACPPHR) (B O Ahinkorah MPH, E K Ameyaw MPhil), University of Technology Sydney, Sydney, NSW, Australia; Department of Epidemiology and Health Statistics (T Ahmad MS), Southeast University, Nanjing, China; Lincoln Medical School (K Ahmadi PhD), Universities of Nottingham & Lincoln, Lincoln, UK; Department of Epidemiology (M B Ahmed MPH), Jimma University, Jimma, Ethiopia; Australian Center for Precision Health (M B Ahmed MPH), School of Pharmacy and Medical Sciences (L G Ciobanu PhD), University of South Australia, Adelaide, SA, Australia; Faculty of Medicine and Public Health (B Aji DrPH), Jenderal Soedirman University, Purwokerto, Indonesia; Department of Medical Physiology (Y Akalu MSc), Department of Reproductive Health (Z N Azene MPH), Institute of Public Health (W F Chanie MPH), Department of Epidemiology (B A Dachew PhD), School of Midwifery (M A Limenih MSc), School of Nursing (H B Netsere MS), Department of Midwifery (A T Tamiru MSc), Department of Epidemiology and Biostatistics (Z T Tessema MSc), University of Gondar, Gondar, Ethiopia; Department of Health Policy and Management (O O Akinyemi FWACP), Department of Health Promotion and Education (S E Ibitoye MPH), Department of Community Medicine (O S Ilesanmi PhD), Department of Medicine (Prof M O Owolabi DrM), University of Ibadan, Ibadan, Nigeria; Department of Medical Laboratory Sciences (A Akilu MSc), Department of Nursing (A M Mersha MSc), Department of Public Health (N B Sidemo MPH), Department of Biomedical Sciences (E G Tadesse MSc), Arba Minch University, Arba Minch, Ethiopia; John T Milliken Department of Internal Medicine (Z Al-Aly MD), Washington University in St Louis, St Louis, MO, USA; Clinical Epidemiology Center (Z Al-Aly MD), Department of Veterans Affairs, St Louis, MO, USA; Murdoch Business School (K Alam PhD), Murdoch

University, Perth, WA, Australia; Health Information Management and Technology Department (T M Alanzi PhD), Department of Health Information Management and Technology (A K Alumran PhD), Environmental Health Department (S M A Dahlawi PhD), Forensic Medicine Division (Prof R G Menezes MD), Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia (F M Alanezi PhD); Center for Health System Research (J E Alcalde-Rabanal PhD, E Serván-Mori PhD), Center for Nutrition and Health Research (E Denova-Gutiérrez DSc), Research in Nutrition and Health (F Mejia-Rodriguez MSc), National Institute of Public Health, Cuernavaca, Mexico; Pediatric Intensive Care Unit (A Al-Eyadhy MD, K A Altirkawi MD, M Temsah MD), Internal Medicine Department (Y Mohammad MD), Department of Pediatrics (B H Sobaih MD), King Saud University, Riyadh, Saudi Arabia; Department of Psychiatry (T Ali MSc), School of Public Health (W F Chanie MPH), School of Nursing and Midwifery (A Desalew MSc), Haramaya University, Harar, Ethiopia; Directorate for Social Statistics and Population Census (G Alicandro PhD), Italian National Institute of Statistics, Rome, Italy; Epidemiology and Preventive Medicine (S M Alif PhD), School of Public Health and Preventive Medicine (S Li PhD), The School of Clinical Sciences at Monash Health (S Zaman MPH), Monash University, Melbourne, VIC, Australia; Health Management and Economics Research Center (V Alipour PhD, J Arabloo PhD, S Azari PhD, A Ghashghaee BSc, M Hosseinzadeh PhD, A Rezapour PhD), Department of Health Economics (V Alipour PhD), Preventive Medicine and Public Health Research Center (M Asadi-Aliabadi MSc, E Babaei PhD, A Tehrani-Banihashemi PhD), Department of Medical Laboratory Sciences (F Dorostkar PhD), Student Research Committee (A Ghashghaee BSc), Minimally Invasive Surgery Research Center (A Kabir MD), Department of Physiology (H Pazoki Toroudi PhD), Physiology Research Center (H Pazoki Toroudi PhD), Colorectal Research Center (A Sarveezad PhD), Department of Community and Family Medicine (A Tehrani-Banihashemi PhD), Iran University of Medical Sciences, Tehran, Iran; Infectious and Tropical Disease Research Center (H Alizade PhD), Hormozgan University of Medical Sciences, Bandar Abbas, Iran; Department of Health Policy and Management (Prof S M Aljunid PhD), Kuwait University, Safat, Kuwait; International Centre for Casemix and Clinical Coding (Prof S M Aljunid PhD), National University of Malaysia, Bandar Tun Razak, Malaysia; Department of Epidemiology (A Almasi-Hashiani PhD, R Moradzadeh PhD, M Zamanian PhD), Department of Health Services Management (S Amini PhD), Department of Pediatrics (J Nazari MD), Arak University of Medical Sciences, Arak, Iran; Physiotherapy Department (Prof N A Almasri PhD), The University of Jordan, Amman, Jordan; Medical Research Center (H M Al-Mekhlafi PhD), Epidemiology Department (M Khan MD), Jazan University, Jazan, Saudi Arabia (Prof N Bedi MD); Department of Parasitology (H M Al-Mekhlafi PhD), Sana'a University, Sana'a, Yemen; Research Program of Epidemiology and Public Health (J Alonso MD), Pompeu Fabra University, Barcelona, Spain; Department of Experimental and Health Sciences (J Alonso MD), Biomedical Research Networking Center in Epidemiology and Public Health (CiberESP), Madrid, Spain; Department of Community Medicine (R M Al-Raddadi PhD), Rabigh Faculty of Medicine (A A Malik PhD), King Abdulaziz University, Jeddah, Saudi Arabia; Research Group in Hospital Management and Health Policies (Prof N Alvis-Guzman PhD), Department of Economic Sciences (N J Alvis-Zakzuk MSc), Universidad de la Costa (University of the Coast), Barranquilla, Colombia; Research Group in Health Economics (Prof N Alvis-Guzman PhD), University of Cartagena, Cartagena, Colombia; National Health Observatory (N J Alvis-Zakzuk MSc, C A Castañeda-Orjuela MD), National Institute of Health, Bogota, Colombia; Health Management and Economics Research Center (M Amini-Rarani PhD), Department of Pathology (P Daneshpajouhnejad MD), Isfahan Cardiovascular Research Institute (Prof N Sarrafzadegan MD), Department of Radiology and Interventional Neuroradiology (O Shafaat MD), Isfahan University of Medical Sciences, Isfahan, Iran; School of Medicine and Public Health (A L Amit BS), Ateneo De Manila University, Manila, Philippines; College of Medicine (A L Amit BS), Department of Health Policy and Administration (C T Antonio MD), University of the Philippines Manila, Manila, Philippines; Maternal and Child Wellbeing (D A Amugsi PhD), Population Dynamics and Sexual and Reproductive Health (Y D Wado PhD), African Population and Health Research Center, Nairobi, Kenya; Pharmacy Department (Prof R Ancuceanu PhD), Cardiology Department (C Andrei PhD), Internal Medicine Department (M Hostiu PhD), Department of Legal Medicine and Bioethics (S Hostiu PhD), Department of General Surgery (I Negoii PhD), Department of Anatomy and Embryology (R I Negoii PhD), Carol Davila University of Medicine and Pharmacy, Bucharest, Romania; Centre for Sensorimotor Performance (D Anderlini MD), School of Dentistry (R Lalloo PhD), Queensland Brain Institute (Prof J J McGrath MD), School of Health and Rehabilitation Sciences (R Uddin PhD), The University of Queensland, Brisbane, QLD, Australia; Neurology Department (D Anderlini MD), Royal Brisbane and Women's Hospital, Brisbane, QLD, Australia; Research Center for Evidence Based Medicine (F Ansari PhD), Department of Biostatistics and Epidemiology (Prof M Asghari Jafarabadi PhD), Department of Health Policy and Management (L Doshmangir PhD), School of Nursing and Midwifery (H Hassankhani PhD), School of Management and Medical Informatics (L R Kalankesh PhD), Social Determinants of Health Research Center (S Karimi PhD), Biotechnology Research Center (M Moghadaszadeh PhD), Molecular Medicine Research Center (M Moghadaszadeh PhD), Alzahra Teaching Hospital (M Vaezi MD), Women's Reproductive Health Research Center (M Vaezi MD), Tabriz University of Medical Sciences, Tabriz, Iran; Razi Vaccine and Serum Research Institute (F Ansari PhD), Agricultural Research, Education, and Extension Organization (AREEO), Tehran, Iran; Department of Epidemiology and Biostatistics (Prof A Ansari-Moghaddam PhD), Health Promotion Research Center (M Khammaria PhD), Zahedan University of Medical Sciences, Zahedan, Iran; Department of Applied Social Sciences (C T Antonio MD), Hong Kong Polytechnic University, Hong Kong, China; Agribusiness Study Program (E Antriyandarti DrAgrSc), Sebelas Maret University, Surakarta, Indonesia; Department of Parasitology (D Anvari PhD), Department of Immunology (Prof A Rafiei PhD), Molecular and Cell Biology Research Center (Prof A Rafiei PhD), Department of Environmental Health (Prof Z Yousefi PhD), Mazandaran University of Medical Sciences, Sari, Iran; Department of Parasitology (D Anvari PhD), Iranshahr University of Medical Sciences, Iranshahr, Iran; Department of Pathology (R Anwer PhD), Imam Mohammad Ibn Saud Islamic University, Riyadh, Saudi Arabia; Department of Psychology (M Aqeel PhD, M Aqeel PhD), Foundation University Islamabad, Rawalpindi, Pakistan; Social Determinants of Health Research Center (M Arab-Zozani PhD), Cardiovascular Diseases Research Center (S Riahi PhD), Birjand University of Medical Sciences, Birjand, Iran; Public Health and Healthcare Management (T Aripov PhD), Tashkent Institute of Postgraduate Medical Education, Tashkent, Uzbekistan; Boston Children's Hospital, Boston, MA, USA (T Aripov PhD); Department of Neurobiology, Care Sciences and Society (Prof J Ärnlöv PhD), Department of Medical Epidemiology and Biostatistics (Prof J J Carrero PhD), Department of Global Public Health (K Deuba DrPH), Department of Neurobiology (S Fereshtehnejad PhD), Karolinska Institute, Stockholm, Sweden; School of Health and Social Studies (Prof J Ärnlöv PhD), Dalarna University, Falun, Sweden; Department of Epidemiology (K D Artanti MSc, A Hargono Dr), Community Health Nursing (F Efendi PhD), Faculty of Public Health (S Martini PhD), Universitas Airlangga (Airlangga University), Surabaya, Indonesia; School of Nursing and Midwifery (A Arzani DrPH), Student Research Committee (M Zamani MD), Babol University of Medical Sciences, Babol, Iran (A Arzani DrPH); Department of Plastic Surgery (M Asaad MD), University of Texas, Houston, TX, USA; Epilepsy Research Center (Prof A A Asadi-Pooya MD), Health Human Resources Research Center (M Bayati PhD), Bacteriology and Virology Department (A Emami PhD), Burn and Wound Healing Research Center (F Javanmardi MSc), Non-communicable Disease Research Center (Prof R Malekzadeh MD, S G Sepanlou MD), Department of Parasitology and Mycology (Prof K Pakshir PhD), Health Policy Research Center (S Shahabi PhD), Shiraz University of Medical Sciences, Shiraz, Iran; Neurology Department (Prof A A Asadi-Pooya MD), Thomas Jefferson University, Philadelphia, PA, USA; Department of Biostatistics and Epidemiology (Prof M Asghari Jafarabadi PhD), Department of Immunology (S Athari MPH), Department of Anatomical

Sciences (S Mohammadi PhD), Zanjan University of Medical Sciences, Zanjan, Iran; Department of Biology (S Athari MPH), Department of Nutrition and Food Sciences (H Pourjafar PhD), Maragheh University of Medical Sciences, Maragheh, Iran; Department of Health System and Health Economics (D D Atnafu MPH), Department of Internal Medicine (Y M Bezabih MD), Department of Reproductive Health and Population Studies (E W Mengesha MPH), Bahir Dar University, Bahir Dar, Ethiopia; Department of Forensic Medicine (A Atreya MD), Lumbini Medical College, Palpa, Nepal; Department of Social Welfare (M S Atteraya PhD), Keimyung University, Daegu, South Korea; School of Business (Prof M Ausloos PhD), Department of Health Sciences (P H Lee PhD), University of Leicester, Leicester, UK; Department of Statistics and Econometrics (Prof M Ausloos PhD, Prof C Hertelju PhD, A Mirica PhD, Prof A Otoi PhD, A Pana MD), Bucharest University of Economic Studies, Bucharest, Romania; School of Nursing and Health Sciences (A T Awan DrPH), Capella University, Minneapolis, MN, USA; Continuing Education- Grant Writing Academy (A T Awan DrPH), University of Nevada, Las Vegas, NV, USA; The Judith Lumley Centre (B Ayala Quintanilla PhD), School of Nursing and Midwifery (F Efendi PhD), School of Psychology and Public Health (M Islam PhD), La Trobe University, Melbourne, VIC, Australia; School of Public Health (G Ayano MSc, B A Dachew PhD, T R Miller PhD, G A Tessema PhD), Curtin University, Perth, WA, Australia; Department of Health Policy Planning and Management (M A Ayanore PhD), University of Health and Allied Sciences, Ho, Ghana; Department of Nursing (Y A Aynalem MSc, W S Shiferaw MSc), Department of Public Health (L Getacher MPH), Debre Berhan University, Debre Berhan, Ethiopia; Department of Environmental Health Engineering (G Azarian PhD), Autism Spectrum Disorders Research Centre (E Jenabi PhD), Department of Biostatistics (N Kamyari MSc), Department of Midwifery (S Masoumi PhD), Research Centre for Molecular Medicine (A Taherkhani PhD), Hamadan University of Medical Sciences, Hamadan, Iran; Kasturba Medical College, Mangalore (D B B MD, R Holla MD, J Padubidri MD, P Rathi MD), Manipal College of Pharmaceutical Sciences (Prof M D Janodia PhD), Department of Nephrology (Prof S Nagaraju DM), Department of Health Information Management (B Reshmi PhD), Manipal Academy of Higher Education, Manipal, India (B Reshmi PhD); Department of Forensic Science (A D Badiye MSc, N Kapoor MSc), Government Institute of Forensic Science, Nagpur, India; Unit of Biochemistry (A A Baig PhD), Universiti Sultan Zainal Abidin (Sultan Zainal Abidin University), Kuala Terengganu, Malaysia; Department of Hypertension (Prof M Banach PhD), Medical University of Lodz, Lodz, Poland; Polish Mothers' Memorial Hospital Research Institute, Lodz, Poland (Prof M Banach PhD); Department of Non-communicable Diseases (P C Banik MPhil), Bangladesh University of Health Sciences, Dhaka, Bangladesh; School of Psychology (Prof S L Barker-Collo PhD), University of Auckland, Auckland, New Zealand; Barcelona Institute for Global Health (Prof Q Bassat MD), University of Barcelona, Barcelona, Spain; Catalan Institution for Research and Advanced Studies (ICREA), Barcelona, Spain (Prof Q Bassat MD, A Koyanagi MD); School of Public Health (S Basu PhD, Prof S Saxena MD), Department of Surgery and Cancer (Prof A C Davis PhD), Imperial College Business School (D Kusuma DSc), Department of Primary Care and Public Health (Prof A Majeed MD, R Palladino MD, Prof S Rawaf MD), WHO Collaborating Centre for Public Health Education and Training (D L Rawaf MD), Imperial College London, London, UK; Department of Psychiatry (Prof B T Baune PhD), Institute for Epidemiology and Social Medicine (A Karch MD), University of Münster, Münster, Germany; Department of Psychiatry (Prof B T Baune PhD), Melbourne Medical School, Melbourne, VIC, Australia; School of Public Health (Prof N Bedi MD), Dr D Y Patil University, Mumbai, India; Department of Neuroscience (E Beghi MD, E Pupillo PhD), Department of Environmental Health Sciences (S Gallus DSc, A Lugo PhD), Laboratory of Neurological Disorders (G Giussani PhD), Mario Negri Institute for Pharmacological Research, Milan, Italy; Mental Health (M Beghi MD), AUSL Romagna, Ravenna, Italy; School of the Environment (Prof M L Bell PhD), Department of Genetics (S Pawar PhD), Yale University, New Haven, CT, USA; Department of Industrial Engineering (S Bendak PhD), Haliç University, Istanbul, Turkey; Nuffield Department of Population Health (D A Bennett PhD, B Lacey PhD), Nuffield Department of Clinical Medicine (N J Henry BS), Centre for Tropical Medicine and Global Health (S Lewycka PhD), Big Data Institute (C E Moore PhD), The George Institute for Global Health (Prof S Yaya PhD), University of Oxford, Oxford, UK; Department of Internal Medicine (I M Bensenor PhD, Prof A R Brunoni PhD), Department of Psychiatry (Prof A R Brunoni PhD, Prof J Castaldelli-Maia PhD, Y Wang PhD), University of São Paulo, São Paulo, Brazil; Department of Nutrition and Dietetics (K Berhe MPH), School of Public Health (F H Tesfay PhD), Mekelle University, Mekelle, Ethiopia; Department of Medicine (A E Berman MD), Medical College of Georgia at Augusta University, Augusta, GA, USA; One Health (Y M Bezabih MD), University of Nantes, Nantes, France; Department of Social and Clinical Pharmacy (A S Bhagavathula PharmD), Charles University, Hradec Kralova, Czech Republic; Institute of Public Health (A S Bhagavathula PharmD, I Elbarazi DrPH, Prof M Grivna PhD), Department of Medical Microbiology & Immunology (Prof G Khan PhD), United Arab Emirates University, Al Ain, United Arab Emirates; School of Public Health (D Bhandari MSc, G A Tessema PhD), Adelaide Medical School (L G Ciobanu PhD, T K Gill PhD), Robinson Research Institute (Z S Lassi PhD), Centre for Heart Rhythm Disorders (J Noubiap MD), University of Adelaide, Adelaide, SA, Australia; Public Health Research Laboratory (D Bhandari MSc), Tribhuvan University, Kathmandu, Nepal; Department of Anatomy (Prof N Bhardwaj MD), Government Medical College Pali, Pali, India; Department of Community Medicine and Family Medicine (P Bhardwaj MD), School of Public Health (P Bhardwaj MD), Department of Pharmacology (J Charan MD), Department of Forensic Medicine and Toxicology (T Kanchan MD), All India Institute of Medical Sciences, Jodhpur, India; Department of Statistical and Computational Genomics (K Bhattacharyya MSc), National Institute of Biomedical Genomics, Kalyani, India; Department of Statistics (K Bhattacharyya MSc), University of Calcutta, Kolkata, India; Department of Global Health (S Bhattarai MD), Global Institute for Interdisciplinary Studies, Kathmandu, Nepal; Centre for Global Child Health (Prof Z A Bhutta PhD), Department of Medicine (V Chattu MD), University of Toronto, Toronto, ON, Canada; Centre of Excellence in Women & Child Health (Prof Z A Bhutta PhD), Division of Women and Child Health (J K Das MD), Aga Khan University, Karachi, Pakistan; Mario Negri Institute for Pharmacological Research, Ranica, Italy (B Bikbov MD); Department of General Surgery and Medical-Surgical Specialties (Prof A Biondi PhD, M Vacante PhD), University of Catania, Catania, Italy; Ethiopian Public Health Institute, Addis Ababa, Ethiopia (B M Birihane MSc); Department of Nursing (B M Birihane MSc), Debre Tabor University, Debre Tabor, Ethiopia; Transport and Road Safety (TARS) Research Centre (R Biswas MSc), Department of Medicine (O John MD), School of Medicine (P K Maulik PhD), World Health Organization (WHO) Centre on eHealth (M Moni PhD), School of Public Health and Community Medicine (A E Peden PhD), School of Optometry and Vision Science (Prof K Pesudovs PhD, Prof S Resnikoff MD), University of New South Wales, Sydney, NSW, Australia; Department of Veterinary Medicine (S Bohlouli PhD), Islamic Azad University, Kermanshah, Iran; University of Genoa, Genoa, Italy (N L Bragazzi PhD); Institute of Medicine (Prof A V Breusov DSc), RUDN University, Moscow, Russia; Department of Community Medicine (Prof S Burugina Nagaraja MD), Employee State Insurance Post Graduate Institute of Medical Sciences and Research, Bangalore, India; Department of Health Care Management (Prof R Busse PhD), Technical University of Berlin, Berlin, Germany; School of Public Health and Health Systems (Z A Butt PhD), University of Waterloo, Waterloo, ON, Canada; Al Shifa School of Public Health (Z A Butt PhD), Al Shifa Trust Eye Hospital, Rawalpindi, Pakistan; Institute of Microengineering (F Caetano dos Santos PhD), Federal Polytechnic School of Lausanne, Lausanne, Switzerland; School of Public Health and Administration (L Cahuana-Hurtado PhD), Peruvian University Cayetano Heredia, Lima, Peru; Internal Medicine Department (Prof L A Cámara MD), Hospital Italiano de Buenos Aires, Buenos Aires, Argentina; Board of Directors (Prof L A Cámara MD), Argentine Society of Medicine, Buenos Aires, Argentina (Prof P R Valdez MEd); Department of Health Care (Prof R Cárdenas DSc), Metropolitan Autonomous University, Mexico City, Mexico; Institute for Cancer Research, Prevention and Clinical

Network, Florence, Italy (G Carreras PhD); Research Unit on Applied Molecular Biosciences (UCIBIO) (Prof F Carvalho PhD, V M Costa PhD, J P Silva PhD), Department of Chemical Sciences (R A S Couto MD, D Ribeiro PhD), Laboratory of Toxicology (Prof D Dias da Silva PhD), Associated Laboratory for Green Chemistry (LAQV) (Prof E Fernandes PhD, M Freitas PhD), Department of Chemistry (M Pinheiro PhD), University of Porto, Porto, Portugal; Epidemiology and Public Health Evaluation Group (C A Castañeda-Orjuela MD), Department of Public Health (Prof F P De la Hoz PhD), National University of Colombia, Bogota, Colombia; Department of Medicine (G Castelpietra PhD), University of Udine, Udine, Italy; Department of Mental Health (G Castelpietra PhD), Healthcare Agency "Friuli Occidentale", Pordenone, Italy; Mary MacKillop Institute for Health Research (Prof E Cerin PhD), Australian Catholic University, Melbourne, VIC, Australia; School of Public Health (Prof E Cerin PhD), Centre for Suicide Research and Prevention (Prof P Yip PhD), Department of Social Work and Social Administration (Prof P Yip PhD), University of Hong Kong, Hong Kong, China; College of Medicine (J Chang PhD), National Taiwan University, Taipei, Taiwan; Department of Nursing (J Chang PhD), National Taiwan University Hospital, Taipei, Taiwan; Department of Microbiology & Infection Control (S Chatterjee MD), Medanta Medicity, Gurugram, India; Department of Public Health (S Chattu PhD), Texila American University, Georgetown, Guyana; Global Institute of Public Health (GIPH), Thiruvananthapuram, India (V Chattu MD); Research Department (S Chaturvedi PhD), Dr D Y Patil University, Pune, India; Heidelberg Institute of Global Health (HIGH) (S Chen DSc, B Moazen MSc, S Mohammed PhD), Department of Ophthalmology (Prof J B Jonas MD, S Panda-Jonas MD), Heidelberg University, Heidelberg, Germany; Biomedical Informatics (J J Choi PhD), Seoul National University Hospital, Seoul, South Korea; Center for Biomedicine and Community Health (D Chu PhD), VNU-International School, Hanoi, Vietnam; Department of Public Health (Prof M Cirillo MD, Prof I Iavicoli PhD, R Palladino MD), University of Naples Federico II, Naples, Italy; Nova Medical School (J Conde PhD), Nova University of Lisbon, Lisbon, Portugal; College of Environmental Sciences and Engineering (Prof H Dai PhD), Peking University, Beijing, China; Department of Research (A Pandey PhD), Public Health Foundation of India, Gurugram, India (Prof L Dandona MD, Prof R Dandona PhD, G Kumar PhD); Indian Council of Medical Research, New Delhi, India (Prof L Dandona MD); Department of Pathology (P Daneshpajouhnejad MD), Department of Radiology and Radiological Science (N Hafezi-Nejad MD, O Shafaat MD, S Sheikhbahaee MD), Johns Hopkins University, Baltimore, MD, USA; Department of Pediatrics (Prof G L Darmstadt MD), Center for Health Policy & Center for Primary Care and Outcomes Research (Prof J A Salomon PhD), Stanford University, Stanford, CA, USA; Department of Population and Development (C A Dávila-Cervantes PhD), Latin American Faculty of Social Sciences Mexico, Mexico City, Mexico; Ear Institute (Prof A C Davis), Division of Psychology and Language Sciences (M Kumar PhD), Medical Research Council Clinical Trials Unit (N M Noor MRCP), University College London, London, UK; Health Research Institute (K Davletov PhD), Al Farabi Kazakh National University, Almaty, Kazakhstan; Australian Institute for Suicide Research and Prevention (Prof D De Leo DSc), Griffith University, Mount Gravatt, QLD, Australia; Centre for Interdisciplinary Research in Basic Sciences (F Deeba PhD), Jamia Millia Islamia, Delhi, India; St Paul's Eye Unit (N Dervenis MD), Royal Liverpool University Hospital, Liverpool, UK; Department of Ophthalmology (N Dervenis MD), Aristotle University of Thessaloniki, Thessaloniki, Greece; National Centre for AIDS and STD Control (K Deuba DrPH), Save the Children, Kathmandu, Nepal; Centre for Atmospheric Sciences (S Dey PhD), Indian Institute of Technology Delhi, New Delhi, India; Department of Community Medicine (Prof S D Dharmaratne MD), University of Peradeniya, Peradeniya, Sri Lanka; Department of Pharmacy Practice (S Dhingra PhD), National Institute of Pharmaceutical Education and Research, Hajipur, India; Department of Microbiology (G P Dhungana MSc), Far Western University, Mahendranagar, Nepal; Faculty of Veterinary Medicine and Zootechnics (Prof D Diaz PhD), Autonomous University of Sinaloa, Culiacán Rosales, Mexico; Institute of Microbiology and Immunology (E Dubljanin PhD), Faculty of Medicine (I M Ilic PhD), Prof M M Santric-Milicevic PhD), School of Public Health and Health Management (Prof M M Santric-Milicevic PhD), University of Belgrade, Belgrade, Serbia; School of Medicine (Prof A R Duraes PhD), Institute of Collective Health (Prof D Rasella PhD), Federal University of Bahia, Salvador, Brazil; Department of Internal Medicine (Prof A R Duraes PhD), Escola Bahiana de Medicina e Saúde Pública (Bahiana School of Medicine and Public Health), Salvador, Brazil; Department of Social Services (A W Eagan MSW), Tufts Medical Center, Boston, MA, USA; School of Health Sciences (H A Edinur PhD), Universiti Sains Malaysia (University of Science Malaysia), Kubang Kerian, Malaysia; Division of Urology (S Eftekharzadeh MD), Children's Hospital of Philadelphia, Philadelphia, PA, USA; Biomedical Informatics and Medical Statistics Department (I El Sayed PhD), Pediatric Dentistry and Dental Public Health Department (Prof M El Tantawi PhD), Alexandria University, Alexandria, Egypt; Division of Cardiology (I Y Elgendy MD), Massachusetts General Hospital, Boston, MA, USA; Department of Microbiology and Immunology (S Enany PhD), Suez Canal University, Ismailia, Egypt; Faculty of Health (O Eyawo PhD), York University, Toronto, BC, Canada; Department of Virology (P S Ezzikouri PhD), Pasteur Institute of Morocco, Casablanca, Morocco; Department of Biology and Biotechnology "Lazzaro Spallanzani" (P S Faris PhD), University of Pavia, Pavia, Italy; Department of Biology (P S Faris PhD), Cihan University-Erbil, Erbil, Iraq; Research Center for Environmental Determinants of Health (N Fattahi PhD, Prof B Karami Matin PhD, A Kazemi Karyani PhD, M Moradi PhD, Prof M Pirsaeheb PhD, Prof E Sadeghi PhD, K Sharafi PhD, S Soltani PhD), Clinical Research Development Center (S Maleki MSc, M Naderi PhD), Substance Abuse Prevention Research Center (B Mansouri PhD), Department of Rehabilitation and Sports Medicine (M Mirzaei MSc), Department of Anatomical Sciences (M R Salahshoor PhD), Department of Vascular and Endovascular Surgery (M Sobhiyeh MD), Department of Health Education and Health Promotion (A Ziapour PhD), Kermanshah University of Medical Sciences, Kermanshah, Iran; College of Medicine and Public Health (N K Fauk MSc, Prof P Ward PhD), Southgate Institute for Health and Society (F H Tesfay PhD), Flinders University, Adelaide, SA, Australia; Institute of Resource Governance and Social Change, Kupang, Indonesia (N K Fauk MSc); Department of Environmental Health Engineering (M Fazlzadeh PhD), Ardabil University of Medical Science, Ardabil, Iran; National Institute for Stroke and Applied Neurosciences (Prof V L Feigin PhD), Auckland University of Technology, Auckland, New Zealand; Third Department of Neurology (E V Gnedovskaya PhD), Research Center of Neurology, Moscow, Russia (Prof V L Feigin PhD, Prof M A Piradov DSc); School of Nursing (T Y Ferede MSc), School of Midwifery (G Kassahun MSc), Hawassa University, Hawassa, Ethiopia; Division of Neurology (S Fereshtehnejad PhD), School of International Development and Global Studies (Prof S Yaya PhD), University of Ottawa, Ottawa, ON, Canada; Research Center on Public Health (P Ferrara MD), University of Milan Bicocca, Monza, Italy; Psychiatry Department (I Filip MD), Kaiser Permanente, Fontana, CA, USA; School of Health Sciences (I Filip MD), AT Still University, Mesa, AZ, USA; Institute of Gerontological Health Services and Nursing Research (F Fischer PhD), Ravensburg-Weingarten University of Applied Sciences, Weingarten, Germany; James Cancer Hospital (J L Fisher PhD), Ohio State University, Columbus, OH, USA; Institute of Gerontology (N A Foigt PhD), National Academy of Medical Sciences of Ukraine, Kyiv, Ukraine; Department of Child Dental Health (Prof M O Folan FWACS), Obafemi Awolowo University, Ile-Ife, Nigeria; Department of Medical Parasitology (M Foroutan PhD), Abadan Faculty of Medical Sciences, Abadan, Iran; School of Public Health, Medical, and Veterinary Sciences (R C Franklin PhD), James Cook University, Douglas, QLD, Australia; School of Global Public Health (S D Friedman BA, E K Peparh PhD), New York University, New York, NY, USA; Department of Dermatology (T Fukumoto PhD), Kobe University, Kobe, Japan; Department of Cardiovascular Medicine (M M Gad MD), Department of Internal Medicine (V Jain MD), Cleveland Clinic, Cleveland, OH, USA; Gillings School of Global Public Health (M M Gad MD), University of North Carolina Chapel Hill, Chapel Hill, NC, USA; Department of Community Medicine (Prof A M Gaidhane MD, Prof Z Quazi Syed PhD), Department of Medicine (S Gaidhane PhD), Department of Ophthalmology (Prof D Singhal MD), Datta Meghe Institute of Medical Sciences,

Wardha, India; Nutrition Innovation Centre for Food and Health (NICHE) (S Gaihre PhD), Ulster University, Coleraine, UK; Department of Tuberculosis (A L Garcia-Basteiro PhD), Manhiça Health Research Center (CISM), Manhiça, Mozambique; Viral and Bacterial Infections Research Program (A L Garcia-Basteiro PhD), Barcelona Institute for Global Health, Barcelona, Spain; Faculty of Business and Management (M Garcia-Gordillo PhD), Universidad Autónoma de Chile (Autonomous University of Chile), Talca, Chile; National Health Service, London, UK (M Gaspar Fonseca PhD); Department of Nursing and Midwifery (K B Gebremedhin MSc), Addis Ababa University, Addis Ababa, Ethiopia; Young Researchers and Elite Club (A Gholamian MSc), Islamic Azad University, Rasht, Iran; Department of Biology (A Gholamian MSc), Department of Microbiology (S Valadan Tahbaz PhD), Islamic Azad University, Tehran, Iran; Faculty of Allied Health Sciences (Prof S Gilani PhD), University Institute of Public Health (A Hanif PhD, A A Malik PhD), The University of Lahore, Lahore, Pakistan; Afro-Asian Institute, Lahore, Pakistan (Prof S Gilani PhD); School of Public Health and Community Medicine (M A Godinho MBBS), University of New South Wales, Kensington, NSW, Australia; Department of Gastroenterology (Prof A Goel DM), Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, India; Health Systems and Policy Research (M Golechha PhD), Indian Institute of Public Health Gandhinagar, Gandhinagar, India; Department of Exercise and Health Sciences (P N Gona PhD), University of Massachusetts Boston, Boston, MA, USA; Hudson College of Public Health (S V Gopalani MPH), University of Oklahoma Health Sciences Center, Oklahoma City, OK, USA; Department of Health and Social Affairs (S V Gopalani MPH), Government of the Federated States of Micronesia, Palikir, Federated States of Micronesia; Department of Respiratory Medicine (H Goudarzi PhD), Center for Environmental and Health Sciences (H Goudarzi PhD), Hokkaido University, Sapporo, Japan; Department of Public Health and Preventive Medicine (Prof M Grivna PhD), Charles University, Prague, Czech Republic; Department of Microbiology (Prof H C Gugnani PhD), Department of Epidemiology (Prof H C Gugnani PhD), Saint James School of Medicine, The Valley, Anguilla; UO Neurologia, Salute Pubblica e Disabilità (D Guido PhD, M Leonardi MD, F G Magnani PhD, A Raggi PhD, D Sattin PsyD, S Schiavolin MSc), Fondazione IRCCS Istituto Neurologico Carlo Besta (Neurology, Public Health and Disability Unit, Carlo Besta Neurological Institute), Milan, Italy; Institute of Tropical Pathology and Public Health (IPTSP) (R A Guimarães MSc), Federal University of Goiás, Goiânia, Brazil; Department of Epidemiology and Biostatistics (R Gupta MPH), University of South Carolina, Columbia, SC, USA; Centre for Noncommunicable Diseases and Nutrition (R Gupta MPH), BRAC University, Dhaka, Bangladesh; Department of Preventive Cardiology (Prof R Gupta MD), Eternal Heart Care Centre & Research Institute, Jaipur, India; Department of Medicine (Prof R Gupta MD), Mahatma Gandhi University Medical Sciences, Jaipur, India; Department of Social and Public Health (M Haider PhD), Ohio University, Athens, OH, USA; School of Health and Environmental Studies (Prof S Hamidi DrPH), Hamdan Bin Mohammed Smart University, Dubai, United Arab Emirates; Medical School (Prof G J Hankey MD), Dorney Hypertension Centre (Prof M P Schlaich MD), University of Western Australia, Perth, WA, Australia; Department of Neurology (Prof G J Hankey MD), Sir Charles Gairdner Hospital, Perth, WA, Australia; Department of Zoology and Entomology (A I Hasaballah PhD), Al Azhar University, Cairo, Egypt; Institute for Social Science Research (M Hasan MPH, A A Mamun PhD), ARC Centre of Excellence for Children and Families over the Life Course (M Hasan MPH), The University of Queensland, Indooroopilly, QLD, Australia; Department of Pharmacy (S Hasan PhD), University of Huddersfield, Huddersfield, UK; School of Biomedical Sciences and Pharmacy (S Hasan PhD), University of Newcastle, Newcastle, NSW, Australia; Gastrointestinal and Liver Diseases Research Center (S Hassanipour PhD, F Joukar PhD), Caspian Digestive Disease Research Center (S Hassanipour PhD, F Joukar PhD), Department of Environmental Health Engineering (J Jaafari PhD), Guilan University of Medical Sciences, Rasht, Iran; Independent Consultant, Tabriz, Iran (H Hassankhani PhD); Skaane University Hospital (R J Havmoeller PhD), Skaane County Council, Malmö, Sweden; Institute of Pharmaceutical Sciences (K Hayat MS), University of Veterinary and Animal Sciences, Lahore, Pakistan; Department of Pharmacy Administration and Clinical Pharmacy (K Hayat MS), Xian Jiaotong University, Xian, China; School of Business (Prof C Herteliu PhD), London South Bank University, London, UK; Department of Pediatrics (M K Hole MD), University of Texas Austin, Austin, TX, USA; Department of Pharmacology (N Hossain MPhil), Bangladesh Industrial Gases Limited, Tangail, Bangladesh; Clinical Legal Medicine Department (S Hostiu PhD), National Institute of Legal Medicine Mina Minovici, Bucharest, Romania; College of Science and Engineering (Prof M Househ PhD), Hamad Bin Khalifa University, Doha, Qatar; Jockey Club School of Public Health and Primary Care (J Huang MD), The Chinese University of Hong Kong, Hong Kong, China; Department of Public Health and Community Medicine (Prof A Humayun PhD), Shaikh Khalifa Bin Zayed Al-Nahyan Medical College, Lahore, Pakistan; Department of Occupational Safety and Health (Prof B Hwang PhD), College of Public Health (R Lin PhD), China Medical University, Taichung, Taiwan; Department of Epidemiology (Prof M D Ilic PhD), University of Kragujevac, Kragujevac, Serbia; Division of Gastroenterology and Hepatology (S Inamdar MD), University of Arkansas for Medical Sciences, Little Rock, AR, USA; Division of Community Health and Family Medicine (L R Inbaraj MD), Bangalore Baptist Hospital, Bangalore, India; Department of Human Nutrition (K Iqbal DrPH), Khyber Medical University, Peshawar, Pakistan; College of Public Health (U Iqbal PhD), Taipei Medical University, Taipei, Taiwan; Institute for Physical Activity and Nutrition (S Islam PhD), Department of Psychology (M A Stokes PhD), Deakin University, Burwood, VIC, Australia; Sydney Medical School (S Islam PhD), Asbestos Diseases Research Institute (J Leigh MD), School of Veterinary Science (B B Singh PhD), University of Sydney, Sydney, NSW, Australia; Public Health Department of Social Medicine (Prof H Iso MD), Graduate School of Medicine (Prof K Yamagishi MD), Osaka University, Suita, Japan; Department of Health Services Research (M Iwagami PhD), Research and Development Center for Health Services (Prof K Yamagishi MD), University of Tsukuba, Tsukuba, Japan; School of Health Systems and Public Health (C C D Iwu MSc), University of Pretoria, Pretoria, South Africa; Department of Global and Community Health (K H Jacobsen PhD), George Mason University, Fairfax, VA, USA; The George Institute for Global Health (J Jagnoor PhD), University of New South Wales, New Delhi, India; Health Informatic Lab (T Javaheri PhD), Department of Computer Science (R Rawassizadeh PhD), Boston University, Boston, MA, USA; Department of Biochemistry (Prof S Jayaram MD), Government Medical College, Mysuru, India; Postgraduate Institute of Medicine (A U Jayatilleke PhD), University of Colombo, Colombo, Sri Lanka; Faculty of Graduate Studies (A U Jayatilleke PhD), Institute for Violence and Injury Prevention, Colombo, Sri Lanka; Department of Community Medicine (R P Jha MSc), Dr Baba Saheb Ambedkar Medical College & Hospital, Delhi, India; Department of Community Medicine (R P Jha MSc), Banaras Hindu University, Varanasi, India; Environmental Research Center (J S Ji DSc), Global Health Research Center (C Wu PhD), Duke Kunshan University, Kunshan, China; Nicholas School of the Environment (J S Ji DSc), Department of Anesthesiology (V Krishnamoorthy MD), Duke Global Health Institute (C Wu PhD), Duke University, Durham, NC, USA; Renal and Cardiovascular Division (O John MD), Research Division (P K Maulik PhD), The George Institute for Global Health, New Delhi, India; Beijing Institute of Ophthalmology (Prof J B Jonas MD), Beijing Tongren Hospital, Beijing, China; Health Services Management Training Centre (T Joo MSc), Faculty of Health and Public Administration (M Szócska PhD), Semmelweis University, Budapest, Hungary; Department of Community Medicine (N Joseph MD, V Kulkarni MD, N Kumar MD, R Thapar MD), Department of Forensic Medicine and Toxicology (Prof P Rastogi MD), Kasturba Medical College (Prof B Unnikrishnan MD), Manipal Academy of Higher Education, Mangalore, India; Department of Family Medicine and Public Health (J J Jozwiak PhD), University of Opole, Opole, Poland; Institute of Family Medicine and Public Health (M Jürisson PhD), University of Tartu, Tartu, Estonia; School of Public Health (Z Kabir PhD), School of Medicine (P M Ryan PhD), University College Cork, Cork, Ireland; International Research Center of Excellence (G A Kayode PhD), Institute of Human Virology Nigeria, Abuja, Nigeria; Julius Centre for Health Sciences and Primary Care (G A Kayode PhD), Institute for Risk

Assessment Sciences (IRAS) (E Traini MSc), Utrecht University, Utrecht, Netherlands; School of Food and Agricultural Sciences (N Khalid PhD), University of Management and Technology, Lahore, Pakistan; Department of Biophysics and Biochemistry (Prof R Khalilov PhD), Baku State University, Baku, Azerbaijan; Russian Institute for Advanced Study (Prof R Khalilov PhD), Moscow State Pedagogical University, Moscow, Russia; Department of Epidemiology and Biostatistics (E A Khan MPH), Health Services Academy, Islamabad, Pakistan; Department of Population Science (M Khan PhD), Jatiya Kabi Kazi Nazrul Islam University, Mymensingh, Bangladesh; Department of Health Policy and Management (Prof Y Khang MD), Institute of Health Policy and Management (Prof Y Khang MD), Seoul National University, Seoul, South Korea; Faculty of Health and Wellbeing (K Khatab PhD), Sheffield Hallam University, Sheffield, UK; College of Arts and Sciences (K Khatab PhD), Ohio University, Zanesville, OH, USA; The Iranian Academy of Medical Sciences, Tehran, Iran (M Khayamzadeh MD); Deputy for Public Health (A Khosravi PhD), Ministry of Health and Medical Education, Tehran, Iran; Department of Health Sciences (Prof D Kim DrPH), Cultures, Societies and Global Studies, & Integrated Initiative for Global Health (R G Wamai PhD), Northeastern University, Boston, MA, USA; Big Data Department (Y Kim PhD), National Health Insurance Service, Wonju, South Korea; School of Traditional Chinese Medicine (Y Kim PhD), Xiamen University Malaysia, Sepang, Malaysia; Department of Nutrition (R W Kimokoti MD), Simmons University, Boston, MA, USA; School of Health Sciences (Prof A Kisa PhD), Kristiania University College, Oslo, Norway; Global Community Health and Behavioral Sciences (Prof A Kisa PhD), Tulane University, New Orleans, LA, USA; Department of Nursing and Health Promotion (S Kisa PhD), Oslo Metropolitan University, Oslo, Norway; Department of Pediatrics (Prof N Kisson MD), School of Population and Public Health (J A Kopec PhD, Prof N Sarrafzadegan MD), University of British Columbia, Vancouver, BC, Canada; Arthritis Research Canada, Richmond, BC, Canada (J A Kopec PhD); Independent Consultant, Jakarta, Indonesia (S Kosen MD); Department of Internal and Pulmonary Medicine (Prof P A Koul MD), Sheri Kashmir Institute of Medical Sciences, Srinagar, India; Kasturba Medical College, Udupi, India (S Koulmane Laxminarayana MD); CIBERSAM (A Koyanagi MD), San Juan de Dios Sanitary Park, Sant Boi de Llobregat, Spain; Department of Anthropology (K Krishan PhD), Panjab University, Chandigarh, India; Department of Demography (Prof B Kuate Defo PhD), Department of Social and Preventive Medicine (Prof B Kuate Defo PhD), University of Montreal, Montreal, QC, Canada; Faculty of Medicine (B Kucuk Bicer PhD), Gazi University, Ankara, Turkey; Department of Psychiatry (M Kumar PhD), School of Public Health (R G Wamai PhD), University of Nairobi, Nairobi, Kenya; Faculty of Health and Life Sciences (O P Kurmi PhD), Coventry University, Coventry, UK; Department of Medicine (O P Kurmi PhD), Population Health Research Institute (T Sathish PhD), McMaster University, Hamilton, ON, Canada; Faculty of Public Health (D Kusuma DSc), University of Indonesia, Depok, Indonesia; Department of Clinical Sciences and Community Health (Prof C La Vecchia MD), University of Milan, Milan, Italy; National Institute for Health Research (NIHR) Oxford Biomedical Research Centre, Oxford, UK (B Lacey PhD); Department of Community and Family Medicine (F H Lami PhD), University of Baghdad, Baghdad, Iraq; Unit of Genetics and Public Health (Prof I Landires MD), Unit of Microbiology and Public Health (V Nuñez-Samudio PhD), Institute of Medical Sciences, Las Tablas, Panama; Department of Public Health (V Nuñez-Samudio PhD), Ministry of Health, Herrera, Panama (Prof I Landires MD); Department of Medical Sciences (Prof A O Larsson PhD), Uppsala University, Uppsala, Sweden; Department of Clinical Chemistry and Pharmacology (Prof A O Larsson PhD), Uppsala University Hospital, Uppsala, Sweden; Department of Otorhinolaryngology (S Lasrado MS), Father Muller Medical College, Mangalore, India; Institute of Clinical Physiology (P Lauriola MD), National Research Council, Pisa, Italy; School of Pharmacy (S W H Lee PhD), Monash University, Bandar Sunway, Malaysia; School of Pharmacy (S W H Lee PhD), Taylor's University Lakeside Campus, Subang Jaya, Malaysia; Graduate School of Public Health (Y Lee PhD), Ajou University, Suwon-si, South Korea; Oxford University Clinical Research Unit (S Lewycka PhD), Wellcome Trust Asia Programme, Hanoi, Vietnam; Department of Sociology (B Li PhD), Shenzhen University, Shenzhen, China; West China Second University Hospital (Prof J Liang MD, Prof Y Wang MD), National Office for Maternal and Child Health Surveillance, Chengdu, China; West China Second University Hospital (Prof J Liang MD, Prof Y Wang MD), National Center of Birth Defects Monitoring of China, Chengdu, China; Department of Medicine (L Lim MRCP), University of Malaya, Kuala Lumpur, Malaysia; Department of Medicine and Therapeutics (L Lim MRCP), The Chinese University of Hong Kong, Shatin, NT, China; Asbestos Diseases Research Institute, Concord, NSW, Australia (R Lin PhD); Department of Systems, Populations, and Leadership (X Liu PhD), University of Michigan, Ann Arbor, MI, USA; Department of Paediatrics (Prof R Lodha MD), Department of Psychiatry (Prof R Sagor MD), All India Institute of Medical Sciences, New Delhi, India; Melbourne School of Population and Global Health (Prof A D Lopez PhD), School of Health Sciences (A Meretoja MD), Department of Pediatrics (Prof G C Patton MD), University of Melbourne, Melbourne, VIC, Australia; Department of General Surgery (Prof R Lunevicius DSc), Liverpool University Hospitals NHS Foundation Trust, Liverpool, UK; Department of Surgery (Prof R Lunevicius DSc), Department of International Public Health (V E Nwatah MD), University of Liverpool, Liverpool, UK; Neurology Department (M T Mackay PhD), Royal Children's Hospital, Melbourne, VIC, Australia; Clinical Sciences Department (M T Mackay PhD), Population Health Theme (Prof G C Patton MD), Murdoch Childrens Research Institute, Melbourne, VIC, Australia; Department of Biochemistry (S Madhava Kunjathur MD), BGS Global Institute of Medical Sciences, Bengaluru, India; Department of Forensic Medicine & Toxicology (D Mahadeshwara Prasad MD), Mysore Medical College & Research Institute, Mysooru, India; Department of Public Health (M Maheri PhD), Urmia University of Medical Science, Urmia, Iran; Radiology and Precision Health Program (M Mahmoudi PhD), Michigan State University, East Lansing, MI, USA; Department of Forensic Medicine (Prof V Maled MD), Shri Dharmasthala Manjunatheshwara University, Dharwad, India; Department of Forensic Medicine (Prof V Maled MD), Rajiv Gandhi University of Health Sciences, Bangalore, India; Environmental Health Research Center (Prof A Maleki PhD), Social Determinants of Health Research Center (G Moradi PhD), Department of Epidemiology and Biostatistics (G Moradi PhD), Kurdistan University of Medical Sciences, Sanandaj, Iran; Department of Economics (Prof G Martinez PhD), Autonomous Technology Institute of Mexico, Mexico City, Mexico; Indonesian Public Health Association, Surabaya, Indonesia (S Martini PhD); Campus Caucaia (F R Martins-Melo PhD), Federal Institute of Education, Science and Technology of Ceará, Caucaia, Brazil; Department of Ophthalmology (C McAlinden PhD), Singleton Hospital, Swansea, UK; National Centre for Register-based Research (Prof J J McGrath MD), Aarhus University, Aarhus, Denmark; Department of Dentistry (C E Medina-Solis MSc), Autonomous University of Hidalgo State, Pachuca, Mexico; College of Medicine (Prof Z A Memish MD), Alfaisal University, Riyadh, Saudi Arabia; Research & Innovation Center (Prof Z A Memish MD), Ministry of Health, Riyadh, Saudi Arabia; Peru Country Office (W Mendoza MD), United Nations Population Fund (UNFPA), Lima, Peru; Center for Translation Research and Implementation Science (G A Mensah MD), National Institutes of Health, Bethesda, MD, USA; Department of Medicine (G A Mensah MD), School of Public Health and Family Medicine (C A Nnaji MPH, Prof C S Wiysonge MD), University of Cape Town, Cape Town, South Africa; Neurology Unit (A Meretoja MD), Breast Surgery Unit (T J Meretoja MD), Helsinki University Hospital, Helsinki, Finland; University of Helsinki, Helsinki, Finland (T J Meretoja MD); Clinical Microbiology and Parasitology Unit (T Mestrovic PhD), Zora Profozic Polyclinic, Zagreb, Croatia; University Centre Varazdin (T Mestrovic PhD), University North, Varazdin, Croatia; Center for Innovation in Medical Education (B Miazgowski MD), Department of Propedeutics of Internal Diseases & Arterial Hypertension (Prof T Miazgowski MD), Pomeranian Medical University, Szczecin, Poland (B Miazgowski MD); Woman-Mother-Child Department (I Michalek PhD), Lausanne University Hospital, Lausanne, Switzerland; Pacific Institute for Research & Evaluation, Calverton, MD, USA (T R Miller PhD); Global Institute of Public Health (Prof G Mini PhD), Ananthapuri Hospitals and Research Institute, Trivandrum, India; Women's Social and Health Studies Foundation,

Trivandrum, India (Prof G Mini PhD); Department of Environmental Health (M Miri PhD), Non-communicable Diseases Research Center (M Miri PhD), Sabzevar University of Medical Sciences, Sabzevar, Iran; Internal Medicine Programme (Prof E M Mirrakhimov PhD), Kyrgyz State Medical Academy, Bishkek, Kyrgyzstan; Department of Atherosclerosis and Coronary Heart Disease (Prof E M Mirrakhimov PhD), National Center of Cardiology and Internal Disease, Bishkek, Kyrgyzstan; Research Center for Biochemistry and Nutrition in Metabolic Diseases (H Mirzaei PhD), Kashan University of Medical Sciences, Kashan, Iran; Institute of Addiction Research (ISFF) (B Moazen MSc), Frankfurt University of Applied Sciences, Frankfurt, Germany; Department of Radiation Oncology (O Mohamad MD), University of California San Francisco, San Francisco, CA, USA; Department of Epidemiology and Biostatistics (A Mohammadian-Hafshejani PhD), Shahrekord University of Medical Sciences, Shahrekord, Iran; Health Systems and Policy Research Unit (S Mohammed PhD), Department of Community Medicine (M B Sufiyan MD), Department of Surgery (M A Tolani FWACS), Ahmadu Bello University, Zaria, Nigeria; Clinical Epidemiology and Public Health Research Unit (L Monasta DSc, L Ronfani PhD, E Traini MSc), Burlo Garofolo Institute for Maternal and Child Health, Trieste, Italy; Department of Biomedical and Dental Sciences and Morphofunctional Imaging (Prof S Mondello MD), Messina University, Messina, Italy; Computer, Electrical, and Mathematical Sciences and Engineering Division (P Moraga PhD), King Abdullah University of Science and Technology, Thuwal, Saudi Arabia; International Laboratory for Air Quality and Health (Prof L Morawska PhD), Queensland University of Technology, Brisbane, QLD, Australia; Section of Plastic Surgery (S D Morrison MD), University of Michigan School of Medicine, Ann Arbor, MI, USA; Department of Food Science (Prof A Mousavi Khaneghah PhD), University of Campinas (Unicamp), Campinas, Brazil; Department of Pediatric Medicine (Prof G Mustafa MD), The Children's Hospital & The Institute of Child Health, Multan, Pakistan; Department of Pediatrics & Pediatric Pulmonology (Prof G Mustafa MD), Institute of Mother & Child Care, Multan, Pakistan; Research and Analytics Department (A J Nagarajan MTech), Initiative for Financing Health and Human Development, Chennai, India; Department of Research and Analytics (A J Nagarajan MTech), Bioinsilico Technologies, Chennai, India; Department of Cardiology (B Naghshtabrizi MD), Hamedan University of Medical Sciences, Hamadan, Iran; Laboratory of Public Health Indicators Analysis and Health Digitalization (M Naimzada MD, N Ostavnov BA, S S Ostavnov PhD), Moscow Institute of Physics and Technology, Dolgoprudny, Russia; Experimental Surgery and Oncology Laboratory (M Naimzada MD), Kursk State Medical University, Kursk, Russia; Suraj Eye Institute, Nagpur, India (V Nangia MD); Mysore Medical College and Research Institute (Prof S Narasimha Swamy MD), Government Medical College, Mysore, India; Department of Biotechnology (M Naveed PhD), University of Central Punjab, Lahore, Pakistan; Department of Disease Control and Environmental Health (R Ndejo MSc), Makerere University, Kampala, Uganda; Department of General Surgery (I Negoï PhD), Emergency Hospital of Bucharest, Bucharest, Romania; Cardio-Aid, Bucharest, Romania (R I Negoï PhD); Department of Medicine (E Nena MD, P Steiropoulos MD), Democritus University of Thrace, Alexandroupolis, Greece; Department of Community Medicine (S Nepal MD), Kathmandu University, Palpa, Nepal; College of Medicine and Health Sciences (H B Netsere MS), Bahir Dar University, Gondar, Ethiopia; Department of Public Health (G Nguefack-Tsague PhD), University of Yaoundé I, Yaoundé, Cameroon; Department of Biological Sciences (J W Ngunjiri DrPH), University of Embu, Embu, Kenya; Department of Research Methodology and Biostatistics (C T Y Nguyen BSc), Vinmec Institute of Applied Sciences and Regenerative Medicine, Hanoi, Vietnam; Institute for Global Health Innovations (C T Nguyen MPH, H L T Nguyen MPH), Duy Tan University, Hanoi, Vietnam; Institute for Mental Health and Policy (Y T Nigatu PhD), Centre for Addiction and Mental Health, Toronto, ON, Canada; Department of Clinical Epidemiology (Y T Nigatu PhD), Institute for Clinical Evaluative Sciences, Ottawa, ON, Canada; Department of Public Health (S N Nigussie MPH), Mizan-Tepi University, Mizan Teferi, Ethiopia; South African Medical Research Council, Cape Town, South Africa (C A Nnaji MPH, Prof C S Wiysonge MD); Department of Health Policy and Management (S Nomura PhD), Keio University, Tokyo, Japan; Department of Global Health Policy (S Nomura PhD), University of Tokyo, Tokyo, Japan; Department of Gastroenterology (N M Noor MRCP), Cambridge University Hospitals, Cambridge, UK; Department of Pediatrics (V E Nwatah MD), National Hospital, Abuja, Nigeria; Administrative and Economic Sciences Department (Prof B Oancea PhD), University of Bucharest, Bucharest, Romania; Department of Community Health and Primary Care (O O Odukoya MSc), University of Lagos, Idi Araba, Nigeria; Department of Family and Preventive Medicine (O O Odukoya MSc), University of Utah, Salt Lake City, UT, USA; Translational Health Research Institute (F A Ogbo PhD), Western Sydney University, Sydney, NSW, Australia; Centre for Healthy Start Initiative, Lagos, Nigeria (B O Olusanya PhD, J O Olusanya MBA); Diplomacy and Public Relations Department (A Omar Bali PhD), University of Human Development, Sulaimaniyah, Iraq; Department of Pharmacology and Therapeutics (Prof O E Onwujekwe PhD), University of Nigeria Nsukka, Enugu, Nigeria; Department of Medicine (Prof A Ortiz MD), (Princess University Hospital) (Prof J B Soriano MD), Autonomous University of Madrid, Madrid, Spain; Department of Nephrology and Hypertension (Prof A Ortiz MD), The Institute for Health Research Foundation Jiménez Díaz University Hospital, Madrid, Spain; Department of Project Management (S S Ostavnov PhD), Department of Health Care Administration and Economics (Prof V Vlassov MD), National Research University Higher School of Economics, Moscow, Russia; Department of Respiratory Medicine (Prof M P A DNB), Jagadguru Sri Shivarathreeswara Academy of Health Education and Research, Mysore, India; Department of Medicine (S Pakhale MD), Ottawa Hospital Research Institute, Ottawa, ON, Canada; Department of Neurology (Prof P K Pal DM), National Institute of Mental Health and Neurosciences, Bangalore, India; Department of Health Metrics (A Pana MD), Center for Health Outcomes & Evaluation, Bucharest, Romania; Research Department (A Pandey MPH), Nepal Health Research Council, Kathmandu, Nepal; Research Department (A Pandey MPH), Public Health Research Society Nepal, Kathmandu, Nepal; Corporate (S R Pandi-Perumal MSc), Somnogen Canada Inc, Toronto, ON, Canada; National Institute of Health Research and Development (H U Pangaribuan MSc), Ministry of Health, Jakarta, Indonesia; Department of Medical Humanities and Social Medicine (Prof E Park PhD), Kosin University, Busan, South Korea; Department of Poverty, Gender and Youth (S K Patel PhD), Population Council, New Delhi, India; School of Public Health, Medical, and Veterinary Sciences (A E Peden PhD), James Cook University, Townsville, NSW, Australia; Center for Research and Innovation (V F Pepito MSc), Ateneo De Manila University, Pasig City, Philippines; Department of Orthopedics (J Pereira MS), Yenepoya Medical College, Mangalore, India; Departamento de Didáctica de la Expresión Musical, Plástica y Corporal (Prof J Pérez-Gómez PhD), University of Extremadura, Cáceres, Spain; Mario Negri Institute for Pharmacological Research, Bergamo, Italy (N Perico MD, Prof G Remuzzi MD); Department of Cardiology (T Pilgrim MD, S Stortecy MD), University of Bern, Bern, Switzerland; Division of Infectious Diseases and International Health (J A Platts-Mills MD), University of Virginia, Charlottesville, VA, USA; HIV and Mental Health Department (K N Pokhrel PhD), Integrated Development Foundation Nepal, Kathmandu, Nepal; University Medical Center Groningen (Prof M J Postma PhD), School of Economics and Business (Prof M J Postma PhD), University of Groningen, Groningen, Netherlands; Dietary Supplements and Probiotic Research Center (H Pourjafar PhD), School of Medicine (M Shams-Beyranvand MSc), Alborz University of Medical Sciences, Karaj, Iran; Centro de Investigaciones Clínicas (S I Prada PhD), Fundación Valle del Lili (Clinical Research Center, Valle del Lili Foundation), Cali, Colombia; Centro PROESA (PROESA Center) (S I Prada PhD), Centro de Investigaciones en Anomalías Congénitas y Enfermedades Raras (Center for Research in Congenital Anomalies and Rare Diseases) (E Rubagotti PhD), Universidad ICESI (ICESI University), Cali, Colombia; Department of Neurology (Prof S Prakash DM), Smt BKS Medical Institute and Research Center, Vadodara, India; Department of Chemistry (N Rabiee MSc), Sharif University of Technology, Tehran, Iran; College of Medicine (A Radfar MD), University of Central Florida, Orlando, FL, USA; Department of Medicine (A Rafiee MSc), University

of Alberta, Edmonton, AB, Canada; Department of Natural Science (S Rahimzadeh MSc), Middlesex University, London, UK; Department of Community Medicine (M Rahman PhD), Maharishi Markandeshwar Medical College & Hospital, Solan, India; Future Technology Research Center (A Rahmani PhD), National Yunlin University of Science and Technology, Yunlin, Taiwan; Institute of Research and Development (A Rahmani PhD), Duy Tan University, Da Nang, Vietnam; Department of Public Health (J Rana MPH), North South University, Dhaka, Bangladesh; Department of Biostatistics and Epidemiology (J Rana MPH), University of Massachusetts Amherst, Amherst, MA, USA; Research Department (C L Ranabhat PhD), Policy Research Institute, Kathmandu, Nepal; Health and Public Policy Department (C L Ranabhat PhD), Global Center for Research and Development, Kathmandu, Nepal; Department of Oral Pathology (S Rao MDS), Srinivas Institute of Dental Sciences, Mangalore, India; University College London Hospitals, London, UK (D L Rawaf MD); Academic Public Health England (Prof S Rawaf MD), Public Health England, London, UK; River Region Cardiology Associates, Montgomery, WV, USA (W F Rawasia MD); School of Medicine (Prof A M N Renzaho PhD), Translational Health Research Institute (Prof A M N Renzaho PhD), Western Sydney University, Campbelltown, NSW, Australia; Brien Holden Vision Institute, Sydney, Australia (Prof S Resnikoff MD); Network of Immunity in Infection, Malignancy and Autoimmunity (NIIMA) (Prof N Rezaei PhD), Universal Scientific Education and Research Network (USERN), Tehran, Iran; Department of Surgery (J Rickard MD), University of Minnesota, Minneapolis, MN, USA; Department of Surgery (J Rickard MD), University Teaching Hospital of Kigali, Kigali, Rwanda; Department of Clinical Research (L Roever PhD), Federal University of Uberlândia, Uberlândia, Brazil; Institute of Epidemiology and Medical Biometry (Prof D Rothenbacher MD), Ulm University, Ulm, Germany; African Genome Center (E Rubagotti PhD), Mohammed VI Polytechnic University (UM6P), Ben Guerir, Morocco; Malaria Atlas Project (S F Rumisha PhD), Telethon Kids Institute, Perth, WA, Australia; Department of Health Statistics (S F Rumisha PhD), National Institute for Medical Research, Dar es Salaam, Tanzania; Applied Biomedical Research Center (A Sahebkar PhD), Biotechnology Research Center (A Sahebkar PhD), Mashhad University of Medical Sciences, Mashhad, Iran; Public Health and Community Medicine Department (M R Salem MD), Cairo University, Giza, Egypt; Faculty of Medicine (Y L Samodra MPH), Duta Wacana Christian University, Yogyakarta, Indonesia; Department of Surgery (Prof J Sanabria MD), Marshall University, Huntington, WV, USA; Department of Nutrition and Preventive Medicine (Prof J Sanabria MD), Case Western Reserve University, Cleveland, OH, USA; Department of Community Medicine (S Y Saraswathy PhD), PSG Institute of Medical Sciences and Research, Coimbatore, India; PSG-FAIMER South Asia Regional Institute, Coimbatore, India (S Y Saraswathy PhD); Health Economics Department (A R Sarker PhD), Bangladesh Institute of Development Studies (BIDS), Dhaka, Bangladesh; Department of Geriatrics and Long Term Care (B Sathian PhD), Hamad Medical Corporation, Doha, Qatar; Faculty of Health & Social Sciences (B Sathian PhD), Bournemouth University, Bournemouth, UK; Department of Preventive and Social Medicine (G Saya MD), Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry, India; Market Access (M Saylan MD), Bayer, Istanbul, Turkey; Hypertension and Kidney Disease Laboratory (Prof M P Schlaich MD), Baker Heart and Diabetes Institute, Melbourne, VIC, Australia; Department of Psychology (D C Schwebel PhD), School of Medicine (Prof J A Singh MD), University of Alabama at Birmingham, Birmingham, AL, USA; Oral Diagnosis, Digital Health and Health Services Research (Prof F Schwendicke PhD), Charité University Medical Center Berlin, Berlin, Germany; Emergency Department (S Senthilkumaran MD), Manian Medical Centre, Erode, India; Center for Biomedical Information Technology (F Sha PhD), Shenzhen Institutes of Advanced Technology, Shenzhen, China; Public Health Division (A A Shaheen PhD), An-Najah National University, Nablus, Palestine; Department of Internal Medicine (I Shahid MBBS), Ziauddin University, Karachi, Pakistan; Independent Consultant, Karachi, Pakistan (M A Shaikh MD); Department of Community Medicine (M Shannawaz PhD), BLDE University, Vijayapur, India; Centre for Medical Informatics (Prof A Sheikh MD), University of Edinburgh, Edinburgh, UK; National Institute of Infectious Diseases, Tokyo, Japan (M Shigematsu PhD); College of Medicine (Prof J Shin MD), Yonsei University, Seoul, South Korea; Finnish Institute of Occupational Health, Helsinki, Finland (R Shiri PhD); Research Executive Agency (I Shiue PhD), European Commission, Brussels, Belgium; School of Public Health (K Shuval PhD), University of Haifa, Haifa, Israel; The Cooper Institute, Dallas, TX, USA (K Shuval PhD); Department of Medicine (T J Siddiqi MB), Department of Internal Medicine (M S Usman MB), Department of Pharmaceutics (S Zaidi PhD), Dow University of Health Sciences, Karachi, Pakistan; Department of Psychology (Prof I D Sigfusdottir PhD), R Sigurvinsdottir PhD), Reykjavik University, Reykjavik, Iceland; Department of Health and Behavior Studies (Prof I D Sigfusdottir PhD), Graduate School of Architecture, Planning and Preservation (C B Swope MPH), Columbia University, New York, NY, USA; Department of Dermatology (J I S Silverberg MD), George Washington University, Washington, DC, USA; Department of Law, Economics, Management and Quantitative Methods (Prof B Simonetti PhD), University of Sannio, Benevento, Italy; WSB University in Gdansk, Gdansk, Poland (Prof B Simonetti PhD); School of Public Health & Zoonoses (B B Singh PhD), Guru Angad Dev Veterinary & Animal Sciences University, Ludhiana, India; Medicine Service (Prof J A Singh MD), US Department of Veterans Affairs, Birmingham, AL, USA; Department of Ophthalmology (Prof D Singhal MD), Gmers Medical College and Civil Hospital, Ahmedabad, India; Department of Epidemiology (D N Sinha PhD), School of Preventive Oncology, Patna, India; Department of Epidemiology (D N Sinha PhD), Healis Sekhsaria Institute for Public Health, Mumbai, India; Department of Ophthalmology (E Skiadaresi MD), Hywel Dda University Health Board, Llanelli, UK; Department No16 (V Y Skryabin MD), Laboratory of Genetics and Genomics (Prof M S Zastrozhin PhD), Moscow Research and Practical Centre on Addictions, Moscow, Russia; Therapeutic Department (A A Skryabina MD), Balashiha Central Hospital, Balashikha, Russia; Division of Injury Prevention (Prof D A Sleet PhD), Centers for Disease Control and Prevention (CDC), Atlanta, GA, USA; Rollins School of Public Health (Prof D A Sleet PhD), Emory University, Atlanta, GA, USA; Department of Pediatrics (B H Sobaih MD), King Khalid University Hospital, Riyadh, Saudi Arabia; Centro de Investigación Biomédica en Red Enfermedades Respiratorias (CIBERES) (Center for Biomedical Research in Respiratory Diseases Network), Madrid, Spain (Prof J B Soriano MD); Division of Community Medicine (C T Sreeramareddy MD), International Medical University, Kuala Lumpur, Malaysia; Department of Statistics (R Suliankatchi Abdulkader MD), Manonmaniam Sundaranar University, Abishekapatti, India; National Institute of Epidemiology (R Suliankatchi Abdulkader MD), Indian Council of Medical Research, Chennai, India; Norwegian Institute of Public Health, Bergen, Norway (G Sulo PhD); Department of Criminology, Law, and Society (Prof B L Sykes PhD), University of California Irvine, Irvine, CA, USA; Department of Dermatology (M D Szeto BS), University of Colorado, Aurora, CO, USA; Department of Medicine (Prof R Tabarés-Seisdedos PhD), University of Valencia, Valencia, Spain; Carlos III Health Institute (Prof R Tabarés-Seisdedos PhD), Biomedical Research Networking Center for Mental Health Network (CiberSAM), Madrid, Spain; Department of Population Science and Human Resource Development (Prof M I Tareque PhD), University of Rajshahi, Rajshahi, Bangladesh; Department of Public Health and Community Medicine (Prof K R Thankappan MD), Central University of Kerala, Kasaragod, India; Department of Pathology and Legal Medicine (M R Tovani-Palone PhD), University of São Paulo, Ribeirão Preto, Brazil; Modestum LTD, London, UK (M R Tovani-Palone PhD); Department of Health Economics (B X Tran PhD), Hanoi Medical University, Hanoi, Vietnam; Department of Community Medicine (J P Tripathy MD), All India Institute of Medical Sciences, Nagpur, India; Faculty of Engineering and Technology (G Tsapparellas MSc), Liverpool John Moores University, Liverpool, UK; Department of Medicine (Prof A Tsatsakis DSc), University of Crete, Heraklion, Greece; Lee Kong Chian School of Medicine (L Tudor Car PhD), Nanyang Technological University, Singapore, Singapore; Institute for Physical Activity and Nutrition (R Uddin PhD), Deakin University, Melbourne, VIC, Australia; Multidisciplinary Department (A Ullah MS), National University of

Medical Sciences (NUMS), Rawalpindi, Pakistan; Department of Community Medicine (C D Umeokonkwo MPH), Alex Ekwueme Federal University Teaching Hospital Abakaliki, Abakaliki, Nigeria; Department of Cardiovascular, Endocrine-metabolic Diseases and Aging (B Unim PhD), National Institute of Health, Rome, Italy; Amity Institute of Biotechnology (E Upadhyay PhD), Amity University Rajasthan, Jaipur, India; Clinical Cancer Research Center (S Valadan Tahbaz PhD, S Yahyazadeh Jabbari MD), Milad General Hospital, Tehran, Iran; Velez Sarsfield Hospital, Buenos Aires, Argentina (Prof P R Valdez MEd); UKK Institute, Tampere, Finland (Prof T J Vasankari MD); Raffles Neuroscience Centre (Prof N Venkatasubramanian MBBS), Raffles Hospital, Singapore, Singapore; Yong Loo Lin School of Medicine (Prof N Venkatasubramanian MBBS), National University of Singapore, Singapore, Singapore; Department of Community Medicine and Family Medicine (M Verma MD), All India Institute of Medical Sciences, Bathinda, India; Department of Medical and Surgical Sciences (Prof F S Violante MD), University of Bologna, Bologna, Italy; Occupational Health Unit (Prof F S Violante MD), Sant'Orsola Malpighi Hospital, Bologna, Italy; Faculty of Information Technology (B Vo PhD), Ho Chi Minh City University of Technology (HUTECH), Ho Chi Minh City, Vietnam; Center of Excellence in Behavioral Medicine (G T Vu BA), Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam; Foundation University Medical College (Prof Y Waheed PhD), Foundation University Islamabad, Islamabad, Pakistan; Demographic Change and Aging Research Area (A Werdecker PhD), Competence Center of Mortality-Follow-Up of the German National Cohort (R Westerman DSc), Federal Institute for Population Research, Wiesbaden, Germany; Department of Community Medicine (N D Wickramasinghe MD), Rajarata University of Sri Lanka, Anuradhapura, Sri Lanka; Department of Orthopaedics (Prof A Wu MD), Wenzhou Medical University, Wenzhou, China; Department of Behavior and Operation Management (Y Xie MD), Beijing Advanced Innovation Center for Big Data-based Precision Medicine, Beijing, China; Division of Cardiology (S Yandrapalli MD), New York Medical College, Valhalla, NY, USA; Division of Cardiology (S Yandrapalli MD), Westchester Medical Center, Valhalla, NY, USA; Health Services Management Research Center (V Yazdi-Feyzabadi PhD), Department of Health Management, Policy, and Economics (V Yazdi-Feyzabadi PhD), Kerman University of Medical Sciences, Kerman, Iran; Department of Neuropsychopharmacology (N Yonemoto MPH), National Center of Neurology and Psychiatry, Kodaira, Japan; Department of Public Health (N Yonemoto MPH), Juntendo University, Tokyo, Japan; Department of Preventive Medicine (Prof S Yoon PhD), Korea University, Seoul, South Korea; Department of Health Policy and Management (Prof M Z Younis PhD), Jackson State University, Jackson, MS, USA; School of Medicine (Prof M Z Younis PhD), Tsinghua University, Beijing, China; Department of Epidemiology and Biostatistics (Prof C Yu PhD), School of Medicine (Z Zhang PhD), School of Health Sciences (X G Zhao PhD), Wuhan University, Wuhan, China; Technology Enabled Girl Ambassadors (TEGA) Programme (S S Yusuf MPH), Girl Effect, London, UK; Maternal and Child Health Division (S Zaman MPH), International Centre for Diarrhoeal Disease Research, Bangladesh, Dhaka, Bangladesh; Addictology Department (Prof M S Zastrozhin PhD), Pediatrics Department (A Zastrozhina PhD), Russian Medical Academy of Continuous Professional Education, Moscow, Russia; School of Public Health (Y Zhang PhD), Hubei Province Key Laboratory of Occupational Hazard Identification and Control (Y Zhang PhD), Wuhan University of Science and Technology, Wuhan, China; School of Biology and Pharmaceutical Engineering (X G Zhao PhD), Wuhan Polytechnic University, Wuhan, China.

Declaration of interests

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Data sharing

To download the data used in these analyses, please visit the Global Health Data Exchange at <http://ghdx.healthdata.org/gbd-2019>.

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