Global fertility in 204 countries and territories, 1950–2021, with forecasts to 2100: a comprehensive demographic analysis for the Global Burden of Disease Study 2021

*GBD 2021 Fertility and Forecasting Collaborators**

Summary

Background Accurate assessments of current and future fertility—including overall trends and changing population age structures across countries and regions—are essential to help plan for the profound social, economic, environmental, and geopolitical challenges that these changes will bring. Estimates and projections of fertility are necessary to inform policies involving resource and health-care needs, labour supply, education, gender equality, and family planning and support. The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2021 produced up-to-date and comprehensive demographic assessments of key fertility indicators at global, regional, and national levels from 1950 to 2021 and forecast fertility metrics to 2100 based on a reference scenario and key policy-dependent alternative scenarios.

Methods To estimate fertility indicators from 1950 to 2021, mixed-effects regression models and spatiotemporal Gaussian process regression were used to synthesise data from 8709 country-years of vital and sample registrations, 1455 surveys and censuses, and 150 other sources, and to generate age-specific fertility rates (ASFRs) for 5-year age groups from age 10 years to 54 years. ASFRs were summed across age groups to produce estimates of total fertility rate (TFR). Livebirths were calculated by multiplying ASFR and age-specific female population, then summing across ages 10–54 years. To forecast future fertility up to 2100, our Institute for Health Metrics and Evaluation (IHME) forecasting model was based on projections of completed cohort fertility at age 50 years (CCF50; the average number of children born over time to females from a specified birth cohort), which yields more stable and accurate measures of fertility than directly modelling TFR. CCF50 was modelled using an ensemble approach in which three sub-models (with two, three, and four covariates variously consisting of female educational attainment, contraceptive met need, population density in habitable areas, and under-5 mortality) were given equal weights, and analyses were conducted utilising the MR-BRT (meta-regression—Bayesian, regularised, trimmed) tool. To capture time-series trends in CCF50 not explained by these covariates, we used a first-order autoregressive model on the residual term. CCF50 as a proportion of each 5-year ASFR was predicted using a linear mixed-effects model with fixed-effects covariates (female educational attainment and contraceptive met need) and random intercepts for geographical regions. Projected TFRs were then computed for each calendar year as the sum of single-year ASFRs across age groups. The reference forecast is our estimate of the most likely fertility future given the model, past fertility, forecasts of covariates, and historical relationships between covariates and fertility. We additionally produced forecasts for multiple alternative scenarios in each location: the UN Sustainable Development Goal (SDG) for education is achieved by 2030; the contraceptive met need SDG is achieved by 2030; pro-natal policies are enacted to create supportive environments for those who give birth; and the previous three scenarios combined. Uncertainty from past data inputs and model estimation was propagated throughout analyses by taking 1000 draws for past and present fertility estimates and 500 draws for future forecasts from the estimated distribution for each metric, with 95% uncertainty intervals (UIs) given as the 2·5 and 97·5 percentiles of the draws. To evaluate the forecasting performance of our model and others, we computed skill values—a metric assessing gain in forecasting accuracy—by comparing predicted versus observed ASFRs from the past 15 years (2007–21). A positive skill metric indicates that the model being evaluated performs better than the baseline model (here, a simplified model holding 2007 values constant in the future), and a negative metric indicates that the evaluated model performs worse than baseline.

Findings During the period from 1950 to 2021, global TFR more than halved, from 4·84 (95% UI 4·63–5·06) to 2·23 (2·09–2·38). Global annual livebirths peaked in 2016 at 142 million (95% UI 137–147), declining to 129 million (121–138) in 2021. Fertility rates declined in all countries and territories since 1950, with TFR remaining above 2·1—canonically considered replacement-level fertility—in 94 (46·1%) countries and territories in 2021. This included 44 of 46 countries in sub-Saharan Africa, which was the super-region with the largest share of livebirths in 2021 (29·2% [28·7–29·6]). 47 countries and territories in which lowest estimated fertility between 1950 and 2021 was below replacement experienced one or more subsequent years with higher fertility; only three of these locations rebounded above replacement levels. Future fertility rates were projected to continue to decline worldwide, reaching a global TFR of 1·83 (1·59–2·08) in 2050 and 1·59 (1·25–1·96) in 2100 under the reference scenario. The number of countries and territories with fertility rates remaining above replacement was forecast to be 49 (24·0%) in 2050 and

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*Collaborators are listed at the end of the Article

Correspondence to: Prof Simon I Hay, Institute for Health Metrics and Evaluation, University of Washington, Seattle, WA 98195, USA **sihay@uw.edu**

only six (2·9%) in 2100, with three of these six countries included in the 2021 World Bank-defined low-income group, all located in the GBD super-region of sub-Saharan Africa. The proportion of livebirths occurring in sub-Saharan Africa was forecast to increase to more than half of the world's livebirths in 2100, to 41·3% (39·6–43·1) in 2050 and 54·3% (47·1–59·5) in 2100. The share of livebirths was projected to decline between 2021 and 2100 in most of the six other super-regions—decreasing, for example, in south Asia from 24·8% (23·7–25·8) in 2021 to 16·7% (14·3–19·1) in 2050 and 7·1% (4·4–10·1) in 2100—but was forecast to increase modestly in the north Africa and Middle East and high-income super-regions. Forecast estimates for the alternative combined scenario suggest that meeting SDG targets for education and contraceptive met need, as well as implementing pro-natal policies, would result in global TFRs of 1·65 (1·40–1·92) in 2050 and 1·62 (1·35–1·95) in 2100. The forecasting skill metric values for the IHME model were positive across all age groups, indicating that the model is better than the constant prediction.

Interpretation Fertility is declining globally, with rates in more than half of all countries and territories in 2021 below replacement level. Trends since 2000 show considerable heterogeneity in the steepness of declines, and only a small number of countries experienced even a slight fertility rebound after their lowest observed rate, with none reaching replacement level. Additionally, the distribution of livebirths across the globe is shifting, with a greater proportion occurring in the lowest-income countries. Future fertility rates will continue to decline worldwide and will remain low even under successful implementation of pro-natal policies. These changes will have far-reaching economic and societal consequences due to ageing populations and declining workforces in higher-income countries, combined with an increasing share of livebirths among the already poorest regions of the world.

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Introduction

Characterising trends in key demographic indicators of fertility and projecting estimates into the future are essential to understand the impact of changing birth rates on social, economic, and geopolitical systems, both now and in the coming century. Dynamics in fertility patterns are central to the well established concept of the demographic transition,[1,2] which classically holds that societies will passage from a condition of high fertility and high mortality with more young than old people to a state of low fertility and low mortality with an increasingly older population. Some theorists have proposed the concept of a demographic dividend, whereby declining fertility rates lead temporarily to higher proportions of working adults available to generate resources and capital, potentially stimulating economic growth and eventual rebounds in fertility rates.[3] Demographic data in the 5 years preceding 2021 demonstrate that the total fertility rate (TFR) in some countries has fallen below replacement levels—the minimum rate necessary for generational replacement of the population assuming no migration—with no evidence of this predicted rebound.[4–7] The replacement level is generally accepted to be a TFR of at least 2·1, although the true replacement level depends on the specific mortality rate and sex ratio at birth in a population.[8] Low levels of fertility have the potential over time to result in inverted population pyramids with growing numbers of older people and declining working-age populations. These changes are likely to place increasing burdens on health care and social systems, transform labour and consumer markets, and alter patterns of resource use. Accurate estimates and future forecasts of fertility rates and their impact on population age structures are therefore essential to anticipate potential economic and geopolitical consequences and to inform the development of effective health, environmental, and economic policies.

At present, an important source of fertility estimates and future forecasts for countries and areas throughout the world has been the Population Division of the UN Department of Economic and Social Affairs, which most recently produced the 2022 Revision of World Population Prospects (WPP 2022).[5] The UN Population Division estimates of past fertility are not compliant with the Guidelines on Accurate and Transparent Health Estimates Reporting (GATHER) statement in important respects; notably, they do not provide all code for statistical models or explicit details on criteria for exclusion or adjustment of primary data sources. Furthermore, the validity of UN Population Division projections has been questioned due to the assumptions applied in countries experiencing low post-transition fertility dropping below replacement level.[9,10] Previous UN Population Division forecasts have assumed that, in such circumstances, fertility rates will increase towards replacement levels,[11–13] and WPP 2022 assumes convergence to a rate that is a combination of country-specific historical rates and the mean rate in low-fertility countries that have experienced fertility increases.[14] The WPP 2022 projects gradual increases in TFR even in countries that have shown no evidence of fertility rate increases, such as South Korea and Thailand.[6,14–17] Additionally, UN Population Division

Research in context

Evidence before this study

Since the 1950s, global and national estimates and projections of key fertility indicators have been produced and regularly updated by the Population Division of the UN Department of Economic and Social Affairs, with the most recent iteration being the 2022 Revision of World Population Prospects. Assessments of fertility at national and subnational levels worldwide have also been conducted by the US Census Bureau since the 1960s, with estimates reported in the Bureau's International Database. More recently, fertility estimates and projections have been generated by the Wittgenstein Centre for Demography and Global Human Capital and by the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD), an ongoing, large-scale research enterprise that systematically analyses worldwide data to assess global health trends. Past estimates of fertility have been produced as part of GBD since 2017, and future forecasts based on GBD findings were first published in 2020.

Added value of this study

Of the existing large-scale efforts to estimate worldwide trends in fertility, only GBD analyses are compliant with the Guidelines on Accurate and Transparent Health Estimates Reporting (GATHER) statement. This study also incorporates several important innovations introduced by the GBD population forecasting study by Vollset and colleagues in 2020 that support forecasting accuracy assessment and provide a framework by which to explore the impact of various policy scenarios on fertility patterns. These methods include: basing the GBD forecasting model on a measure of cohort fertility (completed cohort fertility at age 50 years, CCF50) that reflects the number of children born over time to females from a specific cohort, which better captures long-term choices people make about childbearing—such as delaying having children—than does the classic period-based measure of total fertility rate; and incorporating measures of female education and met need for modern contraceptives as covariates, which improves accuracy and allows for modelling alternative scenarios by changing levels of these indicators. In contrast to other models that assume rates in countries currently experiencing low fertility will tend to increase over time, or those that base their projections on expert judgements, GBD fertility forecasting methods are grounded in existing, real-world evidence about fertility patterns in long-term cohorts of females and in data on related evidence-based covariates such as education and contraception. GBD 2021 has further improved the estimation of past, current, and future fertility in four important ways. First, an additional 147 surveys, 21 censuses, and 634 country-years of vital and sample registration data were added for estimation of past fertility trends. Second, smoothing parameters for estimating past fertility trends were updated to better fit available data. Third, to further improve specificity and accuracy of future fertility projections, two additional covariates were included that account for urbanicity (defined here as population density in habitable areas) and under-5 mortality in the CCF50 model. Fourth, we added a pro-natal alternative scenario to help policy makers plan interventions in countries with fertility rates below replacement level. Based on a skill metric designed to evaluate forecasting accuracy, the model presented here performed better across all age groups compared with a constant prediction.

Implications of all the available evidence

Our past estimates and future forecasts indicate that fertility rates are declining everywhere and are projected to continue to decrease over the coming century. By 2100, we estimate that fertility rates will be below replacement level in more than 95% of the world's countries and territories but that marked disparities in rates will remain. Our forecasts also suggest that, by 2100, the largest concentrations of livebirths will shift to low-income settings, particularly a subset of countries and territories in sub-Saharan Africa, which are among the most vulnerable to economic and environmental challenges. Extreme shifts in the global distribution of livebirths can be partially ameliorated by improved female education and met need for modern contraception. Outside of this subset of low-income areas, most of the world's countries will experience the repercussions of low fertility, with ageing populations, declining workforces, and inverted population pyramids, which are likely to lead to profound fiscal, economic, and social consequences. National policy makers and the global health community must plan to address these divided sets of demographic challenges emerging worldwide.

models are based on TFR, which is a period measure and therefore does not account for change over time in fertility behaviours. For example, in settings where fertility rates in older women increase due to choices to delay births, TFR would underestimate fertility forecasts. Reliance on TFR can also lead to short-term fluctuations in estimated fertility forecasts that are especially impactful in countries with low fertility rates.[18] Moreover, their projections forecast TFR solely as a function of time and do not include other covariates to inform the models, which disregards potentially explanatory data and precludes investigating the effects of alternative policy-related scenarios or other drivers of fertility. The US Census Bureau International Database has also provided worldwide fertility estimates and projections, currently in 227 countries, since the 1960s, but country-specific updates are not performed on a regular basis.[19] Since the 1990s, global and regional fertility forecasts have also been generated by the World Population Program of the International Institute for Applied Systems Analysis,[20] with country-level projections more recently produced by an affiliated group, the Wittgenstein Centre for Demography and Global Human Capital.[21,22] These forecasts rely on

assumptions informed by expert opinions from demographic scientists to predict future fertility rates.[21–23]

The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) is an ongoing, large-scale research enterprise that characterises the state of global health by estimating key health metrics at global, regional, and national levels.[24] Beginning with the 2017 GBD cycle, past and current fertility estimates generated as part of the GBD analytic framework were published;[25] before that, estimates from the UN Population Division were used as inputs to GBD analytic processes.[26,27] For GBD 2019, past and current fertility estimates were reported jointly with mortality, life expectancy, and population measures in a publication focused on overall demographic estimates,[28] and GBD-based forecasts of population and fertility up to 2100 were reported separately by Vollset and colleagues in 2020.[5] GBD fertility estimates are based on clear data and methods applying a standardised approach, providing publicly available code. Vollset and colleagues addressed some of the existing issues regarding the use of TFR in the modelling process by developing an Institute for Health Metrics and Evaluation (IHME) forecasting model based instead on completed cohort fertility at age 50 years (CCF50: the average number of children born over time to females from a specified birth cohort)[29] to capture change over time in fertility behaviours, which yields more stable and accurate fertility estimates. Vollset and colleagues[4] also included covariates representing female educational attainment and contraceptive met need (a measure of the proportion of females of reproductive age whose need for contraception has been met with modern contraceptive methods) to better inform fertility estimates and facilitate exploration of alternative future scenarios associated with achievement of UN Sustainable Development Goals (SDGs) related to education and contraception.

See Online for appendix 1

For the **GBD Sources Tool** see https://ghdx.healthdata.org/gbd-2021/sources

The present GBD 2021 study focuses on fertility metrics, presenting past estimates (1950–2021) along with forecasts up to 2100. Results were improved since GBD 2019 and the 2020 study by Vollset and colleagues by incorporating newly available demographic data and through key methodological advances. This paper provides a high-level overview of our findings. We anticipate that the results will provide insights for policy makers and will be used as a tool to help plan and shape future policies to better prepare for profound changes in global fertility.

This paper was produced as part of the GBD Collaborator Network and in accordance with the GBD Protocol.[30]

Methods

Overview

For each subsequent GBD round, newly available data and updated methods are used to update the full time series of estimates from 1950 up to the latest year of analysis. As a consequence, GBD 2021 estimates supersede all previous estimates. GBD 2021 estimated key fertility metrics in females between ages 10 years and 54 years in 204 countries and territories grouped into 21 regions and seven super-regions. GBD regions are made up of countries and territories that are geographically close and epidemiologically similar.[31] These regions are then grouped into super-regions based on cause of death patterns. The full GBD location hierarchy is shown in appendix 1 (table S1). GBD 2021 drew on the expertise of more than 11 000 collaborators across more than 160 countries and territories. The GBD 2021 fertility analysis framework produced estimates for every year from 1950 to 2021 and forecasts up to 2100.

The methods used to produce fertility estimates from 1950 to 2021 closely followed those of GBD 2019.[28] Methods used to generate fertility forecasts to 2100 were based on a modified and revised version of the modelling approach used in the 2020 study by Vollset and colleagues.[4] These methods have been peer-reviewed over previous GBD rounds and as part of the peer-review process for GBD 2021. Here we provide an overview of the methods with an emphasis on the main changes since GBD 2019 and the 2020 study by Vollset and colleagues;[4,28] a more comprehensive description of the analytical methods for GBD 2021 is provided in appendix 1. Additional details on specific data inputs are accessible through the GBD Sources Tool.

Data sources and processing

We systematically searched for accurate and complete data on livebirths reported according to the age of mothers. In many high-income countries and territories, these data were available from high-quality vital registration systems, but in many lower-income countries, birth registries were incomplete, interrupted, or delayed; in these instances, we instead relied on complete and summary birth histories in censuses and household surveys. Fertility rates from vital registration data were calculated as observed births divided by population estimates. Complete and summary birth history data were collapsed from the available microdata and sample weights applied to calculated age-specific fertility rates (ASFRs) and number of children ever born, respectively. A full description of data seeking and synthesis is provided in appendix 1 (section 2.1). In total, we compiled 58 072 unique location-source-years of data for females aged 10–54 years for the period between 1950 and 2021 (number of sources by location and by year can be found in appendix 1 tables S3 and S4). At the national level, we obtained 8680 unique country-source-years of vital registration data, with an additional 29 country-source-years of data from sample registration systems. We additionally extracted data on period ASFR, or average number of children ever born from surveys and censuses that yielded 735 complete birth histories,

879 summary birth histories, and 28 unclassified forms of birth histories (details are in appendix 1 tables S3 and S4).

Throughout the forecasting modelling processes, we used female education, under-5 mortality, met need for contraceptive use, and population density in habitable areas as covariates. Details of these covariates are available in appendix 1 (section 3.1).

Fertility from 1950 to 2021

GBD 2021 estimates of fertility metrics between 1950 and 2021 were based on a systematic synthesis of all available data for all GBD locations. The fertility estimation process was closely connected to parallel, concordant modelling of population and mortality, with population estimates used iteratively to generate inputs to fertility estimation models and vice versa.[28] GBD methods are designed to account for the diversity of data available and the different biases inherent in various data sources, with customised data processing and data synthesis steps implemented to account for known biases, missing data, and heterogeneous measurement metrics used across data sources. Estimation of fertility rates between 1950 and 2021 for females ages 10–54 years largely followed the methods used in GBD 2019.[28] First, ASFRs were estimated for 5-year age groups between 15 years and 49 years only using age-specific vital registration and complete birth history data. These results were used to split all-age data from vital registration, summary birth history, and other sources into ASFRs, and then another model was fit to estimate ASFRs using the original age-specific ASFR data from vital registration and complete birth history along with these age-split data. Next, we extended these estimates to the age groups of 10–14 years and 50–54 years using data from these ages and adjacent age groups. Finally, ASFR estimates were used to calculate TFR. A summary of these methods follows, with a comprehensive description provided in appendix 1 (section 2).

To estimate ASFRs by 5-year age groups for females aged 15–49 years, we implemented mixed-effects regression models using bounded logit(ASFR) as the outcome. The 20–24-years age group was estimated first, and these estimates were used to model the remaining age groups. Both sets of models were fit separately for the high-income, sub-Saharan Africa, and central Europe, eastern Europe, and central Asia super-regions to account for differences in the relationships between the ASFR of the 20–24-years age group and that of other age groups. ASFRs in the 20–24-years age group were modelled with female educational attainment as a covariate and random intercepts for each location source. Then, we separately modelled ASFRs in the remaining age groups between 15 years and 49 years using a linear spline on the logit(ASFR) in the 20–24-years age group. The selection of spline knots varied by super-region and age group. These models also included female educational attainment as a covariate, except in the high-income super-region, and random intercepts for each location source. After running these mixed-effects models, we corrected for systematic differences across data sources by selecting a reference source for each location and adjusting other sources based on their discrepancy from the reference source. Last, a spatiotemporal Gaussian process regression (ST-GPR) was used to smooth ASFRs across location and time, producing final point estimates and uncertainty intervals (UIs).

First-round ASFR estimates were generated from this modelling approach using age-specific vital registration and complete birth history data. To split total birth data from vital registration data, summary birth histories, and other sources into ASFRs, we calculated the ratio of the parity implied by each total birth data source to the parity estimated in this first-round ASFR model. This ratio was then multiplied by the estimated ASFRs from the first-round model. These age-split data were incorporated into a second round of estimation for each location using the same modelling approach described earlier. To generate estimates for ages 10–14 years and 50–54 years, we estimated the ratio of ASFR to the adjacent age group using all available data, then applied these ratios to the second-round ASFR estimates. We used a mixed-effects regression model to estimate location-specific ratios for ages 10–14 years, whereas we calculated the average ratio across all locations for ages 50–54 years. Finally, TFR was calculated by multiplying the ASFRs from each 5-year age group by five and summing.

Fertility forecasting

We produced forecasts of fertility using an updated modelling framework (appendix 1 section 3) that improved on the methods in the 2020 study by Vollset and colleagues.[4] In our updated methods, we used not only estimates of female educational attainment and contraceptive met need as covariates, but also estimates of under-5 mortality and population density in habitable areas to account for a larger variation in CCF50 across all countries in the sub-models (appendix 1 section 3.1, appendix 2 figure S2). Similar to Vollset and colleagues, we continued to forecast fertility with CCF50 rather than TFR, because modelling in cohort space is more stable than in period space. For this analysis, we used past CCF50 estimates for birth cohorts from 1945 to 1972 to forecast CCF50 up to the 2085 birth cohort of females, followed by predicting ASFR for each 5-year age interval as a proportion of CCF50. CCF50 was defined as the average number of children born to an individual female from an observed birth cohort (indexed by year of birth) if she lived to the end of her reproductive lifespan (ages 15–49 years). CCF50 was forecast using an ensemble modelling approach with three equally weighted sub-models (with two, three, and four covariates) in which each sub-model utilised the MR-BRT (meta-regression—Bayesian, regularised, trimmed) tool.[32] For example, the

See Online for appendix 2

four-covariate sub-model was represented by the following equation:

$$\begin{aligned} logit_{(0\cdot7,10)}(CCF50_{lc}) = {} & \beta_0 + spline(education_{lc}) \times \boldsymbol{\beta_1} \\ & + met\ need_{lc} \times \beta_2 \\ & + under\text{-}5\ mortality_{lc} \times \beta_3 \\ & + population\ density\ per\ habitable\ area_{lc} \times \beta_4 \\ & + \varepsilon_{lc,} \end{aligned}$$

where CCF50 is scaled from more than 0·7 to less than 10 and modelled in logit space for location (l) and cohort (c), β_0 is an intercept, $\boldsymbol{\beta}_1$ is a vector of the spline coefficients of female educational attainment covariate, β_2 is a slope on proportion of met need for contraception, β_3 is a slope on under-5 mortality, β_4 is a slope on population density in habitable areas, and ε is a residual term. Further details are provided in appendix 1 (section 3.2, figure S1).

From forecast CCF50, we then derived ASFR forecasts for the years 2022 to 2100 using a combination of a linear mixed-effects model, spline interpolation, and an autoregressive integrated moving average (ARIMA) model (1,0,0) on residuals to estimate the age pattern of fertility for each cohort. Once ASFR values for ages 15–49 years were obtained, we inferred the ASFR values for the 10–14-years and 50–54-years age groups based on their ratios to the rest of the age pattern during the last observed year (2021). Single-year age interval ASFRs were summed over all ages to yield the TFR for each calendar year (appendix 1 section 3.3).

We also produced fertility forecasts for four alternative scenarios applied to all 204 countries and territories. These scenarios explore shifting forecast values of two known drivers of fertility (education and met need for contraceptives) as well as a proxy pro-natal policy. More specifically, the scenarios included were: the UN SDG target 4.1 for education is achieved by 2030; the contraceptive met need SDG target 3.7 is achieved by 2030; pro-natal policies are enacted that create supportive environments for those who give birth; and the previous three scenarios combined (more details are provided in appendix 1 section 3.4). For the education SDG scenario, the forecasts assume that by 2030, all people will have 12 years or more of education by the age of 25 years and then maintains the same rate of change as the reference scenario up to 2100. For the contraceptive met need scenario, to reflect the SDG scenario of universal access, the forecasts assumed a linear increase in contraceptive coverage to reach 100% by 2030 and then stay constant up to 2100.

In the pro-natal scenario, we assumed a country will introduce pro-natal policies, such as childcare subsidies, extended parental leave, insurance coverage expansion for infertility treatment,[33] and other forms of support for parents to afford high-quality child-care services, once TFR decreases to less than 1·75. We then made three assumptions on the effects of such policies. First, we assumed the full effect of pro-natal policies will be to increase TFR by 0·2. Second, it will take 5 years after the policy is introduced for the full increase in TFR to occur, and TFR will rise linearly over that time span. Last, we assumed that both the policies and the increase in TFR by 0·2 will endure for the remainder of the century. For each pro-natal year, the TFR increase was distributed proportionally among the single-year ages according to their reference forecast ASFR values. The pro-natal scenario parameters were drawn from previously observed increases in TFR that coincided with pro-natal policies and broader empirical evidence regarding effects of pro-natal policies in low-fertility contexts. Further details on the pro-natal scenario can be found in appendix 1 (section 3.4.3).

In the combined scenario, we applied the aforementioned changes to the covariate forecasts simultaneously without assigning any weights because these covariates were already embedded in our model and the coefficients for each covariate were calculated based on the observed data.

GBD 2021 updates

To estimate ASFRs from 1950 to 2021, GBD 2021 added 147 surveys, 21 censuses, and 634 country-years of vital and sample registration data compared with GBD 2019, for a total of 1455 surveys and censuses, 8709 country-years of vital and sample registration data, and 150 other sources. Methods were updated for GBD 2021 by changing the time weight in ST-GPR to use a beta density function, in which hyperparameters were assigned based on quality of available data sources and the number of available datapoints. This better accounted for increased data availability, which improved precision and produced more plausible time trends compared with GBD 2019.

Updates to the fertility forecasting methods first introduced in the 2020 study by Vollset and colleagues[4] included the incorporation of two new covariates in the CCF50 model—namely, under-5 mortality and population density in habitable areas—in addition to those previously used (ie, female educational attainment and contraceptive met need). Furthermore, the current iteration of the IHME model employed a linear fixed-effect model to forecast 5-year ASFRs, which were interpolated to 1-year estimates using an ARIMA model on the residuals to quantify variation not explained by the covariates.

Comparison with other models

We evaluated the IHME fertility forecasting model performance based on out-of-sample predictions during the validation period 2007–21. We used the following skill metric[34] for model evaluation and comparison (see appendix 1 section 3.6 for more details):

$$skill = 1 - \frac{RMSE(Model)}{RMSE(Baseline\ Model),}$$

	Total fertility rate					Livebirths (thousands)					Net reproductive rate, 2021
	1950	1980	2021	2050	2100	1950	1980	2021	2050	2100	
Global	**4·84 (4·63–5·06)**	**3·61 (3·53–3·69)**	**2·23 (2·09–2·38)**	**1·83 (1·59–2·08)**	**1·59 (1·25–1·96)**	**92 675·8 (88 663·5–96 630·8)**	**122 023·7 (119 441·0–124 623·8)**	**129 383·6 (121 382·9–138 206·0)**	**112 073·6 (93 698·4–133 329·8)**	**72 386·8 (40 812·5–118 843·5)**	**1·0 (1·0–1·1)**
Central Europe, eastern Europe, and central Asia	**3·01 (2·91–3·11)**	**2·24 (2·21–2·28)**	**1·81 (1·72–1·92)**	**1·68 (1·56–1·81)**	**1·57 (1·42–1·73)**	**7452·5 (7227·2–7699·6)**	**7113·3 (7020·5–7211·4)**	**4906·1 (4635·7–5195·7)**	**3874·8 (3409·2–4396·4)**	**2344·9 (1739·5–3067·1)**	**0·9 (0·8–0·9)**
Central Asia	4·45 (4·32–4·59)	3·73 (3·65–3·80)	2·79 (2·68–2·91)	2·31 (2·16–2·47)	1·95 (1·76–2·13)	1016·0 (986·0–1046·1)	1676·9 (1642·3–1709·2)	2073·1 (1990·1–2158·2)	1913·2 (1629·7–2201·3)	1418·0 (1007·6–1927·4)	1·3 (1·3–1·4)
Armenia	4·14 (3·95–4·33)	2·49 (2·39–2·61)	1·68 (1·53–1·84)	1·45 (1·27–1·65)	1·24 (1·01–1·49)	49·0 (46·8–51·1)	76·5 (73·2–79·9)	35·0 (31·6–38·5)	16·9 (11·9–22·2)	6·7 (3·5–11·3)	0·8 (0·7–0·9)
Azerbaijan	4·38 (4·09–4·69)	3·33 (3·18–3·48)	1·75 (1·55–1·95)	1·51 (1·27–1·76)	1·29 (1·01–1·59)	107·5 (100·2–114·9)	162·2 (155·0–169·6)	138·7 (123·5–154·9)	93·5 (69·0–122·7)	38·3 (17·9–69·8)	0·8 (0·7–0·9)
Georgia	2·60 (2·42–2·79)	2·21 (2·07–2·33)	2·05 (1·92–2·18)	1·80 (1·65–1·96)	1·52 (1·34–1·71)	84·2 (78·4–90·3)	91·8 (86·3–96·9)	45·2 (42·4–48·1)	36·1 (28·7–43·7)	21·3 (14·2–30·4)	1·0 (0·9–1·0)
Kazakhstan	3·94 (3·79–4·11)	3·02 (2·93–3·11)	3·02 (2·85–3·20)	2·43 (2·21–2·65)	1·94 (1·69–2·19)	253·8 (244·5–264·1)	365·1 (353·6–376·9)	424·9 (400·9–448·7)	392·9 (325·0–461·4)	261·4 (147·7–409·6)	1·4 (1·4–1·5)
Kyrgyzstan	4·19 (4·03–4·35)	4·12 (3·98–4·27)	2·92 (2·66–3·21)	2·35 (2·05–2·70)	1·95 (1·63–2·33)	57·9 (55·6–60·2)	111·9 (107·3–116·3)	159·2 (145·4–175·1)	139·1 (104·2–181·6)	72·0 (21·5–145·6)	1·4 (1·3–1·5)
Mongolia	5·09 (4·78–5·41)	5·76 (5·55–5·97)	3·16 (2·86–3·49)	2·46 (2·02–2·88)	1·87 (1·35–2·35)	30·2 (28·4–32·1)	61·9 (59·7–64·1)	80·0 (72·4–88·0)	100·9 (76·4–124·5)	104·2 (46·7–179·1)	1·5 (1·4–1·6)
Tajikistan	6·65 (6·33–6·96)	5·65 (5·47–5·84)	3·40 (3·17–3·64)	2·66 (2·33–2·97)	2·13 (1·75–2·49)	86·2 (82·6–89·9)	159·7 (154·8–164·5)	286·4 (268·0–306·6)	301·0 (229·2–381·8)	243·2 (101·7–421·6)	1·6 (1·5–1·7)
Turkmenistan	4·82 (4·63–5·01)	4·75 (4·55–4·94)	2·83 (2·54–3·15)	2·25 (1·87–2·66)	1·81 (1·38–2·28)	48·7 (46·7–50·5)	96·4 (92·9–99·8)	110·5 (99·4–122·7)	105·2 (80·2–139·0)	75·9 (33·1–146·2)	1·3 (1·2–1·5)
Uzbekistan	5·68 (5·32–6·06)	4·58 (4·47–4·69)	2·87 (2·66–3·10)	2·34 (2·08–2·62)	1·97 (1·69–2·27)	298·6 (280·9–316·8)	551·5 (538·2–564·1)	793·1 (733·9–854·3)	727·6 (491·2–993·0)	595·0 (307·1–992·9)	1·3 (1·2–1·4)
Central Europe	3·22 (3·13–3·30)	2·21 (2·18–2·24)	1·48 (1·36–1·61)	1·34 (1·19–1·50)	1·21 (1·03–1·41)	2336·9 (2276·3–2399·1)	2085·5 (2056·7–2113·8)	1038·3 (954·3–1129·1)	668·1 (567·7–786·3)	283·6 (185·8–412·4)	0·7 (0·7–0·8)
Albania	5·88 (5·63–6·13)	3·44 (3·31–3·58)	1·50 (1·33–1·69)	1·34 (1·10–1·61)	1·17 (0·86–1·50)	48·0 (45·9–50·0)	71·4 (68·8–74·3)	27·9 (24·7–31·4)	16·4 (11·6–22·4)	6·3 (2·9–12·3)	0·7 (0·6–0·8)
Bosnia and Herzegovina	3·68 (3·31–4·08)	2·21 (1·97–2·46)	1·33 (1·20–1·46)	1·16 (0·99–1·35)	0·95 (0·71–1·19)	92·6 (83·8–102·1)	79·0 (70·7–87·8)	26·7 (24·2–29·4)	12·4 (8·8–16·8)	3·5 (1·7–6·2)	0·6 (0·6–0·7)
Bulgaria	2·77 (2·65–2·91)	2·07 (2·02–2·12)	1·58 (1·47–1·70)	1·43 (1·29–1·59)	1·26 (1·08–1·45)	167·6 (160·5–175·7)	127·8 (124·7–130·8)	58·1 (53·7–62·4)	36·6 (29·6–44·0)	13·9 (8·5–21·6)	0·8 (0·7–0·8)
Croatia	2·89 (2·78–3·00)	1·83 (1·78–1·87)	1·37 (1·22–1·53)	1·27 (1·08–1·46)	1·14 (0·92–1·38)	90·2 (87·0–93·5)	67·4 (65·9–69·2)	34·8 (31·0–38·9)	16·8 (12·3–22·0)	3·2 (0·3–7·2)	0·7 (0·6–0·7)
Czechia	2·81 (2·69–2·94)	2·08 (2·03–2·13)	1·74 (1·57–1·93)	1·54 (1·34–1·76)	1·36 (1·13–1·60)	186·6 (178·6–194·9)	152·3 (148·6–155·8)	105·9 (95·4–117·6)	82·1 (67·2–98·5)	44·9 (27·3–68·3)	0·8 (0·8–0·9)
Hungary	2·58 (2·43–2·72)	1·89 (1·84–1·94)	1·56 (1·40–1·75)	1·42 (1·22–1·65)	1·29 (1·06–1·55)	193·1 (182·7–203·9)	147·0 (143·1–151·2)	87·9 (78·5–98·4)	77·0 (61·9–94·7)	51·6 (32·1–78·9)	0·8 (0·7–0·8)
Montenegro	4·12 (3·89–4·37)	2·22 (2·13–2·30)	1·72 (1·61–1·83)	1·56 (1·43–1·70)	1·40 (1·23–1·58)	12·5 (11·8–13·2)	10·5 (10·1–10·9)	7·0 (6·5–7·4)	4·5 (3·7–5·4)	1·6 (0·9–2·5)	0·8 (0·8–0·9)
North Macedonia	3·62 (3·26–4·02)	2·45 (2·21–2·71)	1·23 (1·16–1·30)	1·10 (1·01–1·20)	0·97 (0·84–1·09)	37·6 (34·0–41·5)	39·9 (36·0–44·0)	18·7 (17·7–19·8)	9·4 (7·3–11·9)	1·8 (0·9–3·0)	0·6 (0·6–0·6)
Poland	3·63 (3·53–3·72)	2·28 (2·24–2·32)	1·37 (1·22–1·53)	1·21 (1·04–1·40)	1·07 (0·87–1·29)	757·4 (737·3–776·6)	693·3 (680·1–706·4)	342·0 (304·9–381·1)	206·2 (163·3–254·7)	74·4 (43·4–116·7)	0·7 (0·6–0·7)

(Table 1 continues on next page)

	Total fertility rate					Livebirths (thousands)					Net reproductive rate, 2021
	1950	1980	2021	2050	2100	1950	1980	2021	2050	2100	
(Continued from previous page)											
Romania	3·02 (2·84–3·22)	2·32 (2·25–2·39)	1·70 (1·57–1·84)	1·48 (1·32–1·66)	1·26 (1·06–1·48)	415·0 (390·9–442·4)	387·3 (375·7–399·2)	177·6 (163·6–192·6)	114·9 (89·2–143·0)	37·7 (18·8–62·7)	0·8 (0·8–0·9)
Serbia	3·31 (3·22–3·40)	2·22 (2·17–2·28)	1·08 (0·99–1·16)	1·01 (0·90–1·11)	0·96 (0·82–1·09)	183·9 (179·1–188·1)	157·5 (153·3–161·7)	61·6 (56·8–66·7)	34·0 (27·8–40·6)	10·5 (7·1–14·6)	0·5 (0·5–0·6)
Slovakia	3·65 (3·56–3·75)	2·32 (2·27–2·36)	1·63 (1·53–1·73)	1·46 (1·34–1·59)	1·31 (1·16–1·46)	99·6 (97·2–102·2)	94·6 (92·9–96·3)	56·3 (52·9–59·8)	40·0 (34·2–45·7)	20·9 (15·1–27·4)	0·8 (0·7–0·8)
Slovenia	2·86 (2·54–3·20)	2·01 (1·97–2·06)	1·63 (1·53–1·74)	1·51 (1·39–1·64)	1·38 (1·24–1·54)	32·3 (28·8–36·2)	29·5 (28·8–30·1)	18·8 (17·6–20·0)	17·9 (15·7–20·5)	13·2 (10·3–16·9)	0·8 (0·7–0·8)
Eastern Europe	2·70 (2·59–2·82)	1·91 (1·88–1·95)	1·38 (1·27–1·49)	1·28 (1·15–1·42)	1·19 (1·05–1·35)	4099·6 (3935·2–4285·2)	3350·8 (3289·2–3418·5)	1794·7 (1651·3–1949·2)	1293·5 (1082·3–1534·3)	643·2 (456·2–881·7)	0·7 (0·6–0·7)
Belarus	3·00 (2·83–3·18)	2·01 (1·94–2·09)	1·42 (1·23–1·64)	1·29 (1·06–1·55)	1·19 (0·95–1·47)	192·3 (181·8–203·2)	156·4 (150·9–162·4)	82·5 (70·6–95·6)	59·8 (43·0–80·3)	30·5 (16·3–53·1)	0·7 (0·6–0·8)
Estonia	2·30 (2·18–2·43)	2·06 (2·01–2·11)	1·60 (1·49–1·71)	1·37 (1·24–1·50)	1·21 (1·06–1·36)	20·1 (19·1–21·2)	22·5 (21·9–23·1)	13·1 (12·2–14·0)	9·4 (8·0–11·2)	4·2 (2·8–5·9)	0·8 (0·7–0·8)
Latvia	1·98 (1·84–2·14)	1·90 (1·86–1·94)	1·52 (1·35–1·71)	1·35 (1·16–1·56)	1·22 (1·01–1·49)	32·9 (30·7–35·5)	35·6 (34·9–36·4)	16·8 (14·9–18·9)	9·7 (7·5–12·4)	3·9 (2·2–6·6)	0·7 (0·6–0·8)
Lithuania	2·92 (2·78–3·10)	2·00 (1·95–2·05)	1·40 (1·30–1·51)	1·23 (1·11–1·35)	1·09 (0·96–1·25)	58·6 (55·7–62·0)	51·3 (49·9–52·6)	23·6 (21·9–25·4)	12·4 (10·0–15·4)	4·2 (2·7–6·1)	0·7 (0·6–0·7)
Moldova	3·77 (3·61–3·92)	2·46 (2·38–2·54)	1·18 (1·06–1·33)	1·09 (0·94–1·25)	1·03 (0·87–1·24)	84·7 (81·4–88·0)	86·1 (83·4–88·9)	28·4 (25·4–32·0)	9·5 (5·6–13·4)	2·7 (1·3–4·7)	0·6 (0·5–0·6)
Russia	2·77 (2·62–2·95)	1·87 (1·83–1·93)	1·48 (1·37–1·60)	1·33 (1·20–1·47)	1·21 (1·06–1·37)	2819·9 (2671·0–2995·4)	2237·6 (2184·0–2299·0)	1352·4 (1251·9–1464·1)	1053·8 (871·5–1239·4)	562·8 (408·0–758·1)	0·7 (0·7–0·8)
Ukraine	2·44 (2·33–2·55)	1·95 (1·90–2·01)	1·05 (0·94–1·18)	1·01 (0·88–1·16)	0·98 (0·83–1·16)	891·1 (853·1–930·3)	761·3 (739·2–783·2)	277·9 (246·7–311·8)	138·8 (104·8–185·4)	34·9 (19·2–60·5)	0·5 (0·4–0·6)
High income	**2·85 (2·78–2·92)**	**1·88 (1·86–1·90)**	**1·51 (1·41–1·61)**	**1·43 (1·30–1·56)**	**1·37 (1·22–1·53)**	**13 626·1 (13 275·0–13 959·1)**	**12 483·6 (12 339·3–12 633·7)**	**10 399·8 (9728·0–11 116·3)**	**9387·4 (8381·2–10 552·0)**	**6961·9 (5348·6–8941·5)**	**0·7 (0·7–0·8)**
Australasia	3·13 (3·06–3·21)	1·93 (1·90–1·97)	1·64 (1·48–1·80)	1·45 (1·25–1·68)	1·33 (1·08–1·59)	251·9 (246·1–258·0)	278·2 (273·0–283·7)	357·9 (324·6–393·9)	404·9 (338·5–481·9)	363·9 (250·1–516·0)	0·8 (0·7–0·9)
Australia	3·06 (2·98–3·14)	1·92 (1·88–1·97)	1·64 (1·47–1·82)	1·45 (1·23–1·70)	1·32 (1·06–1·61)	202·2 (196·9–207·7)	227·7 (222·7–232·9)	299·3 (268·5–332·1)	339·1 (278·3–411·8)	307·8 (204·0–447·8)	0·8 (0·7–0·9)
New Zealand	3·49 (3·41–3·57)	1·96 (1·92–2·00)	1·62 (1·53–1·72)	1·45 (1·33–1·58)	1·35 (1·20–1·51)	49·7 (48·7–50·8)	50·5 (49·4–51·6)	58·6 (55·2–62·0)	65·7 (57·4–74·2)	56·1 (42·5–72·1)	0·8 (0·7–0·8)
High-income Asia Pacific	3·72 (3·59–3·86)	1·94 (1·89–2·00)	1·12 (1·03–1·22)	1·14 (1·00–1·30)	1·14 (0·96–1·35)	3059·8 (2947·5–3174·6)	2467·7 (2400·6–2541·4)	1169·5 (1075·7–1275·1)	908·3 (784·1–1047·7)	499·8 (348·5–707·9)	0·5 (0·5–0·6)
Brunei	6·41 (6·24–6·57)	3·87 (3·65–4·10)	1·65 (1·43–1·88)	1·40 (1·08–1·78)	1·25 (0·87–1·70)	2·7 (2·6–2·7)	5·8 (5·4–6·1)	6·4 (5·6–7·3)	3·4 (2·4–4·7)	1·0 (0·2–2·5)	0·8 (0·7–0·9)
Japan	3·27 (3·12–3·42)	1·69 (1·64–1·76)	1·26 (1·14–1·41)	1·26 (1·09–1·45)	1·21 (1·00–1·43)	2188·1 (2087·3–2289·4)	1573·3 (1518·2–1636·1)	838·0 (754·0–933·3)	667·4 (555·1–790·8)	387·8 (259·2–572·2)	0·6 (0·5–0·7)
Singapore	6·03 (5·75–6·31)	1·77 (1·66–1·88)	1·20 (1·05–1·39)	1·15 (0·93–1·41)	1·12 (0·88–1·41)	48·0 (45·7–50·3)	42·0 (39·2–44·8)	55·5 (48·5–64·0)	56·0 (44·0–70·8)	45·3 (28·5–69·5)	0·6 (0·5–0·7)
South Korea	5·72 (5·37–6·08)	2·56 (2·48–2·64)	0·82 (0·75–0·89)	0·82 (0·73–0·92)	0·82 (0·71–0·95)	821·1 (774·1–869·0)	846·6 (822·3–873·2)	269·6 (246·4–294·2)	181·5 (155·9–209·6)	65·6 (45·4–90·3)	0·4 (0·4–0·4)
High-income North America	3·10 (3·03–3·18)	1·78 (1·75–1·81)	1·63 (1·53–1·73)	1·51 (1·38–1·64)	1·43 (1·27–1·60)	4023·2 (3927·9–4124·2)	3948·6 (3866·5–4026·4)	4014·6 (3772·1–4278·3)	3732·8 (3300·8–4245·6)	2967·3 (2256·1–3805·1)	0·8 (0·7–0·8)

(Table 1 continues on next page)

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	Total fertility rate					Livebirths (thousands)					Net reproductive rate, 2021
	1950	1980	2021	2050	2100	1950	1980	2021	2050	2100	
(Continued from previous page)											
Canada	3·31 (3·23–3·40)	1·65 (1·62–1·69)	1·46 (1·31–1·62)	1·39 (1·21–1·58)	1·32 (1·12–1·54)	361·9 (353·0–370·7)	357·7 (350·4–365·1)	361·6 (324·1–401·3)	442·0 (374·4–521·9)	415·5 (299·8–570·6)	0·7 (0·6–0·8)
Greenland	5·62 (5·37–5·87)	2·32 (2·21–2·43)	1·94 (1·78–2·13)	1·84 (1·60–2·10)	1·67 (1·36–2·00)	1·0 (0·9–1·0)	1·0 (0·9–1·0)	0·8 (0·7–0·9)	0·7 (0·5–0·8)	0·5 (0·3–0·7)	0·9 (0·8–1·0)
USA	3·08 (3·01–3·17)	1·79 (1·76–1·83)	1·64 (1·55–1·75)	1·52 (1·40–1·65)	1·45 (1·30–1·60)	3660·2 (3569·5–3758·9)	3589·8 (3510·8–3663·5)	3652·2 (3445·3–3878·2)	3290·0 (2928·9–3719·1)	2551·2 (1954·8–3256·2)	0·8 (0·7–0·8)
Southern Latin America	3·20 (3·11–3·30)	2·97 (2·93–3·01)	1·49 (1·32–1·67)	1·32 (1·10–1·57)	1·23 (0·97–1·53)	673·6 (653·6–693·9)	987·3 (972·7–1001·9)	769·3 (683·8–862·6)	584·3 (452·6–745·4)	293·8 (159·6–482·9)	0·7 (0·6–0·8)
Argentina	3·03 (2·92–3·15)	3·17 (3·11–3·23)	1·52 (1·34–1·72)	1·33 (1·09–1·60)	1·22 (0·91–1·56)	440·7 (424·2–457·7)	683·1 (669·7–696·0)	536·7 (473·3–606·6)	389·6 (284·0–511·3)	173·1 (80·2–310·7)	0·7 (0·6–0·8)
Chile	4·05 (3·94–4·16)	2·59 (2·53–2·65)	1·39 (1·23–1·54)	1·29 (1·09–1·51)	1·24 (0·99–1·51)	188·2 (183·3–193·1)	250·2 (244·2–256·4)	197·2 (175·7–219·6)	169·6 (136·6–210·7)	109·6 (69·1–169·7)	0·7 (0·6–0·7)
Uruguay	2·44 (2·31–2·57)	2·53 (2·47–2·60)	1·47 (1·30–1·64)	1·36 (1·14–1·60)	1·25 (0·97–1·56)	44·8 (42·3–47·1)	53·9 (52·5–55·4)	35·4 (31·5–39·6)	25·1 (19·6–32·2)	11·1 (5·8–19·3)	0·7 (0·6–0·8)
Western Europe	2·41 (2·34–2·47)	1·79 (1·77–1·81)	1·53 (1·44–1·63)	1·44 (1·32–1·57)	1·37 (1·23–1·52)	5617·5 (5459·1–5774·9)	4801·7 (4750·3–4856·9)	4088·4 (3844·3–4353·4)	3757·3 (3360·8–4160·6)	2837·2 (2247·8–3546·1)	0·7 (0·7–0·8)
Andorra	2·79 (2·44–3·18)	1·59 (1·51–1·66)	0·98 (0·91–1·05)	1·02 (0·92–1·11)	1·01 (0·89–1·13)	0·1 (0·1–0·1)	0·5 (0·5–0·5)	0·5 (0·5–0·6)	0·3 (0·3–0·3)	0·1 (0·1–0·1)	0·5 (0·4–0·5)
Austria	2·08 (2·01–2·15)	1·67 (1·63–1·70)	1·46 (1·37–1·55)	1·42 (1·29–1·55)	1·34 (1·18–1·51)	105·8 (102·3–109·7)	91·3 (89·3–93·3)	85·7 (80·5–91·1)	81·0 (71·2–91·5)	63·4 (48·1–80·5)	0·7 (0·7–0·7)
Belgium	2·30 (2·22–2·38)	1·70 (1·66–1·73)	1·56 (1·41–1·72)	1·43 (1·24–1·63)	1·34 (1·13–1·57)	142·4 (137·8–147·2)	123·3 (120·9–125·7)	113·3 (102·2–124·9)	114·6 (95·9–137·7)	99·9 (69·0–140·3)	0·8 (0·7–0·8)
Cyprus	3·96 (3·80–4·11)	2·42 (2·35–2·49)	1·33 (1·15–1·53)	1·18 (0·97–1·43)	1·13 (0·89–1·40)	13·9 (13·4–14·5)	13·4 (13·0–13·8)	15·1 (13·1–17·4)	11·0 (8·5–13·8)	7·6 (4·7–11·6)	0·6 (0·6–0·7)
Denmark	2·54 (2·46–2·63)	1·49 (1·45–1·52)	1·73 (1·63–1·83)	1·57 (1·46–1·69)	1·47 (1·34–1·60)	78·2 (75·8–81·1)	55·3 (53·9–56·7)	63·2 (59·7–66·7)	62·4 (55·2–70·2)	58·0 (46·1–70·9)	0·8 (0·8–0·9)
Finland	3·08 (2·99–3·19)	1·65 (1·60–1·70)	1·44 (1·35–1·53)	1·36 (1·24–1·49)	1·32 (1·18–1·48)	95·6 (92·8–98·9)	63·9 (62·1–65·7)	48·5 (45·3–51·7)	41·9 (36·2–48·5)	30·1 (23·3–38·7)	0·7 (0·7–0·7)
France	2·80 (2·72–2·87)	1·90 (1·85–1·95)	1·75 (1·57–1·93)	1·56 (1·35–1·79)	1·43 (1·19–1·69)	840·4 (817·3–862·6)	795·3 (774·5–816·9)	693·1 (623·0–766·7)	561·9 (448·3–683·9)	348·5 (214·5–542·2)	0·8 (0·8–0·9)
Germany	2·09 (1·94–2·24)	1·52 (1·48–1·55)	1·53 (1·44–1·62)	1·47 (1·35–1·58)	1·40 (1·27–1·53)	1105·0 (1023·7–1188·6)	852·3 (833·8–873·0)	790·3 (742·4–837·6)	742·6 (647·9–832·5)	609·5 (489·2–740·4)	0·7 (0·7–0·8)
Greece	2·50 (2·41–2·60)	2·07 (2·03–2·12)	1·40 (1·25–1·56)	1·36 (1·17–1·57)	1·28 (1·06–1·54)	154·7 (148·6–160·8)	143·4 (140·4–146·8)	82·3 (73·4–92·1)	52·3 (39·8–66·9)	26·1 (15·2–42·2)	0·7 (0·6–0·8)
Iceland	3·81 (3·57–4·08)	2·40 (2·32–2·49)	1·97 (1·81–2·13)	1·73 (1·54–1·93)	1·58 (1·36–1·82)	4·0 (3·8–4·3)	4·3 (4·2–4·5)	4·7 (4·3–5·1)	5·4 (4·5–6·4)	5·4 (3·8–7·5)	0·9 (0·9–1·0)
Ireland	3·18 (3·09–3·28)	3·14 (3·08–3·20)	1·76 (1·65–1·88)	1·54 (1·40–1·70)	1·40 (1·22–1·58)	63·9 (62·1–66·0)	74·1 (72·8–75·4)	57·7 (54·0–61·4)	61·5 (52·5–70·8)	46·8 (34·4–61·9)	0·9 (0·8–0·9)
Israel	3·79 (3·68–3·90)	3·14 (3·08–3·20)	2·90 (2·76–3·05)	2·38 (2·20–2·59)	2·09 (1·86–2·34)	47·0 (45·6–48·4)	92·9 (91·1–94·7)	183·2 (174·1–192·7)	208·6 (174·7–248·4)	231·4 (167·3–315·1)	1·4 (1·3–1·5)
Italy	2·45 (2·37–2·53)	1·63 (1·60–1·66)	1·21 (1·08–1·36)	1·18 (1·00–1·37)	1·09 (0·88–1·32)	883·2 (855·0–912·8)	640·5 (628·7–652·9)	398·2 (354·1–445·2)	285·5 (236·9–343·9)	136·4 (84·0–209·0)	0·6 (0·5–0·7)
Luxembourg	2·00 (1·87–2·15)	1·51 (1·46–1·55)	1·38 (1·28–1·48)	1·30 (1·17–1·44)	1·24 (1·09–1·40)	4·5 (4·2–4·9)	4·2 (4·0–4·3)	6·6 (6·1–7·1)	8·8 (7·7–10·1)	8·8 (6·8–11·1)	0·7 (0·6–0·7)

(Table 1 continues on next page)

	Total fertility rate					Livebirths (thousands)					Net reproductive rate, 2021
	1950	1980	2021	2050	2100	1950	1980	2021	2050	2100	
(Continued from previous page)											
Malta	4·04 (3·88–4·22)	1·98 (1·91–2·05)	1·53 (1·37–1·71)	1·39 (1·18–1·64)	1·26 (1·01–1·55)	9·8 (9·4–10·2)	5·7 (5·5–6·0)	4·3 (3·9–4·8)	4·8 (3·9–5·9)	4·0 (2·6–6·0)	0·7 (0·7–0·8)
Monaco	2·21 (1·91–2·55)	1·64 (1·43–1·88)	1·52 (1·29–1·80)	1·44 (1·16–1·76)	1·37 (1·06–1·73)	0·3 (0·3–0·4)	0·3 (0·3–0·3)	0·3 (0·2–0·3)	0·2 (0·2–0·3)	0·1 (0·1–0·2)	0·7 (0·6–0·8)
Netherlands	3·12 (3·04–3·22)	1·60 (1·56–1·63)	1·68 (1·58–1·78)	1·54 (1·41–1·67)	1·42 (1·27–1·57)	229·6 (223·4–236·8)	178·6 (174·7–182·6)	177·7 (167·2–188·3)	165·6 (146·4–186·7)	142·0 (112·1–177·0)	0·8 (0·8–0·9)
Norway	2·52 (2·44–2·60)	1·61 (1·57–1·65)	1·55 (1·46–1·64)	1·43 (1·32–1·54)	1·36 (1·24–1·49)	61·9 (60·1–63·9)	47·8 (46·8–48·9)	55·9 (52·8–59·1)	54·8 (48·5–61·5)	46·2 (37·2–57·5)	0·7 (0·7–0·8)
Portugal	3·04 (2·94–3·16)	2·13 (2·09–2·18)	1·30 (1·22–1·39)	1·27 (1·13–1·42)	1·17 (1·00–1·37)	206·3 (199·2–214·4)	154·5 (151·0–158·2)	80·6 (75·2–86·2)	70·9 (59·7–83·9)	46·0 (32·1–63·2)	0·6 (0·6–0·7)
San Marino	2·47 (2·14–2·84)	1·58 (1·48–1·69)	1·30 (1·15–1·48)	1·27 (1·09–1·49)	1·20 (0·99–1·46)	0·3 (0·2–0·3)	0·2 (0·2–0·3)	0·2 (0·2–0·3)	0·2 (0·1–0·2)	0·1 (0·0–0·1)	0·6 (0·5–0·7)
Spain	2·47 (2·38–2·55)	2·13 (2·09–2·17)	1·26 (1·17–1·35)	1·23 (1·10–1·38)	1·11 (0·93–1·30)	560·3 (542·4–579·3)	549·2 (538·5–559·9)	336·7 (312·8–362·0)	377·6 (319·2–439·7)	248·3 (169·5–331·8)	0·6 (0·6–0·7)
Sweden	2·27 (2·20–2·36)	1·65 (1·62–1·69)	1·71 (1·61–1·81)	1·51 (1·39–1·64)	1·38 (1·24–1·53)	113·9 (110·3–118·3)	95·5 (93·4–97·5)	113·9 (107·4–120·7)	135·0 (119·4–151·5)	136·8 (108·5–166·8)	0·8 (0·8–0·9)
Switzerland	2·35 (2·28–2·43)	1·58 (1·54–1·61)	1·48 (1·39–1·59)	1·40 (1·28–1·52)	1·33 (1·20–1·47)	83·2 (80·7–85·8)	75·8 (74·2–77·4)	89·1 (83·5–95·3)	83·8 (74·0–94·7)	68·5 (54·8–84·4)	0·7 (0·7–0·8)
UK	2·19 (2·13–2·25)	1·85 (1·80–1·90)	1·49 (1·33–1·67)	1·38 (1·18–1·58)	1·30 (1·08–1·53)	809·2 (786·1–832·5)	735·5 (715·4–755·5)	683·8 (608·2–762·0)	623·3 (504·8–743·2)	470·8 (303·6–664·1)	0·7 (0·6–0·8)
Latin America and Caribbean	**5·82 (5·58–6·06)**	**4·09 (4·01–4·18)**	**1·98 (1·83–2·13)**	**1·57 (1·38–1·79)**	**1·31 (1·08–1·57)**	**6278·2 (6037·0–6525·3)**	**10 310·9 (10 111·1–10 514·4)**	**9377·7 (8692·9–10 090·5)**	**6763·5 (5627·9–8076·1)**	**3002·6 (1769·5–4786·3)**	**0·9 (0·9–1·0)**
Andean Latin America	6·72 (6·47–6·95)	4·97 (4·86–5·08)	2·32 (2·14–2·51)	1·80 (1·58–2·05)	1·45 (1·19–1·73)	679·8 (655·9–702·4)	1115·9 (1089·4–1141·9)	1242·6 (1146·2–1345·6)	961·5 (782·6–1184·9)	457·7 (242·3–768·2)	1·1 (1·0–1·2)
Bolivia	6·84 (6·49–7·19)	5·65 (5·45–5·85)	2·53 (2·31–2·77)	1·84 (1·55–2·17)	1·40 (1·07–1·77)	150·5 (143·0–157·8)	216·0 (208·8–223·4)	245·0 (223·7–270·0)	208·5 (162·6–277·0)	113·0 (53·3–210·1)	1·2 (1·1–1·3)
Ecuador	6·09 (5·78–6·44)	4·24 (4·10–4·40)	2·20 (1·95–2·50)	1·74 (1·42–2·10)	1·45 (1·10–1·86)	149·7 (142·2–157·9)	249·6 (241·3–259·0)	321·5 (285·0–363·6)	269·3 (194·5–367·0)	152·8 (66·7–298·3)	1·1 (0·9–1·2)
Peru	6·95 (6·68–7·22)	5·10 (4·96–5·24)	2·30 (2·08–2·55)	1·83 (1·56–2·13)	1·44 (1·14–1·80)	379·7 (366·2–392·8)	650·3 (630·8–669·5)	676·2 (611·2–748·3)	483·7 (374·1–630·9)	192·0 (79·6–384·3)	1·1 (1·0–1·2)
Caribbean	5·02 (4·90–5·14)	3·39 (3·31–3·47)	2·19 (2·02–2·39)	1·77 (1·50–2·08)	1·43 (1·11–1·88)	699·5 (682·6–715·4)	837·0 (818·1–856·6)	797·4 (734·1–868·9)	570·0 (432·5–738·2)	241·7 (98·1–477·6)	1·0 (0·9–1·1)
Antigua and Barbuda	4·63 (4·38–4·88)	2·33 (2·24–2·42)	1·49 (1·33–1·68)	1·30 (1·11–1·52)	1·15 (0·93–1·41)	1·7 (1·6–1·7)	1·2 (1·2–1·3)	1·0 (0·9–1·2)	0·7 (0·5–0·9)	0·3 (0·1–0·5)	0·7 (0·6–0·8)
The Bahamas	3·97 (3·77–4·17)	2·65 (2·56–2·76)	1·23 (1·05–1·45)	1·24 (1·02–1·49)	1·24 (0·99–1·52)	2·6 (2·5–2·7)	5·0 (4·8–5·2)	3·9 (3·3–4·5)	3·1 (2·3–4·2)	1·9 (1·0–3·2)	0·6 (0·5–0·7)
Barbados	3·54 (3·36–3·73)	1·94 (1·86–2·04)	1·30 (1·09–1·56)	1·18 (0·95–1·47)	1·10 (0·85–1·42)	6·7 (6·4–7·1)	4·3 (4·1–4·5)	2·6 (2·2–3·1)	1·7 (1·1–2·3)	0·7 (0·3–1·3)	0·6 (0·5–0·7)
Belize	5·47 (5·21–5·76)	5·42 (5·27–5·57)	1·96 (1·74–2·20)	1·58 (1·28–1·90)	1·28 (0·93–1·67)	2·8 (2·7–3·0)	5·7 (5·5–5·8)	7·6 (6·7–8·5)	7·5 (5·5–9·8)	5·2 (2·4–9·0)	0·9 (0·8–1·1)
Bermuda	3·58 (3·38–3·81)	1·62 (1·55–1·70)	1·28 (1·15–1·43)	1·19 (1·04–1·36)	1·07 (0·88–1·28)	1·1 (1·1–1·2)	0·8 (0·8–0·9)	0·5 (0·4–0·5)	0·3 (0·2–0·4)	0·1 (0·1–0·2)	0·6 (0·6–0·7)
Cuba	3·29 (3·13–3·45)	1·65 (1·59–1·71)	1·44 (1·34–1·55)	1·31 (1·18–1·44)	1·23 (1·07–1·39)	151·3 (144·0–158·5)	141·1 (136·2–146·2)	99·6 (92·7–107·0)	58·5 (46·8–71·0)	19·4 (11·9–29·3)	0·7 (0·6–0·7)

(Table 1 continues on next page)

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	Total fertility rate					Livebirths (thousands)					Net reproductive rate, 2021
	1950	1980	2021	2050	2100	1950	1980	2021	2050	2100	
(Continued from previous page)											
Dominica	5·12 (4·88–5·37)	3·50 (3·32–3·69)	1·29 (1·09–1·52)	1·18 (0·96–1·45)	1·13 (0·89–1·42)	1·9 (1·8–2·0)	1·9 (1·8–2·0)	0·6 (0·5–0·7)	0·4 (0·3–0·6)	0·2 (0·1–0·3)	0·6 (0·5–0·7)
Dominican Republic	7·83 (7·60–8·04)	4·72 (4·50–4·94)	2·32 (2·10–2·56)	1·84 (1·55–2·15)	1·51 (1·19–1·86)	132·5 (129·1–135·6)	210·1 (199·5–220·2)	213·5 (192·9–236·2)	159·1 (118·5–211·1)	70·4 (27·8–142·4)	1·1 (1·0–1·2)
Grenada	5·27 (5·05–5·48)	3·57 (3·39–3·75)	1·74 (1·49–2·05)	1·41 (1·09–1·79)	1·19 (0·81–1·62)	3·5 (3·3–3·6)	2·7 (2·5–2·8)	1·4 (1·2–1·6)	0·8 (0·5–1·1)	0·1 (0·0–0·4)	0·8 (0·7–1·0)
Guyana	6·17 (5·96–6·41)	3·91 (3·73–4·09)	2·35 (2·06–2·67)	1·91 (1·54–2·32)	1·58 (1·15–2·04)	19·4 (18·7–20·2)	26·1 (24·8–27·3)	15·3 (13·5–17·4)	8·6 (5·7–12·8)	5·5 (2·0–11·1)	1·1 (1·0–1·2)
Haiti	6·67 (6·36–6·96)	5·98 (5·76–6·18)	3·16 (2·82–3·55)	2·10 (1·68–2·61)	1·44 (0·92–2·05)	175·3 (167·4–182·9)	228·7 (221·2–235·7)	344·4 (308·5–386·7)	271·1 (179·5–381·4)	120·8 (30·5–290·6)	1·4 (1·2–1·5)
Jamaica	4·06 (3·78–4·34)	3·28 (3·18–3·39)	1·37 (1·18–1·56)	1·16 (0·93–1·39)	1·04 (0·79–1·31)	50·1 (46·9–53·6)	58·2 (56·3–60·2)	32·8 (28·4–37·5)	15·8 (11·3–21·6)	2·9 (0·7–6·8)	0·7 (0·6–0·7)
Puerto Rico	5·20 (5·10–5·31)	2·60 (2·53–2·66)	0·90 (0·84–0·97)	0·84 (0·76–0·92)	0·81 (0·72–0·93)	84·9 (83·2–86·8)	71·7 (69·8–73·7)	19·0 (17·7–20·5)	6·7 (5·0–8·5)	1·4 (0·8–2·0)	0·4 (0·4–0·5)
Saint Kitts and Nevis	3·90 (3·73–4·06)	3·32 (3·14–3·52)	1·27 (1·13–1·42)	1·08 (0·92–1·27)	1·00 (0·81–1·20)	1·9 (1·8–1·9)	1·2 (1·1–1·3)	0·6 (0·5–0·6)	0·3 (0·2–0·4)	0·1 (0·0–0·1)	0·6 (0·5–0·7)
Saint Lucia	5·03 (4·80–5·26)	4·24 (4·10–4·38)	1·28 (1·08–1·51)	1·04 (0·79–1·32)	0·87 (0·58–1·19)	2·9 (2·8–3·1)	3·9 (3·8–4·0)	1·7 (1·4–2·0)	1·0 (0·7–1·4)	0·3 (0·1–0·7)	0·6 (0·5–0·7)
Saint Vincent and the Grenadines	4·83 (4·66–4·99)	3·89 (3·76–4·05)	1·60 (1·41–1·82)	1·35 (1·10–1·64)	1·16 (0·87–1·51)	2·8 (2·7–2·9)	3·2 (3·1–3·3)	1·3 (1·1–1·5)	0·8 (0·6–1·1)	0·3 (0·1–0·6)	0·8 (0·7–0·9)
Suriname	5·56 (5·33–5·78)	3·76 (3·65–3·88)	2·09 (1·87–2·33)	1·73 (1·41–2·05)	1·39 (1·02–1·78)	7·8 (7·5–8·1)	10·3 (10·0–10·7)	9·0 (8·1–10·0)	7·4 (5·4–9·8)	3·3 (1·1–6·7)	1·0 (0·9–1·1)
Trinidad and Tobago	4·60 (4·44–4·78)	3·29 (3·18–3·40)	1·52 (1·34–1·72)	1·35 (1·13–1·60)	1·19 (0·94–1·49)	23·7 (23·0–24·6)	31·0 (29·9–32·1)	14·7 (13·0–16·7)	6·6 (4·5–8·9)	0·5 (0·0–2·0)	0·7 (0·6–0·8)
Virgin Islands	4·85 (4·61–5·09)	2·91 (2·73–3·08)	1·68 (1·46–1·94)	1·49 (1·28–1·77)	1·37 (1·13–1·69)	0·9 (0·8–0·9)	2·5 (2·3–2·6)	0·8 (0·7–0·9)	0·5 (0·3–0·6)	0·2 (0·1–0·4)	0·8 (0·7–0·9)
Central Latin America	5·73 (5·49–5·99)	4·32 (4·22–4·42)	1·87 (1·68–2·08)	1·47 (1·23–1·74)	1·21 (0·93–1·53)	2327·7 (2229·7–2431·0)	4477·0 (4375·7–4578·5)	3877·3 (3483·8–4308·1)	2704·0 (2091·0–3465·5)	1064·5 (501·2–1993·8)	0·9 (0·8–1·0)
Colombia	5·67 (5·27–6·12)	3·62 (3·41–3·84)	1·67 (1·43–1·96)	1·35 (1·02–1·71)	1·14 (0·77–1·54)	499·9 (466·3–537·1)	823·8 (774·8–875·5)	675·0 (576·7–788·6)	444·7 (296·9–633·1)	176·8 (59·7–379·0)	0·8 (0·7–0·9)
Costa Rica	6·04 (5·87–6·22)	3·60 (3·52–3·70)	1·38 (1·26–1·51)	1·18 (1·02–1·36)	1·03 (0·84–1·26)	38·2 (37·1–39·4)	69·7 (68·0–71·6)	54·6 (49·8–59·7)	33·8 (26·6–42·3)	11·3 (6·2–18·4)	0·7 (0·6–0·7)
El Salvador	6·47 (6·31–6·64)	5·14 (5·02–5·26)	2·05 (1·80–2·32)	1·58 (1·23–1·93)	1·28 (0·86–1·72)	97·8 (95·4–100·5)	181·2 (177·2–185·3)	115·9 (101·7–130·8)	50·9 (30·9–74·0)	0·2 (0·0–1·7)	1·0 (0·9–1·1)
Guatemala	6·47 (6·38–6·56)	6·66 (6·56–6·77)	2·41 (2·16–2·68)	1·62 (1·26–1·98)	1·16 (0·73–1·61)	146·1 (144·2–148·2)	303·8 (298·8–308·6)	344·7 (309·1–383·9)	228·2 (158·2–314·1)	66·4 (12·7–166·4)	1·1 (1·0–1·3)
Honduras	6·84 (6·49–7·18)	6·38 (6·23–6·52)	2·40 (2·11–2·75)	1·71 (1·35–2·11)	1·27 (0·82–1·76)	73·7 (70·0–77·2)	154·7 (151·1–158·0)	220·5 (195·1–252·5)	175·5 (119·4–238·7)	76·9 (23·0–174·0)	1·1 (1·0–1·3)
Mexico	5·66 (5·39–5·95)	4·29 (4·18–4·40)	1·77 (1·61–1·94)	1·39 (1·19–1·62)	1·15 (0·91–1·41)	1172·2 (1115·3–1232·6)	2275·4 (2222·6–2330·8)	1857·4 (1689·0–2038·3)	1343·9 (1065·2–1696·2)	564·3 (296·0–956·2)	0·9 (0·8–0·9)
Nicaragua	6·12 (5·82–6·43)	6·14 (6·00–6·28)	2·20 (1·93–2·49)	1·65 (1·30–2·01)	1·29 (0·86–1·73)	54·6 (52·0–57·5)	127·7 (125·0–130·3)	126·9 (111·4–143·2)	84·4 (56·0–123·5)	22·2 (1·3–66·1)	1·0 (0·9–1·2)

(Table 1 continues on next page)

	Total fertility rate					Livebirths (thousands)					Net reproductive rate, 2021
	1950	1980	2021	2050	2100	1950	1980	2021	2050	2100	
(Continued from previous page)											
Panama	4·04 (3·90–4·20)	3·54 (3·43–3·65)	2·13 (1·91–2·37)	1·76 (1·49–2·05)	1·49 (1·20–1·81)	26·2 (25·3–27·2)	53·9 (52·2–55·5)	69·8 (62·7–77·3)	70·4 (53·4–93·0)	55·5 (31·8–93·2)	1·0 (0·9–1·1)
Venezuela	5·38 (5·22–5·54)	4·09 (3·99–4·20)	2·13 (1·84–2·43)	1·79 (1·43–2·19)	1·51 (1·10–1·97)	219·1 (212·3–225·6)	486·7 (472·9–501·5)	412·7 (355·6–471·4)	272·2 (186·9–399·4)	90·9 (4·0–255·5)	1·0 (0·9–1·1)
Tropical Latin America	5·95 (5·54–6·36)	3·83 (3·72–3·94)	1·94 (1·79–2·12)	1·57 (1·36–1·81)	1·32 (1·08–1·59)	2571·2 (2402·6–2735·9)	3881·0 (3774·3–3985·9)	3460·4 (3188·0–3775·6)	2528·0 (1966·2–3181·6)	1238·7 (691·6–2043·1)	0·9 (0·9–1·0)
Brazil	5·93 (5·51–6·36)	3·81 (3·70–3·92)	1·93 (1·78–2·12)	1·57 (1·35–1·81)	1·31 (1·06–1·59)	2504·7 (2335·7–2669·2)	3773·8 (3670·2–3875·7)	3332·2 (3059·7–3648·5)	2440·4 (1881·9–3096·7)	1207·6 (654·5–2015·8)	0·9 (0·8–1·0)
Paraguay	6·62 (6·35–6·90)	4·90 (4·50–5·29)	2·15 (1·83–2·50)	1·66 (1·25–2·11)	1·39 (0·93–1·89)	66·5 (63·7–69·6)	107·1 (98·7–115·7)	128·2 (109·5–148·5)	87·5 (53·2–131·0)	31·1 (3·6–88·8)	1·0 (0·9–1·2)
North Africa and Middle East	**5·93 (5·56–6·31)**	**6·25 (6·14–6·37)**	**2·53 (2·33–2·76)**	**1·94 (1·62–2·28)**	**1·64 (1·28–2·06)**	**4777·2 (4479·4–5080·5)**	**10 964·6 (10 754·6–11 168·9)**	**12 137·4 (11 185·8–13 232·1)**	**11 415·2 (8900·7–14 116·1)**	**8157·0 (4021·1–14 491·3)**	**1·2 (1·1–1·3)**
Afghanistan	6·94 (6·60–7·27)	7·25 (7·04–7·46)	5·39 (5·10–5·72)	3·34 (2·78–3·89)	1·61 (0·90–2·32)	353·5 (336·6–370·1)	616·1 (597·7–632·9)	1211·5 (1147·5–1283·0)	1785·5 (1104·3–2491·9)	1349·7 (348·0–2742·3)	2·3 (2·2–2·4)
Algeria	6·55 (6·18–6·91)	6·82 (6·72–6·91)	2·64 (2·38–2·91)	1·79 (1·37–2·18)	1·48 (1·04–1·89)	415·5 (392·0–438·9)	793·9 (781·7–807·2)	907·7 (818·7–1000·0)	704·6 (502·0–930·0)	342·7 (128·4–657·3)	1·2 (1·1–1·4)
Bahrain	6·15 (5·75–6·56)	4·41 (4·31–4·52)	1·71 (1·52–1·91)	1·39 (1·10–1·68)	1·26 (0·92–1·57)	4·0 (3·7–4·3)	10·0 (9·8–10·3)	16·9 (15·0–18·8)	17·6 (13·1–22·1)	13·3 (6·9–21·5)	0·8 (0·7–0·9)
Egypt	3·54 (3·12–4·02)	5·91 (5·73–6·10)	3·16 (2·82–3·54)	2·38 (1·97–2·82)	2·05 (1·62–2·50)	557·4 (491·3–629·7)	1850·4 (1789·0–1913·1)	2611·0 (2335·5–2921·4)	2968·5 (2235·8–3819·0)	3117·2 (1456·3–5603·2)	1·5 (1·3–1·7)
Iran	6·21 (5·79–6·62)	7·41 (7·32–7·51)	1·52 (1·33–1·73)	1·31 (1·03–1·58)	1·28 (0·97–1·58)	772·2 (721·6–822·6)	1948·0 (1921·2–1973·2)	1027·8 (897·0–1168·0)	776·4 (560·5–1032·3)	456·1 (215·5–786·6)	0·7 (0·6–0·8)
Iraq	6·37 (5·98–6·76)	7·06 (6·83–7·26)	2·87 (2·63–3·16)	1·95 (1·63–2·35)	1·59 (1·25–2·01)	223·0 (209·4–236·5)	606·4 (587·4–624·5)	932·7 (853·6–1028·2)	873·0 (596·0–1223·7)	626·4 (284·1–1129·5)	1·3 (1·2–1·5)
Jordan	8·53 (8·41–8·64)	7·05 (6·96–7·14)	2·33 (2·06–2·62)	1·78 (1·44–2·10)	1·57 (1·20–1·93)	23·4 (23·0–23·7)	91·6 (90·1–93·1)	211·7 (187·4–238·2)	289·6 (219·8–367·5)	362·8 (205·1–553·3)	1·1 (1·0–1·2)
Kuwait	5·21 (4·77–5·67)	5·24 (5·11–5·37)	1·13 (0·98–1·30)	1·07 (0·89–1·30)	1·14 (0·93–1·39)	2·7 (2·5–2·9)	50·2 (48·9–51·6)	50·9 (44·1–59·0)	47·2 (37·1–60·8)	40·3 (26·2–60·8)	0·5 (0·5–0·6)
Lebanon	6·90 (6·55–7·24)	4·25 (3·95–4·55)	1·76 (1·49–2·09)	1·44 (1·12–1·80)	1·33 (0·98–1·73)	59·0 (56·0–61·9)	79·4 (74·3–84·5)	81·3 (69·4–96·1)	49·3 (34·2–68·0)	24·2 (8·6–49·8)	0·8 (0·7–1·0)
Libya	7·60 (7·39–7·81)	7·10 (6·92–7·25)	1·37 (1·14–1·63)	1·13 (0·87–1·43)	1·03 (0·75–1·37)	52·0 (50·6–53·3)	121·6 (118·8–124·4)	79·1 (66·1–94·5)	45·8 (31·7–66·0)	14·9 (4·8–34·7)	0·6 (0·5–0·8)
Morocco	7·18 (6·86–7·49)	5·71 (5·45–5·97)	2·26 (2·05–2·49)	1·36 (1·05–1·70)	1·02 (0·67–1·40)	463·2 (443·0–482·8)	806·7 (771·6–842·5)	646·6 (586·7–714·3)	373·2 (262·4–500·7)	90·9 (20·3–206·9)	1·1 (1·0–1·2)
Oman	7·48 (7·25–7·71)	7·57 (7·39–7·76)	2·48 (2·24–2·73)	1·64 (1·27–2·02)	1·29 (0·88–1·72)	23·9 (23·1–24·7)	59·1 (57·5–60·7)	81·7 (74·1–89·8)	76·9 (56·8–99·4)	53·4 (23·6–95·4)	1·2 (1·1–1·3)
Palestine	7·61 (7·37–7·84)	6·75 (6·50–6·98)	2·88 (2·64–3·16)	2·08 (1·79–2·44)	1·77 (1·43–2·15)	36·8 (35·7–38·0)	62·8 (60·4–65·1)	119·8 (109·5–132·2)	108·4 (82·3–139·7)	66·4 (26·4–129·3)	1·4 (1·3–1·5)
Qatar	7·04 (6·75–7·33)	5·35 (5·17–5·54)	1·95 (1·75–2·16)	1·43 (1·17–1·69)	1·29 (1·01–1·57)	1·2 (1·2–1·3)	8·2 (8·0–8·5)	38·0 (34·4–42·0)	59·8 (47·0–72·7)	58·2 (35·0–85·0)	0·9 (0·9–1·0)
Saudi Arabia	6·84 (6·51–7·15)	6·79 (6·48–7·09)	1·44 (1·24–1·68)	1·09 (0·80–1·39)	0·97 (0·65–1·31)	131·3 (124·7–137·8)	396·7 (377·1–416·4)	461·9 (396·5–535·4)	291·3 (195·0–395·8)	128·2 (48·7–242·9)	0·7 (0·6–0·8)
Sudan	6·63 (6·35–6·90)	6·72 (6·51–6·92)	3·38 (3·08–3·72)	1·93 (1·48–2·44)	1·40 (0·93–1·95)	238·8 (229·1–248·2)	702·4 (679·3–723·8)	1168·4 (1067·7–1281·7)	1011·1 (689·4–1360·9)	504·2 (148·5–1154·4)	1·5 (1·4–1·7)

(Table 1 continues on next page)

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	Total fertility rate					Livebirths (thousands)					Net reproductive rate, 2021
	1950	1980	2021	2050	2100	1950	1980	2021	2050	2100	
(Continued from previous page)											
Syria	7·68 (7·47–7·88)	6·79 (6·60–6·98)	2·06 (1·76–2·42)	1·57 (1·21–1·98)	1·39 (1·01–1·84)	165·5 (160·5–170·3)	373·0 (360·4–385·6)	196·6 (165·8–234·5)	167·9 (110·2–241·9)	100·5 (38·4–217·1)	1·0 (0·8–1·1)
Tunisia	6·48 (6·15–6·82)	5·07 (4·90–5·23)	1·82 (1·59–2·09)	1·36 (1·02–1·73)	1·19 (0·82–1·59)	166·5 (157·7–175·1)	222·0 (214·0–230·2)	166·5 (145·6–191·5)	99·5 (68·0–136·0)	28·7 (6·9–67·4)	0·9 (0·7–1·0)
Türkiye	5·73 (5·31–6·16)	4·81 (4·61–5·01)	1·67 (1·52–1·85)	1·32 (1·13–1·56)	1·17 (0·95–1·42)	859·4 (797·8–921·8)	1611·4 (1541·0–1680·6)	1052·9 (955·7–1164·2)	634·5 (497·4–793·2)	218·5 (114·1–382·4)	0·8 (0·7–0·9)
United Arab Emirates	7·14 (6·83–7·46)	5·88 (5·69–6·07)	1·90 (1·68–2·14)	1·53 (1·26–1·81)	1·31 (1·00–1·64)	3·6 (3·4–3·7)	35·5 (34·6–36·5)	74·0 (64·1–84·7)	160·2 (122·7–198·1)	155·8 (88·6–234·7)	0·9 (0·8–1·0)
Yemen	7·36 (7·07–7·64)	7·91 (7·77–8·04)	3·87 (3·47–4·31)	1·91 (1·32–2·54)	1·22 (0·54–1·95)	224·0 (214·9–232·8)	513·9 (504·7–522·7)	989·2 (886·4–1105·7)	863·3 (536·7–1288·7)	396·3 (56·2–1154·2)	1·8 (1·6–1·9)
South Asia	**6·35 (5·95–6·75)**	**4·96 (4·74–5·16)**	**2·07 (1·89–2·28)**	**1·36 (1·09–1·64)**	**1·10 (0·80–1·43)**	**20 472·6 (19 194·5–21 717·6)**	**31 555·9 (30 245·2–32 782·2)**	**32 043·4 (29 175·4–35 206·1)**	**18 743·1 (13 775·0–24 181·6)**	**5272·8 (1922·0–10 462·8)**	**0·9 (0·9–1·0)**
Bangladesh	7·30 (6·99–7·59)	6·03 (5·87–6·18)	1·90 (1·68–2·14)	1·20 (0·84–1·54)	0·97 (0·57–1·37)	2067·5 (1988·9–2140·7)	3641·1 (3563·4–3718·0)	2806·8 (2477·5–3152·8)	1370·6 (828·0–1977·2)	224·3 (6·5–644·2)	0·9 (0·8–1·0)
Bhutan	6·70 (6·35–7·04)	5·89 (5·59–6·18)	1·92 (1·74–2·09)	1·07 (0·73–1·34)	0·69 (0·33–1·00)	8·5 (8·1–8·9)	19·4 (18·5–20·2)	12·6 (11·5–13·8)	6·1 (3·9–8·2)	1·1 (0·2–2·3)	0·9 (0·8–1·0)
India	6·18 (5·75–6·59)	4·60 (4·35–4·83)	1·91 (1·69–2·13)	1·29 (0·97–1·62)	1·04 (0·67–1·42)	16 366·5 (15 255·4–17 463·8)	23 512·7 (22 306·6–24 656·5)	22 393·2 (19 926·1–25 068·0)	13 026·2 (8946·1–17 555·0)	3792·9 (1086·0–7903·8)	0·9 (0·8–1·0)
Nepal	6·33 (6·03–6·60)	6·17 (5·93–6·41)	2·14 (1·92–2·38)	1·18 (0·80–1·53)	0·82 (0·40–1·22)	416·7 (397·7–436·2)	727·6 (702·1–752·3)	642·2 (576·4–711·9)	273·0 (160·3–402·5)	14·6 (0·0–69·7)	1·0 (0·9–1·1)
Pakistan	7·26 (6·95–7·56)	6·75 (6·54–6·96)	3·22 (2·87–3·62)	1·76 (1·25–2·28)	1·16 (0·59–1·77)	1613·4 (1542·5–1682·1)	3655·1 (3533·0–3773·2)	6188·5 (5530·6–6957·2)	4067·1 (2636·1–5810·4)	1239·9 (85·1–3558·0)	1·4 (1·3–1·6)
Southeast Asia, east Asia, and Oceania	**5·76 (5·44–6·09)**	**2·99 (2·89–3·08)**	**1·55 (1·44–1·66)**	**1·37 (1·22–1·54)**	**1·30 (1·11–1·53)**	**31 218·7 (29 613·6–32 875·9)**	**31 743·5 (30 751·9–32 760·5)**	**22 805·8 (21 221·6–24 442·9)**	**15 544·8 (13 337·3–18 252·3)**	**6819·6 (4409·9–10 247·2)**	**0·7 (0·7–0·8)**
East Asia	5·57 (5·25–5·90)	2·46 (2·35–2·56)	1·23 (1·12–1·34)	1·14 (0·99–1·30)	1·16 (0·99–1·34)	22 400·1 (21 213·3–23 644·8)	18 856·4 (18 088·5–19 630·1)	11 202·9 (10 243·8–12 246·4)	6621·8 (5397·9–8088·3)	2201·4 (1341·4–3394·0)	0·6 (0·5–0·6)
China	5·55 (5·24–5·89)	2·44 (2·33–2·55)	1·23 (1·12–1·34)	1·14 (0·99–1·31)	1·16 (0·99–1·35)	21 609·2 (20 451·1–22 827·1)	18 000·3 (17 240·4–18 768·2)	10 747·2 (9807·6–11 774·1)	6360·0 (5139·5–7778·2)	2105·2 (1273·0–3268·7)	0·6 (0·5–0·6)
North Korea	5·41 (5·06–5·77)	3·25 (2·96–3·59)	1·51 (1·32–1·71)	1·24 (1·00–1·48)	1·16 (0·90–1·42)	424·7 (399·0–451·2)	450·7 (408·9–500·1)	299·0 (263·4–339·7)	172·2 (119·0–227·4)	63·4 (27·8–111·8)	0·7 (0·6–0·8)
Taiwan (province of China)	6·82 (6·66–6·98)	2·42 (2·34–2·51)	0·98 (0·87–1·09)	0·90 (0·78–1·04)	0·90 (0·77–1·05)	366·2 (357·7–375·6)	405·5 (391·4–420·2)	156·8 (139·6–175·5)	89·6 (73·8–107·7)	32·8 (22·0–46·8)	0·5 (0·4–0·5)
Oceania	6·63 (6·37–6·90)	5·36 (5·18–5·53)	4·02 (3·68–4·41)	2·93 (2·45–3·46)	1·67 (1·01–2·35)	121·4 (116·7–126·1)	193·5 (186·9–199·5)	430·7 (393·9–472·2)	590·1 (457·1–736·3)	566·7 (224·7–1096·8)	1·8 (1·6–1·9)
American Samoa	5·97 (5·71–6·25)	4·24 (4·08–4·40)	2·42 (2·14–2·71)	1·98 (1·67–2·31)	1·68 (1·34–2·05)	0·8 (0·8–0·8)	1·1 (1·1–1·1)	0·8 (0·7–0·9)	0·8 (0·6–1·0)	0·6 (0·3–1·0)	1·1 (1·0–1·3)
Cook Islands	5·79 (5·49–6·08)	3·66 (3·48–3·84)	1·74 (1·52–2·00)	1·40 (1·14–1·72)	1·25 (0·96–1·58)	0·6 (0·6–0·6)	0·4 (0·4–0·5)	0·2 (0·2–0·3)	0·2 (0·1–0·2)	0·1 (0·0–0·1)	0·8 (0·7–0·9)
Federated States of Micronesia	7·69 (7·48–7·88)	5·87 (5·58–6·14)	2·37 (2·04–2·78)	1·82 (1·39–2·33)	1·46 (0·96–2·05)	2·0 (2·0–2·1)	3·2 (3·1–3·4)	1·9 (1·6–2·2)	1·4 (0·8–2·0)	0·8 (0·2–1·9)	1·1 (1·0–1·3)
Fiji	5·64 (5·38–5·90)	3·34 (3·21–3·46)	2·42 (2·15–2·73)	1·95 (1·61–2·31)	1·64 (1·28–2·04)	11·5 (11·0–12·0)	18·8 (18·0–19·6)	16·7 (14·8–18·8)	12·6 (9·3–17·0)	8·7 (4·2–15·8)	1·1 (1·0–1·3)

(Table 1 continues on next page)

	Total fertility rate					Livebirths (thousands)					Net reproductive rate, 2021
	1950	1980	2021	2050	2100	1950	1980	2021	2050	2100	
(Continued from previous page)											
Guam	5·38 (5·12–5·68)	3·06 (2·94–3·17)	2·59 (2·30–2·86)	2·07 (1·76–2·38)	1·76 (1·42–2·09)	1·8 (1·7–1·8)	2·9 (2·8–3·1)	2·7 (2·4–3·0)	1·9 (1·4–2·4)	1·4 (0·7–2·4)	1·2 (1·1–1·3)
Kiribati	6·40 (6·25–6·54)	4·81 (4·50–5·12)	2·95 (2·63–3·32)	2·13 (1·70–2·62)	1·67 (1·19–2·21)	1·3 (1·3–1·3)	2·3 (2·1–2·4)	2·9 (2·6–3·3)	2·3 (1·7–3·1)	1·0 (0·2–2·3)	1·3 (1·2–1·5)
Marshall Islands	7·08 (6·77–7·38)	5·25 (5·02–5·50)	2·56 (2·31–2·84)	1·98 (1·67–2·32)	1·65 (1·31–2·02)	0·6 (0·6–0·6)	1·3 (1·3–1·4)	1·2 (1·0–1·3)	1·1 (0·8–1·4)	0·7 (0·4–1·3)	1·2 (1·1–1·3)
Nauru	6·62 (6·45–6·80)	4·95 (4·54–5·35)	3·24 (2·86–3·67)	2·40 (1·93–2·95)	1·91 (1·39–2·51)	0·1 (0·1–0·1)	0·3 (0·3–0·4)	0·3 (0·3–0·3)	0·3 (0·2–0·4)	0·3 (0·1–0·6)	1·5 (1·3–1·6)
Niue	6·36 (6·07–6·69)	4·10 (3·87–4·32)	2·09 (1·84–2·38)	1·71 (1·37–2·08)	1·50 (1·13–1·90)	0·2 (0·2–0·2)	0·1 (0·1–0·1)	0·0 (0·0–0·0)	0·0 (0·0–0·0)	0·0 (0·0–0·0)	0·9 (0·8–1·0)
Northern Mariana Islands	6·06 (5·66–6·46)	2·90 (2·58–3·28)	1·93 (1·68–2·21)	1·67 (1·36–2·01)	1·50 (1·17–1·88)	0·2 (0·2–0·2)	0·4 (0·3–0·4)	0·6 (0·5–0·7)	0·5 (0·4–0·7)	0·3 (0·2–0·6)	0·9 (0·8–1·0)
Palau	5·86 (5·44–6·27)	2·75 (2·44–3·09)	1·93 (1·72–2·15)	1·65 (1·37–1·92)	1·44 (1·14–1·74)	0·3 (0·3–0·3)	0·2 (0·2–0·3)	0·2 (0·2–0·2)	0·1 (0·1–0·2)	0·1 (0·0–0·1)	0·9 (0·8–1·0)
Papua New Guinea	6·73 (6·39–7·06)	5·81 (5·59–6·02)	4·26 (3·86–4·71)	3·03 (2·50–3·58)	1·64 (0·94–2·35)	81·5 (77·4–85·4)	125·1 (120·4–129·4)	345·1 (312·9–381·6)	500·2 (374·6–636·3)	491·1 (180·0–958·2)	1·9 (1·7–2·0)
Samoa	7·45 (7·24–7·64)	5·99 (5·70–6·26)	4·25 (3·91–4·61)	3·18 (2·69–3·68)	2·57 (1·98–3·14)	4·5 (4·4–4·6)	5·8 (5·5–6·0)	6·2 (5·7–6·8)	7·8 (6·1–9·6)	11·5 (5·6–19·0)	2·0 (1·8–2·1)
Solomon Islands	7·10 (6·89–7·30)	6·51 (6·25–6·76)	3·90 (3·61–4·20)	2·51 (2·10–2·90)	1·70 (1·21–2·21)	4·8 (4·7–4·9)	9·9 (9·5–10·2)	20·5 (19·0–22·1)	19·7 (14·8–25·6)	10·5 (3·6–21·0)	1·8 (1·7–1·9)
Tokelau	6·71 (6·46–6·97)	4·18 (3·87–4·49)	1·89 (1·61–2·20)	1·54 (1·17–1·94)	1·34 (0·94–1·78)	0·1 (0·1–0·1)	0·0 (0·0–0·0)	0·0 (0·0–0·0)	0·0 (0·0–0·0)	0·0 (0·0–0·0)	0·8 (0·7–0·9)
Tonga	6·66 (6·47–6·86)	5·88 (5·73–6·03)	4·08 (3·75–4·42)	3·04 (2·58–3·50)	2·45 (1·93–2·98)	2·2 (2·1–2·3)	3·6 (3·5–3·7)	3·0 (2·7–3·2)	3·2 (2·5–4·1)	4·3 (2·3–7·1)	1·9 (1·7–2·0)
Tuvalu	6·69 (6·37–7·01)	5·98 (5·67–6·28)	3·08 (2·74–3·45)	2·20 (1·71–2·70)	1·71 (1·17–2·26)	0·2 (0·2–0·2)	0·4 (0·4–0·4)	0·3 (0·2–0·3)	0·3 (0·2–0·4)	0·2 (0·1–0·4)	1·4 (1·3–1·6)
Vanuatu	7·08 (6·77–7·38)	6·10 (5·88–6·31)	3·52 (3·23–3·84)	2·44 (2·06–2·87)	1·79 (1·33–2·31)	2·1 (2·0–2·2)	5·1 (4·9–5·3)	8·7 (8·0–9·5)	9·8 (7·7–12·5)	8·2 (3·8–15·6)	1·6 (1·5–1·8)
Southeast Asia	6·40 (6·08–6·72)	4·31 (4·20–4·43)	2·05 (1·89–2·23)	1·60 (1·40–1·83)	1·35 (1·14–1·60)	8697·2 (8276·7–9096·0)	12 693·6 (12 352·2–13 033·5)	11 172·2 (10 297·5–12 144·2)	8332·9 (7018·9–10 074·5)	4051·6 (2523·7–6469·1)	1·0 (0·9–1·0)
Cambodia	6·60 (6·26–6·93)	5·89 (5·64–6·13)	2·61 (2·39–2·82)	1·65 (1·32–1·93)	1·10 (0·71–1·45)	211·5 (200·4–222·5)	351·8 (337·4–366·1)	372·7 (341·8–403·6)	267·3 (193·9–342·9)	102·9 (35·5–192·8)	1·2 (1·1–1·3)
Indonesia	6·07 (5·71–6·42)	4·28 (4·15–4·41)	1·97 (1·77–2·22)	1·53 (1·25–1·84)	1·29 (0·99–1·63)	3626·7 (3445·3–3802·8)	5175·0 (5017·4–5342·6)	4393·8 (3937·5–4935·6)	3147·3 (2402·1–4049·5)	1453·3 (684·5–2718·1)	0·9 (0·8–1·0)
Laos	6·65 (6·27–7·03)	6·22 (5·88–6·56)	2·76 (2·54–2·98)	1·61 (1·29–1·88)	1·09 (0·73–1·40)	84·4 (79·7–89·0)	147·1 (139·3–154·9)	177·4 (162·5–192·1)	116·7 (88·2–149·0)	32·4 (10·7–63·5)	1·3 (1·2–1·4)
Malaysia	6·89 (6·56–7·22)	3·98 (3·88–4·08)	1·81 (1·62–2·05)	1·39 (1·11–1·70)	1·17 (0·86–1·52)	303·5 (289·8–317·0)	421·1 (409·4–432·6)	474·2 (424·4–534·7)	364·6 (271·6–471·1)	203·4 (106·1–366·8)	0·9 (0·8–1·0)
Maldives	4·97 (4·69–5·25)	6·46 (6·35–6·57)	1·64 (1·47–1·84)	1·07 (0·79–1·34)	0·77 (0·42–1·11)	2·7 (2·5–2·9)	6·8 (6·6–6·9)	6·0 (5·4–6·7)	5·4 (3·9–7·0)	2·6 (1·1–4·8)	0·8 (0·7–0·9)

(Table 1 continues on next page)

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	Total fertility rate					Livebirths (thousands)					Net reproductive rate, 2021
	1950	1980	2021	2050	2100	1950	1980	2021	2050	2100	
(Continued from previous page)											
Mauritius	6·31 (6·17–6·45)	2·61 (2·52–2·71)	1·39 (1·23–1·57)	1·17 (0·94–1·42)	1·03 (0·77–1·32)	23·3 (22·7–23·8)	23·4 (22·6–24·2)	12·7 (11·2–14·3)	6·7 (5·0–9·1)	1·8 (0·6–3·8)	0·7 (0·6–0·8)
Myanmar	6·45 (6·08–6·82)	5·44 (5·18–5·67)	2·40 (2·20–2·62)	1·69 (1·42–1·97)	1·22 (0·89–1·57)	869·3 (819·0–919·4)	1328·9 (1263·1–1389·9)	1073·6 (983·0–1169·8)	754·4 (596·8–943·5)	248·2 (96·8–474·8)	1·1 (1·0–1·2)
Philippines	6·75 (6·43–7·05)	4·77 (4·57–4·98)	2·40 (2·21–2·60)	1·84 (1·61–2·11)	1·50 (1·23–1·79)	937·1 (891·5–982·6)	1767·1 (1681·8–1852·7)	2185·7 (2000·9–2368·9)	1967·3 (1575·7–2425·6)	1254·1 (747·7–2010·5)	1·1 (1·0–1·2)
Seychelles	4·00 (3·75–4·27)	3·55 (3·44–3·68)	2·31 (2·10–2·53)	1·86 (1·60–2·14)	1·60 (1·31–1·91)	1·0 (1·0–1·1)	1·7 (1·6–1·8)	1·6 (1·4–1·7)	1·7 (1·4–2·2)	1·6 (1·0–2·4)	1·1 (1·0–1·2)
Sri Lanka	5·19 (4·94–5·46)	3·39 (3·24–3·53)	1·85 (1·64–2·08)	1·50 (1·24–1·81)	1·30 (0·99–1·66)	306·2 (290·5–323·7)	421·2 (402·2–441·1)	298·6 (265·2–335·8)	179·5 (124·6–245·5)	45·9 (5·8–121·4)	0·9 (0·8–1·0)
Thailand	6·89 (6·58–7·19)	3·15 (3·02–3·27)	1·32 (1·20–1·46)	1·13 (0·96–1·31)	1·04 (0·86–1·24)	1003·1 (956·7–1048·8)	1181·9 (1131·0–1233·1)	573·1 (520·0–635·5)	300·0 (225·5–379·9)	87·3 (44·3–144·5)	0·6 (0·6–0·7)
Timor-Leste	7·00 (6·76–7·26)	6·72 (6·54–6·90)	3·85 (3·43–4·29)	2·27 (1·62–2·90)	1·58 (0·85–2·30)	22·5 (21·6–23·4)	28·8 (27·9–29·6)	41·0 (36·7–45·6)	35·7 (22·7–51·3)	17·5 (1·7–48·6)	1·8 (1·6–1·9)
Viet Nam	6·72 (6·40–7·04)	4·40 (4·25–4·55)	2·06 (1·88–2·28)	1·63 (1·38–1·93)	1·38 (1·10–1·70)	1293·3 (1232·9–1353·8)	1819·8 (1761·6–1875·2)	1546·1 (1416·2–1708·8)	1175·5 (928·2–1496·6)	595·3 (314·7–1084·8)	1·0 (0·9–1·1)
Sub-Saharan Africa	**6·94 (6·62–7·25)**	**6·78 (6·60–6·94)**	**4·29 (4·03–4·58)**	**2·72 (2·32–3·15)**	**1·82 (1·35–2·32)**	**8850·5 (8455·5–9233·0)**	**17 852·0 (17 412·0–18 264·8)**	**37 713·3 (35 513·3–40 151·9)**	**46 344·7 (37 509·8–55 394·7)**	**39 828·0 (19 422·1–69 747·3)**	**1·9 (1·8–2·0)**
Central sub-Saharan Africa	7·19 (6·93–7·42)	7·07 (6·84–7·28)	4·44 (4·15–4·72)	2·52 (2·05–2·94)	1·86 (1·37–2·31)	1010·4 (975·5–1042·7)	2065·0 (1997·0–2125·8)	4459·3 (4183·3–4730·0)	5233·7 (3753·5–6919·5)	4873·6 (2153·5–8575·8)	2·0 (1·9–2·1)
Angola	6·94 (6·61–7·26)	7·29 (7·06–7·52)	5·02 (4·66–5·38)	2·76 (2·21–3·35)	1·97 (1·37–2·62)	241·6 (230·2–252·6)	374·6 (361·9–386·9)	1202·7 (1115·3–1294·1)	1594·1 (1152·6–2079·7)	1735·5 (690·4–3385·4)	2·2 (2·1–2·4)
Central African Republic	5·79 (5·46–6·12)	6·47 (6·18–6·74)	4·36 (4·00–4·74)	2·36 (1·86–2·88)	1·35 (0·77–2·03)	59·7 (56·4–62·7)	110·6 (105·9–115·3)	191·1 (176·5–205·8)	142·5 (93·6–203·7)	29·6 (0·0–98·2)	1·8 (1·7–1·9)
Congo (Brazzaville)	6·65 (6·25–7·03)	6·16 (5·88–6·42)	2·95 (2·69–3·23)	1·90 (1·54–2·32)	1·49 (1·11–1·93)	40·8 (38·4–43·1)	76·4 (73·1–79·5)	128·6 (117·3–141·1)	118·9 (86·6–159·7)	78·2 (34·3–146·1)	1·3 (1·2–1·5)
Democratic Republic of the Congo	7·56 (7·27–7·83)	7·16 (6·90–7·40)	4·40 (4·02–4·77)	2·46 (1·82–3·03)	1·76 (1·09–2·38)	639·8 (615·5–662·2)	1459·4 (1404·9–1507·8)	2856·0 (2620·9–3089·5)	3277·7 (1995·4–4613·9)	2910·6 (858·8–5975·8)	2·0 (1·8–2·1)
Equatorial Guinea	7·18 (6·84–7·50)	6·83 (6·50–7·15)	3·09 (2·69–3·57)	2·19 (1·70–2·75)	1·83 (1·29–2·43)	9·6 (9·1–10·0)	14·4 (13·7–15·0)	37·4 (32·6–42·9)	55·9 (39·6–75·8)	82·7 (37·9–154·9)	1·4 (1·2–1·5)
Gabon	6·51 (6·10–6·91)	5·74 (5·37–6·10)	2·84 (2·46–3·30)	1·93 (1·41–2·52)	1·56 (1·02–2·19)	18·9 (17·7–20·0)	29·6 (27·7–31·4)	43·5 (37·7–50·3)	44·7 (29·8–63·8)	36·9 (12·5–80·6)	1·3 (1·1–1·5)
Eastern sub-Saharan Africa	7·15 (6·86–7·45)	7·02 (6·84–7·17)	4·09 (3·80–4·39)	2·50 (2·04–2·96)	1·68 (1·17–2·22)	3378·3 (3239·4–3512·6)	7091·2 (6932·8–7242·3)	13 778·4 (12 785·2–14 858·1)	15 968·4 (12 317·1–19 784·1)	12 206·9 (4940·5–23 355·8)	1·8 (1·7–1·9)
Burundi	7·14 (6·84–7·43)	6·86 (6·72–6·99)	4·93 (4·55–5·35)	2·74 (2·16–3·31)	1·55 (0·83–2·25)	124·8 (119·4–130·0)	213·9 (209·1–218·4)	468·8 (431·5–510·0)	552·4 (389·3–723·9)	381·8 (97·3–874·8)	2·2 (2·1–2·3)
Comoros	5·53 (5·12–5·90)	7·20 (6·95–7·44)	2·93 (2·55–3·35)	1·73 (1·17–2·33)	1·23 (0·60–1·92)	6·5 (6·0–6·9)	17·2 (16·6–17·7)	17·3 (15·1–19·8)	11·5 (6·5–17·6)	3·5 (0·0–11·1)	1·3 (1·2–1·5)
Djibouti	5·75 (5·35–6·19)	5·18 (4·92–5·44)	2·52 (2·22–2·85)	1·41 (0·92–1·88)	0·95 (0·38–1·51)	2·4 (2·3–2·6)	9·5 (9·0–10·0)	25·2 (22·2–28·4)	22·5 (13·9–31·8)	12·8 (2·9–28·1)	1·1 (1·0–1·3)
Eritrea	6·88 (6·52–7·22)	6·64 (6·35–6·90)	3·85 (3·41–4·34)	2·20 (1·52–2·86)	1·28 (0·49–2·09)	54·3 (51·4–57·2)	118·9 (113·7–123·7)	195·7 (173·8–220·4)	163·7 (88·6–262·8)	66·9 (2·5–221·8)	1·7 (1·5–1·9)

(Table 1 continues on next page)

	Total fertility rate					Livebirths (thousands)					Net reproductive rate, 2021
	1950	1980	2021	2050	2100	1950	1980	2021	2050	2100	
(Continued from previous page)											
Ethiopia	6·73 (6·35–7·08)	6·93 (6·67–7·17)	4·10 (3·79–4·43)	2·40 (1·86–2·89)	1·29 (0·64–1·87)	868·1 (819·0–914·9)	1786·6 (1715·1–1853·9)	3498·1 (3239·1–3788·0)	3957·1 (2829·4–5150·9)	2375·2 (637·3–4829·0)	1·8 (1·7–2·0)
Kenya	7·64 (7·41–7·86)	7·03 (6·84–7·21)	2·75 (2·43–3·13)	1·84 (1·39–2·35)	1·45 (0·96–2·01)	310·2 (302·7–317·4)	811·8 (792·2–830·5)	1186·7 (1053·2–1340·0)	1050·1 (715·7–1486·9)	551·7 (134·8–1299·0)	1·3 (1·1–1·4)
Madagascar	7·44 (7·12–7·73)	6·72 (6·54–6·89)	3·77 (3·48–4·07)	2·33 (1·91–2·78)	1·70 (1·23–2·22)	230·8 (221·6–239·4)	427·6 (416·9–438·2)	877·1 (815·6–945·5)	958·9 (730·1–1221·2)	735·6 (307·9–1382·5)	1·7 (1·6–1·8)
Malawi	6·17 (5·76–6·57)	7·62 (7·42–7·80)	3·46 (3·07–3·87)	2·03 (1·46–2·57)	1·55 (0·94–2·14)	130·2 (121·2–138·9)	348·4 (339·0–356·9)	574·2 (511·5–639·8)	570·3 (363·3–776·9)	417·2 (95·9–891·8)	1·5 (1·4–1·7)
Mozambique	6·95 (6·69–7·19)	6·67 (6·49–6·85)	4·50 (4·15–4·88)	2·44 (1·91–2·93)	1·55 (0·95–2·14)	337·7 (324·7–348·9)	596·5 (581·4–612·7)	1104·9 (1015·0–1202·2)	1221·8 (875·5–1614·2)	790·1 (242·4–1762·7)	1·9 (1·8–2·1)
Rwanda	7·39 (7·15–7·61)	7·45 (7·35–7·55)	3·55 (3·28–3·84)	1·97 (1·54–2·42)	1·24 (0·76–1·77)	137·3 (132·6–141·8)	267·5 (263·5–271·5)	373·6 (345·4–404·5)	405·7 (303·0–518·7)	298·1 (121·9–552·8)	1·6 (1·5–1·7)
Somalia	7·77 (7·51–8·01)	7·68 (7·50–7·84)	6·54 (6·27–6·81)	4·30 (3·92–4·68)	2·45 (1·92–3·00)	109·7 (105·8–113·3)	334·0 (326·2–341·2)	960·1 (919·1–1004·4)	1464·1 (1008·1–2005·2)	1425·7 (492·7–2833·8)	2·7 (2·6–2·8)
South Sudan	6·13 (5·69–6·56)	6·12 (5·79–6·45)	5·45 (5·04–5·87)	4·09 (3·59–4·64)	1·98 (1·22–2·75)	111·3 (103·6–118·7)	208·7 (196·9–219·7)	384·1 (353·8–414·9)	690·1 (519·9–872·8)	791·2 (304·1–1536·2)	2·2 (2·1–2·3)
Tanzania	7·60 (7·30–7·86)	6·94 (6·71–7·14)	4·04 (3·74–4·37)	2·42 (2·02–2·86)	1·70 (1·23–2·20)	481·7 (463·9–498·1)	943·5 (913·1–972·0)	1902·1 (1762·2–2057·9)	2091·0 (1582·8–2666·8)	1577·3 (661·3–2941·2)	1·8 (1·7–1·9)
Uganda	7·86 (7·60–8·09)	7·53 (7·36–7·69)	4·76 (4·47–5·07)	2·72 (2·26–3·19)	1·98 (1·48–2·50)	339·2 (329·0–348·4)	703·0 (688·9–716·8)	1591·6 (1490·7–1704·3)	2049·6 (1533·6–2610·7)	2014·5 (858·0–3620·6)	2·1 (2·0–2·2)
Zambia	7·58 (7·29–7·86)	7·22 (7·01–7·41)	3·84 (3·52–4·21)	2·39 (1·88–2·91)	1·83 (1·28–2·40)	132·3 (127·4–136·7)	300·2 (292·5–307·8)	606·9 (552·7–668·9)	747·0 (534·7–1007·7)	755·7 (306·5–1475·5)	1·7 (1·6–1·9)
Southern sub-Saharan Africa	6·20 (5·77–6·63)	4·86 (4·69–5·05)	2·42 (2·25–2·61)	1·94 (1·67–2·21)	1·63 (1·29–1·99)	792·2 (739·1–844·6)	1517·8 (1465·6–1572·3)	1636·8 (1518·7–1764·9)	1416·1 (1138·4–1739·9)	876·3 (453·7–1528·0)	1·1 (1·0–1·2)
Botswana	7·01 (6·65–7·35)	6·06 (5·78–6·33)	2·31 (2·05–2·61)	1·70 (1·31–2·12)	1·38 (0·94–1·84)	19·4 (18·4–20·4)	40·8 (38·8–42·7)	48·7 (43·1–55·2)	37·7 (26·2–50·8)	21·1 (7·3–43·8)	1·0 (0·9–1·2)
Eswatini	7·19 (6·84–7·52)	6·17 (5·96–6·38)	2·89 (2·65–3·15)	1·98 (1·62–2·36)	1·53 (1·13–1·95)	12·5 (12·0–13·1)	27·7 (26·8–28·5)	29·4 (27·0–32·1)	21·3 (15·1–28·1)	6·7 (0·7–16·1)	1·3 (1·2–1·3)
Lesotho	6·54 (6·14–6·93)	5·66 (5·46–5·84)	2·61 (2·31–2·93)	1·88 (1·50–2·34)	1·47 (1·03–1·98)	29·9 (28·1–31·7)	55·8 (54·2–57·4)	42·5 (37·8–48·1)	34·6 (23·5–48·4)	16·1 (4·1–39·0)	1·1 (1·0–1·2)
Namibia	7·16 (6·81–7·49)	5·63 (5·42–5·84)	2·80 (2·58–3·08)	2·03 (1·70–2·40)	1·62 (1·24–2·03)	22·1 (21·0–23·1)	40·6 (39·2–41·9)	58·0 (53·3–63·7)	54·7 (40·5–71·4)	39·4 (18·8–69·9)	1·3 (1·2–1·4)
South Africa	5·91 (5·46–6·37)	4·35 (4·16–4·56)	2·07 (1·92–2·23)	1·69 (1·46–1·89)	1·45 (1·20–1·67)	572·2 (529·6–614·5)	1007·6 (963·8–1054·9)	988·1 (913·4–1065·5)	785·7 (619·2–968·1)	470·7 (286·1–706·9)	0·9 (0·9–1·0)
Zimbabwe	7·24 (6·90–7·56)	6·63 (6·50–6·75)	3·60 (3·34–3·89)	2·56 (2·12–3·01)	2·01 (1·52–2·51)	136·0 (129·9–141·8)	345·3 (339·1–351·1)	470·0 (437·0–506·3)	482·1 (360·8–626·6)	322·3 (97·3–699·7)	1·6 (1·5–1·7)
Western sub-Saharan Africa	6·87 (6·54–7·17)	7·03 (6·83–7·22)	4·79 (4·51–5·09)	3·03 (2·60–3·48)	1·89 (1·39–2·44)	3669·7 (3499·6–3827·7)	7177·9 (6992·5–7355·4)	17 838·8 (16 834·6–18 900·8)	23 726·4 (19 422·7–28 301·3)	21 871·2 (10 771·0–37 177·5)	2·1 (2·0–2·2)
Benin	6·52 (6·12–6·92)	7·00 (6·79–7·19)	5·17 (4·86–5·50)	3·12 (2·65–3·60)	1·58 (0·95–2·18)	92·8 (87·0–98·3)	171·2 (166·5–175·6)	522·3 (488·8–559·3)	724·6 (552·9–910·7)	568·0 (197·5–1084·8)	2·3 (2·2–2·4)
Burkina Faso	6·30 (5·93–6·65)	7·32 (7·17–7·46)	5·52 (5·18–5·86)	3·76 (3·23–4·28)	1·62 (0·89–2·26)	187·8 (178·1–197·5)	379·6 (371·6–386·8)	950·8 (893·8–1010·0)	1519·4 (1216·6–1833·9)	1193·7 (384·0–2296·1)	2·4 (2·3–2·5)

(Table 1 continues on next page)

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where Model is our IHME

	Total fertility rate					Livebirths (thousands)					Net reproductive rate, 2021
	1950	1980	2021	2050	2100	1950	1980	2021	2050	2100	
(Continued from previous page)											
Cabo Verde	5·08 (4·78–5·37)	5·14 (4·99–5·28)	1·78 (1·53–2·04)	1·09 (0·73–1·48)	0·91 (0·51–1·34)	7·0 (6·5–7·4)	10·9 (10·5–11·3)	8·5 (7·4–9·7)	4·3 (2·5–6·6)	1·0 (0·1–2·7)	0·8 (0·7–1·0)
Cameroon	6·40 (5·98–6·80)	6·73 (6·56–6·89)	4·13 (3·76–4·54)	2·44 (1·92–3·03)	1·71 (1·13–2·36)	216·3 (202·6–229·5)	394·4 (385·4–402·9)	1032·5 (940·4–1137·6)	1138·8 (768·0–1579·8)	811·5 (241·3–1828·0)	1·8 (1·7–2·0)
Chad	7·36 (7·03–7·66)	7·60 (7·39–7·80)	6·99 (6·75–7·24)	4·81 (4·45–5·18)	2·15 (1·65–2·71)	127·4 (121·9–132·5)	242·8 (236·2–248·8)	860·2 (829·3–892·5)	1841·1 (1531·6–2177·8)	2491·7 (1487·4–3800·2)	2·9 (2·8–3·0)
Côte d'Ivoire	6·89 (6·52–7·25)	6·95 (6·77–7·11)	4·54 (4·23–4·90)	2·57 (2·11–3·04)	1·44 (0·87–1·99)	127·5 (120·7–133·9)	405·3 (395·4–414·8)	950·1 (879·5–1027·5)	1000·2 (744·1–1262·9)	521·1 (150·7–1089·8)	2·0 (1·9–2·1)
The Gambia	5·90 (5·45–6·35)	6·57 (6·39–6·76)	4·12 (3·89–4·38)	2·21 (1·81–2·61)	1·37 (0·92–1·87)	10·7 (10·0–11·4)	34·0 (33·2–34·9)	77·9 (73·1–83·1)	67·4 (50·8–86·7)	29·8 (9·4–59·0)	1·9 (1·8–1·9)
Ghana	5·37 (4·92–5·84)	6·71 (6·49–6·90)	3·40 (3·01–3·81)	2·12 (1·57–2·71)	1·57 (0·97–2·20)	204·3 (187·1–223·2)	551·2 (532·4–567·7)	966·8 (855·7–1082·9)	922·4 (602·0–1318·0)	636·0 (168·0–1417·0)	1·5 (1·4–1·7)
Guinea	7·05 (6·76–7·34)	6·81 (6·59–7·01)	4·67 (4·33–5·00)	3·02 (2·58–3·43)	1·42 (0·81–2·00)	127·4 (122·3–132·2)	245·1 (238·0–251·7)	495·4 (462·6–528·8)	633·0 (506·6–787·0)	366·2 (114·2–728·3)	2·0 (1·9–2·1)
Guinea-Bissau	7·11 (6·82–7·38)	6·13 (5·86–6·41)	4·42 (4·08–4·78)	2·41 (1·88–2·91)	1·26 (0·63–1·86)	31·2 (29·9–32·4)	37·4 (35·6–39·0)	72·0 (66·1–78·3)	75·6 (52·9–99·7)	35·5 (8·0–81·5)	1·9 (1·8–2·1)
Liberia	6·78 (6·40–7·15)	6·93 (6·74–7·12)	3·81 (3·39–4·26)	2·10 (1·52–2·71)	1·47 (0·85–2·14)	44·2 (41·8–46·6)	100·9 (98·2–103·2)	163·5 (145·6–183·0)	157·0 (100·9–229·0)	101·5 (22·7–247·4)	1·7 (1·5–1·8)
Mali	7·33 (7·00–7·64)	7·51 (7·29–7·71)	6·15 (5·85–6·46)	4·21 (3·83–4·63)	1·85 (1·30–2·42)	182·8 (174·7–190·4)	389·4 (379·0–398·7)	1064·4 (1007·3–1123·0)	1863·5 (1522·4–2237·3)	1675·3 (779·9–2834·3)	2·6 (2·5–2·7)
Mauritania	6·68 (6·29–7·06)	6·70 (6·53–6·88)	4·22 (3·86–4·64)	2·50 (1·98–3·08)	1·66 (1·04–2·34)	33·5 (31·5–35·4)	71·1 (69·1–72·9)	135·3 (122·6–149·5)	153·2 (109·3–206·1)	113·3 (32·7–258·4)	1·9 (1·8–2·1)
Niger	7·64 (7·36–7·89)	7·98 (7·82–8·12)	6·97 (6·71–7·24)	5·15 (4·68–5·64)	2·24 (1·48–2·92)	144·4 (139·4–149·1)	349·4 (342·8–355·8)	1174·8 (1126·7–1224·8)	2766·0 (2211·9–3290·7)	3891·3 (1737·1–6484·1)	3·0 (2·9–3·1)
Nigeria	7·08 (6·72–7·42)	6·99 (6·71–7·24)	4·75 (4·35–5·14)	2·69 (2·06–3·31)	1·87 (1·19–2·54)	1826·3 (1735·3–1911·0)	3200·3 (3085·6–3310·7)	8333·3 (7671·1–8973·3)	9845·1 (6861·8–13037·8)	8949·4 (2670·4–18113·0)	2·0 (1·9–2·2)
São Tomé and Príncipe	6·22 (6·01–6·42)	6·24 (6·03–6·44)	2·84 (2·51–3·19)	1·77 (1·29–2·28)	1·37 (0·83–1·94)	2·4 (2·3–2·5)	3·7 (3·6–3·9)	4·9 (4·3–5·6)	3·1 (1·9–4·6)	0·3 (0·0–1·9)	1·3 (1·2–1·5)
Senegal	7·17 (6·82–7·49)	7·39 (7·27–7·51)	4·02 (3·72–4·34)	2·32 (1·79–2·79)	1·25 (0·60–1·83)	135·9 (129·3–142·0)	303·8 (298·8–308·7)	479·3 (441·8–520·9)	489·6 (354·1–621·1)	233·5 (50·6–499·9)	1·8 (1·7–2·0)
Sierra Leone	6·60 (6·19–7·00)	6·55 (6·27–6·81)	4·20 (3·86–4·56)	2·43 (1·99–2·85)	1·31 (0·78–1·82)	91·7 (86·2–97·0)	159·2 (152·9–164·8)	302·8 (278·5–327·5)	303·3 (228·2–373·7)	144·7 (42·3–292·0)	1·8 (1·7–1·9)
Togo	7·46 (7·16–7·74)	6·93 (6·76–7·08)	3·72 (3·44–4·02)	2·01 (1·61–2·42)	1·24 (0·79–1·72)	75·8 (72·8–78·7)	127·9 (124·9–130·7)	243·6 (225·8–263·1)	218·3 (157·3–281·1)	107·1 (35·6–216·8)	1·7 (1·6–1·8)

Numbers in parentheses are 95% uncertainty intervals. Super-regions, regions, and countries are listed in alphabetical order.

Table 1: **Total fertility rate and number of livebirths (thousands) by location in 1950, 1980, and 2021, and for the reference scenario in 2050 and 2100; and net reproductive rate in 2021**

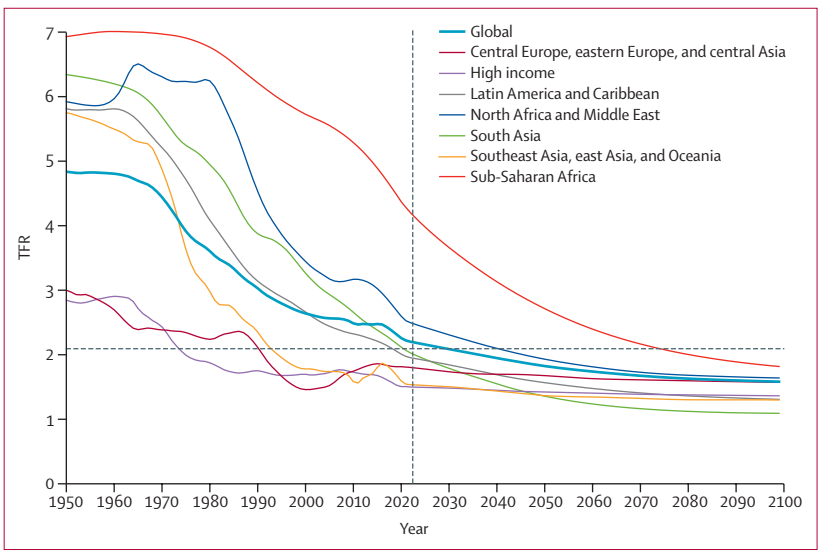
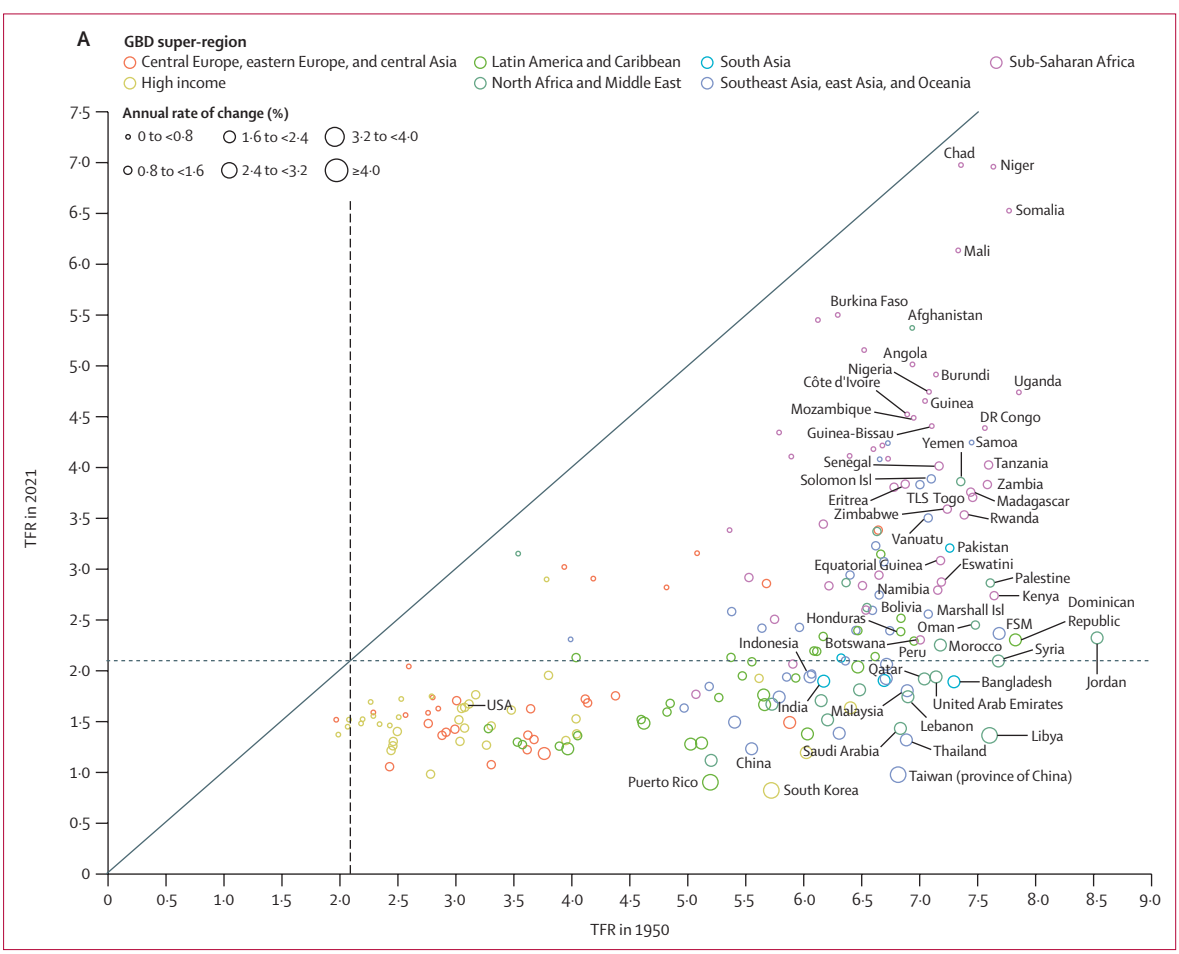


Figure 1: **TFR, globally and by GBD super-region, 1950–2100**
The dashed horizontal line indicates replacement TFR (2·1), and the dashed vertical line indicates the year 2022 (the first forecast year). GBD=Global Burden of Diseases, Injuries, and Risk Factors Study. TFR=total fertility rate.

model, and Baseline Model is a simplistic model in which ASFR of the most recent past year is held constant in the future.[34] Out-of-sample predicted values for our forecasts were based on the GBD fertility model fit using a dataset in which data sources from 2007 to 2021 were excluded, and these were compared to our final GBD 2021 estimates to compute root mean square error (RMSE) values. This skill metric was calculated across locations and reported for each 5-year age group. A positive skill metric indicates that a model being evaluated performs better than the baseline model, whereas a negative skill metric suggests the opposite.

GBD research and reporting practices

Point estimates were computed using the mean across 1000 draws from the estimated distribution of the given metric for past and present fertility estimates and 500 draws for future forecasts (see appendix 1 section 2 and 3.5, respectively, for details), and 95% UIs were obtained by taking the 2·5 and 97·5 percentile values from the draws. UIs were computed for forecast alternative scenarios but are only reported in the text and



(Figure 2 continues on next page)

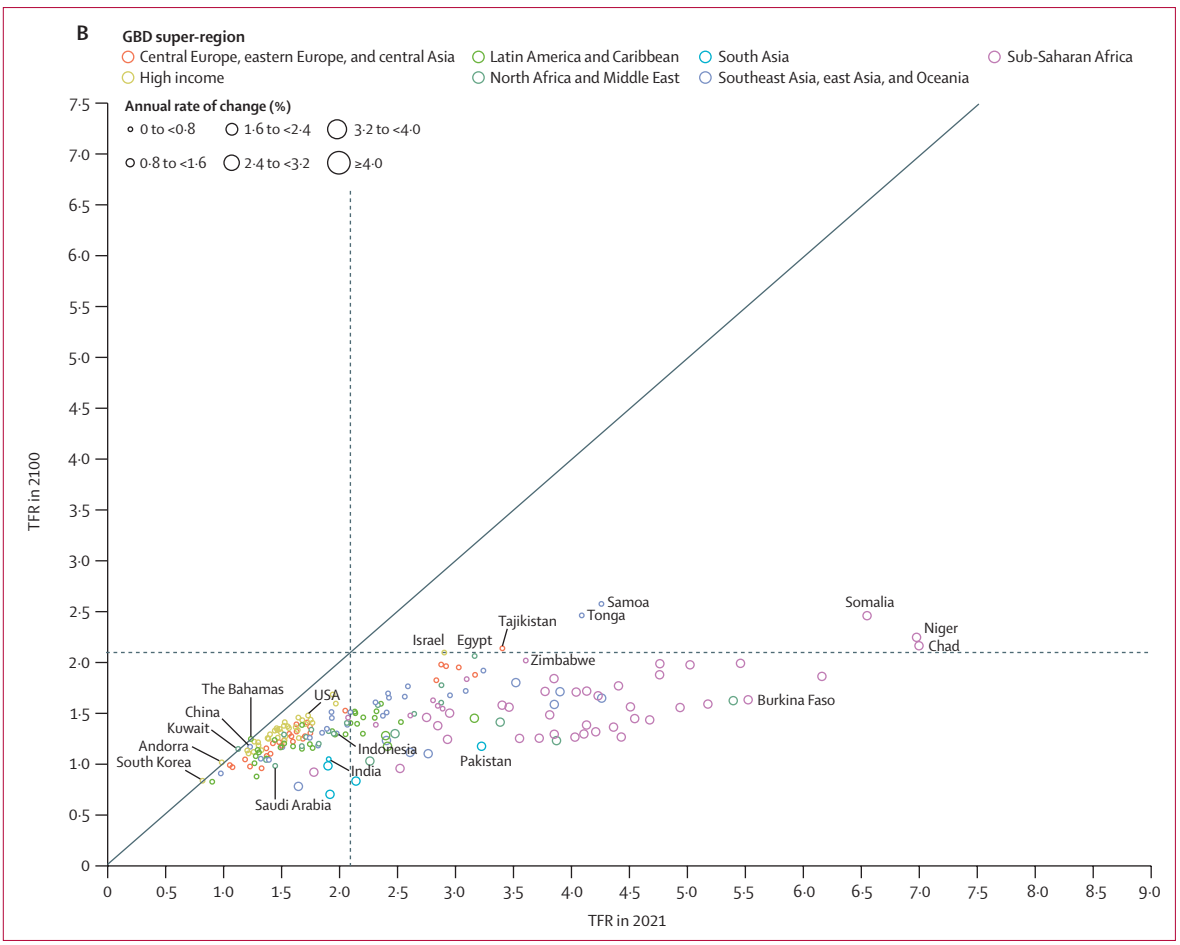


Figure 2: **TFR by country or territory, 1950 *vs* 2021 (A) and 2021 *vs* 2100 (B)**
Each circle represents the TFR for a country or territory in 1950 and 2021 (A) or in 2021 and 2100 (B). The size of the circle indicates the absolute annual rate of change in TFR between the two years. Circles above the diagonal line show countries or territories that have seen an increase in TFR over the study period, whereas those below the diagonal had a decline in TFR over the study period. The horizontal and vertical dashed lines indicate replacement TFR (2·1). Country name labels are provided for locations that have the largest TFR values, those with large TFR values and annualised rates of change, and the five most populous countries with a low TFR value. FSM= Federated States of Micronesia. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study. Isl=Islands. TLS=Timor-Leste. TFR=total fertility rate.

tables. For readability, figures only include UIs for the past and for the future reference scenario. GBD 2021 complies with the GATHER statement (appendix 1 table S2).[35]

Analyses were completed with Python version 3.10.12, Stata 15, and R version 3.5.1. Statistical code used for GBD estimation is publicly available online.

For the **GBD 2021 statistical code** see http://ghdx.healthdata.org/gbd-2021/code

Role of the funding source
The funder of this study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Fertility estimates 1950–2021

There were 129 million (95% UI 121–138) livebirths globally in 2021 (table 1). This is an increase from 92·7 million (88·7–96·6) livebirths in 1950, but a decline from the peak of 142 million (137–147) in 2016 (appendix 2 table S1). The global TFR was 2·23 (95% UI 2·09–2·38) in 2021, a decrease from 4·84 (4·63–5·06) in 1950 and 3·61 (3·53–3·69) in 1980 (table 1, figure 1). This approximate halving constitutes an annualised rate of decline in TFR of 1·1% (1·0–1·2). Across GBD super-regions, the distribution of livebirths changed substantially over the previous seven decades, as did relative levels of TFR. More than one-third of global livebirths in 1950 occurred in southeast Asia, east Asia, and Oceania, which was the largest proportion across super-regions (for livebirth counts, see table 1), corresponding to a TFR of 5·76 (5·44–6·09). This proportion decreased to less than 20% of global livebirths in 2021, with a TFR of 1·55 (1·44–1·66). By contrast, livebirths in south Asia increased from approximately 20% to 25% of global livebirths between 1950 and 2021, and contributed the largest proportion from 1981 to 2011.

TFR in this super-region decreased from 6·35 (5·95–6·75) in 1950 to 2·07 (1·89–2·28) in 2021. After 2011, sub-Saharan Africa contributed the largest share of livebirths, up to approximately 30% by 2021 (up from 8% in 1950). Large numbers of livebirths in sub-Saharan Africa in 2021 resulted from a much less steep decrease in TFR over the study period compared with other super-regions, falling from 6·94 (6·62–7·25) in 1950 to 4·29 (4·03–4·58) in 2021. Livebirths and TFRs over time for all locations are presented in table 1.

At the national level, estimates of TFR in 2021 ranged from 0·82 (95% UI 0·75–0·89) in South Korea to 6·99 (6·75–7·24) in Chad, with below-replacement levels of fertility (TFR <2·1) in 110 of 204 countries and territories (table 1, figures 2A, 3). This was an increase from 82 countries and territories below replacement level in 2000. Since 2000, the steepest declines in TFR were seen in São Tomé and Príncipe, Puerto Rico, and Kuwait, all of which had declines of more than 36%. Overall, fertility has declined steadily at the global level and across nearly all countries and territories since 1950, with rebounds in low fertility levels (ie, below-replacement fertility in the year with lowest TFR followed by higher fertility in at least one subsequent year) observed in 47 countries and territories (appendix 2 figure S1). The magnitude of these rebounds was small, with an average increase of 0·20 from lowest estimated TFR to the TFR in 2021, and only three countries rebounded above replacement levels: Georgia, Kazakhstan, and Seychelles. Cohort-completed fertility is a better indicator of fertility trends due to controlling for general shifts in the timing of childbearing. Since the 1940 birth cohort, CCF50 declined from peak levels in all countries and territories (the 1971 birth cohort is the last one for which we have complete age-specific fertility estimates up to age 50 years). Temporal rebounds from below-replacement CCF50 are less common compared with TFR, with only 15 countries or territories having a cohort that dropped below replacement fertility followed by a subsequent cohort with higher CCF50. These rebounds were also of smaller magnitude, with an average increase of 0·02 from lowest estimated CCF50 to the CCF50 in the 1971 birth cohort, and no rebounds exceeded replacement levels.

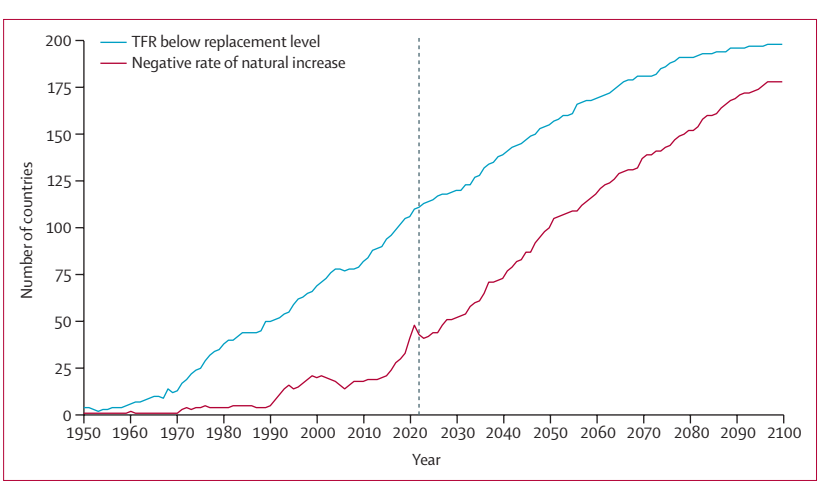


Figure 3: **Number of countries and territories with TFR below replacement level (2·1) and with a negative rate of natural increase, 1950–2100**

The number of countries and territories is out of a total of 204. The rate of natural increase is calculated as the birth rate minus the death rate; a negative rate indicates more deaths than births in a particular year and location. The vertical dashed line is at year 2022 (the first forecast year). TFR=total fertility rate.

Reference scenario fertility forecasts

Our forecasting estimates suggest that fertility rates will continue to decline worldwide from a global TFR of 2·21 (95% UI 2·06–2·36) in 2022 to 1·83 (1·59–2·08) in 2050 and 1·59 (1·25–1·96) in 2100 (table 1, figure 1). Except for four locations (South Korea, Andorra, The Bahamas, and Kuwait), we project that every country and territory will experience a decrease in TFR between 2021 and 2100 (figure 2B). Across GBD super-regions, forecasts of TFR in 2050 range from 1·36 (1·09–1·64) in south Asia to 2·72 (2·32–3·15) in sub-Saharan Africa; in 2100, TFRs in these two super-regions are forecast to be 1·10 (0·80–1·43) and 1·82 (1·35–2·32), respectively (table 1, figure 1). Countries projected to have the highest fertility rates in 2050 are Chad (4·81 [4·45–5·18]) and Niger (5·15 [4·68–5·64]); in 2100, the highest rates are forecast in Tonga (2·45 [1·93–2·98]) and Samoa (2·57 [1·98–3·14]; table 1). Countries projected to have the lowest fertility rates in 2050 are South Korea (0·82 [0·73–0·92]) and Puerto Rico (0·84 [0·76–0·92]), with the lowest rates in 2100 forecast in Bhutan (0·69 [0·33–1·00]) and the Maldives (0·77 [0·42–1·11]; table 1). TFRs are projected to decline between 2021 and 2100 at rates of more than 1% per year in 45 (22·1%) of 204 countries and territories. Burkina Faso and Guinea-Bissau are forecast to have the fastest annualised declines at rates of around 1·6% per year (figure 2B).

Global CCF50 is projected to decrease from 3·59 (95% UI 3·52–3·66) for females who were born in 1950 to 1·64 (1·33–1·97) for females born in 2050 who will have transitioned out of their reproductive years by 2100 (see figure 4, a Lexis diagram heatmap that simultaneously displays single-year ASFR, TFR, and CCF50 estimates for comparison). Globally, ASFRs are forecast to decline from 2022 to 2100, especially between ages 22 years and 32 years (as reflected in the change in pixel colours from lighter green to darker green moving rightward across the horizontal axis). This reflects that in some areas—particularly countries in the high-income GBD super-region and some in the central Europe, eastern Europe, and central Asia super-region—maternal age structure has shifted and will continue to shift dramatically towards females being older when they have children. Country-specific heatmaps that provide insight into different fertility patterns for a range of countries are shown in appendix 2 (figure S3).

103 (50·5%) of the 204 countries and territories included in the study had already reached TFRs below replacement level in 2018, and we project that

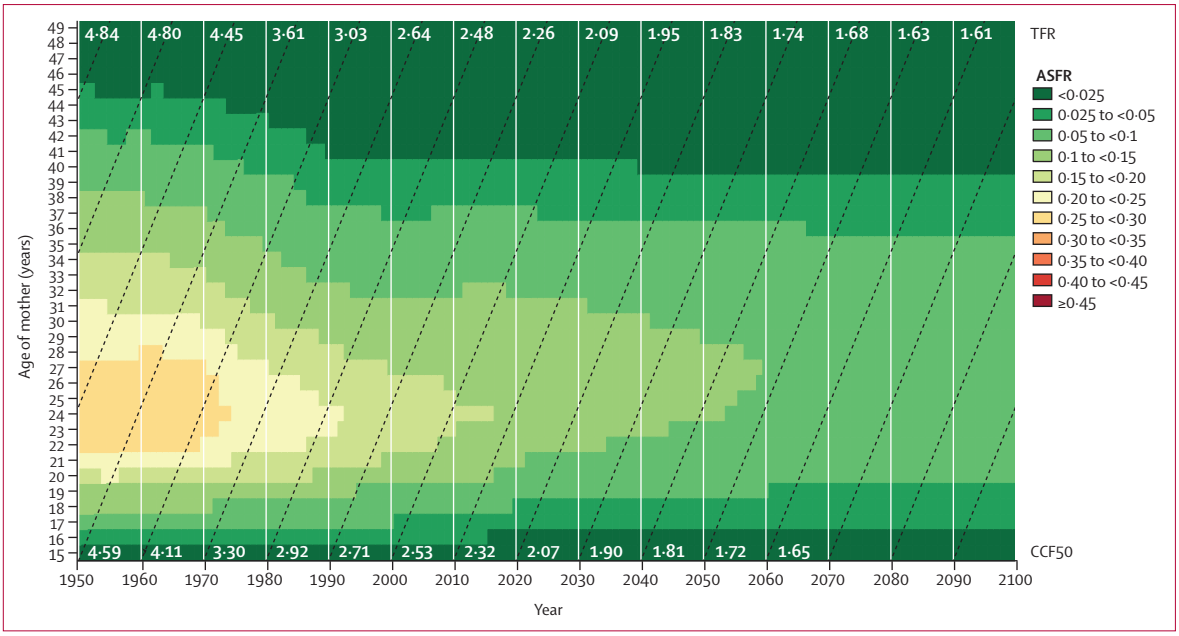


Figure 4: **Lexis diagram of CCF50, single-year age interval ASFR, and TFR by age of mother, globally, 1950–2100**
These Lexis diagram heatmaps simultaneously display single-year ASFR (colour fill), TFR (numbers at the top), and CCF50 estimates (white numbers at the bottom). The horizontal axis of the Lexis diagrams extends from 1950 (the beginning year of data availability) to 2100 (the final year of our forecasts), and the vertical axis indicates age of mother. CCF50 estimates are shown for each 10-year birth cohort. CCF50 is the sum of ASFR cells on the diagonal (ie, representing birth cohort), whereas TFR is the sum of ASFR cells vertically (ie, ASFR values from the same calendar year by age of mother). CCF50 is a cohort measure and years labelled on the x-axis are in period space. CCF50 values correspond to those entering their reproductive age (15–49 years) at that year (in other words, the birth cohort 15 years earlier). For example, the CCF50 value shown in 1950 represents CCF50 for those born in 1935. The vertical white lines indicate each decade, and the diagonal black dashed lines assist with visualising cohort space. ASFR=age-specific fertility rate. CCF50=completed cohort fertility at age 50 years. TFR=total fertility rate.

100 (49·0%) countries will have negative rates of natural increase (ie, the number of deaths will exceed the number of livebirths) by 2050 (figure 3). The concept of population momentum is illustrated in figure 3, which is the tendency of a population to continue to grow beyond the time it falls below replacement-level fertility. Population growth is heavily influenced by the age structure of the population; in locations with relatively large cohorts of young people (particularly younger than 15 years), the population will continue to grow well beyond the first year of below-replacement fertility as these young cohorts move through their reproductive years.[36,37] Our estimates indicate that there is approximately a 30-year gap between the time when TFR falls below 2·1 and when the natural rate of population increase turns negative. We forecast that 155 (76·0%) countries and territories will have fertility rates below replacement level in 2050; by 2100, we project this number will increase to 198 (97·1%), with 178 (87·3%) having a negative natural rate of increase (figure 3).

We project that the 2021 World Bank low-income and lower-middle-income groups[38] combined will contribute the majority of the global share of livebirths in 2100, at 77·4% (95% UI 69·1–83·6; figure 5, appendix 1 table S6, figure S2). Our results indicate that the proportion of global livebirths in the World Bank low-income group will increase from 17·8% (17·3–18·2) in 2021 to 26·5% (24·4–28·5) in 2050 and 34·6% (26·4–40·5) in 2100. In 1992, the number of births in the low-income group (14·9 million [14·6–15·3]) surpassed the number of births in the high-income group (14·0 million [13·8–14·2]; appendix 2 figure S4). We forecast that the number of births in the low-income group will exceed the number in the upper-middle-income group in 2026. In 1972, the number of births in the lower-middle-income group exceeded the number of births in the upper-middle-income group. We project that the lower-middle-income group will have the highest number of births among the four income groups during the 2022–2100 period even though it will decrease from 52·7% (51·7–53·7) of births in 2021 to 48·1% (45·2–50·5) in 2050 and 42·7% (37·5–48·7) in 2100 (figure 5). We forecast that the number of births in the lower-middle-income group will reach 53·9 million (43·3–67·1) by 2050 and 31·2 million (16·2–53·8) by 2100 (appendix 2 figure S4). By contrast, the share of livebirths contributed by the upper-middle-income group will decrease from 20·4% (19·8–21·2) in 2021 to 16·1% (14·7–17·8) in 2050 and 11·6% (8·9–15·3) in 2100 (figure 5). The proportion of the world's livebirths in the high-income group will remain relatively stable at 9·3% (8·3–10·6) in 2050 and 11·1% (7·2–16·2) in 2100 (figure 5). We also computed the global proportion of livebirths projected by GBD super-region (appendix 1 table S5), showing that the share of livebirths in sub-Saharan Africa is forecast to increase from 29·2% (28·7–29·6) in 2021 to

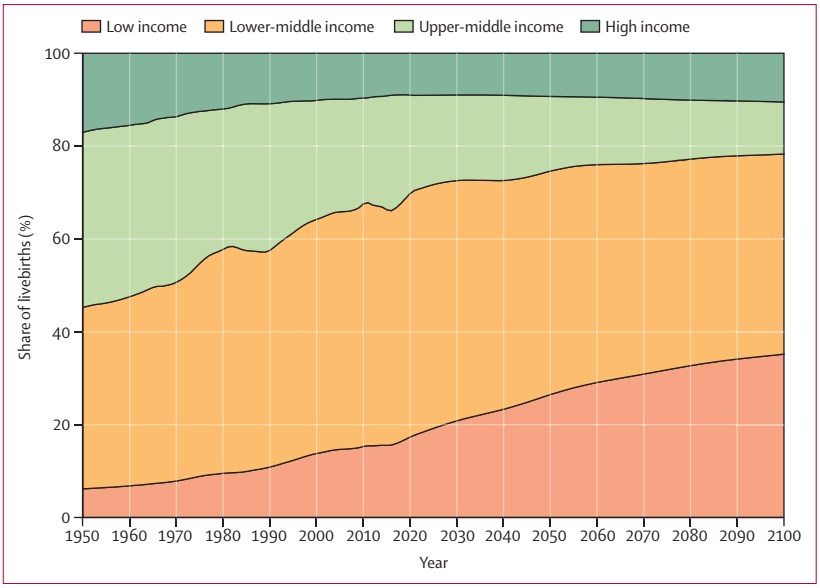


Figure 5: **Share of livebirths by 2021 World Bank income group**
The World Bank income group is explicitly chosen to highlight the share of births according to resources per person. Resources are defined as gross national income (gross domestic product plus net income) per person.

41·3% (39·6–43·1) in 2050 and 54·3% (47·1–59·5) in 2100. The two super-regions of south Asia and southeast Asia, east Asia, and Oceania—which were the primary sources of livebirths in the 1950s and 1980s—are projected to contribute only 7·1% (4·4–10·1) and 9·6% (7·9–12·0) of livebirths, respectively, in 2100. Considerable heterogeneity in livebirth counts exists at the regional and country level within each super-region. For example, the increase in livebirth counts between 2021 and 2100 is most notable in western and eastern sub-Saharan Africa, especially countries in the Sahel along with Somalia and South Sudan (table 1).

Alternative scenario fertility forecasts

We developed four alternative scenarios based on independent drivers that are included in our model: educational attainment, contraceptive met need, implementation of pro-natal policies, and a combination of these three drivers (appendix 1 section 3.4). The first scenario, which assumes meeting the SDG education target by 2030, is estimated to result in global TFRs of 1·65 (95% UI 1·40–1·92) in 2050 and 1·56 (1·26–1·92) in 2100 (table 2). The second scenario, which assumes meeting the SDG contraceptive met need target by 2030, will produce global TFRs of 1·64 (1·39–1·89) in 2050 and 1·52 (1·21–1·87) in 2100. The third scenario, which incorporates pro-natal policy implementation, is forecast to yield global TFRs of 1·93 (1·69–2·19) in 2050 and 1·68 (1·36–2·04) in 2100. The combined scenario, in which all three other alternative scenarios are applied, is projected to result in a global TFR of 1·65 (1·40–1·92) in 2050 and 1·62 (1·35–1·95) in 2100. We also projected country-level future fertility rates based on the reference (presented here) and four alternative (presented in appendix 1 section 3.8) scenarios for the world's ten most populous countries in 2021. Among these countries, only Nigeria and Pakistan will remain above 1·75 (our threshold for the pro-natal scenario implementation) well into the future in our reference scenario (beyond 2100 for Nigeria and 2050 in Pakistan). TFRs in both Brazil and Indonesia are forecast to decrease below 1·75 in 2036. Reference TFR values in Bangladesh and India are projected to decrease below 1·75 by 2026 and 2027, respectively. Mexico, Russia, the USA, and China already experienced TFR values below 1·75 in or before 2021 and are forecast to maintain flat future trends. Detailed results on the alternative scenarios in the world's ten most populous countries are shown in appendix 1 (section 3.8). Projections in all 204 countries and territories are shown in appendix 2 (figure S5) and table 2.

Comparison with other models

The WPP 2022 revision projected a global TFR of 2·15 in 2050 and 1·84 in 2100 compared with the global TFRs forecast by our model of 1·83 (95% UI 1·59–2·08) and 1·59 (1·25–1·96) in the same years (appendix 2 figure S6). In 2100, WPP's TFR forecasts converge to a narrower range of 1·38–2·22 than do our model's reference scenario TFR values, which range from 0·69 to 2·57. Additionally, for countries with low fertility levels, WPP predicts that fertility rates will rebound to a much larger extent than in our projections, which suggest they will remain low or decline (appendix 2 figure S6). We forecast that global TFR will fall below the replacement level of 2·1 after 2030, in contrast to WPP's forecast that global TFR will fall below replacement level in 2056.

Time-series country-level comparisons between ASFR and TFR predictions from our model and WPP 2022 are presented in appendix 2 (figures S5, S6). For example, our model predicts that reference TFR in South Korea will be low throughout the forecast period (0·82 [95% UI 0·73–0·92] in 2050 and 0·82 [0·71–0·95] in 2100), but WPP 2022 forecasts an increase in TFR in South Korea (1·17 in 2050 and 1·43 in 2100; appendix 2 figure S5). These forecasting differences are apparent in other countries and territories, including in Taiwan (province of China), where we forecast almost no change in TFR from 2050 to 2100 (0·90 [0·78–1·04] and 0·90 [0·77–1·05], respectively), compared with the WPP projection of a rebound in TFR to 1·41 in 2050 and 1·53 in 2100. We forecast that TFR will be lower in 200 of 204 countries and territories in 2100, including those that already have very low fertility rates, and projected a much steeper decline in TFR in many African countries than did WPP. For example, our model projected that TFR in Sudan will fall below replacement in approximately 2045, whereas the WPP model forecast that this will happen after 2095. Overall, the WPP model predicted that 142 (69·6%) of 204 countries and territories will have fertility rates below replacement level in 2050, whereas our model forecast

	Reference scenario		Education SDG achieved		Contraceptive met need SDG achieved		Pro-natal policies enacted		Combined scenario	
	2050	2100	2050	2100	2050	2100	2050	2100	2050	2100
Global	**1·83 (1·59–2·08)**	**1·59 (1·25–1·96)**	**1·65 (1·40–1·92)**	**1·56 (1·26–1·92)**	**1·64 (1·39–1·89)**	**1·52 (1·21–1·87)**	**1·93 (1·69–2·19)**	**1·68 (1·36–2·04)**	**1·65 (1·40–1·92)**	**1·62 (1·35–1·95)**
Central Europe, eastern Europe, and central Asia	**1·68 (1·56–1·81)**	**1·57 (1·42–1·73)**	**1·65 (1·52–1·78)**	**1·56 (1·41–1·72)**	**1·52 (1·39–1·66)**	**1·51 (1·36–1·65)**	**1·80 (1·68–1·93)**	**1·64 (1·49–1·79)**	**1·62 (1·49–1·75)**	**1·57 (1·42–1·71)**
Central Asia	2·31 (2·16–2·47)	1·95 (1·76–2·13)	2·27 (2·11–2·43)	1·93 (1·75–2·11)	2·11 (1·95–2·26)	1·88 (1·70–2·07)	2·33 (2·18–2·48)	1·95 (1·77–2·14)	2·09 (1·94–2·25)	1·89 (1·70–2·08)
Armenia	1·45 (1·27–1·65)	1·24 (1·01–1·49)	1·41 (1·23–1·62)	1·21 (0·98–1·46)	1·18 (0·94–1·42)	1·11 (0·87–1·37)	1·65 (1·47–1·85)	1·44 (1·21–1·69)	1·35 (1·12–1·60)	1·29 (1·05–1·55)
Azerbaijan	1·51 (1·27–1·76)	1·29 (1·01–1·59)	1·48 (1·24–1·74)	1·28 (1·00–1·57)	1·15 (0·84–1·44)	1·04 (0·73–1·35)	1·71 (1·47–1·96)	1·49 (1·21–1·79)	1·34 (1·03–1·64)	1·23 (0·92–1·54)
Georgia	1·80 (1·65–1·96)	1·52 (1·34–1·71)	1·71 (1·57–1·88)	1·49 (1·31–1·68)	1·53 (1·34–1·72)	1·39 (1·20–1·60)	1·80 (1·65–1·96)	1·72 (1·54–1·91)	1·67 (1·49–1·87)	1·57 (1·38–1·78)
Kazakhstan	2·43 (2·21–2·65)	1·94 (1·69–2·19)	2·38 (2·16–2·60)	1·92 (1·68–2·16)	2·27 (2·05–2·49)	1·89 (1·64–2·13)	2·43 (2·21–2·65)	1·94 (1·69–2·19)	2·23 (2·01–2·46)	1·87 (1·62–2·11)
Kyrgyzstan	2·35 (2·05–2·70)	1·95 (1·63–2·33)	2·32 (2·01–2·67)	1·94 (1·62–2·31)	2·01 (1·68–2·38)	1·73 (1·40–2·10)	2·35 (2·05–2·70)	1·95 (1·63–2·33)	1·99 (1·65–2·37)	1·92 (1·59–2·29)
Mongolia	2·46 (2·02–2·88)	1·87 (1·35–2·35)	2·36 (1·90–2·80)	1·83 (1·32–2·32)	2·22 (1·79–2·64)	1·77 (1·28–2·24)	2·46 (2·02–2·88)	1·87 (1·35–2·35)	2·15 (1·70–2·58)	1·79 (1·29–2·26)
Tajikistan	2·66 (2·33–2·97)	2·13 (1·75–2·49)	2·59 (2·25–2·91)	2·10 (1·73–2·45)	2·18 (1·83–2·50)	1·84 (1·48–2·18)	2·66 (2·33–2·97)	2·13 (1·75–2·49)	2·13 (1·79–2·46)	1·81 (1·46–2·15)
Turkmenistan	2·25 (1·87–2·66)	1·81 (1·38–2·28)	2·10 (1·68–2·54)	1·74 (1·29–2·22)	2·02 (1·65–2·44)	1·72 (1·30–2·18)	2·25 (1·87–2·66)	1·81 (1·38–2·28)	1·91 (1·51–2·34)	1·86 (1·43–2·32)
Uzbekistan	2·34 (2·08–2·62)	1·97 (1·69–2·27)	2·32 (2·06–2·60)	1·97 (1·69–2·26)	2·27 (2·02–2·54)	1·97 (1·69–2·27)	2·34 (2·08–2·62)	1·97 (1·69–2·27)	2·26 (2·00–2·53)	1·97 (1·70–2·26)
Central Europe	1·34 (1·19–1·50)	1·21 (1·03–1·41)	1·33 (1·17–1·49)	1·21 (1·03–1·41)	1·18 (1·01–1·35)	1·15 (0·97–1·35)	1·54 (1·39–1·70)	1·41 (1·23–1·61)	1·37 (1·20–1·55)	1·34 (1·16–1·55)
Albania	1·34 (1·10–1·61)	1·17 (0·86–1·50)	1·29 (1·04–1·57)	1·15 (0·83–1·48)	0·86 (0·52–1·20)	0·80 (0·44–1·15)	1·54 (1·30–1·81)	1·37 (1·06–1·70)	1·04 (0·69–1·38)	0·99 (0·63–1·35)
Bosnia and Herzegovina	1·16 (0·99–1·35)	0·95 (0·71–1·19)	1·15 (0·98–1·35)	0·96 (0·73–1·20)	0·85 (0·61–1·08)	0·80 (0·55–1·05)	1·36 (1·19–1·55)	1·15 (0·91–1·39)	1·05 (0·80–1·28)	1·01 (0·75–1·25)
Bulgaria	1·43 (1·29–1·59)	1·26 (1·08–1·45)	1·40 (1·25–1·56)	1·26 (1·08–1·45)	1·25 (1·08–1·42)	1·18 (0·99–1·37)	1·63 (1·49–1·79)	1·46 (1·28–1·65)	1·43 (1·26–1·61)	1·38 (1·20–1·57)
Croatia	1·27 (1·08–1·46)	1·14 (0·92–1·38)	1·26 (1·08–1·46)	1·14 (0·92–1·38)	1·05 (0·83–1·26)	1·01 (0·78–1·25)	1·47 (1·28–1·66)	1·34 (1·12–1·58)	1·25 (1·03–1·46)	1·21 (0·98–1·45)
Czechia	1·54 (1·34–1·76)	1·36 (1·13–1·60)	1·53 (1·33–1·75)	1·35 (1·13–1·60)	1·44 (1·23–1·66)	1·31 (1·09–1·55)	1·74 (1·54–1·96)	1·56 (1·33–1·80)	1·62 (1·41–1·84)	1·50 (1·28–1·74)
Hungary	1·42 (1·22–1·65)	1·29 (1·06–1·55)	1·42 (1·22–1·65)	1·29 (1·06–1·55)	1·34 (1·13–1·57)	1·25 (1·02–1·51)	1·62 (1·42–1·85)	1·49 (1·26–1·75)	1·53 (1·33–1·77)	1·44 (1·22–1·71)
Montenegro	1·56 (1·43–1·70)	1·40 (1·23–1·58)	1·55 (1·42–1·69)	1·40 (1·23–1·58)	1·18 (0·95–1·39)	1·12 (0·89–1·34)	1·76 (1·63–1·90)	1·60 (1·43–1·78)	1·38 (1·15–1·58)	1·32 (1·09–1·53)
North Macedonia	1·10 (1·01–1·20)	0·97 (0·84–1·09)	1·08 (0·98–1·18)	0·97 (0·84–1·09)	0·80 (0·66–0·93)	0·76 (0·62–0·90)	1·30 (1·21–1·40)	1·17 (1·04–1·29)	0·99 (0·85–1·11)	0·96 (0·82–1·10)
Poland	1·21 (1·04–1·40)	1·07 (0·87–1·29)	1·21 (1·04–1·39)	1·07 (0·87–1·29)	1·06 (0·86–1·27)	1·00 (0·79–1·22)	1·41 (1·24–1·60)	1·27 (1·07–1·49)	1·26 (1·06–1·47)	1·20 (0·99–1·42)
Romania	1·48 (1·32–1·66)	1·26 (1·06–1·48)	1·45 (1·28–1·63)	1·26 (1·06–1·47)	1·34 (1·15–1·52)	1·23 (1·03–1·44)	1·68 (1·52–1·86)	1·46 (1·26–1·68)	1·51 (1·32–1·70)	1·43 (1·23–1·64)
Serbia	1·01 (0·90–1·11)	0·96 (0·82–1·09)	1·00 (0·90–1·11)	0·96 (0·82–1·09)	0·81 (0·66–0·94)	0·82 (0·66–0·96)	1·21 (1·10–1·31)	1·16 (1·02–1·29)	1·01 (0·85–1·13)	1·02 (0·86–1·16)
Slovakia	1·46 (1·34–1·59)	1·31 (1·16–1·46)	1·45 (1·32–1·58)	1·30 (1·15–1·46)	1·30 (1·15–1·44)	1·22 (1·06–1·38)	1·66 (1·54–1·79)	1·51 (1·36–1·66)	1·49 (1·34–1·63)	1·41 (1·26–1·57)
Slovenia	1·51 (1·39–1·64)	1·38 (1·24–1·54)	1·50 (1·38–1·64)	1·38 (1·24–1·54)	1·32 (1·16–1·47)	1·25 (1·08–1·42)	1·71 (1·59–1·84)	1·58 (1·44–1·74)	1·51 (1·35–1·67)	1·45 (1·28–1·62)
Eastern Europe	1·28 (1·15–1·42)	1·19 (1·05–1·35)	1·24 (1·12–1·39)	1·18 (1·04–1·34)	1·16 (1·02–1·32)	1·13 (0·99–1·30)	1·48 (1·35–1·62)	1·39 (1·24–1·55)	1·34 (1·20–1·49)	1·32 (1·18–1·49)
Belarus	1·29 (1·06–1·55)	1·19 (0·95–1·47)	1·28 (1·05–1·54)	1·19 (0·94–1·47)	1·14 (0·89–1·41)	1·09 (0·83–1·36)	1·49 (1·26–1·75)	1·39 (1·15–1·67)	1·33 (1·09–1·60)	1·28 (1·03–1·56)

(Table 2 continues on next page)

	Reference scenario		Education SDG achieved		Contraceptive met need SDG achieved		Pro-natal policies enacted		Combined scenario	
	2050	2100	2050	2100	2050	2100	2050	2100	2050	2100
(Continued from previous page)										
Estonia	1·37 (1·24–1·50)	1·21 (1·06–1·36)	1·30 (1·16–1·44)	1·19 (1·04–1·35)	1·30 (1·17–1·44)	1·18 (1·04–1·33)	1·57 (1·44–1·70)	1·41 (1·26–1·56)	1·44 (1·31–1·58)	1·37 (1·22–1·52)
Latvia	1·35 (1·16–1·56)	1·22 (1·01–1·49)	1·29 (1·10–1·52)	1·22 (1·00–1·48)	1·25 (1·04–1·47)	1·18 (0·96–1·44)	1·55 (1·36–1·76)	1·42 (1·21–1·69)	1·41 (1·20–1·63)	1·37 (1·15–1·64)
Lithuania	1·23 (1·11–1·35)	1·09 (0·96–1·25)	1·21 (1·09–1·33)	1·08 (0·95–1·24)	1·12 (0·99–1·26)	1·05 (0·91–1·20)	1·43 (1·31–1·55)	1·29 (1·16–1·45)	1·30 (1·18–1·44)	1·24 (1·10–1·40)
Moldova	1·09 (0·94–1·25)	1·03 (0·87–1·24)	1·07 (0·92–1·23)	1·03 (0·87–1·23)	0·95 (0·78–1·13)	0·95 (0·77–1·15)	1·29 (1·14–1·45)	1·23 (1·07–1·44)	1·13 (0·96–1·31)	1·15 (0·97–1·35)
Russia	1·33 (1·20–1·47)	1·21 (1·06–1·37)	1·29 (1·16–1·44)	1·20 (1·06–1·36)	1·21 (1·07–1·37)	1·15 (1·01–1·31)	1·53 (1·40–1·67)	1·41 (1·26–1·57)	1·38 (1·24–1·54)	1·34 (1·20–1·50)
Ukraine	1·01 (0·88–1·16)	0·98 (0·83–1·16)	0·99 (0·85–1·14)	0·97 (0·82–1·15)	0·92 (0·77–1·07)	0·93 (0·77–1·11)	1·21 (1·08–1·36)	1·18 (1·03–1·36)	1·10 (0·95–1·25)	1·12 (0·97–1·30)
High income	**1·43 (1·30–1·56)**	**1·37 (1·22–1·53)**	**1·42 (1·29–1·55)**	**1·36 (1·22–1·52)**	**1·38 (1·24–1·52)**	**1·34 (1·19–1·50)**	**1·62 (1·50–1·76)**	**1·56 (1·41–1·72)**	**1·57 (1·43–1·71)**	**1·52 (1·38–1·68)**
Australasia	1·45 (1·25–1·68)	1·33 (1·08–1·59)	1·46 (1·26–1·67)	1·33 (1·11–1·57)	1·40 (1·18–1·64)	1·31 (1·06–1·58)	1·65 (1·45–1·88)	1·53 (1·28–1·79)	1·60 (1·39–1·84)	1·51 (1·28–1·76)
Australia	1·45 (1·23–1·70)	1·32 (1·06–1·61)	1·46 (1·24–1·69)	1·32 (1·09–1·58)	1·41 (1·16–1·67)	1·31 (1·03–1·59)	1·65 (1·43–1·90)	1·52 (1·26–1·81)	1·61 (1·38–1·86)	1·51 (1·25–1·78)
New Zealand	1·45 (1·33–1·58)	1·35 (1·20–1·51)	1·45 (1·34–1·57)	1·35 (1·22–1·49)	1·39 (1·25–1·54)	1·31 (1·15–1·48)	1·65 (1·53–1·78)	1·55 (1·40–1·71)	1·59 (1·45–1·73)	1·51 (1·37–1·67)
High-income Asia Pacific	1·14 (1·00–1·30)	1·14 (0·96–1·35)	1·12 (0·99–1·28)	1·13 (0·97–1·33)	1·07 (0·91–1·24)	1·08 (0·89–1·30)	1·34 (1·20–1·49)	1·33 (1·15–1·54)	1·25 (1·10–1·42)	1·27 (1·10–1·48)
Brunei	1·40 (1·08–1·78)	1·25 (0·87–1·70)	1·38 (1·08–1·72)	1·26 (0·91–1·65)	1·28 (0·94–1·68)	1·19 (0·81–1·64)	1·60 (1·28–1·98)	1·45 (1·07–1·90)	1·45 (1·13–1·82)	1·39 (1·04–1·80)
Japan	1·26 (1·09–1·45)	1·21 (1·00–1·43)	1·24 (1·07–1·43)	1·20 (1·02–1·41)	1·16 (0·96–1·38)	1·14 (0·92–1·38)	1·46 (1·29–1·65)	1·41 (1·20–1·63)	1·35 (1·15–1·56)	1·33 (1·13–1·56)
Singapore	1·15 (0·93–1·41)	1·12 (0·88–1·41)	1·14 (0·94–1·39)	1·12 (0·90–1·38)	1·14 (0·92–1·39)	1·12 (0·89–1·40)	1·35 (1·13–1·61)	1·32 (1·08–1·61)	1·33 (1·13–1·57)	1·32 (1·11–1·58)
South Korea	0·82 (0·73–0·92)	0·82 (0·71–0·95)	0·82 (0·73–0·91)	0·82 (0·71–0·94)	0·79 (0·67–0·92)	0·82 (0·68–0·95)	1·02 (0·93–1·12)	1·02 (0·91–1·15)	0·99 (0·87–1·11)	1·01 (0·88–1·15)
High-income North America	1·51 (1·38–1·64)	1·43 (1·27–1·60)	1·50 (1·38–1·63)	1·43 (1·28–1·58)	1·44 (1·31–1·58)	1·38 (1·22–1·54)	1·71 (1·58–1·84)	1·63 (1·47–1·80)	1·64 (1·50–1·77)	1·57 (1·42–1·73)
Canada	1·39 (1·21–1·58)	1·32 (1·12–1·54)	1·39 (1·22–1·58)	1·32 (1·13–1·53)	1·36 (1·17–1·56)	1·30 (1·10–1·53)	1·59 (1·41–1·78)	1·52 (1·32–1·74)	1·56 (1·37–1·76)	1·50 (1·30–1·72)
Greenland	1·84 (1·60–2·10)	1·67 (1·36–2·00)	1·74 (1·46–2·02)	1·62 (1·28–1·94)	1·77 (1·52–2·03)	1·62 (1·30–1·94)	1·84 (1·60–2·10)	1·87 (1·56–2·20)	1·88 (1·60–2·16)	1·76 (1·44–2·09)
USA	1·52 (1·40–1·65)	1·45 (1·30–1·60)	1·51 (1·40–1·64)	1·44 (1·30–1·59)	1·46 (1·33–1·59)	1·39 (1·24–1·54)	1·72 (1·60–1·85)	1·65 (1·50–1·80)	1·65 (1·52–1·77)	1·58 (1·44–1·73)
Southern Latin America	1·32 (1·10–1·57)	1·23 (0·97–1·53)	1·30 (1·09–1·54)	1·22 (0·99–1·50)	1·27 (1·04–1·53)	1·22 (0·96–1·52)	1·52 (1·30–1·77)	1·43 (1·17–1·73)	1·45 (1·23–1·71)	1·41 (1·16–1·70)
Argentina	1·33 (1·09–1·60)	1·22 (0·91–1·56)	1·31 (1·07–1·57)	1·21 (0·93–1·51)	1·28 (1·01–1·55)	1·20 (0·89–1·54)	1·53 (1·29–1·80)	1·42 (1·11–1·76)	1·45 (1·20–1·73)	1·39 (1·10–1·71)
Chile	1·29 (1·09–1·51)	1·24 (0·99–1·51)	1·29 (1·10–1·50)	1·24 (1·01–1·50)	1·26 (1·05–1·50)	1·23 (0·98–1·51)	1·49 (1·29–1·71)	1·44 (1·19–1·71)	1·46 (1·25–1·70)	1·43 (1·19–1·70)
Uruguay	1·36 (1·14–1·60)	1·25 (0·97–1·56)	1·27 (1·05–1·52)	1·20 (0·95–1·50)	1·29 (1·05–1·56)	1·22 (0·93–1·55)	1·56 (1·34–1·80)	1·45 (1·17–1·76)	1·42 (1·16–1·69)	1·38 (1·10–1·70)
Western Europe	1·44 (1·32–1·57)	1·37 (1·23–1·52)	1·43 (1·32–1·56)	1·37 (1·24–1·51)	1·42 (1·30–1·55)	1·36 (1·23–1·51)	1·63 (1·52–1·76)	1·55 (1·42–1·70)	1·60 (1·49–1·73)	1·54 (1·42–1·68)
Andorra	1·02 (0·92–1·11)	1·01 (0·89–1·13)	1·01 (0·92–1·11)	1·01 (0·90–1·12)	1·00 (0·91–1·10)	1·00 (0·89–1·12)	1·22 (1·12–1·31)	1·21 (1·09–1·33)	1·20 (1·11–1·30)	1·20 (1·10–1·32)
Austria	1·42 (1·29–1·55)	1·34 (1·18–1·51)	1·41 (1·29–1·55)	1·34 (1·18–1·50)	1·40 (1·27–1·54)	1·34 (1·18–1·51)	1·62 (1·49–1·75)	1·54 (1·38–1·71)	1·60 (1·48–1·73)	1·53 (1·39–1·69)
Belgium	1·43 (1·24–1·63)	1·34 (1·13–1·57)	1·43 (1·25–1·63)	1·34 (1·15–1·56)	1·41 (1·23–1·61)	1·34 (1·13–1·57)	1·63 (1·44–1·83)	1·54 (1·33–1·77)	1·61 (1·43–1·81)	1·54 (1·35–1·76)
Cyprus	1·18 (0·97–1·43)	1·13 (0·89–1·40)	1·18 (0·97–1·41)	1·12 (0·90–1·38)	1·17 (0·96–1·41)	1·12 (0·89–1·38)	1·38 (1·17–1·63)	1·33 (1·09–1·60)	1·36 (1·16–1·60)	1·31 (1·09–1·57)

(Table 2 continues on next page)

	Reference scenario		Education SDG achieved		Contraceptive met need SDG achieved		Pro-natal policies enacted		Combined scenario	
	2050	2100	2050	2100	2050	2100	2050	2100	2050	2100
(Continued from previous page)										
Denmark	1·57 (1·46–1·69)	1·47 (1·34–1·60)	1·56 (1·45–1·68)	1·47 (1·34–1·59)	1·55 (1·44–1·67)	1·46 (1·33–1·59)	1·77 (1·66–1·89)	1·67 (1·54–1·80)	1·75 (1·63–1·86)	1·66 (1·54–1·79)
Finland	1·36 (1·24–1·49)	1·32 (1·18–1·48)	1·36 (1·25–1·49)	1·32 (1·19–1·47)	1·35 (1·23–1·48)	1·31 (1·18–1·46)	1·56 (1·44–1·69)	1·52 (1·38–1·68)	1·55 (1·43–1·67)	1·51 (1·38–1·66)
France	1·56 (1·35–1·79)	1·43 (1·19–1·69)	1·56 (1·36–1·78)	1·42 (1·20–1·67)	1·54 (1·33–1·77)	1·43 (1·19–1·69)	1·76 (1·55–1·99)	1·63 (1·39–1·89)	1·74 (1·53–1·97)	1·63 (1·40–1·87)
Germany	1·47 (1·35–1·58)	1·40 (1·27–1·53)	1·46 (1·35–1·58)	1·41 (1·28–1·53)	1·45 (1·33–1·57)	1·39 (1·26–1·52)	1·67 (1·55–1·78)	1·60 (1·47–1·73)	1·64 (1·52–1·77)	1·59 (1·47–1·72)
Greece	1·36 (1·17–1·57)	1·28 (1·06–1·54)	1·35 (1·17–1·56)	1·28 (1·07–1·52)	1·34 (1·15–1·55)	1·28 (1·06–1·52)	1·56 (1·37–1·77)	1·48 (1·26–1·74)	1·53 (1·35–1·74)	1·48 (1·27–1·71)
Iceland	1·73 (1·54–1·93)	1·58 (1·36–1·82)	1·73 (1·54–1·92)	1·58 (1·38–1·80)	1·71 (1·52–1·92)	1·59 (1·37–1·82)	1·89 (1·70–2·09)	1·78 (1·56–2·02)	1·91 (1·72–2·11)	1·78 (1·58–2·00)
Ireland	1·54 (1·40–1·70)	1·40 (1·22–1·58)	1·54 (1·40–1·69)	1·40 (1·24–1·57)	1·53 (1·38–1·68)	1·40 (1·23–1·57)	1·74 (1·60–1·90)	1·60 (1·42–1·78)	1·72 (1·58–1·87)	1·59 (1·44–1·76)
Israel	2·38 (2·20–2·59)	2·09 (1·86–2·34)	2·33 (2·15–2·54)	2·08 (1·87–2·31)	2·35 (2·16–2·56)	2·09 (1·87–2·34)	2·38 (2·20–2·59)	2·09 (1·86–2·34)	2·31 (2·12–2·52)	2·08 (1·88–2·31)
Italy	1·18 (1·00–1·37)	1·09 (0·88–1·32)	1·18 (1·00–1·37)	1·09 (0·90–1·32)	1·16 (0·99–1·35)	1·09 (0·89–1·32)	1·38 (1·20–1·57)	1·29 (1·08–1·52)	1·36 (1·19–1·55)	1·29 (1·10–1·51)
Luxembourg	1·30 (1·17–1·44)	1·24 (1·09–1·40)	1·30 (1·17–1·43)	1·24 (1·10–1·39)	1·28 (1·16–1·42)	1·24 (1·09–1·39)	1·50 (1·37–1·64)	1·44 (1·29–1·60)	1·48 (1·36–1·61)	1·44 (1·30–1·59)
Malta	1·39 (1·18–1·64)	1·26 (1·01–1·55)	1·39 (1·19–1·64)	1·26 (1·03–1·54)	1·38 (1·16–1·62)	1·26 (1·02–1·55)	1·59 (1·38–1·84)	1·46 (1·21–1·75)	1·58 (1·37–1·82)	1·46 (1·23–1·74)
Monaco	1·44 (1·16–1·76)	1·37 (1·06–1·73)	1·42 (1·14–1·75)	1·36 (1·06–1·72)	1·43 (1·15–1·75)	1·37 (1·06–1·72)	1·64 (1·36–1·96)	1·57 (1·26–1·93)	1·61 (1·33–1·94)	1·56 (1·27–1·92)
Netherlands	1·54 (1·41–1·67)	1·42 (1·27–1·57)	1·54 (1·41–1·67)	1·42 (1·28–1·57)	1·50 (1·37–1·64)	1·40 (1·25–1·56)	1·74 (1·61–1·87)	1·62 (1·47–1·77)	1·70 (1·57–1·83)	1·60 (1·46–1·75)
Norway	1·43 (1·32–1·54)	1·36 (1·24–1·49)	1·43 (1·33–1·54)	1·36 (1·25–1·48)	1·42 (1·31–1·53)	1·36 (1·24–1·48)	1·63 (1·52–1·74)	1·56 (1·44–1·69)	1·62 (1·52–1·73)	1·56 (1·44–1·68)
Portugal	1·27 (1·13–1·42)	1·17 (1·00–1·37)	1·27 (1·14–1·42)	1·17 (1·00–1·36)	1·23 (1·08–1·39)	1·17 (0·99–1·36)	1·47 (1·33–1·62)	1·37 (1·20–1·57)	1·43 (1·28–1·59)	1·37 (1·19–1·56)
San Marino	1·27 (1·09–1·49)	1·20 (0·99–1·46)	1·26 (1·08–1·48)	1·20 (1·00–1·44)	1·25 (1·07–1·47)	1·20 (0·99–1·45)	1·47 (1·29–1·69)	1·40 (1·19–1·66)	1·44 (1·26–1·66)	1·40 (1·20–1·64)
Spain	1·23 (1·10–1·38)	1·11 (0·93–1·30)	1·21 (1·07–1·35)	1·10 (0·93–1·29)	1·21 (1·07–1·35)	1·11 (0·93–1·30)	1·43 (1·30–1·58)	1·31 (1·13–1·50)	1·38 (1·24–1·53)	1·30 (1·13–1·49)
Sweden	1·51 (1·39–1·64)	1·38 (1·24–1·53)	1·48 (1·35–1·61)	1·37 (1·23–1·51)	1·47 (1·34–1·61)	1·36 (1·22–1·51)	1·71 (1·59–1·84)	1·58 (1·44–1·73)	1·64 (1·51–1·78)	1·54 (1·40–1·69)
Switzerland	1·40 (1·28–1·52)	1·33 (1·20–1·47)	1·39 (1·28–1·51)	1·33 (1·21–1·47)	1·38 (1·27–1·50)	1·33 (1·20–1·46)	1·60 (1·48–1·72)	1·53 (1·40–1·67)	1·58 (1·46–1·70)	1·53 (1·41–1·66)
UK	1·38 (1·18–1·58)	1·30 (1·08–1·53)	1·37 (1·18–1·56)	1·30 (1·09–1·52)	1·36 (1·17–1·56)	1·29 (1·07–1·51)	1·58 (1·38–1·78)	1·50 (1·28–1·73)	1·55 (1·36–1·75)	1·49 (1·29–1·70)
Latin America and Caribbean	**1·57 (1·38–1·79)**	**1·31 (1·08–1·57)**	**1·50 (1·30–1·73)**	**1·31 (1·09–1·56)**	**1·49 (1·30–1·71)**	**1·31 (1·08–1·55)**	**1·72 (1·54–1·95)**	**1·50 (1·28–1·76)**	**1·64 (1·45–1·86)**	**1·50 (1·29–1·74)**
Andean Latin America	1·80 (1·58–2·05)	1·45 (1·19–1·73)	1·75 (1·52–2·00)	1·46 (1·20–1·73)	1·66 (1·44–1·91)	1·44 (1·18–1·71)	1·82 (1·59–2·06)	1·65 (1·39–1·93)	1·82 (1·60–2·08)	1·64 (1·39–1·91)
Bolivia	1·84 (1·55–2·17)	1·40 (1·07–1·77)	1·80 (1·50–2·12)	1·44 (1·12–1·80)	1·67 (1·38–1·99)	1·40 (1·08–1·76)	1·84 (1·55–2·17)	1·60 (1·27–1·97)	1·84 (1·55–2·16)	1·63 (1·32–1·98)
Ecuador	1·74 (1·42–2·10)	1·45 (1·10–1·86)	1·73 (1·41–2·10)	1·45 (1·10–1·86)	1·65 (1·34–2·01)	1·44 (1·10–1·83)	1·78 (1·46–2·14)	1·65 (1·30–2·06)	1·85 (1·53–2·21)	1·64 (1·30–2·03)
Peru	1·83 (1·56–2·13)	1·44 (1·14–1·80)	1·74 (1·47–2·06)	1·43 (1·13–1·79)	1·67 (1·41–1·97)	1·42 (1·13–1·77)	1·83 (1·56–2·13)	1·64 (1·34–2·00)	1·80 (1·54–2·12)	1·62 (1·33–1·96)
Caribbean	1·77 (1·50–2·08)	1·43 (1·11–1·88)	1·67 (1·39–2·00)	1·45 (1·15–1·88)	1·57 (1·29–1·89)	1·37 (1·09–1·79)	1·82 (1·56–2·12)	1·61 (1·31–2·05)	1·71 (1·43–2·02)	1·58 (1·31–1·98)
Antigua and Barbuda	1·30 (1·11–1·52)	1·15 (0·93–1·41)	1·26 (1·06–1·48)	1·15 (0·93–1·41)	1·25 (1·06–1·46)	1·15 (0·93–1·40)	1·50 (1·31–1·72)	1·35 (1·13–1·61)	1·41 (1·22–1·64)	1·35 (1·13–1·60)
The Bahamas	1·24 (1·02–1·49)	1·24 (0·99–1·52)	1·21 (0·99–1·47)	1·24 (0·99–1·52)	1·19 (0·98–1·44)	1·21 (0·97–1·50)	1·44 (1·22–1·69)	1·44 (1·19–1·72)	1·37 (1·16–1·62)	1·41 (1·17–1·69)

(Table 2 continues on next page)

	Reference scenario		Education SDG achieved		Contraceptive met need SDG achieved		Pro-natal policies enacted		Combined scenario	
	2050	2100	2050	2100	2050	2100	2050	2100	2050	2100
(Continued from previous page)										
Barbados	1·18 (0·95–1·47)	1·10 (0·85–1·42)	1·17 (0·94–1·46)	1·10 (0·85–1·42)	1·10 (0·85–1·39)	1·06 (0·81–1·38)	1·38 (1·15–1·67)	1·30 (1·05–1·62)	1·29 (1·04–1·58)	1·26 (1·01–1·58)
Belize	1·58 (1·28–1·90)	1·28 (0·93–1·67)	1·46 (1·14–1·81)	1·25 (0·90–1·64)	1·38 (1·08–1·71)	1·18 (0·85–1·56)	1·78 (1·48–2·10)	1·48 (1·13–1·87)	1·49 (1·18–1·83)	1·36 (1·02–1·73)
Bermuda	1·19 (1·04–1·36)	1·07 (0·88–1·28)	1·13 (0·97–1·32)	1·06 (0·88–1·28)	1·15 (0·99–1·31)	1·05 (0·87–1·26)	1·39 (1·24–1·56)	1·27 (1·08–1·48)	1·29 (1·13–1·47)	1·25 (1·07–1·46)
Cuba	1·31 (1·18–1·44)	1·23 (1·07–1·39)	1·29 (1·16–1·43)	1·23 (1·07–1·38)	1·27 (1·15–1·40)	1·22 (1·06–1·37)	1·51 (1·38–1·64)	1·43 (1·27–1·59)	1·46 (1·33–1·59)	1·42 (1·27–1·57)
Dominica	1·18 (0·96–1·45)	1·13 (0·89–1·42)	1·15 (0·93–1·42)	1·13 (0·89–1·42)	1·13 (0·91–1·39)	1·11 (0·87–1·39)	1·38 (1·16–1·65)	1·33 (1·09–1·62)	1·30 (1·09–1·57)	1·31 (1·08–1·59)
Dominican Republic	1·84 (1·55–2·15)	1·51 (1·19–1·86)	1·80 (1·52–2·11)	1·53 (1·22–1·87)	1·72 (1·45–2·03)	1·47 (1·16–1·81)	1·84 (1·55–2·15)	1·71 (1·39–2·06)	1·90 (1·63–2·20)	1·69 (1·39–2·02)
Grenada	1·41 (1·09–1·79)	1·19 (0·81–1·62)	1·37 (1·05–1·76)	1·19 (0·82–1·63)	1·32 (0·99–1·70)	1·17 (0·81–1·60)	1·61 (1·29–1·99)	1·39 (1·01–1·82)	1·49 (1·16–1·87)	1·38 (1·02–1·81)
Guyana	1·91 (1·54–2·32)	1·58 (1·15–2·04)	1·87 (1·48–2·28)	1·58 (1·16–2·04)	1·63 (1·25–2·05)	1·43 (1·02–1·88)	1·91 (1·54–2·32)	1·78 (1·35–2·24)	1·81 (1·42–2·23)	1·63 (1·22–2·07)
Haiti	2·10 (1·68–2·61)	1·44 (0·92–2·05)	1·89 (1·43–2·44)	1·46 (0·95–2·06)	1·73 (1·27–2·28)	1·35 (0·84–1·94)	2·10 (1·68–2·61)	1·64 (1·12–2·25)	1·82 (1·34–2·37)	1·58 (1·07–2·17)
Jamaica	1·16 (0·93–1·39)	1·04 (0·79–1·31)	1·15 (0·93–1·39)	1·05 (0·80–1·32)	1·12 (0·90–1·35)	1·05 (0·80–1·31)	1·36 (1·13–1·59)	1·24 (0·99–1·51)	1·32 (1·10–1·55)	1·25 (1·00–1·51)
Puerto Rico	0·84 (0·76–0·92)	0·81 (0·72–0·93)	0·83 (0·75–0·92)	0·81 (0·72–0·93)	0·81 (0·73–0·89)	0·81 (0·71–0·93)	1·04 (0·96–1·12)	1·01 (0·92–1·13)	1·00 (0·92–1·09)	1·01 (0·91–1·13)
Saint Kitts and Nevis	1·08 (0·92–1·27)	1·00 (0·81–1·20)	1·08 (0·91–1·26)	1·01 (0·83–1·21)	1·05 (0·89–1·23)	1·00 (0·82–1·19)	1·28 (1·12–1·47)	1·20 (1·01–1·40)	1·24 (1·08–1·42)	1·20 (1·03–1·40)
Saint Lucia	1·04 (0·79–1·32)	0·87 (0·58–1·19)	1·03 (0·78–1·31)	0·87 (0·59–1·19)	0·96 (0·70–1·24)	0·86 (0·57–1·17)	1·24 (0·99–1·52)	1·07 (0·78–1·39)	1·15 (0·90–1·43)	1·06 (0·79–1·38)
Saint Vincent and the Grenadines	1·35 (1·10–1·64)	1·16 (0·87–1·51)	1·30 (1·04–1·60)	1·16 (0·88–1·50)	1·30 (1·06–1·59)	1·17 (0·88–1·51)	1·55 (1·30–1·84)	1·36 (1·07–1·71)	1·46 (1·21–1·76)	1·37 (1·09–1·70)
Suriname	1·73 (1·41–2·05)	1·39 (1·02–1·78)	1·64 (1·31–1·98)	1·39 (1·02–1·77)	1·48 (1·18–1·81)	1·26 (0·90–1·63)	1·77 (1·45–2·09)	1·59 (1·22–1·98)	1·62 (1·31–1·97)	1·46 (1·11–1·83)
Trinidad and Tobago	1·35 (1·13–1·60)	1·19 (0·94–1·49)	1·33 (1·10–1·58)	1·19 (0·94–1·49)	1·16 (0·92–1·43)	1·10 (0·84–1·39)	1·55 (1·33–1·80)	1·39 (1·14–1·69)	1·35 (1·11–1·61)	1·30 (1·04–1·59)
Virgin Islands	1·49 (1·28–1·77)	1·37 (1·13–1·69)	1·44 (1·21–1·72)	1·36 (1·12–1·67)	1·44 (1·22–1·72)	1·35 (1·10–1·66)	1·69 (1·48–1·97)	1·57 (1·33–1·89)	1·59 (1·36–1·88)	1·54 (1·29–1·85)
Central Latin America	1·47 (1·23–1·74)	1·21 (0·93–1·53)	1·38 (1·13–1·66)	1·20 (0·93–1·52)	1·40 (1·16–1·67)	1·21 (0·94–1·52)	1·64 (1·40–1·91)	1·40 (1·13–1·72)	1·53 (1·28–1·81)	1·40 (1·14–1·71)
Colombia	1·35 (1·02–1·71)	1·14 (0·77–1·54)	1·32 (0·98–1·68)	1·14 (0·78–1·54)	1·32 (1·00–1·67)	1·16 (0·80–1·56)	1·55 (1·22–1·91)	1·34 (0·97–1·74)	1·49 (1·17–1·85)	1·37 (1·01–1·76)
Costa Rica	1·18 (1·02–1·36)	1·03 (0·84–1·26)	1·15 (0·98–1·34)	1·02 (0·83–1·25)	1·11 (0·96–1·29)	1·01 (0·83–1·23)	1·38 (1·22–1·56)	1·23 (1·04–1·46)	1·29 (1·13–1·47)	1·20 (1·02–1·42)
El Salvador	1·58 (1·23–1·93)	1·28 (0·86–1·72)	1·47 (1·10–1·85)	1·29 (0·88–1·72)	1·52 (1·18–1·88)	1·29 (0·89–1·72)	1·78 (1·43–2·13)	1·48 (1·06–1·92)	1·63 (1·28–2·01)	1·50 (1·10–1·92)
Guatemala	1·62 (1·26–1·98)	1·16 (0·73–1·61)	1·40 (1·02–1·80)	1·15 (0·74–1·58)	1·49 (1·13–1·87)	1·17 (0·76–1·59)	1·82 (1·46–2·18)	1·36 (0·93–1·81)	1·53 (1·16–1·93)	1·37 (0·98–1·79)
Honduras	1·71 (1·35–2·11)	1·27 (0·82–1·76)	1·48 (1·07–1·94)	1·25 (0·80–1·73)	1·63 (1·27–2·04)	1·29 (0·87–1·76)	1·79 (1·43–2·19)	1·47 (1·02–1·96)	1·65 (1·25–2·09)	1·48 (1·06–1·95)
Mexico	1·39 (1·19–1·62)	1·15 (0·91–1·41)	1·31 (1·09–1·54)	1·14 (0·90–1·39)	1·33 (1·13–1·55)	1·15 (0·92–1·41)	1·59 (1·39–1·82)	1·35 (1·11–1·61)	1·46 (1·25–1·69)	1·35 (1·12–1·59)
Nicaragua	1·65 (1·30–2·01)	1·29 (0·86–1·73)	1·51 (1·13–1·91)	1·29 (0·87–1·73)	1·64 (1·29–1·99)	1·33 (0·92–1·76)	1·85 (1·50–2·21)	1·49 (1·06–1·93)	1·72 (1·35–2·11)	1·54 (1·13–1·96)
Panama	1·76 (1·49–2·05)	1·49 (1·20–1·81)	1·72 (1·45–2·02)	1·49 (1·21–1·81)	1·64 (1·38–1·93)	1·45 (1·17–1·76)	1·76 (1·49–2·05)	1·69 (1·40–2·01)	1·82 (1·55–2·11)	1·65 (1·37–1·97)
Venezuela	1·79 (1·43–2·19)	1·51 (1·10–1·97)	1·72 (1·35–2·14)	1·52 (1·12–1·97)	1·65 (1·29–2·05)	1·45 (1·04–1·89)	1·79 (1·43–2·19)	1·71 (1·30–2·17)	1·80 (1·44–2·21)	1·66 (1·27–2·10)
Tropical Latin America	1·57 (1·36–1·81)	1·32 (1·08–1·59)	1·52 (1·30–1·76)	1·32 (1·08–1·58)	1·52 (1·31–1·76)	1·32 (1·08–1·59)	1·77 (1·56–2·01)	1·52 (1·28–1·79)	1·68 (1·47–1·92)	1·52 (1·29–1·79)

(Table 2 continues on next page)

	Reference scenario		Education SDG achieved		Contraceptive met need SDG achieved		Pro-natal policies enacted		Combined scenario	
	2050	2100	2050	2100	2050	2100	2050	2100	2050	2100
(Continued from previous page)										
Brazil	1·57 (1·35–1·81)	1·31 (1·06–1·59)	1·52 (1·29–1·77)	1·31 (1·06–1·59)	1·52 (1·31–1·76)	1·32 (1·07–1·60)	1·77 (1·55–2·01)	1·51 (1·26–1·79)	1·68 (1·46–1·93)	1·52 (1·27–1·79)
Paraguay	1·66 (1·25–2·11)	1·39 (0·93–1·89)	1·61 (1·19–2·06)	1·39 (0·94–1·88)	1·62 (1·21–2·06)	1·41 (0·96–1·90)	1·86 (1·45–2·31)	1·59 (1·13–2·09)	1·77 (1·36–2·22)	1·61 (1·17–2·09)
North Africa and Middle East	**1·94 (1·62–2·28)**	**1·64 (1·28–2·06)**	**1·80 (1·48–2·14)**	**1·67 (1·35–2·06)**	**1·72 (1·40–2·06)**	**1·63 (1·30–2·04)**	**2·00 (1·68–2·34)**	**1·75 (1·40–2·15)**	**1·76 (1·44–2·10)**	**1·73 (1·42–2·12)**
Afghanistan	3·34 (2·78–3·89)	1·61 (0·90–2·32)	2·30 (1·67–2·92)	1·62 (0·98–2·28)	2·63 (2·00–3·24)	1·52 (0·87–2·18)	3·34 (2·78–3·89)	1·81 (1·10–2·52)	1·95 (1·31–2·57)	1·75 (1·16–2·37)
Algeria	1·79 (1·37–2·18)	1·48 (1·04–1·89)	1·74 (1·32–2·13)	1·49 (1·06–1·89)	1·59 (1·19–1·96)	1·37 (0·96–1·77)	1·79 (1·37–2·18)	1·68 (1·24–2·09)	1·75 (1·36–2·12)	1·58 (1·17–1·97)
Bahrain	1·39 (1·10–1·68)	1·26 (0·92–1·57)	1·37 (1·07–1·65)	1·27 (0·94–1·57)	1·22 (0·91–1·51)	1·17 (0·84–1·49)	1·59 (1·30–1·88)	1·46 (1·12–1·77)	1·41 (1·10–1·69)	1·38 (1·06–1·69)
Egypt	2·38 (1·97–2·82)	2·05 (1·62–2·50)	2·38 (1·97–2·80)	2·06 (1·65–2·50)	2·35 (1·94–2·78)	2·07 (1·64–2·51)	2·38 (1·97–2·82)	2·05 (1·62–2·50)	2·34 (1·95–2·77)	2·07 (1·66–2·51)
Iran	1·31 (1·03–1·58)	1·28 (0·97–1·58)	1·30 (1·02–1·58)	1·28 (0·98–1·58)	1·18 (0·91–1·44)	1·20 (0·90–1·49)	1·51 (1·23–1·78)	1·48 (1·17–1·78)	1·38 (1·11–1·63)	1·40 (1·11–1·68)
Iraq	1·95 (1·63–2·35)	1·59 (1·25–2·01)	1·92 (1·61–2·31)	1·60 (1·28–2·01)	1·69 (1·36–2·09)	1·50 (1·15–1·90)	1·95 (1·63–2·35)	1·79 (1·45–2·21)	1·88 (1·56–2·26)	1·71 (1·38–2·10)
Jordan	1·78 (1·44–2·10)	1·57 (1·20–1·93)	1·75 (1·41–2·08)	1·57 (1·21–1·93)	1·50 (1·09–1·88)	1·40 (0·99–1·80)	1·78 (1·44–2·10)	1·77 (1·40–2·13)	1·68 (1·27–2·06)	1·60 (1·20–1·99)
Kuwait	1·07 (0·89–1·30)	1·14 (0·93–1·39)	1·05 (0·87–1·28)	1·14 (0·93–1·39)	1·04 (0·86–1·26)	1·13 (0·92–1·37)	1·27 (1·09–1·50)	1·34 (1·13–1·59)	1·22 (1·04–1·44)	1·33 (1·13–1·57)
Lebanon	1·44 (1·12–1·80)	1·33 (0·98–1·73)	1·40 (1·09–1·77)	1·33 (0·99–1·73)	1·28 (0·93–1·66)	1·24 (0·88–1·65)	1·64 (1·32–2·00)	1·53 (1·18–1·93)	1·45 (1·11–1·84)	1·45 (1·09–1·85)
Libya	1·13 (0·87–1·43)	1·03 (0·75–1·37)	1·09 (0·84–1·40)	1·03 (0·75–1·36)	0·91 (0·62–1·23)	0·90 (0·60–1·24)	1·33 (1·07–1·63)	1·23 (0·95–1·57)	1·09 (0·80–1·41)	1·10 (0·80–1·44)
Morocco	1·36 (1·05–1·70)	1·02 (0·67–1·40)	1·22 (0·88–1·57)	1·04 (0·69–1·42)	1·28 (0·97–1·61)	1·03 (0·69–1·39)	1·56 (1·25–1·90)	1·22 (0·87–1·60)	1·37 (1·04–1·72)	1·26 (0·92–1·62)
Oman	1·64 (1·27–2·02)	1·29 (0·88–1·72)	1·59 (1·23–1·97)	1·31 (0·92–1·72)	1·30 (0·87–1·73)	1·18 (0·76–1·62)	1·84 (1·47–2·22)	1·49 (1·08–1·92)	1·47 (1·05–1·90)	1·40 (0·98–1·83)
Palestine	2·08 (1·79–2·44)	1·77 (1·43–2·15)	2·05 (1·75–2·40)	1·77 (1·45–2·15)	1·82 (1·47–2·22)	1·65 (1·30–2·05)	2·08 (1·79–2·44)	1·77 (1·43–2·15)	1·80 (1·46–2·19)	1·85 (1·51–2·25)
Qatar	1·43 (1·17–1·69)	1·29 (1·01–1·57)	1·40 (1·15–1·66)	1·28 (1·01–1·57)	1·25 (0·97–1·52)	1·20 (0·91–1·49)	1·63 (1·37–1·89)	1·49 (1·21–1·77)	1·43 (1·15–1·70)	1·40 (1·11–1·68)
Saudi Arabia	1·09 (0·80–1·39)	0·97 (0·65–1·31)	1·06 (0·77–1·37)	0·98 (0·66–1·31)	0·92 (0·62–1·23)	0·89 (0·57–1·22)	1·29 (1·00–1·59)	1·17 (0·85–1·51)	1·11 (0·80–1·41)	1·10 (0·78–1·42)
Sudan	1·93 (1·48–2·44)	1·40 (0·93–1·95)	1·83 (1·37–2·34)	1·42 (0·96–1·96)	1·54 (1·06–2·07)	1·30 (0·83–1·85)	1·93 (1·48–2·44)	1·60 (1·13–2·15)	1·69 (1·22–2·22)	1·53 (1·07–2·07)
Syria	1·57 (1·21–1·98)	1·39 (1·01–1·84)	1·55 (1·20–1·96)	1·40 (1·03–1·84)	1·40 (1·03–1·83)	1·33 (0·95–1·77)	1·77 (1·41–2·18)	1·59 (1·21–2·04)	1·59 (1·22–2·01)	1·53 (1·16–1·97)
Tunisia	1·36 (1·02–1·73)	1·19 (0·82–1·59)	1·33 (0·99–1·71)	1·19 (0·83–1·59)	1·22 (0·88–1·59)	1·14 (0·78–1·53)	1·56 (1·22–1·93)	1·39 (1·02–1·79)	1·40 (1·06–1·76)	1·34 (0·98–1·73)
Türkiye	1·32 (1·13–1·56)	1·17 (0·95–1·42)	1·29 (1·09–1·52)	1·17 (0·96–1·41)	1·15 (0·95–1·39)	1·10 (0·88–1·34)	1·52 (1·33–1·76)	1·37 (1·15–1·62)	1·33 (1·12–1·57)	1·30 (1·09–1·54)
United Arab Emirates	1·53 (1·26–1·81)	1·31 (1·00–1·64)	1·52 (1·26–1·79)	1·31 (1·00–1·63)	1·44 (1·13–1·73)	1·30 (0·97–1·62)	1·73 (1·46–2·01)	1·51 (1·20–1·84)	1·63 (1·33–1·92)	1·50 (1·18–1·82)
Yemen	1·91 (1·32–2·54)	1·22 (0·54–1·95)	1·66 (1·04–2·32)	1·29 (0·64–2·00)	1·63 (1·03–2·26)	1·23 (0·59–1·93)	1·91 (1·32–2·54)	1·42 (0·74–2·15)	1·67 (1·07–2·33)	1·49 (0·88–2·18)
South Asia	**1·36 (1·09–1·64)**	**1·10 (0·80–1·43)**	**1·27 (1·00–1·56)**	**1·10 (0·80–1·43)**	**1·24 (0·97–1·53)**	**1·09 (0·78–1·41)**	**1·53 (1·26–1·81)**	**1·28 (0·97–1·61)**	**1·38 (1·10–1·67)**	**1·29 (0·98–1·61)**
Bangladesh	1·20 (0·84–1·54)	0·97 (0·57–1·37)	1·17 (0·80–1·52)	1·03 (0·64–1·41)	1·18 (0·83–1·52)	1·02 (0·63–1·41)	1·40 (1·04–1·74)	1·17 (0·77–1·57)	1·36 (1·01–1·71)	1·26 (0·88–1·64)
Bhutan	1·07 (0·73–1·34)	0·69 (0·33–1·00)	0·93 (0·62–1·20)	0·80 (0·48–1·09)	1·05 (0·76–1·30)	0·75 (0·44–1·03)	1·27 (0·93–1·54)	0·89 (0·53–1·20)	1·15 (0·86–1·40)	1·06 (0·76–1·33)
India	1·29 (0·97–1·62)	1·04 (0·67–1·42)	1·22 (0·89–1·57)	1·04 (0·67–1·41)	1·20 (0·88–1·53)	1·04 (0·67–1·41)	1·49 (1·17–1·82)	1·24 (0·87–1·62)	1·35 (1·01–1·69)	1·24 (0·87–1·62)

(Table 2 continues on next page)

	Reference scenario		Education SDG achieved		Contraceptive met need SDG achieved		Pro-natal policies enacted		Combined scenario	
	2050	2100	2050	2100	2050	2100	2050	2100	2050	2100
(Continued from previous page)										
Nepal	1·18 (0·80–1·53)	0·82 (0·40–1·22)	1·13 (0·77–1·49)	0·94 (0·55–1·32)	1·04 (0·66–1·39)	0·82 (0·43–1·20)	1·38 (1·00–1·73)	1·02 (0·60–1·42)	1·22 (0·86–1·57)	1·11 (0·75–1·48)
Pakistan	1·76 (1·25–2·28)	1·16 (0·59–1·77)	1·56 (1·04–2·11)	1·18 (0·64–1·77)	1·47 (0·93–2·04)	1·12 (0·58–1·72)	1·76 (1·25–2·28)	1·36 (0·79–1·97)	1·54 (1·01–2·11)	1·34 (0·81–1·92)
Southeast Asia, east Asia, and Oceania	**1·37 (1·22–1·54)**	**1·30 (1·11–1·53)**	**1·32 (1·16–1·49)**	**1·29 (1·11–1·51)**	**1·31 (1·15–1·47)**	**1·27 (1·09–1·50)**	**1·53 (1·38–1·70)**	**1·49 (1·30–1·71)**	**1·45 (1·30–1·62)**	**1·46 (1·28–1·66)**
East Asia	1·14 (0·99–1·30)	1·16 (0·99–1·34)	1·11 (0·96–1·27)	1·16 (0·99–1·34)	1·13 (0·99–1·29)	1·16 (1·00–1·34)	1·34 (1·19–1·50)	1·36 (1·19–1·54)	1·31 (1·16–1·47)	1·36 (1·20–1·54)
China	1·14 (0·99–1·31)	1·16 (0·99–1·35)	1·12 (0·97–1·28)	1·16 (1·00–1·35)	1·14 (0·99–1·30)	1·16 (1·00–1·35)	1·34 (1·19–1·51)	1·36 (1·19–1·55)	1·31 (1·17–1·48)	1·37 (1·20–1·55)
North Korea	1·24 (1·00–1·48)	1·16 (0·90–1·42)	1·19 (0·95–1·43)	1·15 (0·90–1·41)	1·18 (0·94–1·41)	1·13 (0·88–1·39)	1·44 (1·20–1·68)	1·36 (1·10–1·62)	1·34 (1·10–1·58)	1·33 (1·08–1·59)
Taiwan (province of China)	0·90 (0·78–1·04)	0·90 (0·77–1·05)	0·89 (0·77–1·03)	0·90 (0·77–1·05)	0·89 (0·77–1·03)	0·89 (0·76–1·05)	1·10 (0·98–1·24)	1·10 (0·97–1·25)	1·08 (0·96–1·22)	1·10 (0·97–1·25)
Oceania	2·93 (2·45–3·46)	1·67 (1·01–2·35)	2·09 (1·51–2·70)	1·58 (0·98–2·22)	2·38 (1·83–2·96)	1·55 (0·93–2·20)	2·93 (2·45–3·46)	1·86 (1·20–2·54)	1·81 (1·22–2·43)	1·68 (1·10–2·32)
American Samoa	1·98 (1·67–2·31)	1·68 (1·34–2·05)	1·84 (1·50–2·19)	1·68 (1·34–2·04)	1·84 (1·51–2·18)	1·61 (1·27–1·97)	1·98 (1·67–2·31)	1·88 (1·54–2·25)	1·89 (1·56–2·24)	1·81 (1·48–2·17)
Cook Islands	1·40 (1·14–1·72)	1·25 (0·96–1·58)	1·36 (1·10–1·68)	1·24 (0·96–1·57)	1·37 (1·11–1·67)	1·25 (0·97–1·58)	1·60 (1·34–1·92)	1·45 (1·16–1·78)	1·53 (1·27–1·84)	1·45 (1·17–1·77)
Federated States of Micronesia	1·82 (1·39–2·33)	1·46 (0·96–2·05)	1·74 (1·30–2·27)	1·46 (0·97–2·04)	1·56 (1·11–2·09)	1·35 (0·87–1·93)	1·82 (1·39–2·33)	1·66 (1·16–2·25)	1·71 (1·26–2·24)	1·56 (1·07–2·13)
Fiji	1·95 (1·61–2·31)	1·64 (1·28–2·04)	1·92 (1·58–2·30)	1·65 (1·30–2·04)	1·84 (1·52–2·20)	1·62 (1·27–2·01)	1·95 (1·61–2·31)	1·84 (1·48–2·24)	1·82 (1·50–2·19)	1·83 (1·48–2·21)
Guam	2·07 (1·76–2·38)	1·76 (1·42–2·09)	2·01 (1·70–2·33)	1·73 (1·40–2·07)	1·98 (1·66–2·30)	1·71 (1·38–2·05)	2·07 (1·76–2·38)	1·76 (1·42–2·09)	1·93 (1·62–2·25)	1·89 (1·56–2·22)
Kiribati	2·13 (1·70–2·62)	1·67 (1·19–2·21)	2·12 (1·69–2·60)	1·68 (1·22–2·21)	1·78 (1·34–2·27)	1·52 (1·06–2·05)	2·13 (1·70–2·62)	1·87 (1·39–2·41)	1·78 (1·34–2·26)	1·74 (1·28–2·26)
Marshall Islands	1·98 (1·67–2·32)	1·65 (1·31–2·02)	1·86 (1·53–2·20)	1·64 (1·31–2·00)	1·94 (1·64–2·27)	1·66 (1·33–2·03)	1·98 (1·67–2·32)	1·85 (1·51–2·22)	1·84 (1·52–2·18)	1·86 (1·53–2·22)
Nauru	2·40 (1·93–2·95)	1·91 (1·39–2·51)	2·27 (1·79–2·84)	1·90 (1·40–2·49)	2·04 (1·53–2·62)	1·76 (1·25–2·36)	2·40 (1·93–2·95)	1·91 (1·39–2·51)	1·95 (1·45–2·54)	1·76 (1·26–2·35)
Niue	1·71 (1·37–2·08)	1·50 (1·13–1·90)	1·66 (1·32–2·04)	1·50 (1·13–1·90)	1·61 (1·28–1·97)	1·47 (1·10–1·86)	1·87 (1·53–2·24)	1·70 (1·33–2·10)	1·78 (1·44–2·14)	1·67 (1·31–2·06)
Northern Mariana Islands	1·67 (1·36–2·01)	1·50 (1·17–1·88)	1·58 (1·27–1·94)	1·49 (1·17–1·86)	1·57 (1·26–1·91)	1·44 (1·11–1·81)	1·87 (1·56–2·21)	1·70 (1·37–2·08)	1·70 (1·38–2·06)	1·64 (1·31–2·00)
Palau	1·65 (1·37–1·92)	1·44 (1·14–1·74)	1·58 (1·29–1·85)	1·43 (1·14–1·72)	1·51 (1·24–1·76)	1·38 (1·09–1·66)	1·85 (1·57–2·12)	1·64 (1·34–1·94)	1·66 (1·38–1·92)	1·57 (1·29–1·85)
Papua New Guinea	3·03 (2·50–3·58)	1·64 (0·94–2·35)	2·08 (1·45–2·72)	1·52 (0·87–2·22)	2·45 (1·84–3·06)	1·53 (0·88–2·22)	3·03 (2·50–3·58)	1·84 (1·14–2·55)	1·79 (1·15–2·46)	1·65 (1·02–2·33)
Samoa	3·18 (2·69–3·68)	2·57 (1·98–3·14)	3·07 (2·56–3·59)	2·54 (1·95–3·12)	2·51 (1·90–3·07)	2·17 (1·55–2·75)	3·18 (2·69–3·68)	2·57 (1·98–3·14)	2·45 (1·83–3·03)	2·16 (1·54–2·75)
Solomon Islands	2·51 (2·10–2·90)	1·70 (1·21–2·21)	2·19 (1·73–2·67)	1·74 (1·25–2·26)	2·01 (1·53–2·47)	1·49 (1·00–1·99)	2·51 (2·10–2·90)	1·90 (1·41–2·41)	1·82 (1·34–2·31)	1·73 (1·26–2·24)
Tokelau	1·54 (1·17–1·94)	1·34 (0·94–1·78)	1·46 (1·09–1·88)	1·33 (0·94–1·76)	1·42 (1·07–1·82)	1·30 (0·92–1·73)	1·74 (1·37–2·14)	1·54 (1·14–1·98)	1·56 (1·21–1·97)	1·49 (1·12–1·92)
Tonga	3·04 (2·58–3·50)	2·45 (1·93–2·98)	2·90 (2·43–3·39)	2·43 (1·92–2·95)	2·47 (1·91–3·00)	2·14 (1·58–2·68)	3·04 (2·58–3·50)	2·45 (1·93–2·98)	2·38 (1·83–2·91)	2·13 (1·59–2·65)
Tuvalu	2·20 (1·71–2·70)	1·71 (1·17–2·26)	2·15 (1·65–2·65)	1·72 (1·19–2·25)	1·84 (1·34–2·35)	1·58 (1·06–2·11)	2·20 (1·71–2·70)	1·91 (1·37–2·46)	1·81 (1·31–2·31)	1·79 (1·28–2·31)
Vanuatu	2·44 (2·06–2·87)	1·79 (1·33–2·31)	2·21 (1·79–2·69)	1·79 (1·34–2·30)	2·04 (1·63–2·50)	1·62 (1·18–2·13)	2·44 (2·06–2·87)	1·79 (1·33–2·31)	1·90 (1·48–2·38)	1·84 (1·40–2·33)
Southeast Asia	1·60 (1·40–1·83)	1·35 (1·14–1·60)	1·54 (1·34–1·78)	1·35 (1·13–1·60)	1·48 (1·28–1·71)	1·31 (1·10–1·57)	1·74 (1·54–1·98)	1·54 (1·32–1·80)	1·63 (1·43–1·87)	1·51 (1·29–1·76)
Cambodia	1·65 (1·32–1·93)	1·10 (0·71–1·45)	1·36 (1·00–1·68)	1·08 (0·70–1·43)	1·49 (1·14–1·78)	1·12 (0·75–1·44)	1·77 (1·44–2·05)	1·30 (0·91–1·65)	1·47 (1·11–1·78)	1·30 (0·93–1·62)

(Table 2 continues on next page)

	Reference scenario		Education SDG achieved		Contraceptive met need SDG achieved		Pro-natal policies enacted		Combined scenario	
	2050	2100	2050	2100	2050	2100	2050	2100	2050	2100
(Continued from previous page)										
Indonesia	1·53 (1·25–1·84)	1·29 (0·99–1·63)	1·51 (1·23–1·82)	1·30 (1·00–1·63)	1·44 (1·17–1·74)	1·26 (0·97–1·60)	1·73 (1·45–2·04)	1·49 (1·19–1·83)	1·62 (1·35–1·92)	1·47 (1·18–1·80)
Laos	1·61 (1·29–1·88)	1·09 (0·73–1·40)	1·43 (1·08–1·72)	1·14 (0·78–1·44)	1·53 (1·22–1·79)	1·14 (0·79–1·44)	1·81 (1·49–2·08)	1·29 (0·93–1·60)	1·60 (1·25–1·89)	1·39 (1·02–1·70)
Malaysia	1·39 (1·11–1·70)	1·17 (0·86–1·52)	1·35 (1·07–1·67)	1·19 (0·88–1·53)	1·32 (1·06–1·62)	1·17 (0·87–1·50)	1·59 (1·31–1·90)	1·37 (1·06–1·72)	1·49 (1·23–1·80)	1·38 (1·09–1·71)
Maldives	1·07 (0·79–1·34)	0·77 (0·42–1·11)	0·97 (0·67–1·27)	0·79 (0·45–1·13)	0·84 (0·52–1·15)	0·71 (0·37–1·05)	1·27 (0·99–1·54)	0·97 (0·62–1·31)	0·98 (0·67–1·30)	0·93 (0·60–1·27)
Mauritius	1·17 (0·94–1·42)	1·03 (0·77–1·32)	1·16 (0·93–1·41)	1·04 (0·78–1·33)	0·97 (0·72–1·24)	0·92 (0·66–1·21)	1·37 (1·14–1·62)	1·23 (0·97–1·52)	1·16 (0·92–1·43)	1·13 (0·87–1·42)
Myanmar	1·69 (1·42–1·97)	1·22 (0·89–1·57)	1·48 (1·17–1·81)	1·22 (0·88–1·56)	1·63 (1·37–1·91)	1·27 (0·95–1·61)	1·77 (1·50–2·05)	1·42 (1·09–1·77)	1·66 (1·37–1·98)	1·47 (1·14–1·81)
Philippines	1·84 (1·61–2·11)	1·50 (1·23–1·79)	1·78 (1·54–2·05)	1·48 (1·21–1·77)	1·62 (1·36–1·90)	1·43 (1·16–1·72)	1·84 (1·61–2·11)	1·70 (1·43–1·99)	1·78 (1·52–2·06)	1·62 (1·35–1·91)
Seychelles	1·86 (1·60–2·14)	1·60 (1·31–1·91)	1·85 (1·58–2·13)	1·61 (1·33–1·91)	1·83 (1·57–2·10)	1·61 (1·33–1·91)	1·86 (1·60–2·14)	1·80 (1·51–2·11)	1·81 (1·55–2·09)	1·82 (1·54–2·12)
Sri Lanka	1·50 (1·24–1·81)	1·30 (0·99–1·66)	1·47 (1·20–1·79)	1·29 (0·99–1·66)	1·40 (1·14–1·72)	1·28 (0·99–1·63)	1·70 (1·44–2·01)	1·50 (1·19–1·86)	1·58 (1·31–1·89)	1·48 (1·19–1·83)
Thailand	1·13 (0·96–1·31)	1·04 (0·86–1·24)	1·13 (0·97–1·31)	1·04 (0·86–1·24)	1·08 (0·92–1·25)	1·02 (0·83–1·21)	1·33 (1·16–1·51)	1·24 (1·06–1·44)	1·28 (1·12–1·45)	1·22 (1·04–1·41)
Timor-Leste	2·27 (1·62–2·90)	1·58 (0·85–2·30)	2·18 (1·54–2·83)	1·61 (0·92–2·32)	1·86 (1·18–2·53)	1·45 (0·75–2·15)	2·27 (1·62–2·90)	1·78 (1·05–2·50)	1·83 (1·14–2·50)	1·70 (1·01–2·39)
Viet Nam	1·63 (1·38–1·93)	1·38 (1·10–1·70)	1·59 (1·34–1·88)	1·36 (1·09–1·69)	1·53 (1·29–1·82)	1·35 (1·07–1·67)	1·83 (1·58–2·13)	1·58 (1·30–1·90)	1·70 (1·44–1·99)	1·53 (1·26–1·85)
Sub-Saharan Africa	**2·72 (2·32–3·15)**	**1·82 (1·35–2·32)**	**2·27 (1·83–2·74)**	**1·80 (1·37–2·28)**	**2·29 (1·88–2·73)**	**1·73 (1·29–2·22)**	**2·73 (2·33–3·16)**	**1·89 (1·42–2·40)**	**2·03 (1·60–2·49)**	**1·82 (1·41–2·31)**
Central sub-Saharan Africa	2·52 (2·05–2·94)	1·86 (1·37–2·31)	2·38 (1·91–2·82)	1·89 (1·42–2·34)	2·06 (1·61–2·48)	1·77 (1·31–2·21)	2·52 (2·05–2·94)	1·86 (1·38–2·31)	2·01 (1·55–2·43)	1·93 (1·48–2·36)
Angola	2·76 (2·21–3·35)	1·97 (1·37–2·62)	2·61 (2·06–3·22)	2·03 (1·46–2·67)	2·30 (1·74–2·91)	1·87 (1·30–2·51)	2·76 (2·21–3·35)	1·97 (1·37–2·62)	2·23 (1·69–2·83)	1·93 (1·39–2·55)
Central African Republic	2·36 (1·86–2·88)	1·35 (0·77–2·03)	1·94 (1·38–2·54)	1·41 (0·81–2·10)	1·74 (1·22–2·29)	1·17 (0·59–1·83)	2·36 (1·86–2·88)	1·55 (0·97–2·23)	1·73 (1·17–2·35)	1·45 (0·85–2·13)
Congo (Brazzaville)	1·90 (1·54–2·32)	1·49 (1·11–1·93)	1·86 (1·51–2·27)	1·49 (1·13–1·92)	1·64 (1·29–2·05)	1·45 (1·08–1·88)	1·90 (1·54–2·32)	1·69 (1·31–2·13)	1·81 (1·46–2·22)	1·65 (1·29–2·07)
Democratic Republic of the Congo	2·46 (1·82–3·03)	1·76 (1·09–2·38)	2·34 (1·69–2·93)	1·78 (1·13–2·40)	2·00 (1·37–2·56)	1·67 (1·02–2·27)	2·46 (1·82–3·03)	1·76 (1·09–2·38)	1·93 (1·31–2·49)	1·89 (1·26–2·49)
Equatorial Guinea	2·19 (1·70–2·75)	1·83 (1·29–2·43)	2·19 (1·71–2·74)	1·83 (1·32–2·42)	1·90 (1·35–2·49)	1·76 (1·23–2·37)	2·19 (1·70–2·75)	1·83 (1·29–2·43)	1·90 (1·37–2·49)	1·77 (1·25–2·36)
Gabon	1·93 (1·41–2·52)	1·56 (1·02–2·19)	1·88 (1·37–2·47)	1·56 (1·03–2·17)	1·68 (1·17–2·27)	1·51 (0·97–2·12)	1·93 (1·41–2·52)	1·76 (1·22–2·39)	1·85 (1·34–2·44)	1·71 (1·18–2·31)
Eastern sub-Saharan Africa	2·50 (2·04–2·96)	1·68 (1·17–2·22)	2·11 (1·64–2·61)	1·70 (1·22–2·21)	2·17 (1·72–2·65)	1·61 (1·12–2·13)	2·50 (2·04–2·96)	1·80 (1·29–2·34)	1·98 (1·51–2·48)	1·77 (1·30–2·27)
Burundi	2·74 (2·16–3·31)	1·55 (0·83–2·25)	2·11 (1·45–2·77)	1·55 (0·86–2·24)	2·20 (1·53–2·84)	1·48 (0·80–2·18)	2·74 (2·16–3·31)	1·75 (1·03–2·45)	1·80 (1·11–2·48)	1·69 (1·03–2·39)
Comoros	1·73 (1·17–2·33)	1·23 (0·60–1·92)	1·66 (1·10–2·26)	1·26 (0·66–1·92)	1·42 (0·82–2·05)	1·17 (0·56–1·84)	1·73 (1·17–2·33)	1·43 (0·80–2·12)	1·58 (1·00–2·21)	1·40 (0·81–2·05)
Djibouti	1·41 (0·92–1·88)	0·95 (0·38–1·51)	1·26 (0·78–1·76)	1·00 (0·47–1·54)	1·27 (0·79–1·75)	0·96 (0·43–1·50)	1·61 (1·12–2·08)	1·15 (0·58–1·71)	1·36 (0·89–1·86)	1·20 (0·71–1·73)
Eritrea	2·20 (1·52–2·86)	1·28 (0·49–2·09)	1·84 (1·15–2·55)	1·32 (0·59–2·09)	1·62 (0·87–2·35)	1·15 (0·41–1·92)	2·20 (1·52–2·86)	1·48 (0·69–2·29)	1·63 (0·91–2·37)	1·39 (0·69–2·13)
Ethiopia	2·40 (1·86–2·89)	1·29 (0·64–1·87)	1·73 (1·15–2·27)	1·30 (0·72–1·86)	2·14 (1·60–2·63)	1·32 (0·75–1·86)	2·40 (1·86–2·89)	1·49 (0·84–2·07)	1·83 (1·28–2·35)	1·53 (1·00–2·06)
Kenya	1·84 (1·39–2·35)	1·45 (0·96–2·01)	1·80 (1·34–2·31)	1·48 (1·00–2·03)	1·77 (1·33–2·26)	1·46 (0·98–2·01)	1·84 (1·39–2·35)	1·65 (1·16–2·21)	1·77 (1·34–2·28)	1·68 (1·22–2·23)
Madagascar	2·33 (1·91–2·78)	1·70 (1·23–2·22)	2·14 (1·69–2·61)	1·71 (1·24–2·21)	2·19 (1·77–2·62)	1·73 (1·25–2·25)	2·33 (1·91–2·78)	1·90 (1·43–2·42)	2·04 (1·60–2·50)	1·93 (1·46–2·45)

(Table 2 continues on next page)

	Reference scenario		Education SDG achieved		Contraceptive met need SDG achieved		Pro-natal policies enacted		Combined scenario	
	2050	2100	2050	2100	2050	2100	2050	2100	2050	2100
(Continued from previous page)										
Malawi	2·03 (1·46–2·57)	1·55 (0·94–2·14)	1·94 (1·36–2·48)	1·59 (1·01–2·16)	2·00 (1·42–2·53)	1·62 (1·02–2·22)	2·03 (1·46–2·57)	1·75 (1·14–2·34)	1·92 (1·35–2·47)	1·86 (1·27–2·45)
Mozambique	2·44 (1·91–2·93)	1·55 (0·95–2·14)	2·09 (1·52–2·65)	1·64 (1·07–2·21)	2·16 (1·62–2·67)	1·56 (0·99–2·13)	2·44 (1·91–2·93)	1·75 (1·15–2·34)	1·93 (1·37–2·49)	1·85 (1·29–2·42)
Rwanda	1·97 (1·54–2·42)	1·24 (0·76–1·77)	1·60 (1·15–2·08)	1·22 (0·76–1·73)	1·76 (1·35–2·20)	1·21 (0·77–1·70)	1·97 (1·54–2·42)	1·44 (0·96–1·97)	1·67 (1·25–2·14)	1·40 (0·97–1·89)
Somalia	4·30 (3·92–4·68)	2·45 (1·92–3·00)	3·15 (2·68–3·62)	2·37 (1·87–2·90)	2·73 (2·15–3·28)	1·69 (1·14–2·24)	4·30 (3·92–4·68)	2·45 (1·92–3·00)	2·15 (1·59–2·69)	1·91 (1·39–2·44)
South Sudan	4·09 (3·59–4·64)	1·98 (1·22–2·75)	2·67 (1·98–3·34)	1·91 (1·18–2·65)	2·54 (1·77–3·26)	1·35 (0·58–2·11)	4·09 (3·59–4·64)	1·98 (1·22–2·75)	1·77 (1·00–2·53)	1·56 (0·82–2·32)
Tanzania	2·42 (2·02–2·86)	1·70 (1·23–2·20)	2·25 (1·81–2·72)	1·74 (1·28–2·24)	2·20 (1·79–2·64)	1·70 (1·24–2·20)	2·42 (2·02–2·86)	1·90 (1·43–2·40)	2·08 (1·66–2·54)	1·75 (1·30–2·25)
Uganda	2·72 (2·26–3·19)	1·98 (1·48–2·50)	2·59 (2·13–3·07)	2·01 (1·54–2·51)	2·49 (2·05–2·96)	2·00 (1·51–2·51)	2·72 (2·26–3·19)	1·98 (1·48–2·50)	2·40 (1·95–2·88)	2·03 (1·56–2·53)
Zambia	2·39 (1·88–2·91)	1·83 (1·28–2·40)	2·31 (1·80–2·83)	1·83 (1·31–2·39)	2·25 (1·77–2·77)	1·85 (1·32–2·43)	2·39 (1·88–2·91)	1·83 (1·28–2·40)	2·19 (1·70–2·72)	1·85 (1·33–2·43)
Southern sub-Saharan Africa	1·94 (1·67–2·21)	1·63 (1·29–1·99)	1·92 (1·66–2·20)	1·63 (1·30–2·00)	1·86 (1·61–2·13)	1·62 (1·29–2·00)	2·07 (1·80–2·34)	1·76 (1·44–2·09)	1·99 (1·73–2·25)	1·75 (1·44–2·10)
Botswana	1·70 (1·31–2·12)	1·38 (0·94–1·84)	1·70 (1·32–2·12)	1·39 (0·96–1·85)	1·68 (1·30–2·10)	1·41 (0·98–1·88)	1·82 (1·43–2·24)	1·58 (1·14–2·04)	1·88 (1·51–2·30)	1·62 (1·20–2·08)
Eswatini	1·98 (1·62–2·36)	1·53 (1·13–1·95)	1·93 (1·56–2·32)	1·55 (1·16–1·97)	1·96 (1·60–2·34)	1·59 (1·20–2·03)	1·98 (1·62–2·36)	1·73 (1·33–2·15)	1·92 (1·55–2·30)	1·81 (1·42–2·24)
Lesotho	1·88 (1·50–2·34)	1·47 (1·03–1·98)	1·78 (1·38–2·25)	1·45 (1·01–1·95)	1·82 (1·45–2·27)	1·49 (1·06–2·01)	1·88 (1·50–2·34)	1·67 (1·23–2·18)	1·78 (1·39–2·24)	1·67 (1·25–2·18)
Namibia	2·03 (1·70–2·40)	1·62 (1·24–2·03)	2·00 (1·67–2·37)	1·63 (1·26–2·04)	1·96 (1·63–2·32)	1·63 (1·26–2·04)	2·03 (1·70–2·40)	1·82 (1·44–2·23)	1·93 (1·60–2·29)	1·84 (1·47–2·25)
South Africa	1·69 (1·46–1·89)	1·45 (1·20–1·67)	1·67 (1·45–1·88)	1·44 (1·19–1·66)	1·60 (1·39–1·79)	1·41 (1·17–1·62)	1·89 (1·66–2·09)	1·65 (1·40–1·87)	1·79 (1·58–1·98)	1·60 (1·37–1·82)
Zimbabwe	2·56 (2·12–3·01)	2·01 (1·52–2·51)	2·55 (2·11–3·00)	2·04 (1·55–2·53)	2·51 (2·09–2·95)	2·05 (1·57–2·56)	2·56 (2·12–3·01)	2·01 (1·52–2·51)	2·50 (2·08–2·94)	2·07 (1·59–2·58)
Western sub-Saharan Africa	3·03 (2·60–3·48)	1·89 (1·39–2·44)	2·40 (1·93–2·91)	1·85 (1·38–2·39)	2·49 (2·05–2·95)	1·80 (1·32–2·33)	3·04 (2·60–3·48)	1·94 (1·44–2·49)	2·08 (1·61–2·57)	1·83 (1·38–2·36)
Benin	3·12 (2·65–3·60)	1·58 (0·95–2·18)	2·26 (1·70–2·80)	1·55 (0·96–2·14)	2·33 (1·75–2·87)	1·46 (0·88–2·03)	3·12 (2·65–3·60)	1·78 (1·15–2·38)	1·81 (1·21–2·36)	1·66 (1·08–2·22)
Burkina Faso	3·76 (3·23–4·28)	1·62 (0·89–2·26)	2·12 (1·42–2·73)	1·53 (0·84–2·15)	3·20 (2·61–3·75)	1·62 (0·93–2·24)	3·76 (3·23–4·28)	1·82 (1·09–2·46)	1·95 (1·27–2·56)	1·75 (1·08–2·38)
Cabo Verde	1·09 (0·73–1·48)	0·91 (0·51–1·34)	1·07 (0·71–1·46)	0·94 (0·55–1·35)	1·08 (0·73–1·46)	0·95 (0·57–1·37)	1·29 (0·93–1·68)	1·11 (0·71–1·54)	1·26 (0·92–1·65)	1·17 (0·80–1·58)
Cameroon	2·44 (1·92–3·03)	1·71 (1·13–2·36)	2·35 (1·82–2·94)	1·74 (1·19–2·36)	2·12 (1·62–2·69)	1·69 (1·13–2·31)	2·44 (1·92–3·03)	1·91 (1·33–2·56)	2·06 (1·55–2·64)	1·92 (1·38–2·53)
Chad	4·81 (4·45–5·18)	2·15 (1·65–2·71)	3·04 (2·57–3·57)	2·10 (1·63–2·65)	3·28 (2·77–3·82)	1·73 (1·26–2·28)	4·81 (4·45–5·18)	2·15 (1·65–2·71)	2·26 (1·73–2·83)	1·77 (1·30–2·33)
Côte d'Ivoire	2·57 (2·11–3·04)	1·44 (0·87–1·99)	2·03 (1·53–2·53)	1·45 (0·93–1·98)	2·13 (1·65–2·63)	1·42 (0·91–1·94)	2·57 (2·11–3·04)	1·64 (1·07–2·19)	1·78 (1·28–2·29)	1·65 (1·15–2·18)
The Gambia	2·21 (1·81–2·61)	1·37 (0·92–1·87)	1·88 (1·49–2·33)	1·41 (0·98–1·88)	1·73 (1·31–2·18)	1·25 (0·81–1·73)	2·21 (1·81–2·61)	1·57 (1·12–2·07)	1·75 (1·33–2·21)	1·50 (1·08–1·97)
Ghana	2·12 (1·57–2·71)	1·57 (0·97–2·20)	2·04 (1·48–2·63)	1·57 (0·98–2·19)	1·81 (1·26–2·39)	1·51 (0·92–2·13)	2·12 (1·57–2·71)	1·77 (1·17–2·40)	1·76 (1·20–2·34)	1·71 (1·14–2·32)
Guinea	3·02 (2·58–3·43)	1·42 (0·81–2·00)	2·02 (1·44–2·54)	1·40 (0·81–1·95)	2·20 (1·62–2·70)	1·28 (0·70–1·80)	3·02 (2·58–3·43)	1·62 (1·01–2·20)	1·81 (1·23–2·33)	1·49 (0·95–2·01)
Guinea-Bissau	2·41 (1·88–2·91)	1·26 (0·63–1·86)	1·80 (1·23–2·35)	1·30 (0·72–1·87)	2·01 (1·47–2·54)	1·25 (0·68–1·82)	2·41 (1·88–2·91)	1·46 (0·83–2·06)	1·81 (1·26–2·37)	1·51 (0·97–2·07)
Liberia	2·10 (1·52–2·71)	1·47 (0·85–2·14)	1·94 (1·34–2·58)	1·52 (0·91–2·18)	1·83 (1·25–2·45)	1·45 (0·85–2·11)	2·10 (1·52–2·71)	1·67 (1·05–2·34)	1·77 (1·18–2·41)	1·70 (1·11–2·36)
Mali	4·21 (3·83–4·63)	1·85 (1·30–2·42)	2·42 (1·86–3·01)	1·70 (1·15–2·28)	3·37 (2·87–3·88)	1·79 (1·26–2·33)	4·21 (3·83–4·63)	1·85 (1·30–2·42)	2·12 (1·56–2·70)	1·89 (1·35–2·49)

(Table 2 continues on next page)

	Reference scenario		Education SDG achieved		Contraceptive met need SDG achieved		Pro-natal policies enacted		Combined scenario	
	2050	2100	2050	2100	2050	2100	2050	2100	2050	2100
(Continued from previous page)										
Mauritania	2·50 (1·98–3·08)	1·66 (1·04–2·34)	2·24 (1·68–2·85)	1·66 (1·07–2·32)	1·97 (1·40–2·57)	1·54 (0·95–2·19)	2·50 (1·98–3·08)	1·86 (1·24–2·54)	1·81 (1·23–2·43)	1·75 (1·17–2·39)
Niger	5·15 (4·68–5·64)	2·24 (1·48–2·92)	2·74 (2·00–3·40)	1·99 (1·28–2·64)	4·34 (3·75–4·89)	2·20 (1·50–2·85)	5·15 (4·68–5·64)	2·24 (1·48–2·92)	2·52 (1·83–3·17)	2·02 (1·36–2·67)
Nigeria	2·69 (2·06–3·31)	1·87 (1·19–2·54)	2·54 (1·88–3·17)	1·90 (1·22–2·56)	2·25 (1·63–2·82)	1·78 (1·12–2·43)	2·69 (2·06–3·31)	1·87 (1·19–2·54)	2·16 (1·53–2·76)	1·81 (1·15–2·46)
São Tomé and Príncipe	1·77 (1·29–2·28)	1·37 (0·83–1·94)	1·67 (1·18–2·19)	1·38 (0·87–1·93)	1·61 (1·12–2·12)	1·35 (0·83–1·90)	1·77 (1·29–2·28)	1·57 (1·03–2·14)	1·74 (1·25–2·26)	1·57 (1·06–2·11)
Senegal	2·32 (1·79–2·79)	1·25 (0·60–1·83)	1·66 (1·08–2·18)	1·24 (0·62–1·80)	1·98 (1·44–2·48)	1·26 (0·67–1·79)	2·32 (1·79–2·79)	1·45 (0·80–2·03)	1·70 (1·14–2·22)	1·45 (0·88–1·97)
Sierra Leone	2·43 (1·99–2·85)	1·31 (0·78–1·82)	1·78 (1·27–2·28)	1·28 (0·76–1·80)	2·04 (1·59–2·47)	1·29 (0·77–1·80)	2·43 (1·99–2·85)	1·51 (0·98–2·02)	1·79 (1·29–2·29)	1·49 (0·97–2·02)
Togo	2·01 (1·61–2·42)	1·24 (0·79–1·72)	1·75 (1·32–2·18)	1·28 (0·84–1·74)	1·65 (1·24–2·08)	1·21 (0·78–1·67)	2·01 (1·61–2·42)	1·44 (0·99–1·92)	1·69 (1·26–2·14)	1·45 (1·03–1·90)

Numbers in parentheses are 95% uncertainty intervals. Super-regions, regions, and countries are listed in alphabetical order. SDG=Sustainable Development Goal.

Table 2: **Total fertility rate for the reference scenario and four alternative scenarios by location, 2050 and 2100**

that the number will be 155 (76·0%). By 2100, the two models reach similar conclusions globally, with 197 countries and territories (96·6%) projected by WPP to reach TFR below replacement level and 198 (97·1%) predicted by our model.

We validated the IHME model over the period 2007–21 using a forecasting skill metric based on RMSE values. The predicted values for our ASFR forecasts were compared with our final GBD 2021 estimates to compute RMSE values across locations for each 5-year age group. Our model had a positive skill value across all age groups, indicating that it is better than the baseline model (here, simply holding 2007 ASFR values constant over the period 2007–21). The lowest skill value was 0·15 (age 30–34 years), and the highest skill value was 0·46 (age 45–49 years; appendix 1 figure S3).

Discussion

Main findings

This study presents comprehensive estimates of past and future trends in fertility in 204 countries and territories from 1950 to 2100. We broadly found that human civilisation is rapidly converging on a sustained low-fertility reality, although comparatively high fertility rates in low-income regions, particularly in a subset of countries and territories in western and eastern sub-Saharan Africa, will result in a demographically divided world. As much of the planet contends with challenges related to low fertility, many low-income countries will still be facing issues associated with high fertility during the 21st century. Overall, fertility has declined steadily at the global level and across almost all countries and territories since 1950 and is likely to continue to do so until 2100, from a global TFR of more than 4·8 births per female in 1950 to approximately 2·2 in 2021, with TFRs of approximately 1·8 and 1·6 projected in our reference scenario in 2050 and 2100, respectively. Only six of 204 countries and territories (Samoa, Somalia, Tonga, Niger, Chad, and Tajikistan) are projected to have above-replacement levels of fertility by 2100, and only 26 will still have a positive rate of natural increase (ie, the number of births will exceed the number of deaths).

Historically, fertility rates have varied dramatically between GBD super-regions, with the highest rates in sub-Saharan Africa and the lowest in the high-income super-region (eg, TFR of approximately 4·3 *vs* 1·5 in 2021), driven by many factors, such as wealth, education, and sociocultural behaviours and practices.[39,40] By 2100, TFRs will continue to differ, but to a smaller extent, from just over 1·8 in sub-Saharan Africa to approximately 1·1 in south Asia, all converging well below replacement levels. Patterns in livebirths will shift dramatically over the coming century, with the proportion of livebirths occurring in sub-Saharan Africa increasing from less than 30% in 2021 to almost 55% in 2100. Likewise, we forecast that the proportion of livebirths occurring in the World Bank low-income group will increase from just under 18% in 2021 to 35% in 2100. The proportion of global livebirths in the low-income and lower-middle-income groups combined will surpass 77% by 2100.

Implications of sustained low fertility

The aforementioned changes in fertility over the coming century will have profound effects on populations, economies, geopolitics, food security, health, and the environment, with a clear demographic divide between the impacts on many middle-to-high-income locations versus many low-income locations. For nearly all countries and territories outside of sub-Saharan Africa, sustained low fertility will produce a contracting

population with fewer young people relative to older people before the end of the 21st century. These changes in age structure are likely to present considerable economic challenges caused by a growing dependency ratio of older to working-age population and a shrinking labour force.[41,42] Unless governments identify unforeseen innovations or funding sources that address the challenges of population ageing, this demographic shift will put increasing pressure on national health insurance, social security programmes, and health-care infrastructure. These same programmes will receive less funding as working-age, tax-paying populations decline, further exacerbating the problem.[43,44]

Sustained low fertility rates might likewise lead to labour shortages in some sectors, potentially hindering economic growth. If productivity per working-aged adult does not increase in accordance with declines in the working-age population, growth in gross domestic product will slow.[4] Reliance on immigrants will become increasingly necessary to sustain economic growth in low-fertility countries.[45] The shifting global distribution of livebirths, with a higher proportion occurring in current lower-income countries, could make immigration a viable way to address these issues. However, this approach will only work if there is a shift in current public and political attitudes towards immigration in many lower-fertility countries and if there are sufficient incentives in place for people to migrate from higher-fertility countries. Continued skilled worker migration to high-income, low-fertility economies—a concept referred to as brain drain—can also have devastating effects on the economies these workers leave behind.[46,47] This underscores the importance of developing ethical and effective immigration policies with global cooperation. Aside from immigration, innovations to the labour force, such as advancements in artificial intelligence and robotics, could reduce the economic effects of changes in age structure, but the potential landscape is difficult to predict and would undoubtedly vary between nations.[48] Furthermore, shifts in productivity in older ages, years of education required to participate fully in certain sectors of the workforce, the proportion of people who could give birth in the workforce, the ability to fulfil fertility intentions in older ages, and other factors could also affect the impact of ageing on economic growth, but these are likewise complex, and the impacts are largely unknown and beyond the scope of this study to consider.

To date, one strategy to reverse declining fertility in low-fertility settings has been to implement pro-natal policies, such as child-related cash transfers and tax incentives, childcare subsidies, extended parental leave, re-employment rights, and other forms of support for parents to care and pay for their children.[49,50] Yet there are few data to show that such policies have led to strong, sustained rebounds in fertility, with empirical evidence suggesting an effect size of no more than 0·2 additional livebirths per female.[51,52] The pro-natal alternative scenario we present here thus assumes that pro-natal policies will be implemented once the TFR of a country or territory falls below 1·75 and that the effect will be to increase TFR by 0·2 births per female 5 years later. Under this scenario, we project a global TFR of 1·68 in 2100 compared with 1·59 in the reference scenario. This modest increase suggests that even under optimistic assumptions on the impact of pro-natal policies based on current data, global TFR will remain low—and well below replacement level—up to 2100. Nevertheless, our pro-natal scenario forecasts also suggest that pro-natal policies might prevent some countries from dropping below very-low (<1·6 TFR) or the lowest-low (<1·3 TFR) fertility in the future. We projected that 64 fewer countries and territories would fall below lowest-low fertility levels in 2100 in the pro-natal scenario compared with the reference scenario (30 *vs* 94). Moreover, although pro-natal policies primarily aim to increase births, they also offer additional benefits to society, including better quality of life, greater household gender equality (ie, more equal division of household labour),[53] higher rates of female labour force participation,[54] lower child-care costs,[55] and better maternal health outcomes,[56] depending on policy design and contextual factors. In the future, it will be beneficial to perform an in-depth analysis on varying impacts of pro-natal policies in selected countries that have a meaningful impact on population.

Importantly, low fertility rates and the modest effects that pro-natal policies might have on them should not be used to justify more draconian measures that limit reproductive rights, such as restricting access to modern contraceptives or abortions. For example, in Romania during and in the aftermath of severely restricting abortions and the sale of contraceptives in the 1960s–80s, coercive policies led to dramatic increases in maternal mortality rates from illegal abortions; large numbers of children placed in orphanages; harmful, long-lasting effects on the labour market and educational outcomes for the population born under the restrictions; and other negative impacts, including long-term trauma to women and children.[6,57,58] Access to modern contraceptives is not only fundamental to the principles of basic human rights and reproductive justice, but also has demonstrated positive effects on the economy; contraceptive access and use is positively associated with formal labour force participation and higher incomes.[59–63]

Although sustained below-replacement fertility will pose serious potential challenges for much of the world over the course of the century, it also presents opportunities for environmental progress. Alongside strong pro-environmental regulations, a smaller global population in the future could alleviate some strain on global food systems, fragile environments, and other finite resources, and also reduce carbon emissions.[64–69] A 2012 study suggests that if global population were to follow a low-growth rather than a medium-growth path, worldwide carbon emissions would be 15% lower by 2050

and 40% lower by 2100.[70] The 2023 Intergovernmental Panel on Climate Change (IPCC) report likewise suggests that low population growth (a result of low fertility) is an important factor in limiting global warming.[71] However, increasing consumption per capita due to economic development could offset the benefits of smaller populations.[72,73]

Implications of the changing global distribution of livebirths

While the world faces the challenges that arise from sustained low fertility in most locations, it will simultaneously be confronted with challenges that arise from the concentration of the world's livebirths shifting from middle-to-high-income towards low-income countries and territories. In the coming decades, the majority of children will be born in some of the poorest regions of the world, with the proportion of global livebirths almost doubling in low-income countries and territories (as defined by the World Bank) between 2021 and 2100, from 18% to 35%. Sub-Saharan Africa is projected to contribute over half of the world's livebirths—more than 54%—by 2100, up from approximately 29% in 2021. Countries in eastern and western sub-Saharan Africa, many in the Sahel, are projected to be primary drivers of livebirths by 2100, but considerable heterogeneity exists across countries within these regions. Child mortality rates are disproportionately high in low-income settings, with the highest rates in western sub-Saharan Africa (at more than 85 deaths per 1000 among children younger than 5 years in 2021 compared with approximately 35 per 1000 at the global level).[74] Thus, this shift in fertility and livebirths from higher-income to lower-income settings will make the challenge of continued progress on improving health outcomes—particularly child mortality—even more difficult.

Many higher-fertility, low-income countries will also face increasingly frequent droughts, flooding, and extreme heat as climate change worsens.[71] All of these aspects of climate change threaten food, water, and other resource security and dramatically increase the risk of heat-related illness and death.[71,75–78] For example, the IPCC projects substantial declines in crop yields across many low-income settings due to climate change, including a 20–40% decrease in millet yield in the Sahel region in response to a potential 30-year mean increase of 2–3°C in maximum temperature.[79,80] Population growth will only worsen the growing strain on food supplies in this region in the future.[81] Food and resource scarcity, along with several other issues including the long legacy of colonialism, contribute to political instability and security issues in some vulnerable areas. Between January, 2020, and July, 2023, there were coups in six Sahel nations[82] and, in 2022, 43% of all global terrorism deaths occurred in this region.[83] Broadly, over the coming decades, the majority of livebirths will become concentrated in the areas of the world that are most vulnerable to climate change, resource insecurity, political instability, poverty, and child mortality. High numbers of births in these regions will further strain all areas of vulnerability.

Our projections suggest that improving access to modern contraceptives and female education—the two primary drivers of fertility[4,84–86]—would reduce fertility rates in higher-fertility countries and territories, limiting the increasing concentration of livebirths in these areas. We project that in sub-Saharan Africa, achieving universal female education or universal contraceptive met need by 2030 would each result in TFRs of approximately 2·3 in 2050, compared with approximately 2·7 in the reference scenario. By combining universal access to both drivers of fertility, plus an increase in TFR of 0·2 in locations with a TFR less than 1·75 from the pro-natal scenario (which will not apply to most locations in this super-region until almost 2100, if at all), our combined scenario highlights opportunities for even larger declines in fertility to 2·03 in sub-Saharan Africa in 2050. Although we project that global TFRs will eventually converge to 1·52–1·68 in 2100 across the reference and three alternative scenarios, the considerably steeper fertility declines in the next several decades achieved through the rapid scale-up of education and contraceptive access would reduce the number of livebirths in sub-Saharan Africa in 2100. For the highest-fertility countries, the opportunities are even greater; in Niger, for example, our reference scenario forecasts a TFR of 5·15 (95% UI 4·68–5·64) in 2050 versus 2·74 (2·00–3·40) in the education SDG target scenario, 4·34 (3·75–4·89) in the contraceptive SDG target scenario, and 2·52 (1·83–3·17) in the combined scenario. Although achieving both SDG targets in all locations by 2030 is likely to be unattainable, our SDG-related scenarios demonstrate that increasing levels of access to female education and contraceptives in higher-fertility countries will result in fewer individuals in the future being born into severely heat-stressed, politically fragile, economically weak environments. Policy makers can and should use these projections to inform priorities.

In addition to its direct impact on fertility rates, expanding female access to education and contraceptives has important societal benefits. First, access to education contributes to women's empowerment: the process through which women gain the freedom to make their own choices and the opportunity to participate fully in society.[87] Quality education increases the knowledge, skills, and self-confidence needed to challenge traditional gender roles, and equips women to make more informed decisions about their health, careers, and lives as a whole.[88–90] It also improves women's decision-making power in the household and lowers their risk of exposure to abuse in the home.[87,90–92] Furthermore, higher female educational attainment is associated with higher paid labour-force participation and higher wages. In fact, the

financial returns on female education exceed those of males (which is not to say that earnings are higher for females; they remain lower for females at the same level of education), as do the returns in low-income settings compared with high-income settings, making female education a valuable personal and societal investment.[93] Finally, universal access to modern contraceptives and education are fundamental human rights that the world should be working towards for all populations regardless of their outcomes on fertility, society, and the economy.

Comparisons with estimates from WPP 2022

TFR estimates from 1950 to 2021 generated by UN Population Division WPP 2022 generally align with the estimates produced by our model in countries with high-quality vital registration data (appendix 2 figure S5). However, estimates differ in some locations with less reliable data sources, particularly in the sub-Saharan Africa and north Africa and the Middle East super-regions. This is mostly due to differences in data sources used and data processing steps. For example, in locations without vital registration data, our methods use complete birth histories as a reference source and correspondingly adjust the estimates of sources such as summary birth histories that do not give information on fertility by mother's age. By contrast, estimates from WPP 2022 more closely follow estimates from these less reliable sources. This process affects estimates in countries for which the most recent data come from summary birth histories, leading to differences in recent time trends that can heavily influence forecasts. For example, in South Sudan, we estimated a decline in TFR from 5·98 (95% UI 5·61–6·33) in 2000 to 5·45 (5·04–5·87) in 2021, compared with the WPP estimates of a decline from 7·51 (6·99–8·09) in 2000 to 4·47 (3·42–5·76) in 2021. Other countries in which there are large discrepancies in 2021 estimates from the two models include the Democratic Republic of the Congo and Central African Republic.

In a comparison between our IHME model forecasts and those of the WPP 2022 revision, we found that the WPP global TFR forecasts were higher throughout the 2022–2100 period and the country-level TFR forecasts converged to a much narrower range in 2100 than the projections from our model (appendix 2 figure S6). Broadly, for countries with low fertility levels, WPP predicts that fertility rates will rebound, whereas our projections suggest they will remain low or decline. The higher TFRs predicted by WPP are primarily a reflection of differences in how post-transition countries were modelled. The WPP forecasting methodology is based in demographic transition theory and assumes that all countries follow the historically observed three-phase pattern of fertility.[14] However, there is some evidence that current higher-fertility countries—especially those in sub-Saharan Africa—have experienced fertility patterns that do not perfectly reflect these phases, such as periods with stalling declines.[94,95] Our method does not make this structural assumption. Furthermore, WPP denotes a country moving from phase II (fertility decline) to phase III (low-fertility post-transition) when it experiences two successive periods of TFR increase after falling below a TFR of 2·0. This threshold of 2·0 might not hold in the future for all countries. In fact, our estimates in Seychelles show a transition into phase III after a TFR of 2·04 (95% UI 1·95–2·12). Due to these assumptions, WPP reference forecasts in all locations might rely too heavily on the fertility patterns of a subset of low-fertility countries that have experienced increases in TFR.

Limitations

This study has a number of limitations, many of which are related to data availability and quality. First, sparsity of recent census data and lags between censuses affected the availability of birth history data for certain locations. This absence of data means that past fertility estimates in some locations—particularly countries in sub-Saharan Africa as well as others such as Afghanistan, Haiti, Syria, and Yemen—were based on modelled projections. Similarly, the absence of high-quality vital registration systems affected the precision of fertility estimates in many locations, resulting in large UIs. This effect was especially apparent during the 2020–21 COVID-19 pandemic period, during which reporting from vital registration systems was particularly limited and delayed. Furthermore, our forecasts rely on past time-series data not only for fertility, but also the drivers of fertility, such as met need for contraceptives. These data were not always available for each location, and even when they were, they were only available as far back as 1970.

Second, we made several simplifying assumptions in the modelling of past fertility. Due to sparse data, we estimated fertility in the age groups of 10–14 years and 50–54 years solely based on neighbouring age groups using data from locations with complete vital registration data. Other factors could be driving fertility rates in these age groups that are not captured in the available data, but the effect of our models for these age groups on TFR is minimal. We compared the TFR in 2021 calculated with and without these age groups across GBD regions and found that the maximum difference was 0·03 (95% UI 0·02–0·04; appendix 2 table S3). Additionally, estimates of uncertainty were simplified due to computational resource constraints. Uncertainty for some covariates was not propagated through our analytical process, including female educational attainment and lag-distributed income in our first-stage regression model. Furthermore, we do not account for correlations between locations when producing geographical aggregate values, which might underestimate uncertainty because estimates in nearby locations are likely to have positive correlation. We could improve accuracy of UIs in the future by accounting for correlations when aggregating estimates.

Third, our forecasting analysis modelled four covariates as potential drivers of fertility: female educational attainment, contraceptive met need, population density in habitable areas, and under-5 mortality. This method contrasts with non-causal time-series models by UN Population Division, in which time is the only driver of fertility and no covariates are used. Our inclusion of covariates can be considered both a strength and a limitation.[13,96,97] Explicitly modelling associations between drivers and outcomes requires us to separately forecast future trends for each driver, which has advantages in that we capture potentially important effects and can vary covariate levels to model fertility outcomes of policy choices related, for example, to education or contraception. However, modelling such associations also presents a challenge in that accurate fertility forecasts rely heavily on accurately forecasting each of these independent drivers into the future. Although we have not studied mechanisms by which our covariates impact fertility, living in urban areas may give better access to education, family planning services, and employment opportunities for women, all of which are associated with lower fertility.[98]

Fourth, more research is needed on determinants of fertility in low-fertility locations; most of the difference between our forecasts and those produced by the UN Population Division WPP 2022 are due to the projected level of fertility to which locations ultimately converge after dropping below replacement levels. Our use of CCF50 captures the effects of age-related declines in each cohort of females.

Fifth, we encountered a range of additional limitations specific to our forecasting models. All long-range forecasting models, regardless of the modelling strategy, face the challenge that the past is not always predictive of the future—ie, there will be potential changes in the future that cannot be predicted. Also, we applied the pro-natal scenario to all locations even if the location has already implemented pro-natal policies, such as Australia, Japan, South Korea, and countries in Scandinavia. We further describe this in appendix 1 (section 3.2–3.3). Additionally, we did not incorporate into any scenarios the possibility that certain locations could exceed their capacity to feed their people. In most locations, any insufficiencies in domestic food production could be solved by importing food. But for several countries with growing food production concerns[71,99] that are forecast to have large population growth and remain low income—including Niger, Chad, and South Sudan—it is possible that our forecast levels of fertility will be unsustainable due to food insecurity. Finally, due to paucity of data, we did not define the pro-natal scenario based on a specific policy or policies that have a known impact on fertility rates. Rather, we considered policies such as paid parental leave, the right to return to work, and subsidised or universal childcare as pro-natal—in other words, policies that have been enacted in countries such as Australia, Sweden, Denmark, Norway, Finland, and elsewhere that are thought of as making it more financially feasible to have children.

Conclusions

Fertility rates have declined dramatically around the world since 1950 and will continue to decline in almost all countries and territories up to 2100. While human civilisation is converging on a sustained low-fertility reality, comparatively high fertility rates in some low-income countries and territories will result in a clear demographic divide between a subset of low-income countries and the rest of the world. On one side, sustained low fertility rates—and a resulting contraction and ageing of the population—will lead to serious economic challenges and increasing pressure on health systems, social security programmes, and the labour force. On the other hand, a dramatic shift in the concentration of livebirths from middle-income and high-income settings to low-income settings will lead to serious challenges related to sustaining and supporting a growing young population in some of the most heat-stressed, politically unstable, economically vulnerable, health system-strained locations. In low-fertility settings, implementing pro-natal policies that support parents and children might provide a small boost to fertility rates, whereas in higher-fertility settings, rapidly expanding access to female education and contraceptives will accelerate declines in fertility and lessen the concentration of livebirths in these locations. Future trends in fertility rates and livebirths will propagate shifts in global population dynamics, driving changes to international relations and a geopolitical environment, and highlighting new challenges in migration and global aid networks. All of these issues will necessitate focused and collaborative work to address.

GBD 2021 Fertility and Forecasting Collaborators

Natalia V Bhattacharjee*, Austin E Schumacher*, Amirali Aali, Yohannes Habtegiorgis Abate, Rouzbeh Abbasgholizadeh, Mohammadreza Abbasian, Mohsen Abbasi-Kangevari, Hedayat Abbastabar, Samar Abd ElHafeez, Sherief Abd-Elsalam, Mohammad Abdollahi, Mohammad-Amin Abdollahifar, Meriem Abdoun, Auwal Abdullahi, Mesfin Abebe, Samrawit Shawel Abebe, Olumide Abiodun, Hassan Abolhassani, Meysam Abolmaali, Mohamed Abouzid, Girma Beressa Aboye, Lucas Guimarães Abreu, Woldu Aberhe Abrha, Michael R M Abrigo, Dariush Abtahi, Hasan Abualruz, Bilyaminu Abubakar, Eman Abu-Gharbieh, Niveen ME Abu-Rmeileh, Tadele Girum Girum Adal, Mesafint Molla Adane, Oluwafemi Atanda Adeagbo Adeagbo, Rufus Adesoji Adedoyin, Victor Adekanmbi, Bashir Aden, Abiola Victor Adepoju, Olatunji O Adetokunboh, Juliana Bunmi Adetunji, Daniel Adedayo Adeyinka, Olorunsola Israel Adeyomoye, Qorinah Estiningtyas Sakilah Adnani, Saryia Adra, Rotimi Felix Afolabi, Shadi Afyouni, Muhammad Sohail Afzal, Saira Afzal, Shahin Aghamiri, Antonella Agodi, Williams Agyemang-Duah, Bright Opoku Ahinkorah, Austin J Ahlstrom, Aqeel Ahmad, Danish Ahmad, Firdos Ahmad, Muayyad M Ahmad, Sajjad Ahmad, Tauseef Ahmad, Ali Ahmed, Ayman Ahmed, Haroon Ahmed, Luai A Ahmed, Meqdad Saleh Ahmed, Syed Anees Ahmed, Marjan Ajami, Budi Aji, Gizachew Taddesse Akalu, Hossein Akbarialiabad, Rufus Olusola Akinyemi,

Mohammed Ahmed Akkaif, Sreelatha Akkala, Hanadi Al Hamad, Syed Mahfuz Al Hasan, Mohammad Al Qadire, Tareq Mohammed Ali AL-Ahdal, Samer O Alalalmeh, Tariq A Alalwan, Ziyad Al-Aly, Khurshid Alam, Rasmieh Mustafa Al-amer, Fahad Mashhour Alanezi, Turki M Alanzi, Almaza Albakri, Mohammed Albashtawy, Mohammad T AlBataineh, Hediyeh Alemi, Sharifullah Alemi, Yihun Mulugeta Alemu, Ayman Al-Eyadhy, Adel Ali Saeed Al-Gheethi, Khalid F Alhabib, Noora Alhajri, Fadwa Alhalaiqa Naji Alhalaiqa, Robert Kaba Alhassan, Abid Ali, Beriwan Abdulqadir Ali, Liaqat Ali, Mohammed Usman Ali, Rafat Ali, Syed Shujait Shujait Ali, Sheikh Mohammad Alif, Mohammad Aligol, Mehran Alijanzadeh, Mohammad A M Aljasir, Syed Mohamed Aljunid, Sabah Al-Marwani, Joseph Uy Almazan, Hesham M Al-Mekhlafi, Omar Almidani, Mahmoud A Alomari, Basem Al-Omari, Jaber S Alqahtani, Ahmed Yaseen Alqutaibi, Rajaa M Al-Raddadi, Salman Khalifah Al-Sabah, Awais Altaf, Jaffar A Al-Tawfiq, Khalid A Altirkawi, Deborah Oyine Aluh, Farrukh Jawad Alvi, Nelson Alvis-Guzman, Hassan Alwafi, Yaser Mohammed Al-Worafi, Hany Aly, Safwat Aly, Karem H Alzoubi, Edward Kwabena Ameyaw, Tarek Tawfik Amin, Alireza Amindarolzarbi, Mostafa Amini-Rarani, Sohrab Amiri, Irene Gyamfuah Ampomah, Dickson A Amugsi, Ganiyu Adeniyi Amusa, Robert Ancuceanu, Deanna Anderlini, Pedro Prata Andrade, Catalina Liliana Andrei, Tudorel Andrei, Abhishek Anil, Sneha Anil, Adnan Ansar, Alireza Ansari-Moghaddam, Catherine M Antony, Ernoiz Antriyandarti, Saeid Anvari, Saleha Anwar, Razique Anwer, Anayochukwu Edward Anyasodor, Jalal Arabloo, Razman Arabzadeh Bahri, Elshaimaa A Arafa, Mosab Arafat, Ana Margarida Araújo, Aleksandr Y Aravkin, Abdulfatai Aremu, Timur Aripov, Mesay Arkew, Benedetta Armocida, Johan Ärnlöv, Mahwish Arooj, Anton A Artamonov, Judie Arulappan, Raphael Taiwo Aruleba, Ashokan Arumugam, Mohsen Asadi-Lari, Zatollah Asemi, Saeed Asgary, Mona Asghariahmadabad, Mohammad Asghari-Jafarabadi, Mubarek Yesse Ashemo, Muhammad Ashraf, Tahira Ashraf, Marvellous O Asika, Seyyed Shamsadin Athari, Maha Moh'd Wahbi Atout, Alok Atreya, Avinash Aujayeb, Marcel Ausloos, Abolfazl Avan, Amlaku Mulat Aweke, Getnet Melaku Ayele, Seyed Mohammad Ayyoubzadeh, Sina Azadnajafabad, Rui M S Azevedo, Ahmed Y Azzam, Muhammad Badar, Ashish D Badiye, Soroush Baghdadi, Nasser Bagheri, Sara Baghernejad, Najmeh Bahmanziari, Ruhai Bai, Atif Amin Baig, Jennifer L Baker, Abdulaziz T Bako, Ravleen Kaur Bakshi, Madhan Balasubramanian, Ovidiu Constantin Baltatu, Kiran Bam, Maciej Banach, Soham Bandyopadhyay, Biswajit Banik, Palash Chandra Banik, Hansi Bansal, Mehmet Firat Baran, Martina Barchitta, Mainak Bardhan, Erfan Bardideh, Suzanne Lyn Barker-Collo, Till Winfried Bärnighausen, Francesco Barone-Adesi, Hiba Jawdat Barqawi, Amadou Barrow, Sandra Barteit, Zarrin Basharat, Asma'u I J Bashir, Hameed Akande Bashiru, Afisu Basiru, João Diogo Basso, Sanjay Basu, Abdul-Monim Mohammad Batiha, Kavita Batra, Bernhard T Baune, Mohsen Bayati, Tahmina Begum, Emad Behboudi, Amir Hossein Behnoush, Maryam Beiranvand, Diana Fernanda Bejarano Ramirez, Alehegn Bekele, Sefealem Assefa Belay, Uzma Iqbal Belgaumi, Michelle L Bell, Olorunjuwon Omolaja Bello, Apostolos Beloukas, Isabela M Bensenor, Zombor Berezvai, Alemshet Yirga Berhie, Amiel Nazer C Bermudez, Paulo J G Bettencourt, Akshaya Srikanth Bhagavathula, Nikha Bhardwaj, Pankaj Bhardwaj, Prarthna V Bhardwaj, Sonu Bhaskar, Vivek Bhat, Gurjit Kaur Bhatti, Jasvinder Singh Bhatti, Manpreet S Bhatti, Rajbir Bhatti, Antonio Biondi, Catherine Bisignano, Atanu Biswas, Raaj Kishore Biswas, Veera R Bitra, Tone Bjørge, Elye Bliss, Micheal Kofi Boachie, Anca Vasilica Bobirca, Virginia Bodolica, Aadam Olalekan Bodunrin, Eyob Ketema Bogale, Kassawmar Angaw Bogale, Milad Bonakdar Hashemi, Berrak Bora Basara, Souad Bouaoud, Dejana Braithwaite, Michael Brauer, Nicholas J K Breitborde, Dana Bryazka, Norma B Bulamu, Danilo Buonsenso, Katrin Burkart, Richard A Burns, Yasser Bustanji, Nadeem Shafique Butt, Zahid A Butt, Florentino Luciano Caetano dos Santos, Daniela Calina, Ismael R Campos-Nonato, Fan Cao, Shujin Cao, Angelo Capodici, Giulia Carreras, Andrea Carugno, Carlos A Castañeda-Orjuela, Giulio Castelpietra, Maria Sofia Cattaruzza, Arthur Caye, Luca Cegolon, Francieli Cembranel, Ester Cerin, Joshua Chadwick, Yaacoub Chahine, Chiranjib Chakraborty, Julian Chalek, Jeffrey Shi Kai Chan, Periklis Charalampous, Vijay Kumar Chattu, Sarika Chaturvedi, Malizgani Paul Chavula, An-Tian Chen, Haowei Chen, Simiao Chen, Gerald Chi, Fatemeh Chichagi, Ju-Huei Chien, Patrick R Ching, William C S Cho, Sungchul Choi, Bryan Chong, Hitesh Chopra, Sonali Gajanan Choudhari, Devasahayam J Christopher, Dinh-Toi Chu, Isaac Sunday Chukwu, Eric Chung, Sheng-Chia Chung, Zinhle Cindi, Iolanda Cioffi, Raffaela Ciuffreda, Rafael M Claro, Kaleb Coberly, Alyssa Columbus, Haley Comfort, Joao Conde, Michael H Criqui, Natália Cruz-Martins, Silvia Magali Cuadra-Hernández, Sriharsha Dadana, Omid Dadras, Tukur Dahiru, Zhaoli Dai, Bronte Dalton, Giovanni Damiani, Aso Mohammad Darwesh, Jai K Das, Saswati Das, Mohsen Dashti, Anna Dastiridou, Claudio Alberto Dávila-Cervantes, Kairat Davletov, Aklilu Tamire Debele, Shayom Debopadhaya, Somayeh Delavari, Ivan Delgado-Enciso, Dessalegn Demeke, Berecha Hundessa Demessa, Xinlei Deng, Edgar Denova-Gutiérrez, Kebede Deribe, Nikolaos Dervenis, Hardik Dineshbhai Desai, Rupak Desai, Vinoth Gnana Chellaiyan Devanbu, Arkadeep Dhali, Kuldeep Dhama, Meghnath Dhimal, Vishal R Dhulipala, Diana Dias da Silva, Daniel Diaz, Michael J Diaz, Adriana Dima, Delaney D Ding, M Ashworth Dirac, Thanh Chi Do, Thao Huynh Phuong Do, Camila Bruneli do Prado, Sushil Dohare, Wanyue Dong, Mario D'Oria, Wendel Mombaque dos Santos, Leila Doshmangir, Robert Kokou Dowou, Ashel Chelsea Dsouza, Haneil Larson Dsouza, Viola Dsouza, John Dube, Joe Duprey, Andre Rodrigues Duraes, Senbagam Duraisamy, Oyewole Christopher Durojaiye, Sulagna Dutta, Laura Dwyer-Lindgren, Paulina Agnieszka Dzianach, Arkadiusz Marian Dziedzic, Alireza Ebrahimi, Hisham Atan Edinur, Kristina Edvardsson, Ferry Efendi, Terje Andreas Eikemo, Michael Ekholuenetale, Maha El Tantawi, Noha Mousaad Elemam, Ghada Metwally Tawfik ElGohary, Muhammed Elhadi, Legesse Tesfaye Elilo, Omar Abdelsadek Abdou Elmeligy, Mohamed A Elmonem, Mohammed Elshaer, Ibrahim Elsohaby, Amir Emami Zeydi, Luchuo Engelbert Bain, Sharareh Eskandarieh, Francesco Esposito, Kara Estep, Farshid Etaee, Natalia Fabin, Adeniyi Francis Fagbamigbe, Saman Fahimi, Aliasghar Fakhri-Demeshghieh, Luca Falzone, Ali Faramarzi, MoezAlIslam Ezzat Mahmoud Faris, Sam Farmer, Andre Faro, Abidemi Omolara Fasanmi, Ali Fatehizadeh, Nelsensius Klau Fauk, Pooria Fazeli, Valery L Feigin, Seyed-Mohammad Fereshtehnejad, Abdullah Hamid Feroze, Pietro Ferrara, Nuno Ferreira, Getahun Fetensa, Irina Filip, Florian Fischer, Joanne Flavel, Nataliya A Foigt, Morenike Oluwatoyin Folayan, Artem Alekseevich Fomenkov, Behzad Foroutan, Matteo Foschi, Kayode Raphael Fowobaje, Kate Louise Francis, Alberto Freitas, Takeshi Fukumoto, John E Fuller, Blima Fux, Peter Andras Gaal, Muktar A Gadanya, Abhay Motiramji Gaidhane, Yaseen Galali, Silvano Gallus, Aravind P Gandhi, Balasankar Ganesan, Mohammad Arfat Ganiyani, M A Garcia-Gordillo, Naval Garg, Rupesh K Gautam, Federica Gazzelloni, Semiu Olatunde Gbadamosi, Miglas W Gebregergis, Mesfin Gebrehiwot, Tesfay Brhane Gebremariam, Tesfay B B Gebremariam, Teferi Gebru Gebremeskel, Yohannes Fikadu Geda, Simona Roxana Georgescu, Urge Gerema, Habtamu Geremew, Motuma Erena Getachew, Peter W Gething, MohammadReza Ghasemi, Ghazal Ghasempour Dabaghi, Afsaneh Ghasemzadeh, Fariba Ghassemi, Ramy Mohamed Ghazy, Sailaja Ghimire, Asadollah Gholamian, Ali Gholamrezanezhad, Mahsa Ghorbani, Aloke Gopal Ghoshal, Arun Digambarrao Ghuge, Artyom Urievich Gil, Tiffany K Gill, Matteo Giorgi, Alem Girmay, James C Glasbey, Laszlo Göbölös, Amit Goel, Ali Golchin, Mahaveer Golechha, Pouya Goleij, Sameer Vali Gopalani, Houman Goudarzi, Alessandra C Goulart, Anmol Goyal, Simon Matthew Graham, Michal Grivna, Shi-Yang Guan, Giovanni Guarducci, Mohammed Ibrahim Mohialdeen Gubari, Mesay Dechasa Gudeta, Stefano Guicciardi, Snigdha Gulati, David Gulisashvili, Damitha Asanga Gunawardane, Cui Guo, Anish Kumar Gupta, Bhawna Gupta, Manoj Kumar Gupta, Mohak Gupta, Sapna Gupta, Veer Bala Gupta, Vijai Kumar Gupta, Vivek Kumar Gupta, Annie Haakenstad, Farrokh Habibzadeh,

Najah R Hadi, Nils Haep, Ramtin Hajibeygi, Sebastian Haller, Rabih Halwani, Randah R Hamadeh, Nadia M Hamdy, Sajid Hameed, Samer Hamidi, Qiuxia Han, Alexis J Handal, Graeme J Hankey, Md Nuruzzaman Haque, Josep Maria Haro, Ahmed I Hasaballah, Ikramul Hasan, Mohammad Jahid Hasan, S M Mahmudul Hasan, Hamidreza Hasani, Md Saquib Hasnain, Amr Hassan, Ikrama Hassan, Soheil Hassanipour, Hadi Hassankhani, Simon I Hay, Jeffrey J Hebert, Omar E Hegazi, Mohammad Heidari, Bartosz Helfer, Mehdi Hemmati, Brenda Yuliana Herrera-Serna, Claudiu Herteliu, Kamran Hessami, Kamal Hezam, Yuta Hiraike, Nguyen Quoc Hoan, Ramesh Holla, Nobuyuki Horita, Md Mahbub Hossain, Mohammad Bellal Hossain Hossain, Hassan Hosseinzadeh, Mehdi Hosseinzadeh, Mihaela Hostiuc, Sorin Hostiuc, Mohamed Hsairi, Vivian Chia-rong Hsieh, Chengxi Hu, Junjie Huang, M Mamun Huda, Ayesha Humayun, Javid Hussain, Nawfal R Hussein, Hong-Han Huynh, Bing-Fang Hwang, Segun Emmanuel Ibitoye, Pulwasha Maria Iftikhar, Olayinka Stephen Ilesanmi, Irena M Ilic, Milena D Ilic, Mustapha Immurana, Leeberk Raja Inbaraj, Afrin Iqbal, Md. Rabiul Islam, Nahlah Elkudssiah Ismail, Hiroyasu Iso, Gaetano Isola, Masao Iwagami, Mahalaxmi Iyer, Linda Merin J, Jalil Jaafari, Louis Jacob, Farhad Jadidi-Niaragh, Khushleen Jaggi, Kasra Jahankhani, Nader Jahanmehr, Haitham Jahrami, Akhil Jain, Nityanand Jain, Ammar Abdulrahman Jairoun, Mihajlo Jakovljevic, Elham Jamshidi, Sabzali Javadov, Tahereh Javaheri, Sathish Kumar Jayapal, Shubha Jayaram, Sun Ha Jee, Jayakumar Jeganathan, Anil K Jha, Ravi Prakash Jha, Heng Jiang, Mohammad Jokar, Jost B Jonas, Tamas Joo, Nitin Joseph, Charity Ehimwenma Joshua, Farahnaz Joukar, Jacek Jerzy Jozwiak, Mikk Jürisson, Vaishali K, Billingsley Kaambwa, Abdulkareem Kabir, Ali Kabir, Hannaneh Kabir, Zubair Kabir, Rizwan Kalani, Leila R Kalankesh, Feroze Kaliyadan, Sanjay Kalra, Rajesh Kamath, Sagarika Kamath, Tanuj Kanchan, Edmund Wedam Kanmiki, Kehinde Kazeem Kanmodi, Suthanthira Kannan S, Sushil Kumar Kansal, Rami S Kantar, Neeti Kapoor, Mehrdad Karajizadeh, Manoochehr Karami, Ibraheem M Karaye, Faizan Zaffar Kashoo, Hengameh Kasraei, Nicholas J Kassebaum, Molly B Kassel, Joonas H Kauppila, Foad Kazemi, Sara Kazeminia, John H Kempen, Evie Shoshannah Kendal, Kamyab Keshtkar, Mohammad Keykhaei, Himanshu Khajuria, Amirmohammad Khalaji, Nauman Khalid, Anees Ahmed Khalil, Alireza Khalilian, Faham Khamesipour, Ajmal Khan, Asaduzzaman Khan, Ikramullah Khan, M Nuruzzaman Khan, Maseer Khan, Mohammad Jobair Khan, Moien AB Khan, Young-Ho Khang, Shaghayegh Khanmohammadi, Khaled Khatab, Armin Khavandegar, Hamid Reza Khayat Kashani, Feriha Fatima Khidri, Moein Khormali, Mohammad Ali Khosravi, Mahmood Khosrowjerdi, Wondwosen Teklesilasie Kidane, Zemene Demelash Kifle, Julie Sojin Kim, Min Seo Kim, Ruth W Kimokoti, Kasey E Kinzel, Girmay Tsegay Kiross, Adnan Kisa, Sezer Kisa, Ali-Asghar Kolahi, Farzad Kompani, Gerbrand Koren, Oleksii Korzh, Soewarta Kosen, Sindhura Lakshmi Koulmane Laxminarayana, Kewal Krishan, Varun Krishna, Vijay Krishnamoorthy, Barthelemy Kuate Defo, Connor M Kubeisy, Burcu Kucuk Bicer, Md Abdul Kuddus, Mohammed Kuddus, Ilari Kuitunen, Mukhtar Kulimbet, Harish Kumar, Satyajit Kundu, Kunle Rotimi Kunle, Om P Kurmi, Asep Kusnali, Dian Kusuma, Evans F Kyei, Ilias Kyriopoulos, Carlo La Vecchia, Ben Lacey, Muhammad Awwal Ladan, Lucie Laflamme, Chandrakant Lahariya, Daphne Teck Ching Lai, Dharmesh Kumar Lal, Ratilal Lalloo, Judit Lám, Demetris Lamnisos, Iván Landires, Francesco Lanfranchi, Berthold Langguth, Ariane Laplante-Lévesque, Heidi Jane Larson, Anders O Larsson, Savita Lasrado, Kamaluddin Latief, Kaveh Latifinaibin, Long Khanh Dao Le, Nhi Huu Hanh Le, Trang Diep Thanh Le, Caterina Ledda, Munjae Lee, Paul H Lee, Seung Won Lee, Yo Han Lee, Gebretsadik Kiros Lema, Elvynna Leong, Temesgen L Lerango, An Li, Ming-Chieh Li, Shanshan Li, Wei Li, Xiaopan Li, Virendra S Ligade, Stephen S Lim, Ro-Ting Lin, Paulina A Lindstedt, Stefan Listl, Gang Liu, Jue Liu, Xiaofeng Liu, Xuefeng Liu, Yuewei Liu, Erand Llanaj, Rubén López-Bueno, Platon D Lopukhov, László Lorenzovici, Paulo A Lotufo, Jailos Lubinda, Giancarlo Lucchetti, Alessandra Lugo, Raimundas Lunevicius, Hengliang Lv, Zheng Feei Ma, Kelsey Lynn Maass, Monika Machoy, Áurea M Madureira-Carvalho, Mohammed Magdy Abd El Razek, Azzam A Maghazachi, Soleiman Mahjoub, Mansour Adam Mahmoud, Azeem Majeed, Jeadran N Malagón-Rojas, Elaheh Malakan Rad, Kashish Malhotra, Ahmad Azam Malik, Iram Malik, Deborah Carvalho Malta, Abdullah A Mamun, Yosef Manla, Yasaman Mansoori, Ali Mansour, Borhan Mansouri, Zeinab Mansouri, Mohammad Ali Mansournia, Joemer C Maravilla, Mirko Marino, Abdoljalal Marjani, Gabriel Martinez, Ramon Martinez-Piedra, Francisco Rogerlândio Martins-Melo, Miquel Martorell, Sharmeen Maryam, Roy Rillera Marzo, Alireza Masoudi, Jishanth Mattumpuram, Richard James Maude, Andrea Maugeri, Erin A May, Mahsa Mayeli, Maryam Mazaheri, John J McGrath, Martin McKee, Anna Laura Wensel McKowen, Susan A McLaughlin, Steven M McPhail, Rahul Mehra, Kamran Mehrabani-Zeinabad, Entezar Mehrabi Nasab, Tesfahun Mekene Meto, Max Alberto Mendez Mendez-Lopez, Walter Mendoza, Ritesh G Menezes, George A Mensah, Alexios-Fotios A Mentis, Sultan Ayoub Meo, Mohsen Merati, Atte Meretoja, Tuomo J Meretoja, Abera M Mersha, Tomislav Mestrovic, Pouya Metanat, Kukulege Chamila Dinushi Mettananda, Sachith Mettananda, Adquate Mhlanga, Laurette Mhlanga, Tianyue Mi, Tomasz Miazgowski, Georgia Micha, Irmina Maria Michalek, Ted R Miller, Le Huu Nhat Minh, Mojgan Mirghafourvand, Erkin M Mirrakhimov, Mizan Kiros Mirutse, Moonis Mirza, Roya Mirzaei, Ashim Mishra, Sanjeev Misra, Philip B Mitchell, Chaitanya Mittal, Babak Moazen, Abdalla Z Mohamed, Ahmed Ismail Mohamed, Jama Mohamed, Mouhand F H Mohamed, Nouh Saad Mohamed, Sakineh Mohammad-Alizadeh-Charandabi, Soheil Mohammadi, Abdollah Mohammadian-Hafshejani, Mustapha Mohammed, Salahuddin Mohammed, Shafiu Mohammed, Ali H Mokdad, Peyman Mokhtarzadehazar, Hossein Molavi Vardanjani, Sabrina Molinaro, Lorenzo Monasta, Mohammad Ali Moni, Maryam Moradi, Yousef Moradi, Paula Moraga, Rafael Silveira Moreira, Negar Morovatdar, Shane Douglas Morrison, Jakub Morze, Abbas Mosapour, Elias Mossialos, Rohith Motappa, Parsa Mousavi, Amin Mousavi Khaneghah, Christine Mpundu-Kaambwa, Sumaira Mubarik, Lorenzo Muccioli, Francesk Mulita, Kavita Munjal, Efrén Murillo-Zamora, Jonah Musa, Fungai Musaigwa, Ana-Maria Musina, Sathish Muthu, Saravanan Muthupandian, Muhammad Muzaffar, Woojae Myung, Ahamarshan Jayaraman Nagarajan, Gabriele Nagel, Pirouz Naghavi, Ganesh R Naik, Gurudatta Naik, Mukhammad David Naimzada, Firzan Nainu, Vinay Nangia, Sreenivas Narasimha Swamy, Bruno Ramos Nascimento, Gustavo G Nascimento, Abdallah Y Naser, Mohammad Javad Nasiri, Zuhair S Natto, Javaid Nauman, Muhammad Naveed, Biswa Prakash Nayak, Vinod C Nayak, Rawlance Ndejjo, Sabina Onyinye Nduaguba, Hadush Negash, Chernet Tafere Negesse, Ionut Negoi, Ruxandra Irina Negoi, Seyed Aria Nejadghaderi, Chakib Nejjari, Samata Nepal, Henok Biresaw Netsere, Georges Nguefack-Tsague, Josephine W. Ngunjiri, Dang H Nguyen, Hau Thi Hien Nguyen, Phuong The Nguyen, QuynhAnh P Nguyen, Van Thanh Nguyen, Robina Khan Niazi, Yeshambel T Nigatu, Taxiarchis Konstantinos Nikolouzakis, Ali Nikoobar, Amin Reza Nikpoor, Chukwudi A Nnaji, Lawrence Achilles Nnyanzi, Efaq Ali Noman, Shuhei Nomura, Mamoona Noreen, Nafise Noroozi, Chisom Adaobi Nri-Ezedi, Mengistu H Nunemo, Virginia Nuñez-Samudio, Dieta Nurrika, Jerry John Nutor, Bogdan Oancea, Kehinde O Obamiro, Ismail A Odetokun, Nkechi Martina Odogwu, Martin James O'Donnell, Oluwakemi Ololade Odukoya, Ayodipupo Sikiru Oguntade, James Odhiambo Oguta, In-Hwan Oh, Sylvester Reuben Okeke, Akinkunmi Paul Okekunle, Osaretin Christabel Okonji, Patrick Godwin Okwute, Andrew T Olagunju, Omotola O Olasupo, Matthew Idowu Olatubi, Gláucia Maria Moraes Oliveira, Bolajoko Olubukunola Olusanya, Jacob Olusegun Olusanya, Gideon Olamilekan Oluwatunase, Hany A Omar, Goran Latif Omer, Obinna E Onwujekwe, Michal Ordak, Orish Ebere Orisakwe, Verner N Orish, Doris V Ortega-Altamirano, Alberto Ortiz, Esteban Ortiz-Prado, Wael M S Osman, Uchechukwu Levi Osuagwu,

Olayinka Osuolale, Adrian Otoiu, Stanislav S Otstavnov, Amel Ouyahia, Guoqing Ouyang, Mayowa O Owolabi, Yaz Ozten, Mahesh Padukudru P A, Mohammad Taha Pahlevan Fallahy, Feng Pan, Hai-Feng Pan, Adrian Pana, Paramjot Panda, Songhomitra Panda-Jonas, Helena Ullyartha Pangaribuan, Georgios D Panos, Leonidas D Panos, Ioannis Pantazopoulos, Anca Mihaela Pantea Stoian, Romil R Parikh, Seoyeon Park, Ashwaghosha Parthasarathi, Ava Pashaei, Roberto Passera, Hemal M Patel, Jay Patel, Shankargouda Patil, Dimitrios Patoulias, Venkata Suresh Patthipati, Uttam Paudel, Mihaela Paun, Hamidreza Pazoki Toroudi, Spencer A Pease, Amy E Peden, Paolo Pedersini, Minjin Peng, Umberto Pensato, Veincent Christian Filipino Pepito, Prince Peprah, Gavin Pereira, Mario F P Peres, Arokiasamy Perianayagam, Norberto Perico, Simone Perna, Richard G Pestell, Fanny Emily Petermann-Rocha, Hoang Tran Pham, Anil K Philip, Daniela Pierannunzio, Manon Pigeolet, David M Pigott, Evgenii Plotnikov, Dimitri Poddighe, Peter Pollner, Ramesh Poluru, Maarten J Postma, Ghazaleh Pourali, Akram Pourshams, Naeimeh Pourtaheri, Disha Prabhu, Sergio I Prada, Pranil Man Singh Pradhan, Manya Prasad, Akila Prashant, Bharathi M Purohit, Jagadeesh Puvvula, Nameer Hashim Qasim, Ibrahim Qattea, Deepthi R, Mehrdad Rabiee Rad, Amir Radfar, Venkatraman Radhakrishnan, Pourya Raee, Hadi Raeisi Shahraki, Alireza Rafiei, Seyedeh Niloufar Rafiei Alavi, Cat Raggi, Pankaja Raghav Raghav, Fakher Rahim, Md Jillur Rahim, Md. Mosfequr Rahman, Mohammad Hifz Ur Rahman, Mosiur Rahman, Muhammad Aziz Rahman, Vahid Rahmanian, Masoud Rahmati, Niloufar Rahnavard, Pramila Rai, Diego Raimondo, Ali Rajabpour-Sanati, Prashant Rajput, Prasanna Ram, Shakthi Kumaran Ramasamy, Juwel Rana, Kritika Rana, Shailendra Singh Rana, Chhabi Lal Ranabhat, Nemanja Rancic, Amey Rane, Shubham Ranjan, Chythra R Rao, Indu Ramachandra Rao, Deepthi Rapaka, Davide Rasella, Sina Rashedi, Vahid Rashedi, Mohammad-Mahdi Rashidi, Azad Rasul, Zubair Ahmed Ratan, Giridhara Rathnaiah Babu, Santosh Kumar Rauniyar, Nakul Ravikumar, David Laith Rawaf, Salman Rawaf, Reza Rawassizadeh, Bharat Rawlley, Murali Mohan Rama Krishna Reddy, Elrashdy Moustafa Mohamed Redwan, Giuseppe Remuzzi, Bhageerathy Reshmi, Nazila Rezaei, Aida Rezaei Nejad, Mohsen Rezaeian, Abanoub Riad, Mavra A Riaz, Jennifer Rickard, Reza Rikhtegar, Hannah Elizabeth Robinson-Oden, Célia Fortuna Rodrigues, Jefferson Antonio Buendia Rodriguez, Ravi Rohilla, Debby Syahru Romadlon, Luca Ronfani, Himanshu Sekhar Rout, Bedanta Roy, Nitai Roy, Priyanka Roy, Enrico Rubagotti, Guilherme de Andrade Ruela, Susan Fred Rumisha, Tilleye Runghien, Manjula S, Chandan S N, Aly M A Saad, Zahra Saadatian, Maha Mohamed Saber-Ayad, Morteza SaberiKamarposhti, Siamak Sabour, Fatos Sada, Basema Saddik, Bashdar Abuzed Sadee, Ehsan Sadeghi, Erfan Sadeghi, Mohammad Reza Saeb, Umar Saeed, Sher Zaman Safi, Dominic Sagoe, Manika Saha, Amirhossein Sahebkar, Soumya Swaroop Sahoo, Monalisha Sahu, Zahra Saif, Joseph W Sakshaug, Payman Salamati, Afeez Abolarinwa Salami, Mohamed A Saleh, Marwa Rashad Salem, Mohammed Z Y Salem, Sohrab Salimi, Sara Samadzadeh, Yoseph Leonardo Samodra, Vijaya Paul Samuel, Abdallah M Samy, Juan Sanabria, Nima Sanadgol, Francesca Sanna, Milena M Santric-Milicevic, Haaris Saqib, Sivan Yegnanarayana Iyer Saraswathy, Aswini Saravanan, Babak Saravi, Yaser Sarikhani, Tanmay Sarkar, Rodrigo Sarmiento-Suárez, Gargi Sachin Sarode, Sachin C Sarode, Arash Sarveazad, Brijesh Sathian, Thirunavukkarasu Sathish, Anudeep Sathyanarayan, Abu Sayeed, Md Abu Sayeed, Nikolaos Scarmeas, Winfried Schlee, Art Schuermans, David C Schwebel, Falk Schwendicke, Siddharthan Selvaraj, Pallav Sengupta, Subramanian Senthilkumaran, Sadaf G Sepanlou, Dragos Serban, Edson Serván-Mori, Yashendra Sethi, SeyedAhmad SeyedAlinaghi, Seyed Arsalan Seyedi, Allen Seylani, Mahan Shafie, Jaffer Shah, Pritik A Shah, Ataollah Shahbandi, Samiah Shahid, Moyad Jamal Shahwan, Ahmed Shaikh, Masood Ali Shaikh, Muhammad Aaqib Shamim, Mehran Shams-Beyranvand, Mohammad Anas Shamsi, Mohd Shanawaz, Abhishek Shankar, Mohammed Shannawaz, Medha Sharath, Sadaf Sharfaei, Amin Sharifan, Javad Sharifi-Rad, Manoj Sharma, Rajesh Sharma, Ujjawal Sharma, Vishal Sharma, Rajesh P Shastry, Amin Shavandi, David H Shaw, Amir Mehdi Shayan, Maryam Shayan, Amr Mohamed Elsayed Shehabeldine, Aziz Sheikh, Rahim Ali Sheikhi, Manjunath Mala Shenoy, Pavanchand H Shetty, Peilin Shi, Desalegn Shiferaw, Mika Shigematsu, Rahman Shiri, Reza Shirkoohi, Aminu Shittu, Velizar Shivarov, Farhad Shokraneh, Sina Shool, Seyed Afshin Shorofi, Kanwar Hamza Shuja, Kerem Shuval, Emmanuel Edwar Siddig, João Pedro Silva, Luís Manuel Lopes Rodrigues Silva, Soraia Silva, Biagio Simonetti, Anjali Singal, Abhinav Singh, Balbir Bagicha Singh, Jasvinder A Singh, Md Shahjahan Siraj, Georgia Smith, Bogdan Socea, Anton Sokhan, Ranjan Solanki, Shipra Solanki, Hamidreza Soleimani, Sameh S M Soliman, Yonatan Solomon, Yimeng Song, Reed J D Sorensen, Michael Spartalis, Chandrashekhar T Sreeramareddy, Vijay Kumar Srivastava, Muhammad Haroon Stanikzai, Vladimir I Starodubov, Antonina V Starodubova, Simona Cătălina Stefan, Paschalis Steiropoulos, Mark A Stokes, Vetriselvan Subramaniyan, Muhammad Suleman, Rizwan Suliankatchi Abdulkader, Abida Sultana, Jing Sun, Chandan Kumar Swain, Bryan L Sykes, Lukasz Szarpak, Mindy D Szeto, Miklós Szócska, Payam Tabaee Damavandi, Rafael Tabarés-Seisdedos, Ozra Tabatabaei Malazy, Seyed-Amir Tabatabaeizadeh, Shima Tabatabai, Karen M Tabb, Mohammad Tabish, Moslem Taheri Soodejani, Jabeen Taiba, Ardeshir Tajbakhsh, Iman M Talaat, Ashis Talukder, Mircea Tampa, Jacques Lukenze Tamuzi, Ker-Kan Tan, Haosu Tang, Derbie Alemu DA Tareke, Mengistie Kassahun Tariku, Vivian Y Tat, Seyed Mohammad Tavangar, Mojtaba Teimoori, Mohamad-Hani Temsah, Reem Mohamad Hani Temsah, Masayuki Teramoto, Dufera Rikitu Terefa, Riki Tesler, Enoch Teye-Kwadjo, Ramna Thakur, Pugazhenthan Thangaraju, Kavumpurathu Raman Thankappan, Rekha Thapar, Samar Tharwat, Rasiah Thayakaran, Nihal Thomas, Ales Tichopad, Jansje Henny Vera Ticoalu, Tenaw Yimer Tiruye, Mariya Vladimirovna Titova, Marcello Tonelli, Marcos Roberto Tovani-Palone, Eugenio Traini, Jasmine T Tran, Nghia Minh Tran, Indang Trihandini, Samuel Joseph Tromans, Thien Tan Tri Tai Truyen, Aristidis Tsatsakis, Evangelia Eirini Tsermpini, Munkhtuya Tumurkhuu, Stefanos Tyrovolas, Sayed Mohammad Nazim Uddin, Aniefiok John Udoakang, Arit Udoh, Atta Ullah, Saeed Ullah, Sana Ullah, Srikanth Umakanthan, Chukwuma David Umeokonkwo, Brigid Unim, Bhaskaran Unnikrishnan, Era Upadhyay, Jibrin Sammani Usman, Marco Vacante, Seyed Mohammad Vahabi, Asokan Govindaraj Vaithinathan, Rohollah Valizadeh, Jef Van den Eynde, Elena Varavikova, Orsolya Varga, Priya Vart, Shoban Babu Varthya, Tommi Juhani Vasankari, Balachandar Vellingiri, Deneshkumar Venugopal, Nicholas Alexander Verghese, Madhur Verma, Massimiliano Veroux, Georgios-Ioannis Verras, Dominique Vervoort, Jorge Hugo Villafañe, Manish Vinayak, Francesco S Violante, Mukesh Vishwakarma, Sergey Konstantinovitch Vladimirov, Vasily Vlassov, Bay Vo, Simona Ruxandra Volovat, Theo Vos, Isidora S Vujcic, Hatem A Wafa, Yasir Waheed, Elias Bekele Wakwoya, Cong Wang, Denny Wang, Fang Wang, Shu Wang, Yanzhong Wang, Yuan-Pang Wang, Paul Ward, Emebet Gashaw Wassie, Stefanie Watson, Marcia R Weaver, Kosala Gayan Weerakoon, Daniel J Weiss, Katherine M Wells, Yi Feng Wen, Ronny Westerman, Taweewat Wiangkham, Dakshitha Praneeth Wickramasinghe, Nuwan Darshana Wickramasinghe, Peter Willeit, Yohannes Addisu Wondimagegene, Felicia Wu, Juan Xia, Hong Xiao, Gelin Xu, Suowen Xu, Xiaoyue Xu, Ali Yadollahpour, Shirin Yaghoobpoor, Tina Yaghoobpour, Sajad Yaghoubi, Zwanden Sule Yahaya, Danting Yang, Lin Yang, Yuichiro Yano, Habib Yaribeygi, Pengpeng Ye, Renjulal Yesodharan, Subah Abderehim Yesuf, Saber Yezli, Amanuel Yigezu, Paul Yip, Dong Keon Yon, Naohiro Yonemoto, Yuyi You, Mustafa Z Younis, Zabihollah Yousefi, Chuanhua Yu, Yong Yu, Chun-Wei Yuan, Nima Zafari, Fathiah Zakham, Nazar Zaki, Giulia Zamagni, Milad Zandi, Ghazal G Z Zandieh, Moein Zangiabadian, Mikhail Sergeevich Zastrozhin, Haijun Zhang, Meixin Zhang, Yunquan Zhang, Chenwen Zhong, Juexiao Zhou, Bin Zhu, Lei Zhu,

Magdalena Zielińska, Zhiyong Zou, Samer H Zyoud, Christopher J L Murray†, Amanda E Smith†, Stein Emil Vollset†.
*Joint first authors. †Joint senior authors.

Affiliations
Institute for Health Metrics and Evaluation (N V Bhattacharjee PhD, A E Schumacher PhD, A J Ahlstrom MSc, C M Antony MA, A Y Aravkin PhD, C Bisignano MPH, E Bliss MSc, Prof M Brauer DSc, D Bryazka BA, K Burkart PhD, S Cao MS, J Chalek BS, K Coberly BS, H Comfort MPH, B Dalton BA, M A Dirac MD, J Duprey MS, L Dwyer-Lindgren PhD, K Estep MPA, S Farmer BA, Prof V L Feigin PhD, J E Fuller MLIS, A Haakenstad ScD, Prof S I Hay FMedSci, N J Kassebaum MD, M B Kassel BA, J S Kim MS, K E Kinzel MSPH, Prof H J Larson PhD, Prof S S Lim PhD, P A Lindstedt MPH, K L Maass PhD, E A May, A L W McKowen, S A McLaughlin PhD, T Mestrovic PhD, A H Mokdad PhD, Q P Nguyen BS, Y Ozten MS, S A Pease BS, D M Pigott PhD, C Raggi MS, H E Robinson-Oden MLIS, T Runghien MSc, H Saqib MA, D H Shaw BA, G Smith MS, R J D Sorensen PhD, N A Verghese BA, Prof T Vos PhD, D Wang BA, S Watson MS, Prof M R Weaver PhD, K M Wells BA, C Yuan PhD, M Zhang MS, Prof C J L Murray DPhil, A E Smith MPA, Prof S E Vollset DrPH), Department of Applied Mathematics (A J Ahlstrom MSc, A Y Aravkin PhD), Department of Health Metrics Sciences, School of Medicine (A Y Aravkin PhD, K Burkart PhD, M A Dirac MD, L Dwyer-Lindgren PhD, Prof S I Hay FMedSci, N J Kassebaum MD, J S Kim MS, Prof S S Lim PhD, A H Mokdad PhD, D M Pigott PhD, Prof T Vos PhD, Prof M R Weaver PhD, Prof C J L Murray DPhil, Prof S E Vollset DrPH), Department of Internal Medicine (Y Chahine MD), Department of Cardiology (Y Chahine MD), Department of Family Medicine (M A Dirac MD), Department of Neurology (R Kalani MD), Department of Anesthesiology & Pain Medicine (N J Kassebaum MD, V Krishnamoorthy MD), Division of Plastic and Reconstructive Surgery (S D Morrison MD), Department of Global Health (R J D Sorensen PhD), University of Washington, Seattle, WA, USA; Faculty of Medicine (A Aali MD, N Rahnavard MD), Dental Research Center (E Bardideh DDS), Orthodontics Department (M Ghorbani DDS), Clinical Research Development Unit (N Morovatdar MD), Metabolic Syndrome Research Center (G Pourali MD), International UNESCO Center for Health-related Basic Sciences and Human Nutrition (G Pourali MD), Applied Biomedical Research Center (A Sahebkar PhD), Biotechnology Research Center (A Sahebkar PhD), Department of Medical Genetics (N Zafari MD), Mashhad University of Medical Sciences, Mashhad, Iran; Department of Clinical Governance and Quality Improvement (Y H Abate MSc), Aleta Wondo Hospital, Aleta Wondo, Ethiopia; Doheny Eye Institute (R Abbasgholizadeh MD), University of California Los Angeles, Pasadena, CA, USA; Department of Orthopedic Surgery (M Abbasian MD), Department of Pediatrics (S Aly MD), T H Chan School of Public Health (Prof T W Bärnighausen MD, P M S Pradhan MD), Center for Primary Care (S Basu PhD), Harvard Business School (F Caetano dos Santos PhD), Division of Cardiovascular Medicine (G Chi MD), Department of Neurological Surgery at Brigham and Women's Hospital (A H Feroze MD), Maternal Fetal Care Center (K Hessami MD), Department of Ophthalmology (Prof J H Kempen MD), Department of Health Policy and Management (C M Kubeisy BA), Department of Radiology and Data Science (X Liu PhD), Department of Health Policy and Oral Epidemiology (Z S Natto DrPH), Department of Global Health and Social Medicine (M Pigeolet MD), Beth Israel Deaconess Medical Center (S Sharfaei MD), Division of General Internal Medicine (Prof A Sheikh MD), Harvard University, Boston, MA, USA; Department of Orthopaedic Surgery (M Abbasian MD), Department of Anesthesiology (D Abtahi MD, S Salimi MD, A Tajbakhsh MD), Department of Biotechnology (S Aghamiri PhD), National Nutrition and Food Technology Research Institute (M Ajami PhD), Research Institute of Dental Sciences (Prof S Asgary MSc), Urology Department (M Bonakdar Hashemi MD), Department of Medical Genetics (M Ghasemi PhD), Center for Comprehensive Genetic Services (M Ghasemi PhD), Department of Immunology (K Jahankhani MSc), Department of Health Policy and Management (N Jahanmehr PhD), Safety Promotion and Injury Prevention Research Center (N Jahanmehr PhD), Department of Epidemiology (M Karami PhD, S Sabour PhD), Department of Neurosurgery (H Khayat Kashani MD), Social Determinants of Health Research Center (A Kolahi MD, A Nikoobar DipSc, M Rashidi MD), Department of Microbiology and Infectious Diseases (M Nasiri PhD), School of Medicine (S Nejadghaderi MD, M Zangiabadian MD), Department of Biology and Anatomical Sciences (P Raee PhD), Ophthalmic Research Center (ORC) (M Shayan MD), Emergency Department (S Shool MD), Department of Medical Education (S Tabatabai PhD), Shahid Beheshti University of Medical Sciences, Tehran, Iran (S Yaghoobpoor MD); Non-communicable Diseases Research Center (M Abbasi-Kangevari MD, S Azadnajafabad MD, M Keykhaei MD, P Mousavi MD, M Rashidi MD, N Rezaei MD), Advanced Diagnostic and Interventional Radiology Research Center (H Abbastabar PhD), The Institute of Pharmaceutical Sciences (TIPS) (Prof M Abdollahi PhD), School of Pharmacy (Prof M Abdollahi PhD), Research Center for Immunodeficiencies (H Abolhassani PhD), Hematology, Oncology and Stem Cell Transplantation Research Center (H Alemi MD), Urology Research Center (R Arabzadeh Bahri MD), Department of Health Information Management (S Ayyoubzadeh PhD), Translational Ophthalmology Research Center (N Bahmanziari PhD), School of Medicine (A Behnoush BS, A Khalaji BS, S Khanmohammadi MD, M Mayeli MD, M Merati MD, S Mohammadi MD), Department of Scientific Research (F Chichagi MD), Multiple Sclerosis Research Center (S Eskandarieh PhD), Digestive Diseases Research Institute (S Fahimi MD, Prof A Pourshams MD, S G Sepanlou MD), Department of Ophthalmology (Prof F Ghassemi MD), Department of Radiology (R Hajibeygi MD), Students' Scientific Research Center (SSRC) (M Keykhaei MD), Center for Research and Training in Skin Diseases and Leprosy (F Khamesipour PhD), Sina Trauma and Surgery Research Center (A Khavandegar MD, M Khormali MD, Prof P Salamati MD, S Shool MD), Children's Medical Center (F Kompani MD), Department of Pediatric Cardiology (Prof E Malakan Rad MD), Department of Obstetrics and Gynecology (Z Mansouri MD), Department of Epidemiology and Biostatistics (M Mansournia PhD), Tehran Heart Center (E Mehrabi Nasab MD), Water Quality Research Center (R Mirzaei PhD), Department of Pharmacology (N Noroozi DVM), Department of Medicine (M Pahlevan Fallahy MD, A Shahbandi MD), Department of Cardiology (S Rashedi MD), Stem Cell and Center of Regenerative Medicine (A Rezaei Nejad MD), Iranian Research Center for HIV/AIDS (S SeyedAlinaghi PhD), Endocrinology and Metabolism Research Center (EMRC) (S Seyedi MD, O Tabatabaei Malazy PhD), Department of Neurology (M Shafie MD), Department of Pharmaceutical Care (A Sharifan PharmD), Research Center for Rational Use of Drugs (A Sharifan PharmD), Cancer Research Center (R Shirkoohi PhD), Cancer Biology Research Center (R Shirkoohi PhD), Department of Pathology (Prof S Tavangar MD), Faculty of Medicine (S Vahabi MD), Tehran University of Medical Sciences, Tehran, Iran; Department of Epidemiology (S Abd ElHafeez DrPH), Department of Pediatric Dentistry and Dental Public Health (Prof M El Tantawi PhD, Prof O A A Elmeligy PhD), Department of Tropical Health (R M Ghazy PhD), Department of Pathology (Prof I M Talaat PhD), Alexandria University, Alexandria, Egypt; Department of Tropical Medicine (S Abd-Elsalam PhD), Tanta University, Tanta, Egypt; Department of Small Animal Clinical Sciences (M Abdollahifar PhD), Department of Community Health and Epidemiology (D A Adeyinka PhD), University of Saskatchewan, Saskatoon, SK, Canada; Department of Medicine (Prof M Abdoun BMedSc), University of Setif Algeria, Sétif, Algeria; Department of Physiotherapy (A Abdullahi PhD, J S Usman PhD), Department of Community Medicine (Prof M A Gadanya FMCPH), Department of Nursing Science (M Ladan PhD), Bayero University Kano, Kano, Nigeria; Department of Rehabilitation Sciences (A Abdullahi PhD, M U Ali MSc, M Khan MPH, J S Usman PhD), School of Nursing (S Tyrovolas PhD), Hong Kong Polytechnic University, Hong Kong, China; Department of Midwifery (M Abebe MSc, G M Ayele MSc), Department of Public Health (T L Lerango MPH, Y A Wondimagegene PhD), Dilla University, Dilla, Ethiopia; Department of Public Health (S S Abebe MPH), Department of Medical Laboratory Sciences (M Arkew MSc), Department of Health Policy and Management (A T Debele MSc), Department of Clinical Pharmacy (M D Gudeta MSc), Haramaya University, Harar, Ethiopia; Department of Community Medicine (O Abiodun MPH), Department of

Medical Physiology (P G Okwute MSc), Babcock University, Ilishan-Remo, Nigeria; Department of Medical Biochemistry and Biophysics (H Abolhassani PhD), Department of Neurobiology, Care Sciences, and Society (Prof J Ärnlöv PhD, S Fereshtehnejad PhD), Department of Molecular Medicine and Surgery (Prof J H Kauppila MD), Department of Global Public Health (Prof L Laflamme PhD), Karolinska Institute, Stockholm, Sweden; Department of Neurosurgery (M Abolmaali MD), Health Management and Economics Research Center (J Arabloo PhD), Department of Epidemiology (M Asadi-Lari PhD), Center for Educational Research in Medical Educaion (CERMS) (S Delavari PhD), Minimally Invasive Surgery Research Center (A Kabir MD), Eye Research Center (H Kasraei MD), Department of Anesthesiology (K Latifinaibin MD), Comprehensive Research Laboratory (R Mirzaei PhD), Department of Physiology (H Pazoki Toroudi PhD), Physiology Research Center (H Pazoki Toroudi PhD), Colorectal Research Center (A Sarveazad PhD), Iran University of Medical Sciences, Tehran, Iran (M Moradi MD); Khatam Al-anbia Hospital (M Abolmaali MD), Shefa Neuroscience Research Center, Tehran, Iran; Department of Physical Pharmacy and Pharmacokinetics (M Abouzid PharmD), Poznan University of Medical Sciences, Poznan, Poland; Department of Public Health (G B Aboye MSc), Madda Walabu University, Addis Ababa, Ethiopia; Nutrition and Dietetics Department (G B Aboye MSc), USAID-JSI Digital Health Activity (B H Demessa MPH), Jimma University, Addis Ababa, Ethiopia; Department of Pediatric Dentistry (Prof L G Abreu PhD), Department of Nutrition (Prof R M Claro 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 Adult Health Nursing (W A Abrha MSc), Department of Nursing (A Girmay MSc), Aksum University, Aksum, Ethiopia; Department of Research (M R M Abrigo PhD), Philippine Institute for Development Studies, Quezon City, Philippines; Department of Nursing (H Abualruz PhD), Al Zaytoonah University of Jordan, Amman, Jordan; Department of Pharmacology and Toxicology (B Abubakar PhD), Department of Veterinary Public Health and Preventive Medicine (A Shittu MSc), Usmanu Danfodiyo University, Sokoto, Sokoto, Nigeria; Nigerian Institute of Medical Research (B Abubakar PhD), Nigerian Institute of Medical Research, Lagos, Nigeria; Clinical Sciences Department (E Abu-Gharbieh PhD, S Adra MD, H J Barqawi MPhil, Prof R Halwani PhD, Prof A A Maghazachi PhD, M M Saber-Ayad MD, Prof I M Talaat PhD), College of Medicine (F Ahmad PhD, Prof R Halwani PhD, Prof B Saddik PhD, M A Saleh PhD), Department of Pharmacy Practice and Pharmacotherapeutics (Prof K H Alzoubi PhD, Prof H A Omar PhD), Department of Physiotherapy (A Arumugam PhD), Department of Basic Biomedical Sciences (Y Bustanji PhD), Sharjah Institute for Medical Research (N M Elemam PhD), Department of Clinical Nutrition and Dietetics (M E M Faris PhD), Department of Medicinal Chemistry (S S M Soliman PhD), University of Sharjah, Sharjah, United Arab Emirates (K A Altirkawi MD); Institute of Community and Public Health (Prof N M Abu-Rmeileh PhD), Birzeit University, Ramallah, Palestine; Department of Public Health (T G G Adal MPH), Department of Midwifery (Y F Geda MSc), Wolkite University, Wolkite, Ethiopia; College of Medicine and Health Sciences (M M Adane PhD, S A Belay MSc), Department of Epidemiology and Biostatistics (Y Alemu MPH, K A Bogale MPH), Department of Midwifery (A M Aweke MSc), School of Health Science (A Y Berhie MSc), Department of Health Promotion and Behavioural Science (E K Bogale MPH), Department of Physiology (D Demeke MSc), Department of Pharmacy (C T Negesse MSc), Bahir Dar University, Bahir Dar, Ethiopia; Department of Health Promotion, Education, and Behavior (O A A Adeagbo PhD, T Mi PhD), University of South Carolina, Columbia, SC, USA; Department of Public Health (O A A Adeagbo PhD), University of KwaZulu-Natal, Durban, South Africa; Department of Medical Rehabilitation (Prof R A Adedoyin PhD), Department of Animal Sciences (H A Bashiru MSc), Department of Child Dental Health (Prof M O Folayan FWACS), Obafemi Awolowo University, Ile-Ife, Nigeria; Department of Obstetrics and Gynecology (V Adekanmbi PhD), University of Texas Medical Branch, Galveston, TX, USA; Department of Molecular Biology and Genetics (Prof M T AlBataineh PhD), Department of Biology (W M S Osman PhD), Khalifa University, Abu Dhabi, United Arab Emirates (B Aden PhD); Institute of Public Health (B Aden PhD), Walden University, Al Ain, United Arab Emirates; Department of HIV and Infectious Diseases (A V Adepoju MD), Jhpiego, Abuja, Nigeria; Department of Adolescent Research and Care (A V Adepoju MD), Adolescent Friendly Research Initiative and Care, Ado Ekiti, Nigeria; DSI-NRF Centre of Excellence for Epidemiological Modelling and Analysis (SACEMA) (O O Adetokunboh PhD), Stellenbosch University, Stellenbosch, South Africa; Division of Epidemiology & Biostatistics (O O Adetokunboh PhD), South African Centre for Epidemiological Modelling and Analysis (SACEMA) (L Mhlanga PhD), Department of Epidemiology (J L Tamuzi MSc), Department of Industrial Psychology (E Teye-Kwadjo PhD), Stellenbosch University, Cape Town, South Africa; Department of Biochemistry (J B Adetunji PhD), Osun State University, Osogbo, Nigeria; Department of Public Health (D A Adeyinka PhD), Federal Ministry of Health, Abuja, Nigeria; Department of Physiology (O I Adeyomoye PhD), Department of Microbiology (O O Bello PhD), Department of Anatomy (G O Oluwatunase MSc), Department of Biosciences and Biotechnology (A J Udoakang PhD), University of Medical Sciences, Ondo, Nigeria; Faculty of Medicine (Q E S Adnani PhD), Center of Excellence in Higher Education for Pharmaceutical Care Innovation (Prof M J Postma PhD), Universitas Padjadjaran (Padjadjaran University), Bandung, Indonesia; Department of Epidemiology and Medical Statistics (R F Afolabi PhD, M Ekholuenetale MSc, A F Fagbamigbe PhD, K R Fowobaje MSc), Institute for Advanced Medical Research and Training (R O Akinyemi PhD), Faculty of Public Health (M Ekholuenetale MSc), Department of Health Promotion and Education (S E Ibitoye MPH), Department of Community Medicine (O S Ilesanmi PhD), College of Medicine (A P Okekunle PhD), Department of Medicine (Prof M O Owolabi DrM), University of Ibadan, Ibadan, Nigeria; Department of Radiology (S Afyouni PhD, A Amindarolzarbi MD, G G Z Zandieh MD), Department of Epidemiology and Population Health (N Alhajri MD), Department of Biostatistics (A Columbus MS), Department of Neurosurgery (F Kazemi MD), Department of Health Policy and Management (D Vervoort MD), Department of International Health (H Zhang MS), Johns Hopkins University, Baltimore, MD, USA (E Jamshidi PharmD); Department of Life Sciences (M S Afzal PhD), University of Management and Technology, Lahore, Pakistan; Department of Community Medicine (Prof S Afzal PhD), King Edward Memorial Hospital, Lahore, Pakistan; Department of Public Health (Prof S Afzal PhD), Public Health Institute, Lahore, Pakistan; Department of Medical and Surgical Sciences and Advanced Technologies "GF Ingrassia" (Prof A Agodi PhD, M Barchitta PhD, A Maugeri PhD, Prof M Veroux PhD), Department of General Surgery and Medical-Surgical Specialties (Prof A Biondi PhD, Prof G Isola PhD, M Vacante PhD), Department of Biomedical and Biotechnological Sciences (L Falzone PhD), Department of Clinical and Experimental Medicine (C Ledda PhD), University of Catania, Catania, Italy; Department of Geography and Planning (W Agyemang-Duah MSc), Department of Biomedical and Molecular Sciences (A Nikpoor PhD), Queen's University, Kingston, ON, Canada; School of Public Health (B O Ahinkorah MPhil), University of Technology Sydney, Sydney, NSW, Australia; Department of Medical Biochemistry (A Ahmad PhD), Department of Pharmacology (M Tabish MPharm), Shaqra University, Shaqra, Saudi Arabia; School of Medicine and Psychology (D Ahmad PhD), National Centre of Epidemiology and Population Health (Y Alemu MPH), Research School of Population Health (N Bagheri PhD, R A Burns PhD), Australian National University, Canberra, ACT, Australia; Public Health Foundation of India, Gandhinagar, India (D Ahmad PhD); Department of Clinical Nursing (Prof M M Ahmad PhD), University of Jordan, Amman, Jordan; Department of Health and Biological Sciences (S Ahmad PhD), Abasyn University, Peshawar, Pakistan; Department of Natural Sciences (S Ahmad PhD), Lebanese American University, Beirut, Lebanon; Department of Epidemiology and Health Statistics (T Ahmad MS), Southeast University, Nanjing, China; Department of Pharmacy Practice (A Ahmed PhD), Riphah Institute of Pharmaceutical Sciences, Islamabad, Pakistan; Division of Infectious Diseases and Global Public Health (IDGPH) (A Ahmed PhD), University of California, San Diego,

CA, USA; Institute of Endemic Diseases (A Ahmed MSc), Unit of Basic Medical Sciences (E E Siddig MD), University of Khartoum, Khartoum, Sudan; Swiss Tropical and Public Health Institute (A Ahmed MSc), University of Basel, Basel, Switzerland; Department of Biosciences (H Ahmed PhD), COMSATS Institute of Information Technology, Islamabad, Pakistan; Institute of Public Health (L A Ahmed PhD), College of Medicine and Health Sciences (Prof M Grivna PhD, J Nauman PhD), Department of Family Medicine (M A Khan MSc), Department of Computer Science and Software Engineering (Prof N Zaki PhD), United Arab Emirates University, Al Ain, United Arab Emirates; Department of Pathology and Microbiology (M S Ahmed MSc), University of Duhok, Duhok, Iraq; Brody School of Medicine (S Ahmed PhD), Department of Computer Science (A O Bodunrin MSc), Department of Physiology (M Tumurkhuu PhD), East Carolina University, Greenville, NC, USA (R T Aruleba PhD); Department of Food and Nutrition Policy and Planning Research (M Ajami PhD), National Institute of Nutrition, Tehran, Iran; Faculty of Medicine and Public Health (B Aji DrPH), Jenderal Soedirman University, Purwokerto, Indonesia; Department of Microbiology, Immunology and Parasitology (G T Akalu MSc), St Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia; Department of Microbial, Cellular and Molecular Biology (G T Akalu MSc), School of Public Health (K Deribe PhD), Addis Ababa University, Addis Ababa, Ethiopia; St George and Sutherland Clinical School (H Akbarialiabad MD), School of Population Health (Z Dai PhD, X Xu PhD), School of Psychiatry (Prof P B Mitchell MD), Centre for Social Research in Health (S R Okeke PhD), School of Public Health and Community Medicine (A E Peden PhD), The George Institute for Global Health (P Ye MPH), University of New South Wales, Sydney, NSW, Australia; Institute of Neuroscience (R O Akinyemi PhD), Newcastle University, Newcastle upon Tyne, UK; Department of Cardiology (M A Akkaif PhD), Department of Health Management Center (X Li PhD), Fudan University, Shanghai, China; Department of Management, Policy, and Community Health (S Akkala MPH), University of Texas, Houston, TX, USA; Department of Geriatric and Long Term Care (H Al Hamad MD, B Sathian PhD), Rumailah Hospital (H Al Hamad MD), Hamad Medical Corporation, Doha, Qatar; Department of Surgery (S Al Hasan PhD), Washington University School of Medicine, St Louis, MO, USA; Department of Nursing (Prof M Al Qadire PhD), Department of Community and Mental Health (Prof M Albashtawy PhD), Al Al-Bayt University, Mafraq, Jordan; Institute of Global Health (T M A AL-Ahdal MPH), Heidelberg Institute of Global Health (HIGH) (Prof T W Bärnighausen MD, S Chen DSc, B Moazen MSc), Heidelberg University, Heidelberg, Germany; Department of Clinical Sciences (S O Alalalmeh Bpharm, Prof E A Arafa PhD, O E Hegazi BPharm), Center for Medical and Bio-Allied Health Sciences Research (Prof M J Shahwan PhD, M A Shamsi PhD, S H Zyoud PhD), Ajman University, Ajman, United Arab Emirates; Department of Biology (T A Alalwan PhD, Prof S Perna PhD), University of Bahrain, Sakhir, Bahrain; John T Milliken Department of Internal Medicine (Z Al-Aly MD), Brown School (C Wang MPH), Department of Surgery (C Wang MPH), Washington University in St Louis, St Louis, MO, USA; Clinical Epidemiology Center (Z Al-Aly MD), US Department of Veterans Affairs (VA), St Louis, MO, USA; Murdoch Business School (K Alam PhD), Health Administration, Policy & Leadership Program (M Hasan MPH), Murdoch University, Perth, WA, Australia; School of Nursing (R M Al-amer PhD), Yarmouk University, Irbid, Jordan; School of Nursing and Midwifery (R M Al-amer PhD), Department of Engineering (G R Naik PhD), Western Sydney University, Sydney, NSW, Australia; Health Information Management and Technology Department (T M Alanzi PhD), Division of Forensic Medicine (Prof R G Menezes MD), Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia (F M Alanezi PhD); Department of Medicine (A Albakri MD), Royal Jordanian Medical Services, Amman, Jordan; Global Health Entrepreneurship (S Alemi PhD), Tokyo Medical and Dental University, Tokyo, Japan; Pediatric Intensive Care Unit (A Al-Eyadhy MD, M Temsah MD), Department of Cardiac Sciences (Prof K F Alhabib MD), Section of Adult Hematology (Prof G M T ElGohary MD), Department of Physiology (Prof S A Meo PhD), King Saud University, Riyadh, Saudi Arabia; Global Centre for Environmental Remediation (A A S Al-Gheethi PhD), Department of Women's Health (G T Kiross MPH), University of Newcastle, Newcastle, NSW, Australia; Cooperative Research Centre for Contamination Assessment and Remediation of the Environment, Newcastle, NSW, Australia (A A S Al-Gheethi PhD); College of Nursing (Prof F A N Alhalaiqa PhD), Department of Physical Education (Prof M A Alomari PhD), QU Health (M Mohammed PhD), Department of Population Medicine (Prof G Rathnaiah Babu PhD), Qatar University, Doha, Qatar; Psychological Sciences Association, Amman, Jordan (Prof F A N Alhalaiqa PhD); Institute of Health Research (R K Alhassan PhD, M Immurana PhD), Department of Health Policy Planning and Management (M K Boachie PhD), Department of Epidemiology and Biostatistics (R K Dowou MPhil), Department of Microbiology and Immunology (V N Orish PhD), University of Health and Allied Sciences, Ho, Ghana; Department of Zoology (A Ali PhD), Department of Botany (Prof I Khan PhD), Abdul Wali Khan University Mardan, Mardan, Pakistan; Erbil Technical Health College (B A Ali PhD), Erbil Polytechnic University, Erbil, Iraq; School of Pharmacy (B A Ali PhD), Tishk International University, Erbil, Iraq; Department of Biological Sciences (L Ali PhD), National University of Medical Sciences (NUMS), Rawalpindi, Pakistan; Department of Medical Rehabilitation (Physiotherapy) (M U Ali MSc), University of Maiduguri, Maiduguri, Nigeria; Department of Biosciences (R Ali MPhil), Centre for Interdisciplinary Research In Basic Sciences (CIRBSc) (M A Shamsi PhD), Jamia Millia Islamia, New Delhi, India; Center for Biotechnology and Microbiology (S S Ali PhD), University of Swat, Swat, Pakistan; School of Public Health and Preventive Medicine (S M Alif PhD, S Li PhD, P Rai MPH), School of Public Health and Preventative Medicine (Prof M Asghari-Jafarabadi PhD), Department of Human-Centred Computing, Faculty of Information Technology (M Saha MSc), Monash University, Melbourne, VIC, Australia; Department of Public Health (M Aligol PhD), Qom University of Medical Sciences, Qom, Iran; Social Determinants of Health Research Center (M Alijanzadeh PhD), Qazvin University of Medical Sciences, Qazvin, Iran; Medical Laboratories (M A M Aljasir PhD), Qassim University, Buraydah, Saudi Arabia; Department of Molecular and Clinical Pharmacology (M A M Aljasir PhD), Institute of Infection and Global Health (Prof A Beloukas PhD), Liverpool Orthopaedic and Trauma Service (SioopD), Department of Surgery (Prof R Lunevicius DSc), University of Liverpool, Liverpool, UK; Department of Health Policy and Management (Prof S M Aljunid PhD), Department of Surgery (S K Al-Sabah MD), Kuwait University, Kuwait City, Kuwait; International Centre for Casemix and Clinical Coding (Prof S M Aljunid PhD), National University of Malaysia, Bandar Tun Razak, Malaysia; Sana'a, Yemen (S Al-Marwani MSc); Irbid, Jordan (S Al-Marwani MSc); Department of Medicine (J U Almazan PhD, Prof D Poddighe PhD), Nazarbayev University, Astana, Kazakhstan; Department of Parasitology (Prof H M Al-Mekhlafi PhD), University of Malaya, Kuala Lumpur, Malaysia; Department of Parasitology (Prof H M Al-Mekhlafi PhD), Sana'a University, Sana'a, Yemen; Department of Urology (O Almidani MSc), Department of Cardiac Surgery (L Göbölös PhD), Cleveland Clinic Abu Dhabi, Abu Dhabi, United Arab Emirates; Nuffield Department of Surgical Sciences (O Almidani MSc, S Bandyopadhyay BA), Nuffield Department of Orthopaedics (S M Graham PhD), Nuffield Department of Population Health (B Lacey PhD), Nuffield Department of Medicine (Prof R J Maude PhD, T Runghien MSc), Health Economics Research Centre (Prof J A B Rodriguez PhD), University of Oxford, Oxford, UK; Department of Rehabilitation Sciences and Physical Therapy (Prof M A Alomari PhD), Department of Clinical Pharmacy (Prof K H Alzoubi PhD), Jordan University of Science and Technology, Irbid, Jordan; Department of Epidemiology and Population Health (B Al-Omari PhD), Khalifa University of Science, Technology & Research, Abu Dhabi, United Arab Emirates; Department of Respiratory Care (J S Alqahtani PhD), Prince Sultan Military College of Health Sciences, Dammam, Saudi Arabia; Department of Prosthodontics and Implant Dentistry (A Alqutaibi PhD), Taibah University, Medinah, Saudi Arabia; Department of Prosthodontics (A Alqutaibi PhD), Ibb University, Ibb, Yemen; Department of Community Medicine (R M Al-Raddadi PhD), Department of Family and Community Medicine (N S Butt PhD), Department of Pediatric Dentistry (Prof O A A Elmeligy PhD), Rabigh Faculty of Medicine (A A Malik PhD), Department of Dental Public Health

(Z S Natto DrPH), King Abdulaziz University, Jeddah, Saudi Arabia; Jaber Al Ahmad Al Sabah Hospital (S K Al-Sabah MD), Ministry of Health, Kuwait City, Kuwait; Institute of Molecular Biology and Biotechnology (A Altaf PhD, S Shahid PhD), University Institute of Public Health (F J Alvi MPH, S Hameed MPH, A A Malik PhD), University College of Medicine & Dentistry (Prof M Arooj PhD), University Institute of Radiological Sciences and Medical Imaging Technology (T Ashraf MS), University Institute of Diet and Nutritional Sciences (A Khalil PhD), Department of Technology (M Muzaffar MBA), Research Centre for Health Sciences (RCHS) (M Muzaffar MBA, S Shahid PhD), The University of Lahore, Lahore, Pakistan (Prof M Ashraf PhD, M A Riaz Mcom); Department of Specialty Internal Medicine (Prof J A Al-Tawfiq MD), Johns Hopkins Aramco Healthcare, Dhahran, Saudi Arabia; Department of Medicine (Prof J A Al-Tawfiq MD, J T Tran BS), Indiana University School of Medicine, Indianapolis, IN, USA; Lisbon Institute of Global Mental Health (D O Aluh MSc), Nova University of Lisbon, Lisbon, Portugal; Department of Clinical Pharmacy and Pharmacy Management (D O Aluh MSc), University of Nigeria Nsukka, Nsukka, Nigeria; Research Group in Hospital Management and Health Policies (Prof N Alvis-Guzman PhD), 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; Department of Clinical Pharmacology and Toxicology (H Alwafi PhD), Umm Al-Qura University, Makkah, Saudi Arabia; Department of Medical Sciences (Prof Y M Al-Worafi PhD), Azal University for Human Development, Sana'a, Yemen; Department of Clinical Sciences (Prof Y M Al-Worafi PhD), University of Science and Technology of Fujairah, Fujairah, United Arab Emirates; Department of Pediatrics (Prof H Aly MD), Department of Internal Medicine (M Gupta MD), Lerner Research Institute (X Liu PhD), Cleveland Clinic, Cleveland, OH, USA; Department of Pediatric Cardiology (S Aly MD), Boston Children's Hospital, Boston, MA, USA (T Aripov PhD); School of Graduate Studies (E K Ameyaw MPhil), Lingnan University, Hong Kong, China; Department of Public Health (Prof T T Amin MD), Department of Neurology (A Hassan MD), Cairo University, Cairo, Egypt; Social Determinants of Health Research Center (M Amini-Rarani PhD), School of Medicine (S Bagherieh BSc, G Ghasempour Dabaghi MD, M Rabiee Rad MD), Department of Environmental Health Engineering (A Fatehizadeh PhD), Cardiac Rehabilitation Research Center (K Mehrabani-Zeinabad PhD), Isfahan University of Medical Sciences, Isfahan, Iran; Medicine, Quran and Hadith Research Center (S Amiri PhD), Baqiyatallah University of Medical Sciences, Tehran, Iran; College of Public Health, Medical and Veterinary Sciences (I G Ampomah MPhil), College of Public Health, Medical, and Veterinary Sciences (A E Peden PhD), James Cook University, Townsville, QLD, Australia (K O Obamiro PhD); Department of Maternal and Child Wellbeing (D A Amugsi PhD), African Population and Health Research Center, Nairobi, Kenya; Department of Medicine (G A Amusa MD), Department of Obstetrics and Gynecology (J Musa MD), University of Jos, Jos, Nigeria; Department of Internal Medicine (G A Amusa MD), Jos University Teaching Hospital, Jos, Nigeria; Faculty of Pharmacy (Prof R Ancuceanu PhD), Department of Cardiology (C Andrei PhD), Department of Internal Medicine and Rheumatology (A V Bobirca PhD), Department of Dermatology and Venereology (Prof S R Georgescu PhD), Department of Internal Medicine (M Hostiuc PhD), Department of Legal Medicine and Bioethics (S Hostiuc PhD), Department of General Surgery (I Negoi PhD, D Serban PhD, B Socea PhD), Department of Anatomy and Embryology (R I Negoi PhD), Department of Diabetes, Nutrition and Metabolic Diseases (A Pantea Stoian PhD), Department of Dermatology (M Tampa PhD), Carol Davila University of Medicine and Pharmacy, Bucharest, Romania; Centre for Sensorimotor Performance (D Anderlini MD), Center of Research Excellence in Stillbirth (T Begum MPH), Department of Urology (Prof E Chung MD), Institute for Social Science Research (M Huda MSc, E Kanmiki MPH, J C Maravilla PhD), School of Health and Rehabilitation Sciences (A Khan PhD, M Moni PhD), School of Dentistry (R Lalloo PhD), Queensland Brain Institute (Prof J J McGrath MD), The University of Queensland, Brisbane, QLD, Australia; Neurology Department (D Anderlini MD), Royal Brisbane and Women's Hospital, Brisbane, QLD, Australia; Department of Health Care Management (P P Andrade MD, S Mohammed PhD), Technical University of Berlin, Berlin, Germany; European University, Lisbon, Portugal (P P Andrade MD); Department of Statistics and Econometrics (Prof T Andrei PhD, Prof C Herteliu PhD, A Otoiu PhD), Department of Statistics and Economics (Prof M Ausloos PhD), Faculty of Management (A Dima PhD, S Stefan PhD), Bucharest University of Economic Studies, Bucharest, Romania; Department of Pharmacology (A Anil MD, M Shamim MBBS, S B Varthya MD), Department of Anatomy (Prof N Bhardwaj MD), Department of Community Medicine and Family Medicine (P Bhardwaj MD, M K Gupta MD, Prof P R Raghav MD), School of Public Health (P Bhardwaj MD), Department of Forensic Medicine and Toxicology (T Kanchan MD), Department of Surgical Oncology (Prof S Misra MCh), Department of Pharmacology and Research (A Saravanan MD), All India Institute of Medical Sciences, Jodhpur, India; Department of Urology (P Ram MS), All India Institute of Medical Sciences, Bhubaneswar, India (A Anil MD); Department of Obstetrics and Gynecology (S Anil MBBS), Ernakulam Medical Centre, Kochi, India; School of Nursing and Midwifery (A Ansar PhD, F Efendi PhD, M Rahman PhD), Department of Public Health (H Jiang PhD), La Trobe University, Melbourne, VIC, Australia; Special Interest Group International Health (A Ansar PhD), Public Health Association of Australia, Canberra, ACT, Australia; Department of Epidemiology and Biostatistics (Prof A Ansari-Moghaddam PhD), Zahedan University of Medical Sciences, Zahedan, Iran; Agribusiness Study Program (E Antriyandarti DrAgrSc), Sebelas Maret University, Surakarta, Indonesia; Regenerative Medicine, Organ Procurement and Transplantation Multi-diciplinary Center (S Anvari MD), 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; Centre for Interdisciplinary Research in Basic Sciences (CIRBSc) (S Anwar PhD), Jamia Millia Islamia, New Delhi, India; SCLS (S Anwar PhD), Jamia Hamdard, New Delhi, India; Department of Pathology (R Anwer PhD), Imam Mohammad Ibn Saud Islamic University, Riyadh, Saudi Arabia; School of Dentistry and Medical Sciences (A E Anyasodor PhD), Charles Sturt University, Orange, NSW, Australia; Faculty of Pharmacy, Department of Pharmacology and Toxicology (Prof E A Arafa PhD, Prof H A Omar PhD), Beni-Suef University, Beni-Suef, Egypt; College of Pharmacy (M Arafat PhD), Al Ain University, Abu Dhabi, United Arab Emirates; Associated Laboratory for Green Chemistry (LAQV) (A M Araújo PhD, Á M Madureira-Carvalho PhD), Institute for Research and Innovation in Health (Prof N Cruz-Martins PhD), Research Unit on Applied Molecular Biosciences (UCIBIO) (Prof D Dias da Silva PhD, J P Silva PhD), Department of Community Medicine, Information and Health Decision Sciences (A Freitas PhD), Department of Chemical Engineering (Prof C F Rodrigues PhD), Universidade do Porto (University of Porto), Porto, Portugal; Department of Veterinary Pharmacology and Toxicology (A Aremu PhD), Department of Veterinary Physiology and Biochemistry (A Basiru PhD), Department of Veterinary Public Health and Preventive Medicine (I A Odetokun PhD), University of Ilorin, Ilorin, Nigeria; Department of Public Health and Healthcare Management (T Aripov PhD), Tashkent Institute of Postgraduate Medical Education, Tashkent, Uzbekistan; Department of Cardiovascular, Endocrine-metabolic Diseases and Aging (B Armocida MSc, B Unim PhD), National Institute of Health, Rome, Italy; Division of Tropical and Humanitarian Medicine (B Armocida MSc), University of Geneva, Geneva, Switzerland; School of Health and Social Studies (Prof J Ärnlöv PhD), Dalarna University, Falun, Sweden; Department of Biophysics (A A Artamonov PhD), K A Timiryazev Institute of Plant Physiology (M V Titova PhD), Russian Academy of Sciences, Moscow, Russia; Department of Maternal and Child Health (J Arulappan DSc), Sultan Qaboos University, Muscat, Oman; Community Medicine and Rehabilitation—Physiotherapy Section (A Arumugam PhD), Department of Epidemiology and Global Health (M P Chavula MPH), Umeå University, Umea, Sweden; International Relations Department (M Asadi-Lari PhD), National Agency for Strategic Research in Medical Education (NASRME) (Prof S Asgary MSc), Ministry of Health and Medical Education, Tehran, Iran; Research Center for Biochemistry and

Nutrition in Metabolic Diseases (Z Asemi PhD), Kashan University of Medical Sciences, Kashan, Iran; Neurological Surgery Department (M Asghariahmadabad MD), School of Nursing, Family Health Care Department (J Nutor PhD), Department of Epidemiology and Biostatistics (M Teramoto MD), Department of Bioengineering and Therapeutic Sciences (Prof M S Zastrozhin PhD), University of California San Francisco, San Francisco, CA, USA; Cabrini Research (Prof M Asghari-Jafarabadi PhD), Cabrini Health, Malvern, VIC, Australia; Department of Public Health (M Y Ashemo PhD, U Gerema MSc, M E Getachew MPH), Institute of Health Science (A I Mohamed MSc), Department of Epidemiology (D Shiferaw MPH), Jimma University, Jimma, Ethiopia; Department of Public Health (M Y Ashemo PhD, L T Elilo MPH), Wachemo University, Hossana, Ethiopia; Department of Medical Laboratory Sciences (M O Asika BMLS), Department of Pharmacology and Therapeutics (Prof O E Onwujekwe PhD), University of Nigeria Nsukka, Enugu, Nigeria; Department of Telemedicine (M O Asika BMLS), Society For Disease Prevention, Hummelstown, PA, USA; Department of Immunology (S Athari PhD), Zanjan University of Medical Sciences, Zanjan, Iran; Faculty of Nursing (M M W Atout PhD, Prof A M Batiha PhD), Philadelphia University, Amman, Jordan; Department of Forensic Medicine (A Atreya MD), Lumbini Medical College, Palpa, Nepal; Northumbria Healthcare NHS Foundation Trust, Newcastle upon Tyne, UK (A Aujayeb MBBS); School of Business (Prof M Ausloos PhD), Department of Health Sciences (P H Lee PhD, S J Tromans PhD), University of Leicester, Leicester, UK; Robarts Research Institute (A Avan MD), The University of Western Ontario, London, ON, Canada; Department of Sciences (Prof R M S Azevedo PhD), Instituto Universitário de Ciências da Saúde (IUCS/CESPU) (University Institute of Health Sciences), Gandra, Portugal; Department of Neurovascular Research (A Y Azzam MBBCh), Nested Knowledge, Saint Paul, MN, USA; Faculty of Medicine (A Y Azzam MBBCh), October 6 University, 6th of October City, Egypt; Gomal Center of Biochemistry and Biotechnology (M Badar PhD), Gomal University, Dera Ismail Khan, Pakistan; Department of Forensic Science (A D Badiye PhD, H Bansal MSc, N Kapoor PhD), Government Institute of Forensic Science, Nagpur, India; Division of Orthopaedics (S Baghdadi MD), Children's Hospital of Philadelphia, Philadelphia, PA, USA; Health Research Institute (N Bagheri PhD), University of Canberra, Canberra, ACT, Australia; School of Public Affairs (R Bai MD), Nanjing University of Science and Technology, Nanjing, China; International Medical School (A A Baig PhD), Management and Science University, Alam, Malaysia; Center for Clinical Research and Prevention (J L Baker PhD), Bispebjerg University Hospital, Frederiksberg, Denmark; Department of Neurosurgery (A T Bako PhD), Houston Methodist Hospital, Houston, TX, USA; Maternal and Child Health Unit (R K Bakshi MD), Indian Council of Medical Research, New Delhi, India (D K Lal MD); Health Care Management Department (M Balasubramanian PhD), Flinders Health and Medical Research Institute (N B Bulamu PhD), Population Health Department (T G Gebremeskel PhD), Health Economics Unit (B Kaambwa PhD), College of Medicine and Public Health (B Kaambwa PhD, G R Naik PhD), Health and Social Care Economics Group (C Mpundu-Kaambwa PhD), Department of Nursing and Health Sciences (S Shorofi PhD), Flinders University, Adelaide, SA, Australia; Menzies Centre for Health Policy and Economics (M Balasubramanian PhD), Charles Perkins Centre (R Biswas PhD), School of Pharmacy and Charles Perkins Centre (Z Dai PhD), Department of Public Health (M Khan PhD), School of Veterinary Science (B B Singh PhD), Save Sight Institute (Y You PhD), University of Sydney, Sydney, NSW, Australia; Center of Innovation, Technology and Education (CITE) (Prof O C Baltatu PhD), Anhembi Morumbi University, Sao Jose dos Campos, Brazil; Department of Medicine (K Bam MPH), Monash University, Clayton, VIC, Australia; 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 Neurosurgery (S Bandyopadhyay BA), Faculty of Medicine (R Thayakaran PhD), University of Southampton, Southampton, UK; Institute of Health and Wellbeing (B Banik PhD), Federation University Australia, Melbourne, VIC, Australia; Manna Institute (B Banik PhD), University of New England, Armidale, NSW, Australia; Department of Non-communicable Diseases (P C Banik MPhil), Bangladesh University of Health Sciences, Dhaka, Bangladesh; Vocational School of Technical Sciences (M Baran PhD), Batman University, Batman, Türkiye; Miami Cancer Institute (M Bardhan MD), Baptist Health South Florida, Miami, FL, USA; School of Psychology (Prof S L Barker-Collo PhD), University of Auckland, Auckland, New Zealand; Department of Translational Medicine (F Barone-Adesi PhD), University of Eastern Piedmont, Novara, Italy; Department of Epidemiology (A Barrow MPH, D Braithwaite PhD, D D Ding BS, D Yang MPH), College of Medicine (M J Diaz BS), Department of Computer and Information Science and Engineering (P Naghavi MSc), University of Florida, Gainesville, FL, USA; Department of Public & Environmental Health (A Barrow MPH), University of The Gambia, Brikama, The Gambia; Heidelberg Institute of Global Health (S Barteit PhD), Department of Translational Health Economics (Prof S Listl PhD), Heidelberg University Hospital, Heidelberg, Germany; Alpha Genomics, Islamabad, Pakistan (Z Basharat PhD); Department of Pharmacology and Toxicology (A I J Bashir PhD), Department of Pharmaceutics and Industrial Pharmacy (Z S Yahaya PhD), Kaduna State University, Kaduna, Nigeria; Faculty of Pharmacy (J D Basso PharmD, S Silva MSc), Coimbra Chemistry Centre (J D Basso PharmD), Coimbra Institute for Biomedical Imaging and Translational Research (S Silva MSc), University of Coimbra, Coimbra, Portugal; School of Public Health (S Basu PhD), Department of Primary Care and Public Health (Prof A Majeed MD, Prof S Rawaf MD), Department of Surgery and Cancer (Prof E Mossialos PhD), WHO Collaborating Centre for Public Health Education and Training (D L Rawaf MRCS), Imperial College London, London, UK; Department of Medical Education (K Batra PhD), Department of Social and Behavioral Health (Prof M Sharma PhD), University of Nevada, Las Vegas, Las Vegas, NV, USA; Department of Psychiatry (Prof B T Baune PhD), University of Münster, Münster, Germany; Department of Psychiatry (Prof B T Baune PhD), Melbourne Medical School, Melbourne, VIC, Australia; Health Human Resources Research Center (M Bayati PhD), Student Research Committee (A Faramarzi MD), Department of Otolaryngology (A Faramarzi MD), Trauma Research Center (P Fazeli MSc, M Karajizadeh PhD), Department of Medical Immunology (P Fazeli MSc), Maternal Fetal Medicine Research Center (K Hessami MD), Health Policy Research Center (H Kasraei MD, Y Sarikhani PhD), Department of Biostatistics (H Molavi Vardanjani PhD, E Sadeghi PhD), Non-communicable Disease Research Center (S G Sepanlou MD), Department of Clinical Science (T Yaghoobpour DVM), Shiraz University of Medical Sciences, Shiraz, Iran (Y Mansoori MD); Health System and Population Studies Division (T Begum MPH), Maternal and Child Health Division (A Iqbal MPH, A Sayeed MSc, M Siraj MSc), International Centre for Diarrhoeal Disease Research, Dhaka, Bangladesh; Department of Basic Sciences (E Behboudi PhD), Khoy University of Medical Sciences, Khoy, Iran; Department of Epidemiology (S Khanmohammadi MD, S Nejadghaderi MD, S Rashedi MD, H Soleimani MD), Non-Communicable Diseases Research Center (NCDRC), Tehran, Iran (A Behnoush BS, A Khalaji BS); Division of Pulmonary, Critical Care, and Sleep (M Beiranvand PhD), University of Florida, Jacksonville, FL, USA; Department of Medicine (D F Bejarano Ramirez BN), Faculty of Medicine (J N Malagón-Rojas MSc), El Bosque University, Bogota, Colombia; Transplant Service Department (D F Bejarano Ramirez BN), University Hospital Foundation Santa Fe de Bogotá, Bogota, Colombia; Department of Medical Anatomy (A Bekele MSc), Department of Nursing (A M Mersha MSc), Medical Laboratory Sciences (D A D Tareke MSc), Arba Minch University, Arba Minch, Ethiopia; Department of Oral Pathology and Microbiology (U I Belgaumi MD), Krishna Vishwa Vidyapeeth Deemed to be University, Karad, India; School of the Environment (Prof M L Bell PhD, Y Song PhD), Department of Internal Medicine (F Etaee MD), Department of Psychiatry (W Li PhD), Yale University, New Haven, CT, USA; Department of Biomedical Sciences (Prof A Beloukas PhD), University of West Attica, Athens, Greece; Department of Internal Medicine (I M Bensenor PhD), Department of Medicine (Prof P A Lotufo DrPH), Department of Psychiatry (Prof M F P Peres MD, Y Wang PhD), University of São Paulo, São Paulo, Brazil; Institute of Marketing (Z Berezvai PhD), Corvinus University of Budapest, Budapest, Hungary; Competition Economics

and Market Research Section (Z Berezvai PhD), Hungarian Competition Authority, Budapest, Hungary; Department of Epidemiology and Biostatistics (A C Bermudez MD), University of the Philippines Manila, Manila, Philippines; Department of Epidemiology (A C Bermudez MD), Department of Internal Medicine (M F H Mohamed MSc), Brown University, Providence, RI, USA; Faculty of Medicine (P J G Bettencourt PhD), Catholic University of Portugal, Rio de Mouro, Portugal; Department of Public Health (A S Bhagavathula PhD), North Dakota State University, Fargo, ND, USA; Department of Hematology Oncology (P V Bhardwaj MD), University of Massachusetts Medical School, Springfield, MA, USA; Global Health Neurology Lab (S Bhaskar PhD), NSW Brain Clot Bank, Sydney, NSW, Australia; Department of Neurology and Neurophysiology (S Bhaskar PhD), South West Sydney Local Heath District and Liverpool Hospital, Sydney, NSW, Australia; Department of Internal Medicine (V Bhat MBBS), St John's National Academy of Health Sciences, Bangalore, India; Medical Lab Technology (G K Bhatti PhD), University Centre for Research and Development (S Kalra DM), Chandigarh University, Mohali, India; Human Genetics and Molecular Medicine Department (Prof J S Bhatti PhD, U Sharma PhD), Department of Zoology (B Vellingiri PhD), Central University of Punjab, Bathinda, India; Department of Botanical and Environmental Sciences (Prof M S Bhatti PhD), Department of Pharmaceutical Sciences (R Bhatti PhD), Guru Nanak Dev University, Amritsar, India; Department of Neurology (Prof A Biswas DM), Department of GI Surgery (A Dhali MBBS), Institute of Post-Graduate Medical Education and Research and Seth Sukhlal Karnani Memorial Hospital, Kolkata, India; Clinical Research Centre (R Biswas PhD), Sydney Local Health District, Sydney, NSW, Australia; Faculty of Health Sciences (V R Bitra PhD), University of Botswana, Gaborone, Botswana; Department of Global Public Health and Primary Care (Prof T Bjørge PhD, O Dadras DrPH), Department of Psychosocial Science (D Sagoe PhD), University of Bergen, Bergen, Norway; Cancer Registry of Norway, Oslo, Norway (Prof T Bjørge PhD); SAMRC Centre for Health Economics and Decision Science (PRICELESS SA) (M K Boachie PhD), University of the Witwatersrand, Johannesburg, South Africa; School of Business Administration (Prof V Bodolica PhD), American University of Sharjah, Sharjah, United Arab Emirates; General Directorate of Health Information Systems (B Bora Basara PhD), Ministry of Health, Ankara, Türkiye; Department of Medicine (Prof S Bouaoud MD), Faculty of Medicine (Prof A Ouyahia PhD), University Ferhat Abbas of Setif, Sétif, Algeria; Department of Epidemiology and Preventive Medicine (Prof S Bouaoud MD), University Hospital Saadna Abdenour, Setif, Algeria; Cancer Population Sciences Program (D Braithwaite PhD), University of Florida Health Cancer Center, Gainesville, FL, USA; School of Population and Public Health (Prof M Brauer DSc), School of Nursing (A Pashaei MSc), University of British Columbia, Vancouver, BC, Canada; Department of Psychiatry and Behavioral Health (Prof N J K Breitborde PhD), Department of Psychology (Prof N J K Breitborde PhD), Ohio State University, Columbus, OH, USA; Department of Woman and Child Health and Public Health (D Buonsenso MD), Fondazione Policlinico Universitario A Gemelli IRCCS (Agostino Gemelli University Polyclinic IRCCS), Rome, Italy; Global Health Research Institute (D Buonsenso MD), Università Cattolica del Sacro Cuore (Catholic University of Sacred Heart), Rome, Italy; Department of Biopharmaceutics and Clinical Pharmacy (Y Bustanji PhD), The University of Jordan, Amman, Jordan; 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; Department of Clinical Pharmacy (Prof D Calina PhD), University of Medicine and Pharmacy of Craiova, Craiova, Romania; Center for Nutrition and Health Research (I R Campos-Nonato PhD, E Denova-Gutiérrez DSc), Center for Health Systems Research (S M Cuadra-Hernández PhD, D V Ortega-Altamirano DrPH, E Serván-Mori PhD), National Institute of Public Health, Cuernavaca, Mexico; Department of Ophthalmology (F Cao MD), Beijing Institute of Ophthalmology, Beijing, China; Department of Biomedical and Neuromotor Sciences (A Capodici MD, S Guicciardi MD, L Muccioli MD), Dipartimento di Scienze Biomediche e Neuromotorie (DIBINEM) (F Esposito MD), Department of Medical and Surgical Sciences (Prof F S Violante MD), University of Bologna, Bologna, Italy; Management and Healthcare (EMbeDS) (A Capodici MD), Sant'Anna School of Advanced Studies, Pisa, Italy; Institute for Cancer Research, Prevention and Clinical Network, Florence, Italy (G Carreras PhD); Dermatology Unit (A Carugno MD), Azienda Socio Sanitaria Territoriale Papa Giovanni XXIII (Territorial Healthcare Company Pope John XXIII), Bergamo, Italy; Colombian National Health Observatory (C A Castañeda-Orjuela MD), Department of Public Health Research (J N Malagón-Rojas MSc), National Institute of Health, Bogota, Colombia; Epidemiology and Public Health Evaluation Group (C A Castañeda-Orjuela MD), 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; Department of Public Health and Infectious Diseases (M S Cattaruzza PhD), La Sapienza University, Rome, Italy; Department of Psychiatry (A Caye PhD), Federal University of Rio Grande do Sul, Porto Alegre, Brazil; Department of Medical, Surgical, and Health Sciences (L Cegolon PhD, Prof M D'Oria MD), University of Trieste, Trieste, Italy; Public Health Unit (L Cegolon PhD), University Health Agency Giuliano-Isontina (ASUGI), Trieste, Italy; Department of Nutrition (Prof F Cembranel DSc), Federal University of Santa Catarina, Florianópolis, Brazil; Mary MacKillop Institute for Health Research (Prof E Cerin PhD), Australian Catholic University, Melbourne, VIC, Australia; School of Public Health (Prof E Cerin PhD), Department of Urban Planning and Design (C Guo 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; ICMR School of Public Health (J Chadwick MD), National Institute of Epidemiology, Chennai, India; Department of Biotechnology (Prof C Chakraborty PhD), Adamas University, Kolkata, India; Department of Skeletal Aging and Orthopedic Surgery (Prof C Chakraborty PhD), Hallym University, Chuncheon, South Korea; Heart Failure and Structural Heart Disease Unit (J Chan MBChB), Cardiovascular Analytics Group, Hong Kong, China; Department of Public Health (P Charalampous PhD), Erasmus University Medical Center, Rotterdam, Netherlands; Temerty Faculty of Medicine (V Chattu MD), University of Toronto, Toronto, ON, Canada; Department of Community Medicine (V Chattu MD), Datta Meghe Institute of Medical Sciences, Sawangi, India; Dr D Y Patil Medical College Hospital and Research Centre (S Chaturvedi PhD), Dr D Y Patil Vidyapeeth, Pune, India; School of Public Health (M P Chavula MPH), University of Zambia, Lusaka, Zambia; Fuwai Hospital (A Chen PhD), Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, China; Department of Computer Science (A Chen PhD), University of Texas Austin, Austin, TX, USA; Clinical Research Center (H Chen MB), Stomatological Hospital (A Li PhD), Southern Medical University, Guangzhou, China; Department of Laboratory Medicine (J Chien PhD), Taichung Tzu-Chi Hospital Buddhist Tzu-Chi Medical Foundation, Tanzih, Taiwan; Department of Medical Laboratory Science and Biotechnology (J Chien PhD), Central Taiwan University of Science and Technology, Taiwan; Division of Infectious Diseases (P R Ching MD), Virginia Commonwealth University, Richmond, VA, USA; Department of Clinical Oncology (W C S Cho PhD), Queen Elizabeth Hospital, Hong Kong, China; College of Medicine (S Choi MD Cand), Department of Epidemiology and Health Promotion (Prof S Jee PhD), Yonsei University, Seoul, South Korea; Department of Medicine (B Chong MBBS), Department of Surgery (K Tan PhD), National University of Singapore, Singapore; Department of Biosciences (H Chopra PhD), Saveetha Dental College and Hospitals (M R Tovani-Palone PhD), Saveetha Institute of Medical and Technical Sciences, Chennai, India; Department of Community Medicine (Prof S G Choudhari MD, Prof A M Gaidhane MD), Datta Meghe Institute of Medical Sciences, Wardha, India; Department of Pulmonary Medicine (Prof D J Christopher MD), Department of Endocrinology, Diabetes and Metabolism (Prof N Thomas PhD), Christian Medical College and Hospital (CMC), Vellore, India; Center for Biomedicine and Community Health (D Chu PhD), Viet Nam National-International School, Hanoi, Viet Nam; Department of Paediatric Surgery (I S Chukwu BMedSc), Federal Medical Centre, Umuahia, Nigeria; Department of AndroUrology (Prof E Chung MD), AndroUrology Centre, Brisbane, QLD, Australia; Department of Health Informatics

(S Chung PhD), Institute of Cardiovascular Science (A S Oguntade MSc), University College London, London, UK; Health Data Research UK, London, UK (S Chung PhD); Department of Genetics (Z Cindi PhD), School of Veterinary Medicine (F Musaigwa PhD), Department of Biostatistics Epidemiology and Informatics (J Puvvula PhD), University of Pennsylvania, Philadelphia, PA, USA; Department of Food, Environmental and Nutritional Sciences (I Cioffi PhD), University of Milan, Milan, Italy; Department of Law, Economics, Management and Quantitative Methods (R Ciuffreda MSc, Prof B Simonetti PhD), University of Sannio, Benevento, Italy; Nova Medical School (J Conde PhD), Nova University of Lisbon, Lisbon, Portugal; Department of Family Medicine and Public Health (Prof M H Criqui MD), University of California San Diego, La Jolla, CA, USA; Department of Therapeutic and Diagnostic Technologies (Prof N Cruz-Martins PhD), Toxicology Research Unit (TOXRUN) (Prof D Dias da Silva PhD, Á M Madureira-Carvalho PhD), Cooperativa de Ensino Superior Politécnico e Universitário (CESPU) (University Polytechnic Higher Education Cooperative), Gandra, Portugal; Department of Internal Medicine (S Dadana MD), Cheyenne Regional Medical Center, Cheyenne, WY, USA; Department of Addiction Medicine (O Dadras DrPH), Haukland University Hospital, Bergen, Norway; Department of Community Medicine (Prof T Dahiru MA), Department of Surgery (A Kabir MD), Health Systems and Policy Research Unit (S Mohammed PhD), Ahmadu Bello University, Zaria, Nigeria; IRCCS Istituto Ortopedico Galeazzi (G Damiani MD), Galeazzi Orthopedic Institute IRCCS (University of Milan), Milan, Italy; Department of Dermatology (G Damiani MD), Lerner College of Medicine (L Göbölös PhD), Department of Quantitative Health Science (X Liu PhD), Department of Neonatology (I Qattea MD), Department of Nutrition and Preventive Medicine (Prof J Sanabria MD), Case Western Reserve University, Cleveland, OH, USA; Department of Information Technology (A M Darwesh PhD), Department of Computer Science (Prof M Hosseinzadeh PhD), University of Human Development, Sulaymaniyah, Iraq; Division of Women and Child Health (J K Das MD), Aga Khan University, Karachi, Pakistan; Department of Biochemistry (S Das MD), Ministry of Health and Welfare, New Delhi, India; Department of Radiology (M Dashti MD, A Ghasemzadeh MD), Department of Health Policy and Management (L Doshmangir PhD), School of Nursing and Midwifery (H Hassankhani PhD), Department of Immunology (F Jadidi-Niaragh PhD), School of Management and Medical Informatics (L R Kalankesh PhD), Department of Midwifery (Prof M Mirghafourvand PhD, Prof S Mohammad-Alizadeh-Charandabi PhD), Social Determinants of Health Research Center (Prof S Mohammad-Alizadeh-Charandabi PhD), Tabriz University of Medical Sciences, Tabriz, Iran; 2nd University Ophthalmology Department (A Dastiridou MD), Department of Ophthalmology (N Dervenis MD), Second Department of Cardiology (D Patoulias PhD), Aristotle University of Thessaloniki, Thessaloniki, Greece; Ophthalmology Department (A Dastiridou MD), University of Thessaly, Thessaly, Greece; Department of Population and Development (C A Dávila-Cervantes PhD), Latin American Faculty of Social Sciences Mexico, Mexico City, Mexico; Health Research Institute (K Davletov PhD), Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan; Medical College (S Debopadhaya BS), Albany Medical College, Albany, NY, USA; School of Medicine (I Delgado-Enciso DSc), University of Colima, Colima, Mexico; Department of Research (I Delgado-Enciso DSc), Colima State Health Services, Colima, Mexico; Epidemiology Branch (X Deng PhD), National Institute of Environmental Health Sciences, Durham, NC, USA; Wellcome Trust Brighton and Sussex Centre for Global Health Research (K Deribe PhD), Brighton and Sussex Medical School, Brighton, UK; St Paul's Eye Unit (N Dervenis MD), Royal Liverpool University Hospital, Liverpool, UK; Graduate Medical Education (H D Desai MD), Gujarat Adani Institute of Medical Sciences, Bhuj, India; Division of Cardiology (R Desai MBBS), Atlanta Veterans Affairs Medical Center, Decatur, GA, USA; Department of Community Medicine (V G C Devanbu MD), Chettinad Academy of Research and Education, Chennai, India; Division of Pathology (K Dhama PhD), ICAR-Indian Veterinary Research Institute, Bareilly, India; Research Department (M Dhimal PhD, S Ghimire MPH, U Paudel PhD), Nepal Health Research Council, Kathmandu, Nepal; The Zena and Michael A Wiener Cardiovascular Institute (V R Dhulipala MD), Institute of Critical Care Medicine (A Shaikh MD), Department of Cardiology (M Vinayak MD), Icahn School of Medicine at Mount Sinai, New York, NY, USA (A Shaikh MD); Faculty of Science (Prof D Diaz PhD), National Autonomous University of Mexico, Mexico City, Mexico; Department of Medicine (T C Do MD), Medical School (H Pham MD), Pham Ngoc Thach University of Medicine, Ho Chi Minh City, Viet Nam; Department of Medicine (T H Do MD), Can Tho University of Medicine and Pharmacy, Can Tho, Viet Nam; Center for Health Sciences (C B do Prado MSc), Department of Pathology (Prof B Fux PhD), Federal University of Espirito Santo, Vitória, Brazil; Department of Epidemiology (S Dohare MD, M Khan MD), Department of Health Education and Promotion (M Shanawaz MD), Jazan University, Jazan, Saudi Arabia; School of Elderly Care Services and Management (W Dong MD), Nanjing University of Chinese Medicine, Nanjing, China; Cardio-Thoraco-Vascular Department (Prof M D'Oria MD), Azienda Sanitaria Universitaria Giuliano Isontina, Trieste, Italy; Responsabilidade Social (W M dos Santos PhD), Hospital Alemão Oswaldo Cruz (Oswaldo Cruz German Hospital), São Paulo, Brazil; Brazilian Centre for Evidence-based Healthcare (W M dos Santos PhD), Joanna Briggs Institute, São Paulo, Brazil; Department of Medicine (A C Dsouza MBBS, A Sathyanarayan MD, M Sharath MD), Bangalore Medical College and Research Institute, Bangalore, India; Department of Forensic Medicine and Toxicology (H L Dsouza MD, V Krishna MD), Department of General Medicine (J Jeganathan MD), Department of Community Medicine (N Joseph MD, R Motappa MD, R Thapar MD), Department of Internal Medicine (M M R Reddy MD), Department of Forensic Medicine (P H Shetty MD), Kasturba Medical College (Prof B Unnikrishnan MD), Manipal Academy of Higher Education, Mangalore, India; Department of Forensic Medicine and Toxicology (H L Dsouza MD), Kasturba Medical College Mangalore, Mangalore, India; Health Policy Department (V Dsouza MSc), Kasturba Medical College, Mangalore (R Holla MD), Department of Physiotherapy (Prof V K PhD), Prasanna School of Public Health (R Kamath MHA), Manipal Institute of Management (S Kamath MHA), Department of Pharmacy Management (V S Ligade PhD), Department of Forensic Medicine and Toxicology (A Mishra MD, Prof V C Nayak MD), Manipal TATA Medical College (M Rahman PhD), Department of Community Medicine (C R Rao MD), Department of Nephrology (I Rao DM), Department of Health Information Management (B Reshmi PhD), Manipal Academy of Higher Education, Manipal, India (B Reshmi PhD); Office of Institutional Analysis (J Dube MA), University of Windsor, Windsor, ON, Canada; 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 Biotechnology (S Duraisamy PhD), SRM College of Pharmacy (M R Tovani-Palone PhD), SRM Institute of Science and Technology (SRMIST), Chennai, India; Department of Infection and Tropical Medicine (O C Durojaiye MPH), School of Health and Related Research (J O Oguta MSc), Department of Psychology (A Yadollahpour PhD), University of Sheffield, Sheffield, UK; School of Life Sciences (S Dutta PhD), Manipal Academy of Higher Education, Dubai, United Arab Emirates; Child Health Analytics Research Program (P A Dzianach PhD, Prof P W Gething PhD, F Sanna PhD, D J Weiss PhD), Geospatial Health and Development Team (J Lubinda PhD), The Malaria Atlas Project (S F Rumisha PhD), Telethon Kids Institute, Perth, WA, Australia; Department of Conservative Dentistry with Endodontics (A M Dziedzic DSc), Medical University of Silesia, Katowice, Poland; Department of Orthopaedic Surgery (A Ebrahimi MD), Department of Radiology (X Liu PhD), Division of Cardiology (D H Nguyen BS), Massachusetts General Hospital, Boston, MA, USA; School of Health Sciences (H A Edinur PhD), Universiti Sains Malaysia (University of Science Malaysia), Kubang Kerian, Malaysia; College of Science, Health and Engineering (K Edvardsson PhD), La Trobe University, Bundoora, VIC, Australia; Department of Community Health Nursing (F Efendi PhD), Universitas Airlangga (Airlangga University), Surabaya, Indonesia; Centre for Global Health Inequalities Research (CHAIN) (Prof T Eikemo PhD), Department of Circulation and Medical Imaging (J Nauman PhD), Norwegian University of Science and Technology,

Trondheim, Norway; Department of Internal Medicine and Hematology Unit (Prof G M T ElGohary MD), Biochemistry Department (Prof N M Hamdy PhD), Department of Entomology (A M Samy PhD), Medical Ain Shams Research Institute (MASRI) (A M Samy PhD), Ain Shams University, Cairo, Egypt; Faculty of Medicine (M Elhadi MD), University of Tripoli, Tripoli, Libya; Egypt Center for Research and Regenerative Medicine (ECRRM), Cairo, Egypt (M A Elmonem PhD); Clinical Pathology Department (M Elshaer MD), Faculty of Pharmacy (M A Saleh PhD), Rheumatology and Immunology Unit (S Tharwat MD), Mansoura University, Mansoura, Egypt; Department of Infectious Diseases and Public Health (I Elsohaby PhD), City University of Hong Kong, Hong Kong, China; Department of Animal Medicine (I Elsohaby PhD), Department of Cardiology (Prof A M A Saad MD), Zagazig University, Zagazig, Egypt; Department of Medical-Surgical Nursing (A Emami Zeydi PhD, S Shorofi 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; Lincoln International Institute for Rural Health (L Engelbert Bain PhD), University of Lincoln, Lincoln, UK; Bologna, Italy (N Fabin MD); Research Centre for Healthcare and Community (A F Fagbamigbe PhD), Faculty of Health and Life Sciences (O P Kurmi PhD), Coventry University, Coventry, UK; Department of Food Hygiene and Quality Control (A Fakhri-Demeshghieh DVM), University of Tehran, Tehran, Iran; Epidemiology and Biostatistics Unit IRCCS Pascale (L Falzone PhD), IRCCS, Naples, Italy; Department of Psychology (Prof A Faro PhD), Federal University of Sergipe, São Cristóvão, Brazil; Satcher Health Leadership Institute (A O Fasanmi PhD), Morehouse School of Medicine, Atlanta, GA, USA; School of Medicine (A O Fasanmi PhD), Department of Family and Preventive Medicine (T Sathish PhD), Emory University, Atlanta, GA, USA; Centre for Health Policy Research (Prof P Ward PhD), Torrens University Australia, Adelaide, SA, Australia (N K Fauk MSc); Institute of Resource Governance and Social Change, Kupang, Indonesia (N K Fauk MSc); National Institute for Stroke and Applied Neurosciences (Prof V L Feigin PhD), Auckland University of Technology, Auckland, New Zealand; Research Center of Neurology, Moscow, Russia (Prof V L Feigin PhD); Division of Neurology (S Fereshtehnejad PhD), University of Ottawa, Ottawa, ON, Canada; Research Center on Public Health (P Ferrara MD), University of Milan Bicocca, Monza, Italy; Department of Social Sciences (Prof N Ferreira PhD), University of Nicosia, Nicosia, Cyprus; Department of Nursing (G Fetensa MSc), Department of Public Health (M E Getachew MPH, D R Terefa MSc), Wollega University, Nekemte, Ethiopia; Department of Psychiatry (I Filip MD), Kaiser Permanente, Fontana, CA, USA; School of Health Sciences (I Filip MD), A T Still University, Mesa, AZ, USA; Institute of Public Health (F Fischer PhD), Department of Surgery (N Haep MD), Department of Neurology (S Samadzadeh MD), Charité Universitätsmedizin Berlin (Charité Medical University Berlin), Berlin, Germany; School of Social Sciences (J Flavel PhD), Stretton Health Equity, Adelaide, SA, Australia; Institute of Gerontology (N A Foigt PhD), National Academy of Medical Sciences of Ukraine, Kyiv, Ukraine; Clinical Science Department (Prof M O Folayan FWACS), Nigerian Institute of Medical Research, Yaba, Nigeria; Department of Cell Biology and Biotechnology (A A Fomenkov PhD), K A Timiryazev Institute of Plant Physiology, Moscow, Russia; Department of Pharmacology (Prof B Foroutan PhD), Iranshahr University of Medical Sciences, Iranshahr, Iran; Department of Biotechnological and Applied Clinical Sciences (DISCAB) (M Foschi MD), University of L'Aquila, L'Aquila, Italy; Department of Neuroscience (M Foschi MD), Hospital Santa Maria delle Croci, Ravenna, Italy; Child Survival Unit (K R Fowobaje MSc), Centre for African Newborn Health and Nutrition, Ibadan, Nigeria; Centre for Adolescent Health (K L Francis MBiostat), Murdoch Children's Research Institute, Melbourne, VIC, Australia; Center for Health Technology and Services Research (CINTESIS), Porto, Portugal (A Freitas PhD); Department of Dermatology (T Fukumoto PhD), Kobe University, Kobe, Japan; Health Services Management Training Centre (P A Gaal PhD, T Joo PhD, J Lám PhD), Institute of Digital Health Sciences (P Pollner PhD), Faculty of Health and Public Administration (M Szócska PhD), Semmelweis University, Budapest, Hungary; Department of Applied Social Sciences (P A Gaal PhD), Sapientia Hungarian University of Transylvania, Targu Mures, Romania; Department of Community Medicine (Prof M A Gadanya FMCPH), Aminu Kano Teaching Hospital, Kano, Nigeria; Department of Food Technology (Y Galali ResM, B A Sadee PhD), Salahaddin University-Erbil, Erbil, Iraq; Department of Nutrition and Dietetics (Y Galali ResM, B A Sadee PhD), Cihan University-Erbil, Erbil, Iraq; Department of Environmental Health Sciences (S Gallus DSc, A Lugo PhD), Mario Negri Institute for Pharmacological Research, Milan, Italy; Department of Community Medicine and Family Medicine (A P Gandhi MD), All India Institute of Medical Sciences, Nagpur, India; Institute of Health and Wellbeing (B Ganesan PhD), Federation University, Churchill, VIC, Australia; Department of General Medicine (M Ganiyani MD), Grant Medical College & Sir J J Group of Hospitals, Mumbai, India; Department of Medicine (M Ganiyani MD), Miami Cancer Institute, Miami, FL, USA; Faculty of Business and Management (M Garcia-Gordillo PhD), Universidad Autonóma de Chile (Autonomous University of Chile), Talca, Chile; University School of Management and Entrepreneurship (N Garg PhD, R Sharma PhD), Delhi Technological University, Delhi, India; Department of Pharmacology (Prof R K Gautam PhD), Indore Institute of Pharmacy, Indore, India; Institute and Faculty of Actuaries, London, UK (F Gazzelloni BSc); Department of Epidemiology (S O Gbadamosi MD), Florida International University, Miami, FL, USA; Department of Midwifery (M W Gebregergis MSc), Department of Medical Laboratory Sciences (H Negash MSc), Adigrat University, Adigrat, Ethiopia; Department of Environmental Health (M Gebrehiwot DSc), Wollo University, Dessie, Ethiopia; Department of Public Health (T B Gebremariam MPH), Debre Berhan University, Debre Berhan, Ethiopia; Addis Ababa, Ethiopia (T B Gebremariam MPH, S A Yesuf MSc); Department of Public Health Nutrition (T B Gebremariam MPH), Aksum University, Mekelle, Ethiopia; Reproductive and Family Health Department (T G Gebremeskel PhD), Axum College of Health Science, Axum, Ethiopia; School of Population Health (Prof P W Gething PhD), School of Public Health (T R Miller PhD), Curtin School of Population Health (D J Weiss PhD), Curtin University, Perth, WA, Australia; Department of Dermatology (Prof S R Georgescu PhD), "Victor Babes" Clinical Hospital of Infectious and Tropical Diseases, Bucharest, Romania; College of Health Science (H Geremew MPH), Oda Bultum University, Chiro, Ethiopia; Young Researchers and Elite Club (A Gholamian MSc), Islamic Azad University, Rasht, Iran; Department of Biology (A Gholamian MSc), Islamic Azad University, Tehran, Iran; Department of Radiology (A Gholamrezanezhad MD), University of Southern California, Los Angeles, CA, USA; Department of Respiratory Medicine (Prof A G Ghoshal MD), National Allergy Asthma Bronchitis Institute, Kolkata, India; Department of Respiratory Medicine (Prof A G Ghoshal MD), Fortis Hospital, Kolkata, India; Department of Forensic Biology (A D Ghuge MPhil), Government Institute of Forensic Science, Aurangabad, India; Department of Clinical Research (A D Ghuge MPhil), National Institute for Research In Reproductive and Child Health, Mumbai, India; NCD Surveillance Unit (A U Gil PhD), World Health Organization (WHO), Moscow, Russia; Institute for Leadership and Health Management (A U Gil PhD), Moscow Medical Academy, Moscow, Russia; Adelaide Medical School (T K Gill PhD), University of Adelaide, Adelaide, SA, Australia; Department of Molecular and Developmental Medicine (M Giorgi MD), Post Graduate School of Public Health (G Guarducci MD), University of Siena, Siena, Italy; NIHR Global Health Research Unit on Global Surgery (J C Glasbey MSc), Institute of Applied Health Research (R Thayakaran PhD), University of Birmingham, Birmingham, UK; Department of Hepatology (Prof A Goel DM), Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, India; Department of Applied Cell Sciences (A Golchin PhD), Cellular and Molecular Medicine Institute (A Golchin PhD), School of Medicine (P Mokhtarzadehazar MD), Urmia University of Medical Sciences, Urmia, Iran (R Valizadeh PhD); Department of Health Systems and Policy Research (M Golechha PhD), Indian Institute of Public Health, Gandhinagar, India; Department of Genetics (P Goleij MSc), Sana Institute of Higher Education, Sari, Iran; Universal Scientific Education and Research Network (USERN) (P Goleij MSc), Substance Abuse

Prevention Research Center (B Mansouri PhD), Research Center for Environmental Determinants of Health (Prof E Sadeghi PhD), Kermanshah University of Medical Sciences, Kermanshah, Iran; 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 Epidemiology (Prof A C Goulart PhD), Universidade de São Paulo (University of São Paulo), São Paulo, Brazil; Blood and Marrow Transplantation and Cellular Therapy Program (A Goyal MD), Stanford University, Palo Alto, CA, USA; Department of Public Health and Preventive Medicine (Prof M Grivna PhD), Charles University, Prague, Czech Republic; Department of Epidemiology and Biostatistics (S Guan MD, Prof H Pan PhD), Anhui Medical University, Hefei, China; Department of Family and Community Medicine (M I M Gubari PhD), University Of Sulaimani, Sulaimani, Iraq; Health Directorate (S Guicciardi MD), Local Health Authority of Bologna, Bologna, Italy; Department of General Surgery (S Gulati MD), Dignity Health, Phoenix, AZ, USA; Diagnostic Radiology and Nuclear Medicine (D Gulisashvili MD), University of Maryland, Baltimore, MD, USA; Department of Community Medicine (D A Gunawardane MD), University of Peradeniya, Kandy, Sri Lanka; Department of Internal Medicine (A K Gupta PharmD), Shree Guru Gobind Singh Tricentenary University, Gurugram, India; Non-communicable Division (NCD) (A K Gupta PharmD), Indian Council of Medical Research, Delhi, India; Department of Public Health (B Gupta PhD), Torrens University Australia, Melbourne, VIC, Australia; Department of Toxicology (S Gupta MSc), Shriram Institute for Industrial Research, Delhi, India; School of Medicine (V Gupta PhD), Deakin University, Geelong, VIC, Australia; School of Biotechnology (V Gupta PhD), Dublin City University, Glasnevin, Ireland; Faculty of Medicine Health and Human Sciences (Prof V K Gupta PhD), Macquarie Medical School (Y You PhD), Macquarie University, Sydney, NSW, Australia; Department of Global Health and Population (A Haakenstad ScD), T H Chan School of Public Health, Boston, MA, USA; Global Virus Network, Middle East Region, Shiraz, Iran (F Habibzadeh MD); Department of Clinical Pharmacology and Medicine (Prof N R Hadi PhD), University of Kufa, Najaf, Iraq; Clinician Scientist Program (N Haep MD), Berlin Institute of Health, Berlin, Germany; Department of Infectious Disease Epidmiology (S Haller MD), Robert Koch Institute, Berlin, Germany; Department of Public Health (S Haller MD), Charité Insitute of Public Health, Berlin, Germany; Department of Family and Community Medicine (Prof R R Hamadeh PhD), College of Medicine and Medical Sciences (H Jahrami PhD), Arabian Gulf University, Manama, Bahrain; School of Health and Environmental Studies (Prof S Hamidi DrPH), Hamdan Bin Mohammed Smart University, Dubai, United Arab Emirates; Department of Nephrology (Q Han PhD), Beijing Chao-yang Hospital, Beijing, China; Department of Epidemiology (A J Handal PhD), University of Michigan, Ann Arbor, MI, USA; Centre for Neuromuscular and Neurological Disorders (Prof G J Hankey MD), University of Western Australia, Perth, WA, Australia; Perron Institute for Neurological and Translational Science, Perth, WA, Australia (Prof G J Hankey MD); Department of Population Science and Human Resource Development (Prof M Haque PhD, Prof M Rahman PhD, M Rahman DrPH), Department of Mathematics (M Kuddus PhD), University of Rajshahi, Rajshahi, Bangladesh; Research Unit (J M Haro MD), University of Barcelona, Barcelona, Spain; Biomedical Research Networking Center for Mental Health Network (CiberSAM), Barcelona, Spain (J M Haro MD); Department of Zoology and Entomology (A I Hasaballah PhD), Al Azhar University, Cairo, Egypt; Department of Pharmaceutical Technology (I Hasan MPharm), Department of Population Sciences (Prof M B H Hossain PhD), University of Dhaka, Dhaka, Bangladesh; Department of Public Health (M Hasan MPH), Tropical Disease and Health Research Center, Bangladesh, Dhaka, Bangladesh; Department of Biomedical Engineering and Public Health (S Hasan PhD), World University of Bangladesh, Dhaka, Bangladesh; Department of Ophthalmology (H Hasani MD), Iran University of Medical Sciences, Karaj, Iran; Department of Pharmacy (Prof M S Hasnain PhD), Palamau Institute of Pharmacy, Daltonganj, India; Department of Public Health (I Hassan MPH), Dalhatu Araf Specialist Hospital, Lafia, Nigeria; Public Health Department (I Hassan MPH), Federal University of Lafia, Lafia, Nigeria; Tabriz, Iran (H Hassankhani PhD); Faculty of Kinesiology (Prof J J Hebert PhD), University of New Brunswick, Fredericton, NB, Canada; School of Allied Health (Prof J J Hebert PhD), Murdoch University, Murdoch, WA, Australia; Community-Oriented Nursing Midwifery Research Center (M Heidari PhD), Department of Epidemiology and Biostatistics (A Mohammadian-Hafshejani PhD), Department of Health in Disasters and Emergencies (R Sheikhi BHlthSci), Shahrekord University of Medical Sciences, Shahrekord, Iran; Institute of Psychology (B Helfer PhD), University of Wrocław, Wrocław, Poland; Meta Research Centre (B Helfer PhD), University of Wrocław, Wrocław, Poland; Department of Medicine (M Hemmati MD), MedStar Health, Columbia, MD, USA; Department of Medicine (M Hemmati MD), Georgetown University, Washington, DC, USA; Departamento de Salud Oral (Department of Oral Health) (B Y Herrera-Serna PhD), Universidad Autónoma de Manizales (Autonomous University of Manizales), Manizales, Colombia; School of Business (Prof C Herteliu PhD), London South Bank University, London, UK; Department of Microbiology (K Hezam PhD), Department of Applied Microbiology (E A Noman PhD), Taiz University, Taiz, Yemen; School of Medicine (K Hezam PhD), Nankai University, Tianjin, China; Division for Health Service Promotion (Y Hiraike PhD), Department of Global Health Policy (S Nomura PhD, S K Rauniyar PhD), University of Tokyo, Tokyo, Japan; School of Dentistry (N Q Hoan DDS), Hanoi Medical University, Hanoi, Viet Nam; Department of Pulmonology (N Horita PhD), Yokohama City University, Yokohama, Japan; National Human Genome Research Institute (NHGRI) (N Horita PhD), Center for Translation Research and Implementation Science (G A Mensah MD), National Institutes of Health, Bethesda, MD, USA; Social and Environmental Health Research (M Hossain MPH), Nature Study Society of Bangladesh, Khulna, Bangladesh; Department of Health Promotion and Community Health Sciences (M Hossain MPH), Texas A&M University, College Station, TX, USA; School of Health and Society (H Hosseinzadeh PhD, Z Ratan MSc), University of Wollongong, Wollongong, NSW, Australia; Institute of Research and Development (Prof M Hosseinzadeh PhD), Faculty of Medicine (H T H Nguyen MD), Institute for Research and Training in Medicine, Biology and Pharmacy (H T H Nguyen MD), Duy Tan University, Da Nang, Viet Nam; Department of Clinical Legal Medicine (S Hostiuc PhD), National Institute of Legal Medicine Mina Minovici, Bucharest, Romania; Faculty of Medicine of Tunis (Prof M Hsairi MPH), University Tunis El Manar, Tunis, Tunisia; Department of Health Services Administration (V Hsieh PhD), Department of Occupational Safety and Health (Prof B Hwang PhD), College of Public Health (R Lin PhD), China Medical University, Taichung, Taiwan; Department of Psychology (C Hu PhD), Tsinghua University, Beijing, China; Jockey Club School of Public Health and Primary Care (J Huang MD, C Zhong 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 Biological Sciences and Chemistry (Prof J Hussain PhD), Natural and Medical Sciences Research Center (A Khan PhD, A Ullah MS, S Ullah MSc), School of Pharmacy (A K Philip PhD), University of Nizwa Oman, Nizwa, Oman; Department of Biomolecular Sciences (N R Hussein PhD), University of Zakho, Zakho, Iraq; International Master Program for Translational Science (H Huynh BS), Department of Global Health and Health Security (K Latief MS), International PhD Program in Medicine (L Minh MD), Research Center for Artificial Intelligence in Medicine (L Minh MD), School of Public Health (Y L Samodra MPH), Taipei Medical University, Taipei, Taiwan; Department of Occupational Therapy (Prof B Hwang PhD), Asia University, Taichung, Taiwan; Health Policy and Management Department (P M Iftikhar MD), City University of New York, New York, NY, USA; Department of Community Medicine (O S Ilesanmi PhD), Department of Medicine (A S Oguntade MSc, Prof M O Owolabi DrM), Department of Oral and Maxillofacial Surgery (A A Salami BDS), University College Hospital, Ibadan, Nigeria; 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), Faculty of Medicine Institute of Epidemiology (I S Vujcic PhD), University of Belgrade, Belgrade, Serbia; Department of Epidemiology (Prof M D Ilic PhD), University of Kragujevac, Kragujevac, Serbia; Department of Health Research (L R Inbaraj MD), ICMR National Institute for Research in Tuberculosis, Chennai, India; Department of Pharmacy (M R Islam PhD), University of Asia Pacific, Dhaka, Bangladesh; Department of Clinical Pharmacy and Pharmacy Practice (Prof N Ismail PhD), Asian Institute of Medicine, Science and Technology, Kedah, Malaysia; Malaysian Academy of Pharmacy, Puchong, Malaysia (Prof N Ismail PhD); Public Health Department of Social Medicine (Prof H Iso MD), Osaka University, Suita, Japan; Department of Health Services Research (M Iwagami PhD), University of Tsukuba, Tsukuba, Japan; Department of Non-Communicable Disease Epidemiology (M Iwagami PhD), Department of Infectious Disease Epidemiology (Prof H J Larson PhD), Department of Health Services Research and Policy (Prof M McKee DSc), London School of Hygiene & Tropical Medicine, London, UK; Department of Biotechnology (M Iyer PhD, S Muthu MS), Karpagam Academy of Higher Education (Deemed to be University), Coimbatore, India; Department of Orthodontics & Dentofacial Orthopedics (L J BDS), Department of Oral Pathology and Microbiology (Prof G S Sarode PhD, Prof S C Sarode PhD), Dr D Y Patil University, Pune, India; Research and Development Unit (L Jacob MD), Biomedical Research Networking Center for Mental Health Network (CiberSAM), Sant Boi de Llobregat, Spain; Faculty of Medicine (L Jacob MD), University of Versailles Saint-Quentin-en-Yvelines, Montigny-le-Bretonneux, France; Department of Nephrology (K Jaggi MD), San Mateo Medical Center, San Mateo, CA, USA; Department of Nephrology, Internal Medicine (K Jaggi MD), Mills Peninsula Medical Center, Burlingame, CA, USA; Psychiatric Hospital (H Jahrami PhD), Department of Psychiatry (Z Saif MBA), Ministry of Health, Manama, Bahrain; Department of Leukemia (A Jain MD), The University of MD Anderson Cancer Center, Houston, TX, USA; Statistics Unit (N Jain MD), Riga Stradins University, Riga, Latvia; Department of Health and Safety (A A Jairoun PhD), Dubai Municipality, Dubai, United Arab Emirates; The World Academy of Sciences UNESCO, Trieste, Italy (Prof M Jakovljevic PhD); Shaanxi University of Technology, Hanzhong, China (Prof M Jakovljevic PhD); Department of Physiology (Prof S Javadov PhD), University of Puerto Rico Medical Sciences Campus, San Juan, Puerto Rico; Health Informatic Lab (T Javaheri PhD), Department of Computer Science (R Rawassizadeh PhD), Boston University, Boston, MA, USA; Centre of Studies and Research (S Jayapal PhD), Ministry of Health, Muscat, Oman; Department of Biochemistry (Prof S Jayaram MD), Government Medical College, Mysuru, India; Department of Cardiovascular Medicine (A K Jha MD), Saint Vincent Hospital, Worcester, MA, USA; Department of Community Medicine (R P Jha MSc), Dr Baba Saheb Ambedkar Medical College and Hospital, Delhi, India; Department of Community Medicine (R P Jha MSc), Banaras Hindu University, Varanasi, India; Melbourne School of Population and Global Health (H Jiang PhD), School of Health Sciences (A Meretoja MD), University of Melbourne, Melbourne, VIC, Australia; Zoonoses Research Center (M Jokar DVM), Islamic Azad University, Karaj, Iran; Department of Clinical Sciences (M Jokar DVM), Department of Public Health (Y Sarikhani PhD), Jahrom University of Medical Sciences, Jahrom, Iran; Institute of Molecular and Clinical Ophthalmology Basel, Basel, Switzerland (Prof J B Jonas MD); Department of Ophthalmology (Prof J B Jonas MD), Heidelberg University, Mannheim, Germany; Hungarian Health Management Association, Budapest, Hungary (T Joo PhD); Department of Economics (C E Joshua BSc), National Open University, Benin City, Nigeria; 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; Department of Bioengineering (H Kabir MSc), University of California Berkeley, Berkeley, CA, USA; School of Public Health (Z Kabir PhD), University College Cork, Cork, Ireland; Department of Dermatology (F Kaliyadan MD), King Faisal University, Hofuf, Saudi Arabia; Department of Endocrinology (S Kalra DM), Bharti Hospital Karnal, Karnal, India; Care and Public Health Research Institute (CAPHRI) (R Kamath MHA), Maastricht University, Maastricht, Netherlands; Regional Institute for Population Studies (E Kanmiki MPH), University of Ghana, Accra, Ghana; Faculty of Dentistry (K K Kanmodi MPH), University of Puthisastra, Phnom Penh, Cambodia; Office of the Executive Director (K K Kanmodi MPH), Campaign for Health and Neck Cancer Education (CHANCE) Programme (A A Salami BDS), Cephas Health Research Initiative, Ibadan, Nigeria; Department of Community Medicine (S Kannan S MD), ESIC Medical College and Hospital Chennai, Chennai, India; Dr S S Bhatnagar University Institute of Chemical Engineering and Technology (Prof S K Kansal PhD), Department of Anthropology (Prof K Krishan PhD), Department of Community Medicine (R Rohilla MD), Institute of Forensic Science and Criminology (V Sharma PhD), Panjab University, Chandigarh, India; The Hansjörg Wyss Department of Plastic and Reconstructive Surgery (R S Kantar MD), Nab'a Al-Hayat Foundation for Medical Sciences and Health Care, New York, NY, USA; Cleft Lip and Palate Surgery Division (R S Kantar MD), Global Smile Foundation, Norwood, MA, USA; School of Health Professions and Human Services (I M Karaye MD), Hofstra University, Hempstead, NY, USA; Department of Anesthesiology (I M Karaye MD), Montefiore Medical Center, Bronx, NY, USA; Department of Physical Therapy and Health Rehabilitation (F Z Kashoo MPT), Majmaah University, Majmaah, Saudi Arabia; Surgery Research Unit (Prof J H Kauppila MD), University of Oulu, Oulu, Finland; Division of Nephrology and Hypertension (S Kazeminia MD), Radiology Department (P Metanat MD), Division of General Internal Medicine (N M Odogwu PhD), Mayo Clinic, Rochester, MN, USA; Eye Unit (Prof J H Kempen MD), MyungSung Medical College, Addis Ababa, Ethiopia; Department of Health Sciences and Biostatistics (E S Kendal PhD), Swinburne University of Technology, Hawthorn, VIC, Australia; Biomedical Informatics Department (K Keshtkar BSc), Arizona State University, Phoenix, AZ, USA; Amity Institute of Forensic Sciences (H Khajuria PhD, B P Nayak PhD), Amity Institute of Pharmacy (K Munjal PhD), Amity Institute of Public Health (M Shannawaz PhD), Amity University, Noida, India; College of Health Sciences (N Khalid PhD), Abu Dhabi University, Adu Dhabi, United Arab Emirates; Department of Biostatistics (Prof A Khalilian PhD), Mazandaran University of Medical Sciences, Mazandaran, Iran; Research Center for Hydatid Disease (F Khamesipour PhD), Kerman University of Medical Sciences, Kerman, Iran; Population Science Department (M Khan PhD), Jatiya Kabi Kazi Nazrul Islam University, Mymensingh, Bangladesh; Department of Primary Care (M A Khan MSc), NHS North West London, London, UK; Department of Health Policy and Management (Prof Y Khang MD), Institute of Health Policy and Management (Prof Y Khang MD), Department of Food and Nutrition (A P Okekunle PhD), Seoul National University, Seoul, South Korea; College of Health, Wellbeing and Life Sciences (Prof K Khatab PhD), Sheffield Hallam University, Sheffield, UK; College of Arts and Sciences (Prof K Khatab PhD), Ohio University, Zanesville, OH, USA; Department of Biochemistry (F Khidri PhD), Liaquat University Of Medical and Health Sciences, Jamshoro, Pakistan; Molecular Medicine Department (M Khosravi PhD), Pasteur Institute of Iran, Tehran, Iran; Research Department (M Khosrowjerdi PhD), Inland Norway University of Applied Sciences, Elverum, Norway; School of Public Health (W T Kidane PhD), Hawassa University, Hawassa, Ethiopia; Department of Pharmacology (Z D Kifle MSc), School of Nursing (H B Netsere MS), University of Gondar, Gondar, Ethiopia; Cardiovascular Disease Initiative (M Kim MD), Broad Institute of MIT and Harvard, Cambridge, MA, USA; Millennium Prevention, Westwood, MA, USA (R W Kimokoti MD); Department of Public Health (G T Kiross MPH), Debre Markos University, East Gojjam, Ethiopia; School of Health Sciences (Prof A Kisa PhD), Kristiania University College, Oslo, Norway; Department of International Health and Sustainable Development (Prof A Kisa PhD), Tulane University, New Orleans, LA, USA; Department of Nursing and Health Promotion (S Kisa PhD), Oslo Metropolitan University, Oslo, Norway; Copernicus Institute of Sustainable Development (G Koren PhD), Institute for Risk Assessment Sciences (IRAS) (E Traini MSc), Utrecht University, Utrecht, Netherlands; Department of General Practice (Prof O Korzh DSc), Department of Infectious Diseases (A Sokhan PhD), Kharkiv National Medical University, Kharkiv, Ukraine; Jakarta, Indonesia (S Kosen MD); Kasturba Medical College (S Koulmane Laxminarayana MD), Manipal College of Nursing (R Yesodharan MSc), Manipal Academy of Higher

Education, Udupi, India; Department of Anesthesiology (V Krishnamoorthy MD), Duke University, Durham, NC, USA; 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; Smart Approaches to Marijuana/Foundation for Drug Policy Solutions, Washington, DC, USA (C M Kubeisy BA); Faculty of Medicine (B Kucuk Bicer PhD), Gazi University, Ankara, Türkiye; Department of Biochemistry (Prof M Kuddus PhD), University of Hail, Hail, Saudi Arabia; Department of Pediatrics (I Kuitunen PhD), Kuopio University Hospital, Kuopio, Finland; Institute of Clinical Medicine (I Kuitunen PhD), University of Eastern Finland, Kuopio, Finland; Department of Health Research (M Kulimbet MSc), Atchabarov Scientific Research Institute of Fundamental and Applied Medicine (M Kulimbet MSc), Kazakh National Medical University, Almaty, Kazakhstan; Department of Food Technology (Prof H Kumar PhD), Shri Vishwakarma Skill University, Palwal, India; Department of Biotechnology (Prof H Kumar PhD), Amity University Rajasthan India, Jaipur, India; Global Health Institute (S Kundu MPH), North South University, Dhaka, Bangladesh; Department of Nutrition and Food Science (S Kundu MPH), Department of Biochemistry and Food Analysis (N Roy PhD), Department of Post-Harvest Technology and Marketing (A Sayeed MSc), Patuakhali Science and Technology University, Patuakhali, Bangladesh; Department of Public Health/Malaria (K R Kunle MSc), Malaria Consortium, Abuja, Nigeria; Public Health Pharmacy Department (K R Kunle MSc), West African Postgraduate College of Pharmacists, Lagos, Nigeria; Department of Medicine (O P Kurmi PhD), Department of Psychiatry and Behavioural Neurosciences (A T Olagunju MD), McMaster University, Hamilton, ON, Canada; National Research and Innovation Agency, Jakarta, Indonesia (A Kusnali LLB, H U Pangaribuan MSc); Department of Health Services Research and Management (D Kusuma DSc), City University of London, London, UK; Faculty of Public Health (D Kusuma DSc, Prof I Trihandini PhD), Centre for Family Welfare (K Latief MS), University of Indonesia, Depok, Indonesia; Department of Nursing (E F Kyei MSc), University of Massachusetts Boston, Boston, MA, USA; Department of Health Policy (I Kyriopoulos PhD, Prof E Mossialos PhD), London School of Economics and Political Science, London, UK; 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); Institute for Social and Health Sciences (Prof L Laflamme PhD), University of South Africa, Pretoria, South Africa; Department of Health Policy and Strategy (Prof C Lahariya MD), Foundation for People-centric Health Systems, New Delhi, India; SD Gupta School of Public Health (Prof C Lahariya MD), Indian Institute of Health Management Research University, Jaipur, India; School of Digital Science (D T C Lai PhD), Institute of Applied Data Analytics (D T C Lai PhD), Universiti Brunei Darussalam (University of Brunei Darussalam), Gadong, Brunei; NEVES Society for Patient Safety, Budapest, Hungary (J Lám PhD); Department of Health Sciences (D Lamnisos PhD), European University Cyprus, Nicosia, Cyprus; 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 Health Sciences (DISSAL) (F Lanfranchi MD), University of Genoa, Genoa, Italy; Department of Psychiatry and Psychotherapy (B Langguth PhD, W Schlee PhD), University of Regensburg, Regensburg, Germany; Department of Behavioural Sciences and Learning (A Laplante-Lévesque PhD), Linköping University, Linköping, Sweden; 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; Health Economcs Division (L K D Le PhD), Monash University, Burwood, VIC, Australia; Faculty of Medicine (N Le MD), Department of General Medicine (V T Nguyen MD), University of Medicine and Pharmacy at Ho Chi Minh City, Ho Chi Minh City, Viet Nam (T D T Le MD); Cardiovascular Research Department (N Le MD), Methodist Hospital, Merrillville, IN, USA; Ho Chi Minh City, Viet Nam (T D T Le MD); Department of Medical Science (M Lee PhD), Ajou University School of Medicine, Suwon, South Korea; Department of Precision Medicine (Prof S W Lee MD), Sungkyunkwan University, Suwon-si, South Korea; Department of Preventive Medicine (Prof Y Lee PhD), Korea University, Seoul, South Korea; Department of Reproductive Health (G Lema MPH), Department of Medical Microbiology and Immunology (S Muthupandian PhD), Mekelle University, Mekelle, Ethiopia; Faculty of Science (E Leong PhD), Universiti Brunei Darussalam (University of Brunei Darussalam), Bandar Seri Begawan, Brunei; Center for Dentistry and Oral Hygiene (A Li PhD), Unit of Pharmacotherapy, Epidemiology and Economy (S Mubarik MS), University Medical Center Groningen (Prof M J Postma PhD), Department of Internal Medicine (P Vart PhD), University of Groningen, Groningen, Netherlands; Department of Health Promotion and Health Education (M Li PhD), National Taiwan Normal University, Taipei, Taiwan; Asbestos Diseases Research Institute, Concord, NSW, Australia (R Lin PhD); Department of Dentistry—Quality and Safety of Oral Health Care (Prof S Listl PhD), Radboud University, Nijmegen, Netherlands; School of Life Sciences (G Liu PhD), University of Technology Sydney, Ultimo, NSW, Australia; Centre for Inflammation (G Liu PhD), Centenary Institute, Camperdown, NSW, Australia; Department of Epidemiology and Biostatistics (Prof J Liu PhD), School of Public Health (H Zhang MS), Institute of Child and Adolescent Health (Z Zou MD), Peking University, Beijing, China; School of Public Health (Y Liu PhD), Sun Yat-sen University, Guangzhou, China; Department of Molecular Epidemiology (E Llanaj PhD), German Institute of Human Nutrition Potsdam-Rehbrücke, Potsdam, Germany; German Center for Diabetes Research (DZD), Munich-Neuherberg, Germany (E Llanaj PhD); Department of Physical Medicine and Nursing (R López-Bueno PhD), University of Zaragoza, Zaragoza, Spain; Department of Musculoskeletal Disorders (R López-Bueno PhD), National Research Centre for the Working Environment, Copenhagen, Denmark; Department of Epidemiology and Evidence-Based Medicine (P D Lopukhov PhD), Department of Information and Internet Technologies (S K Vladimirov PhD), I M Sechenov First Moscow State Medical University, Moscow, Russia; Department of Health Economics (L Lorenzovici MSc), Syreon Research Romania, Targu Mures, Romania; Department of Doctoral Studies (L Lorenzovici MSc), George Emil Palade University of Medicine, Pharmacy, Science, and Technology of Targu Mures, Targu Mures, Romania; School of Medicine (Prof G Lucchetti PhD), Federal University of Juiz de Fora, Juiz de Fora, Brazil; Department of General Surgery (Prof R Lunevicius DSc), Liverpool University Hospitals NHS Foundation Trust, Liverpool, UK; Department of Epidemiology (H Lv BA), Chinese Center for Disease Control and Prevention, Shenyang, China; Centre for Public Health and Wellbeing (Z Ma PhD), University of the West of England, Bristol, UK; Periodontal Department, Faculty of Medicine and Dentistry (Prof M Machoy PhD), Department of Propedeutics of Internal Diseases & Arterial Hypertension (Prof T Miazgowski MD), Pomeranian Medical University, Szczecin, Poland; Ophthalmology Department (M Magdy Abd El Razek MSc), Ministry of Health and Population, Aswan, Egypt; Cellular and Molecular Biology Research Center (Prof S Mahjoub PhD), Department of Clinical Biochemistry (Prof S Mahjoub PhD, A Mosapour PhD), Babol University of Medical Sciences, Babol, Iran; Department of Clinical and Hospital Pharmacy (M A Mahmoud PhD), Taibah University, Al-Madinah Al-Munawarrah, Saudi Arabia; Department of Internal Medicine (K Malhotra MBBS), Dayanand Medical College and Hospital, Ludhiana, India; Department of Electrical Engineering (I Malik PhD), Prince Sattam bin Abdulaziz University, Al Kharj, Saudi Arabia; Institute for Social Science Research (A A Mamun PhD), The University of Queensland, Indooroopilly, QLD, Australia; Smidt Heart Institute (Y Manla MD), Cedars-Sinai Medical Center, Los Angeles, CA, USA; STIC (Prof A Mansour PhD), ENSTA Bretagne, Brest, France; Security, Intelligence and Integrity of Information Team (SI3) (Prof A Mansour PhD), Laboratoire des Sciences et Techniques de l'Information de la Communication et de la Connaissance (LABSTICC), Brest, France; Department of Food, Environmental and Nutritional Sciences (M Marino PhD), University of Milan, Milan, Italy; Department

of Biochemistry (A Marjani PhD), Golestan University of Medical Sciences, Gorgan, Iran; Department of Economics (Prof G Martinez PhD), Autonomous Technology Institute of Mexico, Mexico City, Mexico; Noncommunicable Diseases and Mental Health Department (R Martinez-Piedra BSc), Pan American Health Organization, Washington, DC, USA; Campus Fortaleza (F R Martins-Melo PhD), Federal Institute of Education, Science and Technology of Ceará, Fortaleza, Brazil; Department of Nutrition and Dietetics (M Martorell PhD), Centre for Healthy Living (M Martorell PhD), University of Concepción, Concepción, Chile; Department of Pharmacy (S Maryam PharmD), Bahauddin Zakariya University, Multan, Pakistan; Faculty of Humanities and Health Sciences (Prof R R Marzo MD), Curtin University, Sarawak, Malaysia; Jeffrey Cheah School of Medicine and Health Sciences (Prof R R Marzo MD), Monash University, Subang Jaya, Malaysia; Department of Pharmacology (A Masoudi PhD), Shahroud University of Medical Sciences, Shahroud, Iran; Department of Medicine (J Mattumpuram MD), University of Louisville, Louisville, KY, USA; Department of Epidemiology (Prof R J Maude PhD), Mahidol Oxford Tropical Medicine Research Unit, Bangkok, Thailand; Department of Social Medicine and Family (M Mazaheri PhD), Dezful University of Medical Sciences, Dezful, Iran; National Centre for Register-based Research (Prof J J McGrath MD), Aarhus University, Aarhus, Denmark; Australian Centre for Health Services Innovation (Prof S M McPhail PhD), Queensland University of Technology, Kelvin Grove, QLD, Australia; Digital Health and Informatics Directorate (Prof S M McPhail PhD), Queensland Health, Brisbane, QLD, Australia; Department of Food Science and Technology (R Mehra PhD), Maharishi Markandeshwar (Deemed to be University), Ambala, India; Department of Public Health (T Mekene Meto MPH), Arba Minch University, Arbaminch, Ethiopia; Department of Medical Oncology and Hematology (M A M Mendez-Lopez PhD), Kantonsspital St Gallen, St Gallen, Switzerland; Peru Country Office (W Mendoza MD), United Nations Population Fund (UNFPA), Lima, Peru; Department of Medicine (G A Mensah MD), School of Public Health and Family Medicine (C A Nnaji MPH), University of Cape Town, Cape Town, South Africa; International Dx Department (A A Mentis MD), BGI Genomics, Copenhagen, Denmark; Neurology Unit (A Meretoja MD), Breast Surgery Unit (T J Meretoja MD), Helsinki University Hospital, Helsinki, Finland; Department of Virology (F Zakham PhD), University of Helsinki, Helsinki, Finland (T J Meretoja MD); University Centre Varazdin (T Mestrovic PhD), University North, Varazdin, Croatia; Department of Pharmacology (Prof K D Mettananda PhD), Department of Paediatrics (Prof S Mettananda DPhil), University of Kelaniya, Ragama, Sri Lanka; Clinical Medicine Department (Prof K D Mettananda PhD), North Colombo Teadhing Hospital, Ragama, Sri Lanka; University Paediatrics Unit (Prof S Mettananda DPhil), Colombo North Teaching Hospital, Ragama, Sri Lanka; Stritch School of Medicine (A Mhlanga PhD), Loyola University Chicago, Chicago, IL, USA; Department of Preventive Medicine (L Mhlanga PhD), Center for Global Health (J Musa MD), Northwestern University, Chicago, IL, USA; Anaesthesiology Department (G Micha PhD), "Helena Venizelou" General and Maternity Hospital, Athens, Greece; Department of Epidemiology (I Michalek PhD), National Cancer Registry (I Michalek PhD), Maria Sklodowska-Curie National Research Institute of Oncology, Warsaw, Poland; Pacific Institute for Research and Evaluation, Calverton, MD, USA (T R Miller PhD); 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; Office of the Minster (M K Mirutse MPH), Federal Ministry of Health, Addis Ababa, Ethiopia; Department of Hospital Administration (M Mirza MD), Department of Dentistry (S S Rana MDS), Department of Community Medicine and Family Medicine (S S Sahoo MD, M Verma MD), Department of Anatomy (A Singal PhD), All India Institute of Medical Sciences, Bathinda, India; Department of Forensic Medicine and Toxicology (C Mittal MD), Dr B C Roy Multi-Specialty Medical Research Centre, Kharagpur, India; Institute of Addiction Research (ISFF) (B Moazen MSc), Frankfurt University of Applied Sciences, Frankfurt, Germany; Thompson Institute (A Z Mohamed PhD), University of the Sunshine Coast, Birtinya, QLD, Australia; College of Health Science (A I Mohamed MSc), College of Applied and Natural Science (J Mohamed MSc), University of Hargeisa, Hargeisa, Somalia; Molecular Biology Unit (N S Mohamed MSc), Bio-Statistical and Molecular Biology Department (N S Mohamed MSc), Sirius Training and Research Centre, Khartoum, Sudan; Department of Pharmaceutical Sciences (S Mohammed PhD), Notre Dame of Maryland University, Baltimore, MD, USA; Department of Pharmacy (S Mohammed PhD), Mizan-Tepi University, Mizan, Ethiopia; Institute of Clinical Physiology (S Molinaro PhD), National Research Council, Pisa, Italy; Clinical Epidemiology and Public Health Research Unit (L Monasta DSc, L Ronfani PhD, E Traini MSc, G Zamagni MSc), Burlo Garofolo Institute for Maternal and Child Health, Trieste, Italy; Department of Epidemiology and Biostatistics (Y Moradi PhD), Kurdistan University of Medical Sciences, Sanandaj, Iran; Computer, Electrical, and Mathematical Sciences and Engineering Division (P Moraga PhD), King Abdullah University of Science and Technology, Thuwal, Saudi Arabia; Department of Public Health (Prof R S Moreira PhD), Oswaldo Cruz Foundation, Recife, Brazil; Department of Public Health (Prof R S Moreira PhD), Federal University of Pernambuco, Recife, Brazil; Department of Biology and Biological Engineering (J Morze PhD), Chalmers University of Technology, Gothenburg, Sweden; College of Medical Sciences (J Morze PhD), SGMK Copernicus University, Warsaw, Poland; Department of Clinical Biochemistry (A Mosapour PhD), Tarbiat Modares University, Tehran, Iran; Department of Fruit and Vegetable Product Technology (Prof A Mousavi Khaneghah PhD), Prof Wacław Dąbrowski Institute of Agricultural and Food Biotechnology State Research Institute, Warsaw, Poland; Department of Surgery (F Mulita PhD, G Verras MD), General University Hospital of Patras, Patras, Greece; Faculty of Medicine (F Mulita PhD), Department of Emergency Medicine (I Pantazopoulos PhD), University of Thessaly, Larissa, Greece; Clinical Epidemiology Research Unit (E Murillo-Zamora PhD), Mexican Institute of Social Security, Villa de Alvarez, Mexico; Postgraduate in Medical Sciences (E Murillo-Zamora PhD), Universidad de Colima, Colima, Mexico; Surgery Department (A Musina MD), Department of Medical Oncology (S R Volovat PhD), University of Medicine and Pharmacy Grigore T Popa, Iaşi, Romania; Second Surgical Unit (A Musina MD), Department of Medical Oncology (S R Volovat PhD), Regional Institute of Oncology, Iaşi, Romania; Department of Research Methodology (S Muthu MS), Orthopaedic Research Group, Coimbatore, India; Saveetha Dental College (S Muthupandian PhD), Saveetha Institute of Medical and Technical Sciences (SIMATS), Chennai, India; Department of Neuropsychiatry (W Myung PhD), Seoul National University, Seongnam-si, South Korea; 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; Institute of Epidemiology and Medical Biometry (Prof G Nagel PhD), Ulm University, Ulm, Germany; Comprehensive Cancer Center (G Naik MPH), Department of Health Policy and Organization (M Rahim MA), Department of Health Services Administration (M Rahim MA), Department of Psychology (D C Schwebel PhD), School of Medicine (Prof J A Singh MD), University of Alabama at Birmingham, Birmingham, AL, USA; Laboratory of Public Health Indicators Analysis and Health Digitalization (M Naimzada MD, S S Otstavnov PhD), Department of Information Technologies and Management (S K Vladimirov PhD), Moscow Institute of Physics and Technology, Dolgoprudny, Russia; Experimental Surgery and Oncology Laboratory (M Naimzada MD), Kursk State Medical University, Kursk, Russia; Faculty of Pharmacy (F Nainu PhD), Hasanuddin University, Makassar, Indonesia; Suraj Eye Institute, Nagpur, India (V Nangia MD); Mysore Medical College and Research Institute (Prof S Narasimha Swamy MD), Government Medical College, Mysore, India; National Dental Research Institute Singapore (G G Nascimento PhD), Duke-NUS Medical School, Singapore; Department of Applied Pharmaceutical Sciences and Clinical Pharmacy (A Y Naser PhD), Isra University, Amman, Jordan; Department of Biotechnology (M Naveed PhD), University of Central Punjab, Lahore, Pakistan; Department of Disease Control and Environmental Health

(R Ndejjo MSc), Makerere University, Kampala, Uganda; School of Pharmacy (S O Nduaguba PhD), West Virginia University, Morgantown, WV, USA; Department of General Surgery (I Negoi PhD), Fourth Department of General Surgery (D Serban PhD), Emergency University Hospital Bucharest, Bucharest, Romania; Department of Cardiology (R I Negoi PhD), Cardio-Aid, Bucharest, Romania; Faculty of Medicine (Prof C Nejjari PhD), Euromed University of Fes, Fez, Morocco; Faculty of Medicine (Prof C Nejjari PhD), University Sidi Mohammed Ben Abdellah, Fez, Morocco; 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 Medical Engineering (D H Nguyen BS), University of South Florida, Tampa, FL, USA; Institute for Cancer Control (P T Nguyen MPH), National Cancer Center, Tokyo, Japan; Graduate School of Public Health (P T Nguyen MPH), St Luke's International University, Chuo-ku, Japan; International Islamic University Islamabad, Islamabad, Pakistan (R K Niazi PhD); Institute for Mental Health and Policy (Y T Nigatu PhD), Centre for Addiction and Mental Health, Toronto, ON, Canada; Department of General Surgery (T K Nikolouzakis PhD), University Hospital of Heraklion, Heraklion, Greece; Laboratory of Toxicology (T K Nikolouzakis PhD), Department of Medicine (Prof A Tsatsakis DSc), University of Crete, Heraklion, Greece; South African Medical Research Council, Cape Town, South Africa (C A Nnaji MPH); Center for Public Health (L A Nnyanzi PhD), Teesside University, Middlesbrough, UK; Faculty of Applied Sciences and Technology (E A Noman PhD), Universiti Tun Hussein Onn Malaysia, Johor, Malaysia; Department of Health Policy and Management (S Nomura PhD), Keio University, Tokyo, Japan; Department of Microbiology and Molecular Genetics (M Noreen PhD), The Women University Multan, Multan, Pakistan; Department of Paediatrics (C A Nri-Ezedi MD), Nnamdi Azikiwe University, Awka, Nigeria; Department of Public Health (M H Nunemo MPH), Wachemo University, Addis Ababa, Ethiopia; Department of Public Health (D Nurrika PhD), Banten School of Health Science, South Tangerang, Indonesia; Ministry of Research, Technology and Higher Education, Higher Education Service Institutions (LL-DIKTI) Region IV, Bandung, Indonesia (D Nurrika PhD); Department of Applied Economics and Quantitative Analysis (Prof B Oancea PhD), Department of Statistics and Cybernetics (Prof M Paun PhD), University of Bucharest, Bucharest, Romania; School of Public Health (N M Odogwu PhD), Department of Epidemiology and Community Health (R R Parikh MD), Department of Surgery (J Rickard MD), University of Minnesota, Minneapolis, MN, USA; Department of Medicine (M J O'Donnell PhD), National University of Ireland, Galway, Ireland; 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; Department of Preventive Medicine (I Oh PhD), Department of Pediatrics (Prof D Yon MD), Kyung Hee University, Seoul, South Korea; Sydney, NSW, Australia (S R Okeke PhD); School of Pharmacy (O C Okonji MSc), University of the Western Cape, Cape Town, South Africa; Department of Medical Physiology (P G Okwute MSc), Department of Psychiatry (A T Olagunju MD), University of Lagos, Lagos, Nigeria; Health Information Research Unit (O O Olasupo PhD), McMaster University, Hamilton, Ontario, Canada; Department of Nursing Science (M I Olatubi PhD), Bowen University, Iwo, Nigeria; Cardiology Department (G M M Oliveira PhD), Federal University of Rio de Janeiro, Rio de Janeiro, Brazil; Centre for Healthy Start Initiative, Lagos, Nigeria (B O Olusanya PhD, J O Olusanya MBA); Department of Anatomy (G O Oluwatunase MSc), Olabisi Onabanjo University, Sagamu, Nigeria; Surgery Department (G L Omer MD), Sulaimani University, Sulaimani, Iraq; ENT Department (G L Omer MD), Tor Vergata University of Rome, Rome, Italy; Department of Pharmacotherapy and Pharmaceutical Care (M Ordak PhD), Department of Biochemistry and Pharmacogenomics (M Zielińska MPharm), Medical University of Warsaw, Warsaw, Poland; University of Port Harcourt, Port Harcourt, Nigeria (Prof O E Orisakwe PhD); Sickle Cell Unit (V N Orish PhD), Ho Teaching Hospital, Ho Municipality, Ghana; Department of Medicine (Prof A Ortiz MD), Universidad Autónoma de Madrid (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; One Health Global Research Group (Prof E Ortiz-Prado PhD), Universidad de las Americas, Quito, Ecuador; School of Medicine (U L Osuagwu PhD), Translation Health Research Institute (K Rana PhD), Western Sydney University, Campbelltown, NSW, Australia; Department of Optometry and Vision Science (U L Osuagwu PhD), University of KwaZulu-Natal, KwaZulu-Natal, South Africa; Department of Biological Sciences (O Osuolale PhD), Elizade University, Ilara-Mokin, Nigeria; Department of Project Management (S S Otstavnov PhD), Department of Health Care Administration and Economics (Prof V Vlassov MD), National Research University Higher School of Economics, Moscow, Russia; Division of Infectious Diseases (Prof A Ouyahia PhD), University Hospital of Setif, Setif, Algeria; Department of General Surgery (G Ouyang MD), Central South University, ChangSha, China; Department of Respiratory Medicine (Prof M P P A DNB), Department of Oral and Maxillofacial Surgery (M S MDS, C S N PhD), Jagadguru Sri Shivarathreeswara University, Mysore, India; Menzies Institute for Medical Research (F Pan PhD), University of Tasmania, Hobart, TAS, Australia; Department of Public Health (A Pana PhD), Babes Bolyai University, Cluj Napoca, Romania; Department of Health Metrics (A Pana PhD), Center for Health Outcomes and Evaluation, Bucharest, Romania; School of Public Health (P Panda MPH), Asian Institute of Public Health University, Bhubaneswar, India; Privatpraxis, Heidelberg, Germany (S Panda-Jonas MD); Department of Ophthalmology (G D Panos PhD), Nottingham University Hospitals—Queen's Medical Center Campus, Nottingham, UK; Division of Ophthalmology and Visual Sciences (G D Panos PhD), People in Psychiatry and Applied Psychology (F Shokraneh PhD), University of Nottingham, Nottingham, UK; Department of Neurology (L D Panos MD), Department of Emergency Medicine (I Pantazopoulos PhD), University of Bern, Bern, Switzerland; Yonsei University College of Medicine, Seodaemun-gu, South Korea (S Park MD); Center for Pharmacoepidemiology and Treatment Science (A Parthasarathi MD), Rutgers University, New Brunswick, NJ, USA; Research Center (A Parthasarathi MD), Allergy Asthma and Chest Center, Mysore, India; Department of Medical Sciences (R Passera PhD), University of Torino, Torino, Italy; Department of Imaging (R Passera PhD), AOU Città della Salute e della Scienza di Torino, Torino, Italy; Department of Physiotherapy (H M Patel PhD), Charotar University of Science and Technology, Anand, India; Global Health Governance Programme (J Patel BSc), Centre for Medical Informatics (Prof A Sheikh MD), College of Medicine and Veterinary Medicine (G Verras MD), University of Edinburgh, Edinburgh, UK; School of Dentistry (J Patel BSc), University of Leeds, Leeds, UK; College of Dental Medicine (Prof S Patil PhD), Roseman University of Health Sciences, South Jordan, UT, USA; Centre of Molecular Medicine and Diagnostics (COMManD) (Prof S Patil PhD), Saveetha University, Chennai, India; Second Department of Internal Medicine (D Patoulias PhD), European Interbalkan Medical Center, Thessaloniki, Greece; Department of Internal Medicine (V Patthipati MD), Advent Health, Palm Coast, FL, USA; Department of Hospital Medicine (V Patthipati MD), Sound Physicians, Palm Coast, FL, USA; Faculty of Humanities and Social Sciences (U Paudel PhD), Department of Community Medicine (P M S Pradhan MD), Tribhuvan University, Kathmandu, Nepal; Department of Bioinformatics and Biostatistics (Prof M Paun PhD), National Institute of Research and Development for Biological Sciences, Bucharest, Romania; Clinical Research Department (P Pedersini MSc, J H Villafañe PhD), IRCCS Fondazione Don Carlo Gnocchi, Milan, Italy; Outpatient Department (M Peng MPH), Taihe Hospital, Shiyan, China; The First Clinical College (M Peng MPH), School of Public Health and Management (Y Yu MS), Hubei University of Medicine, Shiyan, China; Department of Neurology (U Pensato MD), IRCCS Humanitas Research Hospital, Milan, Italy; Center for Research and Innovation (V F Pepito MSc), Ateneo De Manila University, Pasig City, Philippines; Centre for Primary Health Care and Equity (P Peprah MSc), University of New South Wales, Kensington, NSW, Australia; Curtin School of Population Health (Prof G Pereira PhD), Curtin University, Bentley, WA, Australia; Centre

for Fertility and Health (Prof G Pereira PhD), Norwegian Institute of Public Health, Oslo, Norway; International Institute for Educational Planning (IIEP) (Prof M F P Peres MD), Albert Einstein Hospital, São Paulo, Brazil; Department of Development Studies (Prof A Perianayagam PhD), International Institute for Population Sciences, Mumbai, India; Mario Negri Institute for Pharmacological Research, Bergamo, Italy (N Perico MD, Prof G Remuzzi MD); Pennsylvania Cancer and Regenerative Medicine Center (R G Pestell MD), Baruch S Blumberg Institute, Doylestown, PA, USA; Department of Medicine (R G Pestell MD), Xavier University School of Medicine, Woodbury, NY, USA; Facultad de Medicina (F E Petermann-Rocha PhD), Universidad Diego Portales (Diego Portales University), Santiago, Chile; School of Cardiovascular and Metabolic Health (F E Petermann-Rocha PhD), University of Glasgow, Glasgow, UK; National Centre for Disease Prevention and Health Promotion (D Pierannunzio PhD), National Institute of Health, Rome, Italy; Department of Pediatric Orthopedic Surgery (M Pigeolet MD), Hôpital Necker–Enfants Malades, Paris, France; Research School of Chemistry and Applied Biomedical Sciences (E Plotnikov PhD), Tomsk Polytechnic University, Tomsk, Russia; Mental Health Research Institute (E Plotnikov PhD), Tomsk National Research Medical Center of the Russian Academy of Sciences, Tomsk, Russia; Clinical Academic Department of Pediatrics (Prof D Poddighe PhD), University Medical Center (UMC), Astana, Kazakhstan; Data Driven Health Division (P Pollner PhD), Hungarian Healthcare Management Association, Budapest, Hungary; Department of Data Management and Analysis (R Poluru PhD), The INCLEN Trust International, New Delhi, India; Non-communicable Diseases Research Center (N Pourtaheri PhD), Bam University of Medical Sciences, Bam, Iran; University of Mississippi, Oxford, MS, USA (D Prabhu PhD); Centro de Investigaciones Clinicas (Clinical Research Center) (S I Prada PhD), Fundación Valle del Lili (Valle del Lili Foundation), Cali, Colombia; Centro de Estudios en Protección Social y Economía de la Salud (PROESA) (Research Center for Social and Health Economics) (S I Prada PhD), Universidad Icesi (ICESI University), Cali, Colombia; Department of Clinical Research and Epidemiology (M Prasad MD), Institute of Liver and Biliary Sciences, New Delhi, India; Department of Biochemistry (Prof A Prashant PhD), Jagadguru Sri Shivarathreeswara University, Mysuru, India; Centre for Dental Education and Research (B M Purohit MDS), Department of Radiation Oncology (A Shankar MD), All India Institute of Medical Sciences, New Delhi, India; Department of Computer Science (N H Qasim PhD), Department of Health Sciences (Prof F Rahim PhD), Cihan University Sulaimaniya, Sulaymaniyah, Iraq; Department of Community Medicine (D R MD), Government Medical College, Bengaluru, India; Cardiovascular Research Center (M Rabiee Rad MD), Isfahan Cariovascular Research Institute, Isfahan, Iran; College of Medicine (A Radfar MD), University of Central Florida, Orlando, FL, USA; Department of Medical Oncology (Prof V Radhakrishnan MD), Cancer Institute (WIA), Chennai, India; Department of Epidemiology and Biostatistics (H Raeisi Shahraki PhD), Shiraz University of Medical Sciences, Shahrekord, Iran; Department of Radiology (S Rafiei Alavi MD), University of California Irvine, Irvine, CA, USA; Cihan University Sulaimaniya Research Center (CUSRC), Sulaymaniyah, Iraq (Prof F Rahim PhD); Institute of Health and Wellbeing (M Rahman PhD), Federation University Australia, Berwick, VIC, Australia; Department of Public Health (V Rahmanian PhD), Torbat Jam Faculty of Medical Sciences, Torbat Jam, Iran; Department of Physical Education and Sport Sciences (Prof M Rahmati PhD), Hepatitis Research Center (M Zandi PhD), Lorestan University of Medical Sciences, Khorramabad, Iran; Hospital of Women and Children, IRCCS Azienda Ospedaliero (D Raimondo PhD), Occupational Health Unit (Prof F S Violante MD), Sant'Orsola Malpighi Hospital, Bologna, Italy; Faculty of Medicine (A Rajabpour-Sanati MD), Birjand University of Medical Sciences, Birjand, Iran; Centre for Chronic Disease Control, New Delhi, India (P Rajput PhD); Department of Radiology (S Ramasamy MD), Stanford University, Stanford, CA, USA; Department of Epidemiology, Biostatistics and Occupational Health (J Rana MPH), McGill University, Montreal, QC, Canada; Research and Innovation Division (J Rana MPH), South Asian Institute for Social Transformation (SAIST), Dhaka, Bangladesh; 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; Centre for Clinical Pharmacology (N Rancic PhD), University of Defence in Belgrade, Belgrade, Serbia; Centre for Clinical Pharmacology (N Rancic PhD), Medical College of Georgia at Augusta University, Belgrade, Serbia; Department of Health Economics and Outcomes Research (A Rane MS), Agios Pharmaceuticals, Cambridge, MA, USA; Department of Pharmaceutical Economics and Policy (A Rane MS), Massachusetts College of Pharmacy and Health Sciences, Boston, MA, USA; School of Humanities and Social Sciences (S Ranjan MA, R Thakur PhD), Indian Institute of Technology Mandi, Mandi, India; College of Pharmaceutical Sciences (D Rapaka PhD), Andhra University, Visakhapatnam, India; University of Social Welfare and Rehabilitation Sciences, Tehran, Iran (V Rashedi PhD); Department of Geography (A Rasul PhD), Soran University, Soran, Iraq; Department of Biomedical Engineering (Z Ratan MSc), Khulna University of Engineering and Technology, Khulna, Bangladesh; Section of Pulmonary and Critical Care Medicine (N Ravikumar MD), University of Chicago, Chicago, IL, USA; Inovus Medical, St Helens, UK (D L Rawaf MRCS); Academic Public Health England (Prof S Rawaf MD), Public Health England, London, UK; Department of Internal Medicine (B Rawlley MD), State University of New York, Syracuse, NY, USA; Department Biological Sciences (Prof E M M Redwan PhD), King Abdulaziz University, Jeddah, Egypt; Department of Protein Research (Prof E M M Redwan PhD), Research and Academic Institution, Alexandria, Egypt; Department of Epidemiology and Biostatistics (Prof M Rezaeian PhD), Rafsanjan University of Medical Sciences, Rafsanjan, Iran; Department of Public Health (A Riad DDS), Czech National Centre for Evidence-based Healthcare and Knowledge Translation (A Riad DDS), Masaryk University, Brno, Czech Republic; Department of Surgery (J Rickard MD), University Teaching Hospital of Kigali, Kigali, Rwanda; Institute of Diagnostic and Interventional Radiology and Neuroradiology (R Rikhtegar MD), Essen University Hospital, Essen, Germany; One Health Toxicology Research Unit (1H-TOXRUN) (Prof C F Rodrigues PhD), Instituto Universitário de Ciências da Saúde (CESPU), Porto, Portugal; Department of Pharmacology and Toxicology (Prof J A B Rodriguez PhD), Universidad de Antioquia (University of Antioquia), Medellin, Colombia; Faculty of Nursing (D S Romadlon PhD), Chulalongkorn University, Bangkok, Thailand; Department of Analytical and Applied Economics (Prof H S Rout PhD, C K Swain MPhil), Utkal University, Bhubaneswar, India; Faculty of Medicine (B Roy PhD), Quest International University Perak, Ipoh, Malaysia; Department of Labour (P Roy PhD), Directorate of Factories, Government of West Bengal, Kolkata, India; Centro de Investigación Palmira (Palmira Research Center) (E Rubagotti PhD), Corporación Colombiana de Investigación Agropecuaria AGROSAVIA (Colombian Agricultural Research Corporation), Bogota, Colombia; Advanced Campus Governador Valadares (Prof G d Ruela MSc), Juiz de For a Federal University, Governador Valadares, Brazil; Nursing Department (Prof G d Ruela MSc), Universidade Presidente Antônio Carlos (President Antônio Carlos University), Governador Valadares, Brazil; Department of Health Statistics (S F Rumisha PhD), National Institute for Medical Research, Dar es Salaam, Tanzania; Faculty of Medicine (Z Saadatian PhD), Infectious Diseases Research Center (Z Saadatian PhD), Gonabad University of Medical Sciences, Gonabad, Iran; Department of Medical Pharmacology (M M Saber-Ayad MD), Public Health and Community Medicine Department (M R Salem MD), Cairo University, Giza, Egypt; Faculty of Computing and Informatics (M SaberiKamarposhti PhD), Multimedia University, Cyberjaya, Malaysia; Department of Anesthesiology and Reanimation (F Sada PhD), University of Pristina, Pristina, Kosovo; Department of Anesthesiology and Intensive Care (F Sada PhD), University Clinical Center of Kosovo, Pristina, Kosovo; Department of Pharmaceutical Chemistry (Prof M R Saeb PhD), Medical University of Gdańsk, Gdańsk, Poland; Multidisciplinary Laboratory Foundation University School of Health Sciences (FUSH) (Prof U Saeed PhD), Foundation University, Islamabad, Pakistan; International Center of Medical Sciences Research (ICMSR), Islamabad, Pakistan (Prof U Saeed PhD); Faculty of Medicine, Bioscience and Nursing (S Z Safi PhD), MAHSA University, Selangor, Malaysia; Interdisciplinary Research Centre in Biomedical Materials (IRCBM) (S Z Safi PhD), COMSATS Institute of Information

Technology, Lahore, Pakistan; Department of Humanities and Social Sciences (M Saha MSc), Deakin University, Melbourne, VIC, Australia; Department of Preventive and Social Medicine (M Sahu MD), All India Institute of Hygiene and Public Health, Kolkata, India; Ludwig Maximilian University of Munich, Munich, Germany (J W Sakshaug PhD); Institute for Employment Research, Nuremberg, Germany (J W Sakshaug PhD); Technology Management Department (Prof M Z Y Salem PhD), University College of Applied Sciences, Gaza, Palestine; School of Economics and Management (Prof M Z Y Salem PhD), University of Kassel, Kassel, Germany; Department of Neurology (S Samadzadeh MD), University of Southern Denmark, Odense, Denmark; Department of Anatomy (Prof V P Samuel PhD), Ras Al Khaimah Medical and Health Sciences University, Ras Al Khaimah, United Arab Emirates; Department of Surgery (Prof J Sanabria MD), Marshall University, Huntington, WV, USA; Institute of Neuroanatomy (N Sanadgol PhD), Uniklinik Rhine-Westphalia Technical University of Aachen, Aachen, Germany; Thiruvananthapuram, India (S Y Saraswathy PhD); Indira Gandhi Medical College and Research Institute, Puducherry, India (A Saravanan MD); Department of Orthpaedics and Trauma Surgery (B Saravi PhD), University of Freiburg, Freiburg, Germany; Department of Orthopaedics (B Saravi PhD), Loretto Hospital Freiburg, Freiburg, Germany; Department of Food Processing Technology (T Sarkar PhD), West Bengal State Council of Technical Education, Malda, India; Department of Health and Society (Prof R Sarmiento-Suárez MPH), University of Applied and Environmental Sciences, Bogota, Colombia; National School of Public Health (Prof R Sarmiento-Suárez MPH), Carlos III Health Institute, Madrid, Spain; Faculty of Health & Social Sciences (B Sathian PhD), Bournemouth University, Bournemouth, UK; National Centre for Epidemiology and Population Health (M Sayeed MS, A Talukder MSc), Australian National University, Acton, ACT, Australia; Department of Neurology (Prof N Scarmeas PhD), National and Kapodistrian University of Athens, Athens, Greece; Department of Neurology (Prof N Scarmeas PhD), Columbia University, New York, NY, USA; Cardiovascular Research Center (A Schuermans BSc), Massachusetts General Hospital, Cambridge, MA, USA; Department of Cardiovascular Sciences (A Schuermans BSc, J Van den Eynde BSc), Katholieke Universiteit Leuven, Leuven, Belgium; Clinic for Conservative Dentistry and Periodontology (Prof F Schwendicke PhD), University Hospital of the Ludwig-Maximilians-University Munich, Munich, Germany; Faculty of Dentistry (S Selvaraj PhD), AIMST University, Bedong, Malaysia; Department of Biomedical Sciences (P Sengupta PhD), Gulf Medical University, Ajman, United Arab Emirates; Emergency Department (S Senthilkumaran MD), Manian Medical Centre, Erode, India; Department of Medicine and Surgery (Y Sethi MBBS), Government Doon Medical College, Dehradun, India; National Heart, Lung, and Blood Institute (A Seylani BS), National Institutes of Health, Rockville, MD, USA; Medical Research Center (J Shah BS), Kateb University, Kabul, Afghanistan; Department of Infectious Diseases and Microbiology (P A Shah MBBS), Rajiv Gandhi University of Health Sciences, Bangalore, India; HepatoPancreatoBiliary Surgery and Liver Transplant Department (P A Shah MBBS), Healthcare Global Limited Cancer Care Hospital, Bangalore, India; Karachi, Pakistan (M A Shaikh MD); School of Medicine (M Shams-Beyranvand MSc), Alborz University of Medical Sciences, Karaj, Iran; Department of Clinical Review and Safety (S Sharfaei MD), Baim Institute for Clinical Research, Boston, MA, USA; Facultad de Medicina (Faculty of Medicine) (J Sharifi-Rad PhD), Universidad del Azuay (University of Azuay), Cuenca, Ecuador; Department of Microbiology (R P Shastry PhD), Yenepoya University, Mangalore, India; Department of Engineering (A Shavandi PhD), Free University of Brussels (ULB), Brussels, Belgium; Bioengineering Department (A Shayan BS), Clemson University, Clemson, SC, USA; Department of Ophthalmology (M Shayan MD), Harvard Medical School, Boston, MA, USA; Department of Plant and Microbiology (A M E Shehabeldine PhD), A C S Medical College and Hospital, Cairo, Egypt; Department of Dermatology, Venereology and Leprosy (Prof M M Shenoy MD), Yenepoya Medical College, Mangalore, India; Friedman School of Nutrition Science and Policy (P Shi PhD), Tufts University, Boston, MA, USA; Department of Public Health (D Shiferaw MPH), Dambi Dollo University, Dembi Dollo, Ethiopia; National Institute of Infectious Diseases, Tokyo, Japan (M Shigematsu PhD); Finnish Institute of Occupational Health, Helsinki, Finland (R Shiri PhD); Department of Clinical Immunology and Hematology (V Shivarov PhD), Sofiamed University Hospital, Sofia, Bulgaria; Department of Genetics (V Shivarov PhD), Sofia University "St Kliment Ohridiski", Sofia, Bulgaria; Department of Public Health and Primary Care (F Shokraneh PhD, Prof P Willeit PhD), University of Cambridge, Cambridge, UK; National Institute of Psychology (K Shuja MS), Quaid-i-Azam University, Islamabad, Pakistan; The Cooper Institute, Dallas, TX, USA (K Shuval PhD); Department of Medical Microbiology and Infectious Diseases (E E Siddig MD), Erasmus University, Rotterdam, Netherlands; Center of Potential and Innovation of Natural Resources (Prof L M R Silva PhD), Polytechnic Institute of Guarda, Guarda, Portugal; Health Sciences Research Centre (Prof L M R Silva PhD), University of Beira Interior, Covilhã, Portugal; WSB University in Gdańsk, Gdańsk, Poland (Prof B Simonetti PhD); Department of Dentistry (A Singh MD), All India Institute of Medical Sciences, Bhopal, India; School of Public Health and Zoonoses (B B Singh PhD), Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, India; Medicine Service Department (Prof J A Singh MD), US Department of Veterans Affairs (VA), Birmingham, AL, USA; Department of Surgery (B Socea PhD), "Sf. Pantelimon" Emergency Clinical Hospital Bucharest, Bucharest, Romania; Department of Systemic Pathology (R Solanki MD), Touro College of Osteopathic Medicine, Middletown, NY, USA; Department of Pathology (R Solanki MD), American University of the Caribbean School of Medicine, Cupecoy, Saint Martin; Department of Biochemistry (S Solanki MD), American University of Integrative Sciences, Barbados, Barbados; Department of Nursing (Y Solomon MSc), Dire Dawa University, Dire Dawa, Ethiopia; 3rd Department of Cardiology (M Spartalis PhD), University of Athens, Athens, Greece; Division of Community Medicine (C T Sreeramareddy MD), International Medical University, Kuala Lumpur, Malaysia; Amity Institute of Biotechnology (V K Srivastava PhD, E Upadhyay PhD), Amity University Rajasthan, Jaipur, India; Department of Biosciences (V K Srivastava PhD), Indian Institute of Science Education and Research, Bhopal, India; Department of Public Health (M Stanikzai MPH), Kandahar University, Kandahar, Afghanistan; Central Research Institute of Cytology and Genetics (E Varavikova PhD), Federal Research Institute for Health Organization and Informatics of the Ministry of Health (FRIHOI), Moscow, Russia (Prof V I Starodubov DSc); Nutrition and Dietetics Department (A V Starodubova DSc), Federal Research Institute of Nutrition, Biotechnology and Food Safety, Moscow, Russia; Department of Internal Disease (A V Starodubova DSc), Pirogov Russian National Research Medical University, Moscow, Russia; Department of Medicine (P Steiropoulos MD), Democritus University of Thrace, Alexandroupolis, Greece; Department of Psychology (M A Stokes PhD), Deakin University, Burwood, VIC, Australia; School of Medicine (V Subramaniyan PhD), Monash University, Sunway, Malaysia; Center for Biotechnology and Microbiology (M Suleman PhD), University of Swat, Mingora, Pakistan; School of Life Sciences (M Suleman PhD), Xiamen University, Xiamen, China; National Institute of Epidemiology (R Suliankatchi Abdulkader MD), Indian Council of Medical Research, Chennai, India; Nature Study of Bangladesh (A Sultana MD), Khulna, Bangladesh; Division of Global Mental Health (A Sultana MD), EviSyn Health, Khulna, Bangladesh; Rural Health Research Institute (Prof J Sun PhD), Charles Sturt University, Bathurst, NSW, Australia; Institute of Integrated Intelligence and Systems (Prof J Sun PhD), Griffith University, Brisbane, QLD, Australia; Jeb E Brooks School of Public Policy and the Department of Sociology (Prof B L Sykes PhD), Cornell University, Ithaca, NY, USA; Department of Clinical Outcomes (Prof L Szarpak PhD), Maria Sklodowska-Curie Medical Academy, Warsaw, Poland; Department of Clinical Research and Development (Prof L Szarpak PhD), LUXMED Group, Warsaw, Poland; Department of Dermatology (M D Szeto BS), University of Colorado, Aurora, CO, USA; Department of Neurology (P Tabaee Damavandi MD), Neurocenter of Southern Switzerland (NSI), Lugano, Switzerland; 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 Basic Medical Sciences (S Tabatabaeizadeh PhD), Department of Internal Medicine (S Tabatabaeizadeh PhD), Islamic Azad University, Mashhad, Iran; School of Social Work (Prof K M Tabb PhD), University of Illinois, Urbana, IL, USA; Department of Biostatistics and Epidemiology (M Taheri Soodejani PhD), Shahid Sadoughi University of Medical Sciences, Yazd, Iran; Department of Environmental, Agricultural and Occupational Health (J Taiba MPH), University of Nebraska Medical Center, Omaha, NE, USA; Statistics Discipline (A Talukder MSc), Khulna University, Khulna, Bangladesh; Department of Dermato-Venereology (M Tampa PhD), Dr Victor Babes Clinical Hospital of Infectious Diseases and Tropical Diseases, Bucharest, Romania; Department of Medicine (J L Tamuzi MSc), Northlands Medical Group, Omuthiya, Namibia; State Key Laboratory of Numerical Modeling for Atmospheric Sciences and Geophysical Fluid Dynamics (LASG) (H Tang PhD), Chinese Academy of Sciences, Beijing, China; Department of Epidemiology and Biostatistics (M K Tariku MPH), Department of Public Health (T Y Tiruye PhD), Department of Human Nutrition and Food Sciences (E G Wassie MSc), Debre Markos University, Debre Markos, Ethiopia; Department of Pathology (V Y Tat BS), University of Texas, Galveston, TX, USA; Department of Urology (M Teimoori MD), Sabzevar University of Medical Sciences, Sabzevar, Iran; College of Pharmacy (R M H Temsah PharmD), Alfaisal University, Riyadh, Saudi Arabia; Outpatient Department (D R Terefa MSc), Wollega University, Bedele, Ethiopia; Health Management Department (R Tesler PhD), Ariel University, Ariel, Israel; Psychology Department (E Teye-Kwadjo PhD), University of Ghana, Legon, Accra, Ghana; Department of Pharmacology (P Thangaraju MD), All India Institute of Medical Sciences, Raipur, India; Public Health Department (Prof K R Thankappan MD), Amrita Institute of Medical Sciences, Kochi, India; Faculty of Biomedical Engeneering (A Tichopad PhD), Czech Technical University, Prague, Czech Republic; Faculty of Public Health (J H V Ticoalu MPH), Universitas Sam Ratulangi, Manado, Indonesia; Department of Allied Health and Human Performance (T Y Tiruye PhD), University of South Australia, Adelaide, SA, Australia; Laboratory of Public Health Indicators Analysis and Health Digitalization (M V Titova PhD), Moscow Institute of Physics and Technology, Moscow, Russia; Department of Medicine (Prof M Tonelli MD), Department of Oncology (L Yang PhD), University of Calgary, Calgary, AB, Canada; Department of Health (N M Tran MD), Children's Hospital 1, Ho Chi Minh City, Viet Nam; Adult Learning Disability Service (S J Tromans PhD), Leicestershire Partnership National Health Service Trust, Leicester, UK; School of Medicine (T T Truyen MD), Nam Can Tho University, Can Tho, Viet Nam; Department of Psychiatry (E Tsermpini PhD), Dalhousie University, Halifax, NS, Canada; Department of Nutrition and Food Studies (S Tyrovolas PhD), George Mason University, Fairfax, VA, USA; Environmental Sciences Program (S Uddin PhD), Asian University for Women, Chittagong, Bangladesh; Department of Geography (S Uddin PhD), University of Victoria, Victoria, BC, Canada; Department of Health and Community Sciences (A Udoh PhD), University of Exeter, Exeter, UK; International Center for Chemical and Biological Sciences (S Ullah MSc), University of Karachi, Karachi, Pakistan; Department of Zoology (S Ullah PhD), Division of Science and Technology (S Ullah PhD), University of Education, Lahore, Pakistan; Department of Paraclinical Sciences (S Umakanthan MD), The University of the West Indies, St Augustine, Trinidad and Tobago; Department of Community Medicine (C D Umeokonkwo MPH), Alex Ekwueme Federal University Teaching Hospital Abakaliki, Abakaliki, Nigeria; College of Health and Sport Sciences (A G Vaithinathan MSc), University of Bahrain, Salmanya, Bahrain; Department of Public Health and Epidemiology (O Varga PhD), University of Debrecen, Debrecen, Hungary; UKK Institute, Tampere, Finland (Prof T J Vasankari MD); Faculty of Medicine and Health Technology (Prof T J Vasankari MD), Tampere University, Tampere, Finland; Department of Human Genetics and Molecular Biology (B Vellingiri PhD), Bharathiar University, Coimbatore, India; Department of Statistics (D Venugopal PhD), Manonmaniam Sundaranar University, Tirunelveil, India; Department of Mathematics and Statistics (M Vishwakarma MSc), Banasthali Vidyapith, Tonk, India; Department of Community Medicine (M Vishwakarma MSc), Government Medical College, Barmer, India; Faculty of Information Technology (B Vo PhD), HUTECH University, Ho Chi Minh City, Viet Nam; School of Population Health and Environmental Sciences (H A Wafa MPH, Y Wang PhD), King's College London, London, UK; Office of Research, Innovation, and Commercialization (ORIC) (Prof Y Waheed PhD), Shaheed Zulfiqar Ali Bhutto Medical University (SZABMU), Islamabad, Pakistan; Gilbert and Rose-Marie Chagoury School of Medicine (Prof Y Waheed PhD), Lebanese American University, Byblos, Lebanon; Department of Midwifery (E B Wakwoya MSc), Arsi University, Asella, Ethiopia; School of Public Health (F Wang PhD), Xuzhou Medical University, Xuzhou, China; Department of Neurosurgery (S Wang MD), School of Public Health (J Xia PhD), Capital Medical University, Beijing, China; Department of Parasitology (Prof K G Weerakoon PhD), Department of Community Medicine (N D Wickramasinghe MD), Rajarata University of Sri Lanka, Anuradhapura, Sri Lanka; Key Laboratory of Shaanxi Province for Craniofacial Precision Medicine Research (Y Wen PhD), Stomatological Hospital (College) of Xi'an Jiaotong University, Xi'an, China; Competence Center of Mortality-Follow-Up of the German National Cohort (R Westerman DSc), Federal Institute for Population Research, Wiesbaden, Germany; Department of Physical Therapy (T Wiangkham PhD), Naresuan University, Phitsanulok, Thailand; Department of Surgery (D P Wickramasinghe MD), University of Colombo, Colombo, Sri Lanka; Department of Medical Statistics, Informatics and Health Economics (Prof P Willeit PhD), Medical University Innsbruck, Innsbruck, Austria; Department of Food Science and Human Nutrition (Prof F Wu PhD), Michigan State University, East Lansing, MI, USA; School of Public Health (H Xiao PhD), Zhejiang University, Zhejiang, China; Department of Public Health Science (H Xiao PhD), Fred Hutchinson Cancer Research Center, Seattle, WA, USA; School of Medicine (Prof G Xu MD), Nanjing University, Nanjing, China; Department of Endocrinology (Prof S Xu PhD), University of Science and Technology of China, Hefei, China; School of Medicine (Prof S Xu PhD), University of Rochester, Rochester, NY, USA; Cardiovascular Program (X Xu PhD), The George Institute for Global Health, Sydney, NSW, Australia; Department of Basic Medical Sciences (S Yaghoubi PhD), Neyshabur University of Medical Sciences, Neyshabur, Iran; Department of Cancer Epidemiology and Prevention Research (L Yang PhD), Alberta Health Services, Calgary, AB, Canada; Faculty of Medicine (Y Yano MD), Department of Public Health (N Yonemoto PhD), Juntendo University, Tokyo, Japan; Research Center of Physiology (H Yaribeygi PhD), Semnan University of Medical Sciences, Semnan, Iran; National Center for Chronic and Noncommunicable Disease Control and Prevention (P Ye MPH), Chinese Center for Disease Control and Prevention, Beijing, China; Department of Family Medicine (S A Yesuf MSc), St Peter's Specialized Hospital, Addis Ababa, Ethiopia; Biostatics, Epidemiology, and Science Computing Department (S Yezli PhD), King Faisal Specialist Hospital & Research Center, Riyadh, Saudi Arabia; Trinity College Institute for Neuroscience (A Yigezu MPH), School of Medicine (A Yigezu MPH), Trinity College Dublin, Dublin, Ireland; Department of Neuropsychopharmacology (N Yonemoto PhD), National Center of Neurology and Psychiatry, Kodaira, Japan; Department of Health Policy and Management (Prof M Z Younis PhD), Jackson State University, Jackson, MS, USA; School of Business & Economics (Prof M Z Younis PhD), Universiti Putra Malaysia (University of Putra Malaysia), Kuala Lumpur, Malaysia; Department of Epidemiology and Biostatistics (Prof C Yu PhD), Wuhan University, Wuhan, China; Faculty of Medicine and Health Sciences (F Zakham PhD), Hodeidah University, Hodeidah, Yemen; Addictology Department (Prof M S Zastrozhin 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; Computational Bioscience Research Center (J Zhou PhD), King Abdullah University of Science and Technology, Jeddah, Saudi Arabia; School of Public Health and Emergency Management (B Zhu PhD), Southern University of Science and Technology, Shenzhen, China; School of Life Sciences (L Zhu PhD), Yunnan University, Kunming, China; School of Physics (S H Zyoud PhD), Universiti Sains Malaysia, Penang, Malaysia; GBD

Collaborating Unit, Norwegian Institute of Public Health, Bergen, Norway (Prof S E Vollset DrPH).

Contributors

Please see appendix 1 section 6 for detailed information about individual author contributions to the research, divided into the following categories: managing the overall research enterprise; writing the first draft of the manuscript; primary responsibility for applying analytical methods to produce estimates; primary responsibility for seeking, cataloguing, extracting, or cleaning data; designing or coding figures and tables; providing data or critical feedback on data sources; developing methods or computational machinery; providing critical feedback on methods or results; drafting the manuscript or revising it critically for important intellectual content; and managing the estimation or publications process. The lead, corresponding, and senior authors had full access to the data in the study and had final responsibility for the decision to submit for publication.

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S Afzal reports payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing, or educational events and webinars with King Edward Medical University and collaborative partners including University of Johns Hopkins, University of California, and University of Massachusetts; participation on a Data Safety Monitoring Board or Advisory Board with the National Bioethics Committee Pakistan, King Edward Medical University Institutional Ethical Review Board, and the Ethical Review Board Fatima Jinnah Medical University and Sir Ganga Ram Hospital; leadership or fiduciary roles in board, society, committee, or advocacy groups, paid or unpaid, with Pakistan Association of Medical Editors, Fellow of Faculty of Public Health Royal Colleges UK (FFPH), the Society of Prevention, Advocacy and Research of King Edward Medical University (SPARK), and as a Member of the Pakistan Society of Infectious Diseases; and other financial support as Dean of Public Health and Preventive Medicine, King Edward Medical University, as the Chief Editor of *Annals of King Edward Medical University* since 2014, as the Director of Quality Enhancement Cell, King Edward Medical University, and with the Member Research and Publications Higher Education Commission Pakistan; all outside the submitted work. R Ancuceanu reports consulting fees from AbbVie, Sandoz, B Braun, and Laropharm, all outside the submitted work. J Ärnlöv reports payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing, or educational events from AstraZeneca and Novartis; participation on a Data Safety Monitoring Board or Advisory Board with AstraZeneca, Astella, and Boehringer Ingelheim; all outside the submitted work. M Ausloos reports grants or contracts from the Romanian National Authority for Scientific Research and Innovation, CNDS-UEFISCDI (project number PN-III-P4-ID-PCCF-2016-0084), outside the submitted work. R Bai reports support for the present manuscript from the Social Science Fund of Jiangsu Province (grant number 21GLD008). 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A Biswas reports consulting fees from Lupin Pharmaceuticals (India), Alkem Laboratories (India), and Intas Pharmaceuticals (India); payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing, or educational events from Roche Diagnostics (India); outside the submitted work. J Conde reports grants or contracts from the European Research Council Starting Grant (ERC-StG-2019-848325), outside the submitted work. S Das reports a leadership or fiduciary role in a board, society, committee, or advocacy group, unpaid, as an executive voluntary member and leadership position in the Association for Diagnostic and Laboratory Medicine and Women in Global Health India Chapter; outside the submitted work. A Dastiridou reports payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing, or educational events from AbbVie and Thea; outside the submitted work. A Faro reports support for the present manuscript from Coordination of Superior Level Staff Improvement (CNPq, Brazil) Productivity in Research Scholarship (PQ Scholarship). A A Fomenkov reports support for the present manuscript from the Ministry of Science and Higher Education of the Russian Federation (theme number 121050500047-5). M Foschi reports consulting fees from Roche, Biogen, Merck, Sanofi, and Novartis; support for attending meetings or travel from Roche, Novartis, Biogen, Sanofi, and Merck; leadership or fiduciary role in a board, society, committee, or advocacy group, paid or unpaid, as a current member of the MSBase collaboration scientific leadership group; outside the submitted work. I Filip reports support for the present manuscript from Avicenna Medical and Clinical Research Institute. 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Genzyme, Biologix, Merck, Hikma Pharma, Janssen, Inspire Pharma, Future Pharma, and Elixir Pharma; payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing, or educational events from Novartis, Allergan, Merck, Biologix, Janssen, Roche, Sanofi Genzyme, Bayer, Hikma Pharma, Al Andalus, Chemipharm, Lundbeck, Inspire Pharma, Future Pharma and Habib Scientific Office, and Everpharma; support for attending meetings or travel from Novartis, Allergan, Merck, Biologix, Roche, Sanofi Genzyme, Bayer, Hikma Pharma, Chemipharm, Al Andalus Pharmaceuticals, and Clavita Pharmaceuticals; a leadership or fiduciary role in a board, society, committee, or advocacy group, paid or unpaid, as a member of educational, membership, and regional committees of international headache societies; outside the submitted work. 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T Joo reports support for the present manuscript from the National Research, Development and Innovation Office in Hungary (RRF-2.3.1-21-2022-00006), Data-Driven Health Division of National Laboratory for Health Security. J Jozwiak reports payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing, or educational events from Novartis, ADAMed, and Amgen, outside the submitted work. J H Kempen reports support for the present manuscript from Sight for Souls and the Mass Eye and Ear Global Surgery Program; participation on a Data Safety Monitoring Board or Advisory Board with Gilead; leadership or fiduciary role in a board, society, committee, or advocacy group, unpaid, on the board of Sight for Souls; stock or stock options with Betaliq and Tarsier; outside the submitted work. 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P B Mentis reports payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing, or educational events from Janssen (Australia) and Sanofi (Hangzhou); participation on a Data Safety Monitoring Board or Advisory Board from Janssen (Australia); outside the submitted work. L Monasta and L Ronfani report support for the present manuscript from the Italian Ministry of Health (Ricerca Corrente 34/2017) via payments made to the Institute for Maternal and Child Health Istituto di Ricovero e Cura a Carattere Scientifico (IRCCS) Burlo Garofolo. R S Moreira reports grants or contracts from the National Council for Scientific and Technological Development CNPq Research Productivity Scholarship (scholarship registration number 316607/2021-5). J Morze reports grants or contracts from SciLifeLab and Wallenberg Data Driven Life Science Program (KAW 2020.0239); consulting fees from ALAB Laboratoria; outside the submitted work. S Muthu reports leadership or fiduciary role in other board, society, committee, or advocacy group, paid or unpaid, on the NEXTGen Committee (ICRS), Grants Committee (SICOT), and with the Knowledge Forum Degenerative Associate as a member (AO Spine); outside the submitted work. S Nomura reports support for the present manuscript from the Ministry of Education, Culture, Sports, Science and Technology of Japan (21H03203) and Precursory Research for Embryonic Science and Technology from the Japan Science and Technology Agency (JPMJPR22R8). A P Okekunle reports support for the present manuscript from the National Research Foundation of Korea funded by the Ministry of Science and ICT (2020H1D3A1A04081265); support for attending meetings or travel from the National Research Foundation of Korea funded by the Ministry of Science and ICT (2020H1D3A1A04081265), outside the submitted work. A Pantea Stoian reports payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing, or educational events from AstraZeneca, Eli Lilly, Merck, Medtronic, Novo Nordisk, Servier, and Sanofi; support for attending meetings or travel from Sanofi, Novo Nordisk, and Eli Lilly; participation on a Data Safety Monitoring Board or Advisory Board with Eli Lilly, Novo Nordisk, and Sanofi; leadership or fiduciary role in other board, society, committee or advocacy group, paid or unpaid, as the Vice-president of the Central European Diabetes Association and as the President of the Romanian National Diabetes Committee; outside the submitted work. R Passera reports participation on a Data Safety Monitoring Board or Advisory Board as the expert biostatistician member for the clinical trial Consolidation with ADCT-402 (loncastuximab tesirine) after immunochemotherapy: a phase II study in BTKi-treated/ineligible Relapse/Refractory Mantle Cell Lymphoma (MCL) patients, sponsor FIL, Fondazione Italiana Linfomi, Alessandria-I; outside the submitted work. M Pigeolet reports grants or contracts from the Belgian Kids' Fund for Pediatric Research; outside the submitted work. A E Peden reports support for the present manuscript from the Australian National Health and Medical Research Council (grant number APP2009306). V C F Pepito reports grants or contracts from Sanofi Consumer Healthcare and International Initiative for Impact Evaluation; outside the submitted work. A Radfar reports support for the present manuscript from Avicenna Medical and Clinical Research Institute. 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Data sharing

To download the data used in these analyses, please visit the Global Health Data Exchange GBD 2021 website (http://ghdx.healthdata.org/gbd-2021/sources).

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