meaning the relative contribution of risk factors such as ambient particulate matter pollution, high systolic blood pressure, high body-mass index (BMI), and high fasting plasma glucose continue to increase. It must be noted, however, that much of the rise in absolute burden from these latter risk factors is due to increases in population size and population ageing. Only two of the top 25 risk factors in 2021, high fasting plasma glucose and high BMI, had increases in age-standardised DALY rates from 2000 to 2021. Although this is good news, there are still more health gains to be made from much greater absolute reductions in levels of hazardous exposure to these risk factors.

GBD's attribution of burden to risk factors, and how this has changed over time, provides a high-level roadmap for policy makers and researchers. Looking to future evolution of GBD and global health metrics, a more detailed roadmap requires taking these cross-sectional estimates through to forecasts of cohort disease and burden rates to use in simulation studies of the effectiveness and cost-effectiveness of actual interventions.

TB uses GBD data in his SHINE program; most of these data are freely available from IHME, but he also occasionally receives direct data supplied from IHME, which are more extensive than what is provided at the IHME and Global Health Data Exchange websites. SH has received grants from the NHMRC Centre of Research Excellence on Achieving the Tobacco Endgame, is the current recipient of a Seed Grant (AU$20 000 over 12 months from 2023–24) to quantify the health burden from second-hand smoke exposure in the social housing population in Australia; and has received a Research Training Program PhD Scholarship for modelling Tobacco Endgame policies in Australia from the University of Melbourne.

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1 GBD 2021 Causes of Death Collaborators. Global burden of 288 causes of death and life expectancy decomposition in 204 countries and territories and 811 subnational locations, 1990–2021: a systematic analysis for the Global Burden of Disease Study 2021. *Lancet* 2024; **403:** 2100–32.
2 GBD 2021 Risk Factors Collaborators. Global burden and strength of evidence for 88 risk factors in 204 countries and 811 subnational locations, 1990–2021: a systematic analysis for the Global Burden of Disease Study 2021. *Lancet* 2024; **403:** 2162–203.
3 GBD 2021 Forecasting Collaborators. Burden of disease scenarios for 204 countries and territories, 2022–2050: a forecasting analysis for the Global Burden of Disease Study. *Lancet* 2024; **403:** 2204–56.
4 Ait Ouakrim D, Wilson T, Waa A, et al. Tobacco endgame intervention impacts on health gains and Maori:non-Maori health inequity: a simulation study of the Aotearoa/New Zealand Tobacco Action Plan. *Tob Control* 2023; published online Jan 10. https://doi.org/10.1136/tc-2022-057655.
5 Zheng P, Afshin A, Biryukov S, et al. The burden of proof studies: assessing the evidence of risk. *Nat Med* 2022; **28:** 2038–44.

Forecasting the global burden of disease to 2050

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In their study published in *The Lancet*, the GBD 2021 Forecasting Collaborators[1] assessed cause-specific mortality, years of life lost, years lived with disability, disability-adjusted life-years (DALYs), life expectancy, and healthy life expectancy (HALE) from 2022 to 2050 for 204 countries and territories under five scenarios—a reference scenario (the most likely future, based on historical trends) and alternative scenarios in which certain risk factors are eliminated by 2050 (Safer Environment scenario, Improved Childhood Nutrition and Vaccination scenario, Improved Behavioural and Metabolic Risks scenario, and a combination of these three scenarios). To our knowledge, this report is the first forecasting study incorporating comprehensive health metrics, including mortality and non-fatal outcomes from a comprehensive list of diseases and conditions. Such analysis provides a unique and important avenue for countries to gauge progress made in achieving health-related Sustainable Development Goals (SDGs) and potential options to accelerate progress given how off-track the world is in improving population health by 2030.

The authors predict a continued shift in global disease burden from communicable, maternal, neonatal, and nutritional diseases towards non-communicable diseases (NCDs), with the largest increase in DALYs coming from neoplasms and diabetes and kidney diseases. The study estimates that under the reference scenario, life expectancy is expected to continue to increase from 73·6 years (95% uncertainty interval 72·7–74·4) in 2022 to 78·2 years (75·2–80·3) in 2050, and HALE will continue to increase from 63·6 years (60·7–66·3) to 66·7 years (63·0–70·4) from 2022 to 2050. The forecasted effects are strongest for the Improved Behavioural and Metabolic Risks scenario globally. Moreover, the Safer Environment scenario and the Improved Childhood Nutrition and Vaccination scenario are forecasted to have a relatively larger impact on DALYs in sub-Saharan Africa and south Asia compared with other super-regions.

Caroline Purser via Getty Images

The findings of the study suggest that there are gaps between the goal of SDG 3 and country-specific foreseeable achievement.[2] There is an urgent need for NCD prevention and control, given the disruption of the COVID-19 pandemic. Now, we call for countries to identify the most important local drivers of NCDs and re-evaluate their goals to be achieved after the pandemic, especially in relation to reducing the burden of NCDs.

The results of this study reflect the improvements in the forecasting methods.[3] These improvements include the incorporation of more risk factors and mediating pathways, an ensemble model that uses predictive validity to inform the sub-model selection, and accounting for the impact of COVID-19 on the future trajectories of population health.

A key contribution of this study is that it incorporates Coupled Model Intercomparison Project Phase 6 climate scenarios, which quantify the effects of non-optimal temperature due to climate change on cause-specific mortality. The next step, if more research is available, is to further quantify the impact of other drivers of climate change-related events and inform health-centred climate action.[4] Moreover, the demographic shifts across the globe from 2022 to 2050 will be highly diverse due to conflict and unpredictable policies. The demographic shift and fast population-ageing around the world challenge the limited capacity of health systems, exacerbating the related mortality risks.[5] Localised population projection is encouraged for a better understanding of the burden of diseases.[6]

More importantly, this study examines the ideal scenarios that humanity aims to achieve. For instance, the Improved Childhood Nutrition and Vaccination scenario assumes vaccine coverage to 100% in all locations by 2050 for the following vaccines: third-dose diphtheria, tetanus, and pertussis vaccine; measles conjugate vaccine doses 1 and 2; *Haemophilus influenzae* type B vaccine; pneumococcal conjugate vaccine; and rotavirus vaccine. The Improved Behavioural and Metabolic Risks scenario assumes a linear reduction of current tobacco smokers to zero by 2050 as well as no new smokers after 2022 in all locations. The Safer Environment scenario assumes that exposure to unsafe water, sanitation, and hygiene, and to household air pollution will be eliminated linearly by 2050 in all locations. Therefore, it is necessary to estimate the likelihood of achieving these scenarios, and gaps remain when considering goals on a more localised basis. Moreover, in future research, it is important to explore more realistic combinations of risk factors, taking into account accessibility and affordability of measures to mitigate these factors, rather than presenting scenarios in which these factors are completely eliminated.

However, as the authors state, the world faces multiple potential threats to human health other than the 81 drivers included in the study, such as antimicrobial resistance, emerging infectious diseases, war and conflict, food insecurity and famines, and more. Health might also be improved by artificial intelligence and other emerging technologies. Under the framework of this study, other forecasting models can be built to evaluate the impact of technological innovation scale-up.

Modelling can better support public health policy making.[7] We believe the information presented in the work by the GBD 2021 Forecasting Collaborators is essential for health policy setting and long-term planning. Better uptake of such information and its utilisation in decision making by national governments require much closer collaboration between policy makers and researchers. A customisable scenario projection tool based on the work done in this study that can be fine-tuned to answer specific policy questions that policy makers might have will be essential to help expand the application of scenario-based projections at the country level.

We declare no competing interests.

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1 GBD 2021 Forecasting Collaborators. Burden of disease scenarios for 204 countries and territories, 2022–2050: a forecasting analysis for the Global Burden of Disease Study 2021. *Lancet* 2024; **403:** 2204–56.
2 NCD Countdown 2030 Collaborators. NCD Countdown 2030: efficient pathways and strategic investments to accelerate progress towards the Sustainable Development Goal target 3.4 in low-income and middle-income countries. *Lancet* 2022; **399:** 1266–78.
3 Murray CJL. The Global Burden of Disease Study at 30 years. *Nat Med* 2022; **28:** 2019–26.
4 Romanello M, Napoli CD, Green C, et al. The 2023 report of the *Lancet* Countdown on health and climate change: the imperative for a health-centred response in a world facing irreversible harms. *Lancet* 2023; **402:** 2346–94.
5 Li T, Horton RM, Bader DA, et al. Aging will amplify the heat-related mortality risk under a changing climate: projection for the elderly in Beijing, China. *Sci Rep* 2016; **6:** 28161.
6 Zhang S, Zhao M, Liu Z, et al. City-level population projection for China under different pathways from 2010 to 2100. *Sci Data* 2023; **10:** 809.
7 The Lancet Commission on Strengthening the Use of Epidemiological Modelling of Emerging and Pandemic Infectious Diseases. How modelling can better support public health policy making: the *Lancet* Commission on Strengthening the Use of Epidemiological Modelling of Emerging and Pandemic Infectious Diseases. *Lancet* 2023; **403:** 789–91.

Measuring haemoglobin concentration to define anaemia: WHO guidelines

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Anaemia is conventionally determined when the haemoglobin concentration falls below a defined threshold for age, sex, and physiological status.[1] The accurate definition of haemoglobin concentration thresholds to determine anaemia is essential for clinical diagnosis and patient care, and for understanding the scale of the associated public health problem to plan policy and actions. WHO estimates that globally, in 2019, anaemia affected 30% of women aged 15–49 years (including 36% of all pregnant women) and 40% of children aged 6–59 months.[2] A Global Burden of Disease Study found that in 2021, 1·9 billion people (24% of the world's population) were anaemic, and that anaemia was among the three leading causes of years of life lived with disability worldwide.[3] Reducing anaemia prevalence in women is a 2025 Global Nutrition Target, and an indicator of progress towards the Sustainable Development Goals.

WHO recommendations for haemoglobin thresholds to define anaemia were initially proposed in 1958,[4] updated in 1968,[5] and have remained consistent since then.[6] However, there has been no consensus on these thresholds, with other expert groups (eg, the US Centers for Disease Control and Prevention),[7] expert bodies,[8] and clinical and laboratory haematology textbooks[9] separately proposing haemoglobin concentration thresholds to define anaemia. This uncertainty has produced heterogeneous thresholds between different diagnostic laboratories.[10] There is also ambiguity regarding progress towards global public health anaemia reduction targets and even the best approach to pursue them.[11]

In addition to uncertainty in the thresholds themselves, there have been doubts about the rationale for higher haemoglobin concentration thresholds in adult males (<130 g/L) than adult females (<120 g/L) to diagnose anaemia, particularly whether this difference in haemoglobin concentration thresholds represents a physiological difference between sexes or is an effect of the lower iron stores often present in individuals who menstruate.[12] There has also been uncertainty regarding whether haemoglobin concentration thresholds should vary by ancestry (and hence vary across regions) because of possible associated subclinical genetic differences influencing haemoglobin concentration and red blood cell physiology.[13] Thresholds in young children aged between 6 months and 2 years have also been challenged, with suggestions that thresholds should be lower than those of current guidelines, which might overestimate the prevalence of anaemia in this group.[14]

For more on the **2025 Global Nutrition Targets** see https://www.who.int/publications/i/item/WHO-NMH-NHD-14.2

For more on the **Sustainable Development Goals** see https://unstats.un.org/sdgs/metadata/

In March, 2024, WHO released the guideline on haemoglobin cutoffs to define anaemia in individuals and populations,[15] developed following the rigorous procedures outlined in the WHO handbook for guideline development,[16] which aims to apply a consistent, evidence-informed approach to support health providers and policy makers to implement anaemia detection. Key recommendations of the WHO guideline[15] are summarised in table 1. Evidence informing the guideline