Measuring progress and projecting attainment on the basis of past trends of the health-related Sustainable Development Goals in 188 countries: an analysis from the Global Burden of Disease Study 2016

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Summary

Background The UN's Sustainable Development Goals (SDGs) are grounded in the global ambition of "leaving no one behind". Understanding today's gains and gaps for the health-related SDGs is essential for decision makers as they aim to improve the health of populations. As part of the Global Burden of Diseases, Injuries, and Risk Factors Study 2016 (GBD 2016), we measured 37 of the 50 health-related SDG indicators over the period 1990–2016 for 188 countries, and then on the basis of these past trends, we projected indicators to 2030.

Methods We used standardised GBD 2016 methods to measure 37 health-related indicators from 1990 to 2016, an increase of four indicators since GBD 2015. We substantially revised the universal health coverage (UHC) measure, which focuses on coverage of essential health services, to also represent personal health-care access and quality for several non-communicable diseases. We transformed each indicator on a scale of 0–100, with 0 as the 2·5th percentile estimated between 1990 and 2030, and 100 as the 97·5th percentile during that time. An index representing all 37 health-related SDG indicators was constructed by taking the geometric mean of scaled indicators by target. On the basis of past trends, we produced projections of indicator values, using a weighted average of the indicator and country-specific annualised rates of change from 1990 to 2016 with weights for each annual rate of change based on out-of-sample validity. 24 of the currently measured health-related SDG indicators have defined SDG targets, against which we assessed attainment.

Findings Globally, the median health-related SDG index was 56·7 (IQR 31·9–66·8) in 2016 and country-level performance markedly varied, with Singapore (86·8, 95% uncertainty interval 84·6–88·9), Iceland (86·0, 84·1–87·6), and Sweden (85·6, 81·8–87·8) having the highest levels in 2016 and Afghanistan (10·9, 9·6–11·9), the Central African Republic (11·0, 8·8–13·8), and Somalia (11·3, 9·5–13·1) recording the lowest. Between 2000 and 2016, notable improvements in the UHC index were achieved by several countries, including Cambodia, Rwanda, Equatorial Guinea, Laos, Turkey, and China; however, a number of countries, such as Lesotho and the Central African Republic, but also high-income countries, such as the USA, showed minimal gains. Based on projections of past trends, the median number of SDG targets attained in 2030 was five (IQR 2–8) of the 24 defined targets currently measured. Globally, projected target attainment considerably varied by SDG indicator, ranging from more than 60% of countries projected to reach targets for under-5 mortality, neonatal mortality, maternal mortality ratio, and malaria, to less than 5% of countries projected to achieve targets linked to 11 indicator targets, including those for childhood overweight, tuberculosis, and road injury mortality. For several of the health-related SDGs, meeting defined targets hinges upon substantially faster progress than what most countries have achieved in the past.

Interpretation GBD 2016 provides an updated and expanded evidence base on where the world currently stands in terms of the health-related SDGs. Our improved measure of UHC offers a basis to monitor the expansion of health services necessary to meet the SDGs. Based on past rates of progress, many places are facing challenges in meeting defined health-related SDG targets, particularly among countries that are the worst off. In view of the early stages of SDG implementation, however, opportunity remains to take actions to accelerate progress, as shown by the catalytic effects of adopting the Millennium Development Goals after 2000. With the SDGs' broader, bolder development agenda, multisectoral commitments and investments are vital to make the health-related SDGs within reach of all populations.

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Research in context

Evidence before this study

Since the establishment of the Sustainable Development Goals (SDGs) in September, 2015, an increasing number of global efforts have sought to measure levels and progress in achieving the health-related SDGs. International agencies such as WHO currently report on a subset of the 50 health-related SDG indicators, but inconsistencies in the years reported and countries represented for each SDG indicator provide an incomplete understanding of health priorities in the SDG era. Drawing on the Global Burden of Diseases, Injuries, and Risk Factors Study 2015 (GBD 2015), we measured 33 health-related indicators and an overall health-related SDG index for 188 countries from 1990 to 2015. A number of indicators were not included in this baseline assessment, and some indicators such as universal health coverage (UHC; SDG indicator 3.8.1) had substantial measurement limitations. Demand for initial projections of SDG achievement in 2030, based on past trends, has increased as national and global institutions alike aim to solidify actionable strategies and concrete policy agendas. To date, however, no studies have produced projections across health-related SDG indicators and locations.

Added value of this study

Based on work by more than 2500 collaborators from more than 135 countries and territories, GBD 2016 provides an independent and systematic assessment of 37 of the 50 health-related indicators. This represents an increase of four indicators since GBD 2015: vaccine coverage for targeted populations by vaccines in national programmes (SDG indicator 3.b.1); two violence indicators (prevalence of physical or sexual violence [SDG indicator 16.1.3] and childhood sexual abuse [SDG indicator 16.2.3]); and well-certified death registration (SDG indicator 17.19.2c). For the UHC index (SDG indicator 3.8.1), to better represent a full range of essential health services, we combined risk-standardised mortality rates from 32 causes from which death should not occur in the presence of high-quality health care with estimates of nine types of intervention coverage for infectious diseases and maternal and child health outcomes. Based on past trends measured from 1990 to 2016, this study provides projections of each health-related indicator through 2030 and an assessment of attainment against defined SDG targets.

Implications of all available evidence

Country-level performance for the health-related SDG index varied greatly in 2016, emphasising health inequalities by location and levels of sociodemographic development. Our improved measure of UHC showed a divide across the sociodemographic spectrum, which might be associated with major differences in access to high-quality health services focused on non-communicable diseases and complex conditions in higher-income countries. Nonetheless, considerable progress occurred for many countries on the UHC index between 2000 and 2016, especially in Cambodia, Rwanda, Equatorial Guinea, Laos, Turkey, and China. Based on projections of past trends, meeting a subset of established SDG targets by 2030 might be possible for some areas of the world, with more than 60% of countries projected to meet targets on under-5 mortality, neonatal mortality, maternal mortality ratio, and malaria. At the same time, on the basis of past trends, much of western and central sub-Saharan Africa was projected to attain very few—if any—defined targets in 2030. Furthermore, at current rates of progress, fewer than 5% of countries were projected to reach 2030 targets for 11 indicators, including childhood overweight, tuberculosis, and road injury mortality. Translation of the global SDG framework into investments and policy remains in its infancy, offering decision makers the opportunity to address both long-standing and emerging health challenges in the SDG era.

Introduction

"Leaving no one behind" is the cornerstone of the Sustainable Development Goals (SDGs), the international development agenda formally adopted by the UN and its member states in September, 2015.[1] To deliver on this aim, it is essential to measure where advances have been achieved—and where challenges or new threats are occurring—through routinely updated, comparable monitoring and evaluation.[2,3] After the SDGs's adoption, debate continued around the SDG indicator framework, implementation, and monitoring,[4] which ultimately led to an open call for revision proposals overseen by the Inter-Agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs) in 2016. In March, 2017, the UN Statistical Commission agreed on several indicator revisions and established formal mechanisms for ongoing indicator refinement and additions.[5] At this time, 232 individual SDG indicators are included in the global SDG indicator framework,[5] aligned with the original 17 goals and 169 targets. 50 health-related indicators (ie, indicators that directly involve health services, health outcomes, and risk factors with well established causal connections to health) exist within 29 health-related targets and 11 goals, including SDG 3, which aims to "ensure healthy lives and promote wellbeing for all at all ages".

As part of the Global Burden of Diseases, Injuries, and Risk Factors Study 2015 (GBD 2015),[6] we generated a baseline assessment for 33 health-related SDG indicators, producing an overall summary indicator (the health-related SDG index), and examined historical trends for the overall index and individual indicators for 188 countries from 1990 to 2015. Other efforts have also sought to measure the health-related SDGs across countries, including assessments by the WHO,[7,8] the Sustainable Development Solutions Network (SDSN),[9,10] and the World Bank;[11] however, they experience

limitations in terms of the years covered and countries included for each indicator. By contrast, the GBD study uses highly standardised analytical approaches to produce comprehensive and comparable estimates across countries and over time. A collaboration of more than 2500 global health researchers and experts from more than 135 countries and territories enables GBD to incorporate the latest data, reflect regional and local knowledge, and to facilitate policy translation at local levels. Additionally, established mechanisms, including a Scientific Council and Independent Advisory Committee,[12] ensure scientific rigour and independence from undue political influence.

A key component of the health-related SDGs is universal health coverage (UHC).[13–18] SDG target 3.8 explicitly highlights the importance of UHC, aiming to "achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality, and affordable essential medicines and vaccines for all".[5] SDG indicator 3.8.1 focuses on coverage of essential health services, capturing the role of health systems in delivering effective interventions to improve a wide range of health outcomes. On the basis of GBD 2015 results, we developed a proxy measure of UHC based on the coverage of maternal, child, and selected communicable disease interventions.[6] WHO has proposed a similar proxy UHC measure,[7,19] although the WHO UHC indicator also seeks to incorporate the absence of selected risk factors at the population level (eg, blood pressure, cholesterol, and smoking). However, measures of risk exposure might not optimally capture access to high-quality health care or broader health system functioning; rather, they might represent behavioural, cultural, or environmental determinants (eg, diet, air pollution) that are less directly addressed by health systems. Considerable opportunity exists to improve current UHC measures by combining more traditional measures of intervention coverage with analyses of amenable mortality, such as those used in the Healthcare Access and Quality (HAQ) Index;[20] this would allow the incorporation of a broader set of health services as well as reflect both access to and quality of care.

Understanding of how past rates of progress translate into future trajectories for the SDGs is an important input for decision makers, particularly during these initial years of SDG policy development and implementation. Health-related SDG targets and their corresponding indicators represent a substantially broader range of health needs than those represented in the Millennium Development Goals (MDGs), which primarily concentrated on maternal and child health outcomes and infectious diseases;[21] furthermore, the SDGs are meant to apply to all countries, irrespective of their development status, whereas the MDGs were viewed as lower priority or less applicable to higher-income countries. Subsequently, it is crucial to know where—and how much—progress needs to be accelerated during the next years of SDG implementation to reach stated targets. Selected studies have generated projections based on past trends, but have generally been restricted to specific SDG indicators (eg, under-5 mortality,[22] maternal mortality,[23] non-communicable disease [NCD] mortality,[24] and met need for family planning[25]) or focused on individual countries and indicators (eg, premature mortality from NCDs in Mexico[26] and child mortality in India[27]). A comprehensive assessment of how past progress could translate into SDG performance in 2030 across health-related indicators is essential to help global, regional, and national decision makers identify the countries and areas of greatest need and align current and future investment plans accordingly.

In this study, we provide updated estimates from 1990 to 2016 for each health-related SDG indicator and the overall health-related SDG index. In doing so, we also improve the measurement for several indicators, most notably the UHC index (SDG indicator 3.8.1) by incorporating components of the HAQ Index. We also include four additional health-related indicators since GBD 2015: vaccine coverage for targeted populations by vaccines in national programmes (SDG indicator 3.b.1), two violence indicators (prevalence of physical or sexual violence [SDG indicator 16.1.3] and childhood sexual abuse [SDG indicator 16.2.3]), and well-certified death registration (SDG indicator 17.19.2c). Based on past trends, we produce indicator-by-indicator projections for 188 countries from 2017 to 2030. It is important to note that these projections are not intended to predict what progress would be achieved as a result of the SDGs; instead, these projections are meant to shed light on potential gaps and gains on the health-related SDGs by 2030, and where countries are likely to be, based on past progress, in relation to defined SDG targets.

Methods

Overview of GBD

This analysis of the health-related SDGs is based on the GBD study, which measures the health of populations on an annual basis. GBD produces age-specific, sex-specific, and country-specific estimates (including selected sub-national units) of cause-specific mortality and morbidity, risk factor exposure, mortality and morbidity attributable to these risks, and a range of health system characteristics, from 1990 to the most recent year. Various summary measures are computed, including disability-adjusted life-years (DALYs) and healthy life expectancy. GBD uses highly standardised and validated approaches applied to all available data sources adjusted for major sources of bias. Further details on GBD 2016, which covers 1990–2016, are available elsewhere.[28–32]

As with all revisions of the GBD study, GBD 2016 provides an update of the full time series from 1990–2016 based on methodological improvements and newly identified data sources; subsequently, the full time series on the health-related SDGs published here as part of GBD 2016 supersedes previous GBD studies. The

GBD 2016 study and this analysis comply with the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER).[33] Further detail on the estimation and data sources used for all indicators are available in appendix 1.

See Online for appendix 1

Indicators, definitions, and measurement approach

In this updated analysis we cover 37 of 50 health-related SDG indicators (table). Additional details on data and methods for estimating each indicator are in appendix 1. Appendix 2 outlines the 13 indicators not presently measured (pp 10–12). The addition of new causes, risks, and health indicators are considered by the GBD Scientific Council for each annual cycle of the GBD. For GBD 2016, four health-related SDG indicators were added: vaccine coverage (SDG indicator 3.b.1); two violence indicators (prevalence of physical or sexual violence [SDG indicator 16.1.3] and childhood sexual abuse [SDG indicator 16.2.3]); and well-certified death registration (SDG indicator 17.19.2c).

See Online for appendix 2

Vaccine coverage (SDG indicator 3.b.1), defined as "proportion of the target population covered by all vaccines included in their national programme", became a separate indicator as part of the March, 2017, revision to the SDG framework.[5] We report on this indicator by using the geometric mean of the coverage of three-dose diphtheria, pertussis, and tetanus (DPT3); three-dose polio; first-dose measles vaccine; and for countries where the vaccine(s) are included in the national schedule: BCG vaccine, three-dose pneumococcal conjugate vaccine (PCV3), three-dose *Haemophilus influenzae* type b vaccine (Hib3), three-dose hepatitis B vaccine (delivered as part of pentavalent vaccines), and two-dose or three-dose rotavirus vaccine. To account for the scale-up period for newly introduced vaccines, we include new vaccines in the geometric mean only 3 years after the introduction year in each country.

We also added two violence indicators in GBD 2016: age-standardised prevalence of physical or sexual violence experienced by populations in the last 12 months (SDG indicator 16.1.3) and age-standardised prevalence of women and men aged 18–29 years who experienced sexual violence by age 18 years (SDG indicator 16.2.3). The UN definition for SDG indicator 16.1.3 includes psychological violence, but due to limited data availability and highly variable definitions of self-reported psychological violence, we restricted this measurement to physical and sexual violence.

As part of GBD 2016, we developed a data quality measure to reflect the proportion of well-certified deaths by a vital registration (VR) system among a country's total population, which corresponds with the third component of 17.19.2 (referred to as SDG indicator 17.19.2c). Well-certified deaths were determined by three measures: (1) completeness of death registration; (2) fraction of deaths not assigned to major garbage codes (ie, causes that cannot or should not be underlying causes of death); and (3) fraction of deaths assigned to detailed GBD causes. More detail on this measure can be found elsewhere [29] and in appendix 1.

We also refined the measurement of several previously included health-related indicators. First, SDG indicator 16.1.2 (conflict mortality) now exclusively focuses on deaths due to conflict and terrorism. Second, we revised the exposure period from lifetime to 12 months for SDG indicator 5.2.1 (intimate partner violence) to match the UN SDG definition. Third, we limited our measurement of SDG indicator 6.2.1b (hygiene) to access to a handwashing facility, which also aligns more directly with the UN SDG target. Fourth, we extended the measurement of SDG indicator 3.8.1 (coverage of essential health services, or UHC tracer interventions) to include the individual components of the HAQ Index,[20] which is based on risk-standardised death rates from 32 causes amenable to personal health care.[34,35] This revised approach expands the range of potential health services, particularly those for NCDs, captured by this summary measure. The previous UHC tracer indicator included only maternal and child health and selected infectious disease interventions (malaria, HIV, and tuberculosis).[6] Last, a subset of indicators have undergone substantial revision due to data improvements, methodological improvements, or both, implemented in GBD 2016, including alcohol consumption and child growth failure (ie, under-5 stunting and wasting). Further detail on these updates can be found in appendix 1, as well as accompanying GBD 2016 papers.[28–32]

Projection of health-related SDG indicators to 2030

We projected the health-related SDG indicators on the basis of past trends. We first calculated for each location the annual rate of change between 1990 and 2016 for each individual year in natural-log space or, for indicators bounded between 0 and 1 (eg, intervention coverage, percentage of population) in logit-space. We then calculated the weighted median annualised rate of change for each country using the following weighting function:

$$weight_{year} = \frac{(\text{year} - 1990)^{\omega}}{\sum_{t=1991}^{T} (t - 1990)^{\omega}}$$

The value of ω denotes how much weight is given to recent years compared with past years when calculating the median annualised rate of change. To determine the appropriate value of ω for each SDG indicator, we did an out-of-sample predictive validity test in which we held out data for all countries from 2008 to 2016 and predicted values for this time period using the data from 1990 to 2007. We tested values of ω ranging from 0 to 2 in increments of 0·2 and chose the indicator-specific value of ω that minimised the root mean squared error (RMSE) in the held out data (2008–16). This was used to project each indicator to 2030. Appendix 1 provides the indicator specific values of ω used and further details on methods.

For HIV, we used an alternative approach. In many countries, antiretroviral therapy (ART) coverage, through large internal investments, substantial development assistance via programmes such as the President's Emergency Plan for AIDS Relief (PEPFAR),[36] and reductions in drug prices, has been scaled up considerably. If past trends are used to project future coverage, many countries would be projected to achieve 100% coverage by 2030. This ignores health system constraints in scaling up ART. For ART coverage, our projections were a function of projected ART price based on data from the Global Price Reporting Mechanism (GPRM),[37] projected government health expenditure as source,[38] and projected development assistance for health (DAH) for HIV or AIDS.[38] We bounded ART projections with an ART coverage frontier produced on the basis of income per capita to reflect health system constraints. We then used projected ART coverage to project HIV incidence hazard and HIV incidence using Spectrum.[39] Further detail on this method is in appendix 1.

Health-related SDG indices, health-related MDG indices, and health-related non-MDG indices

As in GBD 2015, we developed an overall health-related SDG index that is a function of the 37 health-related SDG indicators (referred to as the health-related SDG

	Health-related SDG indicator	Definition used in this analysis	Further details	SDG target	SDG target used in this analysis	Inclusion in MDG or non-MDG index
Goal 1: End poverty in all its forms everywhere						
Target 1.5: By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social, and environmental shocks, and disasters	Disaster mortality (1.5.1; same as indicators 11.5.1 and 13.1.1)	Death rate due to exposure to forces of nature (per 100 000 population)	Existing datasets do not comprehensively measure missing persons and people affected by natural disasters; we thus report on deaths due to exposure to forces of nature.	Undefined	··	Non-MDG
Goal 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture						
Target 2.2: By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children younger than 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women, and older people	Child stunting (2.2.1)	Prevalence of stunting in children younger than 5 years, %	Stunting is defined as below –2 SDs from the median height-for-age of the WHO reference population. No indicator modifications are required.	Eliminate by 2030	≤0·5%	MDG
Target 2.2 (as above)	Child wasting (2.2.2a)	Prevalence of wasting in children younger than 5 years, %	We have separated reporting for indicator 2.2.2 into wasting (2.2.2a) and overweight (2.2.2b). Wasting is defined as below –2 SDs from the median weight-for-height of the WHO reference population.	Eliminate by 2030	≤0·5%	MDG
Target 2.2 (as above)	Child overweight (2.2.2b)	Prevalence of overweight in children aged 2–4 years, %	We used the IOTF thresholds because the WHO cutoff at age 5 years can lead to an artificial shift in prevalence estimates when the analysis covers more age groups. Furthermore, considerably more studies use IOTF cutoffs, which allowed us to build a larger database for estimating child overweight.	Eliminate by 2030	≤0·5%	Non-MDG
Goal 3: Ensure healthy lives and promote wellbeing for all at all ages						
Target 3.1: By 2030, reduce the global maternal mortality ratio to less than 70 per 100 000 livebirths	Maternal mortality ratio (3.1.1)	Maternal deaths per 100 000 livebirths in women aged 10–54 years	No indicator modifications required	Reduce to <70 deaths per 100 000 livebirths by 2030	<70 deaths per 100 000 livebirths	MDG
Target 3.1 (as above)	Skilled birth attendance (3.1.2)	Proportion of births attended by skilled health personnel (doctors, nurses, midwives, or country-specific medical staff [eg, clinical officers]), %	No indicator modifications required	Universal access (100%)	≥99%	MDG
Target 3.2: By 2030, end preventable deaths of newborns and children younger than 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1000 livebirths and under-5 mortality to at least as low as 25 per 1000 livebirths	Under-5 mortality (3.2.1)	Probability of dying before the age of 5 years per 1000 livebirths	No indicator modifications required	Reduce to 25 deaths per 1000 livebirths or lower by 2030	≤25 deaths per 1000 livebirths	MDG

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	Health-related SDG indicator	Definition used in this analysis	Further details	SDG target	SDG target used in this analysis	Inclusion in MDG or non-MDG index
(Continued from previous page)						
Target 3.2 (as above)	Neonatal mortality (3.2.2)	Probability of dying during the first 28 days of life per 1000 livebirths	No indicator modifications required	Reduce to 12 deaths per 1000 livebirths or lower by 2030	≤12 deaths per 1000 livebirths	MDG
Target 3.3: By 2030, end the epidemics of AIDS, tuberculosis, malaria, and neglected tropical diseases and combat hepatitis, water-borne diseases, and other communicable diseases	HIV incidence (3.3.1)	Age-standardised rate of new HIV infections per 1000 population	We report HIV incidence of all populations and in terms of age-standardised rates	Eliminate by 2030	≤0·005 per 1000 population	MDG
Target 3.3 (as above)	Tuberculosis incidence (3.3.2)	Age-standardised rate of tuberculosis cases per 100 000 population	No indicator modifications required	Eliminate by 2030	≤0·5 per 100 000 population	MDG
Target 3.3 (as above)	Malaria incidence (3.3.3)	Age-standardised rate of malaria cases per 1000 population	No indicator modifications required	Eliminate by 2030	≤0·005 per 1000 population	MDG
Target 3.3 (as above)	Hepatitis B incidence (3.3.4)	Age-standardised rate of hepatitis B incidence per 100 000 population	No indicator modifications required	Undefined	··	Non-MDG
Target 3.3 (as above)	Prevalence of 15 neglected tropical diseases (3.3.5)	Age-standardised prevalence of the sum of 15 neglected tropical diseases, %	People requiring interventions against neglected tropical diseases is not well defined; thus this indicator is revised to the sum of the prevalence of 15 neglected tropical diseases currently measured in the GBD study: African trypanosomiasis, Chagas disease, cystic echinococcosis, cysticerosis, dengue, food-borne trematodiases, Guinea worm, intestinal nematode infections, leishmaniasis, leprosy, lymphatic filariasis, onchocerciasis, rabies, schistosomiasis, and trachoma.	Eliminate by 2030	≤0·5%	Non-MDG
Target 3.4: By 2030, reduce by one-third premature mortality from NCDs through prevention and treatment and promote mental health and wellbeing	Mortality due to a subset of NCDs (3.4·1)	Age-standardised death rate due to cardiovascular disease, cancer, diabetes, and chronic respiratory disease in populations aged 30–70 years per 100 000 population	No indicator modifications required	Reduce by one-third by 2030	Reduce by one-third	Non-MDG
Target 3.4 (as above)	Suicide mortality (3.4.2)	Age-standardised death rate due to self-harm per 100 000 population	No indicator modifications required	Reduce by one-third by 2030	Reduce by one-third	Non-MDG
Target 3.5: Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol	Alcohol use (3.5.2)	Risk-weighted prevalence of alcohol consumption, as measured by the SEV for alcohol use, %	For this indicator, we include three categories of alcohol consumption because national alcohol consumption per capita does not capture the distribution of use. The SEV for alcohol use is based on two primary dimensions: individual-level drinking (current drinkers and lifetime abstainers, and alcohol consumption by age and sex) and population-level consumption (L per capita of pure alcohol stock). The SEV then weights these categories with their corresponding relative risks, which translate to risk-weighted prevalences on a scale of 0% (no risk in the population) to 100% (the entire population experiences maximum risk associated with alcohol consumption).	Undefined	··	Non-MDG
Target 3.6: By 2020, halve the number of global deaths and injuries from road traffic accidents	Road injury mortality (3.6.1)	Age-standardised death rate due to road injuries per 100 000 population	No indicator modifications required	Reduce by one-half by 2020	Reduce by 50%	Non-MDG
Target 3·7: By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes	Family planning need met, modern contraception methods (3.7.1)	Proportion of women of reproductive age (15–49 years) who have their need for family planning satisfied with modern methods, %	No indicator modifications required	Universal access (100%)	≥99%	MDG

(Table continues on next page)

	Health-related SDG indicator	Definition used in this analysis	Further details	SDG target	SDG target used in this analysis	Inclusion in MDG or non-MDG index
(Continued from previous page)						
Target 3.7 (as above)	Adolescent birth rate (3.7.2)	Number of livebirths per 1000 women aged 10–14 years and women aged 15–19 years	No indicator modifications required	Undefined	..	MDG
Target 3.8: Achieve universal health coverage, including financial risk protection, access to quality essential health-care services, and access to safe, effective, quality, and affordable essential medicines and vaccines for all	Universal health coverage index (3.8.1)	Coverage of essential health services, as defined by a universal health coverage index of the coverage of nine tracer interventions and risk-standardised death rates from 32 causes amenable to personal health care	Tracer interventions included vaccination coverage (coverage of three doses of diphtheria-pertussis-tetanus, measles vaccine, and three doses of the oral polio vaccine or inactivated polio vaccine); met need for modern contraception; antenatal care coverage (one or more visits and four or more visits); skilled birth attendence coverage; in-facility delivery rates; and coverage of antiretroviral therapy among people living with HIV. The 32 causes amenable to personal health care, which compose the HAQ Index, included tuberculosis, diarrhoeal diseases, lower respiratory infections, upper respiratory infections, diphtheria, whooping cough, tetanus, measles, maternal disorders, neonatal disorders, colon and rectum cancer, non-melanoma cancer, breast cancer, cervical cancer, uterine cancer, testicular cancer, Hodgkin's lymphoma, leukaemia, rheumatic heart disease, ischaemic heart disease, cerebrovascular disease, hypertensive heart disease, peptic ulcer disease, appendicitis, hernia, gallbladder and biliary diseases, epilepsy, diabetes, chronic kidney disease, congenital heart anomalies, and adverse effects of medical treatment. We then scaled these 41 individual inputs on a scale of 0–100, with 0 reflecting the worst levels observed between 1990 and 2016 and 100 reflecting the best observed during this time. We took the arithmetic mean of these 41 scaled indicators so as to collectively capture a wide range of essential health services pertaining to reproductive, maternal, newborn, and child health; infectious diseases; NCDs; and service capacity and access.	Universal access (100%)	≥99%	Non-MDG
Target 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination	Mortality attributable to air pollution (3.9.1)	Age-standardised death rate attributable to household air pollution and ambient air pollution, per 100 000 population	No indicator modifications required	Undefined	..	Non-MDG
Target 3.9 (as above)	Mortality attributable to WaSH (3.9.2)	Age-standardised death rate attributable to unsafe WaSH, per 100 000 population	No indicator modifications required	Undefined	..	Non-MDG
Target 3.9 (as above)	Poisoning mortality (3.9.3)	Age-standardised death rate due to unintentional poisonings, per 100 000 population	No indicator modifications required	Undefined	..	Non-MDG
Target 3.a: Strengthen the implementation of the WHO Framework Convention on Tobacco Control in all countries, as appropriate	Smoking prevalence (3.a.1)	Age-standardised prevalence of daily smoking in populations aged 10 years and older, %	We report daily smoking due to data limitations regarding the systematic measurement of current smoking and to reflect populations aged 10 years and older.	Undefined	..	Non-MDG
Target 3.b: Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade-Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all	Vaccine coverage (3.b.1)	Coverage of eight vaccines, conditional on inclusion in national vaccine schedules, in target populations, %	Vaccines included diphtheria-pertussis-tetanus (three doses), measles (one dose), BCG, polio vaccine (three doses), hepatitis B (three doses), *Haemophilus influenzae* type b (three doses), pneumococcal conjugate vaccine (three doses), and rotavirus vaccine (two or three doses). We then used the geometric mean of coverage of these eight vaccines, based on their inclusion in the national vaccine schedule, to compute overall vaccine coverage.	Coverage of all target populations (100%)	≥99%	Non-MDG

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	Health-related SDG indicator	Definition used in this analysis	Further details	SDG target	SDG target used in this analysis	Inclusion in MDG or non-MDG index
(Continued from previous page)						
Goal 5: Achieve gender equality and empower all women and girls						
Target 5.2: Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation	Intimate partner violence (5.2.1)	Age-standardised prevalence of women aged 15 years and older who experienced physical or sexual violence by an intimate partner in the past 12 months, %	Data for exposure to subtypes of violence are not systematically available across locations and over time; we thus report on physical or sexual violence by an intimate partner.	Eliminate by 2030	≤0·5%	Non-MDG
Goal 6: Ensure availability and sustainable management of water and sanitation for all						
Target 6.1: By 2030, achieve universal and equitable access to safe and affordable drinking water for all	Water (6.1·1)	Risk-weighted prevalence of populations using unsafe or unimproved water sources, as measured by the SEV for unsafe water, %	Different types of unsafe water sources have correspondingly different relative risks associated with poor health outcomes; we thus report on the SEV for water, which captures the relative risk of different types of unsafe water sources and then combines them into a risk-weighted prevalence on a scale of 0% (no risk in the population) to 100% (the entire population experiences maximum risk associated with unsafe water).	Universal access to safe water (100%); 0% on the SEV for unsafe water	≤1%	MDG
Target 6.2: By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	Sanitation (6.2·1a)	Risk-weighted prevalence of populations using unsafe or unimproved sanitation, as measured by the SEV for unsafe sanitation, %	We have separated reporting for indicator 6.2.1 into sanitation (6.2.1a) and hygiene (6·2·1b). We had three mutually exclusive, collectively exhaustive categories for sanitation at the household level: households with piped sanitation (with a sewer connection); households with improved sanitation without a sewer connection (pit latrine, ventilated improved latrine, pit latrine with slab, composting toilet), as defined by the JMP; and households without improved sanitation (flush toilet that is not piped to sewer or septic tank, pit latrine without a slab or open pit, bucket, hanging toilet or hanging latrine, shared facilities, no facilities), as defined by the JMP.	Universal access to safe sanitation (100%); 0% on the SEV for unsafe sanitation	≤1%	MDG
Target 6.2 (as above)	Hygiene (6.2.1b)	Risk-weighted prevalence of populations without access to a handwashing facility, as measured by the SEV for unsafe hygiene, %	We have separated reporting for indicator 6.2.1 into sanitation (6.2.1a) and hygiene (6.2.1b). Access to a handwashing facility was defined as having an observed handwashing station with soap and water available in the household.	Universal access to handwashing facility (100%); 0% on the SEV for hygiene	≤1%	Non-MDG
Goal 7: Ensure access to affordable, reliable, sustainable, and modern energy for all						
Target 7.1: By 2030, ensure universal access to affordable, reliable, and modern energy services	Household air pollution (7.1.2)	Risk-weighted prevalence of household air pollution, as measured by the SEV for household air pollution, %	Existing datasets do not comprehensively measure population use of clean fuels and technology for heating and lighting across geographies; we thus report on the exposure to clean (or unclean) fuels used for cooking.	Universal access to improved fuels (100%); 0% on the SEV for household air pollution	≤1%	MDG
Goal 8: Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all						
Target 8.8: Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment	Disease burden attributable to occupational risks (8.8.1)	Age-standardised all-cause DALY rate attributable to occupational risks per 100 000 population	This indicator is reported as DALY rates attributable to occupational risks because DALYs combine measures of mortality and non-fatal outcomes into a singular summary measure, and occupational risks represent the full range of safety hazards that might be encountered in working environments.	Undefined	··	Non-MDG
Goal 11: Make cities and human settlements inclusive, safe, resilient, and sustainable						
Target 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations	Disaster mortality (11.5.1; same as indicators 1.5.1 and 13.1.1)	Death rate due to exposure to forces of nature per 100 000 population	Existing datasets do not comprehensively measure missing persons and people affected by natural disasters; we thus report on deaths due to exposure to forces of nature.	Undefined	··	Non-MDG

(Table continues on next page)

	Health-related SDG indicator	Definition used in this analysis	Further details	SDG target	SDG target used in this analysis	Inclusion in MDG or non-MDG index
(Continued from previous page)						
Target 11.6: By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	Mean $PM_{2·5}$ (11.6.2)	Population-weighted mean levels of $PM_{2·5}$, μg/m³	No indicator modifications required	Undefined	··	Non-MDG
Goal 13: Take urgent action to combat climate change and its impacts						
Target 13.1: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	Disaster mortality (13.1.1; same as indicators 1.5.1 and 11.5.1)	Death rate due to exposure to forces of nature (per 100 000 population)	Existing datasets do not comprehensively measure missing persons and persons affected by natural disasters; we thus report on deaths due to exposure to forces of nature.	Undefined	··	Non-MDG
Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels						
Target 16.1: Significantly reduce all forms of violence and related death rates everywhere	Homicide (16.1.1)	Age-standardised death rate due to interpersonal violence per 100 000 population	No indicator modifications required	Undefined	··	Non-MDG
Target 16.1 (as above)	Conflict and terrorism mortality (16.1·2)	Death rate due to conflict and terrorism per 100 000 population	No indicator modifications required	Undefined	··	Non-MDG
Target 16.1 (as above)	Violence prevalence (16.1.3)	Age-standardised prevalence of physical or sexual violence experienced by populations in the past 12 months, %	Data for exposure to psychological violence are not systematically available across locations and over time; we thus report on prevalence of physical or sexual violence.	Undefined	··	Non-MDG
Target 16.2: End abuse, exploitations, trafficking and all forms of violence against and torture of children	Childhood sexual abuse (16.2.3)	Age-standardised prevalence of women and men aged 18–29 years who experienced sexual violence by age 18 years, %	No indicator modifications required	Eliminate by 2030	≤0·5%	Non-MDG
Goal 17: Strengthen the means of implementation and revitalise the global partnership for sustainable development						
Target 17.19: By 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity-building in developing countries	Well-certified death registration (17.19.2c)	Well-certified deaths by a vital registration system among a country's total population, %	Indicator 17.19.2 involves three separate country-level components pertaining to demographic and health data collection and monitoring: status of conducting at least one population and housing census in the past 10 years; birth registration; and death registration. Although these data collection and monitoring systems are inter-connected, their actual status or functionality at a given time can vary. Subsequently, we have separated reporting on 17.19.2 into three indicators, and thus report death registration as 17.19.2c. Well-certified deaths were determined by three measures: completeness of death registration; fraction of deaths not assigned to major garbage codes (ie, causes that cannot or should not be underlying causes of death); and fraction of deaths assigned to detailed GBD causes.	80% of total deaths	≥80%	Non-MDG

Detailed descriptions of the data and methods used to estimate each health-related SDG indicator are in appendix 1. DALY=disability-adjusted life-year. GBD=Global Burden of Disease. HAQ Index=Healthcare Access and Quality Index. IOTF=International Obesity Task Force. JMP=Joint Monitoring Programme. MDG=Millennium Development Goal. NCDs=non-communicable diseases. SDG=Sustainable Development Goal. SEV=summary exposure value. WaSH=water, sanitation, and hygiene. $PM_{2·5}$=fine particulate matter smaller than 2.5 μm.

***Table*: Health-related goals, targets, and health-related SDG indicators used in the present analysis and further details regarding any indicator modifications, and inclusion in the health-related MDG index or health-related non-MDG index**

index), an index reflecting the 14 SDG health-related indicators previously included in the MDG monitoring framework (referred to as the MDG index), and one reflecting the 23 SDG health-related indicators not included in the MDGs (referred to as the non-MDG index).

A variety of approaches exist to create indices from multidimensional data. As in GBD 2015,[6] we adopted a preference-weighted approach that weights each indicator by expressed preferences for the relative importance of different indicators. We interpret the SDG targets to represent the expressed preferences of UN member

states and thus assume that each SDG target should be treated equally.

To combine indicators, we first transformed each indicator on a scale from 0 to 100. Scaling indicator values in this way allows comparisons to be made on the relative performance on very different SDG indicators and allows us to produce an overall health-related SDG index by calculating an arithmetic or geometric mean of the scaled values. For GBD 2016, we transformed each health-related SDG indicator on a scale from 0 to 100, in order from worst to best, with 0 being the 2·5th percentile value observed over the time period 1990–2030 (ie, including projected values) and 100 the 97·5th percentile value observed during this time. This was implemented in log-space for mortality and incidence rates.

To estimate the health-related SDG index, we first computed the geometric mean of each scaled health-related SDG indicator for a given target, followed by the geometric mean of resulting values across all SDG targets (reflecting the preference-weighted approach described above). The geometric mean allows indicators with very high values to partly compensate for low values on other indicators (referred to as partial substitutability). To avoid problems with indicator values close to 0, when computing indices we applied a floor of 1 to all indicators. The same process was used to construct the MDG and non-MDG indices. Results of sensitivity analyses based on alternative approaches to create the SDG, MDG, and non-MDG indices are detailed in appendix 1.

SDG indicator attainment

Of the 37 health-related indicators measured in GBD 2016, 24 had defined targets, with 21 having absolute targets to reach by 2030, and three featuring targets relative to 2015 levels (ie, SDG target 3.4, "By 2030, reduce by one third premature mortality from NCDs"). For these 24 indicators, we applied these thresholds to determine achievement by 2030 (or 2020, in the case of road injury mortality [SDG indicator 3.6.1]). 17 health-related indicators had targets citing "achieving elimination", "ending epidemics", or "reaching universal coverage or access". For these indicators we set target thresholds as at least 99% for universal coverage or access and achieving a rate of 0·000005 or less for measures of morbidity (ie, ≤0·005 per 1000 or ≤0·5 per 100 000) and 0·5% for prevalence. The table details the target thresholds or relative reductions applied for each indicator with a defined target.

Because some of these elimination targets have been operationalised in terms of reducing incidence or prevalence by 2030,[40] we applied a more conservative 80% reduction threshold from 2015 to 2030 for indicators with established elimination SDG targets and compared these results. We also used a threshold of 90% or more for indicators with universal coverage or access in this conservative target attainment scenario.[41]

Comparing performance on the health-related SDGs across the development spectrum

In addition to examining global patterns in SDG performance, we report on differences in the health-related SDG index and individual indicators across levels of development. To do this, we use the Sociodemographic Index (SDI), a summary measure of overall development that was originally introduced as part of GBD 2015.[30] SDI is based on income per capita, mean years of education among populations 15 years and older, and total fertility rates, on a scale of 0 to 1. We use the SDI quintiles established in the GBD study to compare performance and progress on the health-related SDGs. More details on the estimation of SDI can be found in accompanying GBD 2016 publications.[28–32]

Uncertainty analysis

GBD produces 1000 draws for all indicator estimates by location, age, and sex (when relevant) and for all years from 1990 to 2016. These draws from the posterior distribution represent uncertainty in the underlying data sources as well as the various steps in the estimation process. Further details on this are provided in the accompanying GBD 2016 papers[28–32] and in appendix 1 for each indicator. These 1000 draws are used to determine 95% uncertainty intervals (UIs) in each of the scaled SDG indicators, as well as the three indices, using simulation analysis.

To estimate uncertainty in SDG indicators and indices for the projected values, we applied the median rate of change chosen from the out-of-sample validity test to each of the 1000 draws of the indicator to estimate 1000 draws of each indicator for the time period 2017–30. Additionally, for each of the 1000 draws we allow for year-to-year deviation from the median rate of change on the basis of the variance across all draws.

Role of the funding source

The funder of the study had no role in the study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Health-related SDGs in 2016

Globally, the median health-related SDG index was 56·7 (IQR 31·9–66·8) in 2016, with marked country-level variation. Countries with the highest values on the health-related SDG index in 2016 were Singapore (86·8, 95% UI 84·6–88·9), Iceland (86·0, 84·1–87·6), and Sweden (85·6, 81·8–87·8). Countries with the lowest were Afghanistan (10·9, 9·6–11·9), the Central African Republic (11·0, 8·8–13·8), and Somalia (11·3, 9·5–13·1; figure 1). For many health-related indicators, in particular those associated with the MDG era, such as the maternal

mortality ratio (MMR), child stunting and wasting, malaria, and environmental risks, higher-SDI countries as expected performed better than lower-SDI countries. For other indicators, including childhood overweight, suicide mortality, harmful alcohol use, smoking, and interpersonal violence mortality, performance was much more heterogeneous across levels of SDI, with many high-SDI countries performing relatively poorly. These findings were exemplified by the USA, which fell below 50 on suicide mortality, harmful alcohol use, and interpersonal violence mortality in 2016. Notably, performance on vaccine coverage, a new indicator as part of the GBD SDG assessment, was generally high across the development spectrum with the exception of the lowest SDI countries; in fact, several middle-SDI countries such as Brazil had among the highest scores.

In 2016, the highest scores on the health-related SDG index were found among Nordic countries, the UK, a subset of western European countries, Singapore, Australia, Canada, and Israel, with these countries comprising the tenth decile of performance (figure 2). Several western European countries (eg, France, Spain, and Portugal), the USA, New Zealand, Japan, and South Korea occupied the next decile of highest performance on the health-related SDG index. The vast majority of countries in the first decile—places with the lowest scores on the health-related SDG index—were in sub-Saharan Africa, particularly western sub-Saharan Africa, as well as a subset of central and eastern sub-Saharan African countries. Afghanistan was the only country in the first decile outside of sub-Saharan Africa. Other regions showed sizeable differences on the health-related SDG index in 2016; for instance, in Latin America, Costa Rica scored as high as the ninth decile and several countries (ie, Colombia, Mexico, Panama, and Uruguay) were in the eighth decile, whereas Guyana scored as low as the fourth decile. A similar range was found in North Africa and the Middle East, spanning from Jordan in the eighth decile to Yemen in the second decile. China was in the seventh decile on the health-related SDG index in 2016, while Russia was in the fifth decile and India was in the fourth decile.

By comparing performance on the health-related SDG index in 2016 with total health expenditure and DAH per capita received from 2010 to 2014 (figure 3),[28,31] insights might be gleaned regarding the association between overall health funding and performance on the health-related SDG index and whether DAH is being directed toward those countries with the greatest need. Generally, total health expenditure is positively correlated with performance on the health-related SDG index; however, considerable variation exists at the same level of expenditure. For example, among countries with a health-related SDG index of 30 to 70, the association between total health expenditure per capita and performance varied massively, spanning at least a 7 times difference in spending with similar levels of performance on the health-related SDG index. For countries that received DAH between 2010–14, some of the most pronounced differences in cumulative DAH per capita received in the 2016 index were in sub-Saharan Africa, with several countries in southern sub-Saharan Africa posting nearly three times more cumulative DAH per capita than a number of countries in central and western sub-Saharan Africa. Most notably, some of the poorest performers on the health-related SDG index, such as the Central African Republic, South Sudan, Somalia, and Niger, received relatively little DAH.

Progress on UHC

Among the health-related indicators refined or added for GBD 2016, the UHC index (SDG indicator 3.8.1) saw the most substantive revision because it was expanded to represent a broader range of essential health services and to capture quality of care. From 2000 to 2016, performance on the UHC index generally improved throughout the world (figure 4 and appendix 2 p 5). Cambodia, Rwanda, Equatorial Guinea, Laos, Turkey, and China recorded the largest improvements since 2000, all recording an increase of 15 or more on the UHC index. Other countries with particularly pronounced progress on the UHC index included Timor-Leste, Bangladesh, Myanmar, and Nepal in Asia and Oceania; Ethiopia and Angola in sub-Saharan Africa; and Lebanon in north Africa and the Middle East. At the same time, a mixture of countries registered minimal progress on the UHC index since 2000. These included lower-SDI countries, such as Lesotho and the Central African Republic, as well as some of the highest-SDI countries, such as the USA and Andorra. In 2016, Switzerland, Iceland, and Finland had the highest UHC index performance, all exceeding 85 on a scale of 0–100, followed by Norway, Sweden, and Japan. Conversely, the lowest levels on the UHC index were in Somalia, the Central African Republic, and Afghanistan, which were all below 35, followed by South Sudan, Chad, and Guinea-Bissau.

Health-related SDGs in 2030

Based on trends from 1990 to 2016, projections of the health-related SDG index in 2030 generally showed gains (figure 5). Nonetheless, these projections also highlighted the potential for stagnated progress in places, as well as possible worsening of performance by 2030 if current trajectories are not addressed. Kazakhstan, Timor-Leste, Angola, Nigeria, and Swaziland were projected to have the largest improvements by 2030 on the basis of past trends. For most of these countries, projected gains in performance on the UHC index and for a number MDG-related indicators, including MMR, under-5 mortality, neonatal mortality, met need for family planning with modern contraception methods, and skilled birth attendance were shared contributing factors (appendix 2 pp 6–7). Kazakhstan had somewhat different patterns, where projections based on past trends for mortality rates from

incorporating the HAQ Index into our UHC measure for GBD 2016. Another priority area for GBD expansion is the increased ability to track key health indicators, not only at subnational administrative levels, but also as a continuous geospatial surface. Research on mapping inequalities in child mortality at a 5 km × 5 km resolution in Africa has leveraged the GBD study,[70] providing an example of the increasing ability to track SDG indicator attainment at levels beyond national averages.

Limitations

A number of specific limitations for SDG indicators exist, described in the underlying GBD papers as well as in appendix 1. Of note, for sanitation (a key determinant of health) we have used a proxy indicator based on measuring the fraction of the populations that have unimproved sanitation, improved sanitation without a sewer connection, and improved sanitation with a sewer connection. This does not take into account whether waste is safely managed or treated. For the vaccine coverage indicator, we used a proxy indicator based on the geometric mean of vaccine coverage of individual vaccines and did not explicitly account for the correlation structure that exists between individual vaccines.

As noted in more detail above, we have used a relatively simple approach for projecting SDG indicator values. Limitations also exist in terms of the construction of the health-related SDG index. Ideally, we would develop an index that scales indicator values to SDG target values. We have not implemented this in GBD 2016 for several reasons. First, 13 of the health-related SDG indicators do not presently specify a target. Second, a subset of SDG targets are relatively modest for many middle-SDI to high-SDI countries (eg, reducing MMR to <70 deaths per 100 000 livebirths), and the effect of rescaling to these targets is that any differences beyond the target are ignored. In constructing the health-related SDG index, we used the geometric rather than arithmetic mean. The geometric mean allows for partial substitutability (ie, poor performance on one indicator is only partially offset by good performance on another), while the arithmetic mean allows for complete substitutability (ie, poor performance on one indicator can be completely offset by good performance on another indicator). As a result, stagnating progress on some indicators—most notably indicators such as childhood overweight and harmful alcohol use—can have a notable effect on progress and our projections based on past trends of the overall health-related SDG index. As noted in appendix 1, constructing the health-related SDG index using the arithmetic mean suggests somewhat more optimistic but qualitatively similar progress on the health-related SDGs as measured by the index, with no country showing a decline. As part of future iterations of the GBD we will continue to test and refine alternative index construction approaches that can take into account SDG targets.

Our assessment reflects ongoing gaps in data availability and coverage across countries for some indicators and remains a major limitation to any SDG monitoring effort, including GBD. For example, data for the violence indicators are sparse, particularly for non-intimate partner violence, men as victims of sexual violence, and psychological violence. Measurement issues, such as the variability and accuracy of self-report of different types of violence across settings, pose additional challenges. Limitations also exist for the water, sanitation, and hygiene indicators, particularly in view of the relative absence of data to estimate safe sanitation management. A benefit of the GBD study is that it can help identify these data gaps, both over time and by location, and provide an interim solution to data gaps through the use of standardised estimation approaches. Nevertheless, the GBD is not, and should not be, a replacement for investing in high-quality, routine health information systems that are crucial for measuring and evaluating SDG progress at national and subnational levels. Last, any limitations of GBD 2016 relevant to the 37 currently measured health-related SDG indicators apply.[28–32]

Conclusion

Understanding where countries are, and where they are likely to go on the basis of past trends, is essential to guide strategic and investment decisions to achieve the SDG agenda by 2030. With this updated GBD analysis of the SDGs, we measure 37 of the 50 health-related SDG indicators from 1990 to 2016, and provide projections of SDG attainment by 2030 on the basis of past trends. For a subset of indicators, such as under-5 mortality and neonatal mortality, MMR, and malaria, projected levels of SDG achievement are promising, particularly among higher-SDI countries. However, these more positive projections for SDG attainment appear to be the exception, with most countries, especially countries in western and central sub-Saharan Africa and low-SDI countries, facing a challenging road toward SDG achievement by 2030 on the basis of current trajectories. It is increasingly clear that the health-related SDG agenda hinges upon markedly accelerating progress, particularly among the world's poorest populations. Succeeding in this endeavour is not yet an impossibility—nonetheless, it will demand extraordinary financial and political commitment by national and international agencies alike to ensure that truly no one is left behind in 2030.

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Contributors

Please see the appendix 1 for more detailed information about individual authors' contributions to the research, divided into the following categories: managing the estimation process; writing the first draft of the manuscript; providing data or critical feedback on data sources; developing methods or computational machinery; applying analytical methods to produce estimates; providing critical feedback on methods or results; drafting the work or revising it critically for important intellectual content; extracting, cleaning, or cataloguing data; designing or coding figures and tables; and managing the overall research enterprise.

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