Measuring the health-related Sustainable Development Goals in 188 countries: a baseline analysis from the Global Burden of Disease Study 2015

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Summary

Background In September, 2015, the UN General Assembly established the Sustainable Development Goals (SDGs). The SDGs specify 17 universal goals, 169 targets, and 230 indicators leading up to 2030. We provide an analysis of 33 health-related SDG indicators based on the Global Burden of Diseases, Injuries, and Risk Factors Study 2015 (GBD 2015).

Methods We applied statistical methods to systematically compiled data to estimate the performance of 33 health-related SDG indicators for 188 countries from 1990 to 2015. We rescaled each indicator on a scale from 0 (worst observed value between 1990 and 2015) to 100 (best observed). Indices representing all 33 health-related SDG indicators (health-related SDG index), health-related SDG indicators included in the Millennium Development Goals (MDG index), and health-related indicators not included in the MDGs (non-MDG index) were computed as the geometric mean of the rescaled indicators by SDG target. We used spline regressions to examine the relations between the Socio-demographic Index (SDI, a summary measure based on average income per person, educational attainment, and total fertility rate) and each of the health-related SDG indicators and indices.

Findings In 2015, the median health-related SDG index was 59·3 (95% uncertainty interval 56·8–61·8) and varied widely by country, ranging from 85·5 (84·2–86·5) in Iceland to 20·4 (15·4–24·9) in Central African Republic. SDI was a good predictor of the health-related SDG index (r^2=0·88) and the MDG index (r^2=0·92), whereas the non-MDG index had a weaker relation with SDI (r^2=0·79). Between 2000 and 2015, the health-related SDG index improved by a median of 7·9 (IQR 5·0–10·4), and gains on the MDG index (a median change of 10·0 [6·7–13·1]) exceeded that of the non-MDG index (a median change of 5·5 [2·1–8·9]). Since 2000, pronounced progress occurred for indicators such as met need with modern contraception, under-5 mortality, and neonatal mortality, as well as the indicator for universal health coverage tracer interventions. Moderate improvements were found for indicators such as HIV and tuberculosis incidence, minimal changes for hepatitis B incidence took place, and childhood overweight considerably worsened.

Interpretation GBD provides an independent, comparable avenue for monitoring progress towards the health-related SDGs. Our analysis not only highlights the importance of income, education, and fertility as drivers of health improvement but also emphasises that investments in these areas alone will not be sufficient. Although considerable progress on the health-related MDG indicators has been made, these gains will need to be sustained and, in many cases, accelerated to achieve the ambitious SDG targets. The minimal improvement in or worsening of health-related indicators beyond the MDGs highlight the need for additional resources to effectively address the expanded scope of the health-related SDGs.

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Background

In September, 2015, the UN General Assembly adopted "Transforming our World: The 2030 Agenda for Sustainable Development", a resolution outlining a new framework to form the cornerstone of the sustainable development agenda for the period leading up to 2030.[1] This new framework replaced the Millennium Development Goal (MDG) framework that expired in 2015, establishing 17 universal goals and 169 targets referred to as the Sustainable Development Goals (SDGs). The SDGs substantially broaden the development agenda beyond the MDGs and are expected to frame UN member state policies over the next 15 years. To measure progress towards achieving the goals, the UN Statistical Commission created the Inter-Agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs) with a mandate to draft an indicator framework that aligns with the targets. The IAEG-SDGs announced a total of 230 indicators to measure achievement of the 169 targets.[2] Health is a core dimension of the SDGs; goal 3 aims to "ensure healthy lives and promote wellbeing for all at all ages". Health-related indicators—ie, indicators directly pertaining to health services, health outcomes, and environmental, occupational, behavioural, or metabolic

Research in context

Evidence before this study
Since the adoption of the Sustainable Development Goals (SDGs) in September, 2015, demand to establish independent, robust avenues for monitoring progress for the SDGs has escalated. However, substantial challenges exist in undertaking comprehensive and comparable assessments of health-related SDG indicators to monitor and guide development agendas and health policy implementation.

Added value of this study
The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) features more than 1870 collaborators from 124 countries and three territories and provides an independent analytical platform through which levels of health-related SDG indicators can be assessed across geographies and over time in a comparable manner. Drawing from GBD, we provide the measurement of 33 of the 47 health-related SDG indicators and introduce an overall health-related SDG index for 188 countries from 1990 to 2015.

Implications of all the available evidence
GBD and its analytical framework allow detailed analyses of country-level performance across health-related SDG indicators and over time. This information can be used to identify high-performing and low-performing countries, inform policy decisions, guide resource allocation, and monitor progress towards the health-related SDGs. The varied historical progress in improving a subset of health-related SDG indicators and rising prevalence of risks such as child overweight underscores the complex health landscape the world faces in the SDG era.

risks with well established causal connections to health—are also present in ten of the other 16 goals.[34] Across these 11 goals, there are 28 health-related targets with a total of 47 health-related indicators.

The SDGs were developed through a highly consultative and iterative process that included multiple meetings with expert groups, civil society, and governments. However, the process of developing the SDGs and the accompanying goals, targets, and indicators has not been without its critics. In both scientific settings and the news media, the common refrain has been that the SDGs are a long list of vague goals that lack clear, realistic, and measurable targets and indicators,[5–11] and that they are not accompanied by a clear theory of change[12] articulating how the pieces fit together.[3] In view of the potential importance of the SDGs in directing national policies and donor investments, there has also been intense debate about the selection of targets and indicators;[12] despite the lengthy list, some think that the SDGs are missing key areas of development, ranging from prohibition of forced labour[13] to improvement of mental health.[14–16] Concerns have also been expressed about the feasibility of measuring the 230 proposed indicators.[5,6,17] Indeed, measurement of countries' current status and progress towards meeting the SDG targets will be an enormous task and will require collective action across a range of national and international organisations, both governmental and non-governmental. The difficulties of measurement are also further compounded by persistent problems of data availability, quality, and comparability across a host of indicators.[4,18] Furthermore, measurement of development indicators is accompanied by a high potential for political entanglement, which can lead to distorted estimates.[19–22] Independent monitoring of the SDG indicators will be crucial if they are to be used to accurately evaluate progress to ensure accountability and drive national and international development agendas towards meeting the SDGs.[4,23–26]

Despite these concerns, increasing work has been done in the past decade to generate independent, comparable, valid, and consistent measurements of development indicators.[27–32] To measure progress on the SDGs, these existing efforts will need to be leveraged, particularly those that provide comparable assessments of health outcomes and risks across countries and over time. The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) is a primary example of such an initiative. GBD is an open, collaborative, independent study to comprehensively measure epidemiological levels and trends of disease and risk factor burden worldwide, with more than 1870 individual collaborators from 124 countries and three territories across the full range of development. GBD uses a highly standardised approach to overcome challenges of inconsistent coding and indicator definitions across countries, missing and conflicting data, and time lags in measurement and estimation. Of the 47 health-related indicators included as part of the SDGs, estimates for 33 indicators are presently included as part of GBD. The GBD study also has several mechanisms to ensure independence, including the GBD Scientific Council that meets regularly to review all methods and major data changes, and the Independent Advisory Committee that meets twice yearly to review GBD progress and provide recommendations for strengthening GBD estimates.[33]

In this analysis, while acknowledging the continued debate about the structure, selection, and construction of SDG indicators, we used the GBD study to assess the current status of these 33 health-related SDG indicators. With this baseline assessment, we developed and estimated a summary indicator for the health-related SDG indicators and documented historical trends for this summary indicator. With the GBD results, we identified countries with the largest improvements between 1990 and 2015 to inform roadmaps and provide a basis for monitoring the health-related SDG indicators.

Methods

Overview of GBD

GBD is an annual effort to measure the health of populations at regional, country, and selected subnational levels.[33] GBD produces estimates of mortality and morbidity by cause, age, sex, and country for the period 1990 to the most recent year, reflecting all available data sources adjusted for bias. GBD also measures many health system characteristics, risk factor exposure, and mortality and morbidity attributable to these risks. In addition to providing highly detailed standardised information for many outcomes and risks, various summary measures are also computed, including disability-adjusted life-years (DALYs) and healthy life expectancy. For the present analysis, we used estimates from GBD 2015 to provide a baseline assessment for 188 countries. Further details on GBD 2015, which covers 1990–2015, are available elsewhere.[34–39]

Indicators, definitions, and measurement approach

We defined health-related SDG indicators as indicators for health services, health outcomes, and environmental, occupational, behavioural, and metabolic risks with well established causal connections to health. Many of the 47 health-related SDG indicators selected by the IAEG-SDGs are produced as part of GBD. Table 1 outlines the ten goals, corresponding to 21 health-related targets and 33 health-related indicators included in this present iteration of GBD. This table also outlines the definition of the indicator used in this analysis; detailed descriptions of the estimation methods and data sources are given in the methods appendix pp 10–311. For the 14 health-related indicators that were not included in this analysis, their prospects for measurement in future iterations of GBD are described in table 2.

Direct outputs of GBD that are health-related SDG indicators include mortality disaggregated by age (under-5 and neonatal) and cause (maternal, cardiovascular disease, cancer, diabetes, chronic respiratory diseases, road injuries, self-harm, unintentional poisonings, exposure to forces of nature, interpersonal violence, and collective violence and legal intervention [ie, deaths due to law enforcement actions, irrespective of their legality]), as well as disease incidence (HIV, malaria, tuberculosis, and hepatitis B) and prevalence (neglected tropical diseases). The GBD comparative risk assessment includes measurement of exposure prevalence included as health-related SDG indicators (under-5 stunting, wasting, and overweight; tobacco smoking; harmful alcohol use; intimate partner violence; unsafe water, sanitation, and hygiene; household air pollution; and ambient particulate matter pollution), as well as deaths or disease burden attributable to risk factors selected as health-related SDG indicators (unsafe water, sanitation, and hygiene; household air pollution and ambient particulate matter pollution; and occupational risks).

Underlying GBD outputs are a range of additional health determinants that contribute to the estimation of morbidity and mortality, for which data are systematically compiled and estimates are produced. For example, GBD comprehensively analyses data from household surveys on vaccine coverage and combines survey estimates with reported administrative data to produce time series of vaccine coverage for all countries from 1990 to 2015. Estimates of vaccine coverage are then included as predictors of vaccine-preventable morbidity and mortality in GBD. Additional health indicators produced as part of GBD and included as health-related SDG indicators in this analysis are: met need with modern contraception among women of reproductive age, adolescent birth rate, skilled birth attendance coverage, and universal health coverage (UHC) tracer interventions. For UHC tracer interventions, we developed an index based on the coverage of a set of UHC tracer interventions: met need with modern contraception; antenatal care (one or more visits and four or more visits); skilled birth attendance coverage; in-facility delivery rates; vaccination coverage (three doses of diphtheria–pertussis–tetanus, measles vaccine, and three doses of oral polio vaccine or inactivated polio vaccine); tuberculosis case detection rate; coverage of antiretroviral therapy for populations living with HIV, and coverage of insecticide-treated nets for malaria-endemic countries.

For selected indicators proposed by the IAEG-SDGs, we made modifications to the definition for clarity or on the basis of the definition used in GBD (table 1). For example, Indicator 2.2.2 proposes a measure of malnutrition that combined prevalence of wasting and overweight among children under age 5 years. As childhood wasting and overweight have very different determinants, we opted to report them separately. For childhood overweight, we report prevalence in children aged 2–4 years, the definition used in GBD based on thresholds set by the International Obesity Task Force.[40]

Further details on the estimation and data sources used for all indicators, compliant with Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER),[41,42] are included in the methods appendix pp 10–311.

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

To identify broad patterns and more easily track general progress, we developed an overall health-related SDG index that is a function of the 33 health-related SDG indicators (referred to as the health-related SDG index). We also constructed two related indices: one reflecting the SDG health-related indicators previously included in the MDG monitoring framework (referred to as the MDG index) and one reflecting SDG health-related indicators not included in the MDGs (referred to as the non-MDG index).

	Health-related SDG indicator	Definition used in this analysis	Further details	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 (1.5.1; same as Indicators 11.5.1 and 13.1.2)	Age-standardised death rate due to exposure to forces of nature, per 100 000 population	Existing datasets do not comprehensively measure missing people and people affected by natural disasters. We revised this indicator to exposure to forces of nature and reported in age-standardised rates	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 under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women, and older persons	Stunting (2.2.1)	Prevalence of stunting in children under age 5 years, %	Stunting is defined as below –2 SDs from the median height-for-age of the reference population. No indicator modifications required	MDG
Target 2.2 (as above)	Wasting (2.2.2a)	Prevalence of wasting in children under age 5 years, %	Wasting is defined as below –2 SDs from the median weight-for-height of the reference population. We separated reporting for indicator 2.2.2 into wasting (2.2.2a) and overweight (2.2.2b)	MDG
Target 2.2 (as above)	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 than WHO cutoffs, which allowed us to build a larger database for estimating child overweight. We separated reporting for indicator 2.2.2 into wasting (2.2.2a) and overweight (2.2.2b)	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	No indicator modifications required	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	MDG
Target 3.2: By 2030, end preventable deaths of newborns and children under 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 age 5 years per 1000 livebirths	No indicator modifications required	MDG
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	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 (3.3.1)	Age-standardised rate of new HIV infections, per 1000 population	We revised this indicator to HIV incidence of all populations and reported in age-standardised rates	MDG
Target 3.3 (as above)	Tuberculosis (3.3.2)	Age-standardised rate of new and relapsed tuberculosis cases, per 1000 population	No indicator modifications required	MDG
Target 3.3 (as above)	Malaria (3.3.3)	Age-standardised rate of malaria cases, per 1000 population	No indicator modifications required	MDG
Target 3.3 (as above)	Hepatitis B (3.3.4)	Age-standardised rate of hepatitis B incidence, per 100 000 population	No indicator modifications required	Non-MDG
Target 3.3 (as above)	Neglected tropical diseases (3.3.5)	Age-standardised prevalence of neglected tropical diseases, per 100 000 population	People requiring interventions against neglected tropical diseases are not well defined; thus, we revised this indicator to the sum of the prevalence of 14 neglected tropical diseases currently measured in GBD: African trypanosomiasis, Chagas disease, cystic echinococcosis, cysticerosis, dengue, food-borne trematodiases, intestinal nematode infections, leishmaniasis, leprosy, lymphatic filariasis, onchocerciasis, rabies, schistosomiasis, and trachoma	Non-MDG

(Table 1 continues on next page)

	Health-related SDG indicator	Definition used in this analysis	Further details	Inclusion in MDG or non-MDG index
(Continued from previous page)				
Target 3.4: By 2030, reduce by one-third premature mortality from NCDs through prevention and treatment, and promote mental health and wellbeing	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	Non-MDG
Target 3.4 (as above)	Suicide (3.4.2)	Age-standardised death rate due to self-harm, per 100 000 population	No indicator modifications required	Non-MDG
Target 3.5: Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol	Alcohol (3.5.2)	Risk-weighted prevalence of alcohol consumption, as measured by the SEV for alcohol use, %	We revised this indicator to include six categories of alcohol consumption because national alcohol consumption per person does not capture the distribution of use. The SEV for alcohol use is based on two primary dimensions and subcategories of each: individual-level drinking (current drinkers, lifetime drinkers, lifetime abstainers, and alcohol consumption by current drinkers) and drinking patterns (binge drinkers and frequency of binge drinks). The SEV then weights these categories with their corresponding relative risks, which translates to a risk-weighted prevalence on a scale of 0% (no risk in the population) to 100% (the entire population experiences maximum risk associated with alcohol consumption)	Non-MDG
Target 3.6: By 2020, halve the number of global deaths and injuries from road traffic accidents	Road injuries (3.6.1)	Age-standardised death rate due to road traffic injuries, per 100 000 population	No indicator modifications required	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 (3.7.1)	Proportion of women of reproductive age (15–49 years) who have their need for family planning satisfied with modern methods, % women aged 15–49 years	No indicator modifications required	MDG
Target 3.7 (as above)	Adolescent birth rate (3.7.2)	Birth rates for women aged 10–14 years and women aged 15–19 years, number of livebirths per 1000 women aged 10–14 years and women aged 15–19 years	No indicator modifications required	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 tracer (3.8.1)	Coverage of universal health coverage tracer interventions for prevention and treatment services, %	Tracer interventions included immunisation coverage (ie, coverage of three doses of diphtheria-pertussis–tetanus, measles vaccine, and three doses of oral polio vaccine or inactivated polio vaccine), met need with modern contraception, antenatal care coverage (one or more visits and four or more visits), skilled birth attendance, in-facility delivery rates, coverage of antiretroviral therapy for people living with HIV, tuberculosis case detection rate, and coverage of insecticide-treated nets in malaria-endemic countries	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	Air pollution mortality (3.9.1)	Age-standardised death rate attributable to household air pollution and ambient air pollution, per 100 000 population	No indicator modifications required	Non-MDG
Target 3.9 (as above)	WaSH mortality (3.9.2)	Age-standardised death rate attributable to unsafe WaSH, per 100 000 population	No indicator modifications required	Non-MDG
Target 3.9 (as above)	Poisons (3.9.3)	Age-standardised death rate due to unintentional poisonings, per 100 000 population	No indicator modifications required	Non-MDG

	Health-related SDG indicator	Definition used in this analysis	Further details	Inclusion in MDG or non-MDG index
(Continued from previous page)				
Target 3.a: Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate	Smoking (3.a.1)	Age-standardised prevalence of daily smoking in populations aged 10 years and older, % population aged 10 years and older	We revised this indicator to daily smoking because of data limitations regarding the systematic measurement of current smoking and to reflect populations aged 10 years and older	Non-MDG
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 intimate partner violence, % women aged 15 years and older	Existing datasets do not comprehensively measure the status of ever-partnered women relative to never-partnered women; therefore, the denominator was revised to all women aged 15 years and older. Data on exposure to subtypes of violence are not systematically available across geographies and over time	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 different relative risks associated with poor health outcomes; thus, we revised this indicator to 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)	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 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, or 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, or no facilities), as defined by the JMP	MDG
Target 6.2 (as above)	Hygiene (6.2.1b)	Risk-weighted prevalence of populations with unsafe hygiene (no handwashing with soap), as measured by the SEV for unsafe hygiene, %	Safe hygiene practices were defined as handwashing with soap and water following toilet use or contact with excreta. We separated reporting for indicator 6.2.1 into sanitation (6.2.1a) and hygiene (6.2.1b)	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; thus, we revised this indicator to focus on exposure to clean (or unclean) fuels used for cooking	Non-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	Occupational risk burden (8.8.1)	Age-standardised all-cause DALY rate attributable to occupational risks, per 100 000 population	We revised this indicator to the DALY rate 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 could be encountered in working environment	Non-MDG

(Table 1 continues on next page)

	Health-related SDG indicator	Definition used in this analysis	Further details	Inclusion in MDG or non-MDG index
(Continued from previous page)				
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 (11.5.1; same as Indicators 1.5.1 and 13.1.2)	Age-standardised death rate due to exposure to forces of nature, per 100 000 population	Existing datasets do not comprehensively measure missing people and people affected by natural disasters; we revised this indicator to exposure to forces of nature and reported in age-standardised rates	Non-MDG
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 PM2·5 (11.6.2)	Population-weighted mean levels of PM2·5, µg/m³	No indicator modifications required	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 (13.1.2; same as Indicators 1.5.1 and 11.5.1)	Age-standardised death rate due to exposure to forces of nature, per 100 000 population	Existing datasets do not comprehensively measure missing people and people affected by natural disasters; we revised this indicator to exposure to forces of nature and reported in age-standardised rates	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	Violence (16.1.1)	Age-standardised death rate due to interpersonal violence, per 100 000 population	Existing datasets do not comprehensively measure displacement and migratory status of victims of intentional homicide; we revised this indicator to deaths due to interpersonal violence (ie, homicide)	Non-MDG
Target 16.1 (as above)	War (16.1.2)	Age-standardised death rate due to collective violence and legal intervention, per 100 000 population	Existing datasets do not comprehensively measure the displacement status of deaths due to conflict; we revised this indicator to deaths due to collective violence and legal intervention (ie, war)	Non-MDG

Detailed descriptions of the data sources and methods used to estimate each health-related SDG indicator are in the methods appendix pp 10–311. SDG=Sustainable Development Goal. MDG=Millennium Development Goal. IOTF=International Obesity Task Force. GBD=Global Burden of Disease Study. NCDs=non-communicable diseases. SEV=summary exposure value. WaSH=water, sanitation, and hygiene. JMP=Joint Monitoring Program. DALY=disability-adjusted life-year. PM2·5=fine particulate matter smaller than 2·5 µm.

Table 1: Health-related SDG goals and targets proposed by the Inter-Agency and Expert Group on SDG Indicators, and health-related SDG indicators used in this analysis

Three broad approaches can be used to create composite measures: normative, preference weighted, and statistical. Normative approaches combine each indicator based on first principles or an over-riding construct such as the contribution of each indicator to overall health. Preference-weighted approaches weight each indicator by expressed or elicited social preferences for the relative importance of different indicators. Statistical approaches seek to reduce a long set of variables or indicators into common components of variance using methods such as principal component analysis or factor analysis. In this case, because the SDGs reflect the collective vision of UN member states, we used a preference-weighted approach, assuming that each SDG target should be treated equally.

To combine indicators, we adopted methods used to construct the Human Development Index,[43] which include rescaling each indicator on a scale from 0 to 100 and then combining indicators using the geometric mean. The geometric mean allows indicators with very high values to partly compensate for low values on other indicators (referred to as partial substitutability). In the methods appendix pp 312–13, we describe results from alternative index construction methods (ie, principal

component analysis; the arithmetic mean across targets referred to as complete substitutability; and the minimum value across targets referred to as zero substitutability). Quantitative targets for each of the health-related SDG indicators are not universally specified. As a result, we rescaled each health-related SDG indicator on a scale from 0 to 100, with 0 being the lowest (worst) value observed and 100 being the highest (best) value observed over the time period 1990–2015. We log-transformed mortality and morbidity before rescaling. We then estimated the health-related SDG index by first computing the geometric mean of each rescaled health-related SDG indicator for a given target, followed by the geometric mean of resulting values across all SDG targets. To avoid problems with indicator values close to 0, when computing indices we applied a floor of one to all indicators. This analytic approach weights each of the health-related SDG targets equally. In addition to the health-related SDG index, we also used the same methods to construct an index that represents 14 health-related SDG indicators that were previously MDG indicators and an index representing 19 non-MDG indicators (table 1). Uncertainty in the indicator and indices values was computed using a simulation analysis.

	Health-related SDG indicator	Measurement needs and strategy
Goal 3: Ensure healthy lives and promote wellbeing for all at all ages		
Target 3.5: Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol	3.5.1: Coverage of treatment interventions (pharmacological, psychosocial and rehabilitation and aftercare services) for substance use disorders	Prevalence of specific substance use disorders (opioid use disorders, cocaine use disorders, amphetamine use disorders, and cannabis use disorders), as well as alcohol use disorders, are presently estimated as part of GBD. Systematic reviews on coverage of specific interventions (eg, opioid substitution therapy) are in progress by GBD collaborators
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	3.8.2: Number of people covered by health insurance or a public health system per 1000 population	Omission of information on insurance depth and status of user fees within the public health system might limit the applications of this indicator. Construction of proxy measures of health-care use, for both outpatient and hospital care, by country and over time is feasible as part of future iterations of GBD and is likely to be an improved measurement strategy
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 TRIPS regarding flexibilities to protect public health, and, in particular, provide access to medicines for all	3.b.1: Proportion of the population with access to affordable medicines and vaccines on a sustainable basis. The recommended measure is percentage of health facilities with essential medicines and life-saving commodities in stock	Across all geographies and over time, comparable data on the stocking and stock-out rates of essential medicines and vaccines for all facility types (hospitals, primary care facilities, pharmacies, and other health-care outlets) and facility ownership (public, private, informal) are not available at present. In the absence of robust measures of stock-outs in both the public and private sectors across countries and over time, the measurement strategy for producing comparable results for this indicator is unclear. Furthermore, the proposed indicator stipulates measurement of not only access to medicines and vaccines, but also access to affordable medicines and vaccines. No comprehensive and comparable datasets on the status of essential medicine and vaccine affordability, in addition to their stocks, presently exist
Target 3.b (as above)	3.b.2: Total net official development assistance to the medical research and basic health sectors	DAH is currently assessed within a comprehensive, comparable analytical framework by source, channel, recipient country, and health focus area from 1990 to 2015; however, funding specifically for medical research (eg, research and development of vaccines and medicines, as described in Target 3.b) is not systematically available across source and recipient countries. Additionally, the appropriate assessment of country-level performance remains unclear (eg, whether countries that receive high levels of DAH for medical research are equivalent, in terms of indicator performance, to countries that disperse high levels of DAH for medical research)
Target 3.c: Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States	3.c.1: Health worker density and distribution, as measured by number of health workers per 1000 population by cadre. Cadres include generalist medical practitioners, specialist medical practitioners (surgeons, anaesthetists, obstetricians, emergency medicine specialists, cardiologists, paediatricians, psychiatrists, ophthalmologists, gynaecologists, etc), nursing and midwifery professionals, and traditional and complementary medicine professionals, among others	A systematic analysis of population census data and Labour Force Surveys is possible as part of future iterations of GBD. The total quantity of individual health worker cadres that could be comparably assessed by geography and by year will be a function of the availability of detailed International Labour Organization occupational codes across geographies and survey iteration
Target 3.d: Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks	3.d.1: International Health Regulations (IHR) capacity and health emergency preparedness. The WHO-recommended measure is the percentage of 13 core capacities that have been attained at a specific time (IHR core capacity index). The 13 core capacities are (1) national legislation, policy, and financing; (2) coordination and national focal point communications; (3) surveillance; (4) response; (5) preparedness; (6) risk communication; (7) human resources; (8) laboratory; (9) points of entry; (10) zoonotic events; (11) food safety; (12) chemical events; and (13) radionuclear emergencies	Comprehensive and comparable data for all components of the IHR core capacity index, for all geographies and over time, are not available at present. Specific core capacities, such as zoonotic events, could be assessed as part of future iterations of GBD; other core capacities, such as coordination and national focal point communications, have no clear measurement strategy beyond self-report from country representatives or secondary research on policy status and types of surveillance systems available, among others

(Table 2 continues on next page)

Relations between health-related SDG indicators and the Socio-demographic Index and healthy life expectancy

As part of GBD 2015, we assessed cause-specific disease burden and risk exposure along the development spectrum, providing context on expected changes as countries progress to higher levels of income per person, higher educational attainment, and lower fertility.[34,37–39] We conducted a similar analysis by examining the relations of the overall health-related SDG index and each of the individual health-related SDG indicators

	Health-related SDG indicator	Measurement needs and strategy
(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	5.2.2: Proportion of women and girls aged 15 years and older subjected to sexual violence by persons other than an intimate partner in the previous 12 months, by age and place of occurrence	Prevalence of intimate partner violence among women and girls aged 15 years and older is currently estimated as part of GBD. An updated systematic review of the literature, data re-extraction, and analysis are needed to specifically quantify prevalence of sexual violence (separately or in addition to physical violence, or both) and by persons other than an intimate partner. Data availability by geography by year on the latter, sexual violence by persons other than intimate partners, might be limited
Target 5.6: Ensure universal access to sexual and reproductive health and reproductive rights as agreed in accordance with the Programme of Action of the International Conference on Population and Development and the Beijing Platform for Action and the outcome documents of their review conferences	5.6.1: Proportion of women aged 15–49 years who make their own informed decisions regarding sexual relations, contraceptive use, and reproductive health care	The proportion of women who make their own informed decisions regarding all three dimensions of this indicator—sexual relations, contraceptive use, and reproductive health care—are included in the Demographic and Health Survey (DHS) series. Data availablility for non-DHS countries is unclear. The feasibility of measuring this indicator as part of future iterations of GBD is under review at present
Target 5.6 (as above)	5.6.2: Number of countries with laws and regulations that guarantee women aged 15–49 access to sexual and reproductive health care, information, and education	Across all geographies and over time, comprehensive and comparable data documenting the status of laws and regulations regarding access to sexual and reproductive health care, information, and education do not exist at present. Compiling the past and current status of such laws and regulations might be possible; however, systematic assessment of their depth or intensity, enforcement, and effectiveness in guaranteeing access to reproductive health care, information, and education might be challenging across countries and over time
Goal 6: Ensure availability and sustainable management of water and sanitation for all		
Target 6.3: By 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated waste water, and substantially increasing recycling and safe reuse globally	6.3.1: Proportion of waste water safely treated. UN Water defines this indicator as the proportion of waste water generated by both households (sewage and faecal sludge), as well as economic activities (based on ISIC categories) safely treated compared to total waste water generated both through households and economic activities. While the definition conceptually includes waste water generated from all economic activities, monitoring will focus on waste water generated from hazardous industries (as defined by relevant ISIC categories)	Across all geographies and over time, comprehensive and comparable data containing information on total waste water, as generated by both households and non-household entities (however they are to be defined), and waste water treatment status do not exist at present. UN Water suggests there will be sufficient data to generate estimates of global and regional levels of safely treated waste water by 2018; however, in the absence of more country-level data, it is difficult to determine the representativeness of such global and regional estimates
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	16.1.3: Proportion of population subjected to physical, psychological, or sexual violence in the previous 12 months	Prevalence of intimate partner violence among women and girls aged 15 years and older is currently estimated as part of GBD, as are the incidence and prevalence of interpersonal violence among all populations. An expanded systematic review of the literature and available data sources for all types of violence (physical, psychological, and sexual) for both men and women of all ages would be required for inclusion in future iterations of GBD
Target 16.1 (as above)	16.1.4: Proportion of people that feel safe walking alone around the area they live	Comprehensive data on reported safety, in general or walking alone near one's residence (or both), do not currently exist across geographies or over time. Substantive primary data collection is likely to be required
Target 16.2: End abuse, exploitations, trafficking and all forms of violence against and torture of children	16.2.3: Proportion of young women and men aged 18–29 years who experienced sexual violence by age 18	Prevalence of intimate partner violence among women and girls aged 15 years and older is estimated as part of GBD. An expanded systematic review and analysis of the literature and available data sources for both men and women, and for all types of sexual violence (ie, not limited to intimate partners) would be required. The feasibility of measuring this indicator as part of future iterations of GBD is under review at present

(Table 2 continues on next page)

with the Socio-demographic Index (SDI), a summary measure of development that uses lag-distributed income per person, average educational attainment in the population over age 15 years, and the total fertility rate. The SDI was constructed using the same method for the Human Development Index and the health-related SDG index. Each of the three components was first rescaled on a 0–1 scale, with 0 being the lowest (worst)

	Health-related SDG indicator	Measurement needs and strategy
(Continued from previous page)		
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	17.19.2: Proportion of countries that (a) have conducted at least one population and housing census in the last 10 years; and (b) have achieved 100% birth registration and 80% death registration	For Indicator 17.19.2(a), a comprehensive assessment of the availability and timing of population and housing censuses across all geographies is possible as part of GBD. For Indicator 17.19.2(b), the systematic collation of vital registration data for all geographies is required; at present, vital registration data reported to WHO do not fully cover all geographies or years under analysis. Such data collation efforts would be required for both birth and death registration individually to determine completeness, with the latter viewed as more immediately feasible for future iterations of GBD

SDG=Sustainable Development Goal. GBD=Global Burden of Disease. TRIPS=Agreement on Trade-Related Aspects of Intellectual Property Rights. DAH=development assistance for health. IHR=International Health Regulations. DHS=Demographic and Health Survey. ISIC=International Standard Industrial Classification.

Table 2: Health-related SDG indicators (proposed by the Inter-Agency and Expert Group on SDG Indicators) excluded in the present analysis, and measurement needs and strategy for future reporting, by SDG target

value observed in the time period 1980–2015 and 1 being the highest (best) value observed. SDI was then computed as the geometric mean of these three rescaled components. To capture average relations, we used a spline regression (ie, piecewise linear regression with so-called knots specifying the intersection between pieces) of the health-related SDG indicators and health-related SDG index on SDI using the full set of data by country from 1990 to 2015. We also compared the health-related SDG indicators with the GBD 2015 estimates of healthy life expectancy[38] to explore the relation between the SDGs and overall health achievement for each country.

Role of the funding source
The funder of the study had no role in 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
Of the 33 health-related SDG indicators, 21 were associated with a defined target, with 18 of them having an absolute level and three having a target relative to 2015 levels (table 3). The proportion of countries already meeting targets linked to health-related SDG indicators in 2015, as specified by absolute levels to be achieved, ranged from more than 60% for two indicators (maternal mortality ratio and under-5 mortality) to 0% for nine indicators. For these nine indicators, all targets involved full elimination of diseases (eg, tuberculosis, HIV, and neglected tropical diseases), reducing prevalence of health outcomes or risk to 0% (eg, childhood overweight and intimate partner violence), or reaching 100% for intervention coverage or health service provision (eg, skilled birth attendance, met need with modern contraception, and UHC tracer interventions).

In 2015, the median health-related SDG index was 59·3 (95% uncertainty interval [UI] 56·8–61·8) across all 188 countries. This index was highest in Iceland (85·5, 84·2–86·5), Singapore (85·3, 84·1–86·3), and Sweden (85·3, 84·2–86·2) and lowest in the Central African Republic (20·4, 15·9–24·9), Somalia (21·6, 16·0–25·9), and South Sudan (22·5, 15·5–26·6; figure 1). Differences in the 95% UI range stem largely from differences in the availability and quality of underlying data sources for estimating individual indicators; for example, data were sparser for Somalia than they were for Sweden. Some patterns emerged contrary to what might have been expected. For example, the USA (74·9, 73·6–75·9) ranked 28th, driven by poorer performance on MDG indicators (eg, maternal mortality ratio) than other high-income countries[44] and worse performance on non-MDG indicators—most notably, alcohol consumption, childhood overweight, and mortality due to inter-personal violence, self-harm, and unintentional poisoning. India (41·7, 39·7–43·7), despite rapid economic growth, was ranked 143rd, just below Comoros and Ghana.

Levels of the health-related SDG index were highly clustered (figure 2), with countries in the highest quintile (≥71·5) located mainly in western Europe, high-income North America, parts of Asia (Japan, South Korea, Singapore, and Brunei), and Australasia. The second highest quintile (62·5–71·5) included countries in southern Latin America, parts of eastern Europe, most of the Caribbean, and a subset of countries across other regions (eg, Mexico, Jordan, Azerbaijan, Malaysia, and Costa Rica), whereas countries in the middle quintile (55·7–62·5) were primarily located in South America; parts of east, central, and southeast Asia; and parts of North Africa and the Middle East. The countries in the fourth quintile (37·8–55·7) were mainly found in south and southeast Asia, southern sub-Saharan Africa, parts of