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Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013

GBD 2013 Mortality and Causes of Death Collaborators*

Summary

Background—Up-to-date evidence on levels and trends for age-sex-specific all-cause and cause-specific mortality is essential for the formation of global, regional, and national health policies. In the Global Burden of Disease Study 2013 (GBD 2013) we estimated yearly deaths for 188 countries between 1990, and 2013. We used the results to assess whether there is epidemiological convergence across countries.

Methods—We estimated age-sex-specific all-cause mortality using the GBD 2010 methods with some refinements to improve accuracy applied to an updated database of vital registration, survey, and census data. We generally estimated cause of death as in the GBD 2010. Key improvements included the addition of more recent vital registration data for 72 countries, an updated verbal autopsy literature review, two new and detailed data systems for China, and more detail for Mexico, UK, Turkey, and Russia. We improved statistical models for garbage code redistribution. We used six different modelling strategies across the 240 causes; cause of death ensemble modelling (CODEm) was the dominant strategy for causes with sufficient information. Trends for Alzheimer's disease and other dementias were informed by meta-regression of prevalence studies. For pathogen-specific causes of diarrhoea and lower respiratory infections we used a counterfactual approach. We computed two measures of convergence (inequality) across countries: the average relative difference across all pairs of countries (Gini coefficient) and the average absolute difference across countries. To summarise broad findings, we used multiple decrement life-tables to decompose probabilities of death from birth to exact age 15 years, from

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Contributors

ADL and CJLM conceived the study and provided overall guidance. CJLM, ADL, MN, and HW prepared the first draft. All other authors provided data, developed models, reviewed results, initiated modelling infrastructure, or reviewed and contributed to the report.

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See **Online** for appendix

For the **input data and key indicators for each country** see http://vizhub.healthdata.org/mortality/

For the **Human Mortality Database** see http://mortality.org/

For **online data visualisation of the cause of death database** see http://vizhub.healthdata.org/cod

For the **source code for estimation** see http://ghdx.healthdata.org/node/156633

For **CHERG estimates** see http://cherg.org/main.html

For the **age-standardised death rates by cause for each country** see http://vizhub.healthdata.org/cod

For the **INDEPTH Network** see http://www.indepth-network.org/

For interactive versions of figure 7 and figure appendices 1-3, visit http://vizhub.healthdata.org/le

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exact age 15 years to exact age 50 years, and from exact age 50 years to exact age 75 years, and life expectancy at birth into major causes. For all quantities reported, we computed 95% uncertainty intervals (UIs). We constrained cause-specific fractions within each age-sex-country-year group to sum to all-cause mortality based on draws from the uncertainty distributions.

Findings—Global life expectancy for both sexes increased from 65·3 years (UI 65·0–65·6) in 1990, to 71·5 years (UI 71·0–71·9) in 2013, while the number of deaths increased from 47·5 million (UI 46·8–48·2) to 54·9 million (UI 53·6–56·3) over the same interval. Global progress masked variation by age and sex: for children, average absolute differences between countries decreased but relative differences increased. For women aged 25–39 years and older than 75 years and for men aged 20–49 years and 65 years and older, both absolute and relative differences increased. Decomposition of global and regional life expectancy showed the prominent role of reductions in age-standardised death rates for cardiovascular diseases and cancers in high-income regions, and reductions in child deaths from diarrhoea, lower respiratory infections, and neonatal causes in low-income regions. HIV/AIDS reduced life expectancy in southern sub-Saharan Africa. For most communicable causes of death both numbers of deaths and age-standardised death rates fell whereas for most non-communicable causes, demographic shifts have increased numbers of deaths but decreased age-standardised death rates. Global deaths from injury increased by 10·7%, from 4·3 million deaths in 1990 to 4·8 million in 2013; but age-standardised rates declined over the same period by 21%. For some causes of more than 100 000 deaths per year in 2013, age-standardised death rates increased between 1990 and 2013, including HIV/AIDS, pancreatic cancer, atrial fibrillation and flutter, drug use disorders, diabetes, chronic kidney disease, and sickle-cell anaemias. Diarrhoeal diseases, lower respiratory infections, neonatal causes, and malaria are still in the top five causes of death in children younger than 5 years. The most important pathogens are rotavirus for diarrhoea and pneumococcus for lower respiratory infections. Country-specific probabilities of death over three phases of life were substantially varied between and within regions.

Interpretation—For most countries, the general pattern of reductions in age-sex specific mortality has been associated with a progressive shift towards a larger share of the remaining deaths caused by non-communicable disease and injuries. Assessing epidemiological convergence across countries depends on whether an absolute or relative measure of inequality is used. Nevertheless, age-standardised death rates for seven substantial causes are increasing, suggesting the potential for reversals in some countries. Important gaps exist in the empirical data for cause of death estimates for some countries; for example, no national data for India are available for the past decade.

Introduction

The Global Burden of Disease (GBD) study provides a unique comprehensive framework to systematically assess national trends in age-specific and sex-specific all-cause and cause-specific mortality. Up-to-date and comprehensive evidence for levels and trends for each country is critical for informed priority setting. Trends quantify progress against explicit health targets, whether local, national, or global, and help to evaluate where programmes are working or not. Quantification across populations and over time using comparable definitions and methods can also enable benchmarking. Regular comprehensive updates

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about causes of death will identify emerging public health challenges. The GBD 2013 study provides the first GBD study to use a continuously updated approach to global health surveillance.[1]

The GBD 2010 study, a collaboration of 488 investigators, showed important global and regional trends for all-cause and cause-specific mortality.[2-8] The GBD 2010 reported substantial decreases in child mortality driven by reductions in diarrhoea, lower respiratory infections, and more recently, malaria. The lowest income regions had progressed in combating maternal mortality, HIV/AIDS, tuberculosis, and malaria. Nevertheless, much work remains to be done for these Millennium Development Goal-related diseases. Outside sub-Saharan Africa, 1990–2010 saw rapid shifts towards a larger share of death from non-communicable diseases and injuries and a rising mean age of death. Country analyses using the GBD 2010 database have been reported for China, Iran, Mexico, UK, and USA, taking advantage of the comparable methods and definitions of the GBD to benchmark these countries against their peers.[9-16]

Much debate surrounds what should follow the Millennium Development Goals; objective, timely, and comprehensive evidence for the levels and trends in causes of death can be a useful input. Ambitious goals have been discussed,[16] such as the elimination of preventable child and maternal mortality in a generation. Targets of zero disease have been formulated for HIV/AIDS, tuberculosis, and malaria by various groups.[17-23] *The Lancet* Commission on *Global health 2035: a world converging within a generation*[24] suggested that a grand convergence in health can be achieved between poor and rich countries by 2035. Advocates for non-communicable disease programmes argue[25] that rapid epidemiological transitions in many regions of the world require broader health goals for the development community. Movements to focus on universal health coverage in the post-2015 health agenda emphasise the consequences of failure to meet basic health-care needs.[24-27]

Broad interest in the GBD 2010 has led to the expansion of the GBD collaboration to include more than 1000 investigators in 106 countries. The GBD 2013 not only incorporates newly published or released datasets, particularly from the past 5 years, but also expands the analysis in other ways. We included subnational assessments for provinces of China, states of Mexico, and regions of the UK. These subnational assessments will help national decision makers to identify inequalities and local variation in leading diseases, injuries, and risk factors. The list of causes has been expanded and many new and more detailed data sources incorporated. We report the new findings for the first time at the country-level for 1990–2013.

Methods

Study design

The GBD approach to estimating all-cause mortality and cause-specific mortality has been previously described.[2,3] Here, we describe several refinements.[28] Figure 1 shows the general analysis of all-cause mortality and cause-specific mortality and their interactions. GBD 2010 included 291 causes of death or disability, of which 235 were causes of death; we have expanded the list to include 306 causes of death or disability, of which 240 are causes of

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death. The extra causes were added on the basis of three considerations: (1) causes that were for epidemiological reasons already modelled separately but reported combined with other causes in GBD 2010—for example, silicosis, asbestosis, anorexia nervosa, and typhoid and paratyphoid fever; (2) the category of other unintentional injuries was large and heterogeneous so we broke it down further to include pulmonary aspiration and foreign body in trachea or lung, foreign body in other part of body, and unintentional suffocation; and (3) new datasets became available to enable estimation of mesothelioma, new maternal sub-causes, neonatal haemolytic anaemia, and chronic kidney disease caused by glomerulonephritis. Appendix pp 245–251 provides the International Classification of Diseases codes for the GBD 2013 cause list. After broad consultation, we have removed from the cause list the pathogen-specific causes of diarrhoeal diseases and lower respiratory infections. Instead, we analysed these causes with a counterfactual approach.

We assessed 21 regions and seven super-regions as defined in the GBD 2010. The GBD 2013 also included an assessment of subnational populations in three countries: provinces for China, states for Mexico, and the UK broken down into Scotland, Wales, Northern Ireland, and nine regions of England. We analysed these countries subnationally because of the interest from national collaborators and because sufficient data were made available by the teams in each country. In future iterations of the GBD, we hope to include further subnational breakdowns. In addition, we separately analysed data sources for rural and urban regions in India. This approach improved our estimation of mortality and causes of death and enabled us to analyse causes of death that were specific to urban or rural regions alone.

Covariates

We estimated national time series (1980–2013) for a range of covariates with data from surveys (household-level and individual-level data), censuses, official reports, administrative data, and a systematic review. For lagged distributed income and education, we estimated national time series from 1950, to 2013. Details of how we imputed series for GDP, educational attainment, tobacco prevalence, and obesity prevalence have been published previously.[29-32] Appendix (pp 4961–4974) shows the sources and imputation methods used to generate time series for each covariate. Generally, we estimated uncertainty in covariate values when sufficient infor mation was available.

All-cause mortality

We analysed all-cause mortality for 188 countries from 1950 to 2013; we present only results for 1990–2013 to coincide with the period of the overall GBD 2013 assessment. As a result of the split of Sudan, we re-extracted data and made new separately generated estimates for Sudan and South Sudan. We improved how we adjusted for data source bias for the analysis of child mortality in two ways. First, by using the improved functional forms between summary mortality indicators for child (age <5 years) and adult (age 15–59 years) age groups and other covariates, including crude rates of death caused by HIV/AIDS. And second, by modification of the model lifetable system to use a unified standard life-table selection process and improved redistribution of excess mortality rate from HIV/AIDS. We

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divided the analysis into eight steps. Input data and key indicators for all countries are available online.

First, to estimate under-5 mortality ($_5q_0$), we analysed all survey, census, sample registration, and vital registration sources. Wherever possible, we analysed microdata from surveys and censuses with updated methods for child mortality.[33] We synthesised all measurements of under-5 mortality with spatiotemporal regression and Gaussian process regression.[33] We corrected for bias in different sources in specific countries.

Second, to estimate adult mortality ($_{45}q_{15}$), we systematically identified all available vital registration data, sibling history survey data, sample registration data, and household recall of deaths. We assessed vital registration data for completeness by optimised death distribution methods.[2,34] We analysed sibling history data to account for survivor bias, zero-surviving sibships, and recall bias.[2,35] We synthesised sources with a combination of spatiotemporal regression and Gaussian process regression. The mean function for the Gaussian process regression was based on the combination of a non-linear hierarchical model with income per person, mean years of education in age group 15–60 years, mortality caused by HIV/AIDS, and country random effects[2] as covariates, and a spatiotemporal regression in which we added to the first stage model without country random effects, the smoothed residuals between the first stage model and observed data (appendix pp 66–79). We selected the hyper-parameters for Gaussian process regression through an out-of-sample predictive validity testing process.[2] We ranked the estimated subnational adult mortality in China, India, Mexico, and the UK to ensure that the sum of subnational estimates for a given age-sex group equalled the national estimates accounting for different population sizes.

Third, we assessed HIV-free under-5 mortality and adult mortality. HIV/AIDS causes more excess mortality in younger people and thus changes the age pattern of mortality that otherwise can be readily described by Gompertz law of mortality or the Kannisto-Thatcher model.[36,37] Where HIV/AIDS is common, this pattern of mortality should be explicitly taken into account. We estimated the HIV-counterfactual under-5 mortality and adult mortality rates using the estimated coefficients of crude death rate from HIV from the non-linear mixed effects models for under-5 mortality and adult mortality respectively, and setting the crude death rates from HIV/AIDS in the respective age groups to zero (appendix pp 90–94).

Fourth, we constructed an HIV-free life-table. The GBD 2010 introduced a model life-table system that used the under-5 death rate and adult mortality rate along with a selected standard mortality schedule to estimate the full age pattern of mortality for country-years of interest.[33] For GBD 2013, we modified how the standard mortality schedule was selected for each country-year so that the same approach was used for all countries. Specifically, we empirically computed a set of space-time weights that relate the observed age pattern of the probability of death in a sex-country-year with other sex-country-year observations. These weights were derived by comparing every empirical life-table that is not affected by the HIV/AIDS epidemic in the GBD database (10 673 life-tables) with every other life-table for the same sex. We estimated space-time weights as a function of the time lag between the paired life-tables and location (ie, within the country, region, or super-region). We estimated

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these weights as the inverse of the average sum of age-specific differences in the logit of the probability of death (appendix pp 79–91). The key observation from this spatial-temporal analysis of age-specific probabilities of death is that the mortality pattern in a country in a given year was more strongly related to the mortality pattern in the same country within 15 years than to mortality patterns in other countries; however, other countries in the same region or other regions generally are similarly related when the lag-in time was more than 20 years.

Fifth, we assessed the age pattern of HIV/AIDS mortality. Excess mortality from HIV/AIDS as quantified between the estimated ${}_5q_0$ and ${}_{45}q_{15}$ with their HIV counterfactual counterparts leads to increased mortality in specific age groups. This excess HIV/AIDS mortality was assigned by age with the estimated relative risk of death caused by HIV/AIDS in an age group compared with the HIV/AIDS excess death rate in age group 40–44 years. We estimated these relative risks with data from vital registration systems that have International Classification of Diseases 10 coded causes of death from HIV/AIDS, which includes South Africa.[38] We used Seemingly Unrelated Regression model[39] with only a constant and generated 95% uncertainty intervals (UIs) for the age pattern of relative risks by repeatedly sampling from the mean and covariance matrix of the estimated βs and the error term. Seemingly Unrelated Regression enables the error term of a series of linear regressions to be correlated. We used separate regressions by sex and for the pattern of mortality in concentrated epidemics and generalised epidemics as defined by UNAIDS.[38-40]

Sixth, we minimised the difference between demographic estimation of age-specific mortality and HIV models. Murray and colleagues[38] used a refined version of the EPP-Spectrum framework to model HIV/AIDS mortality. This analysis yielded very large UIs for HIV/AIDS in many countries. However, in some southern African countries, there remained a large discrepancy between data for all-cause mortality and estimates of HIV/AIDS mortality with demographic sources suggesting smaller epidemics. To minimise the difference between HIV/AIDS mortality and the demographic estimates, which are also uncertain, we computed a loss function that quantifies the extent to which the age-sex-country-year HIV/AIDS estimates exceed all-cause mortality:

$$e_r = \sum_t \sum_a \sum_s max\left(0, m^{HIV}_{r,t,a,s} - 0 \cdot 8 \times m^{all-cause}_{r,t,a,s}\right)$$

For run (r) of a given country, excess mortality (e) is equal to the sum of all non-zero differences between HIV/AIDS mortality (m^{HIV}) and 0·8 times a randomly selected all-cause mortality draw ($m^{all\text{-}cause}$) across all year (t), age (a), and sex (s) combinations. 0·8 was the highest observed cause fraction caused by HIV in any age group in any vital registration system. We selected from the uncertainty ranges for HIV and all-cause mortality those that minimised the difference. If no draws had a positive loss function, we sampled randomly from all matched draws.

The CoDCorrect algorithm includes HIV/AIDS cause-specific mortality and can alter the age and time distribution of deaths from HIV/AIDS. To incorporate the overall change in the number of HIV/AIDS deaths over the course of the epidemic in a country implied by the

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application of the CoDCorrect algorithm, but not to distort the Spectrum estimated time and age pattern, we adjusted the entire HIV/AIDS epidemic up or down on the basis of the cumulative effects of CoDCorrect on HIV/AIDS for all estimated years in each country.

Seventh, we used the same method as Wang and colleagues[2] to generate child mortality rate and adult mortality rate for natural disasters and armed conflicts. We obtained data for conflict and war, including deaths from one-sided violence, non-state conflict, armed force battles, and other national or international conflicts, from the Uppsala Conflict Data Program[41] and the International Institute for Strategic Studies.[42] Further data for war were obtained from countries' vital registration systems and classified as caused by war.[43] We included disaster data from the International Disaster Database from the Center for Research on the Epidemiology of Disasters (University of Louvain, Brussels, Belgium).[44] From this database, we included deaths caused by complex disaster, drought, earthquake, flood, and others. When these databases were not fully up-to-date or did not contain shocks known to exist, we supplemented with case-by-case sources. These with-shock mortality rates were then used as entry parameters to the GBD relational model life-table system to generate age-specific mortality rates with the effect of shocks added.

Eighth, we used age-specific and sex-specific death rates from the life-table to generate numbers of death by multiplying by population estimates from the World Population Prospects 2012 revision[45] and the Human Mortality Database for people older than age 5 years. For the under-5 age groups, we applied the method of Wang and colleagues.[33] In some cases, assumptions in the UN estimation process led to implausible population numbers for some countries and age groups—for example, low population estimates for older age groups in South Africa, especially for the most recent years. For GBD 2013, we applied a Bayesian population reconstruction model[46] to re-estimate population for South Africa for 1970–2013.

Cause of death database

Lozano and colleagues[3] described the key steps in the development of the GBD cause of death database. The database has been expanded to capture 2233 additional site-years of vital registration data and 52 additional verbal autopsy site-years (table 1); a site-year is defined as data for a specific geographical location (eg, a province of China) in a given year. We included data up to April 15, 2014.

A major new addition was the incorporation of two data systems in China. First, the China National Office for Maternal and Child Health Surveillance provided detailed information for child and maternal mortality by cause from 363 surveillance sites in China for 1996–2013. Second, the Disease Surveillance Points system was the main source of mortality data for 1991–2007, with 145 disease surveillance points used from 1991 to 2003, and 161 points used from 2004 to 2007. From 2008 to 2012, all of the deaths and cause of death information from the Disease Surveillance Points system and other system points throughout China were collected and reported via the Mortality Registration and Reporting System, an online reporting system of the Chinese Center for Disease Control and Prevention, which included 4·0 million deaths in 2012.[47,48] Because of the discrepancy in proportions of deaths in hospital and out of hospital in the Mortality Registration and Reporting System, we

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divided each province in China into two strata based on the degree of urbanisation from the 2010 China Census. We then applied the proportion of deaths in hospital and out of hospital and degree of urbanisation from the Disease Surveillance Points system to the Mortality Registration and Reporting System to account for biases in the latter. We disaggregated data for both systems by province and urban and rural regions within each province. We obtained new datasets for Russia that provided more detailed causes (appendix pp 180–244). Turkey expanded its vital registration system to cover nearly all the population after 2009 and we incorporated these new data into the analysis.

In total, we identified 538 verbal autopsy site-years, 52 more than in GBD 2010. India, Bangladesh, and Tanzania had the most verbal autopsy site-years available. We re-extracted and re-mapped data from all verbal autopsy studies to ensure consistency with the GBD 2013 cause list. We excluded from the database verbal autopsy studies reporting cause assignment using InterVA because it has very low published validity.[47] We incorporated 1145 registry-years of new cancer data, including 128 from Cancer Incidence in Five Continents Volume X[48] and 1017 from supplemental sources. Our analysis of cancer incidence and models of the death:incidence ratio remains unchanged from GBD 2010. Figure 2 shows site-years of data by country for any cause. Of note, Somalia and Equatorial Guinea had no cause of death data for any specific cause.

Assessment and enhancement of quality and comparability of cause of death data

Using the general approach of the GBD 2010, we followed six steps to assess the quality of data and enhance comparability. First, we adjusted cause of death data from vital registration systems for incompleteness. The analysis of all-cause mortality yields a separate estimate of completeness for deaths of children younger than 5 years and deaths of people older than 5 years, which we used to correct the data for cause of death. When correcting for incomplete registration, we assumed that for each age-sex-country group, the cause of death composition of registered deaths and non-registered deaths were the same. 77% of datapoints were from registration or sample registration that were more than 85% complete, 17% from systems that were 70–84% complete, and 6% were from systems less than 70% complete. Of the 6% of observations less than 70% complete, most (62%) were for children younger than 5 years. In sensitivity tests in the GBD 2010, exclusion of data below a fixed threshold of completeness for child causes of death did not substantially change the results; thus, we have used all the data in our analysis for GBD 2013.[3]

Second, we developed 103 maps (excluding verbal autopsy studies) to translate causes found in the data to the GBD 2013 cause list. The expanded cause list of this study required us to adjust the maps used for data included in GBD 2010. Appendix pp 245–251 show GBD 2013 cause maps for International Classification of Diseases 9 and 10. The appendix (pp 252–253) includes more detail about changes made to the handling of various shorter tabulation lists used by some countries for reporting, such as the International Classification of Diseases 9 Basic Tabulation List.

Third, a crucial aspect of enhancing the comparability of data for cause of death is to deal with uninformative, so-called garbage codes. Garbage codes are codes for which deaths are assigned that cannot or should not be considered as the underlying cause of death—for

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example, heart failure, ill-defined cancer site, senility, ill-defined external causes of injuries, and septicaemia. Figure 3 shows the number of deaths in the database for each calendar year with the number assigned to garbage codes. Because of lags in national reporting of cause of death data, the number of deaths available after 2010 fell. Important changes for the GBD 2013 in our approach to redistributing garbage codes included the statistical estimation of the fraction of deaths following the methods outlined by Ahern and colleagues[49] for deaths assigned to ill-defined cancer site, ill-defined external causes of injury, heart failure, unspecified stroke, hypertension, and atherosclerosis by region, age, and sex. Because of variation in the coding of International Classification of Diseases 10 code X59 (exposure to unspecified factor)[50] and its subcauses in high-income countries, we redistributed these garbage codes with country-specific estimates for high-income countries derived from our statistical analysis. Additionally, we did not use malaria as a target for any garbage code redistribution in adults.[51] We also implemented geographical restrictions on garbage code redistribution for Chagas disease based on endemicity so that Chagas disease was not assigned deaths in countries outside Latin America.

Fourth, for some datasets, particularly some verbal autopsy studies, deaths were reported for broad age groups or with both sexes combined. With the addition of new data for GBD 2013, we identified 30 new age formats, totalling 112 unique age tabulations in the database. We used the algorithms described in the GBD 2010 to split these aggregated categories into estimates for specific age-sex groups.

Fifth, because few overall deaths were included in verbal autopsy studies or reported in small countries, the number of deaths by cause can fluctuate substantially from year to year. For example, in Iceland, no maternal deaths were recorded from 1991 to 2000, then one maternal death in 2001. We modified our approach to smoothing these stochastic fluctuations used in the GBD 2010 by use of a simple Bayesian algorithm. We assume a normally distributed prior and a normal data likelihood, such that:

$$\text{Posterior mean} = \left(\frac{\tau^2}{\tau^2+\sigma^2}\text{X} + \frac{\sigma^2}{\tau^2+\sigma^2}\mu\right)$$

$$\text{Posterior variance} = \left(\frac{\tau^2\sigma^2}{\tau^2+\sigma^2}\right)$$

Where *X* is the mean of the data and μ is the mean of the prior. We estimated the prior for vital registration series with a negative binomial regression with fixed effects for year and age estimated separately for each country. When the data are based on a large sample size the variance is small and the prior has little effect on the posterior. When the data have a large variance because of a small sample size, the prior has more effect, effectively borrowing strength on the age pattern from data within the same country but allowing for different levels in each year. For verbal autopsy studies, we modified this approach because many published reports are for a single site in a single year. The prior for each cause was based on a negative binomial with fixed effects for age groups and random effects for study-

year; the regression was estimated independently for each region. For malaria, we did not group studies by region but by super-region and level of endemicity. To avoid very large negative values for log death rates or logit cause fractions, we limited the minimum non-zero posterior values to 1 per 10 000 000.

Sixth, we excluded outliers based on four criteria. (1) Studies with biologically implausible values, such as 100% of mortality from a single rare cause. (2) Studies with results that were greatly inconsistent with other studies for the same country. (3) Studies that were greatly inconsistent with studies from other countries with similar sociodemographic profiles within the same region. (4) Studies that, if included, led to abrupt changes in model-estimated time trends that could not be explained by contextual changes or policy initiatives. Outliers (0·89% of database entries) are shown in the online data visualisation of the cause of death database.

Modelling individual causes of death

As in the GBD 2010, we used six modelling strategies for causes of death depending on the strength of the available data. Where extensive data were available, we used cause of death ensemble modelling (CODEm), where fewer data were available we used simpler statistical models, and where available cause of death data might be substantially biased or not available we used natural history models (appendix pp 278–282). We generated 95% UIs from all the modelling strategies. Uncertainty in the number of deaths for an age-sex-country-year was propagated into the computation of years of life lost (YLLs) for the same category.

We used CODEm for 155 causes of death. CODEm has been extensively used for global health estimation including the GBD 2010.[3,52,53] An advantage is that a wide range of different models are tested; only models meeting predetermined criteria for statistical significance and direction of regression coefficients are retained. We excluded 30% of the data from the initial analysis so that the performance of different models could be assessed in terms of how well they predict the omitted data. Through multiple iterations of this process (cross-validation), we obtained stable objective information about the model's performance. The best performing models in terms of root-mean squared error for level and trend were combined into a model ensemble. For some causes, we developed separate ensemble models for GBD developed and GBD developing regions;[54] the main advantage of this approach is that uncertainty in model estimation from heterogeneous data in low-income regions does not inflate the UI for high-income countries. We used this approach for all cancers and transport injuries.

For 13 causes, the number of deaths in the cause of death database was too low to generate stable estimates. For these causes, we developed negative binomial regressions with either a constant or constant multiplied by the mean assumption for the dispersion parameter, using reverse step-wise model building. We selected between the two model dispersion assumptions on the basis of best fit to the data. Compared with the GBD 2010, we modified how we generated uncertainty from these regressions by including in the uncertainty sampling draws from the γ distribution with shape equal to the expected rate (μ) divided by expected dispersion, and scale equal to the expected dispersion if the dispersion was

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assumed to be constant. For models in which dispersion was assumed to equal a constant multiplied by the mean, the scale parameter included μ as a multiplicative term (instead of the shape parameter).

As in the GBD 2010, for 14 causes for which death is rare, we first modelled the parent cause in the GBD hierarchy with CODEm and then allocated deaths to specific causes using proportions of the parent cause for each sub-cause. For these causes, we identified no significant predictors in negative binomial regressions. We estimated proportions by simple averaging based on available vital registration data. Depending on the availability of data, we averaged the data across age, sex, region, and year.

We used DisMod-MR[55] to estimate detailed cause fractions for several causes of death that had sufficient data to estimate proportions of a parent cause resulting from subcauses that vary across regions and countries but insufficient data to run CODEm. The source code for estimation is available online. DisMod-MR uses data for subcause fractions gathered from systematic review and from International Classification of Diseases-coded vital registration and sample registration systems. It uses two types of fixed effects (study characteristics and country covariates) with hierarchical random effects for super-region, region, and country to generate estimates for each country, age group, both sexes, and six discrete time points: 1990, 1995, 2000, 2005, 2010, and 2013. We calculated predictions for intervening years—and back to 1980—assuming an exponential rate of change. We used this approach for eight causes of maternal death, four causes of meningitis, one cause of chronic kidney disease, four causes of cirrhosis, four causes of liver cancer, and three causes of haemoglobinopathies.

For 14 causes in the GBD 2010, we used natural history models because data systems for cause of death did not capture sufficient information. The natural history model for African trypanosomiasis was updated to include the most recent case notification data from WHO (up to 2012). We made substantial changes to the HIV natural history model.[25] Our natural history model for congenital syphilis was estimated as in the GBD 2010, with updated data for antenatal care coverage to inform the number of births at risk and additional vital registration data sources to inform age and sex distribution of deaths. We also used simple natural history models for typhoid and paratyphoid fever, whooping cough, measles, visceral leishmaniasis, and yellow fever. Additionally, because vital registration data recording the specific type of hepatitis were very sparse, we used natural history models for all the detailed causes of hepatitis. The natural history model takes into account the extensive serological data for the prevalence of antibodies or antigens for hepatitis A, B, and C, and more limited data for case-fatality rates.

Alzheimer's disease and other dementias were analysed with CODEm in GBD 2010. Because of the large inconsistency between the data for prevalence and mortality, we used a natural history model in the GBD 2013. Prevalences have not changed substantially over time, whereas age-standardised mortality rates in high-income countries have increased, ranging from about 25% (Denmark, Switzerland, Norway) to 46% (Germany). The prevalence of dementia varies between countries by a factor of three, whereas dementia mortality recorded in vital registration data and verbal autopsy studies varies by more than

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20-fold. On the basis of these findings, we believe that the variation in dementia mortality rates between countries and over time was probably affected by changes in coding practices with increased propensity to assign dementia as an underlying cause of death. To correct for this, we assessed data from 23 high-income countries with high-quality vital registration systems to estimate the ratio of registered dementia deaths:prevalent cases. In DisMod-MR, we used the mean of these ratios as an estimate of excess mortality to estimate age-specific and sex-specific mortality from dementia consistent with the meta-regression of prevalence.

In GBD 2010, because single-cause models were developed for each cause, the final step was to combine these models into estimates that are consistent with all-cause mortality for each age-sex-country-year group. For each cause-specific model and for all-cause mortality, we had 1000 draws from the posterior distribution for each age-sex-country-year group. We combined causes by taking a random draw without replacement from the posterior distribution of each cause and all-cause mortality. Each cause was rescaled by a scalar equal to the draw of all-cause mortality divided by the sum of the draws of individual causes. The GBD 2010 induced a correlation of 1·0 between the sum of cause-specific and all-cause mortality. CoDCorrect was applied in a hierarchical fashion: first to level 1 causes and then to level 2 and level 3 causes. Level 2 causes were constrained to sum to the level 1 parent cause. Levels of this cascade were largely the same as those used in the GBD 2010 and were chosen on the basis of the amount and quality of available data for cause of death.

For GBD 2013, we made slight modifications to this approach. Because tests showed no substantial effect of the 1·0 correlation between draws of all-cause mortality and the sum of individual causes and because each cause is modelled independently such that the ordering of draws across causes were unrelated, we have removed this assumption. Furthermore, because the modelling of HIV through the GBD version of Spectrum uses relationships between incidence, CD4 progression, and death that are age-dependent and antiretroviral therapy scale-up over time has had major effects, we modified the way in which HIV deaths are handled in CoDCorrect. We ran CoDCorrect for all causes and then computed the pre-CoDCorrect cumulative deaths over time and age and compared with the cumulative deaths post-CoDCorrect. This provided an overall scalar, which we used to adjust the entire HIV epidemic. To avoid in any age-sex-country-year the sum of individual deaths exceeding all-cause mortality, we computed the difference between the cumulatively scaled HIV deaths and the CoDCorrect HIV deaths and added this difference to the estimate of all-cause mortality at the draw level.

In GBD 2010, diarrhoea deaths and lower respiratory infection deaths were reported for pathogen-specific causes in tabulations that summed to 100% of each parent cause. Since the GBD 2010, the GEMS study[56] has been published, which provided data for the relative risk of diarrhoea being related to different pathogens. This relative risk approach used a different conceptual framework than did the International Classification of Diseases approach for underlying cause. Underlying cause follows the more than 200-year history of health statistics of assigning each death uniquely to a single underlying cause. The relative risk approach follows the approach used more generally for risk factors, where cause is assigned based on comparison to a counterfactual. Counterfactual attribution to specific risks or in this case pathogens, can sum to more or less than 100%. On the basis of the

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GEMS study and consultations among experts in both diarrhoea and lower respiratory infection, we report results for counterfactual causes in GBD 2013. To estimate diarrhoea mortality attributable to different pathogens, we calculated the population attributable fraction for pathogens including rotavirus, *Shigella*, enteropathogenic *Escherichia coli*, enterotoxigenic *E coli*, adenovirus (enteric adenovirus), norovirus, *Aeromonas*, other *Salmonella* (non-typhoidal *Salmonella*), *Cryptosporidium*, *Campylobacter*, and *Entamoeba*. We used the Miettinen formula, which uses the distribution of pathogens in patients and relative risks of pathogens for diarrhoea, to provide a population attributable fraction for each pathogen:[57,58]

$$PAF_i = p_i\,(pathogen \quad in \quad patients)\left(1 - \frac{1}{odds \quad ratio_i}\right)$$

Where PAF_i is the population attributable fraction of diarrhoea caused by pathogen i, p_i is the prevalence of pathogen i in patients with diarrhoea, and $odds\ ratio_i$ is the odds ratio of diarrhoea in people with the pathogen. We used DisMod-MR to estimate the proportion of patients in each age-sex-country-year with each pathogen with data from studies of inpatients and community samples. By use of study-level covariates in the meta-regression, we obtained different estimates for inpatients and community samples. We assumed inpatients to be a proxy for severe diarrhoea and death. We reanalysed GEMS[59] to estimate the odds ratio for each pathogen in a multipathogen model by conditional logistic regression. Regression models included fixed effects for a specific pathogen with interaction terms for three age groups (0–1 years, 1–2 years, and 2–6 years) to allow different odds ratios by age and interaction terms for different GEMS field sites (Bangladesh, India, Kenya, Mali, Mozambique, Pakistan, and The Gambia) to estimate site-specific odds ratios. For other countries in the region, the odds ratio we used was the average of the odds ratios (in logarithm scale) of the countries with GEMS sites in that region. For countries in central and southern sub-Saharan Africa, we used the average of GEMS sites located in eastern and western sub-Saharan Africa. For all other countries in regions without GEMS sites, we used the average of all odds ratio. To produce odds ratio uncertainty while averaging odds ratio, we generated 1000 draws of joint normal distribution using a covariance matrix from the conditional logistic regression for each of the GEMS countries in a region. To produce the draws for non-GEMS countries, we selected draws from each of the GEMS countries until we had a full set of 1000 draws. For example, to generate 1000 draws for countries in eastern sub-Saharan Africa, we used draws from Kenya and Mozambique—the two GEMS countries within that region. We pulled 500 of the Kenya draws and 500 of the Mozambique draws to produce our full set of 1000 draws, which were used for all the other countries in this region. Because GEMS included only diarrhoea in children younger than 5 years, we applied the odds ratio of pathogens calculated for children aged 2–5 years when calculating for adults. We did not assign diarrhoea cases or deaths to a pathogen for an age-country-year if more than 95% of draws were greater than 1.

For cholera, we used data from previous studies (appendix p 310) and compared them with WHO case notification data to estimate under-reporting for cholera and then the number of

cases (appendix p 310). To estimate cholera deaths, we modelled cholera case fatality in DisMod-MR with data from previous studies.

Clostridium difficile as a cause of diarrhoea in children is rarely studied; we could not estimate the epidemiological population attributable fraction as we did for other pathogens because *C difficile* was not included in GEMS. Because *C difficile* is related to hospital and health-care use, we used hospital data as the primary source for estimation. We modelled the incidence and case fatality of *C difficile* and assumed a 1-month risk of death[60] in DisMod-MR to estimate the number of deaths.

For GBD 2013, we split lower respiratory infection mortality into four categories: *Streptococcus pneumoniae*, *Haemophilus influenzae* type B pneumonia, respiratory syncytial virus pneumonia, and influenza. The counterfactual approach captures the complex interactions between the these causes[61] and also excludes the "other lower respiratory infection" category included in GBD 2010. Moreover, we did not attribute lower respiratory infection to any cause for children younger than age 1 month. We adopted a different approach to estimate bacterial and viral causes on the basis of available data. For pneumococcal and *H influenzae* type B pneumonia, we estimated the causal fraction from vaccine efficacy studies.[62-64] For pneumococcal pneumonia, we included data from controlled trials and observational studies, such as before-after population analyses of the introduction of pneumococcal vaccine.[65-76] For *H influenzae* type B, we excluded case-control studies because of implausibly large estimates of vaccine efficacy. Furthermore, unlike for pneumococcal vaccine, little data were available from vaccine efficacy studies on the effect outside of child ages. As a result, we did not estimate the causal fraction of *H influenzae* type B for lower respiratory infection in people aged 5 years or older. We adjusted data for efficacy, using invasive disease as a marker as well as serotype coverage for pneumococcal vaccine.[64] We calculated pooled estimates of causal fractions by age with DisMod-MR for pneumococcal vaccine and random-effects meta-analysis for *H influenzae* type B, adjusted post-hoc for national-level coverage of pneumococcal vaccine and *H influenzae* type B vaccine. For respiratory syncytial virus and influenza, we relied on observational studies that measured causal fractions among hospital admissions for lower respiratory infection. We estimated the causal fractions among cases by country, age, and sex with DisMod-MR and the odds ratio of exposure from case-control studies. To account for the higher case-fatality of bacterial versus viral lower respiratory infections, we applied a relative case-fatality differential based on in-hospital case-fatality using hospital admissions that included cases coded to the specific pneumonia causes.

Convergence measures

To test whether all-cause and cause-specific mortality converged in the 188 countries since 1990, we computed two measures: the average relative difference and the average absolute difference between any pair of countries included in the GBD 2013 study. The average relative difference is known as the Gini coefficient and is the most commonly used measure of inequality. For international comparisons, we used the population-weighted version of the Gini coefficient in age-specific mortality rates so that small populations do not have an undue influence on the assessment of global mortality convergence (appendix pp 556–

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557).[77] For the Gini coefficient to fall, the percent decrease in mortality for countries with higher mortality must in general be faster than that for countries with lower mortality.

We also computed the mean absolute difference for all-cause mortality for each age group for 1990–2013 and for age-standardised rates for each cause (appendix pp 556–557). Average absolute difference can fall while average relative difference (the Gini coefficient) rises. The two measures provide different perspectives on convergence.

Multiple decrement lifetables

We used age-specific cause of death and all-cause mortality life-tables to compute the conditional probability of death for three summary intervals: childhood and adolescence (0 to exact age 15 years), reproductive-age adults (15 years to exact age 50 years), middle-aged adults (50 years to exact age 75 years), and the cause-specific contributions to each of these summary indicators. For each conditional probability of death, we used the multiple decrement life-table method[78] to compute the probability of death from each cause and the overall contribution of each cause of death to the summary probability of death indicators for the three broad age groups (appendix pp 556–557). We calculated the decomposition of changes in life expectancy by age and cause of death as detailed by Beltran-Sanchez, Preston, and Canudas-Romo.[79]

Age-standardised rates and YLLs

For GBD 2010, we computed age-standardised mortality rates and YLL rates from the world population age standard issued by WHO in 2001.[80] To account for the substantial change in global demographics since 2001, we updated this standard. We used the same method as WHO and computed a standard population structure with population estimates for 2010–35 from the most recent World Population Prospects by the United Nations Population Division. Appendix pp 95–96 provides details of the GBD world population age-standard. We computed YLLs by multiplying numbers of deaths from each cause in each age group by the reference life expectancy at the average age of death for those who die in the age group following the standard GBD 2010 methods.[3] The appendix (pp 121–40) shows key indicators from the new GBD standard life-table.

Ranking lists and decomposition analysis

We used the GBD 2010 approach to create ranked lists of specific diseases and injuries. We modified GBD 2010 ranking list to incorporate newly estimated causes with the same overall assignment of rank causes as GBD 2010: typhoid and paratyphoid separately, haemolytic disease in fetus and newborn and other neonatal jaundice, mesothelioma, unintentional suffocation, pulmonary aspiration and foreign body in trachea or lung, and foreign body in other part of body. Following the methods developed by Lozano and colleagues,[3] we decomposed changes in the number of global deaths and global YLLs into the contributions from population growth, population aging, and age-specific death rates.

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Results

Global all-cause mortality

Global life expectancy at birth for both sexes increased from 65·3 years in 1990, to 71·5 years in 2013, an average increase of 0·27 years per calendar year. Life expectancy increased over this period by 6·6 years for females and 5·8 years for males. Figure 4 shows the yearly change in global life expectancy at birth, with a large drop in the 1990s as a result of the Rwanda genocide and famine in North Korea and the return to increases of about 0·3 years or more per year since 2003. If the median rate of change of the last 23 years continues, by 2030 global female life expectancy will be 85·3 years and male life expectancy will be 78·1 years. Reduced fertility and the consequent demographic shift of the world's population to older ages has led to the mean age of death increasing from 46·7 years in 1990, to 59·3 years in 2013.[81]

The number of deaths globally for both sexes all ages increased from 47·47 (UI 46·77–48·22) million in 1990, to 54·86 (53·57–56·33) million in 2013, partly because of consistent increases in global population over the past decades. Rapid falls in child death rates compared with other age-specific death rates have led to a shift in the age structure of global deaths with substantial decreases in children and large increases in the proportion of deaths of people older than age 80 years (figure 5). The number of child deaths fell between 1990 and 2013 in southeast Asia, east Asia, and Oceania with very substantial falls in north Africa and the Middle East, and Latin America and the Caribbean (figure 5). However, the number of child deaths in sub-Saharan Africa only changed from 3·68 (3·63–3·73) million in 1990, to 3·20 (3·00–3·42) million in 2013. Substantial increases in the number of deaths of people older than age 80 years have occurred in high-income regions as well as in southeast Asia, east Asia, and Oceania.

Rising global life expectancy at birth has not come from uniform progress across age-groups or countries. In all age-groups except the 80 years and older age group, mean mortality rate has decreased more for females than for males (figure 6). Larger decreases in males older than age 80 years might be a result of the differences in the age composition between males and females in this open-ended age group. The mortality rate in the under-5 age group has fallen much more between 1990 and 2013 than has that for older age groups. The smallest decreases occurred in men in age groups 30–34 years, 35–39 years, and 80 years or older, and in women aged 80 years or older.

For all age groups, population-weighted average relative difference for age-specific mortality rates differences across countries (ie, inequality) increased except in age group 10–14 years and 15–19 years for females. The divergence in age-specific mortality rates was greatest in young adult age groups between ages 20 years and 44 years for both males and females; dominant causes in these age groups include HIV/AIDS, interpersonal violence,

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maternal mortality, and road injury (data not shown). For many age groups, in both sexes, the absolute differences have fallen while relative inequalities have increased (figure 6). For women aged 25–39 years and 75 years and older, and for men aged 20–49 years and 65 years and older, both relative and absolute differences in mean age-specific mortality rates have increased since 1990.

Global causes of death

We decomposed change in global and regional life expectancy by cause (level 2 of the GBD cause hierarchy; figure 7). Increased life expectancy since 1990 was mainly caused by a fall in mortality from lower respiratory infections and diarrhoeal diseases (contributing 2·2 years), cardiovascular and circulatory diseases (contributing 1·1 years), neonatal conditions (contributing 0·7 years), cancers (contributing 0·4 years), and chronic respiratory diseases (contributing 0·5 years). Decreases in mortality from unintentional injuries added another 0·3 years to life expectancy, while female life expectancy increased by about 0·2 years because of reductions in maternal mortality. These gains were offset by increased mortality from diabetes, chronic kidney diseases, and related conditions, as well as musculoskeletal disorders, although the net effect of these increases was small, reducing life expectancy, on average, by about 0·1 years. Five main causes reduced life expectancy: HIV/AIDS was a major cause of death in southern sub-Saharan Africa and to a smaller extent in western and eastern sub-Saharan Africa; diabetes, chronic kidney disease, and other endocrine disorders decreased life expectancy across many regions, most notably in Oceania and central Latin America; mental disorders made a negative contribution in multiple regions, especially high-income north America; intentional injuries reduced life expectancy in south Asia, high-income Asia Pacific, and southern sub-Saharan Africa; and cirrhosis made a negative impact in eastern Europe and central Asia (figure 7). Large gains in life expectancy in sub-Saharan Africa were mainly driven by reductions of diarrhoea and lower respiratory infections and of neonatal disorders. Gains in high-income regions were driven by reductions in cardiovascular disease, some cancers, transport injuries, and chronic respiratory conditions (figure 7).

Between 1990 and 2013, numbers of deaths from non-communicable diseases and injuries steadily increased while deaths from communicable, maternal, neonatal, and nutritional causes decreased (table 2). However, age-standardised rates decreased in these three broad categories. The shift to non-communicable diseases, at least at globally, was driven by faster rates of decline for communicable, maternal, neonatal and nutritional causes and an ageing world population.

In 2013, 11·8 million (11·3–12·3) deaths were caused by communicable, maternal, neonatal, and nutritional disorders: 2·7 million (2·4–2·8) by lower respiratory infections, 1·3 million (1·3–1·5) by HIV/AIDS, 1·3 million (1·2–1·4) by tuberculosis, and 1·3 million (1·2–1·4) by diarrhoeal diseases, 2·0 million (1·9–2·2) by neonatal conditions, 854 600 (702 924–1 032 497) by malaria, and 293 336 (261 322–328 200) by maternal causes (about 20% less than in 2000). Between 2000 and 2013, deaths from diarrhoeal diseases fell by 31·1% (from 1·8 million [1·7–2·0] to 1·3 million [1·2–1·4]), tuberculosis and meningitis each by about 20% (1·6 million [1·4–1·7] to 1·3 million [1·2–1·4] for tuberculosis, 377 300 [331 400–438 000]

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to 303 500 [261 400–346 300] for meningitis), while mortality from tetanus fell by about 60% (142 400 [108 800–163 100] to 58 900 [39 800–77 300]), from measles by about 80% (494 500 [279·4–763·8] to 95 600 [48 500–172 900]), from diphtheria by about 40% (5400 [2800–10 700] to 3300 [1700–6600]), and from whooping cough by about 40% (111 800 [42 300–242 400] to 60 600 [22 300–136 800]). Deaths from neonatal causes fell by a quarter since 2000 (2·8 million to 2·0 million), and by about one-fifth for maternal causes (364 900 to 293 300). Comparing 2013 to 1990, malaria deaths decreased by 4·4% and HIV/AIDS increased by 368% (table 2). HIV/AIDS mortality and malaria mortality both peaked in 2005 (1·7 million [1·6–1·9] for HIV/AIDS, 1·2 million [1·1–1·4] for malaria); HIV/AIDS mortality fell by 21% (20·4–21·5) from 2005 to 2013, and malaria mortality fell by 30% (24·8–35·4).[38] The risk of death from various leading causes of communicable, maternal, neonatal, and nutritional disorders as measured by the age-standardised death rate (table 2), has generally declined by an even greater amount than the risk for HIV/AIDS and malaria. Age-standardised death rates decreased by about 40% since 1990 for the category as a whole, as well as most notably, for lower respiratory infections, maternal disorders, neonatal disorders, and asthma, and by 50–60% for tuberculosis, diarrhoeal diseases, pneumoconiosis and several neglected tropical diseases (table 2). Despite a small decrease in numbers of deaths, age-standardised malaria mortality have fallen by 19% since 1990, with much of that decline occurring in the past 5 years or so (data not shown).[33]

For most of the leading non-communicable diseases, the number of deaths has increased, by 42% between 1990 and 2013 (from 27·0 million [UI 26·3–27·6] in 1990, to 38·3 million [37·2–39·4] in 2013), but age-standardised mortality rates have fallen. Allowing for changes in the age structure of the world's population between 1990 and 2013, age-standardised death rates from non-communicable diseases fell by 18·6%; by 22% for cardiovascular and circulatory diseases, 13·7–14·7% for cirrhosis of the liver and cancer, and 21·9–30·4% for other digestive diseases and chronic respiratory diseases (table 2). For many disorders, including stomach cancer, Hodgkin lymphoma, rheumatic heart disease, peptic ulcer disease, appendicitis, and schizophrenia, age-standardised death rates have fallen by more than one-third since 1990 (table 2). Age-standardised death rates for some cancers have fallen (lung by 9%, breast by 18%, and leukaemia by 20%), but have remained unchanged for others (table 2). Global age-standardised death rates have fallen by more than one-fifth for ischaemic heart disease and stroke (table 2).

Global age-standardised mortality rates increased significantly for very few disease between 1990 and 2013. The largest increase was for HIV/AIDS, which peaked in 2005 and then fell by 31·0% (UI 25·7% to 35·9%) from 2005 to 2013 (from 26·9 to 18·5 per 100 000). Among the cancers, only liver cancer caused by hepatitis C increased substantially (table 2). Although age-standardised mortality for cardiovascular and circulatory diseases decreased by 22%, significant increases occurred for atrial fibrillation and flutter and peripheral vascular disease (table 2). Mortality rates for Alzheimer's disease and other dementias increased by only 3·2% (UI −3·01 to 11·61) and Parkinson's disease by 28·2% (−6·42 to 37·83; table 2). Important worldwide increases occurred for diabetes (9·0%) and an even larger increase for chronic kidney disease (36·9%; table 2). The age-standardised death rate for sickle-cell disease increased while that of other haemoglobinopathies fell (table 2). The

residual category of endocrine, metabolic, blood, and immune disorders increased by 11·6% (table 3).

Age-standardised death rates for injuries and most specific causes of injury also fell between 1990 and 2013, but typically much less than for diseases (table 2). Age-standardised death rates for transport injury decreased since 1990, with most deaths from road injuries. The number of deaths from unintentional injuries as a whole remained essentially unchanged since 1990, although age-standardised death rates fell by more than a quarter (table 2). Especially large falls occurred for drowning, fires, unintentional suffocation, and venomous animal contact (table 2). Age-standardised death rates also fell for self-harm and interpersonal violence (table 2). Among injuries, only falls, foreign body in other body part, adverse effects of medical treatment, and pedestrian road injuries had increased age-standardised death rates, but these were not statistically significant.

For only three level 2 causes did the age-standardised death rates increase: neurological disorders; diabetes, urogenital, blood, and endocrine diseases; and musculoskeletal disorders (figure 8). Increases in the musculoskeletal disorders were driven by the category other musculoskeletal disorders; causes with high number of death in this category were systemic lupus erythematosus, systemic sclerosis (scleroderma), pyogenic arthritis, and chronic osteomyelitis (data not shown). The average relative difference between countries (the inter-country Gini coefficient) ranged from 0·31 for non-communicable diseases to 0·90 for forces of nature, war, and legal intervention. Mean differences in the age-standardised rates between countries ranged from 0·32 for musculoskeletal disorders to 104·87 for communicable, maternal, neonatal, and nutritional diseases. Generally, inequality was much greater for communicable, maternal, neonatal, and nutritional causes than for non-communicable causes or injuries. An important exception to that general pattern was war and disaster, which were extraordinarily unequal across countries. For neoplasms, chronic respiratory diseases, and forces of nature, war, and legal intervention the age-standardised death rate had fallen and the two convergence metrics improved significantly from 1990 to 2013. For many communicable, maternal, neonatal, and nutritional causes, age-standardised death rates and mean absolute differences decreased but relative differences increased. For digestive diseases, unintentional injuries, and other communicable, maternal, neonatal, and nutritional diseases, death rates and mean absolute differences were falling and relative difference was not significantly different than zero.

Global causes of child death

We divided child causes of death into those occurring in children younger than age 1 month and those aged 1–59 months (table 3). The number of neonatal deaths decreased from 4·5 [UI 4·4–4·6] million in 1990, to 2·6 [2·5–2·7] million in 2013, a 42% (40–45) decrease. The most important cause of neonatal death in 2013 was neonatal encephalopathy, followed by neonatal sepsis, congenital anomalies, and lower respiratory infections (table 3). Causes with more than a 50% reduction in the number of neonatal deaths include tetanus, diarrhoeal diseases, lower respiratory infections, other neonatal disorders, and other communicable diseases.

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For children aged 1–59 months, the global number of deaths fell by 52·0% from 1990 (7·6 [UI 7·4–7·8] million) to 2013 (3·7 [3·4–3·9] million). Communicable, neonatal, and nutritional causes accounted for three-quarters of deaths in 2013, the remainder from non-communicable diseases and injuries (table 3). For this age group, two causes each accounted for more than half a million deaths and collectively accounted for more than a third of deaths: lower respiratory infections, and malaria (table 3). Four causes accounted for 100 000–500 000 deaths: diarrhoeal disease, meningitis, congenital anomalies, and nutritional deficiencies (table 3). Another seven causes each caused 50 000–100 000 deaths: drowning, syphilis, measles, whooping cough, intestinal infectious diseases, HIV/AIDS, and road injuries (table 3). Deaths fell by more than 50% between 1990, and 2013, for diarrhoeal diseases, lower respiratory infections, meningitis, whooping cough, tetanus, measles, preterm birth complications, drowning, other neonatal disorders, and other injuries. Of the causes detailed in table 3, only HIV/AIDS increased significantly from 1990, to 2013, although from 2005, to 2013, deaths fell from 25·95 (UI 24·54–27·50) per 100 000 to 9·83 (9·01–11·04) per 100 000. In high-income countries, cancers accounted for 5·86% (5·06–6·66) of deaths for children younger than 5 years compared with only 1·02% (0·89–1·16%) in low-income countries.

Figure 9 shows death rates of children for 19 major cause groups for the 21 GBD regions. Because infants younger than age 1 month are exposed to, at most, 1 person-month, rates in that group were high compared with children aged 1–59 months. Across regions, death rates varied widely for preterm birth complications, neonatal encephalopathy (birth asphyxia and birth trauma), other neonatal disorders and jaundice, sepsis, and lower respiratory infections (figure 9). In addition, lower respiratory infections, HIV/AIDS, congenital syphilis, malaria, diarrhoeal diseases and congenital abnormalities had an important contribution. Congenital anomalies varied by more than five-times from a high in central sub-Saharan Africa to a low in high-income Asia Pacific. Eastern, central, and western sub-Saharan Africa had substantially high death rates for children aged 1–59 months compared with other regions including south Asia (figure 9B). These higher rates were largely related to malaria, diarrhoeal diseases, measles, and nutritional disorders.

Global YLLs

Between 1990 and 2013, large falls occurred for measles, meningitis, tetanus, syphilis, and whooping cough (figure 10). Increases of 50% or more are evident for diabetes, HIV/AIDS, hypertensive heart disease, chronic kidney disease, Alzheimer's disease and other dementias, interstitial lung disease, and pancreatic cancer. Among the top ten causes in 1990, nine remain in the top ten in 2013, with HIV/AIDS moving in and tuberculosis moving to 11th. The largest percentage increases in YLLs were for HIV/AIDS (343·97%, 95% UI 245·48–444·17), atrial fibrillation and flutter (211·89%, 182·55–242·63), peripheral vascular disease (119·79%, 101·04–136·78), and drug use disorders (119·22%, 83·77–140·02).

Identification of key transition points in the comparative importance of different causes of premature mortality will help to better inform programme evaluation. From 1990 to 2013, worldwide crude YLLs fell by about 16% (from 2005·5 million to 1685·4 million), more so

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for communicable, maternal, neonatal, and nutritional diseases (39% decrease, 1098·3 million to 667·8 million) compared with non-communicable diseases (20% increase, 674·6 million to 806·5 million), and injuries (9% decrease, 232·6 million to 210·8 million). Recent progress with disease control programmes for HIV/AIDS and malaria is clear, as is the substantial and steady progress to prevent child deaths from neonatal disorders, diarrhoeal diseases, and lower respiratory infections; YLLs from these diseases fell by 40–65% since 1990. The success of vaccination programmes since 1990 is also evident (figure 11), with YLLs from measles and tetanus, in particular, at very low levels in 2013. Specific trends for major non-communicable diseases are much less evident, with incremental decreases for several leading causes of cancer, as well as from major vascular and chronic respiratory diseases, contributing to the 30% reduction in YLLs since 1990 (37 021·0 to 24 493·4 per 100 000). With the exception of drowning, only modest progress was made in reducing premature mortality from other leading causes of injury, with the effect of the 1994 genocide in Rwanda clearly visible (figure 11).

Causes of diarrhoea and lower respiratory infection

Deaths caused by diarrhoea fell by 51% (46–56) between 1990 and 2013 (table 2). Rotavirus was the main cause of diarrhoea in children younger than 5 years. It was also the most common cause of diarrhoea deaths in this age group in 2013, with a slight decrease in the population attributable fraction since 1990, followed by cholera, *Cryptosporidium*, and shigellosis (table 4). At least 55·6% of diarrhoea in 2013 was unexplained by these pathogens in all ages, an increase from 48·1% in 1990 (table 4).

The distribution of *Shigella* and *Aeromonas* in patients had a significant ecological association with sanitation (data not shown) and along with non-typhoid *Salmonella*, deaths from these pathogens fell by 5·4% (28 062 deaths) since 1990. Rotavirus was the most important pathogen for children younger than age 5 years in east and southeast Asia and eastern Europe, with a population attributable fraction of 35–41% (104–6390); although it had the lowest population attributable fraction in high-income north America, central sub-Saharan Africa, and Caribbean. *Shigella* was an important pathogen in north Africa and Middle East and Oceania (causing 19·4% [11·8–29·4] of deaths, 3790 [1976–6381] deaths and 13·9% [9·5–19·3] of deaths, 118·4 [45·4–249·6] deaths, respectively). *Cryptosporidium* in sub-Saharan Africa, cholera in central sub-Saharan Africa, Andean Latin America, and Oceania, and enterotoxigenic *E coli* were important causes of diarrhoea death. *Campylobacter* did not have a significant epidemiological relationship with diarrhoea in most countries and was an important cause only in some age groups in the GEMS data in India, Bangladesh, and Mozambique (data not shown). *Clostridium difficile* caused more than 45% of diarrhoea deaths in western Europe, high-income north America, high-income Asia Pacific, and Australasia in 2013, ranging from eight deaths in Australasia to 92 in high-income North America, and to a lesser extent in central Europe (20·1% [14·0–27·1] or 16 [14–19] deaths, and eastern Europe (19·0% [12·6–26·6] or 47 [38–57] deaths).

Cholera caused 45 000 (23 000–68 000) deaths of children younger than age 5 years, with most deaths (34 000 [76%]) in central and eastern sub-Saharan Africa and south and southeast Asia. Cholera was the third leading cause of diarrhoea deaths for all ages in 2013,

behind rotavirus and shigellosis (table 4). *Clostridium difficile* was particularly important in adults in high-income countries, where it caused as many as 95% of diarrhoea deaths in elderly people.

Globally in 2013, pneumococcus was responsible for the largest number of lower respiratory infection deaths in children younger than age 5 years—followed by *H influenzae* type B, respiratory syncytial virus, and influenza—and in people of all ages (table 4). The fraction of deaths caused by lower respiratory infection in children younger than age 5 years attributable to *H influenzae* type B has decreased substantially since 1990, as a result of the global scale-up of *H influenzae* type B vaccine, with the largest decreases in high-income regions and Latin America (data not shown), where vaccine coverage is highest. The fraction of lower respiratory infection deaths in children younger than 5 years attributable to pneumococcus also fell in high-income regions such as western Europe, north America and Australasia, caused by the scale-up of pneumococcal conjugate vaccine, but continued to account for a large proportion of such deaths in eastern Europe and elsewhere. Many lower respiratory infection deaths attributable to the four pathogens occurred in older populations.

Country-specific probabilities of death during childhood and young adolescence

We computed conditional probabilities of death for three phases of life (children and young adolescents, reproductive age, and middle age) by country and cause; conditional probabilities are a useful summary because the values are readily interpretable. The probability of death in children and adolescents (age 0–14 years) varied greatly between and within regions, from a low of three per 1000 girls in Iceland to a high of 179 per 1000 boys in Guinea-Bissau (figure appendix 1). In the more demographically advanced regions (measured by mean age of death, fertility, and mortality change) the probability of death was below ten per 1000 people for both sexes in all countries except Albania, Bulgaria, Belarus, Brunei, Moldova, Macedonia, Romania, Russia, and Ukraine. Causes of death were dominated by congenital anomalies and neonatal causes. In southeast Asia, Malaysia had the lowest probability of death and Laos the highest, with substantial mortality from lower respiratory infections, diarrhoea, and neonatal disorders. Drowning was an important cause of death for children in this region. In central Asia, probabilities of death ranged from 17 per 1000 people in Armenia to 65 per 1000 people in Turkmenistan, with unusually high contributions from lower respiratory infections; drowning was also an important cause. Bahrain, Oman, and United Arab Emirates had death rates below ten per 1000 for girls, whereas in Sudan and Yemen, they were more than 40 per 1000. Mortality in these countries was dominated by congenital and neonatal causes. Pulmonary aspiration and foreign body in trachea and lung was an unusually high cause of child death in Bolivia based on the available vital registration data. In south Asia, the contribution of drowning in Bangladesh was notable but mortality was still dominated by neonatal causes, diarrhoea, and pneumonia in all the countries of the region. Throughout sub-Saharan Africa, patterns of causes of death varied but malaria, HIV/AIDS, tuberculosis, nutritional deficiencies, and haemoglobinopathies played an important part in many countries. Mauritius, Seychelles, and Cape Verde all had much lower probabilities of death during childhood than did other countries in this region. Countries with the highest probabilities of death in central and western sub-Saharan Africa had important contributions from malaria. Interpersonal

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violence was an important contributor to the probability of death in children and adolescents in many countries of Latin America and several in southern Africa.

Country-specific probabilities of death during reproductive age

The probability of death in reproductive-age adults (exact age 15 years to exact age 50 [$_{35}q_{15}$]) ranged from 1·2% for women in Andorra to 52% for men in Lesotho (figure appendix 2). In high-income regions, the probability of death was generally twice as high for men as for women. Across all countries, transport injuries made an important contribution, especially in men.

Among men in low-income countries, suicide and transport accidents made important contributions. In some countries, such as Norway and USA, drug and alcohol use disorders account for more than 8% of the total probability of dying in this age interval for either sex. In central Europe, interpersonal violence was high in Albania, drug and alcohol disorders were notable in Poland, Croatia, Slovakia, and Montenegro, and cirrhosis was a common cause in Bulgaria, Croatia, Hungary, Poland, Romania, Slovakia, and Slovenia. In east Asia, liver cancer was an important cause of death. In southeast Asia, maternal mortality in Laos, Cambodia, Myanmar, and Timor-Leste were important contributors for women. For men in the same region, interpersonal violence in Philippines, Sri Lanka, and Thailand were notable; suicide in Sri Lanka also accounted for a large probability of death (2·2%). Other studies have suggested that interpersonal violence in Philippines is concentrated in Mindanao.[82]

Risk of death from transport injuries was greater than 2% for men in Afghanistan, Côte d'Ivoire, Cameroon, Ecuador, Gabon, Guinea-Bissau, Equatorial Guinea, Kazakhstan, Mauritania, Nigeria, Oman, Sierra Leone, El Salvador, Thailand, and Uganda. Probability of death from cirrhosis in Myanmar was 1·9% for men. Tuberculosis stood out in Cambodia, Indonesia, Laos, Myanmar, and Philippines for men. The gap between the probability of death for men and women was particularly large in eastern Europe and central Asia. Mongolia had the highest probability of death in reproductive age for men in these two regions, as a result of unusually high probabilities of interpersonal violence, self-harm, alcohol and drug use, cirrhosis, liver cancer, and tuberculosis. More generally for men, in eastern Europe and central Asia, there were major contributions from ischaemic heart disease, self-harm, alcohol and drug use, cirrhosis, and tuberculosis; HIV played an important part in Ukraine and Russia. In north Africa and Middle East, transport injuries and ischaemic heart disease were predominant. For women in the region, breast cancer in all countries and maternal mortality in Sudan and Yemen were also major factors.

In Latin America and Caribbean, there was a large contribution of interpersonal violence in men, with the probability of death exceeding 2% in Brazil, Colombia, El Salvador, Guatemala, Honduras, and Venezuela. Despite generally high violence in the region, Cuba, Costa Rica, Bolivia, and Peru had low probabilities of death from violence. In men, the probability of death because of HIV/AIDS exceeded 1% in Belize, Haiti, Saint Vincent and the Grenadines, The Bahamas, Grenada, Guyana, Suriname, and Trinidad and Tobago. Cirrhosis contributed more than 1% to the probability of death of men in Guatemala, Mexico, and Guyana. Cervical cancer was a larger contributor to the probability of death

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than was breast cancer in eight countries of Latin America and Caribbean (Bolivia, Ecuador, Guatemala, Nicaragua, Peru, Paraguay, El Salvador, and Venezuela). Probabilities of death for men and women in Afghanistan were more than twice that of other countries in the region; for women, maternal mortality was the largest cause. In Oceania, Samoa and Tonga had much lower probabilities of death than did other countries in the region. Throughout sub-Saharan Africa, there were major contributions for women from maternal mortality, HIV/AIDS, and tuberculosis. For men in the region, HIV/AIDS, tuberculosis, and transport injuries dominated in most countries. Liver cancer was also a major factor, particularly for men in western sub-Saharan Africa.

Country-specific probabilities of death during middle age

The probability of death in middle age (exact age 50 years to exact age 75 years [$_{25}q_{50}$]) ranged from 10·3% for women in Andorra to 76·3% for men in Lesotho (figure appendix 3). In all countries, ischaemic heart disease and stroke were important contributors to the risk of death in middle age, and were greater for men than for women. Probabilities of death from ischaemic heart disease ranged from 0·8% in Japan for women to more than 24% in Belarus for men. In high-income regions, lung cancer was as a major contributor to the risk of death for men. Breast cancer for women and prostate cancer for men also made substantial contributions. Probability of death from liver cancer was greater than 2% in China, Mongolia, Myanmar, North Korea, South Korea, Taiwan (province of China), Thailand, and Vietnam.

In central Europe, chronic respiratory diseases and cirrhosis made clear contributions in Bulgaria, Croatia, Hungary, Poland, Romania, and Slovenia. In some high-income countries, including Singapore, Argentina, and Uruguay, lower respiratory infections were important causes of death for this age group, more so for men than for women. In southeast Asia, liver cancer, diabetes, and tuberculosis made larger contributions than in many other regions, particularly in Myanmar, Philippines, Laos, Indonesia, and Cambodia. Elsewhere in the region, stroke, ischaemic heart disease, other cardiovascular and circulatory diseases, and chronic respiratory diseases were predominant. In all countries of eastern Europe and central Asia, stroke and ischaemic heart disease were particularly prominent for both sexes. Liver cancer in Mongolia had the highest probability of causing death in the world for this age group.

Egypt had extraordinarily high cirrhosis mortality, particularly from hepatitis C, in middle aged men and women. Deaths caused by diabetes were particularly high in Morocco, Bahrain, Oman, and Qatar. In central Latin America and Caribbean, diabetes made large contributions to causes of death in men and women; the highest probability of death in these regions from diabetes for males was 9·2% in Trinidad and Tobago and 8·4% for women in Guyana. Chronic kidney disease was particularly high in El Salvador, Mexico, and Nicaragua; more so for men than for women.[75,76] In the Caribbean, diabetes, stroke, and ischaemic heart disease accounted for 33·4% of the probability of death in this age group in Haitian men, and 54·8% in Guyanese women.

In all the countries of Oceania, diabetes accounted for an extremely large fraction of mortality in middle-aged women. For nearly all countries in sub-Saharan Africa, stroke and

other cardiovascular diseases (including cardiomyopathies) were important. HIV/AIDS and tuberculosis, diarrhoea, and lower respiratory infections were also estimated to be important causes in almost every country in the region. The probability of death from liver cancer was high in most countries of western sub-Saharan Africa.

Country-specific leading causes of YLLs

Worldwide, the top ten causes of YLLs were ischaemic heart disease, lower respiratory infections, stroke, diarrhoea, road injury, HIV/AIDS, preterm birth, malaria, neonatal encephalopathy, and congenital causes (figure 12). The differences between high-income and low-income countries was substantial. Self-harm was the fourth highest cause of YLLs in high-income countries and the 14th in low-income countries. Lung cancer, self harm, Alzheimer's disease and other dementias, cirrhosis, chronic obstructive pulmonary disease, and colorectal cancer were in the top ten causes in high-income countries but not in low-income countries. Conversely, diarrhoea, malaria, HIV/AIDS, preterm birth complications, neonatal encephalopathy, and congenital disorders were in the top ten in low-income, but not high-income, regions.

Ischaemic heart disease, stroke, and lung cancer were the top three causes in 32 GBD developed countries. More notable differences in the rankings across high-income countries were self-harm as the second highest cause of YLLs in South Korea, Alzheimer's disease and other dementias as the third highest cause in Canada, Finland, and Israel, and lower respiratory infections as the second cause in Singapore and the third highest cause in Argentina and Japan. Cirrhosis was the third highest cause in Chile. Colorectal cancer was a top five cause in 13 high-income countries and diabetes was in three high-income countries.

In central Europe, eastern Europe, and central Asia, ischaemic heart disease and stroke dominated but in Bosnia and Herzegovina, Serbia, Latvia, and Russia cardiomyopathies were also in the top five. As a result of higher child mortality in these regions, Azerbaijan, Kyrgyzstan, Mongolia, Tajikistan, Turkmenistan, and Uzbekistan had preterm, or neonatal encephalopathy, in the top five causes. In eastern Europe, five causes (ischaemic heart disease, stroke, self-harm, cirrhosis, and road injury) made up 49·7% of YLLs (95% UI 48·5–51·3; or 29·3 million [28·5–30·2]). In Latin America and Caribbean, more variation exists in the leading cause of YLLs. Lower respiratory infections were the leading cause in Bolivia, Peru, Guatemala, and Ecuador; HIV/AIDS was in Haiti; interpersonal violence was in Colombia, El Salvador, and Venezuela; stroke was in Jamaica; congenital anomalies were in Nicaragua, and ischaemic heart disease was in the rest. Road injury was in the top five for 17 of 29 countries. Diabetes was also in the top five for 13 countries. Chronic kidney disease was in the top five for Barbados, Costa Rica, El Salvador, Mexico, and Nicaragua. Perhaps most unusually, interpersonal violence was in the top five causes in 15 countries in the region, but only one country outside Latin America and Caribbean, namely South Africa.

In east Asia, the top five causes of YLLs, in order, were stroke, ischaemic heart disease, road injury, chronic obstructive pulmonary disorder, and lung cancer. These are almost the same top five causes as in USA: the only difference is Alzheimer's disease and other dementias, which was fourth and road injury was sixth, providing evidence of epidemiological convergence between east Asian countries and some high-income countries.

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In Oceania, ischaemic heart disease, lower respiratory infections, diabetes, and diarrhoea were important. In Papua New Guinea, malaria was also a top five cause. Southeast Asia as a whole, Indonesia, Myanmar, and Philippines have tuberculosis as a top five cause of YLLs. Road injury was a top five cause in Indonesia, Malaysia, Thailand, and Vietnam. Cirrhosis was in the top five in Myanmar and liver cancer in Thailand and Vietnam. Among the countries of south Asia, the leading causes are a mix of neonatal causes and ischaemic heart disease, lower respiratory infections, and stroke in most countries. Tuberculosis was the third highest cause in India.

In north Africa and Middle East, ischaemic heart disease and stroke, preterm birth complications, congenital anomalies, and road injury were prominent leading causes of YLLs. In four countries—Oman, Qatar, Saudi Arabia, and United Arab Emirates—road injury was the leading cause of YLLs. Cirrhosis was the third highest cause of YLLs in Egypt. Self-harm was in the top five in Bahrain, Qatar, and United Arab Emirates. The profile of leading causes of YLLs in sub-Saharan Africa was greatly different from the rest of the world with the exception of Cape Verde, Mauritius, and Seychelles. HIV/AIDS was the leading cause in 18 countries. Malaria was the leading cause in 14 countries. Lower respiratory infection was the leading cause in Angola, Comoros, Ethiopia, Madagascar, Rwanda, South Sudan, Côte d'Ivoire, Mauritania, and São Tomé and Princípe. Diarrhoea was the leading cause in D R Congo, Eritrea, Somalia, and Chad. Tuberculosis was in the top five causes in 18 countries. Violence was the fifth highest cause in South Africa. Road injury was the fifth highest cause in Equatorial Guinea, Gabon, Botswana, Swaziland, Cameroon, and Nigeria.

Discussion

Main findings

The GBD 2013 incorporates many new datasets for cause of death, particularly from China, and new data for 155 other countries. Compared with the GBD 2010, it provides the most comprehensive and up-to-date assessment of causes of death. The results for the GBD 2013 are based on re-estimation of all causes from 1990 to 2013, and thus supersede all previously published GBD time series (panel). Publication of country-level results provides many opportunities for comparing a country's performance with that of its peers.

On the broadest level, our analysis of 240 causes of death for 188 countries confirms that global life expectancy at birth has continued to improve over the past 23 years and these improvements are driven largely by falls in diarrhoea, lower respiratory infections, and neonatal causes in low-income countries, and decreases in cardiovascular diseases and some cancers in middle-income and high-income countries. HIV/AIDS has had a large enough effect to negate progress made in other causes contributing to decreases in life expectancy, particularly in southern sub-Saharan Africa.

This general progress masks enormous heterogeneity across countries and age groups. Even within regions, substantially different mortality, leading causes of death, and trends exist. Outside sub-Saharan Africa, premature mortality is dominated by relatively few causes including ischaemic heart disease, stroke, lower respiratory infections, road injury,

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diarrhoea, preterm birth complications, neonatal encephalopathy, congenital anomalies, tuberculosis, chronic obstructive pulmonary disease, cirrhosis, self-harm, and lung cancer. In addition to these common causes, great regional and country variation exists, such as the dominant role of interpersonal violence in most countries of central Latin America and Brazil.

Our study points to extraordinary epidemiological progress: global age-standardised death rates fell significantly for 157 of 240 causes from 1990 to 2013. The largest decreases were for some of the major communicable diseases including diarrhoeal diseases, lower respiratory infections, tuberculosis, and measles. Age-standardised rates for many non-communicable causes are also falling. At the same time, numbers of deaths from 115 of these 240 causes, have increased, driven by both growth in population and shifts in the population age-structure towards older ages. For a further 58 causes, changes in the age-standardised death rate over the 23 year period were not statistically different from no change. For some of these causes, sparse data might have contributed to wide UIs and in other cases uncertainty might have arisen from inconsistent coding across countries. However, eight specific causes account for more than 100 000 deaths and their age-standardised death rates have increased significantly since 1990: HIV/AIDS, liver cancer caused by hepatitis C, pancreatic cancer, atrial fibrillation and flutter, drug use disorders, diabetes, chronic kidney disease, and sickle cell disorders. Of these causes, three (HIV/AIDS, diabetes, and chronic kidney disease) account for more than a half a million deaths each. HIV/AIDS, however, has been decreasing as a cause of death since 2005. These causes, which run counter to an extraordinary global trend towards lower age-standardised death rates, deserve special attention.

The rise and subsequent fall of HIV/AIDS is well known as is the rise in diabetes. Increases for atrial fibrillation and flutter, pancreatic cancer, drug use disorders, and chronic kidney disease have received far less global attention. Drug use disorders and chronic kidney diseases cause many more deaths in some regions and countries than in others. Nevertheless, they are important emerging global challenges that show the potential adverse effects of some behaviours and socioeconomic developments. In view of the important behavioural component for some of these causes, there is potentially an important role for public health policy and resources to modify these causes of death. These diseases, particularly HIV/AIDS and drug use disorders are also subject to social stigmatisation, which adds an important challenge for effective policy interventions. Although global age-standardised death rates have increased for very few causes, there is remarkable and important variation in trends across countries such that causes with falling global age-standardised rates are increasing in some countries—for example, ischaemic heart disease in China.

Convergence or divergence?

Ambitious goals have been set for maternal and child mortality,[84-86] such as the end of preventable maternal and child death in a generation. *The Lancet* Commission *Global health 2035: a world converging within a generation* has argued that a grand convergence in health is possible between high-income, middle-income, and low-income countries.[24] Trends in the past 23 years provide an important starting point for framing how great a challenge

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achieving these aspirations will be and the political will and financial resources required. Part of the answer depends on how the goals are framed—for example, what does convergence mean? In the development literature on economic convergence,[87-89] convergence has been framed in terms of poverty rates or in terms of income inequality measured by the Gini coefficient or other measures of inequality. Work on convergence in life expectancy has tended to focus on measures of absolute difference[90-92] rather than relative difference.[93] We found unequivocal divergence in mortality rates for women aged 25–39 years and older than 80 years and for men aged 20–44 years and 65 years and older, similar to previous estimates of divergence of life expectancy at birth since the 1980s.[94] In these age groups, both the Gini coefficient and the mean absolute difference in death rates are rising. In all other age groups, except girls aged 10–14 years, relative inequality is increasing but the absolute gap is narrowing. Framing a grand convergence as simply achieving a reduction in the differences in mortality rates across countries might not be sufficiently ambitious to meet the goals of many national policy makers. If mortality decreases in all countries by the same percent per year, absolute difference will decrease and relative differences will stay constant. For age groups in which global relative and absolute differences in death rates are diverging, extraordinary efforts will be needed to achieve laudable goals such as a grand convergence. If convergence includes reducing the ratio of the highest to lowest death rates, even for under-5 mortality, major new efforts will be needed to have faster percent decreases in countries with higher mortality.

Arguments that convergence is technically and financially feasible are grounded on the rapid improvements of some countries.[24] For example, from 1990 to 2013, 13 countries (all low-income), achieved increases in life expectancy greater than 10 years (appendix pp 141–151). The real challenge is whether the strategies to decrease mortality used by these countries are generalisable or transferable to those countries who are making the least progress. *The Lancet* Commission on global health 2035 drew attention to the four Cs (Cuba, Costa Rica, Chile, and China). Life expectancy has improved faster than the global aggregate trend in China and Chile in the past 23 years.

The good news is that some countries that were low-income in 1990 have achieved remarkable progress in the past 23 years—for example, in Nepal, life expectancy has increased by 12·16 years since 1990, reaching 70·64 years in 2013 for both sexes combined (appendix pp 141–151). Other examples of improvements greater than 12 years for both sexes combined include Rwanda, Ethiopia, Niger, Maldives, Timor-Leste, and Iran. Because the Rwandan genocide occurred after 1990, the progress from the peak of mortality during the genocide until 2013 is even larger, 49·63 years. Studies have already assessed progress in Bangladesh, Ethiopia, and Niger, particularly in reducing child mortality.[95] Further study of these countries might provide insights about how to achieve low mortality, including the role of development assistance for health, rapid economic growth, and addressing chronic challenges such as famines. Simple assessments built up from individual technology analyses, such as the Disease Control Priorities-2,[96] assume a high-level of health system efficiency and contextual factors that enable technology to be delivered such as levels of maternal education. Plans to achieve a grand convergence in the face of diverging mortality will need to take into account low levels of health system efficiency and low levels of health

system resourcing in some countries and the greater efforts needed to achieve high intervention coverage in low-income countries with inadequate primary health-care systems and low levels of educational attainment. The challenge of improving health system management, particularly locally, is a crucial component of the future plans.

The analysis of average relative difference between countries and average absolute difference between countries by cause (data not shown) shows the general pattern that many communicable, maternal, and neonatal causes, along with war and natural disasters, are highly unequal across countries; almost all have average relative differences of more than 50%. Among the non-communicable disease categories, mental and substance use disorders is the only cause with a mean relative difference greater than 40%. Following the more stringent criteria for convergence—in which global rates and the Gini coefficient are both falling—only neoplasms and chronic respiratory diseases are converging. As more countries go through the epidemiological transition, it seems likely that cross-country inequalities or relative differences for communicable causes will rise and inequalities for non-communicable causes will narrow. Narrowing inequalities across countries will not necessarily narrow inequalities for non-communicable disease within countries. Because mortality exponentially rises with age, at least after age 50 years, relative differences at older ages, when mortality becomes concentrated, tend to be small. Causes such as diabetes, chronic kidney disease, and alcohol and drug use disorders—for which global death rates are rising and inequality is increasing—are exceptions to this general pattern.

Non-communicable diseases

Age-standardised death rates for cardiovascular and circulatory diseases have fallen in high-income and many middle-income countries since 1990. Rapid falls have occurred in some countries. For example, five countries (Israel, Denmark, Norway, South Korea, and UK), had at least a 65% decrease in age-standardised death rates for ischaemic heart disease. Many other countries have had decreases of 40–65%. Age-adjusted death rates caused by haemorrhagic stroke fell by three-quarters in South Korea.

The ageing and growth of populations has led to an increase in the total number of cardiovascular deaths, accounting for almost a third of all deaths globally in 2013. Ischaemic heart disease, ischaemic stroke, and haemorrhagic stroke continue to cause most cardiovascular and circulatory deaths in almost all countries. Some Balkan countries are an exception; cardiomyopathy was a leading cause of death, possibly as a result of alcohol exposure or local patterns of garbage codes.[97] Additional studies are needed to establish whether this finding is driven by medical certification practices or is related to alcohol or some other factor.[97] Age-standardised death rates for atrial fibrillation and flutter and peripheral vascular disease have increased, possibly because of increased awareness of these conditions or better survival from cardiovascular diseases that share the same risk factors. Much uncertainty remains for trends in mortality caused by rheumatic heart disease, partly because endemic populations are concentrated within poorer subnational regions where data collection is limited and rheumatic heart disease might not always be coded as the underlying cause of death.[98] Efforts to benchmark changes in cardiovascular and circulatory diseases will benefit from increasing access to verbal autopsy in India and sub-Saharan

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Africa, household surveys focused on chronic diseases, and improvements in electronic health records.

Generally, cancer deaths are increasing but age-standardised cancer death rates are falling. Some cancer-related risk factors, such as tobacco consumption, have decreased, but others, such as obesity, have increased. The substantial general fall in cancers require further explanation. Death rates for five cancers increased (non-Hodgkin lymphoma, mesothelioma, kidney cancer, pancreatic cancer, and multiple myeloma); some explanations, such as the potential link between the rise of diabetes and pancreatic cancer might account for some of these reversals. Because of different rates of decrease for other sites, the mix of cancers is steadily changing, particularly in low-income regions, such as the relative importance of breast cancer compared with cervical cancer. These local changes have important implications for the development of cancer care programmes and training. Because of the strong relation between cancer mortality and age, ageing of the world's population is the most important driver of the rising number of cancer deaths in most countries. Most countries can expect to have to deal with more patients who need diagnosis, treatment, and palliation in coming years.

Alzheimer's disease and other dementias

We used a substantially different approach to estimate Alzheimer's disease and other dementia mortality in the GBD 2013 by focusing on studies of prevalence and using data from countries with the highest death to prevalence ratios in 2013 to estimate mortality in other regions and back in time. This change greatly lowers the increase compared with GBD 2010 in the age-standardised death rate for dementia although the numbers of dementia deaths nevertheless increased. Lower increases in the age-standardised rate were because the meta-regression of prevalence studies did not show a rapidly rising trend; one study, reported decreases in age-specific rates, although our overall assessment suggests a slight increase in age-specific rates.[99] Even in high-income countries with complete medical certification of causes of death, we argue that dementia was systematically underestimated as a cause of death in earlier periods. Other studies, such as the National Mortality Followback Study in USA, support this idea.[100] Dementia deaths might have been misclassified into categories such as senility. Our garbage code redistribution algorithms for this broad category might have under-allocated dementia deaths in earlier periods. For future research, we may want to more carefully trace to which garbage codes dementia deaths might have been assigned using hospital linkage or other approaches.

The other effect of using this approach is that we estimated considerably more dementia deaths in middle-income countries than in the GBD 2010. Prevalence studies suggest dementia occurs in these countries although it is rarely recorded on a death certificate as a cause of death. Our overall conclusion is that dementia is more common worldwide and that numbers are increasing because of population ageing with only a small component of the increase caused by rising age-specific rates. The analysis of dementia will benefit from further population-based prevalence surveys, especially with repeated measurement over time using standardised definitions and methods. As further studies of this type become available and incorporated into the GBD, our estimates of dementia burden might be

substantially revised. Trends in the category Alzheimer's disease and other dementias might mask upward trends in Alzheimer's and downward trends in vascular dementia; however, these disorders are difficult to tell apart in population-based prevalence studies and cause of death data. Nevertheless, our finding that the number of dementia deaths is increasing implies that governments should remain concerned about the rising demands for care that will come with population ageing even if future rates do not increase substantially.

Diarrhoea and lower respiratory infections

We report that the distribution of the causes of diarrhoea is different around the world. The distribution of pathogens has also changed significantly since 1990—for example, almost 50% (20 343 [9054–41 216] deaths) of all cholera deaths in children occur in sub-Saharan Africa. Because we used GEMS data to estimate relative risks, it is perhaps not surprising that our results are comparable to their findings.[57] The population attributable fraction for pathogens such as *Campylobacter*, *Shigella*, and *Salmonella* were not significant in some countries and some ages. Because of the nature of case notification data, we had to estimate all types of cholera and were unable to breakdown cholera into O1, non-O1, and O-139.

In high-income countries, *C difficile* is an important threat that has increased during the past two decades. 65% (744 413 deaths) of unexplained diarrhoea in people older than 5 years is an important knowledge gap. Although the new counterfactual approach is successful for estimating attributable death empirically and adjusts for the overall pathogen load in the country, it still suffers from limitations such as the potential low sensitivity of diagnostic tests. Some pathogens are more prevalent in controls than in cases, which might present a distorted causal picture because of continuous shedding of pathogen long after the acute phase.[101-105] These findings could also suggest a protective effect of infection from one or more pathogens against other pathogens or could be simply caused by a differential decrease in the sensitivity of diagnostic tests (for other pathogens) where diarrhoea presents assuming a single pathogen caused the diarrhoea. More sensitive diagnostic tests help to improve sensitivity but at the price of decreased specificity because of contamination and post-diarrhoea pathogen excretion. Follow-up studies with multiple measurements of pathogens in children during healthy and diarrhoea periods could help to elucidate the true causal associations. Better case definition and more strict criteria for pathogens such as excluding recent cases of diarrhoea could decrease exposure misclassifications.

Our estimates of the fraction of under-5 lower respiratory infection deaths attributable to the four causes of pneumonia (pneumococcus, *H influenzae* B, respiratory syncytial virus, and influenza) are much the same as previous estimates, with pneumococcus and *H influenzae* B the predominant causes.[63,64,106-108] The large fraction of lower respiratory infection attributable to pneumococcus and *H influenzae* B, particularly in low-income regions where the absolute burden is highest, shows the potential benefit of continuing to scale up pneumococcal conjugate and *H influenzae* B vaccination. We calculated the contribution of each cause with a counterfactual approach. This approach means that they do not add up to 100% but also that there might be overlap; for example, death from lower respiratory infection might involve viral and bacterial co-infection. These results should also be

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interpreted with caution because of the data used to generate these estimates. Data for cause are sparse and prone to several biases, which is shown in the large UIs.

Estimates of the mortality burden of pneumococcal pneumonia in children rely on data from vaccine probe studies, which showed that disease in infants fell after pneumococcal conjugate vaccination; there are no sensitive diagnostic tests to detect non-bacteraemic pneumococcal pneumonia in children. To calculate burden in the absence of a diagnostic assay, the pneumococcal conjugate vaccination probe studies assumed a vaccine efficacy against non-bacteraemic pneumonia caused by vaccine types equal to that of protection from vaccine type bacteraemia (75%). Data from a large randomised trial of pneumococcal conjugate vaccination in adults confirmed efficacy against bacteraemic pneumonia of 75%, but efficacy against non-bacteraemic pneumonia was only 45%.[109] If similar efficacy estimates are applied to infants, then the contribution of the pneumococcus to pneumonia mortality in infants could be as high as 63% (166 324 deaths). Because data were sparse, we did not estimate the fraction of deaths caused by *H influenzae* B among people aged 5 years and older. The before-and-after vaccine efficacy studies used to estimate the burden of pneumococcus were limited to high-income settings. These types of studies might also be biased because of underlying temporal trends in hospital admissions for lower respiratory infection. Furthermore, the only variation included for pneumococcus and *H influenzae* B is a result of differences in vaccination coverage.

The observational studies used for respiratory syncytial virus and influenza were based on case series data from predominantly tertiary-level hospitals, which might not be representative of the underlying population and are prone to varying case-definitions and diagnostic methods. Finally, hospital discharge data for the relative differences in case-fatality for respiratory syncytial virus and influenza compared with pneumococcus and *H influenzae* B were limited to high-income and middle-income countries. Several of these shortcomings are being addressed by the Pneumonia Etiological Research for Child Health project.[110]

Injuries

Most global road traffic deaths occur in low-income and middle-income countries and are rapidly increasing because of the growth in motorisation. Mortality rates caused by traffic-related injuries are increasing in low-income and middle-income countries. Pedestrians are most often affected, followed by car occupants and motorcyclists. Conversely, traffic deaths are decreasing in high-income countries. We noted a similar divergence between low-income and high-income countries for occupational injuries: they generally fell in high-income countries (with the exception of deaths resulting from asbestos-related mesotheliomas), whereas occupational injury deaths have increased in low-income countries (data not shown).

Suicide continues to be a major public health problem in many regions. Half of all suicide deaths occur in China and India alone. However, the trends are in opposite directions, decreasing rapidly in China but rising in India between 1990 and 2013. Both countries have undergone economic growth and urbanisation, a key factor in limiting access to lethal

pesticides, a common method of suicide by poisoning in both countries.[111] Therefore, as yet unexplained reasons must exist for the divergence between the two countries.

We recorded several sharp increases in mortality caused by war and disaster. Particularly, the 2010 Haiti earthquake, conflict in Syria over the past several years, the 2011 Tōhoku earthquake and tsunami in Japan, and conflict in Libya in 2011 have caused considerable loss of life. The war in Syria led to an estimated 29 947 deaths (19 392–54 903) in 2013, and about 10 504 deaths and 21 422 deaths in each of the preceding 2 years. Uncertainty around these estimates is large because several different estimates exist. These estimates are of the direct deaths attributable to armed conflicts and natural disasters and do not account for the full effects of mechanisms such as the breakdown of health systems or critical infrastructure. For example, the conflict in Syria has had a substantial effect on routine immunisation for polio, with coverage now as low as 50% in some areas.[112] The estimation of direct deaths caused by war and natural disasters is one of the most challenging components of the GBD measurement. We depend on the work of various groups to collate combatant reports, newspaper reports, humanitarian agency assessments, and other direct accounts to approximate the number of deaths. Vital registration systems often do not function in war or conflict but might be more useful in countries with natural disasters as a way of measuring the number of deaths. More work is needed to better measure shock mortality.

India

India accounts for 19% of the world's deaths in 2013. Estimations of cause of death for India are important both for health policy in India and for global understanding of causes of death. India has had remarkable progress in reducing both child and adult mortality over the past 23 years. Average yearly rates of decline were 1·3% per year for adults and 3·7% for children.

Unfortunately, less cause of death data were available for 2013 than for 1990 or 2000. The Medical Certification of Causes of Death system provided ongoing information about patterns of urban mortality with better completeness in some states than in others. In rural areas, the Survey of Causes of Death (Rural) routinely reported causes of death from verbal autopsy from 1980 to 1998. This survey was replaced with a verbal autopsy sample collected by the Registrar-General of India based on the ongoing Sample Registration Scheme. Data for 2002–04 have been reported but not in full detail—results were released in a series of articles spanning 2008–14 but even these have not provided the standard tabulation of deaths by International Classification of Diseases cause, age, and sex used by most countries. Verbal autopsies were collected after 2004 but no data have been analysed or released. Attempts to add verbal autopsy to other major data collection efforts of the Government of India, such as the Annual Health Survey and the latest round of the District Level Household Survey, have so far been unsuccessful. Small community studies continue to be published but there is a major gap in knowledge of rural cause of death.

In view of the rapid change in India, including decreases in child mortality and adult mortality, simple predictions based on the 2002–04 data are inadequate. Our modelling strategy takes into account trends for key covariates that explain some changes in age-specific rates for many causes; nevertheless, more recent national data would be helpful to

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develop more precise estimates of causes of death for India. Epidemics such as Chikungunya, dengue, and H1N1 influenza also point to the need for better ongoing surveillance of causes of death in India that does not suffer from long time lags.[113-116]

Comparing different global health estimates

Comparison of the GBD 2013 results with GBD 2010 for 1990 or 2010 shows some important differences. The overall correlation coefficient of age-sex-country-cause rates was 0·998 in both 1990 and 2010 but some causes have changed substantially at the global level. The ten causes in terms of the largest change in the number of global deaths were Alzheimer's disease and other dementias, ischaemic heart disease, interstitial lung disease and pulmonary sarcoidosis, cerebrovascular disease, neonatal encephalopathy caused by birth asphyxia and trauma, lower respiratory infections, other cardiovascular and circulatory diseases, cirrhosis, malaria, and chronic kidney disease. These changes might be because of new data, modifications of garbage coding algorithms, and revised modelling strategies (appendix). Generally, the data used has substantially increased: from 8967 site-years to 14 244 site-years.

Some specific changes are worth noting. First, data for China has greatly increased. Given China's population, the incorporation of large amounts of new data for cause of death led to large changes in China and these affected even global estimates. The five largest changes for China in 2013 compared with the GBD 2010 were ischaemic heart disease, Alzheimer's disease and other dementias, cerebrovascular disease, interstitial lung disease and pulmonary sarcoidosis, and chronic obstructive pulmonary disease. Second, more detailed cause of death data covering 189 causes instead of 98 causes were available for Russia for the GBD 2013. This affected several smaller causes, such as those related to alcohol. Third, we included new vital registration data for Turkey for 2010–12. Fourth, we modelled India in two components, urban and rural, which enabled us to make much more use of some data sources such as the Survey of Causes of Death (Rural) for rural India. Because India is large, these changes have a global effect. Fifth, for cancers, we incorporated 1145 registry-years of new data, including 128 from the Cancer Incidence in Five Continents Volume X.[48] Sixth, the change to use of a Bayesian noise reduction algorithm for smoothing has reduced the number of outliers, particularly in small verbal autopsy studies, some of which were included in the GBD 2010. Seventh, changes to garbage code redistribution algorithms, particularly the use of statistically derived algorithms that vary by region and country, has had effects on injuries, cancers, and cardiovascular diseases. Other changes included treating unspecified anaemia as a garbage code whereas in the GBD 2010 it was mapped to iron-deficiency anaemia, moving abdominal hernia from other digestive diseases to hernia, as well as moving deaths related to specific procedures to the category of adverse effects of medical treatment. In the GBD 2010, we included abdominal hernia, including umbilical hernia, ventral hernia, and diaphragmatic hernia in the category "other digestive diseases". In the GBD 2013, we combined these with inguinal hernia and femoral hernia into one cause named "hernia". Additionally, we moved some ill-defined causes from the other digestive diseases category to more specific causes, thereby reducing the number of deaths in other digestive and changing the distribution of all digestive deaths among its more disaggregated causes. Seventh, the assessment of all-cause mortality in the GBD 2013 benefited from both

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new data and improved approaches for assessment of the age pattern of mortality in the model life-table system. Finally, the more detailed analysis of HIV/AIDS led to major changes both for HIV/AIDS (particularly in countries with concentrated epidemics) and for other causes, particularly in the people of reproductive age and in countries with moderate-to-large epidemics.

The International Agency for Research on Cancer produces cancer estimates by country, age, sex, and cancer site for 2008 and 2012 (GLOBOCAN). Our definitions and the GLOBOCAN definitions are compatible for 25 sites. For these cancer sites, the total estimated prevalence from GLOBOCAN was 6 848 204 cases in 2008 and 7 483 018 cases in 2012. By comparison, the GBD estimates were 6 930 377 for 2008, and 7 437 018 for 2012. Worldwide, the largest variation in estimates occurs for thyroid cancer, testicular cancer, and other pharynx cancers, with differences of 20–30%. The rough similarity of results at worldwide masks substantial national variation. Comparing age-standardised death rates for 2012, the correlation ranges from 0·94 for tracheal, bronchus, and lung cancer, to 0·20 for thyroid cancer. Five cancers have correlations below 0·5 (ovarian, non-Hodgkin lymphoma, testicular, Hodgkin lymphoma, and thyroid). A further six cancers have correlations of 0·5–0·7 (uterine, nasopharynx, lip and oral cavity, breast, leukaemia, and multiple myeloma).

Because both GLOBOCAN and our estimates used population-based cancer registry data and vital registration data as inputs, the wide variation in results requires explanation. As with all comparisons of global health estimates, the differences stem from data, data processing, and model development. We included a wider range of registries than did GLOBOCAN, particularly in China, and we used of a broader database of vital registration data. Our redistribution of cancer of unknown primary was based on a statistical model. The most important differences, however, probably stem from the modelling strategy. For all cancer sites in all countries, we used CODEm. GLOBOCAN used nine different methods to estimate cancer mortality depending on the country.[83,117] The choice of method can lead to surprising differences in estimated rates for neighbouring countries without data. For example, the age-standardised death rate for male thyroid cancer in Timor Leste is 250% higher than that for Indonesia; age-standardised death rates for testicular cancer differ by 1300% between Mali and Mauritania. The GLOBOCAN estimates have a substantial subjective component in the choice of which modelling strategy to use and do not provide any estimate of uncertainty. Empirical assessment of the validity of the GLOBOCAN methods—for example, through cross-validation—would help to understand the strength of the approach.

Understanding causes of death begins with assessment of all-cause mortality. There are some notable differences between our assessment of global age-specific deaths and those produced by the United Nations Population Division in their World Population Prospects 2012 revision (WPP2012). For the three periods (1995–2000, 2000–05, and 2005–10) as defined in WPP2012, the total numbers of deaths were 2·4–3·6% higher (6·1 million–9·1 million deaths) than estimated by us. These differentials translate into a difference of 7·8 million deaths for the 5-year period between 2005 and 2010. The difference is greatest for

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younger age groups. For 2005–10, estimated under-5 deaths from WPP2012 are 10·7% higher (3·9 million more deaths) than for the GBD 2013.

The WPP2012 global under-5 death estimates were also higher than those of UNICEF; part of this difference might be a result of the agencies releasing their estimates at different times. The biggest relative difference was for the adolescent age group (age 5–14 years). For 2005–10, the estimated deaths in adolescents from WPP2012 were 45·1% higher than in the GBD 2013, even though the absolute difference was about 2·2 million for a 5-year period, less than 1% (2·17 million of 264·7 million) of the total deaths for the same period. The differences are even greater at the GBD regional level. For 2005–10, the relative difference between WPP2012 and GBD 2013 ranged from 26·7% (122 800) lower in WPP2012 in Oceania, to 36·0% (1·9 million) higher in WPP2012 in central sub-Saharan Africa. WPP2012 tends to have high estimates of adolescent mortality compared with the GBD 2013 for all regions in sub-Saharan Africa, Andean Latin America, north Africa and Middle East, and southeast Asia. Overall, we find more differences in estimates for sub-Saharan Africa across all age group in both relative and absolute terms.

Such discrepancy originates from different assessments of child mortality rates and the difference in model life-table systems, both of which used child mortality rate to generate age-specific mortality rates. Estimating mortality for the adolescent age group is important.[118-120] As part of the background research for the GBD 2013, we assessed the Demographic Health Surveys complete birth history data for age groups 5–9 years and 10–14 years and compared this data in countries with almost complete vital registration or sample registration systems, such as India. We also systematically assessed estimates of adolescent mortality from sites of the health and demographic surveillance systems, a network known as INDEPTH. When we assessed the ratio of ${}_5q_5$ (probability of death from age 5 years to age 10 years) and ${}_5q_{10}$ (probability of death from age 10 years to age 15 years) to under-5 mortality, conflicting pictures arise: our GBD 2013 estimates are sometimes higher than one source and lower than the other. Further analysis is warranted to validate our approaches for estimating adolescent mortality in low-income and middle-income countries without working vital registration systems. In addition, efforts are needed to improve both data collection and method development to better estimate mortality for adolescents.

As in the GBD 2010, we noted differences for causes of child death compared with those produced by the Child Health Epidemiology Reference Group (CHERG; table 5). Given the complexity of both approaches, it is difficult to isolate the reason for the differences. One reason might be the different studies used: we included 5039 site-years of vital registration and 358 of verbal autopsy data compared with 578 and 192 for CHERG. Our modelling strategy was founded on modelling each individual cause separately, using the most appropriate method for each cause, and then combining the different cause estimates into an overall assessment consistent with all-cause mortality using CoDCorrect. CHERG used separate modelling strategies for HIV/AIDS, measles, pertussis, and malaria outside of Africa, and four different models for the remainder of the child causes. Separate logistic models, each with subtly incomparable cause lists, were used for neonates and children older than 1 month, for low mortality countries excluding China, for high mortality countries

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excluding India, for India alone, and for China alone. This partition of the world into separate models was not justified statistically—for example, they have not shown statistically different relationships with covariates for their four sets of models. Additionally, post-estimation adjustments were applied to pneumonia, meningitis, and malaria to account for intervention effectiveness; pneumonia, sepsis, meningitis, and tetanus to account for the reliance on a combined severe infection cause in the primary model; and diarrhoea, neonatal sepsis, and sudden infant death syndrome in China to account for studies that report few causes.

We used a more empirical approach. We quantified both the root-mean squared error and validity of the UIs through cross-validation; CHERG has not to date reported any cross-validation results. Given the possibility that different relationships might exist between covariates such as access to clean water or sanitation and diarrhoeal mortality in different parts of the world, we undertook a sensitivity analysis in which we excluded vital registration data from high-income regions from the models for lower respiratory infections and diarrhoea. We detected no substantial differences for estimated global cause of death patterns in these cases. Furthermore, in CHERG, neonatal causes were assumed to not cause deaths after 1 month although high quality vital registration systems routinely report deaths from these causes that extend into the second month of life.

Challenges and limitations

In the GBD 2013, we did not include several clinical pathways to death on the cause list, such as heart failure, sepsis, fungal infection, and acute kidney injury. These clinical entities following the underlying cause construct of the International Classification of Disease are treated as garbage codes and redistributed to the likely underlying cause. Although this approach is consistent with the idea of assigning each death uniquely to the underlying cause, it masks endpoints for clinical service delivery. For example, most fungal infections are relatively minor, but potentially millions of people contract invasive fungal diseases[121] that can be important pathways to death. Similar assessments can be made for sepsis, acute kidney injury, and heart failure. In future iterations of the GBD, we will aim to quantify mortality that occurs through these intermediate causes. Such intermediate cause estimation cannot be presented in the same causes lists as underlying causes of death but can provide supplemental and important information that would otherwise go unrecognised in global epidemiology.

Even in high-income countries with complete vital registration systems, our results differ from official statistics.[122] This difference is largely caused by the emphasis in the GBD on enhancing comparability through redistribution of deaths assigned to garbage codes. Country-specific data for cause of death show substantial national variation in coding practices. Generally, we used global or regional algorithms to redistribute deaths assigned to garbage codes. This approach is fairly coarse and does not capture local variation in certification practice or timing of implementation of coding rules. The GBD 2013 is the most detailed effort to date to try and systematically deal with garbage code redistribution. Some changes, such as the treatment of ill-defined cancers or heart failure using statistical approaches, altered the GBD 2013 results compared with the GBD 2010. We believe that

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the GBD results including the fraction of deaths assigned to different types of garbage codes can be useful for national statistical authorities' efforts to improve medical certification of causes of death. We also believe that through the extensive network of GBD collaborators, we can move in future research to more country-specific redistribution algorithms. To ensure comparability, however, these national variations will have to be grounded in a sound statistical approach and theory of measurement.

A study of this scope has many limitations. First is the quality of the underlying medical certification of causes of death and verbal autopsy data. Even medical certification of causes of death has limitations, which is shown by the need for garbage code redistribution.[106,123,124] Moreover, verbal autopsy data vary substantially in terms of the instrument used and the training given to physicians assigning causes of death. These shortcomings might reduce the comparability of cause of death data between countries and of our estimates based on these data.

Second, we did not incorporate uncertainty from garbage code redistribution into our estimation of UIs. Propagating such uncertainty into the CODEm models will require revision of the modelling strategy or an enormous increase in computational time. As evidenced by the change for some causes compared with the GBD 2010 as a result of changes in redistribution derived from statistical methods, this is an important area for future research.

Third, the major expansion of data for China and the associated changes in the estimates for some but not all causes, shows that UIs cannot take into account data that have not been included in the analysis.

Fourth, for some causes, CODEm produces larger UIs in high-income countries than might be expected. This difference is largely the result of heterogeneity across high-income countries for a cause that cannot be explained by the models. This effect is more notable for causes such as diabetes, for which there are reasons to believe that large variation in certification practice remains in high-income countries.[125] Because diabetes or increased fasting plasma glucose is a risk factor for macrovascular outcomes, differences in how physicians interpret the meaning of underlying cause could explain such national variation in practice. In the GBD, the full consequences of high fasting plasma glucose are captured in the risk factor assessment;[8] deaths caused by diabetes in our analysis were only those that were recorded on the death certificate to be the underlying cause.

Fifth, although we tried to improve the comparability of cause of death data over time through mapping variants of the International Classification of Diseases and garbage-code redistribution, some time trends might be affected by changes in diagnostic technology. Some causes, such as cancers, might have been less likely to have been diagnosed in the 1980s and 1990s, when imaging and other diagnostic techniques were not widespread.

Sixth, for chronic kidney disease, the breakdown into deaths from diabetes, hypertension, acute glomerulonephritis, and other depends on both detailed cause of death data and renal registry data. In clinical practice, assigning chronic kidney disease to a particular cause might be difficult for patients with both hypertension and diabetes.

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Seventh, in some unusual cases such as chronic respiratory diseases in India, the sum of modelled estimates for CoDCorrect level 2 causes are much smaller than the level 1 modelled estimate leading to very large corrections for the CoDCorrect step. Very large corrections for CoDCorrect suggests that the component models for these causes can be improved in the future with better data or methods.

Eighth, for natural history models, most notably for HIV/AIDS, changes in parameter assumptions such as the death rate on or off antiretroviral therapy, can have a large effect on estimated mortality. We believe that progressive revision of these models improves the estimates but nevertheless, validation of natural history models is difficult. For CODEm, we were able to quantify with the cross-validation strategy model performance but this is not possible with the natural history models.

Ninth, a strength of the GBD approach is that all estimates of cause-specific mortality must sum to all-cause mortality in a country-age-sex-year group. However, this means that estimates for a specific cause are affected by the estimates for all other causes. Causes of death such as malaria, that have very wide UIs are particularly affected by the estimates of other causes.

Tenth, models used to generate estimates of all-cause mortality and cause-specific mortality make use of a long list of covariates. Uncertainty in these covariates, such as GDP per head, was not routinely quantified but nevertheless might be substantial. We were not able to propagate uncertainty in the independent variables used in the modelling stages into the final results. 95% UIs might therefore be under-estimated. However, when we have tested in a few cases the effect of propagating uncertainty in the independent variables in the case of the HIV crude death rate, the changes to UIs, were minor (data not shown).

Eleventh, we made extraordinary efforts to propagate uncertainty throughout our all-cause mortality estimation process, which is not yet common practice in modern demographic research. However, uncertainty in covariates used in the first stage model of child and adult mortality rate was not included because of the complexity of added computation and the fact that these covariates have little effect on our final estimates, as indicated by our preliminary testing.

Lastly, empirical age patterns of mortality, which are vital for the estimation of mortality for many low-income and middle-income countries, mostly come from high-income countries with great vital registration systems and some low-income and middle-income countries in the most recent period. Countries in the sub-Saharan African region are least represented in our empirical database of age pattern of mortality (appendix pp 81–89). Propagating uncertainty from both under-5 and adult mortality rates (two key entry parameters for our new model life-table system), and from the standard life-table generation process has given our death estimates in sub-Saharan African countries substantial uncertainty; accurate documentation of age pattern of mortality in these countries are key for producing best all-cause mortality estimates in the future.

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Conclusion

Global public policy to reduce premature death needs a detailed, up-to-date, and accurate understanding of progress (or lack thereof) of disease and injury control strategies. This understanding applies not just to diseases that have been the focus of global public health efforts for the past few decades, but increasingly, as we have shown, for newly recognised contributors to global health trends. Through the process of providing yearly updates, the GBD is transforming into a collective approach to global health surveillance. Ideally, it will aggregate data from all available sources and provide a coherent view of health levels and trends that is timely, valid, and local. To fully achieve a collective process of global health surveillance, the time lag will need to be shortened between data collection, reporting, and inclusion in the GBD. Public policy in countries will be much better informed if more frequent assessments are accompanied by less uncertainty around the estimates. Uncertainty will decrease not so much as a result of further methodological advances in disease modelling and data synthesis, but much more as a result of greater investment and awareness among countries and donors alike of the need to strengthen vital registration systems.

Global collective action to reduce mortality from major communicable diseases such as diarrhoea, measles, tetanus, tuberculosis, and, more recently, HIV/AIDS and malaria, is working, but will require continued intervention efforts and resources and will probably be even more responsive if periodic assessments such as that reported here are available and used. While progress is being made to control several major non-communicable diseases of global concern, others have been largely neglected but are rising in importance, particularly drug use disorders, cirrhosis, diabetes, and chronic kidney disease. Greater prominence to reducing disease burden from these diseases, as well as continuing priority for injury control, is strongly suggested by our analysis. The findings on global, regional, and national trends in mortality from diseases should provide an important baseline for discussions about the next generation of health goals and targets after the Millennium Development Goals.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Declaration of interests

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Panel: Research in context

Systematic review

The GBD 2013 assessment of causes of death is a major improvement in the evidence base compared with GBD 2010 through the inclusion of new data from vital registration systems, verbal autopsy studies, maternal mortality surveillance, injury surveillance and other sources. Through the inclusion of sub-national data on China, Mexico, and UK the evidence base for causes of death has been greatly expanded. Redistribution algorithms for ill-defined causes of death used to enhance the comparability of data were based on new statistical models. GBD 2013 also benefits from several improvements in the methods used to estimate all-cause mortality and specific causes of death such as HIV/AIDS. GBD 2013 provides a more up-to-date and comprehensive assessment of causes of death than do other studies of cause of death in particular age groups (CHERG), for particular causes (GLOBOCAN),[83] and previous GBD analyses (GBD 2010).[2-8]

Interpretation

This study provides a comprehensive description of mortality levels and patterns worldwide, and provides the evidence to assess progress of global development goals, including control of non-communicable diseases, and priorities for further global health and development debates. Because the study provides a complete re-analysis of trends for each cause from 1990 to 2013, it supersedes the results of the GBD 2010 study. This is the first time that country-specific results for all 188 countries with populations of more than 50 000 people have been comprehensively published. Country-specific data provide the opportunity to examine the extent to which epidemiological convergence is occurring across countries.

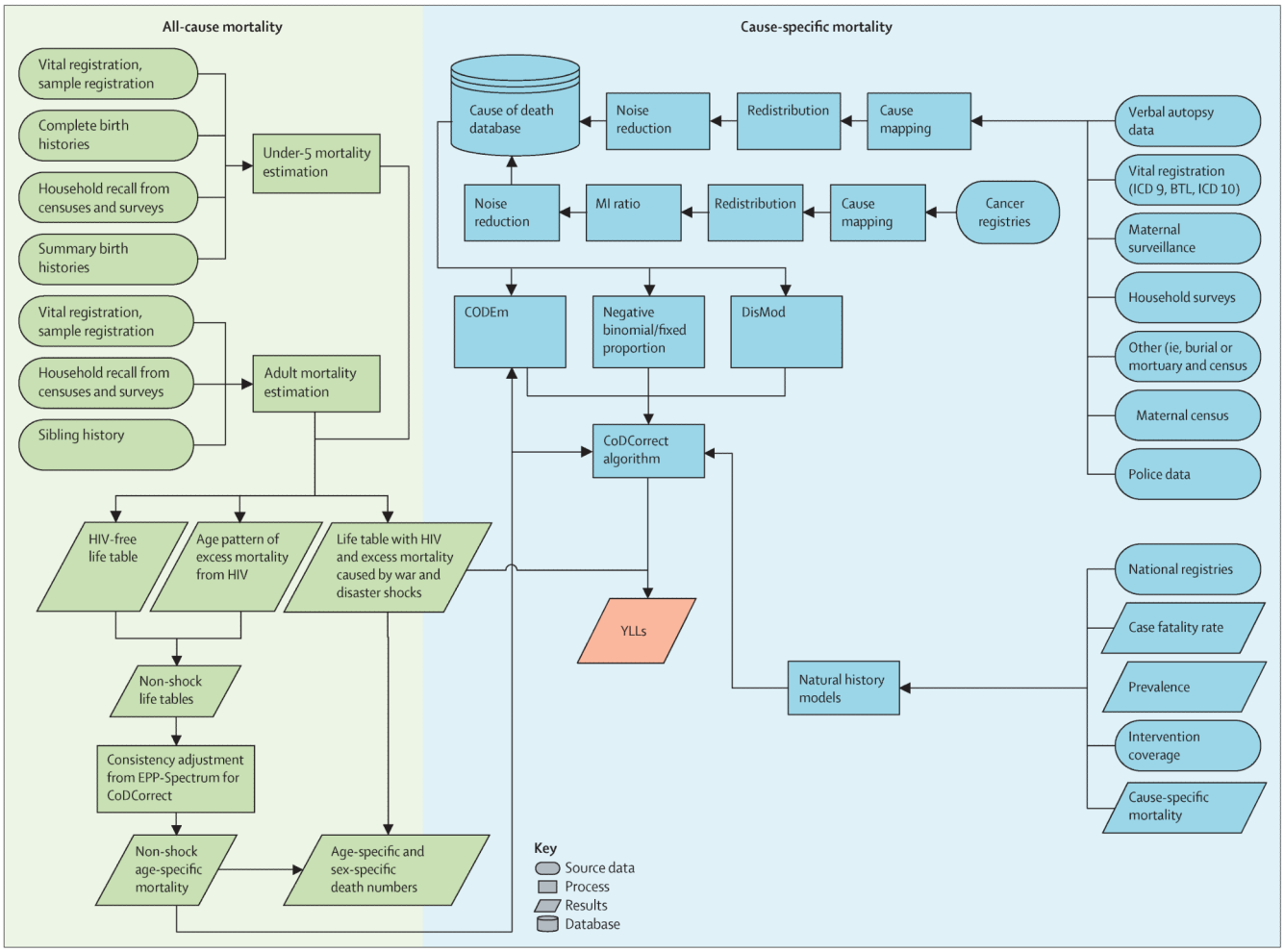


Figure 1. Components of GBD 2013 and their relations

ICD=International Classification of Diseases. BTL=basic tabulation list. MI ratio=mortality:incidence ratio. CODEm=Cause of Death Ensemble model. YLLs=years of life lost. EPP=UNAIDS Estimates and Projects Package.

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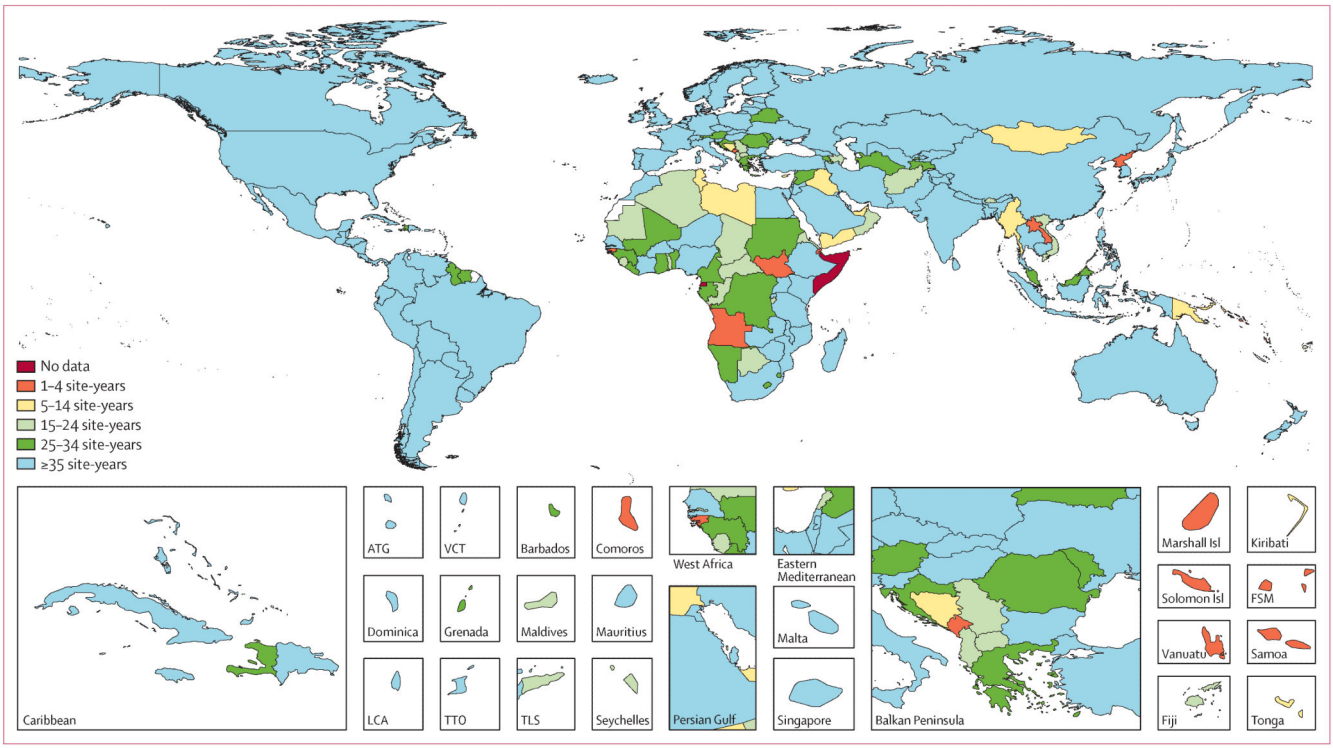


Figure 2. Site-years for all causes of death data by country, 1980–2013

ATG=Antigua and Barbuda. VCT=Saint Vincent and the Grenadines. LCA=Saint Lucia. TTO=Trinidad and Tobago. TLS=Timor-Leste. FSM=Federated States of Micronesia.

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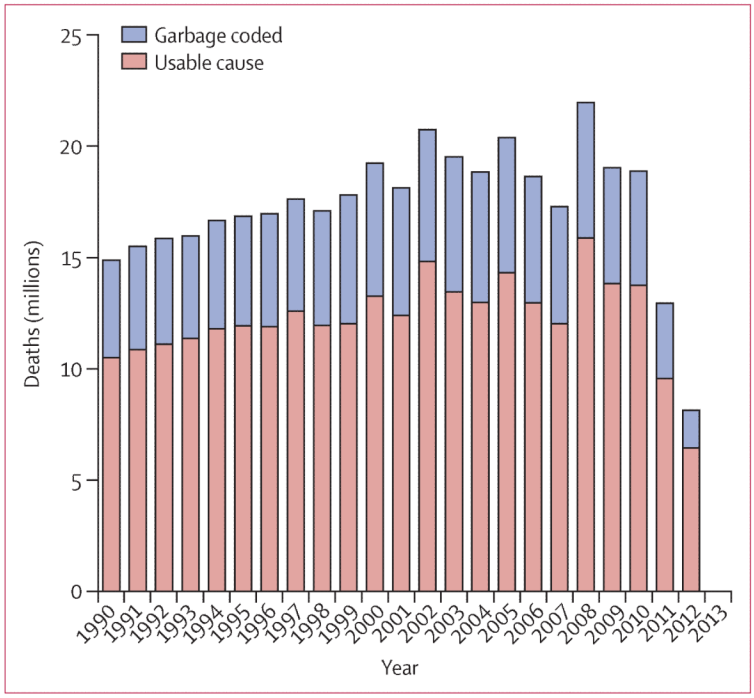


Figure 3. Total garbage and non-garbage coded deaths from vital registration and verbal autopsy sources, 1990–2013

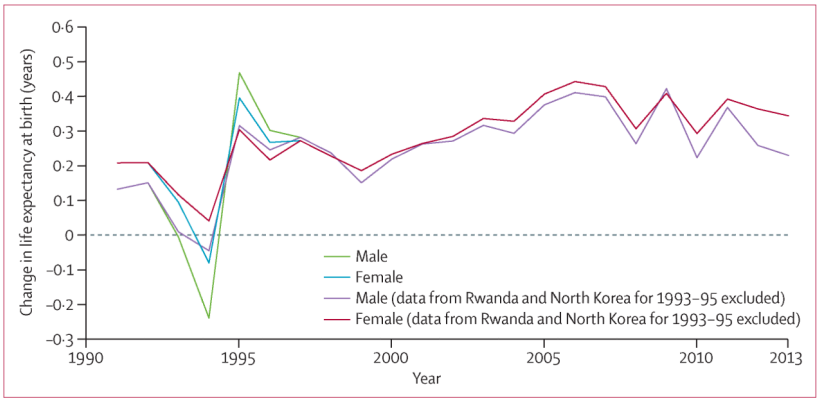


Figure 4. Change in global life expectancy at birth for males and females

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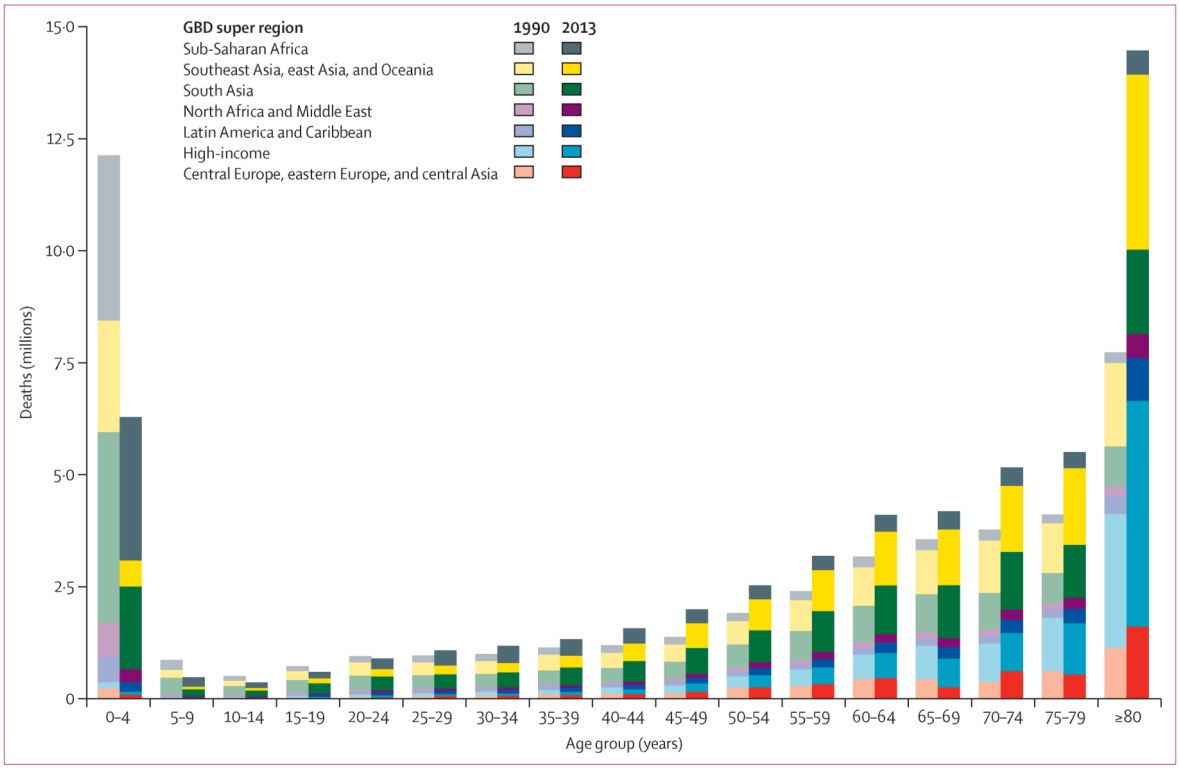


Figure 5. Global deaths by age and super region in 1990 and 2013

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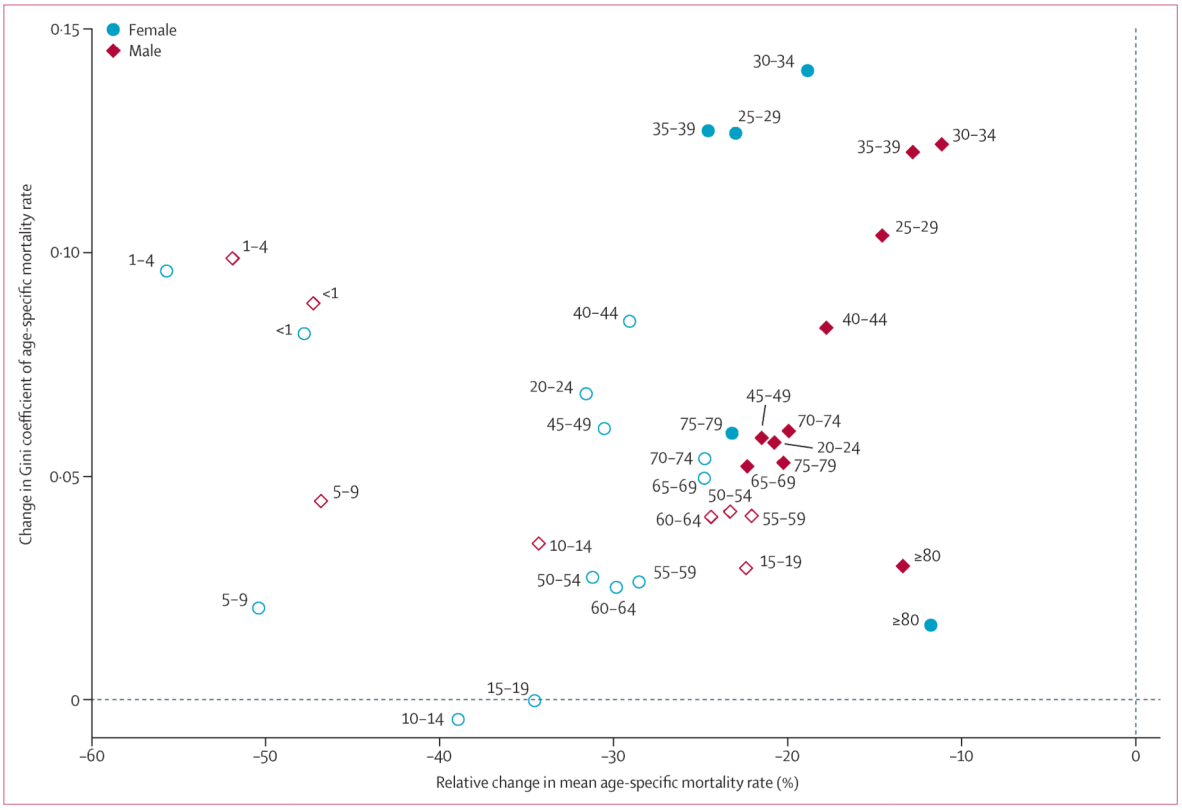


Figure 6. Change in age-specific population-weighted Gini coefficient versus relative change in mortality rate from 1990 to 2013

Solid points show age groups for which the mean absolute difference between countries has increased and hollow points show those for which mean absolute difference has decreased.

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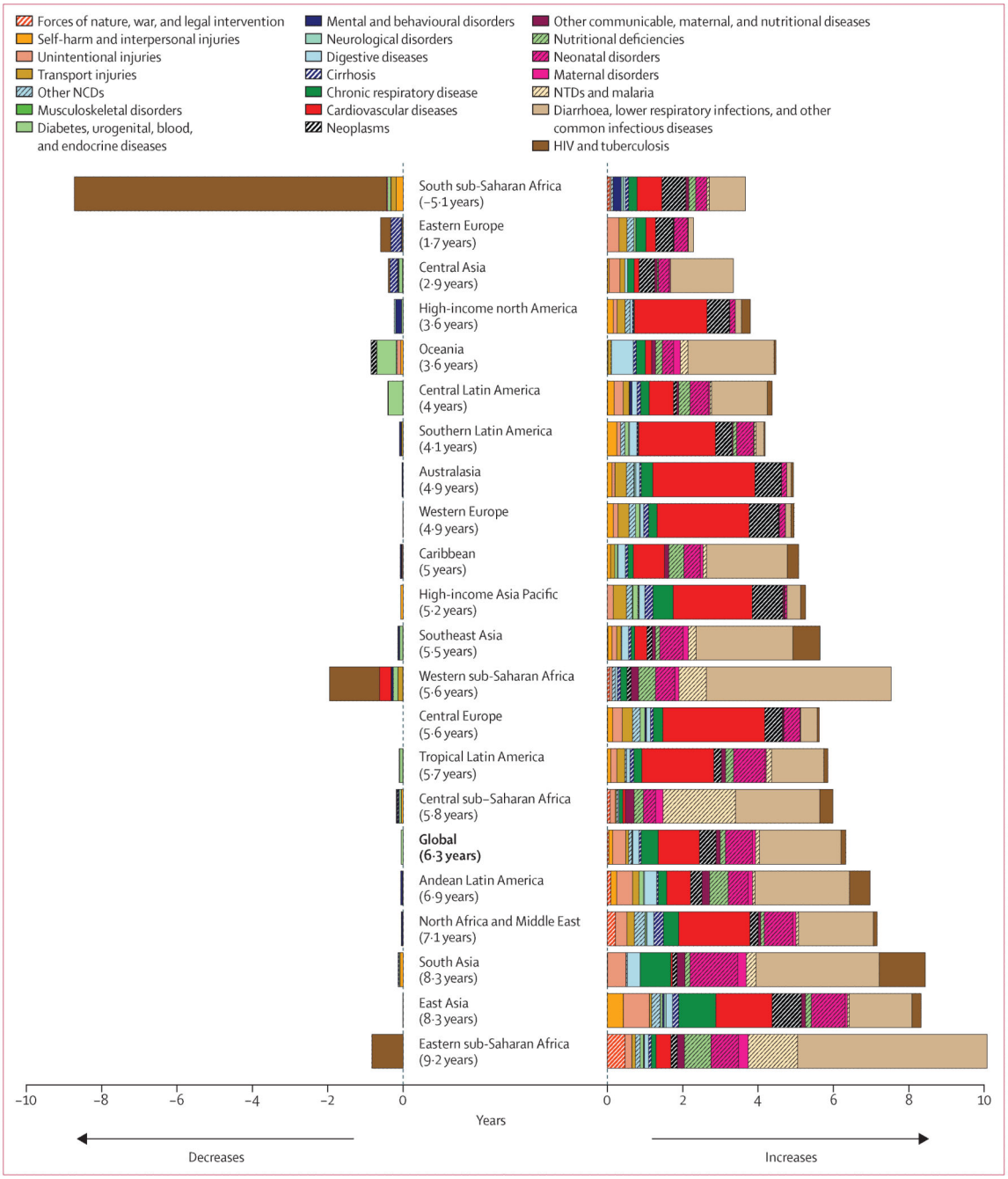


Figure 7. Change in life expectancy at birth by GBD region and cause group from 1990 to 2013

An interactive figure with these data is available at http://vizhub.healthdata.org/le. Changes in life expectancy as a result of specific causes were decomposed from the difference between all-cause lifetables and cause-deleted lifetables (mortality set to zero for a specific cause). Because all changes in life expectancy are based on cross-sectional lifetables, the cause-specific changes add up to the total change in life-expectancy. NTDs=neglected tropical diseases.

	Age-standardised death rates (% change)	Mean absolute difference in age-standardised death rate		Gini coefficient	
		2013	Change (1990–2013)	2013	Change (1990–2013)
All causes	−24·2%	182·04	−19·40	0·19	0·024
Communicable, maternal, neonatal, and nutritional diseases	−40·5%	104·87	−42·23	0·54	0·068
HIV/AIDS and tuberculosis	−23·0%	35·91	−1·37	0·69	0·114
Diarrhoea, lower respiratory, and other common infectious diseases	−49·6%	40·44	−29·80	0·49	0·027
Neglected tropical diseases and malaria	−24·5%	9·28	−4·37	0·78	0·023
Maternal disorders	−43·4%	2·88	−1·64	0·69	0·085
Neonatal disorders	−41·1%	9·75	−5·07	0·44	0·068
Nutritional deficiencies	−28·9%	8·00	−1·40	0·59	0·044
Other communicable, maternal, neonatal, and nutritional diseases	−37·2%	2·96	−1·54	0·49	0·011
Non-communicable diseases	−18·5%	86·74	2·02	0·13	0·021
Neoplasms	−14·8%	18·65	−6·44	0·15	−0·021
Cardiovascular diseases	−21·9%	59·97	7·51	0·18	0·044
Chronic respiratory diseases	−30·1%	32·35	−18·44	0·36	−0·030
Cirrhosis	−13·6%	6·45	−0·08	0·30	0·028
Digestive diseases	−33·2%	7·31	−3·31	0·32	−0·001
Neurological disorders	2·5%	5·51	0·24	0·18	−0·003
Mental and substance use disorders	−6·4%	1·77	−0·04	0·44	0·002
Diabetes, urogenital, blood, and endocrine diseases	14·5%	16·67	3·99	0·30	0·026
Musculoskeletal disorders	8·3%	0·32	0·01	0·18	−0·012
Other non-communicable diseases	−17·6%	2·49	0·27	0·24	0·071
Injuries	−20·8%	17·31	−0·33	0·23	0·039
Transport injuries	−8·5%	5·80	0·84	0·25	0·048
Unintentional injuries	−25·5%	9·21	−2·67	0·28	0·001
Self-harm and interpersonal violence	−20·7%	6·06	0·23	0·34	0·072
Forces of nature, war, and legal intervention	−65·9%	0·85	−1·65	0·90	−0·038

Significant increase No significant increase Significant decrease

Figure 8. Measures of convergence for causes of death in 188 countries

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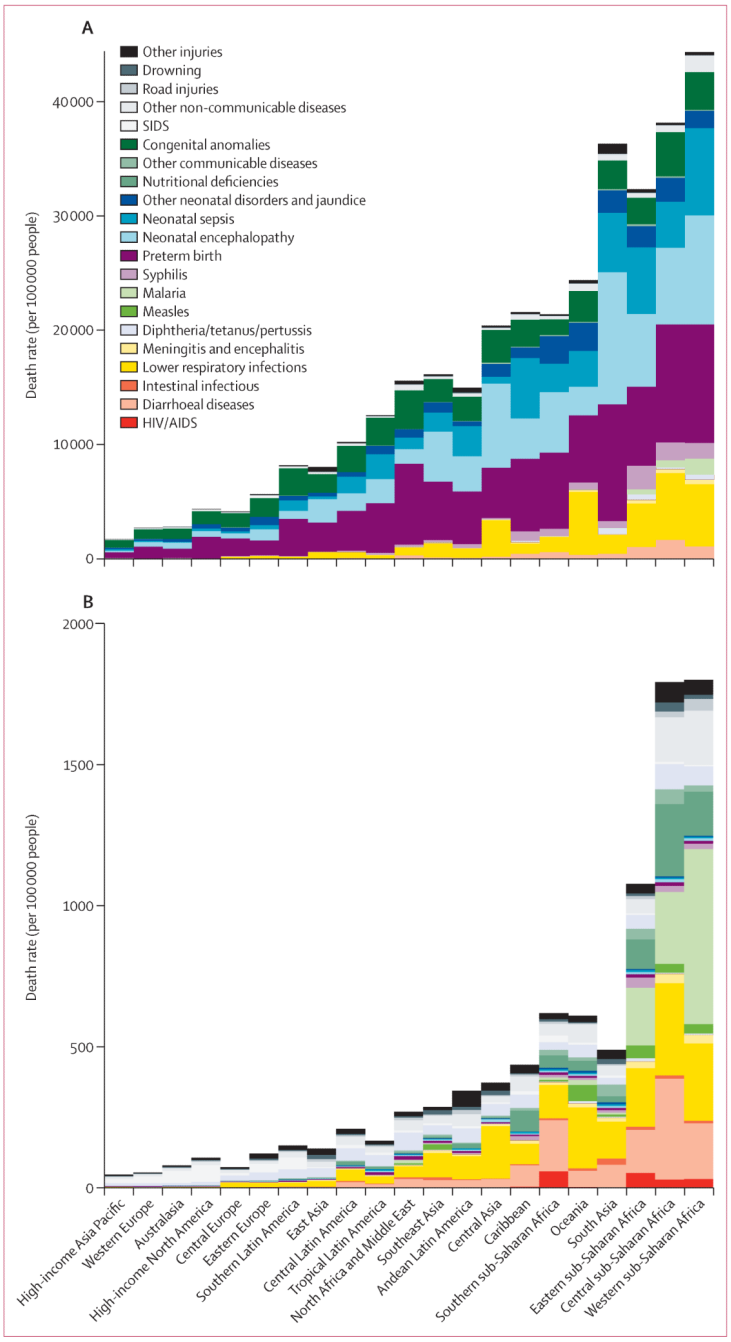


Figure 9. Child death rates by region and cause groups in 2013

(A) Of children younger than age 1 month per person-year of exposure. (B) Of children aged 1–59 months per person-year of exposure. The set of causes is mutually exclusive and collectively exhaustive. SIDS=sudden infant death syndrome.

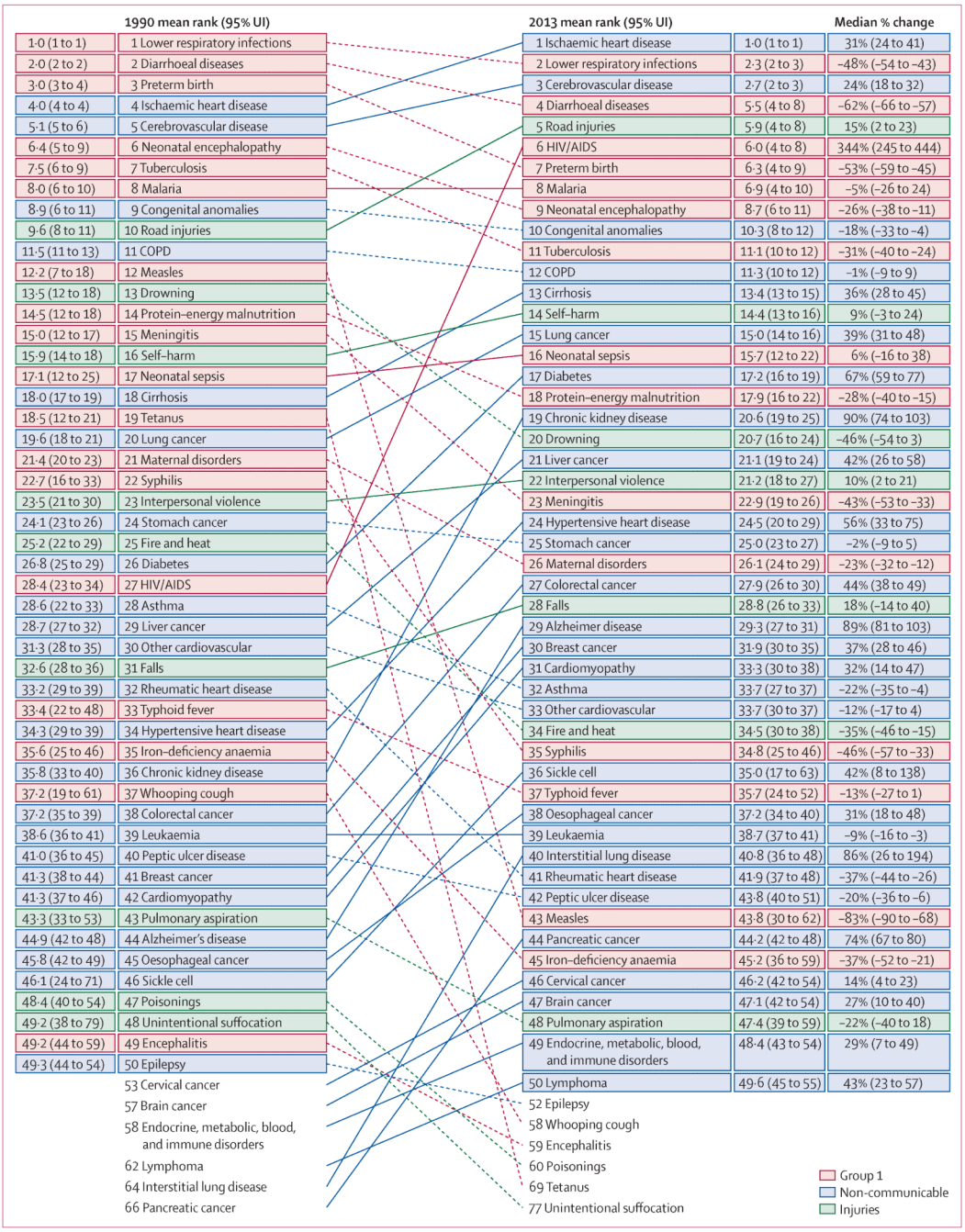


Figure 10. Top 50 causes of global years of life lost in 1990 and 2013

An interactive version of this figure is available at http://vizhub.healthdata.org/gbd-compare/. COPD=chronic obstructive pulmonary disease.

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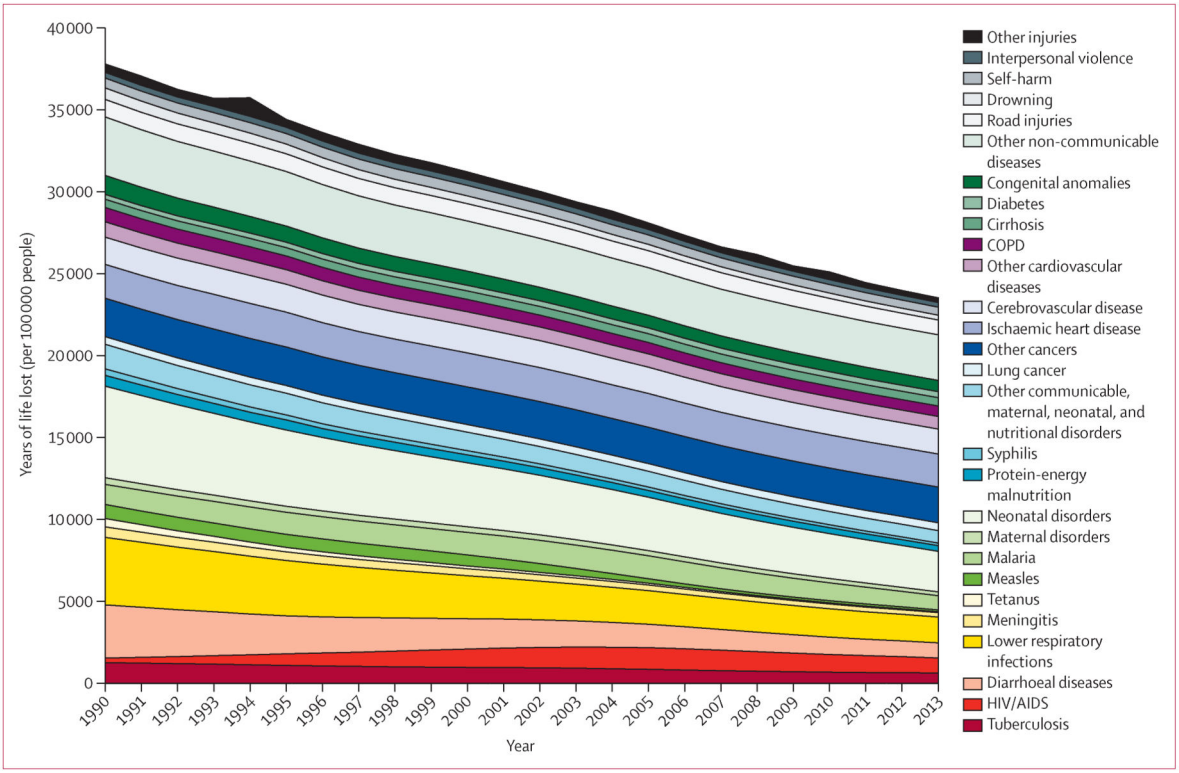


Figure 11. Global years of life lost by large cause groupings for 1990 to 2013
COPD=chronic obstructive pulmonary disease.

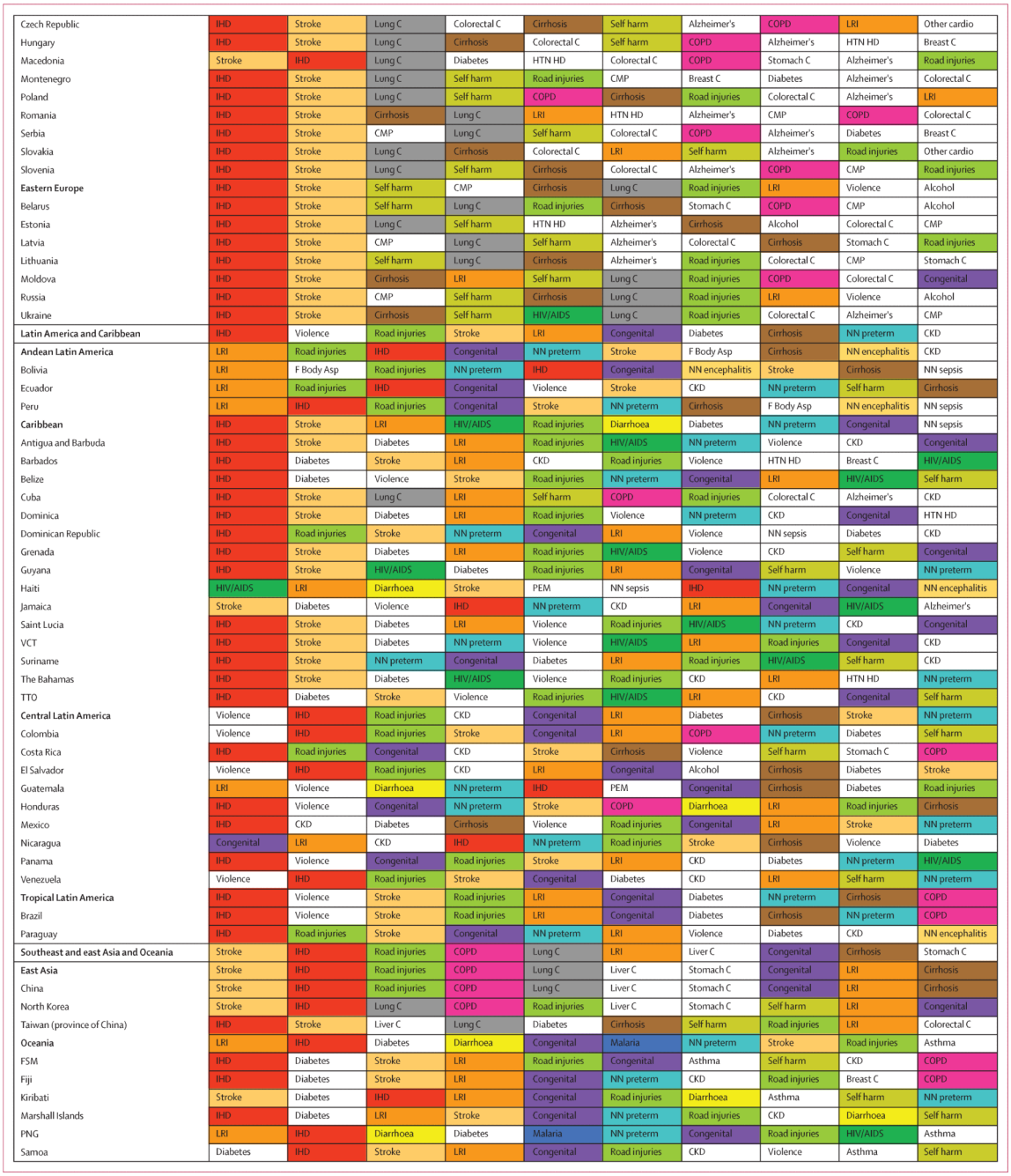
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	1	2	3	4	5	6	7	8	9	10
Global	IHD	LRI	Stroke	Diarrhoea	Road injuries	HIV/AIDS	NN preterm	Malaria	NN encephalitis	Congenital
Developed	IHD	Stroke	Lung C	Self harm	Alzheimer's	Cirrhosis	COPD	Colorectal C	LRI	Road injuries
Developing	LRI	IHD	Stroke	Diarrhoea	HIV/AIDS	NN preterm	Malaria	Road injuries	NN encephalitis	Congenital
High-income	IHD	Lung C	Stroke	Alzheimer's	COPD	Self harm	Colorectal C	LRI	Road injuries	Cirrhosis
Australasia	IHD	Lung C	Stroke	Self harm	Colorectal C	Alzheimer's	COPD	Road injuries	Breast C	Diabetes
Australia	IHD	Lung C	Stroke	Self harm	Alzheimer's	Colorectal C	COPD	Road injuries	Breast C	Diabetes
New Zealand	IHD	Lung C	Stroke	Colorectal C	COPD	Self harm	Alzheimer's	Road injuries	Breast C	Congenital
High-income Asia Pacific	Stroke	IHD	Self harm	Lung C	LRI	Stomach C	Liver C	Colorectal C	Cirrhosis	COPD
Brunei	IHD	Stroke	Diabetes	Road injuries	Congenital	Lung C	LRI	HIV/AIDS	COPD	Colorectal C
Japan	Stroke	IHD	LRI	Lung C	Self harm	Stomach C	Liver C	Colorectal C	COPD	Pancreatic C
Singapore	IHD	LRI	Stroke	Lung C	Colorectal C	Self harm	CKD	Breast C	COPD	Liver C
South Korea	Stroke	Self harm	Lung C	Liver C	IHD	Stomach C	Cirrhosis	Road injuries	Diabetes	Colorectal C
High-income North America	IHD	Lung C	Alzheimer's	COPD	Stroke	Road injuries	Self harm	Cirrhosis	Diabetes	Colorectal C
Canada	IHD	Lung C	Alzheimer's	Stroke	Self harm	Colorectal C	COPD	Road injuries	Breast C	Diabetes
USA	IHD	Lung C	COPD	Alzheimer's	Stroke	Road injuries	Self harm	Cirrhosis	Diabetes	Colorectal C
Southern Latin America	IHD	Stroke	LRI	COPD	Road injuries	Lung C	Congenital	Cirrhosis	Self harm	Colorectal C
Argentina	IHD	Stroke	LRI	COPD	Road injuries	Congenital	Lung C	NN preterm	Colorectal C	Self harm
Chile	IHD	Stroke	Cirrhosis	Road injuries	Self harm	Stomach C	LRI	Alzheimer's	Congenital	Lung C
Uruguay	IHD	Stroke	Lung C	Alzheimer's	COPD	LRI	Road injuries	Self harm	Colorectal C	Congenital
Western Europe	IHD	Lung C	Stroke	Alzheimer's	Colorectal C	COPD	Self harm	Cirrhosis	Breast C	LRI
Andorra	IHD	Lung C	Stroke	Alzheimer's	Colorectal C	COPD	LRI	Self harm	HIV/AIDS	Pancreatic C
Austria	IHD	Lung C	Stroke	Alzheimer's	Self harm	Cirrhosis	Colorectal C	COPD	Breast C	Diabetes
Belgium	IHD	Lung C	Stroke	Self harm	COPD	Alzheimer's	LRI	Colorectal C	Breast C	Road injuries
Cyprus	IHD	Stroke	Lung C	Road injuries	Diabetes	Alzheimer's	Breast C	Colorectal C	COPD	LRI
Denmark	IHD	Lung C	Stroke	COPD	Colorectal C	Alzheimer's	Cirrhosis	Self harm	LRI	Diabetes
Finland	IHD	Stroke	Alzheimer's	Lung C	Self harm	Cirrhosis	Colorectal C	Pancreatic C	Falls	Alcohol
France	IHD	Lung C	Stroke	Self harm	Colorectal C	Alzheimer's	Cirrhosis	Breast C	Road injuries	Other cardio
Germany	IHD	Lung C	Stroke	Alzheimer's	Colorectal C	COPD	Cirrhosis	Self harm	Breast C	Pancreatic C
Greece	IHD	Stroke	Lung C	Alzheimer's	COPD	Road injuries	Colorectal C	Breast C	LRI	CKD
Iceland	IHD	Lung C	Stroke	Alzheimer's	Self harm	Colorectal C	COPD	Breast C	Prostate C	Road injuries
Ireland	IHD	Lung C	Stroke	Self harm	COPD	Colorectal C	LRI	Alzheimer's	Breast C	Congenital
Israel	IHD	Lung C	Alzheimer's	Diabetes	Stroke	Colorectal C	Road injuries	CKD	Congenital	Breast C
Italy	IHD	Stroke	Lung C	Alzheimer's	Colorectal C	COPD	Diabetes	Breast C	Cirrhosis	Road injuries
Luxembourg	IHD	Lung C	Stroke	Self harm	COPD	Colorectal C	Cirrhosis	Alzheimer's	Breast C	Road injuries
Malta	IHD	Stroke	Lung C	Colorectal C	Breast C	COPD	Congenital	LRI	Pancreatic C	Diabetes
Netherlands	IHD	Lung C	Stroke	Colorectal C	COPD	Alzheimer's	Breast C	LRI	Self harm	Pancreatic C
Norway	IHD	Lung C	Stroke	Alzheimer's	Colorectal C	COPD	Self harm	LRI	Drugs	Breast C
Portugal	Stroke	IHD	Lung C	LRI	Colorectal C	Alzheimer's	Cirrhosis	COPD	Stomach C	Road injuries
Spain	IHD	Lung C	Stroke	Alzheimer's	Colorectal C	COPD	Cirrhosis	LRI	Breast C	Road injuries
Sweden	IHD	Stroke	Lung C	Colorectal C	Self harm	Alzheimer's	COPD	Prostate C	LRI	Breast C
Switzerland	IHD	Lung C	Stroke	Alzheimer's	Self harm	Colorectal C	Breast C	Other cardio	COPD	Pancreatic C
UK	IHD	Lung C	Stroke	COPD	Alzheimer's	LRI	Colorectal C	Breast C	Cirrhosis	Self harm
England	IHD	Lung C	Stroke	COPD	Alzheimer's	LRI	Colorectal C	Breast C	Cirrhosis	Self harm
Northern Ireland	IHD	Lung C	Stroke	COPD	LRI	Colorectal C	Alzheimer's	Self harm	Breast C	Cirrhosis
Scotland	IHD	Lung C	Stroke	COPD	Alzheimer's	Colorectal C	LRI	Cirrhosis	Self harm	Breast C
Wales	IHD	Lung C	Stroke	Alzheimer's	COPD	LRI	Colorectal C	Breast C	Cirrhosis	Self harm
Central and eastern Europe and central Asia	IHD	Stroke	LRI	Self harm	Cirrhosis	Lung C	CMP	Road injuries	COPD	Colorectal C
Central Asia	IHD	LRI	Stroke	NN encephalitis	Cirrhosis	Congenital	Road injuries	Self harm	NN preterm	Drowning
Armenia	IHD	Stroke	Lung C	Diabetes	Road injuries	Cirrhosis	Congenital	LRI	COPD	Breast C
Azerbaijan	IHD	LRI	Stroke	NN encephalitis	Congenital	Cirrhosis	Road injuries	NN preterm	Diabetes	TB
Georgia	IHD	Stroke	COPD	Cirrhosis	Lung C	Road injuries	LRI	NN encephalitis	Other cardio	Alzheimer's
Kazakhstan	IHD	Stroke	Self harm	Road injuries	Cirrhosis	LRI	Congenital	NN encephalitis	Violence	COPD
Kyrgyzstan	IHD	Stroke	LRI	Cirrhosis	NN encephalitis	NN preterm	Congenital	Road injuries	COPD	Self harm
Mongolia	IHD	Stroke	LRI	Liver C	NN encephalitis	Cirrhosis	Self harm	Congenital	Road injuries	NN preterm
Tajikistan	LRI	IHD	NN encephalitis	NN preterm	Diarrhoea	Congenital	Stroke	Drowning	Cirrhosis	Meningitis
Turkmenistan	IHD	LRI	Stroke	NN encephalitis	Diarrhoea	Cirrhosis	Congenital	NN preterm	Road injuries	Drowning
Uzbekistan	IHD	LRI	Stroke	NN encephalitis	Cirrhosis	Road injuries	Congenital	HTN HD	Drowning	Self harm
Central Europe	IHD	Stroke	Lung C	Cirrhosis	COPD	Self harm	Colorectal C	Alzheimer's	HTN HD	Road injuries
Albania	IHD	Stroke	LRI	Lung C	Other cardio	Road injuries	COPD	Violence	Stomach C	Congenital
Bosnia and Herzegovina	IHD	Stroke	Lung C	CMP	Diabetes	COPD	Colorectal C	Alzheimer's	Self harm	Cirrhosis
Bulgaria	IHD	Stroke	COPD	HTN HD	Lung C	Other cardio	Colorectal C	Alzheimer's	Cirrhosis	LRI
Croatia	IHD	Stroke	Lung C	Colorectal C	Cirrhosis	COPD	Alzheimer's	Self harm	Road injuries	HTN HD



Czech Republic	IHD	Stroke	Lung C	Colorectal C	Cirrhosis	Self harm	Alzheimer's	COPD	LRI	Other cardio
Hungary	IHD	Stroke	Lung C	Cirrhosis	Colorectal C	Self harm	COPD	Alzheimer's	HTN HD	Breast C
Macedonia	Stroke	IHD	Lung C	Diabetes	HTN HD	Colorectal C	COPD	Stomach C	Alzheimer's	Road injuries
Montenegro	IHD	Stroke	Lung C	Self harm	Road injuries	CMP	Breast C	Diabetes	Alzheimer's	Colorectal C
Poland	IHD	Stroke	Lung C	Self harm	COPD	Cirrhosis	Road injuries	Colorectal C	Alzheimer's	LRI
Romania	IHD	Stroke	Cirrhosis	Lung C	LRI	HTN HD	Alzheimer's	CMP	COPD	Colorectal C
Serbia	IHD	Stroke	CMP	Lung C	Self harm	Colorectal C	COPD	Alzheimer's	Diabetes	Breast C
Slovakia	IHD	Stroke	Lung C	Cirrhosis	Colorectal C	LRI	Self harm	Alzheimer's	Road injuries	Other cardio
Slovenia	IHD	Stroke	Lung C	Self harm	Cirrhosis	Colorectal C	Alzheimer's	COPD	CMP	Road injuries
Eastern Europe	IHD	Stroke	Self harm	CMP	Cirrhosis	Lung C	Road injuries	LRI	Violence	Alcohol
Belarus	IHD	Stroke	Self harm	Lung C	Road injuries	Cirrhosis	Stomach C	COPD	CMP	Alcohol
Estonia	IHD	Stroke	Lung C	Self harm	HTN HD	Alzheimer's	Cirrhosis	Alcohol	Colorectal C	CMP
Latvia	IHD	Stroke	CMP	Lung C	Self harm	Alzheimer's	Colorectal C	Cirrhosis	Stomach C	Road injuries
Lithuania	IHD	Stroke	Self harm	Lung C	Cirrhosis	Alzheimer's	Road injuries	Colorectal C	CMP	Stomach C
Moldova	IHD	Stroke	Cirrhosis	LRI	Self harm	Lung C	Road injuries	COPD	Colorectal C	Congenital
Russia	IHD	Stroke	CMP	Self harm	Cirrhosis	Lung C	Road injuries	LRI	Violence	Alcohol
Ukraine	IHD	Stroke	Cirrhosis	Self harm	HIV/AIDS	Lung C	Road injuries	Colorectal C	Alzheimer's	CMP
Latin America and Caribbean	IHD	Violence	Road injuries	Stroke	LRI	Congenital	Diabetes	Cirrhosis	NN preterm	CKD
Andean Latin America	LRI	Road injuries	IHD	Congenital	NN preterm	Stroke	F Body Asp	Cirrhosis	NN encephalitis	CKD
Bolivia	LRI	F Body Asp	Road injuries	NN preterm	IHD	Congenital	NN encephalitis	Stroke	Cirrhosis	NN sepsis
Ecuador	LRI	Road injuries	IHD	Congenital	Violence	Stroke	CKD	NN preterm	Self harm	Cirrhosis
Peru	LRI	IHD	Road injuries	Congenital	Stroke	NN preterm	Cirrhosis	F Body Asp	NN encephalitis	NN sepsis
Caribbean	IHD	Stroke	LRI	HIV/AIDS	Road injuries	Diarrhoea	Diabetes	NN preterm	Congenital	NN sepsis
Antigua and Barbuda	IHD	Stroke	Diabetes	LRI	Road injuries	HIV/AIDS	NN preterm	Violence	CKD	Congenital
Barbados	IHD	Diabetes	Stroke	LRI	CKD	Road injuries	Violence	HTN HD	Breast C	HIV/AIDS
Belize	IHD	Diabetes	Violence	Stroke	Road injuries	NN preterm	Congenital	LRI	HIV/AIDS	Self harm
Cuba	IHD	Stroke	Lung C	LRI	Self harm	COPD	Road injuries	Colorectal C	Alzheimer's	CKD
Dominica	IHD	Stroke	Diabetes	LRI	Road injuries	Violence	NN preterm	CKD	Congenital	HTN HD
Dominican Republic	IHD	Road injuries	Stroke	NN preterm	Congenital	LRI	Violence	NN sepsis	Diabetes	CKD
Grenada	IHD	Stroke	Diabetes	LRI	Road injuries	HIV/AIDS	Violence	CKD	Self harm	Congenital
Guyana	IHD	Stroke	HIV/AIDS	Diabetes	Road injuries	LRI	Congenital	Self harm	Violence	NN preterm
Haiti	HIV/AIDS	LRI	Diarrhoea	Stroke	PEM	NN sepsis	IHD	NN preterm	Congenital	NN encephalitis
Jamaica	Stroke	Diabetes	Violence	IHD	NN preterm	CKD	LRI	Congenital	HIV/AIDS	Alzheimer's
Saint Lucia	IHD	Stroke	Diabetes	LRI	Violence	Road injuries	HIV/AIDS	NN preterm	CKD	Congenital
VCT	IHD	Stroke	Diabetes	NN preterm	Violence	HIV/AIDS	LRI	Road injuries	Congenital	CKD
Suriname	IHD	Stroke	NN preterm	Congenital	Diabetes	LRI	Road injuries	HIV/AIDS	Self harm	CKD
The Bahamas	IHD	Stroke	Diabetes	HIV/AIDS	Violence	Road injuries	CKD	LRI	HTN HD	NN preterm
TTO	IHD	Diabetes	Stroke	Violence	Road injuries	HIV/AIDS	LRI	CKD	Congenital	Self harm
Central Latin America	Violence	IHD	Road injuries	CKD	Congenital	LRI	Diabetes	Cirrhosis	Stroke	NN preterm
Colombia	Violence	IHD	Road injuries	Stroke	Congenital	LRI	COPD	NN preterm	Diabetes	Self harm
Costa Rica	IHD	Road injuries	Congenital	CKD	Stroke	Cirrhosis	Violence	Self harm	Stomach C	COPD
El Salvador	Violence	IHD	Road injuries	CKD	LRI	Congenital	Alcohol	Cirrhosis	Diabetes	Stroke
Guatemala	LRI	Violence	Diarrhoea	NN preterm	IHD	PEM	Congenital	Cirrhosis	Diabetes	Road injuries
Honduras	IHD	Violence	Congenital	NN preterm	Stroke	COPD	Diarrhoea	LRI	Road injuries	Cirrhosis
Mexico	IHD	CKD	Diabetes	Cirrhosis	Violence	Road injuries	Congenital	LRI	Stroke	NN preterm
Nicaragua	Congenital	LRI	CKD	IHD	NN preterm	Road injuries	Stroke	Cirrhosis	Violence	Diabetes
Panama	IHD	Violence	Congenital	Road injuries	Stroke	LRI	CKD	Diabetes	NN preterm	HIV/AIDS
Venezuela	Violence	IHD	Road injuries	Stroke	Congenital	Diabetes	CKD	LRI	Self harm	NN preterm
Tropical Latin America	IHD	Violence	Stroke	Road injuries	LRI	Congenital	Diabetes	NN preterm	Cirrhosis	COPD
Brazil	IHD	Violence	Stroke	Road injuries	LRI	Congenital	Diabetes	Cirrhosis	NN preterm	COPD
Paraguay	IHD	Road injuries	Stroke	Congenital	NN preterm	LRI	Violence	Diabetes	CKD	NN encephalitis
Southeast and east Asia and Oceania	Stroke	IHD	Road injuries	COPD	Lung C	LRI	Liver C	Congenital	Cirrhosis	Stomach C
East Asia	Stroke	IHD	Road injuries	COPD	Lung C	Liver C	Stomach C	Congenital	LRI	Cirrhosis
China	Stroke	IHD	Road injuries	COPD	Lung C	Liver C	Stomach C	Congenital	LRI	Cirrhosis
North Korea	Stroke	IHD	Lung C	COPD	Road injuries	Liver C	Stomach C	Self harm	LRI	Congenital
Taiwan (province of China)	IHD	Stroke	Liver C	Lung C	Diabetes	Cirrhosis	Self harm	Road injuries	LRI	Colorectal C
Oceania	LRI	IHD	Diabetes	Diarrhoea	Congenital	Malaria	NN preterm	Stroke	Road injuries	Asthma
FSM	IHD	Diabetes	Stroke	LRI	Road injuries	Congenital	Asthma	Self harm	CKD	COPD
Fiji	IHD	Diabetes	Stroke	LRI	Congenital	NN preterm	CKD	Road injuries	Breast C	COPD
Kiribati	Stroke	Diabetes	IHD	LRI	Congenital	Road injuries	Diarrhoea	Asthma	Self harm	NN preterm
Marshall Islands	IHD	Diabetes	LRI	Stroke	Congenital	NN preterm	Road injuries	CKD	Diarrhoea	Self harm
PNG	LRI	IHD	Diarrhoea	Diabetes	Malaria	NN preterm	Congenital	Road injuries	HIV/AIDS	Asthma
Samoa	Diabetes	IHD	Stroke	LRI	Congenital	Road injuries	CKD	Violence	Asthma	Self harm

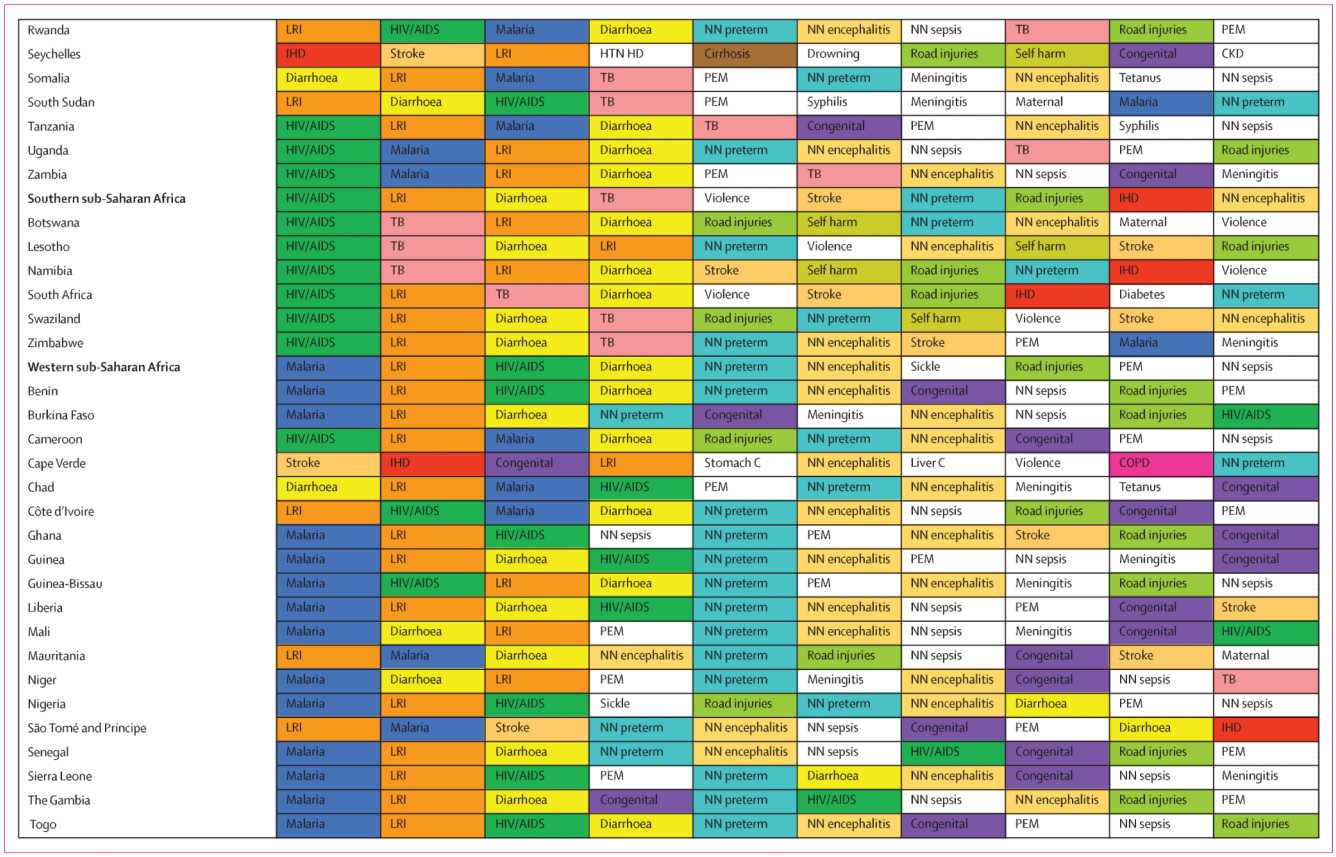
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Solomon Islands	IHD	Diabetes	Stroke	LRI	Diarrhoea	Congenital	NN preterm	Asthma	TB	Road injuries
Tonga	IHD	Diabetes	LRI	Stroke	NN preterm	Congenital	Road injuries	Lung C	Breast C	Meningitis
Vanuatu	IHD	LRI	Diabetes	Stroke	NN preterm	Congenital	Road injuries	Diarrhoea	Asthma	TB
Southeast Asia	Stroke	IHD	LRI	Road injuries	TB	NN preterm	Diabetes	Congenital	Cirrhosis	NN encephalitis
Cambodia	IHD	LRI	NN preterm	Stroke	Congenital	Road injuries	NN encephalitis	TB	Diarrhoea	Self harm
Indonesia	Stroke	IHD	LRI	TB	Road injuries	NN encephalitis	Diabetes	Diarrhoea	NN preterm	Cirrhosis
Laos	LRI	NN preterm	IHD	Stroke	Diarrhoea	Road injuries	Congenital	NN encephalitis	TB	Drowning
Malaysia	IHD	Road injuries	Stroke	LRI	Lung C	Congenital	COPD	Diabetes	HIV/AIDS	CKD
Maldives	IHD	Stroke	Congenital	NN encephalitis	NN preterm	Drowning	COPD	Road injuries	CKD	LRI
Myanmar	Stroke	LRI	Cirrhosis	TB	IHD	Malaria	NN preterm	Road injuries	Lung C	NN encephalitis
Philippines	IHD	LRI	Stroke	TB	NN preterm	Congenital	Diabetes	Violence	Road injuries	NN encephalitis
Sri Lanka	IHD	Self harm	Stroke	Diabetes	COPD	Road injuries	Cirrhosis	LRI	Congenital	Violence
Thailand	IHD	Road injuries	Stroke	LRI	Liver C	Cirrhosis	CKD	HIV/AIDS	Self harm	Diabetes
Timor-Leste	LRI	NN preterm	Congenital	Diarrhoea	IHD	Stroke	NN encephalitis	Road injuries	Drowning	Maternal
Vietnam	Stroke	Road injuries	LRI	Liver C	NN preterm	IHD	Drowning	Cirrhosis	Congenital	Lung C
South Asia	IHD	LRI	NN encephalitis	NN preterm	Diarrhoea	TB	Stroke	COPD	Road injuries	Self harm
Afghanistan	LRI	NN preterm	IHD	Diarrhoea	Congenital	Road injuries	Stroke	Meningitis	Maternal	TB
Bangladesh	Stroke	IHD	NN encephalitis	LRI	NN preterm	Drowning	NN sepsis	Cirrhosis	Self harm	Congenital
Bhutan	IHD	LRI	NN encephalitis	Stroke	NN preterm	Road injuries	Congenital	Cirrhosis	COPD	NN sepsis
India	IHD	LRI	TB	NN encephalitis	NN preterm	Diarrhoea	Stroke	COPD	Self harm	Road injuries
Nepal	LRI	IHD	NN encephalitis	Stroke	Diarrhoea	Self harm	TB	NN preterm	NN sepsis	COPD
Pakistan	LRI	NN encephalitis	Diarrhoea	IHD	NN preterm	NN sepsis	Stroke	Meningitis	Congenital	TB
North Africa and Middle East	IHD	NN preterm	Congenital	Stroke	Road injuries	LRI	Cirrhosis	COPD	Diabetes	Diarrhoea
Algeria	NN preterm	IHD	Stroke	Congenital	Road injuries	Diabetes	LRI	NN encephalitis	CKD	NN sepsis
Bahrain	IHD	Road injuries	Diabetes	Self harm	Congenital	Stroke	NN preterm	Drugs	CKD	Breast C
Egypt	IHD	Stroke	Cirrhosis	Congenital	LRI	COPD	Other cardio	NN preterm	CKD	Road injuries
Iran	IHD	NN preterm	Congenital	Road injuries	Stroke	LRI	Other cardio	HTN HD	COPD	Self harm
Iraq	NN preterm	IHD	Congenital	Stroke	LRI	CKD	Road injuries	Violence	Diabetes	Diarrhoea
Jordan	Congenital	IHD	NN preterm	LRI	Stroke	Road injuries	Drowning	Diabetes	CKD	NN encephalitis
Kuwait	IHD	Congenital	Road injuries	NN preterm	Stroke	LRI	CKD	HTN HD	Diabetes	Cirrhosis
Lebanon	IHD	Congenital	Stroke	Lung C	Road injuries	Diabetes	Breast C	NN preterm	COPD	CKD
Libya	IHD	Stroke	Congenital	Road injuries	NN preterm	Diabetes	LRI	CKD	COPD	Lung C
Morocco	NN preterm	IHD	Diabetes	Stroke	LRI	Road injuries	Congenital	NN encephalitis	Drugs	NN sepsis
Oman	Road injuries	IHD	Stroke	Diabetes	Congenital	LRI	Other cardio	NN preterm	Drowning	CKD
Palestine	Congenital	IHD	Stroke	LRI	NN preterm	Road injuries	CKD	Diabetes	Violence	Drugs
Qatar	Road injuries	Congenital	IHD	NN preterm	Self harm	Stroke	Diabetes	Falls	Oth mech	Drowning
Saudi Arabia	Road injuries	IHD	Congenital	NN preterm	Stroke	CKD	LRI	Falls	NN sepsis	Drugs
Sudan	NN preterm	IHD	Congenital	Diarrhoea	LRI	Stroke	Road injuries	Malaria	HIV/AIDS	Vis Leish
Syria	War	IHD	Stroke	Congenital	Road injuries	COPD	NN preterm	LRI	Endocrine	Typhoid
Tunisia	IHD	Road injuries	Stroke	Congenital	NN preterm	Lung C	LRI	COPD	Diabetes	CKD
Turkey	IHD	Stroke	Lung C	Congenital	COPD	Road injuries	NN preterm	Diabetes	LRI	Stomach C
UAE	Road injuries	IHD	Congenital	Stroke	Self harm	LRI	Drugs	NN preterm	Falls	Diabetes
Yemen	NN preterm	IHD	Diarrhoea	Congenital	LRI	Stroke	Malaria	Road injuries	Maternal	COPD
Sub-Saharan Africa	HIV/AIDS	Malaria	LRI	Diarrhoea	NN preterm	NN encephalitis	PEM	Congenital	NN sepsis	TB
Central sub-Saharan Africa	LRI	Diarrhoea	Malaria	PEM	HIV/AIDS	NN preterm	Congenital	TB	NN encephalitis	Meningitis
Angola	LRI	Diarrhoea	HIV/AIDS	Malaria	Congenital	PEM	NN preterm	NN encephalitis	TB	Road injuries
CAR	HIV/AIDS	LRI	Diarrhoea	Malaria	TB	NN preterm	PEM	NN encephalitis	Syphilis	Meningitis
Republic of Congo	HIV/AIDS	LRI	Malaria	Congenital	Stroke	NN preterm	Diarrhoea	Measles	NN encephalitis	TB
DR Congo	Diarrhoea	LRI	PEM	Malaria	NN preterm	HIV/AIDS	Congenital	TB	NN encephalitis	Meningitis
Equator Guinea	HIV/AIDS	LRI	Malaria	Congenital	Road injuries	Diarrhoea	Stroke	PEM	NN preterm	NN encephalitis
Gabon	HIV/AIDS	LRI	Malaria	Stroke	Road injuries	Congenital	NN encephalitis	TB	IHD	NN preterm
Eastern sub-Saharan Africa	HIV/AIDS	LRI	Malaria	Diarrhoea	TB	NN preterm	NN encephalitis	PEM	NN sepsis	Congenital
Burundi	Malaria	LRI	Diarrhoea	TB	HIV/AIDS	NN preterm	PEM	NN encephalitis	NN sepsis	Congenital
Comoros	LRI	TB	Diarrhoea	NN preterm	Malaria	NN encephalitis	NN sepsis	Stroke	Road injuries	Congenital
Djibouti	HIV/AIDS	LRI	Malaria	Diarrhoea	TB	Stroke	NN encephalitis	PEM	NN preterm	Congenital
Eritrea	Diarrhoea	LRI	TB	HIV/AIDS	Malaria	NN preterm	PEM	Maternal	NN encephalitis	NN sepsis
Ethiopia	LRI	Diarrhoea	HIV/AIDS	TB	NN preterm	NN encephalitis	Malaria	NN sepsis	Congenital	Stroke
Kenya	HIV/AIDS	LRI	Diarrhoea	TB	NN preterm	NN encephalitis	Malaria	Congenital	NN sepsis	PEM
Madagascar	LRI	Diarrhoea	Stroke	NN preterm	PEM	Syphilis	Malaria	NN sepsis	Congenital	Meningitis
Malawi	HIV/AIDS	LRI	Diarrhoea	PEM	TB	NN preterm	Malaria	Congenital	NN encephalitis	Meningitis
Mauritius	Diabetes	IHD	Stroke	CKD	Cirrhosis	LRI	Road injuries	Self harm	HTN HD	Congenital
Mozambique	HIV/AIDS	Malaria	LRI	Diarrhoea	TB	NN sepsis	NN encephalitis	Syphilis	NN preterm	Road injuries



Rwanda	LRI	HIV/AIDS	Malaria	Diarrhoea	NN preterm	NN encephalitis	NN sepsis	TB	Road injuries	PEM
Seychelles	IHD	Stroke	LRI	HTN HD	Cirrhosis	Drowning	Road injuries	Self harm	Congenital	CKD
Somalia	Diarrhoea	LRI	Malaria	TB	PEM	NN preterm	Meningitis	NN encephalitis	Tetanus	NN sepsis
South Sudan	LRI	Diarrhoea	HIV/AIDS	TB	PEM	Syphilis	Meningitis	Maternal	Malaria	NN preterm
Tanzania	HIV/AIDS	LRI	Malaria	Diarrhoea	TB	Congenital	PEM	NN encephalitis	Syphilis	NN sepsis
Uganda	HIV/AIDS	Malaria	LRI	Diarrhoea	NN preterm	NN encephalitis	NN sepsis	TB	PEM	Road injuries
Zambia	HIV/AIDS	Malaria	LRI	Diarrhoea	PEM	TB	NN encephalitis	NN sepsis	Congenital	Meningitis
Southern sub-Saharan Africa	HIV/AIDS	LRI	Diarrhoea	TB	Violence	Stroke	NN preterm	Road injuries	IHD	NN encephalitis
Botswana	HIV/AIDS	TB	LRI	Diarrhoea	Road injuries	Self harm	NN preterm	NN encephalitis	Maternal	Violence
Lesotho	HIV/AIDS	TB	Diarrhoea	LRI	NN preterm	Violence	NN encephalitis	Self harm	Stroke	Road injuries
Namibia	HIV/AIDS	TB	LRI	Diarrhoea	Stroke	Self harm	Road injuries	NN preterm	IHD	Violence
South Africa	HIV/AIDS	LRI	TB	Diarrhoea	Violence	Stroke	Road injuries	IHD	Diabetes	NN preterm
Swaziland	HIV/AIDS	LRI	Diarrhoea	TB	Road injuries	NN preterm	Self harm	Violence	Stroke	NN encephalitis
Zimbabwe	HIV/AIDS	LRI	Diarrhoea	TB	NN preterm	NN encephalitis	Stroke	PEM	Malaria	Meningitis
Western sub-Saharan Africa	Malaria	LRI	HIV/AIDS	Diarrhoea	NN preterm	NN encephalitis	Sickle	Road injuries	PEM	NN sepsis
Benin	Malaria	LRI	HIV/AIDS	Diarrhoea	NN preterm	NN encephalitis	Congenital	NN sepsis	Road injuries	PEM
Burkina Faso	Malaria	LRI	Diarrhoea	NN preterm	Congenital	Meningitis	NN encephalitis	NN sepsis	Road injuries	HIV/AIDS
Cameroon	HIV/AIDS	LRI	Malaria	Diarrhoea	Road injuries	NN preterm	NN encephalitis	Congenital	PEM	NN sepsis
Cape Verde	Stroke	IHD	Congenital	LRI	Stomach C	NN encephalitis	Liver C	Violence	COPD	NN preterm
Chad	Diarrhoea	LRI	Malaria	HIV/AIDS	PEM	NN preterm	NN encephalitis	Meningitis	Tetanus	Congenital
Côte d'Ivoire	LRI	HIV/AIDS	Malaria	Diarrhoea	NN preterm	NN encephalitis	NN sepsis	Road injuries	Congenital	PEM
Ghana	Malaria	LRI	HIV/AIDS	NN sepsis	NN preterm	PEM	NN encephalitis	Stroke	Road injuries	Congenital
Guinea	Malaria	LRI	Diarrhoea	HIV/AIDS	NN preterm	NN encephalitis	PEM	NN sepsis	Meningitis	Congenital
Guinea-Bissau	Malaria	HIV/AIDS	LRI	Diarrhoea	NN preterm	PEM	NN encephalitis	Meningitis	Road injuries	NN sepsis
Liberia	Malaria	LRI	Diarrhoea	HIV/AIDS	NN preterm	NN encephalitis	NN sepsis	PEM	Congenital	Stroke
Mali	Malaria	Diarrhoea	LRI	PEM	NN preterm	NN encephalitis	NN sepsis	Meningitis	Congenital	HIV/AIDS
Mauritania	LRI	Malaria	Diarrhoea	NN encephalitis	NN preterm	Road injuries	NN sepsis	Congenital	Stroke	Maternal
Niger	Malaria	Diarrhoea	LRI	PEM	NN preterm	Meningitis	NN encephalitis	Congenital	NN sepsis	TB
Nigeria	Malaria	LRI	HIV/AIDS	Sickle	Road injuries	NN preterm	NN encephalitis	Diarrhoea	PEM	NN sepsis
São Tomé and Príncipe	LRI	Malaria	Stroke	NN preterm	NN encephalitis	NN sepsis	Congenital	PEM	Diarrhoea	IHD
Senegal	Malaria	LRI	Diarrhoea	NN preterm	NN encephalitis	NN sepsis	HIV/AIDS	Congenital	Road injuries	PEM
Sierra Leone	Malaria	LRI	HIV/AIDS	PEM	NN preterm	Diarrhoea	NN encephalitis	Congenital	NN sepsis	Meningitis
The Gambia	Malaria	LRI	Diarrhoea	Congenital	NN preterm	HIV/AIDS	NN sepsis	NN encephalitis	Road injuries	PEM
Togo	Malaria	LRI	HIV/AIDS	Diarrhoea	NN preterm	NN encephalitis	Congenital	PEM	NN sepsis	Road injuries

Figure 12. Top ten causes in 2013 of years of life lost by location

The top 15 global causes of years of life lost are coloured. VCT=Saint Vincent and the Grenadines. TTO=Trinidad and Tobago. FSM=Federated States of Micronesia. PNG=Papua New Guinea. UAE=United Arab Emirates. CAR=Central African Republic. STP=São Tomé and Princípe. IHD=ischaemic heart disease. LRI=lower respiratory infections. Road inj=road injuries. NN Preterm=preterm birth complications. NN enceph=neonatal encephalitis. Congenital=congenital disorders. C=cancer. COPD=chronic obstructive pulmonary disease. CKD=chronic kidney disease. CMP=cardiomyopathies. Other cardio=other cardiovascular disease. Drugs=drug use disorders. Alcohol=alcohol use disorders. Violence=interpersonal violence. HTN HD=hypertensive heart disease. F body asp=pulmonary aspiration and foreign body in airway. NN sepsis=neonatal sepsis. PEM=protein–energy malnutrition. TB=tuberculosis. Vis leish=visceral leishmaniasis. Other mech=other mechanical forces. Endocrine=endocrine, metabolic, blood, and immune disorders. Maternal=maternal disorders. Sickle=sickle cell disorders.

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Table 1
Number of site-years in database by source type

	All geographies		GBD 2013			
	GBD 2010	GBD 2013	Difference	National	State, province, or region*	Local
Vital registration	2798	5039	2241†	2765	2112	162
Cancer registry	2715	3860	1145	1216	979	1665
Sibling history	1557	1798	241	1788	0	10
Police records	1129	1433	304	1429	1	3
Surveillance	128	1430	1302	73	1074	283
Verbal autopsy	486	538	52	110	0	428
Survey or census; hospital; burial or mortuary	154	146	−8‡	94	0	52
Total	8967	14244	5277	7475	4166	2603

GBD=Global Burden of Disease Study.

*Data were analysed at the state level for Mexico, the province level for China, and the region level for the UK.

†Significant increase because of incorporation of subnational sites in China, Mexico, and the UK.

‡Decrease caused by omission of World Health Survey data where adequate vital registration data was available for GBD 2013.

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Table 2

Global deaths for 235 causes in 1990 and 2013 for all ages and both sexes combined and age-standardised death rates

	All ages deaths (thousands)			Age-standardised death rate (per 100 000)		
	1990	2013	Median % change	1990	2013	Median % change
All causes	**47 468·7 (46 771·7 to 48 223·3)**	**54 863·8 (53 576·1 to 56 333·6)**	**15·6 (12·54 to 19·11)**	**1160·5 (1143·2 to 1179·0)**	**879·7 (859·9 to 902·2)**	**−24·2 (−26·20 to −21·96)**
Communicable, maternal, neonatal, and nutritional diseases	**16 149·4 (15 674·5 to 16 597·6)**	**11 809·6 (11 335·5 to 12 283·0)**	**−26·8 (−29·99 to −24·10)**	**289·5 (281·2 to 298·4)**	**172·2 (165·2 to 178·8)**	**−40·5 (−42·98 to −38·35)**
HIV/AIDS and tuberculosis	2072·5 (1938·2 to 2246·1)	2631·2 (2497·3 to 2863·2)	26·8 (17·08 to 37·92)	49·3 (46·2 to 53·3)	38·0 (36·0 to 41·6)	−23·1 (−29·02 to −16·39)
Tuberculosis	1786·1 (1666·4 to 1945·4)	1290·3 (1167·3 to 1406·2)	−27·7 (−34·99 to −20·56)	43·5 (40·4 to 47·2)	19·4 (17·6 to 21·2)	−55·3 (−59·67 to −51·01)
HIV/AIDS	286·4 (227·4 to 370·3)	1341·0 (1257·8 to 1482·6)	374·2 (262·47 to 490·73)	5·8 (4·6 to 7·6)	18·5 (17·4 to 20·5)	222·0 (145·14 to 303·34)
HIV/AIDS resulting in mycobacterial infection	27·8 (20·5 to 37·4)	84·0 (67·4 to 104·9)	205·1 (130·68 to 291·83)	0·6 (0·4 to 0·8)	1·2 (0·9 to 1·4)	105·5 (55·00 to 166·22)
HIV/AIDS resulting in other diseases	258·6 (206·1 to 334·4)	1257·0 (1178·1 to 1391·1)	393·2 (276·86-511·66)	5·3 (4·2 to 6·8)	17·4 (16·3 to 19·2)	235·0 (154·55 to 319·43)
Diarrhoea, lower respiratory infections, and other common infectious diseases	**7880·5 (7468·3 to 8337·2)**	**4750·5 (4388·8 to 5029·9)**	**−39·4 (−45·17 to −35·89)**	**143·7 (137·3 to 151·9)**	**72·4 (66·7 to 76·5)**	**−49·4 (−53·54 to −46·75)**
Diarrhoeal diseases	2578·7 (2412·2 to 2748·9)	1264·1 (1151·2 to 1383·2)	−51·0 (−55·55 to −46·25)	47·4 (44·4 to 50·1)	19·0 (17·4 to 20·8)	−59·8 (−63·54 to −55·96)
Intestinal infectious diseases	259·1 (145·6 to 424·6)	221·3 (122·6 to 362·6)	−14·3 (−26·08 to −2·75)	4·3 (2·4 to 7·0)	3·1 (1·7 to 5·0)	−28·7 (−38·19 to −18·98)
Typhoid fever	180·5 (96·4 to 302·3)	160·7 (85·9 to 268·0)	−10·8 (−23·70 to 4·24)	3·0 (1·6 to 5·0)	2·2 (1·2 to 3·7)	−25·9 (−36·31 to −13·57)
Paratyphoid fever	63·4 (33·6 to 106·7)	54·3 (29·3 to 92·0)	−14·9 (−30·51 to 9·48)	1·0 (0·6 to 1·7)	0·7 (0·4 to 1·3)	−28·0 (−40·99 to −7·97)
Other intestinal infectious diseases	15·3 (13·5 to 17·3)	6·3 (5·5 to 7·0)	−59·1 (−63·26 to −54·09)	0·3 (0·2 to 0·3)	0·1 (0·1 to 0·1)	−66·7 (−70·02 to −62·84)
Lower respiratory infections	3420·7 (3211·6 to 3638·4)	2652·6 (2368·0 to 2808·1)	−22·2 (−29·71 to −16·32)	66·8 (63·1 to 71·6)	41·7 (37·1 to 44·1)	−37·4 (−42·54 to −33·45)
Upper respiratory infections	4·7 (4·0 to 5·6)	3·9 (3·3 to 4·7)	−16·4 (−33·55 to 4·22)	0·1 (0·1 to 0·1)	0·1 (0·1 to 0·1)	−40·8 (−52·40 to −26·16)
Otitis media	4·9 (4·5 to 5·3)	2·4 (2·3 to 2·6)	−50·8 (−54·22 to −46·41)	0·1 (0·1 to 0·1)	0·0 (0·0 to 0·0)	−60·8 (−63·34 to −57·76)
Meningitis	464·4 (405·0 to 559·0)	303·5 (261·4 to 346·3)	−34·3 (−45·34 to −24·08)	7·7 (6·8 to 9·0)	4·3 (3·7 to 4·9)	−43·9 (−52·65 to −36·07)

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	All ages deaths (thousands)			Age-standardised death rate (per 100 000)		
	1990	2013	Median % change	1990	2013	Median % change
Pneumococcal meningitis	112·1 (97·7 to 132·6)	79·1 (67·8 to 91·1)	−29·4 (−39·84 to −16·86)	1·9 (1·7 to 2·2)	1·1 (1·0 to 1·3)	−41·7 (−49·60 to −31·37)
Haemophilus influenzae type B meningitis	118·0 (98·2 to 147·0)	64·4 (53·0 to 76·4)	−45·4 (−54·79 to −33·50)	1·8 (1·5 to 2·2)	0·9 (0·7 to 1·1)	−49·7 (−58·21 to −39·32)
Meningococcal meningitis	88·1 (76·1 to 108·0)	65·7 (55·9 to 75·8)	−24·9 (−38·82 to −12·62)	1·5 (1·3 to 1·8)	0·9 (0·8 to 1·1)	−37·3 (−47·55 to −27·80)
Other meningitis	146·1 (128·0 to 174·9)	94·2 (82·2 to 106·4)	−35·1 (−47·16 to −24·71)	2·5 (2·2 to 2·9)	1·3 (1·2 to 1·5)	−45·9 (−54·98 to −37·48)
Encephalitis	92·2 (65·2 to 116·2)	77·3 (65·4 to 97·0)	−15·2 (−40·15 to 16·01)	1·6 (1·1 to 1·9)	1·1 (0·9 to 1·4)	−28·7 (−48·10 to −4·52)
Diphtheria	8·0 (3·9 to 18·8)	3·3 (1·7 to 6·6)	−57·7 (−85·61 to 12·54)	0·1 (0·1 to 0·3)	0·0 (0·0 to 0·1)	−60·8 (−86·70 to 2·82)
Whooping cough	138·2 (52·9 to 300·2)	60·6 (22·3 to 136·8)	−56·7 (−83·76 to 14·31)	1·9 (0·7 to 4·2)	0·8 (0·3 to 1·9)	−58·2 (−84·31 to 10·44)
Tetanus	356·2 (292·9 to 578·6)	58·9 (39·8 to 77·3)	−82·1 (−92·00 to −76·10)	5·7 (4·7 to 9·1)	0·8 (0·6 to 1·1)	−83·9 (−92·72 to −77·84)
Measles	544·5 (304·0 to 867·8)	95·6 (48·5 to 172·9)	−83·0 (−90·23 to −67·93)	7·8 (4·3 to 12·4)	1·3 (0·7 to 2·4)	−83·7 (−90·66 to −69·19)
Varicella	8·9 (7·2 to 11·7)	7·0 (5·7 to 8·7)	−21·4 (−43·72 to 4·63)	0·2 (0·2 to 0·3)	0·1 (0·1 to 0·1)	−45·6 (−61·28 to −27·33)
Neglected tropical diseases and malaria	**1092·4 (994·1 to 1196·7)**	**997·0 (840·5 to 1185·2)**	**−9·2 (−25·09 to 10·78)**	**18·5 (17·0 to 20·2)**	**13·9 (11·8 to 16·5)**	**−24·9 (−37·19 to −9·70)**
Malaria	888·1 (793·4 to 992·7)	854·6 (702·9 to 1032·5)	−4·4 (−23·61 to 19·83)	14·6 (13·2 to 16·2)	11·9 (9·8 to 14·4)	−18·9 (−34·32 to 0·18)
Chagas disease	12·7 (5·2 to 39·4)	10·6 (4·2 to 33·0)	−19·3 (−41·12 to 25·58)	0·3 (0·1 to 1·1)	0·2 (0·1 to 0·5)	−51·7 (−66·06 to −24·52)
Leishmaniasis	52·2 (44·6 to 60·6)	62·5 (52·3 to 73·3)	19·8 (3·56 to 37·74)	0·9 (0·7 to 1·0)	0·9 (0·7 to 1·0)	−0·3 (−14·18 to 14·25)
Visceral leishmaniasis	52·2 (44·6 to 60·6)	62·5 (52·3 to 73·3)	19·8 (3·56 to 37·74)	0·9 (0·7 to 1·0)	0·9 (0·7 to 1·0)	−0·3 (−14·18 to 14·25)
African trypanosomiasis	23·0 (11·4 to 37·7)	6·9 (3·7 to 10·9)	−69·7 (−73·88 to −64·94)	0·5 (0·2 to 0·7)	0·1 (0·1 to 0·1)	−78·9 (−81·76 to −75·54)
Schistosomiasis	17·4 (14·8 to 20·6)	5·5 (4·9 to 6·2)	−68·2 (−73·56 to −61·68)	0·4 (0·4 to 0·5)	0·1 (0·1 to 0·1)	−80·7 (−84·06 to −76·71)
Cysticercosis	0·9 (0·8 to 1·1)	0·7 (0·5 to 1·0)	−28·6 (−35·23 to −15·09)	0·0 (0·0 to 0·0)	0·0 (0·0 to 0·0)	−53·0 (−57·59 to −43·63)
Cystic echinococcosis	4·0 (3·8 to 4·3)	2·2 (2·1 to 2·4)	−45·0 (−48·34 to −41·22)	0·1 (0·1 to 0·1)	0·0 (0·0 to 0·0)	−60·8 (−62·99 to −58·26)
Dengue	8·8 (5·2 to 11·3)	9·1 (5·6 to 10·8)	−1·3 (−21·69 to 74·08)	0·1 (0·1 to 0·2)	0·1 (0·1 to 0·2)	−13·6 (−31·42 to 42·41)
Yellow fever	2·2 (1·9 to 2·5)	0·5 (0·4 to 0·6)	−77·2 (−80·99 to −72·34)	0·0 (0·0 to 0·0)	0·0 (0·0 to 0·0)	−83·3 (−86·08 to −79·71)
Rabies	38·4 (26·7 to 48·7)	23·5 (17·3 to 28·6)	−38·3 (−53·14 to −24·37)	0·7 (0·5 to 0·9)	0·3 (0·2 to 0·4)	−54·0 (−64·09 to −44·23)

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	1990	2013	Median % change	1990	2013	Median % change
Intestinal nematode infections	9·1 (8·1 to 10·2)	4·5 (4·0 to 5·1)	−50·7 (−56·28 to −43·47)	0·1 (0·1 to 0·2)	0·1 (0·1 to 0·1)	−54·7 (−59·66 to −48·46)
Ascariasis	9·1 (8·1 to 10·2)	4·5 (4·0 to 5·1)	−50·7 (−56·28 to −43·47)	0·1 (0·1 to 0·2)	0·1 (0·1 to 0·1)	−54·7 (−59·66 to −48·46)
Other neglected tropical diseases	35·6 (26·4 to 44·2)	16·3 (13·9 to 19·6)	−54·4 (−64·57 to −36·37)	0·6 (0·5 to 0·8)	0·2 (0·2 to 0·3)	−62·3 (−69·58 to −49·75)
Maternal disorders	**376·6 (344·0 to 408·2)**	**293·3 (261·3 to 328·2)**	**−22·3 (−31·63 to −11·38)**	**6·9 (6·3 to 7·5)**	**3·9 (3·5 to 4·4)**	**−43·6 (−50·45 to −35·70)**
Maternal haemorrhage	71·4 (64·6 to 78·5)	44·2 (38·3 to 51·0)	−38·1 (−47·24 to −27·03)	1·3 (1·2 to 1·4)	0·6 (0·5 to 0·7)	−55·0 (−61·51 to −46·97)
Maternal sepsis and other maternal infections	34·1 (30·5 to 38·0)	23·8 (20·1 to 28·0)	−30·4 (−42·43 to −15·10)	0·6 (0·6 to 0·7)	0·3 (0·3 to 0·4)	−50·0 (−58·40 to −39·00)
Maternal hypertensive disorders	36·6 (33·3 to 39·9)	29·3 (25·7 to 33·5)	−20·0 (−30·89 to −7·22)	0·7 (0·6 to 0·7)	0·4 (0·3 to 0·4)	−41·3 (−49·14 to −32·20)
Obstructed labour	29·3 (26·3 to 32·7)	18·8 (16·3 to 21·8)	−35·9 (−45·56 to −23·86)	0·5 (0·5 to 0·6)	0·2 (0·2 to 0·3)	−53·4 (−60·20 to −44·45)
Complications of abortion	50·0 (45·8 to 54·8)	43·7 (38·3 to 49·9)	−12·6 (−24·72 to 2·00)	0·9 (0·9 to 1·0)	0·6 (0·5 to 0·7)	−37·5 (−46·15 to −26·71)
Indirect maternal deaths	40·1 (35·5 to 44·4)	31·1 (26·8 to 35·8)	−22·7 (−34·25 to −7·62)	0·7 (0·6 to 0·8)	0·4 (0·4 to 0·5)	−43·4 (−51·81 to −32·38)
Late maternal deaths	44·9 (36·4 to 53·2)	43·5 (35·7 to 52·4)	−1·8 (−26·81 to 21·95)	0·8 (0·7 to 1·0)	0·6 (0·5 to 0·7)	−28·4 (−46·61 to −11·67)
Maternal deaths aggravated by HIV/AIDS	0·8 (0·5 to 1·1)	2·1 (1·3 to 2·9)	161·7 (128·02 to 202·66)	0·0 (0·0 to 0·0)	0·0 (0·0 to 0·0)	94·1 (69·26 to 124·47)
Other maternal disorders	68·6 (58·4 to 80·4)	56·2 (48·7 to 64·4)	−18·2 (−31·79 to −0·04)	1·3 (1·1 to 1·5)	0·7 (0·6 to 0·9)	−40·8 (−50·36 to −27·88)
Neonatal disorders	**3433·3 (3225·7 to 3586·1)**	**2048·0 (1934·7 to 2160·3)**	**−40·3 (−43·96 to −36·30)**	**46·9 (44·1 to 49·0)**	**27·6 (26·1 to 29·1)**	**−41·1 (−44·71 to −37·13)**
Preterm birth complications	1570·5 (1285·0 to 1803·5)	742·4 (591·3 to 910·8)	−52·9 (−58·70 to −45·50)	21·4 (17·5 to 24·6)	10·0 (8·0 to 12·3)	−53·5 (−59·23 to −46·20)
Neonatal encephalopathy (birth asphyxia/trauma)	874·1 (688·5 to 1055·4)	643·8 (515·0 to 760·5)	−26·1 (−38·29 to −11·35)	11·9 (9·4 to 14·4)	8·7 (6·9 to 10·3)	−27·1 (−39·06 to −12·49)
Neonatal sepsis and other neonatal infections	346·4 (195·7 to 484·0)	366·0 (233·2 to 510·8)	6·1 (−15·94 to 38·04)	4·7 (2·7 to 6·6)	4·9 (3·1 to 6·9)	4·6 (−17·13 to 35·99)
Haemolytic disease and other neonatal jaundice	64·8 (39·5 to 96·3)	19·6 (13·0 to 29·7)	−70·0 (−79·78 to −50·43)	0·9 (0·5 to 1·3)	0·3 (0·2 to 0·4)	−70·6 (−80·17 to −51·17)
Other neonatal disorders	577·6 (457·5 to 756·0)	276·2 (219·6 to 350·7)	−52·3 (−62·41 to −36·77)	7·9 (6·3 to 10·3)	3·7 (3·0 to 4·7)	−53·0 (−63·01 to −37·68)
Nutritional deficiencies	**757·7 (641·5 to 934·4)**	**681·1 (533·5 to 795·5)**	**−9·7 (−22·87 to 1·86)**	**14·7 (12·4 to 18·2)**	**10·4 (8·2 to 12·2)**	**−28·6 (−38·77 to −20·45)**
Protein-energy malnutrition	507·9 (394·3 to 648·5)	468·8 (350·0 to 560·9)	−7·3 (−22·92 to 7·51)	9·2 (7·1 to 11·8)	7·1 (5·3 to 8·5)	−22·5 (−34·54 to −11·34)

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Iodine deficiency	2·1 (1·4 to 3·4)	2·7 (1·5 to 4·7)	24·5 (−29·82 to 137·21)	0·0 (0·0 to 0·1)	0·0 (0·0 to 0·1)	−7·9 (−47·13 to 80·62)
Iron-deficiency anemia	213·4 (143·5 to 309·3)	183·4 (122·0 to 259·2)	−13·8 (−32·36 to 5·33)	4·6 (3·3 to 6·6)	2·8 (1·9 to 4·0)	−38·8 (−50·36 to −26·57)
Other nutritional deficiencies	34·3 (23·8 to 56·1)	26·2 (17·0 to 41·2)	−22·5 (−42·66 to −4·64)	0·8 (0·5 to 1·3)	0·4 (0·3 to 0·7)	−45·4 (−56·40 to −33·85)
Other communicable, maternal, neonatal, and nutritional diseases	**536·5 (433·0 to 674·9)**	**408·4 (342·1 to 488·3)**	**−23·8 (−33·94 to −11·53)**	**9·4 (7·9 to 11·4)**	**5·9 (5·0 to 7·0)**	**−37·4 (−44·55 to −28·28)**
Sexually transmitted diseases excluding HIV	257·6 (154·7 to 396·4)	142·0 (87·6 to 213·9)	−44·5 (−55·96 to −32·77)	3·8 (2·4 to 5·7)	1·9 (1·2 to 2·9)	−48·4 (−58·54 to −37·36)
Syphilis	250·6 (147·4 to 389·1)	136·8 (82·4 to 208·9)	−45·1 (−56·56 to −33·02)	3·6 (2·2 to 5·5)	1·9 (1·1 to 2·9)	−48·0 (−58·61 to −36·83)
Chlamydial infection	1·5 (1·1 to 1·9)	1·1 (0·9 to 1·4)	−23·0 (−42·59 to 0·03)	0·0 (0·0 to 0·0)	0·0 (0·0 to 0·0)	−51·1 (−64·66 to −34·62)
Gonococcal infection	3·2 (2·5 to 3·8)	2·3 (2·0 to 2·9)	−26·6 (−41·91 to −6·75)	0·1 (0·1 to 0·1)	0·0 (0·0 to 0·0)	−54·0 (−64·57 to −39·74)
Other sexually transmitted diseases	2·4 (1·9 to 2·8)	1·7 (1·5 to 2·1)	−27·3 (−42·08 to −10·71)	0·1 (0·0 to 0·1)	0·0 (0·0 to 0·0)	−53·2 (−63·49 to −40·60)
Hepatitis	162·0 (152·8 to 171·4)	136·7 (123·7 to 163·2)	−16·8 (−25·24 to 2·96)	3·3 (3·1 to 3·5)	2·0 (1·8 to 2·4)	−39·6 (−45·37 to −25·80)
Hepatitis A	22·6 (7·9 to 40·2)	14·9 (5·0 to 27·7)	−36·3 (−50·41 to −2·45)	0·3 (0·1 to 0·6)	0·2 (0·1 to 0·4)	−41·9 (−54·39 to −12·04)
Hepatitis B	85·0 (65·1 to 104·0)	68·6 (52·0 to 86·6)	−19·7 (−28·94 to −4·23)	1·9 (1·5 to 2·2)	1·1 (0·8 to 1·3)	−44·6 (−50·38 to −35·37)
Hepatitis C	2·3 (0·5 to 5·3)	3·5 (0·7 to 8·2)	51·0 (24·40 to 86·56)	0·1 (0·0 to 0·1)	0·1 (0·0 to 0·1)	−4·2 (−20·86 to 17·67)
Hepatitis E	52·1 (39·0 to 67·2)	49·7 (36·1 to 67·5)	−6·1 (−17·83 to 20·41)	1·0 (0·7 to 1·3)	0·7 (0·5 to 1·0)	−30·8 (−39·35 to −11·37)
Other infectious diseases	116·9 (94·0 to 144·3)	129·8 (89·6 to 164·9)	11·3 (−21·67 to 45·00)	2·4 (1·9 to 3·0)	2·0 (1·4 to 2·5)	−17·7 (−42·92 to 7·31)
Non-communicable diseases	**26 993·5 (26 298·1 to 27 639·1)**	**38 267·2 (37 202·2 to 39 417·6)**	**41·7 (36·86 to 47·00)**	**782·5 (765·5 to 798·2)**	**637·5 (620·4 to 655·7)**	**−18·6 (−21·08 to −15·78)**
Neoplasms	**5659·7 (5440·4 to 5826·6)**	**8235·7 (7941·4 to 8538·9)**	**45·6 (39·82 to 51·55)**	**157·0 (151·3 to 161·5)**	**133·8 (128·9 to 138·6)**	**−14·7 (−17·91 to −11·49)**
Oesophageal cancer	313·1 (275·0 to 351·5)	440·2 (389·2 to 516·8)	39·9 (26·42 to 56·36)	8·8 (7·8 to 9·9)	7·2 (6·3 to 8·4)	−19·3 (−27·13 to −9·94)
Stomach cancer	763·4 (725·6 to 803·2)	841·0 (791·6 to 894·1)	10·1 (3·94 to 17·43)	21·7 (20·6 to 22·9)	13·8 (13·0 to 14·7)	−36·3 (−39·82 to −32·14)
Liver cancer	510·1 (474·9 to 543·1)	818·0 (763·7 to 879·0)	60·3 (46·21 to 75·28)	13·7 (12·7 to 14·5)	13·0 (12·1 to 13·9)	−5·0 (−13·01 to 3·61)

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Liver cancer secondary to hepatitis B	198·4 (181·7 to 215·4)	300·0 (272·0 to 329·2)	51·6 (33·51 to 72·02)	5·1 (4·7 to 5·5)	4·6 (4·2 to 5·1)	−9·1 (−19·63 to 2·69)
Liver cancer secondary to hepatitis C	87·4 (79·5 to 94·7)	342·5 (317·1 to 375·3)	290·8 (251·46 to 342·52)	2·4 (2·2 to 2·6)	5·5 (5·1 to 6·0)	125·4 (103·82 to 154·85)
Liver cancer secondary to alcohol use	122·8 (113·8 to 132·5)	92·2 (84·8 to 100·3)	−25·2 (−31·20 to −17·09)	3·5 (3·2 to 3·7)	1·5 (1·4 to 1·6)	−56·4 (−59·87 to −51·82)
Other liver cancer	101·5 (92·8 to 110·0)	83·3 (75·1 to 92·2)	−17·5 (−28·57 to −7·02)	2·6 (2·4 to 2·9)	1·3 (1·2 to 1·4)	−50·5 (−56·97 to −44·23)
Larynx cancer	76·2 (62·7 to 88·1)	87·6 (74·3 to 106·2)	14·2 (7·25 to 27·55)	2·1 (1·7 to 2·4)	1·4 (1·2 to 1·7)	−33·4 (−37·26 to −26·29)
Tracheal, bronchus, and lung cancer	1050·0 (1010·6 to 1078·2)	1639·6 (1565·6 to 1706·0)	56·5 (47·83 to 62·84)	29·6 (28·5 to 30·4)	27·0 (25·7 to 28·1)	−8·7 (−13·62 to −5·16)
Breast cancer	327·3 (289·2 to 366·8)	471·0 (412·0 to 514·2)	44·2 (35·01 to 51·82)	9·0 (7·9 to 10·1)	7·4 (6·4 to 8·1)	−17·5 (−23·42 to −13·38)
Cervical cancer	196·3 (162·9 to 212·4)	235·7 (201·9 to 257·9)	20·1 (10·74 to 30·15)	5·2 (4·3 to 5·6)	3·6 (3·1 to 4·0)	−30·1 (−35·55 to −24·13)
Uterine cancer	45·6 (36·6 to 55·6)	67·7 (53·6 to 79·0)	48·6 (30·64 to 64·39)	1·3 (1·0 to 1·6)	1·1 (0·9 to 1·3)	−15·0 (−24·61 to −6·58)
Prostate cancer	157·1 (124·0 to 193·1)	292·7 (242·2 to 373·9)	82·8 (71·77 to 109·02)	5·1 (4·0 to 6·3)	5·2 (4·3 to 6·6)	−1·0 (−7·17 to 13·05)
Colon and rectum cancer	490·2 (476·1 to 504·5)	771·1 (741·5 to 799·2)	57·4 (51·89 to 62·64)	14·5 (14·1 to 14·9)	12·8 (12·4 to 13·3)	−11·1 (−14·40 to −8·17)
Lip and oral cavity cancer	83·9 (74·0 to 96·2)	135·0 (115·3 to 154·3)	59·7 (46·91 to 78·39)	2·3 (2·0 to 2·6)	2·1 (1·8 to 2·5)	−7·9 (−14·96 to 2·32)
Nasopharynx cancer	53·7 (47·7 to 63·5)	60·5 (54·0 to 69·5)	12·7 (1·19 to 24·74)	1·4 (1·2 to 1·6)	0·9 (0·8 to 1·1)	−32·5 (−39·31 to −25·55)
Other pharynx cancer	48·9 (43·7 to 53·5)	78·6 (67·0 to 86·3)	60·9 (43·26 to 76·41)	1·3 (1·2 to 1·4)	1·2 (1·0 to 1·3)	−7·1 (−16·97 to 2·04)
Gallbladder and biliary tract cancer	115·4 (100·6 to 130·4)	139·5 (120·0 to 155·0)	22·1 (6·85 to 32·36)	3·4 (3·0 to 3·9)	2·3 (2·0 to 2·6)	−31·2 (−39·96 to −25·22)
Pancreatic cancer	186·4 (181·3 to 191·8)	352·4 (339·4 to 364·8)	89·0 (82·43 to 95·46)	5·4 (5·3 to 5·6)	5·9 (5·6 to 6·1)	7·4 (3·63 to 11·04)
Malignant skin melanoma	38·7 (30·1 to 50·9)	56·9 (43·9 to 75·7)	47·6 (31·54 to 57·81)	1·1 (0·8 to 1·4)	0·9 (0·7 to 1·2)	−14·1 (−23·86 to −8·06)
Non-melanoma skin cancer	25·0 (20·2 to 30·0)	39·2 (32·8 to 48·7)	55·0 (43·30 to 76·59)	0·8 (0·6 to 0·9)	0·7 (0·6 to 0·8)	−12·9 (−20·00 to −0·93)
Ovarian cancer	98·9 (93·1 to 106·1)	157·8 (147·5 to 169·5)	59·6 (50·81 to 68·88)	2·7 (2·6 to 2·9)	2·5 (2·3 to 2·7)	−7·8 (−12·97 to −2·56)
Testicular cancer	7·0 (5·4 to 8·2)	8·3 (6·3 to 10·4)	18·4 (8·86 to 35·42)	0·2 (0·1 to 0·2)	0·1 (0·1 to 0·1)	−23·0 (−28·60 to −11·08)
Kidney cancer	77·9 (73·8 to 83·0)	133·8 (126·0 to 141·1)	71·8 (63·06 to 81·02)	2·1 (2·0 to 2·3)	2·2 (2·0 to 2·3)	1·6 (−3·95 to 8·11)

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Bladder cancer	130·8 (116·6 to 140·9)	173·9 (156·8 to 192·5)	32·2 (27·35 to 43·06)	4·0 (3·5 to 4·3)	3·0 (2·7 to 3·3)	−25·6 (−28·36 to −20·14)
Brain and nervous system cancers	136·0 (116·6 to 155·2)	203·9 (169·5 to 234·8)	50·4 (34·04 to 60·33)	3·3 (2·8 to 3·8)	3·1 (2·6 to 3·6)	−4·6 (−13·99 to 0·96)
Thyroid cancer	23·8 (20·3 to 26·1)	33·7 (29·6 to 38·2)	41·1 (29·80 to 59·27)	0·7 (0·6 to 0·8)	0·6 (0·5 to 0·6)	−19·6 (−25·50 to −9·09)
Mesothelioma	17·0 (15·2 to 20·3)	33·7 (29·4 to 38·7)	100·5 (69·94 to 115·47)	0·5 (0·4 to 0·6)	0·5 (0·5 to 0·6)	16·2 (−2·42 to 24·92)
Hodgkin lymphoma	33·6 (24·1 to 38·0)	24·2 (22·0 to 31·6)	−33·0 (−40·41 to 15·35)	0·8 (0·5 to 0·8)	0·4 (0·3 to 0·5)	−54·9 (−58·93 to −24·34)
Non-Hodgkin lymphoma	133·6 (116·3 to 158·0)	225·5 (186·3 to 245·8)	72·0 (41·51 to 84·35)	3·5 (3·1 to 4·2)	3·6 (2·9 to 3·9)	6·1 (−14·56 to 13·42)
Multiple myeloma	45·3 (37·4 to 57·4)	79·4 (65·3 to 94·2)	77·1 (53·64 to 90·08)	1·3 (1·1 to 1·7)	1·3 (1·1 to 1·6)	0·4 (−13·32 to 8·27)
Leukaemia	223·8 (215·1 to 234·2)	265·1 (253·9 to 275·8)	18·7 (11·69 to 24·19)	5·2 (5·0 to 5·4)	4·1 (3·9 to 4·3)	−20·0 (−24·12 to −16·68)
Other neoplasms	250·6 (231·8 to 305·2)	369·6 (328·0 to 400·1)	51·3 (15·57 to 62·10)	6·2 (5·8 to 7·3)	5·8 (5·2 to 6·3)	−4·2 (−23·44 to 3·32)
Cardiovascular diseases	**12 279·6 (11 776·6 to 12 764·1)**	**17 297·5 (16 520·2 to 18 071·9)**	**40·8 (36·17 to 46·36)**	**375·5 (360·5 to 389·1)**	**293·2 (280·4 to 306·1)**	**−22·0 (−24·50 to −19·07)**
Rheumatic heart disease	373·5 (302·5 to 464·6)	275·1 (222·6 to 353·9)	−26·5 (−33·64 to −17·20)	9·8 (7·9 to 12·2)	4·4 (3·5 to 5·6)	−55·4 (−59·47 to −50·11)
Ischaemic heart disease	5737·5 (5254·9 to 6148·6)	8139·9 (7322·9 to 8758·5)	41·7 (35·96 to 48·44)	177·3 (161·8 to 190·2)	137·8 (123·9 to 148·2)	−22·3 (−25·48 to −18·68)
Cerebrovascular disease	4584·8 (4162·1 to 4968·1)	6446·9 (5963·0 to 7155·2)	40·2 (34·43 to 49·56)	141·6 (128·5 to 153·9)	110·1 (101·8 to 122·2)	−22·5 (−25·56 to −17·30)
Ischaemic stroke	2182·9 (1923·3 to 2430·9)	3272·9 (2812·7 to 3592·6)	50·2 (41·02 to 59·27)	71·3 (63·0 to 79·3)	57·3 (49·3 to 62·9)	−19·6 (−24·52 to −14·97)
Haemorrhagic stroke	2401·9 (2109·4 to 2669·1)	3174·0 (2885·7 to 3719·7)	30·7 (22·23 to 49·07)	70·3 (61·2 to 77·9)	52·8 (48·0 to 62·3)	−25·9 (−30·64 to −14·73)
Hypertensive heart disease	622·1 (525·7 to 783·9)	1068·6 (849·8 to 1242·2)	74·1 (47·34 to 93·73)	19·3 (16·4 to 24·4)	18·2 (14·5 to 21·3)	−4·5 (−18·86 to 6·41)
Cardiomyopathy and myocarditis	293·9 (243·5 to 346·3)	443·3 (370·1 to 512·0)	51·4 (37·27 to 61·45)	8·2 (6·9 to 9·6)	7·1 (6·0 to 8·3)	−12·6 (−19·98 to −7·68)
Atrial fibrillation and flutter	28·9 (26·0 to 32·4)	112·2 (97·7 to 126·7)	288·1 (246·32 to 335·03)	1·0 (0·9 to 1·1)	2·0 (1·8 to 2·3)	100·0 (77·55 to 124·90)
Aortic aneurysm	99·6 (82·4 to 118·5)	151·5 (124·2 to 180·0)	52·1 (43·75 to 60·91)	3·0 (2·5 to 3·6)	2·6 (2·1 to 3·1)	−15·3 (−20·06 to −10·50)

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Peripheral vascular disease	15·9 (14·4 to 17·5)	40·5 (35·5 to 44·9)	155·3 (126·51 to 178·39)	0·5 (0·5 to 0·6)	0·7 (0·6 to 0·8)	34·1 (18·77 to 46·62)
Endocarditis	45·1 (35·6 to 58·6)	65·0 (48·6 to 79·4)	46·3 (23·88 to 65·52)	1·2 (1·0 to 1·6)	1·0 (0·8 to 1·3)	−12·7 (−25·81 to −2·80)
Other cardiovascular and circulatory diseases	478·3 (403·9 to 546·4)	554·6 (499·1 to 654·2)	15·2 (9·38 to 32·52)	13·6 (11·5 to 15·5)	9·3 (8·3 to 10·8)	−32·2 (−35·44 to −22·40)
Chronic respiratory diseases	**3490·2 (3280·4 to 3795·3)**	**4267·5 (3996·3 to 4694·2)**	**21·9 (14·95 to 31·48)**	**104·5 (98·5 to 113·3)**	**73·0 (68·4 to 80·2)**	**−30·4 (−34·19 to −25·05)**
Chronic obstructive pulmonary disease	2421·3 (2151·3 to 2632·4)	2931·2 (2626·3 to 3215·8)	21·0 (12·70 to 31·26)	74·8 (66·8 to 81·2)	50·7 (45·4 to 55·6)	−32·3 (−36·75 to −26·54)
Pneumoconiosis	251·2 (184·0 to 317·8)	259·7 (201·7 to 331·2)	1·9 (−15·21 to 40·27)	7·2 (5·3 to 9·0)	4·3 (3·3 to 5·5)	−40·5 (−50·81 to −19·84)
Silicosis	55·4 (36·7 to 77·1)	46·3 (32·1 to 64·8)	−16·0 (−32·85 to 6·14)	1·6 (1·0 to 2·2)	0·8 (0·5 to 1·1)	−50·7 (−61·18 to −38·06)
Asbestosis	21·0 (13·9 to 30·4)	24·1 (17·5 to 32·3)	14·2 (−10·20 to 54·87)	0·6 (0·4 to 0·9)	0·4 (0·3 to 0·5)	−32·6 (−47·35 to −9·61)
Coal workers pneumoconiosis	28·9 (18·2 to 43·9)	25·2 (19·0 to 35·6)	−13·7 (−30·65 to 23·06)	0·8 (0·5 to 1·2)	0·4 (0·3 to 0·6)	−50·2 (−60·26 to −29·13)
Other pneumoconiosis	145·9 (100·3 to 189·2)	164·1 (123·1 to 213·6)	10·9 (−13·48 to 61·23)	4·2 (2·9 to 5·5)	2·7 (2·0 to 3·6)	−35·3 (−50·19 to −6·77)
Asthma	504·3 (399·7 to 731·8)	489·0 (397·7 to 676·8)	−2·9 (−24·58 to 19·21)	13·7 (10·8 to 20·4)	8·0 (6·5 to 11·1)	−41·5 (−55·17 to −28·01)
Interstitial lung disease and pulmonary sarcoidosis	217·6 (128·7 to 299·4)	471·5 (372·3 to 606·8)	114·1 (53·25 to 214·86)	6·6 (3·9 to 8·9)	8·0 (6·3 to 10·3)	20·1 (−11·89 to 74·20)
Other chronic respiratory diseases	95·8 (78·3 to 113·8)	116·1 (99·2 to 136·9)	21·2 (7·78 to 40·66)	2·2 (1·8 to 2·7)	1·9 (1·6 to 2·3)	−15·1 (−24·22 to −3·39)
Cirrhosis of the liver	**838·0 (807·0 to 866·7)**	**1221·1 (1170·3 to 1284·3)**	**45·6 (38·47 to 54·52)**	**21·8 (20·9 to 22·5)**	**18·8 (18·0 to 19·7)**	**−13·7 (−17·75 to −8·49)**
Cirrhosis of the liver secondary to hepatitis B	233·9 (220·8 to 250·0)	317·4 (292·3 to 344·6)	35·6 (22·66 to 49·58)	6·1 (5·7 to 6·5)	4·9 (4·5 to 5·3)	−19·3 (−26·86 to −11·11)
Cirrhosis of the liver secondary to hepatitis C	213·1 (200·4 to 226·7)	357·8 (334·3 to 386·1)	67·3 (54·60 to 83·86)	5·7 (5·4 to 6·0)	5·6 (5·2 to 6·0)	−2·4 (−9·58 to 7·48)
Cirrhosis of the liver secondary to alcohol use	292·2 (276·5 to 307·1)	383·8 (356·2 to 414·7)	31·2 (20·27 to 43·97)	7·8 (7·4 to 8·2)	5·9 (5·5 to 6·4)	−24·1 (−30·24 to −16·92)
Other cirrhosis of the liver	98·8 (92·1 to 106·0)	162·1 (145·5 to 182·9)	63·5 (47·65 to 86·21)	2·2 (2·0 to 2·3)	2·4 (2·1 to 2·7)	9·3 (−1·52 to 24·19)
Digestive diseases	**1053·2 (958·6 to 1131·2)**	**1168·3 (1064·4 to 1275·5)**	**10·4 (2·11 to 22·38)**	**28·4 (25·8 to 30·5)**	**19·0 (17·4 to 20·7)**	**−335 (−38·30 to −26·51)**

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Peptic ulcer disease	326·9 (288·8 to 388·7)	301·4 (249·8 to 350·5)	−7·6 (−21·26 to 5·52)	9·1 (8·0 to 10·7)	4·9 (4·1 to 5·7)	−45·8 (−53·37 to −38·53)
Gastritis and duodenitis	54·2 (32·1 to 76·3)	59·5 (42·2 to 90·1)	5·8 (−13·46 to 50·38)	1·4 (0·8 to 2·0)	1·0 (0·7 to 1·5)	−35·1 (−46·54 to −6·86)
Appendicitis	87·5 (70·8 to 105·9)	71·9 (51·4 to 89·5)	−17·8 (−34·66 to 2·68)	2·0 (1·6 to 2·4)	1·1 (0·8 to 1·4)	−45·7 (−56·37 to −33·27)
Paralytic ileus and intestinal obstruction	178·0 (116·3 to 228·5)	235·7 (175·6 to 327·0)	29·4 (11·32 to 68·61)	4·7 (3·1 to 6·1)	3·8 (2·8 to 5·3)	−20·3 (−31·07 to 1·80)
Inguinal, femoral, and abdominal hernia	50·5 (33·2 to 61·2)	32·5 (25·6 to 48·8)	−41·8 (−49·26 to −4·88)	1·4 (0·9 to 1·7)	0·5 (0·4 to 0·8)	−64·8 (−69·29 to −44·12)
Inflammatory bowel disease	54·9 (40·4 to 67·2)	51·2 (42·4 to 69·7)	−8·7 (−17·41 to 13·01)	1·4 (1·0 to 1·6)	0·8 (0·7 to 1·1)	−41·8 (−47·30 to −25·30)
Vascular intestinal disorders	52·6 (34·7 to 78·4)	79·5 (51·9 to 113·3)	51·8 (36·03 to 67·16)	1·6 (1·1 to 2·4)	1·4 (0·9 to 1·9)	−16·3 (−24·49 to −8·10)
Gallbladder and biliary diseases	80·5 (68·9 to 94·1)	105·9 (89·1 to 122·3)	32·2 (18·76 to 43·46)	2·4 (2·0 to 2·8)	1·8 (1·5 to 2·1)	−24·5 (−31·76 to −18·21)
Pancreatitis	83·0 (59·2 to 111·3)	122·6 (85·9 to 152·3)	49·1 (16·02 to 76·94)	2·1 (1·5 to 2·9)	1·9 (1·3 to 2·4)	−10·2 (−29·33 to 5·74)
Other digestive diseases	85·2 (73·3 to 99·5)	108·0 (90·4 to 124·2)	27·1 (14·25 to 39·04)	2·3 (2·0 to 2·6)	1·8 (1·5 to 2·0)	−21·9 (−29·04 to −15·13)
Neurological disorders	**1017·5 (965·0 to 1072·3)**	**1976·8 (1875·0 to 2080·7)**	**94·0 (83·99 to 106·61)**	**34·2 (32·3 to 36·1)**	**35·0 (33·2 to 36·9)**	**2·3 (−3·27 to 9·08)**
Alzheimer's disease and other dementias	795·8 (747·9 to 844·3)	1655·1 (1563·5 to 1765·3)	107·2 (94·94 to 124·00)	28·9 (27·1 to 30·7)	29·9 (28·2 to 31·9)	3·2 (−3·01 to 11·61)
Parkinson's disease	43·7 (38·3 to 55·1)	102·5 (79·3 to 112·6)	139·8 (77·36 to 156·99)	1·5 (1·3 to 1·9)	1·8 (1·4 to 2·0)	28·2 (−6·42 to 37·83)
Epilepsy	111·0 (95·5 to 129·9)	115·8 (93·7 to 132·0)	4·7 (−12·05 to 24·00)	2·2 (1·9 to 2·5)	1·7 (1·3 to 1·9)	−22·4 (−33·73 to −10·21)
Multiple sclerosis	12·4 (9·2 to 19·0)	19·8 (12·8 to 25·5)	64·8 (3·60 to 87·09)	0·3 (0·2 to 0·5)	0·3 (0·2 to 0·4)	−1·1 (−38·78 to 11·91)
Other neurological disorders	54·6 (47·1 to 60·8)	83·7 (71·8 to 90·8)	54·2 (37·88 to 60·72)	1·4 (1·2 to 1·5)	1·3 (1·1 to 1·4)	−3·6 (−10·27 to 0·43)
Mental and substance use disorders	**188·3 (157·2 to 242·3)**	**282·4 (233·9 to 329·3)**	**51·5 (32·26 to 63·84)**	**4·3 (3·6 to 5·7)**	**4·0 (3·3 to 4·7)**	**−5·7 (−18·55 to 2·10)**
Schizophrenia	22·8 (14·7 to 28·3)	16·0 (13·7 to 22·8)	−35·5 (−46·52 to 29·94)	0·6 (0·4 to 0·7)	0·2 (0·2 to 0·3)	−59·7 (−66·47 to −20·07)
Alcohol use disorders	111·9 (84·0 to 165·3)	139·2 (90·2 to 178·5)	28·2 (1·78 to 35·66)	2·7 (2·0 to 3·9)	2·0 (1·3 to 2·6)	−22·0 (−38·53 to −17·54)
Drug use disorders	53·2 (47·8 to 64·1)	126·6 (110·8 to 135·5)	140·4 (101·60 to 159·88)	1·1 (1·0 to 1·3)	1·8 (1·6 to 1·9)	63·0 (36·10 to 74·81)

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Opioid use disorders	18·0 (16·5 to 22·2)	50·7 (43·4 to 54·4)	187·3 (134·80 to 210·24)	0·4 (0·3 to 0·5)	0·7 (0·6 to 0·8)	92·7 (56·69 to 107·16)
Cocaine use disorders	2·4 (2·2 to 2·9)	4·3 (3·9 to 4·7)	77·2 (49·11 to 102·26)	0·1 (0·0 to 0·1)	0·1 (0·1 to 0·1)	20·9 (1·97 to 36·34)
Amphetamine use disorders	2·1 (1·9 to 2·5)	3·8 (3·4 to 4·1)	80·4 (52·49 to 106·70)	0·0 (0·0 to 0·1)	0·1 (0·0 to 0·1)	23·2 (4·70 to 40·49)
Other drug use disorders	30·7 (26·1 to 37·3)	67·7 (59·5 to 72·8)	122·8 (86·51 to 146·32)	0·6 (0·6 to 0·8)	1·0 (0·8 to 1·0)	51·6 (26·34 to 65·39)
Eating disorders	0·4 (0·3 to 0·4)	0·6 (0·5 to 0·7)	60·4 (41·17 to 84·68)	0·0 (0·0 to 0·0)	0·0 (0·0 to 0·0)	13·5 (−0·42 to 30·16)
Anorexia nervosa	0·4 (0·3 to 0·4)	0·6 (0·5 to 0·7)	60·4 (41·17 to 84·68)	0·0 (0·0 to 0·0)	0·0 (0·0 to 0·0)	13·5 (−0·42 to 30·16)
Diabetes, urogenital, blood, and endocrine diseases	**1569·4 (1456·7 to 1709·2)**	**2955·0 (2764·0 to 3171·1)**	**88·9 (76·44 to 99·49)**	**42·2 (39·5 to 44·7)**	**48·3 (45·1 to 51·4)**	**14·4 (9·53 to 20·14)**
Diabetes mellitus	684·3 (653·2 to 711·5)	1299·4 (1234·5 to 1374·8)	89·7 (81·77 to 99·94)	19·8 (18·9 to 20·6)	21·6 (20·6 to 22·9)	9·0 (4·59 to 14·69)
Acute glomerulonephritis	23·6 (13·7 to 33·4)	18·8 (14·3 to 22·8)	−21·4 (−36·96 to 14·96)	0·5 (0·3 to 0·8)	0·3 (0·2 to 0·3)	−45·8 (−55·70 to −21·57)
Chronic kidney disease	408·6 (363·8 to 433·4)	956·2 (812·9 to 1034·5)	134·6 (115·70 to 150·20)	11·6 (10·4 to 12·3)	15·8 (13·5 to 17·1)	36·9 (25·43 to 46·11)
Chronic kidney disease due to diabetes mellitus	46·3 (34·8 to 54·8)	173·1 (139·3 to 208·8)	274·1 (243·06 to 309·05)	1·4 (1·0 to 1·6)	2·9 (2·3 to 3·5)	106·5 (89·67 to 127·74)
Chronic kidney disease due to hypertension	120·0 (91·6 to 144·8)	275·7 (196·9 to 336·5)	130·6 (106·28 to 151·38)	3·6 (2·8 to 4·4)	4·6 (3·3 to 5·6)	29·4 (15·20 to 40·43)
Chronic kidney disease due to glomerulonephritis	99·0 (84·5 to 114·7)	116·3 (92·9 to 144·0)	16·9 (1·69 to 35·32)	2·5 (2·1 to 2·9)	1·8 (1·5 to 2·3)	−26·8 (−35·84 to −15·66)
Chronic kidney diseases due to other causes	143·3 (115·3 to 168·0)	391·2 (297·0 to 452·3)	175·3 (140·05 to 202·16)	4·1 (3·3 to 4·8)	6·5 (4·9 to 7·5)	58·8 (37·59 to 74·71)
Urinary diseases and male infertility due to other causes	151·4 (129·1 to 161·1)	245·8 (205·5 to 264·7)	62·8 (49·74 to 72·37)	4·3 (3·7 to 4·6)	4·1 (3·4 to 4·4)	−3·7 (−12·86 to 1·66)
Interstitial nephritis and urinary tract infections	109·9 (92·9 to 118·1)	175·5 (144·6 to 192·0)	58·9 (48·57 to 74·08)	3·1 (2·7 to 3·4)	2·9 (2·4 to 3·2)	−6·3 (−14·36 to 2·19)
Urolithiasis	15·1 (11·1 to 18·7)	14·7 (12·4 to 20·1)	−5·9 (−16·02 to 44·87)	0·4 (0·3 to 0·5)	0·2 (0·2 to 0·3)	−45·3 (−50·97 to −14·32)
Other urinary diseases	26·3 (21·9 to 35·0)	55·5 (40·4 to 66·5)	122·4 (69·54 to 151·57)	0·7 (0·6 to 1·0)	0·9 (0·7 to 1·1)	32·5 (2·75 to 50·04)
Gynaecological diseases	5·3 (3·9 to 7·0)	3·4 (2·9 to 4·8)	−36·7 (−47·76 to −14·33)	0·1 (0·1 to 0·2)	0·1 (0·0 to 0·1)	−59·5 (−67·15 to −45·56)
Uterine fibroids	1·2 (0·9 to 1·7)	0·9 (0·7 to 1·2)	−29·7 (−43·96 to −6·20)	0·0 (0·0 to 0·0)	0·0 (0·0 to 0·0)	−57·8 (−66·54 to −43·72)
Polycystic ovarian syndrome	0·2 (0·1 to 0·3)	0·1 (0·1 to 0·2)	−56·2 (−63·48 to −29·90)	0·0 (0·0 to 0·0)	0·0 (0·0 to 0·0)	−68·5 (−73·81 to −49·56)
Endometriosis	0·5 (0·4 to 0·6)	0·2 (0·2 to 0·4)	−54·7 (−62·11 to −29·37)	0·0 (0·0 to 0·0)	0·0 (0·0 to 0·0)	−68·9 (−74·05 to −51·25)

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Genital prolapse	0·9 (0·7 to 1·2)	0·6 (0·5 to 0·9)	−29·9 (−44·02 to −8·28)	0·0 (0·0 to 0·0)	0·0 (0·0 to 0·0)	−55·7 (−65·45 to −42·31)
Other gynaecological diseases	2·5 (1·8 to 3·2)	1·6 (1·3 to 2·2)	−37·4 (−48·19 to −15·38)	0·1 (0·0 to 0·1)	0·0 (0·0 to 0·0)	−59·7 (−67·23 to −46·18)
Haemoglobinopathies and haemolytic anaemias	182·7 (91·5 to 302·5)	240·4 (106·0 to 456·1)	20·6 (−1·35 to 92·91)	3·1 (1·6 to 5·0)	3·4 (1·5 to 6·3)	0·4 (−19·05 to 51·95)
Thalassaemias	36·2 (21·2 to 49·4)	24·8 (16·9 to 32·1)	−36·4 (−46·90 to 14·05)	0·6 (0·3 to 0·8)	0·3 (0·2 to 0·4)	−43·7 (−52·63 to −2·83)
Sickle cell disorders	112·9 (39·4 to 222·6)	176·2 (56·3 to 385·7)	45·3 (14·30 to 131·19)	1·8 (0·6 to 3·4)	2·4 (0·8 to 5·3)	28·8 (1·53 to 94·35)
G6PD deficiency	3·4 (2·0 to 4·6)	4·1 (2·6 to 5·6)	12·7 (−7·12 to 91·90)	0·1 (0·0 to 0·1)	0·1 (0·0 to 0·1)	−8·2 (−23·19 to 45·12)
Other haemoglobinopathies and haemolytic anaemias	30·3 (19·8 to 38·6)	35·4 (24·3 to 44·9)	15·1 (3·42 to 46·66)	0·8 (0·5 to 1·0)	0·6 (0·4 to 0·7)	−25·8 (−31·66 to −9·80)
Endocrine, metabolic, blood, and immune disorders	113·5 (90·6 to 134·4)	191·0 (150·5 to 218·5)	69·5 (49·11 to 85·62)	2·7 (2·2 to 3·2)	3·0 (2·4 to 3·4)	11·6 (0·55 to 20·87)
Musculoskeletal disorders	**65·9 (55·0 to 73·4)**	**116·3 (100·4 to 137·7)**	**77·1 (54·42 to 105·22)**	**1·7 (1·5 to 1·9)**	**1·9 (1·6 to 2·2)**	**8·5 (−4·62 to 23·48)**
Rheumatoid arthritis	27·8 (23·8 to 31·7)	38·1 (33·0 to 46·9)	35·6 (16·43 to 64·74)	0·8 (0·7 to 0·9)	0·6 (0·5 to 0·8)	−20·5 (−31·22 to −4·53)
Other musculoskeletal disorders	38·1 (30·3 to 44·1)	78·2 (65·2 to 90·3)	107·2 (76·94 to 145·59)	0·9 (0·8 to 1·1)	1·2 (1·0 to 1·4)	32·7 (14·17 to 51·37)
Other non-communicable diseases	**831·7 (690·7 to 1061·0)**	**746·6 (674·1 to 846·2)**	**−7·6 (−25·31 to 4·05)**	**12·9 (10·9 to 16·1)**	**10·5 (9·5 to 11·9)**	**−164 (−30·83 to −7·20)**
Congenital anomalies	750·6 (611·8 to 969·7)	632·1 (561·3 to 730·3)	−13·5 (−30·40 to −0·80)	11·0 (9·0 to 14·1)	8·7 (7·7 to 10·0)	−18·9 (−34·07 to −7·54)
Neural tube defects	151·3 (109·1 to 256·3)	68·9 (40·9 to 124·4)	−54·8 (−65·35 to −42·39)	2·1 (1·5 to 3·6)	0·9 (0·6 to 1·7)	−56·6 (−66·71 to −44·61)
Congenital heart anomalies	366·2 (293·0 to 485·2)	323·4 (288·3 to 372·6)	−9·8 (−29·83 to 7·37)	5·4 (4·4 to 7·0)	4·5 (4·0 to 5·1)	−15·8 (−33·64 to −0·61)
Orofacial clefts	7·6 (4·2 to 11·5)	3·3 (1·9 to 5·2)	−57·8 (−68·83 to −33·93)	0·1 (0·1 to 0·2)	0·0 (0·0 to 0·1)	−58·5 (−69·40 to −35·04)
Down's syndrome	42·5 (16·4 to 73·0)	36·4 (20·4 to 52·4)	−12·9 (−39·13 to 40·14)	0·7 (0·3 to 1·1)	0·5 (0·3 to 0·7)	−22·6 (−45·11 to 19·89)
Chromosomal unbalanced rearrangements	19·1 (8·5 to 41·2)	17·3 (10·6 to 26·8)	5·5 (−40·18 to 35·89)	0·3 (0·1 to 0·6)	0·2 (0·1 to 0·4)	−3·0 (−43·13 to 25·13)
Other congenital anomalies	163·9 (119·9 to 301·9)	182·8 (150·2 to 261·9)	18·0 (−16·45 to 40·74)	2·4 (1·8 to 4·4)	2·5 (2·1 to 3·6)	8·5 (−20·90 to 29·30)
Skin and subcutaneous diseases	59·1 (54·1 to 63·1)	99·4 (89·9 to 107·3)	68·3 (51·36 to 86·44)	1·6 (1·5 to 1·7)	1·6 (1·5 to 1·8)	2·5 (−7·66 to 10·83)
Cellulitis	27·0 (19·0 to 34·1)	29·5 (22·5 to 39·3)	8·0 (−5·23 to 30·03)	0·7 (0·5 to 0·8)	0·5 (0·4 to 0·6)	−29·8 (−38·47 to −16·25)

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	All ages deaths (thousands)			Age-standardised death rate (per 100 000)		
	1990	2013	Median % change	1990	2013	Median % change
Pyoderma	16·7 (11·6 to 23·1)	37·7 (30·2 to 42·9)	129·9 (71·83 to 186·99)	0·4 (0·3 to 0·6)	0·6 (0·5 to 0·7)	44·0 (14·02 to 75·43)
Decubitus ulcer	13·7 (11·5 to 16·9)	28·5 (24·4 to 33·0)	109·6 (82·53 to 132·42)	0·5 (0·4 to 0·6)	0·5 (0·4 to 0·6)	8·3 (−4·81 to 19·09)
Other skin and subcutaneous diseases	1·7 (1·2 to 2·2)	3·8 (3·0 to 4·9)	138·4 (74·18 to 201·77)	0·0 (0·0 to 0·1)	0·1 (0·0 to 0·1)	35·9 (4·37 to 69·36)
Sudden infant death syndrome	22·0 (12·7 to 40·2)	15·1 (9·6 to 21·4)	−29·5 (−54·51 to −4·22)	0·3 (0·2 to 0·6)	0·2 (0·1 to 0·3)	−31·0 (−55·52 to −6·34)
Injuries	**4325·8 (4095·7 to 4524·0)**	**4786·9 (4507·9 to 5072·8)**	**10·4 (4·23 to 18·04)**	**88·5 (84·5 to 93·0)**	**70·0 (65·9 to 74·2)**	**−21·0 (−25·27 to −15·85)**
Transport injuries	**1150·0 (1092·9 to 1253·9)**	**1482·7 (1364·8 to 1588·8)**	**29·3 (17·11 to 38·66)**	**23·2 (22·1 to 25·1)**	**21·2 (19·5 to 22·7)**	**−8·4 (−16·54 to −2·02)**
Road injuries	1058·4 (1005·0 to 1167·2)	1395·8 (1286·1 to 1492·7)	32·4 (19·21 to 41·84)	21·3 (20·3 to 23·4)	20·0 (18·4 to 21·3)	−6·1 (−15·12 to 0·28)
Pedestrian road injuries	389·7 (339·6 to 472·0)	543·8 (452·0 to 629·1)	40·2 (17·55 to 58·63)	8·0 (7·0 to 9·6)	8·0 (6·7 to 9·2)	0·1 (−15·84 to 12·51)
Cyclist road injuries	68·6 (58·5 to 83·3)	90·6 (74·2 to 106·6)	32·0 (13·51 to 51·06)	1·4 (1·2 to 1·7)	1·3 (1·1 to 1·6)	−7·5 (−20·14 to 5·51)
Motorcyclist road injuries	202·0 (169·3 to 236·4)	248·5 (200·9 to 294·4)	22·8 (7·72 to 40·45)	3·9 (3·2 to 4·5)	3·4 (2·8 to 4·0)	−12·2 (−22·77 to 0·56)
Motor vehicle road injuries	364·4 (324·4 to 409·1)	492·7 (431·0 to 555·1)	35·5 (24·24 to 46·49)	7·3 (6·5 to 8·2)	6·9 (6·1 to 7·8)	−4·9 (−12·90 to 2·69)
Other road injuries	33·8 (21·9 to 44·1)	20·2 (14·4 to 25·5)	−40·7 (−54·01 to −7·44)	0·7 (0·4 to 0·9)	0·3 (0·2 to 0·4)	−57·3 (−67·23 to −34·33)
Other transport injuries	91·6 (77·4 to 102·0)	86·9 (72·0 to 97·2)	−5·3 (−18·27 to 10·72)	1·9 (1·6 to 2·1)	1·2 (1·0 to 1·4)	−33·6 (−42·61 to −22·72)
Unintentional injuries other than transport injuries	**2017·2 (1848·6 to 2165·7)**	**2006·7 (1857·1 to 2183·1)**	**−1·0 (−8·96 to 10·95)**	**40·8 (38·2 to 43·8)**	**30·4 (28·0 to 32·9)**	**−25·7 (−31·89 to −18·23)**
Falls	340·5 (311·7 to 411·5)	556·4 (448·5 to 610·7)	66·7 (21·25 to 82·98)	9·0 (8·2 to 10·8)	9·1 (7·3 to 9·9)	3·4 (−23·97 to 11·61)
Drowning	544·9 (409·2 to 635·8)	368·1 (311·0 to 515·4)	−35·0 (−43·35 to 17·98)	9·4 (7·2 to 10·8)	5·2 (4·4 to 7·3)	−46·3 (−52·33 to −6·00)
Fire, heat, and hot substances	299·6 (262·7 to 352·9)	237·5 (199·3 to 282·9)	−21·2 (−33·96 to −1·98)	5·9 (5·2 to 7·0)	3·5 (2·9 to 4·1)	−41·9 (−50·85 to −29·74)
Poisonings	120·2 (104·1 to 168·5)	98·0 (70·2 to 110·8)	−12·7 (−44·83 to −0·08)	2·4 (2·1 to 3·3)	1·4 (1·0 to 1·6)	−36·0 (−58·97 to −27·57)
Exposure to mechanical forces	232·7 (186·3 to 273·9)	196·8 (177·9 to 244·6)	−15·6 (−31·65 to 18·68)	4·1 (3·4 to 4·8)	2·8 (2·5 to 3·5)	−32·6 (−43·48 to −9·05)
Unintentional firearm injuries	51·4 (44·5 to 60·0)	47·3 (41·0 to 55·7)	−7·6 (−26·30 to 13·15)	1·0 (0·9 to 1·2)	0·7 (0·6 to 0·8)	−32·8 (−46·94 to −18·02)

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	All ages deaths (thousands)			Age-standardised death rate (per 100 000)		
	1990	2013	Median % change	1990	2013	Median % change
Unintentional suffocation	84·0 (26·9 to 124·6)	37·6 (29·1 to 80·7)	−58·3 (−74·65 to 90·29)	1·2 (0·4 to 1·8)	0·5 (0·4 to 1·1)	−59·7 (−75·13 to 71·19)
Other exposure to mechanical forces	97·2 (88·8 to 119·9)	111·9 (95·5 to 122·4)	16·6 (−13·64 to 30·93)	1·9 (1·7 to 2·3)	1·6 (1·4 to 1·7)	−14·7 (−36·50 to −5·26)
Adverse effects of medical treatment	93·5 (77·2 to 110·2)	141·7 (107·5 to 165·9)	53·2 (27·88 to 73·38)	2·1 (1·8 to 2·6)	2·2 (1·7 to 2·6)	4·6 (−11·30 to 16·34)
Animal contact	95·5 (59·8 to 126·6)	79·6 (62·3 to 138·7)	−22·0 (−35·47 to 34·57)	1·9 (1·2 to 2·5)	1·2 (0·9 to 2·0)	−43·0 (−52·23 to −2·49)
Venomous animal contact	76·3 (47·5 to 104·7)	57·2 (44·1 to 102·5)	−30·1 (−43·14 to 28·05)	1·5 (0·9 to 2·0)	0·8 (0·6 to 1·5)	−49·3 (−58·49 to −6·80)
Non-venomous animal contact	19·2 (11·5 to 26·3)	22·4 (16·4 to 36·8)	11·2 (−9·33 to 73·85)	0·4 (0·2 to 0·5)	0·3 (0·2 to 0·6)	−16·9 (−31·27 to 25·18)
Foreign body	142·2 (99·5 to 211·6)	165·7 (114·8 to 219·1)	16·2 (−10·22 to 45·91)	2·9 (2·1 to 4·3)	2·6 (1·8 to 3·4)	−10·2 (−29·81 to 5·96)
Pulmonary aspiration and foreign body in airway	139·8 (97·2 to 209·7)	162·1 (109·8 to 214·7)	15·5 (−11·10 to 45·78)	2·9 (2·0 to 4·2)	2·5 (1·7 to 3·4)	−10·6 (−30·35 to 5·87)
Foreign body in other body part	2·5 (1·6 to 3·5)	3·6 (2·7 to 5·4)	51·5 (−3·11 to 84·33)	0·1 (0·0 to 0·1)	0·1 (0·0 to 0·1)	6·8 (−25·59 to 31·38)
Other unintentional injuries	148·1 (119·9 to 162·8)	162·8 (143·9 to 180·3)	9·3 (−4·23 to 33·11)	3·1 (2·5 to 3·4)	2·4 (2·1 to 2·7)	−21·1 (−30·53 to −4·99)
Self-harm and interpersonal violence	**1052·8 (929·3 to 1152·0)**	**1247·1 (1067·2 to 1390·9)**	**18·2 (8·38 to 29·00)**	**22·4 (19·8 to 24·6)**	**17·8 (15·3 to 19·8)**	**−20·8 (−27·32 to −13·83)**
Self-harm	712·0 (630·6 to 784·7)	842·4 (718·1 to 939·0)	17·8 (6·04 to 32·20)	15·8 (13·9 to 17·3)	12·2 (10·4 to 13·6)	−23·1 (−30·45 to −13·97)
Interpersonal violence	340·7 (253·9 to 415·1)	404·7 (298·7 to 496·6)	18·4 (10·24 to 29·34)	6·6 (4·9 to 8·1)	5·6 (4·1 to 6·9)	−16·0 (−21·65 to −8·41)
Assault by firearm	127·6 (89·9 to 165·1)	180·4 (120·5 to 231·3)	41·3 (26·05 to 55·53)	2·5 (1·7 to 3·2)	2·5 (1·6 to 3·2)	0·0 (−10·58 to 10·11)
Assault by sharp object	94·0 (65·1 to 127·8)	114·3 (77·1 to 163·2)	21·0 (6·27 to 40·68)	1·8 (1·3 to 2·5)	1·6 (1·1 to 2·2)	−15·2 (−25·63 to −1·29)
Assault by other means	119·1 (84·4 to 142·9)	110·0 (78·7 to 142·1)	−8·5 (−16·48 to 7·97)	2·3 (1·6 to 2·8)	1·5 (1·1 to 2·0)	−33·9 (−39·44 to −22·31)
Forces of nature, war, and legal intervention	**105·8 (77·2 to 170·7)**	**50·4 (34·4 to 88·8)**	**−53·1 (−58·41 to −46·15)**	**2·2 (1·5 to 3·6)**	**0·7 (0·5 to 1·3)**	**−66·2 (−70·18 to −61·18)**
Exposure to forces of nature	33·4 (19·4 to 63·5)	19·2 (13·5 to 32·0)	−43·9 (−58·70 to −6·92)	0·7 (0·4 to 1·4)	0·3 (0·2 to 0·5)	−60·4 (−71·50 to −33·98)
Collective violence and legal intervention	72·4 (54·7 to 106·5)	31·2 (20·3 to 57·0)	−57·9 (−66·76 to −45·85)	1·5 (1·1 to 2·2)	0·5 (0·3 to 0·8)	−69·3 (−75·76 to −61·23)

Data in parentheses are 95% uncertainty intervals.

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Table 3
Selected causes of global child deaths in 1990 and 2013

	Neonates age <1 month			Children age 1–59 months		
	1990 (thousands)	2013 (thousands)	Median % change	1990 (thousands)	2013 (thousands)	Median % change
All causes	**4506·8 (4394·5 to 4612·8)**	**2614·3 (2506·4 to 2723·2)**	**−42·0 (−44·5 to −39·5)**	**7608·5 (7447·7 to 7757·3)**	**3665·7 (3449·4 to 3905·8)**	**−52·0 (−54·7 to −48·6)**
Communicable, maternal, neonatal, and nutritional diseases	**4063·8 (3935·0 to 4181·4)**	**2275·5 (2163·6 to 2374·6)**	**−44·0 (−46·6 to −41·4)**	**6012·6 (5724·0 to 6256·5)**	**2766·2 (2528·6 to 3010·5)**	**−54·0 (−57·5 to −50·4)**
HIV/AIDS	..	..	..	35·2 (32·3 to 38·3)	63·8 (58·5 to 71·6)	81·1 (64·5 to 99·9)
Diarrhoeal diseases	124·8 (110·5 to 140·5)	44·8 (36·8 to 53·3)	−64·2 (−70·6 to −56·7)	1482·4 (1339·7 to 1633·3)	474·9 (398·1 to 545·0)	−68·0 (−72·8 to −62·5)
Intestinal infectious diseases	..	..	..	82·0 (46·7 to 135·2)	62·4 (33·0 to 103·6)	−24·2 (−37·2 to −8·1)
Lower respiratory infections	399·3 (362·2 to 436·9)	196·5 (169·3 to 224·5)	−50·9 (−57·3 to −43·7)	1768·8 (1597·7 to 1926·6)	708·6 (628·6 to 791·4)	−59·9 (−64·8 to −54·5)
Meningitis	35·6 (27·7 to 47·0)	20·6 (14·9 to 26·8)	−42·6 (−52·7 to −28·4)	262·5 (212·1 to 346·3)	121·4 (90·2 to 157·0)	−54·0 (−63·4 to −41·5)
Whooping cough	..	..	..	129·8 (49·9 to 280·7)	56·4 (20·7 to 127·0)	−57·1 (−83·9 to 12·7)
Tetanus	216·9 (174·8 to 370·5)	26·0 (12·3 to 38·9)	−87·0 (−95·8 to −80·1)	65·4 (48·2 to 121·6)	5·5 (3·9 to 7·7)	−91·2 (−95·5 to −86·9)
Measles	..	..	..	472·4 (265·3 to 749·9)	82·1 (41·7 to 145·0)	−83·1 (−90·3 to −68·5)
Malaria	18·1 (13·4 to 23·5)	16·8 (11·0 to 26·4)	−9·6 (−42·6 to 52·8)	566·3 (470·8 to 662·0)	570·0 (437·5 to 733·2)	−1·3 (−27·7 to 40·9)
Preterm birth complications	1452·1 (1190·6 to 1677·3)	693·0 (553·6 to 853·9)	−52·5 (−58·6 to −45·0)	118·4 (80·1 to 157·3)	49·4 (34·5 to 69·8)	−58·3 (−69·4 to −41·3)
Neonatal encephalopathy (birth asphyxia/trauma)	820·8 (651·3 to 993·1)	611·5 (491·9 to 724·0)	−25·3 (−38·1 to −9·8)	53·3 (35·5 to 72·6)	32·3 (21·4 to 48·7)	−40·6 (−58·2 to −9·0)
Neonatal sepsis and other neonatal infections	328·3 (186·3 to 462·1)	342·2 (214·9 to 479·3)	4·6 (−17·3 to 38·5)	18·1 (9·2 to 28·3)	23·8 (13·3 to 38·0)	30·3 (−15·9 to 114·6)
Other neonatal disorders	489·9 (381·6 to 654·9)	238·2 (187·7 to 297·0)	−51·3 (−62·5 to −35·0)	87·7 (58·5 to 123·5)	38·1 (25·0 to 59·8)	−57·4 (−73·9 to −27·8)
Nutritional deficiencies	..	..	..	451·6 (376·5 to 560·5)	260·7 (197·9 to 316·6)	−42·3 (−52·4 to −30·1)
Syphilis	122·6 (68·9 to 194·3)	63·7 (37·0 to 98·4)	−47·9 (−58·6 to −35·5)	100·9 (56·9 to 157·6)	56·9 (32·5 to 90·9)	−43·3 (−56·8 to −28·5)
Other communicable diseases	55·3 (37·9 to 79·1)	22·4 (16·4 to 30·7)	−59·0 (−70·6 to −44·7)	317·7 (283·8 to 355·0)	159·9 (134·5 to 192·6)	−49·7 (−58·7 to −39·8)
Non-communicable diseases	**366·4 (316·1 to 443·9)**	**292·3 (258·4 to 349·7)**	**−19·8 (−32·4 to 4·3)**	**906·4 (766·4 to 1138·2)**	**578·8 (462·6 to 739·5)**	**−36·6 (−43·4 to −23·6)**
Congenital anomalies	303·6 (256·8 to 375·4)	246·6 (219·0 to 280·0)	−17·6 (−33·1 to −0·1)	343·6 (255·5 to 493·5)	248·7 (198·8 to 322·9)	−25·7 (−40·6 to −13·7)
Sudden infant death syndrome	3·0 (1·2 to 6·1)	2·4 (1·1 to 4·5)	−13·8 (−60·1 to 54·0)	19·1 (11·2 to 34·3)	12·7 (8·4 to 18·4)	−32·2 (−55·5 to −4·9)
Other non-communicable diseases	59·8 (52·3 to 70·5)	43·3 (32·4 to 76·9)	−31·3 (−43·3 to 18·7)	543·7 (469·1 to 642·8)	317·4 (244·2 to 422·8)	−42·8 (−52·6 to −23·3)
Injuries	**76·6 (58·5 to 95·1)**	**46·4 (37·5 to 63·5)**	**−41·7 (−53·4 to −2·9)**	**689·5 (567·1 to 776·3)**	**320·7 (277·8 to 371·5)**	**−54·6 (−61·1 to −41·9)**

	Neonates age <1 month			Children age 1–59 months		
	1990 (thousands)	2013 (thousands)	Median % change	1990 (thousands)	2013 (thousands)	Median % change
Road injuries	4·1 (3·3 to 5·1)	3·8 (2·6 to 5·3)	−6·6 (−30·8 to 30·5)	105·2 (88·7 to 128·2)	64·5 (51·3 to 79·5)	−38·3 (−52·6 to −23·7)
Drowning	2·7 (1·9 to 3·5)	1·8 (1·1 to 2·8)	−38·2 (−56·7 to 16·9)	212·3 (132·4 to 275·1)	80·1 (61·7 to 111·4)	−63·3 (−74·1 to −20·4)
Other injuries	69·9 (52·2 to 88·2)	40·8 (32·1 to 58·0)	−44·1 (−55·9 to −1·0)	372·0 (280·9 to 424·3)	176·2 (153·1 to 203·7)	−53·7 (−60·8 to −37·6)

Data in parentheses are 95% uncertainty intervals. Shows major causes of death within each level 1 group that accounted for deaths in children.

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Table 4

Counterfactual deaths and population attributable fractions for diarrhoea and lower respiratory infection pathogens for 1990 and 2013

	Children younger than age 5 years				All ages				
	1990		2013		1990		2013		Rate of change for deaths 1990-2013 (%)
	Deaths (thousands)	Population attributable fractions (%)	Deaths (thousands)	Population attributable fractions (%)	Deaths (thousands)	Population attributable fractions (%)	Deaths (thousands)	Population attributable fractions (%)	
Diarrhoea									
Adenovirus	63·0 (44·4 to 89·9)	3·9 (2·7 to 5·5)	18·3 (11·8 to 25·5)	3·5 (2·4 to 4·9)	81·3 (55·9 to 115·9)	3·2 (2·1 to 4·4)	31·8 (21·5 to 44·7)	2·5 (1·7 to 3·6)	−61·2% (−67·8 to −52·5)
Aeromonas	12·3 (6·4 to 21·4)	0·8 (0·4 to 1·3)	5·5 (2·6 to 10·1)	1·1 (0·5 to 1·9)	28·0 (16·7 to 44·9)	1·1 (0·7 to 1·7)	13·0 (7·3 to 22·0)	1·0 (0·6 to 1·7)	−53·6% (−66·1 to −37·8)
Amoebiasis	5·8 (2·6 to 10·0)	0·4 (0·2 to 0·6)	1·3 (0·6 to 2·3)	0·2 (0·1 to 0·5)	18·3 (8·9 to 30·6)	0·7 (0·3 to 1·2)	11·3 (5·0 to 19·7)	0·9 (0·4 to 1·6)	−39·1% (−57 to −17·5)
Campylobacter enteritis	20.8 (11·0 to 31·9)	1·3 (0·7 to 2·0)	9·5 (3·7 to 15·7)	1·8 (0·7 to 3·0)	28·4 (16·4 to 42·8)	1·1 (0·6 to 1·6)	14·1 (6·9 to 22·4)	1·1 (0·5 to 1·8)	−50·7% (−63·7 to −37·5)
Cholera	81·7 (39·1 to 117·0)	5·1 (2·5 to 7·2)	45·2 (23·4 to 67·6)	8·7 (4·5 to 12·7)	125·3 (61·1 to 173·4)	4·9 (2·4 to 6·7)	69·9 (37·7 to 97·0)	5·5 (3·0 to 7·7)	−44·3% (−56·8 to −26·6)
Clostridium difficile	2·1 (2·0 to 2·3)	0·1 (0·1 to 0·1)	2·5 (2·4 to 2·7)	0·5 (0·4 to 0·6)	20·8 (19·9 to 21·9)	0·8 (0·7 to 0·9)	41·5 (39·1 to 43·9)	3·3 (3·0 to 3·6)	99·4% (84·3 to 114·3)
Cryptosporidiosis	92·4 (68·7 to 125·1)	5·8 (4·3 to 7·8)	35·2 (25·9 to 48·2)	6·8 (5·1 to 9·3)	98·8 (72·8 to 132·7)	3·8 (2·8 to 5·2)	41·9 (30·0 to 58·4)	3·3 (2·4 to 4·7)	−57·8% (−64·8 to −49·6)
Enteropathogenic *Escherichia coli* infection	4·3 (1·3 to 7·8)	0·3 (0·1 to 0·5)	1·8 (0·7 to 3·4)	0·3 (0·1 to 0·7)	4·3 (1·3 to 7·8)	0·2 (0·1 to 0·3)	1·8 (0·7 to 3·4)	0·1 (0·1 to 0·3)	−57·5% (−76·5 to −32)
Enterotoxigenic *Escherichia coli* infection	86·0 (61·3 to 114·1)	5·4 (3·8 to 7·2)	23·1 (17·0 to 30·4)	4·4 (3·4 to 5·9)	134·7 (97·5 to 178·2)	5·2 (3·8 to 6·8)	59·2 (44·2 to 77·7)	4·7 (3·5 to 6·1)	−56·0% (−63·0 to −46·9)

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	Children younger than age 5 years				All ages				
	1990		2013		1990		2013		Rate of change for deaths 1990-2013 (%)
	Deaths (thousands)	Population attributable fractions (%)	Deaths (thousands)	Population attributable fractions (%)	Deaths (thousands)	Population attributable fractions (%)	Deaths (thousands)	Population attributable fractions (%)	
Norovirus	7·3 (2·7 to 11·8)	0·5 (0·2 to 0·7)	1·8 (0·7 to 3·1)	0·3 (0·1 to 0·6)	7·3 (2·7 to 11·8)	0·3 (0·1 to 0·5)	1·8 (0·7 to 3·2)	0·1 (0·1 to 0·2)	−75·8% (−85·1 to −61·6)
Other *Salmonella* infections	19·2 (11·1 to 29·1)	1·2 (0·7 to 1·8)	3·8 (1·6 to 6·7)	0·7 (0·3 to 1·2)	58·9 (42·4 to 77·8)	2·3 (1·6 to 3·0)	24·3 (16·0 to 33·3)	1·9 (1·3 to 2·6)	−58·9% (−65·4 to −51·1)
Rotaviral enteritis	398·9 (334·5 to 464·2)	24·8 (21·4 to 28·2)	122·4 (96·6 to 152·1)	23·5 (20·1 to 27·2)	477·5 (397·9 to 555·1)	18·5 (15·8 to 21·2)	176·6 (140·4 to 218·4)	14·0 (11·4 to 16·6)	−63·2% (−68·5 to −57·1)
Shigellosis	161·0 (130·0 to 200·3)	10·0 (8·2 to 12·2)	33·4 (24·9 to 43·5)	6·4 (5·1 to 7·9)	254·2 (207·9 to 311·7)	9·9 (8·2 to 11·9)	73·9 (58·9 to 93·8)	5·8 (4·7 to 7·3)	−70·9% (−74·4 to −67·3)
No identified aetiology*	652·4 (542·4 to 783·1)	40·6 (35·3 to 46·8)	215·9 (169·6 to 265·2)	41·5 (35·7 to 48·1)	1240·9 (1096·8 to 1421·5)	48·1 (43·5 to 53·5)	702·9 (619·2 to 796)	55·6 (51·4 to 60·3)	−43·2% (−49·3 to −36·1)
Lower respiratory infections									
Haemophilus influenzae type B pneumonia	427·1 (−39·8 to 853·4)	19·7 (−1·8 to 39·1)	108·7 (−9·9 to 226·9)	12·0 (−1·1 to 25·5)	427·1 (−39·8 to 853·4)	12·5 (−1·2 to 24·8)	108·7 (−9·9 to 226·9)	4·1 (−0·4 to 8·8)	−75·1% (−79·1 to ·71−2)
Influenza	36·3 (14·2 to 73·5)	1·7 (0·7 to 3·3)	15·1 (5·7 to 30·4)	1·7 (0·6 to 3·3)	85·1 (36·1 to 156·2)	2·5 (1·1 to 4·5)	105·4 (45·3 to 188·1)	4·0 (1·7 to 7·3)	24·0% (3·4 to 47·7)
Pneumococcal pneumonia	652·4 (402·6 to 879·4)	30·1 (19·0 to 40·2)	264·0 (155·7 to 365·8)	29·2 (18·0 to 39·2)	919·5 (553·1 to 1320·5)	26·9 (16·3 to 38·4)	594·4 (295·6 to 970·2)	22·4 (11·4 to 35·9)	−36·1% (−52·7 to −19·8)
Respiratory syncytial virus pneumonia	145·1 (82·7 to 228·0)	6·7 (3·8 to 10·5)	41·1 (23·0 to 65·5)	4·5 (2·6 to 7·1)	185·5 (114·4 to 268·6)	5·4 (3·5 to 7·9)	81·5 (53·6 to 109·9)	3·1 (2·0 to 4·2)	−55·7% (−63 to −47·2)
No identified aetiology*	907·2 (407·3 to 1451·3)	41·9 (19·0 to 66·7)	476·2 (313·3 to 651·6)	52·6 (35·2 to 70·2)	1803·4 (1211·8 to 2452·5)	52·7 (35·4 to 71·1)	1762·6 (1385·3 to 2134·1)	66·5 (52·8 to 79·9)	−0·8% (−19·8 to 22·9)

Data in parentheses are 95% uncertainty intervals.

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* Number or proportion of diarrhea or lower respiratory infection deaths attributable to any diarrhea or lower respiratory infection pathogens. Because of interaction between pathogens (especially for lower respiratory infection), the value is the minimum amount of unexplained deaths.

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Table 5
Comparison of GBD and CHERG estimated child deaths for select causes in 2010

	CHERG	GBD 2013
Neonates aged 0–27 days		
Congenital abnormalities	270 (207-366)	251 (221-291)
Diarrhoea	50 (17-151)	52 (44-61)
Pneumonia	325 (209-470)	213 (186-242)
Intrapartum-related complications*	717 (610-876)	657 (532-770)
Sepsis or meningitis	393 (252-552)	369 (237-504)
Tetanus	58 (20-276)	34 (16-48)
Other neonatal disorders	181 (115-284)	470 (411-557)
All causes	3072†	2807 (2719-2898)
Children aged 1–59 months		
Injury	354 (274-429)	350 (310-394)
Diarrhoea	751 (538-1031)	536 (461-607)
AIDS	159 (131-185)	102 (95-111)
Pneumonia	1071 (977-1176)	772 (693-850)
Malaria	564 (432-709)	699 (576-855)
Measles	114 (92-176)	95 (52-166)
Meningitis	180 (136-237)	129 (98-163)
Other disorders	1356 (1112-1581)	1355 (1211-1524)
All causes	4550†	4039 (3883-4207)

Data are thousands of deaths (95% uncertainty interval). GBD=Global Burden of Disease Study. CHERG=Child Health Epidemiology Reference Group.

*Compares GBD cause “Neonatal encephalopathy (birth asphyxia/trauma)” with CHERG cause “intrapartum-related complications”.

†CHERG did not report uncertainty estimates for all-cause mortality in children.