Burden of 375 diseases and injuries, risk-attributable burden of 88 risk factors, and healthy life expectancy in 204 countries and territories, including 660 subnational locations, 1990–2023: a systematic analysis for the Global Burden of Disease Study 2023

*GBD 2023 Disease and Injury and Risk Factor Collaborators**

Summary

Background For more than three decades, the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) has provided a framework to quantify health loss due to diseases, injuries, and associated risk factors. This paper presents GBD 2023 findings on disease and injury burden and risk-attributable health loss, offering a global audit of the state of world health to inform public health priorities. This work captures the evolving landscape of health metrics across age groups, sexes, and locations, while reflecting on the remaining post-COVID-19 challenges to achieving our collective global health ambitions.

Methods The GBD 2023 combined analysis estimated years lived with disability (YLDs), years of life lost (YLLs), and disability-adjusted life-years (DALYs) for 375 diseases and injuries, and risk-attributable burden associated with 88 modifiable risk factors. Of the more than 310 000 total data sources used for all GBD 2023 (about 30% of which were new to this estimation round), more than 120 000 sources were used for estimation of disease and injury burden and 59 000 for risk factor estimation, and included vital registration systems, surveys, disease registries, and published scientific literature. Data were analysed using previously established modelling approaches, such as disease modelling meta-regression version 2.1 (DisMod-MR 2.1) and comparative risk assessment methods. Diseases and injuries were categorised into four levels on the basis of the established GBD cause hierarchy, as were risk factors using the GBD risk hierarchy. Estimates stratified by age, sex, location, and year from 1990 to 2023 were focused on disease-specific time trends over the 2010–23 period and presented as counts (to three significant figures) and age-standardised rates per 100 000 person-years (to one decimal place). For each measure, 95% uncertainty intervals [UIs] were calculated with the 2·5th and 97·5th percentile ordered values from a 250-draw distribution.

Findings Total numbers of global DALYs grew 6·1% (95% UI 4·0–8·1), from 2·64 billion (2·46–2·86) in 2010 to 2·80 billion (2·57–3·08) in 2023, but age-standardised DALY rates, which account for population growth and ageing, decreased by 12·6% (11·0–14·1), revealing large long-term health improvements. Non-communicable diseases (NCDs) contributed 1·45 billion (1·31–1·61) global DALYs in 2010, increasing to 1·80 billion (1·63–2·03) in 2023, alongside a concurrent 4·1% (1·9–6·3) reduction in age-standardised rates. Based on DALY counts, the leading level 3 NCDs in 2023 were ischaemic heart disease (193 million [176–209] DALYs), stroke (157 million [141–172]), and diabetes (90·2 million [75·2–107]), with the largest increases in age-standardised rates since 2010 occurring for anxiety disorders (62·8% [34·0–107·5]), depressive disorders (26·3% [11·6–42·9]), and diabetes (14·9% [7·5–25·6]). Remarkable health gains were made for communicable, maternal, neonatal, and nutritional (CMNN) diseases, with DALYs falling from 874 million (837–917) in 2010 to 681 million (642–736) in 2023, and a 25·8% (22·6–28·7) reduction in age-standardised DALY rates. During the COVID-19 pandemic, DALYs due to CMNN diseases rose but returned to pre-pandemic levels by 2023. From 2010 to 2023, decreases in age-standardised rates for CMNN diseases were led by rate decreases of 49·1% (32·7–61·0) for diarrhoeal diseases, 42·9% (38·0–48·0) for HIV/AIDS, and 42·2% (23·6–56·6) for tuberculosis. Neonatal disorders and lower respiratory infections remained the leading level 3 CMNN causes globally in 2023, although both showed notable rate decreases from 2010, declining by 16·5% (10·6–22·0) and 24·8% (7·4–36·7), respectively. Injury-related age-standardised DALY rates decreased by 15·6% (10·7–19·8) over the same period. Differences in burden due to NCDs, CMNN diseases, and injuries persisted across age, sex, time, and location. Based on our risk analysis, nearly 50% (1·27 billion [1·18–1·38]) of the roughly 2·80 billion total global DALYs in 2023 were attributable to the 88 risk factors analysed in GBD. Globally, the five level 3 risk factors contributing the highest proportion of risk-attributable DALYs were high systolic blood pressure (SBP), particulate matter pollution, high fasting plasma glucose (FPG), smoking, and low birthweight and short gestation—with high SBP accounting for 8·4% (6·9–10·0) of total DALYs. Of the three overarching level 1 GBD risk factor categories—behavioural, metabolic, and environmental and occupational—risk-attributable DALYs rose between 2010 and 2023 only for metabolic risks, increasing by 30·7% (24·8–37·3); however, age-standardised DALY

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rates attributable to metabolic risks decreased by 6·7% (2·0–11·0) over the same period. For all but three of the 25 leading level 3 risk factors, age-standardised rates dropped between 2010 and 2023—eg, declining by 54·4% (38·7–65·3) for unsafe sanitation, 50·5% (33·3–63·1) for unsafe water source, and 45·2% (25·6–72·0) for no access to handwashing facility, and by 44·9% (37·3–53·5) for child growth failure. The three leading level 3 risk factors for which age-standardised attributable DALY rates rose were high BMI (10·5% [0·1 to 20·9]), drug use (8·4% [2·6 to 15·3]), and high FPG (6·2% [–2·7 to 15·6]; non-significant).

Interpretation Our findings underscore the complex and dynamic nature of global health challenges. Since 2010, there have been large decreases in burden due to CMNN diseases and many environmental and behavioural risk factors, juxtaposed with sizeable increases in DALYs attributable to metabolic risk factors and NCDs in growing and ageing populations. This long-observed consequence of the global epidemiological transition was only temporarily interrupted by the COVID-19 pandemic. The substantially decreasing CMNN disease burden, despite the 2008 global financial crisis and pandemic-related disruptions, is one of the greatest collective public health successes known. However, these achievements are at risk of being reversed due to major cuts to development assistance for health globally, the effects of which will hit low-income countries with high burden the hardest. Without sustained investment in evidence-based interventions and policies, progress could stall or reverse, leading to widespread human costs and geopolitical instability. Moreover, the rising NCD burden necessitates intensified efforts to mitigate exposure to leading risk factors—eg, air pollution, smoking, and metabolic risks, such as high SBP, BMI, and FPG—including policies that promote food security, healthier diets, physical activity, and equitable and expanded access to potential treatments, such as GLP-1 receptor agonists. Decisive, coordinated action is needed to address long-standing yet growing health challenges, including depressive and anxiety disorders. Yet this can be only part of the solution. Our response to the NCD syndemic—the complex interaction of multiple health risks, social determinants, and systemic challenges—will define the future landscape of global health. To ensure human wellbeing, economic stability, and social equity, global action to sustain and advance health gains must prioritise reducing disparities by addressing socioeconomic and demographic determinants, ensuring equitable health-care access, tackling malnutrition, strengthening health systems, and improving vaccination coverage. We live in times of great opportunity.

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Introduction

High-quality, comprehensive, mutually exclusive, and timely estimates of health and health loss produced through the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) are a valuable source of publicly accessible health data. For more than 30 years, GBD has equipped researchers, policy makers, and the public with evidence-based tools to better understand the global impact of diseases, injuries, and modifiable risk factors at the population level.[1] GBD has enabled close, quantitative monitoring of progress towards international health targets, especially the UN Sustainable Development Goals (SDGs). An early innovation of GBD was the metric of disability-adjusted life-years (DALYs), which measures overall disease burden as the years of lost health and life combined, and has been adopted by global health institutions such as WHO. More recent work, including reports by WHO World Health Statistics[2] the NCD Risk Factor Collaboration, and the Prospective Urban and Rural Epidemiological (PURE) study, provide estimates for specific diseases or risk factors; however, GBD is broader in scope.

For the **NCD Risk Factor Collaboration** see https://www.ncdrisc.org/

For the **Prospective Urban and Rural Epidemiological (PURE) study** see https://www2.phri.ca/pure/

Estimation of disease and injury burden in GBD has evolved since its inception and original publication, which established DALYs as the primary metric for burden analysis. GBD 2010 highlighted the rise of non-communicable diseases (NCDs), particularly mental disorders, musculoskeletal conditions, and cardiovascular diseases, while also accounting for persistent burden from communicable, maternal, neonatal, and nutritional (CMNN) diseases in low-income regions.[3] GBD 2015 introduced improved geographical detail, allowing for more granular subnational assessments of disease burden.[4] The 2015 iteration reinforced the ongoing epidemiological shift, showing reductions in infectious disease burden but increases in NCD-related DALYs, particularly due to metabolic risks. GBD 2017 expanded risk factor analysis and also revealed growing disparities in NCD burden across regions, with lower-income countries experiencing a dual burden of infectious and chronic diseases.[5] GBD 2019 further refined cause-of-death modelling and highlighted increasing longevity alongside persistent morbidity, demonstrating that years lived with disability (YLDs) were rising faster than mortality reductions.[6] GBD 2021 incorporated disruptions related to the COVID-19 pandemic and improved modelling of multimorbidity, emphasising the continued shift in burden towards NCDs, with metabolic and behavioural risk factors increasingly driving DALYs, even in regions with a

Research in context

Evidence before this study

Since its inception in the early 1990s, the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) has systematically quantified health and health loss across time, age, sex, location, and sociodemographic groups. GBD introduced and uses disability-adjusted life-years (DALYs) as a measure of disease burden that captures disability and premature mortality. DALYs have been widely adopted by WHO, the UN, and public health agencies to measure overall disease burden in a population. Previous research efforts, including WHO World Health Statistics and initiatives such as the NCD Risk Factor Collaboration and the Prospective Urban and Rural Epidemiological (PURE) study, have advanced understanding of specific diseases or risk factors and, like GBD, are continuously updated, making it possible to track progress towards the UN Sustainable Development Goals. GBD stands out for its comprehensive scope, wealth of data, and rigorous methodological provenance and updates, as well as its global coverage and commitment to reporting scientific findings free of political bias and the influence of special interests.

Added value of this study

GBD 2023 analysed 375 diseases and injuries and 88 modifiable risk factors, providing updated estimates of prevalence, incidence, years lived with disability (YLDs), years of life lost (YLLs), DALYs, and risk-attributable DALYs for 204 countries and territories from 1990 to 2023. Our estimates of burden improved on those from GBD 2021 by the inclusion of data from more than 35 000 new sources, with particularly notable increases in data used to estimate the burden of diseases such as ischaemic heart disease, chronic obstructive pulmonary disease, and tuberculosis. Analyses were extended to five new causes: ulcerative colitis; Crohn's disease; thyroid diseases; other endocrine, metabolic, blood, and immune disorders; and electrocution. "Other pandemic-related outcomes" was removed as a cause. Additionally, we began to transition our primary tool to model prevalence from disease modelling meta-regression version 2.1 (DisMod-MR 2.1) to disease modelling age-time (DisMod-AT), which more effectively captures temporal trends in data. GBD 2023 advanced risk factor analyses from previous GBD cycles, strengthening attributable burden estimates by conducting 85 new or updated systematic reviews and incorporating additional data from more than 16 000 new sources, particularly for intimate partner violence, lead exposure, high BMI, and high fasting plasma glucose. Based on new evidence or further specification of outcomes or mediation factors, 50 new risk–outcome pairs, such as the relationship between particulate matter pollution and dementia, were analysed; two pairs were excluded (child wasting and malaria, and high alcohol use and nasopharynx cancer) for not meeting inclusion criteria or for overlapping with other outcomes. In total, 676 risk–outcome pairs were analysed for GBD 2023. Methods were updated for specific risk factors, notably regarding estimation of burden attributable to lead exposure and revision of the theoretical minimum risk exposure level for diet high in trans fatty acids.

Implications of all the available evidence

This study reaffirms that the global epidemiological transition has continued up to 2023. Although the COVID-19 pandemic temporarily disrupted health trends, the long-term decline in burden due to communicable, maternal, neonatal, and nutritional (CMNN) diseases has continued, whereas absolute burden of NCDs has risen sharply, largely due to demographic changes. It is an opportune time to revisit these two patterns at the highest policy levels. First, acknowledging and celebrating the staggering success of reducing the impact of CMNN diseases worldwide is important, alongside warnings that progress is fragile. The threats of stagnation or resurgence do not recede simply because our global policy focus might shift. Second, there is an opportunity to make substantial progress in reducing the burden of NCDs across sociodemographic strata. Since our present analyses show that almost half of total disease burden is attributable to specific modifiable risk factors—with increasing contributions, especially in ageing populations, of metabolic risks (eg, high systolic blood pressure, smoking, lead exposure, and ambient particulate matter air pollution)—considerable progress can be made by addressing risk-attributable burden, although successful mitigation varies substantially across risk factors. Equitable scaling of implementation remains a challenge, requiring coordinated policy efforts, targeted prevention strategies, and strengthened health-care systems to mitigate disparities and improve population health outcomes.

historically high burden of infectious diseases.[7] These advances underscore how the GBD framework has progressively illuminated the changing nature of global disease burden, reinforcing the need for targeted interventions to mitigate the growing impact of NCDs, while sustaining infectious disease control efforts. GBD 2023 shows disease burden trends amid a fundamentally altered and severely constrained global health financing system. As global budget cuts threaten progress towards the SDGs, future iterations of GBD must prioritise monitoring of the impact on populations globally. GBD 2023 can inform priorities for international health agendas, while anticipating demographic trends, the growing burden of NCDs, and other challenges.

The comparative risk assessment framework of GBD has continually advanced in methodology and scope. Risk factor estimates have been a part of GBD since its inception. GBD 2010 refined a unified methodological foundation by systematically quantifying 67 risk factors across regions, highlighting a global epidemiological

shift from CMNN disease-related to NCD-related risk factors, such as high systolic blood pressure (SBP), smoking, and poor diet.[8] Subsequent updates in GBD 2015 enhanced risk exposure estimation, particularly for dietary and metabolic risks, and intensified policy attention on cardiovascular implications of air pollution.[9] GBD 2016 further emphasised behavioural risks, including alcohol and drug use, and provided detailed subnational estimates that promoted localised policy responses.[10] GBD 2017 refined mediation pathways and updated risk curves.[11] GBD 2019 introduced methods to model non-linear exposure–response relationships and refined counterfactual analyses, shifting the policy discourse towards integrated, system-level interventions addressing complex interactions among risk factors.[12] Most recently, GBD 2021 leveraged advanced Bayesian techniques and explicitly recognised the rising importance of climate-sensitive risks.[13] An added dimension is the burden-of-proof methodology, which quantitatively evaluates the strength of evidence between risks and outcomes.[13–15] The methodological innovations and policy messages contained in GBD 2021 underscored the transition from addressing individual health behaviours towards comprehensive systemic interventions to mitigate interconnected and emerging global health threats.

See Online for appendices 1 and 2

For *The Lancet*'s serialisation of GBD see https://www.thelancet.com/gbd

As part of *The Lancet*'s serialisation of GBD, GBD 2023 continues this theme by analysing the relationships between 375 diseases and injuries and 88 risk factors together in a single framework. GBD 2023 provides detailed and comprehensive estimates of health loss over the period of 1990–2023 to highlight major global trends that have preceded and persisted beyond the COVID-19 pandemic. GBD 2023 facilitates a deeper understanding of health disparities within and across populations, evaluates how differential health outcomes have changed over time, quantifies health improvements and gains, and serves as a valuable resource to help identify the specific policies and targeted interventions that will be most impactful. Here, the key GBD 2023 findings are presented for metrics quantifying health and health loss, including prevalence, incidence, YLDs, years of life lost (YLLs), and DALYs. Metrics used to measure the attributable burden of risk factors include relative risk and risk-attributable DALYs. The estimation of causes of deaths and YLLs for GBD 2023 is reported in a separate publication.[16]

This manuscript was produced with contributions from the GBD Collaborator Network and in accordance with the GBD Protocol.[17]

Methods

Overview

For each GBD round, newly available data and refined methods are used to update the complete time series of metrics from 1990 to the latest year of analysis. GBD 2023 results therefore supersede all previous estimates. GBD 2023 methods closely followed those used in GBD 2021.[7,13] A summary of the methods is given, with emphasis on any notable improvements; a more detailed description of all methods is available in appendix 1 and appendix 2. Based on review and approval by the GBD Scientific Council, which considers factors such as policy relevance, data availability, and epidemiological profile, we report here for the first time on health outcomes for five additional causes: ulcerative colitis; Crohn's disease; thyroid diseases; other endocrine, metabolic, blood, and immune disorders; and electrocution. The cause introduced in GBD 2021 titled "other pandemic-related outcomes" was removed because improved data availability since 2021 allowed for more precise assignment of pandemic-related outcomes to specific causes.[16] These changes bring the total number of diseases and injuries reported in GBD 2023 to 375. We improved our burden estimates through the incorporation of data from more than 35 000 new sources. Moreover, we began transitioning from our principal tool to model prevalence—disease modelling meta-regression version 2.1 (DisMod-MR 2.1; appendix 1 section 2.6)—to an updated version, disease modelling age-time (DisMod-AT), with one of the main improvements being the ability to factor cohort effects over time and location-level covariates by age and sex (appendix 1 section 2.7). This allows us to model changes in prevalence or incidence among specific age cohorts as population segments grow older to more accurately reflect how disease patterns evolve over time, which is important for diseases with rapidly changing epidemiology, such as diabetes. Data availability by location and year for modelling of disease and injury burden is included in appendix 1 (figures S1, S2). Additionally, changes to the estimation of impairments and aetiologies have been made for GBD 2023 (appendix 1 sections 2.8, 6). Similarly, by adding more than 16 000 new data sources on risk factors, we improved estimates of risk-attributable burden (appendix 2 table S7). For GBD 2023, we conducted 85 new or updated systematic reviews of the literature on relative risk (appendix 2 section 2.1.3) and risk factor exposure (appendix 2 section 2.2.1). No new risk factors were added for GBD 2023; however, based on new evidence or further specification of outcomes, 50 new risk–outcome pairs were added, eight of which were based on further specification of mediation factors. Two pairs were removed from the analysis (appendix 2 table S3). Across all analytical components of the risk factor estimation process, 676 risk–outcome pairs were analysed for GBD 2023. Details of our standardised inclusion and exclusion criteria for GBD 2023 risk–outcome pairs are provided in appendix 2 (section 2.1.1). We also updated our methods for certain risk–outcome pairs, such as lead exposure and ischaemic heart disease (appendix 2 section 4). The inclusion of new data sources

and methodological improvements for GBD 2023 contributed to improvements in internal consistency, trend stability, and cross-source harmonisation.

Data sources and processing

Details for all data sources used for disease and injury burden and for risk factor estimation for GBD 2023 are available online via the GBD 2023 Sources Tool on the Global Health Data Exchange. All data sources underwent strict systematic quality assurance processes.[1] Data sources ensure quality by applying data-vetting protocols to assess internal consistency, completeness, and plausibility; using tools, such as MR-BRT (meta-regression—Bayesian, regularised, trimmed), to adjust for known biases; and cross-validating new sources against existing datasets.

Burden of diseases and injuries

DALY calculations for GBD 2023 were based on more than 120 000 cause-related data sources, of which more than 35 000 were newly added between GBD 2021 and the current release. Cause-related sources included more than 98 000 total entries, distributed over 50 000 incidence-related and 25 000 prevalence-related sources, and a range of other sources necessary for tracking severity splits, duration, and similar characteristics. GBD 2023 included newly incorporated data sources on numerous causes, including cardiovascular diseases (eg, ischaemic heart disease and ischaemic stroke), chronic obstructive pulmonary disease, tuberculosis, asthma, and chronic kidney disease. Notable changes were most evident in chronic respiratory conditions and in specific regions where the inclusion of new data addressed gaps. Details on data sources for YLLs are documented in another publication[16] and are available via the GBD 2023 Sources Tool. Estimates of burden reported here draw from a wide range of sources, including scientific literature, household surveys, disease registries, and clinical informatics, as detailed in appendix 1 (section 2.1). The process for conducting cause-specific literature reviews is detailed in appendix 1 (section 2.1.1). The search strategy covered online research databases, public governmental and international organisation websites, and published reports, as well as contributions of primary data from GBD collaborators. The methods and data sources for fatal estimates, such as vital registration systems, are discussed in a separate publication.[16]

Cause-related data with known biases, such as alternative case definitions or measurement methods, were adjusted using the meta-regression tool MR-BRT (appendix 1 section 2.5).[15] The adjustment process involved analysing paired estimates based on reference and alternative case definitions for the same age, sex, location, and year. For data sources without sex-specific information, we applied a correction factor derived from the pooled, within-study sex ratios. Data missing both age and sex details were adjusted using a process (age-sex splitting) that leverages within-source sex ratios to adjust age-specific data from sources that reported by age and by sex separately. When data sources spanned wide age ranges (typically >25 years), we derived more granular age-specific estimates using age patterns based on other available data sources (appendix 1 section 2.3.5).

Data processing also extended to clinical data. The comprehensive series of data-processing steps are detailed in appendix 1 (section 2). We analysed data from several clinical settings, including inpatient hospital admissions, outpatient visits, and health insurance claims. For inpatient data reporting a single diagnosis, we adjusted data to account for factors such as re-admissions, non-primary diagnoses, and outpatient care. We made these adjustments by calculating age-sex-specific ratios by cause using RegMod, a new GBD regression modelling package, which was used in this instance to create correction factor models for clinical data (appendix 1 section 2.2.5). To ensure that estimates of inpatient data accurately reflected population data, inpatient sources were scaled using estimates of total inpatient admission rates per capita for each location-year-age-sex for which demographic data were incomplete.

Moreover, we adjusted inpatient sources to account for disparities in health-care access across all locations by scaling estimates using a scalar developed for the Healthcare Access and Quality Index (appendix 1 section 2.2.5).[17] These adjustments produce standardised, population-level clinical estimates that represent both the incidence and prevalence of causes and mitigate the impact of known biases in the data.

For the **GBD 2023 Sources Tool** see https://ghdx.healthdata.org/gbd-2023/sources

For the **Global Health Data Exchange** see https://ghdx.healthdata.org/

Disease and injury burden attributable to risk factors

To estimate the burden of disease attributable to risk factors, we combined four inputs: exposure; relative risk of each health outcome associated with the risk factor; the theoretical minimum risk exposure level (TMREL); and deaths and burden for each of the health outcomes with which a risk factor is associated. In GBD 2023, we estimated the burden associated with 88 risk factors. The TMREL and deaths and burden for each health outcome associated with a risk factor are derived and did not require additional data, so data seeking for risk factor analyses focused on exposure and relative risks. The exposure estimation processes used more than 55 000 distinct data sources, about 16 000 of which were new for GBD 2023, related primarily to the incorporation of new data sources for various risk factors, such as sexual violence against children, intimate partner violence, bullying victimisation, high BMI, high fasting plasma glucose (FPG), and various dietary risk factors. These sources were identified through systematic reviews of risk factor exposure studies, in addition to other data that include household and health examination surveys and censuses, ground-sensing or remote-sensing data, and administrative records (appendix 2 section 2.2.1).

Relative risk estimates were derived from meta-analyses incorporating more than 3800 distinct data sources, more than 900 of which were new for GBD 2023. Data used to estimate relative risks were identified and extracted through systematic literature reviews of randomised controlled trials and prospective cohort studies reporting fatal and non-fatal health outcomes associated with risk factor exposures, and from studies underlying risk–outcome meta-analyses (appendix 2 section 2.1.3). Where data from randomised controlled trials or cohort studies were unavailable, odds ratios from case–control studies were potentially included in relative risk estimation (generally reflected by including a bias covariate in the burden-of-proof estimation framework). Across relative risk and exposure estimation processes, 85 new or updated systematic reviews were conducted. Decisions were made to undertake or prioritise reviews based on various circumstances, including the availability of literature providing new or more nuanced or detailed data, or newly available resources to support review of particular risk–outcome pairs. Appendix 2 includes PRISMA diagrams for each of the 85 systematic reviews and risk factor-specific strategies to maximise data collection, search procedures, and bias assessment (section 4), and systematic review and bias assessment guidelines (section 2.1.3). For risk factor exposure data, MR-BRT was used to adjust for bias and perform age-sex splitting; further details are provided in appendix 2 (section 2.2.2).

Estimation methods

Burden of diseases and injuries

GBD 2023 estimated incidence, prevalence, YLDs, YLLs, and DALYs for 375 diseases and injuries: 371 with non-fatal outcomes and 292 with fatal outcomes. Specific diseases and injuries are organised within a four-level cause hierarchy. The broadest category—level 1—includes three large cause groupings of NCDs, CMNN diseases, and injuries. Level 2 categories are further disaggregated into specific subgroupings, such as cardiovascular diseases and transport injuries. Level 3 causes include specific causes (eg, stroke and road injuries). In some cases, level 3 causes are the most granular level of analysis; however, in other cases, causes are further disaggregated at level 4. Level 4 causes are the most specific (eg, ischaemic stroke and pedestrian road injuries). Detailed information on the GBD cause hierarchy is in appendix 1 (table S3).

The modelling of prevalence and incidence was mainly conducted using DisMod-MR 2.1, a Bayesian disease modelling meta-regression tool.[7] A new tool, DisMod-AT, modelled prevalence and incidence for four causes: type 1 diabetes, major depressive disorder, anxiety disorders, and autism spectrum disorders (appendix 1 section 2.7). For certain diseases and injuries, the use of spatiotemporal Gaussian process regression (ST-GPR) models allowed for the analysis of data that are both heterogeneous and incomplete and which require statistical smoothing (appendix 1 section 2.4). The methodology for cause-specific estimations, including the calculation of sequela-specific prevalence, is described in appendix 1 (section 6).

To estimate YLDs, we calculated cause-age-sex-location-year-specific prevalence of sequelae (or duration of nature of injury) and then multiplied these prevalence values by their respective disability weights for each disease and injury. The process for estimating disability weights is detailed further in appendix 1 (section 2.9). YLDs were adjusted for comorbidity, assuming that a multiplicative function of disability weights accounts for the co-occurrence of non-fatal causes within individuals. YLLs were derived by multiplying the cause-age-sex-location-year-specific number of deaths by the standard life expectancy at the age of death for each cause, as detailed by the GBD 2023 Causes of Death Collaborators.[16] DALYs were computed by summing YLDs and YLLs (appendix 1 section 4). A complementary measure to DALYs—healthy life expectancy (HALE), which measures a population's mean number of years of life spent in full health—was calculated using YLDs per capita and age-specific mortality rates by location, age, sex, year, and cause.[16] This method was developed by Sullivan[19] and described in appendix 1 (section 5). Both DALYs and HALE were estimated by location, age, sex, and year. More comprehensive details can be found in appendix 1 (sections 4, 5). Cause-specific disease and injury estimation methods were updated for GBD 2023 for several causes, including for rheumatic heart disease, autism spectrum disorders, and HIV/AIDS. Details on these and other cause-specific updates are in appendix 1 (section 6).

Disease and injury burden attributable to risk factors

Risk factor analysis was based on the comparative risk assessment framework, which is premised on a causal web of hierarchically organised, modifiable risk factors that affect health outcomes[20,21] (appendix 2 section 2, table S2). Risk factors were classified into a four-level hierarchy with the broadest categories—environmental and occupational, behavioural, and metabolic risks—at level 1. Level 1 categories were then further disaggregated, allowing for analysis focused both on risk groups at level 2 (eg, air pollution) and on increasingly granular risk factors at levels 3 (eg, particulate matter pollution) and 4 (eg, household air pollution from solid fuels). GBD 2021 and GBD 2023 included 88 total risk factors across hierarchy levels (appendix 2 table S1). Risk factor definitions and modelling details are in appendix 2 (section 4).

Described briefly are the methods for estimating each of the four inputs into assessing risk-attributable burden: exposure, relative risk of each health outcome associated with the risk factor, the TMREL, and deaths and burden for each of the health outcomes with which a risk factor is associated.

Methods to estimate mean levels of exposure to each risk factor by age-sex-location-year varied across risks. Data for most risks were extracted from household surveys and the scientific literature and were modelled using either ST-GPR or DisMod-MR 2.1.[7,13] Some risks (eg, ambient air pollution) required other approaches, such as satellite data and geospatial analysis for environmental exposures. For most risks, the distribution of exposure across individuals was estimated by modelling a measure of dispersion, usually the SD, and fitting an ensemble of parametric distributions to the predicted mean and SD (appendix 2 section 2.2.3 [step 2]). Summary exposure values (SEVs), reflecting both the prevalence of a given risk factor and the relative harm caused by that risk factor, were calculated from exposure estimates (appendix 2 section 2 [step 5]).

For the GBD 2023 risk factor analysis, we evaluated a total of 88 risk factors and 159 health outcomes, including four outcomes (bipolar disorder, bulimia nervosa, conduct disorder, and schizophrenia) that in previous iterations of the GBD had not been linked to any risk factors. At the most detailed risk and cause level, relative risks for a total of 676 risk–outcome pairs—including pairs in mediation pathways and pairs for which, by definition, a fixed percentage (often 100%) of the disease is attributed to the risk—were estimated. This included 50 new risk–outcome pairs, while two previously included pairs—child wasting and malaria, and high alcohol use and nasopharynx cancer—were excluded for not meeting inclusion criteria or for overlapping with other outcomes (appendix 2 table S3).

For 256 of the pairs for which standard effect size analyses were applicable to estimate the relative risk, we applied our burden-of-proof meta-regression approach.[13–15] The burden-of-proof framework used a range of systematic strategies, including ensemble spline models to capture the potentially non-linear shape of the risk–outcome relationship, robust likelihood-based trimming of outliers, covariate selection and adjustment to account for known variation in input study design characteristics, and quantification and incorporation of remaining between-study heterogeneity into uncertainty. See appendix 2 (section 2.1.2–2.1.8 [step 1]) for details.

The burden-of-proof approach further generates a burden-of-proof risk function (BPRF), which is conservatively defined for harmful risks as the 5th and for protective risks as the 95th quantile relative risk curve, inclusive of between-study heterogeneity, closest to null. The BPRF extends relative risk estimates using the same data inputs and modelling processes to provide a conservative measure of both effect size and evidence strength that incorporates between-study heterogeneity to formally account for divergence or convergence in findings across input studies. For ease of interpretation and comparison, risk–outcome scores (ROSs) are calculated summarising average BPRFs across the data-dense range (15th to 85th percentile) of risk exposure levels reported in the input studies, and summary scores are mapped to a (one to five) star rating system, with higher positive ROS values and more stars corresponding to incrementally stronger evidence for the risk–outcome relationship (appendix 2 section 2.1.6, table S8). The uncertainty intervals (UIs) for relative risks estimated with burden-of-proof methods in this analysis include between-study heterogeneity for all risk factors except tobacco use, given concerns raised during GBD 2021 regarding the interpretation of the resulting wide UIs with respect to policy. Efforts to review and potentially revise the incorporation of unexplained between-study heterogeneity in UIs are part of regular GBD methodology updates. For the purposes of this combined GBD 2023 disease burden and risk factor analysis, we present BPRF-related metrics only in appendix 3 (table S18). More detailed BPRF results can be found in GBD 2021 Risk Factor Collaborators[13] and other risk-specific papers,[22–27] and accessed through the Burden of Proof tool.

See **Online** for appendix 3

For the **Burden of Proof tool** see https://vizhub.healthdata.org/burden-of-proof/

For each risk factor, the TMREL—the counterfactual level of exposure that is theoretically possible and would minimise health risks in exposed populations—was estimated either on the basis of epidemiological evidence quantifying risk–outcome relationships and the distribution of observed risk factor exposure (eg, ozone air pollution), or on the basis of risk factor definition (eg, smoking; appendix 2 section 2 [step 3], table S4). Differing TMRELs reflect the range of behavioural, metabolic, and environmental risk factors, including those for which zero exposure is theoretically achievable and those for which non-zero levels reflect minimum risk.

For each risk–outcome pair, estimates of exposure, TMREL, and relative risk were used to compute the population attributable fraction (PAF; the proportional difference between disease or injury burden at current levels of risk factor exposure and the burden that would have occurred had the population been exposed to the risk factor at the TMREL; appendix 2 section 2 [step 4]). For associations involving risk factors that act on outcomes via intermediate risks (ie, many risk factors, particularly dietary risks, are associated with disease outcomes mediated through metabolic risks, such as a relationship between diet high in sodium and hypertensive heart disease mediated through high SBP), PAFs were adjusted based on values estimated in the GBD 2023 mediation matrix (appendix 2 section 2 [step 6], table S5). Eight additional risk–outcome pairs were incorporated in the 2023 matrix, for a total of 165 mediated pairs (appendix 2 table S6).

To calculate measures of risk-attributable burden—ie, the disease burden (DALYs, deaths, YLLs, or YLDs) attributable to a particular risk factor or combination of risks—PAFs were multiplied by the estimated disease burden associated with particular outcomes (appendix 2

section 2 [step 7]). There have been several updates to the estimation of risk-attributable burden for GBD 2023, including for outcomes such as ischaemic heart disease, with prevalence and disease burden now modelled directly rather than on the basis of non-specific chest pain symptoms, and for risk factors such as lead exposure, with one of the important changes being that the effect of lead on ischaemic heart disease is now estimated directly, whereas this effect was previously exclusively mediated via high SBP. Additionally, names and case definitions were updated for some risk factors, such as sexual violence against children (previously childhood sexual abuse), and the TMREL was revised for one risk factor: diet high in trans fatty acids. See appendix 2 (section 4) for all GBD 2023 risk-specific methods.

For assessments of model robustness for the primary models used in estimating disease and injury burden and risk-attributable burden, refer to appendix 2 section 2.2.3 for ST-GPR, appendix 1 section 4.5 of GBD 2019 Diseases and Injuries Collaborators[6] for DisMod-MR, appendix 1 section 6 for DisMod-AT, and Zheng and colleagues[14] for burden-of-proof methods.

GBD research and reporting practices

This research complies with the GATHER statement;[28] a completed GATHER checklist is provided in appendix 1 (table S2). The University of Washington Institutional Review Board approved the GBD study (STUDY00009060) up to July 26, 2026. The software used for analyses included Python (version 3.10.4), Stata (version 13.1), and R (version 4.2.1). The statistical code used in GBD 2023 is publicly available online. An international network of collaborators helped to provide, review, and analyse the available data to generate health metrics; GBD 2023 drew on the expertise of more than 14 000 collaborators from more than 160 countries and territories.

For the **statistical code** see https://ghdx.healthdata.org/gbd-2023/code

All GBD 2023 estimates for diseases, injuries, and risk factors are reported by age, sex, location, and year for 25 age groups from early neonatal (0–6 days) to 95 years and older; for males, females, and all sexes combined; for every year from 1990 to 2023; and in 204 countries and territories grouped into 21 regions and seven super-regions. The super-regions are central Europe, eastern Europe, and central Asia; high income; Latin America and the Caribbean; north Africa and the Middle East; south Asia; southeast Asia, east Asia, and Oceania; and sub-Saharan Africa (appendix 1 section 1.1–1.2). GBD 2023 also produced estimates for 660 subnational locations in 20 countries (Brazil, China, Ethiopia, India, Indonesia, Italy, Iran, Japan, Kenya, Mexico, New Zealand, Nigeria, Norway, Pakistan, the Philippines, Poland, Russia, South Africa, the UK, and the USA). Results are also presented by Socio-demographic Index (SDI) quintile, which is a composite measure of lag-distributed income per capita, average years of education, and fertility rates among females younger than 25 years.[29] Each location at the most specific level is assigned an SDI value ranging from 0 (lowest income and educational attainment, and highest fertility) to 100 and then grouped into quintiles from low SDI to high SDI (appendix 1 table S12).

For the **GBD 2023 Results Tool** see https://vizhub.healthdata.org/gbd-results/

For **GBD Compare** see https://vizhub.healthdata.org/gbd-compare/

Estimates are reported here as absolute counts and as rates per 100 000 person-years, with age-standardised rates calculated using the GBD 2023 world standard population[30] to account for varying age structures across populations. Count data are presented to three significant figures, and rates are presented to one decimal place. Uncertainty was propagated throughout the estimation process. Mean estimates for all metrics reported represent the mean value across 250 draws from the estimate's distribution, with 95% UIs calculated as the 2·5th and 97·5th percentile values across the draws. To reduce computing power and time across the estimation process, the number of draws was reduced from 500 in GBD 2021 to 250 for GBD 2023. Simulations revealed that estimates and uncertainty were minimally affected by this reduction (see appendix 1 section 1.1 for more details).

Role of the funding source

The funders of this study had no role in study design, data collection, data analysis, data interpretation, or the writing of the report.

Results

Overview

To capture worldwide long-term patterns of disease burden and changes in the global health outlook since the COVID-19 pandemic, we report estimated DALYs from 1990 to 2023, across level 1 causes, then primarily focus on results from 2010 to 2023, the most recent period of acute public health and policy interest. HALE results are presented in appendix 3 (table S9). For risk factor analyses, we present estimates of risk factor exposure in SEVs and risk-attributable burden in DALYs. More detailed estimates and metrics are presented in appendix 3. Comprehensive results can also be accessed through the GBD 2023 Results Tool and visualised via GBD Compare. Results specific to risk factor analyses can also be accessed through the Burden of Proof Tool.

The changing landscape of global health across sociodemographic levels

The number of global all-cause DALYs remained statistically stable between 1990 and 2023 (2·74 billion [95% UI 2·60–2·90] in 1990 and 2·80 billion [2·57–3·08] in 2023; appendix 3 table S10). This apparent stasis hides an epidemiological transition among level 1 causes that broadly reflects a decrease in burden due to CMNN diseases, a rise in NCD DALYs, and an unchanged level of injuries (figure 1A). Global age-standardised DALY rates—which account for variation in population

structure—decreased for CMNN diseases, NCDs, and injuries, reflecting per-person improvements in burden between 1990 and 2023 (figure 1B), but these gains were not seen in DALY counts for NCDs or injuries because the global population is growing and ageing. The biggest deviation during the COVID-19 pandemic from these long-term favourable trajectories in DALY rates was for CMNN diseases, and this disturbance was more acute in countries in lower SDI quintiles (ie, the effect of the pandemic was greatest for countries with lower income per capita and educational attainment and higher fertility rates; figure 1B). A similar pandemic-related disruption was not evident for NCDs or injuries at the global level.

Declines in age-standardised DALY rates for CMNN diseases were steepest over time at lower SDI levels and more attenuated with higher SDI. In the high SDI quintile, total DALY counts and age-standardised rates for CMNN diseases were below those for injuries in all but the pandemic years (figure 1). Much less substantial decreases in age-standardised rates were seen for NCDs and injuries except in the high-middle and high SDI quintiles.

Global trends in DALYs, 2010–23

Although the 2023 all-cause global DALYs rose 6·1% (95% UI 4·0–8·1) from 2·64 billion (2·46–2·86) in 2010 to 2·80 billion (2·57–3·08) in 2023, the global age-standardised DALY rate declined by 12·6% (11·0–14·1; appendix 3 table S10). Across level 1 causes, NCDs contributed the highest burden globally in 2023 and were the only disease group for which DALY counts increased between 2010 and 2023, from 1·45 billion (1·31–1·61) to 1·80 billion (1·63–2·03). However, age-standardised DALY rates for NCDs decreased during this period by 4·1% (1·9–6·3; appendix 3 table S10). DALY counts for CMNN diseases decreased from 874 million (837–917) in 2010 to 681 million (642–736) in 2023, and the age-standardised DALY rate decreased more markedly by 25·8% (22·6–28·7). DALY counts due to injuries also exhibited a decreasing but non-significant trend from 319 million (288–357) in 2010 to 316 million (280–356) in 2023. The age-standardised DALY rate due to injuries decreased by 15·6% (10·7–19·8) during the same period (appendix 3 table S10).

In 2023, males accounted for 1·47 billion (95% UI 1·37–1·59) global all-cause DALYs and females

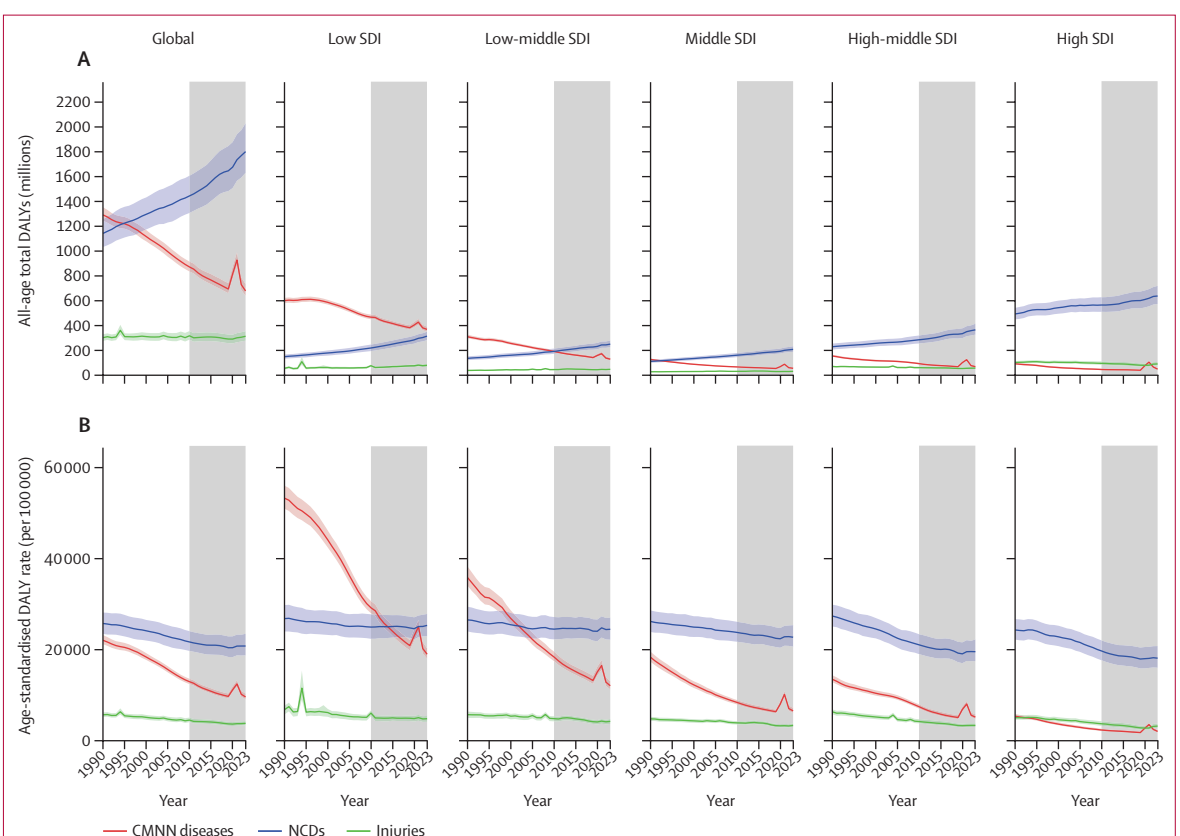


Figure 1: **Trends of total DALYs (A) and age-standardised DALY rates (B) by GBD level 1 cause and by SDI quintile, 1990–2023**
The grey shading indicates the 2010–23 period. The bump in injury-related DALYs that can be seen in the low SDI and global panels in 1994 is largely the result of the Rwanda genocide. The larger bump in CMNN diseases in almost all plots in 2021 and 2022 is the larger DALY effect of the COVID-19 pandemic. Shading around mean trend lines represents 95% uncertainty intervals. CMNN=communicable, maternal, neonatal, and nutritional. DALY=disability-adjusted life-year. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study. NCDs=non-communicable diseases. SDI=Socio-demographic Index.

for 1·33 billion (1·20–1·49; appendix 3 table S3; see figure 2 for age-cause-specific DALYs, by sex). For both sexes, ischaemic heart disease was the leading level 3 cause of DALY burden in 2023 (74·8 million [64·2–84·8] DALYs in females and 118 million [106–130] in males), followed by neonatal disorders (71·7 million [65·7–78·9] in females and 98·3 million [89·4–107] in males) and stroke (70·8 million [61·8–83·4] in females and 85·7 million [75·8–97·8] in males; appendix 3 table S3). By age group, CMNN diseases were leading causes of burden in children younger than 5 years, with maternal and neonatal disorders the greatest cause of DALYs in the neonatal phase (age <28 days), accounting for 72·2% (68·4–75·3) of 184 million (178–190) total DALYs in this age group in 2023 (figure 2; see the GBD 2023 Results Tool for total DALYs by age group). NCDs increasingly contributed to disease burden with ageing, accounting for 45·0% (40·8–49·8) of 152 million (130–180) total DALYs in individuals aged 5–14 years, 61·6% (58·6–64·1) of 882 million (778–1006) total DALYs for those aged 15–49 years, and 85·5% (84·6–86·3) of 1150 million (1060–1260) total DALYs for those aged 55 years and older. The burden of injuries was higher in males aged 10–54 years, accounting for 24·7% (22·4–27·0) of 590 million (529–662) total DALYs in this age group, compared with 11·1% (9·7–12·5) of 540 million (463–631) total DALYs in females of the same age, with the difference between sexes declining gradually for those 55 and older.

In total, 15 NCDs, seven CMNN diseases, and three types of injuries featured within the 25 leading level 3 causes of global DALYs in 2023 (figure 3). In 2010, neonatal disorders, ischaemic heart disease, and stroke were the leading causes of DALYs for all ages and sexes combined. In 2023, the top five causes were ischaemic heart disease (193 million [95% UI 176–209] DALYs), neonatal disorders (170 million [159–183]), stroke (157 million [141–172]), lower respiratory infections (98·7 million [87·7–112]), and diabetes (90·2 million [75·2–107]). Notable health gains among leading CMNN diseases included lower respiratory infections (with a decrease in the age-standardised DALY rate of 24·8% [7·4–36·7] between 2010 and 2023) and diarrhoeal diseases (decrease of 49·1% [32·7–61·0]). Rates also declined for HIV/AIDS (by 42·9% [38·0–48·0]), tuberculosis (42·2% [23·6–56·6]), and malaria (21·4% [5·4–45·4]). Another notable health gain among CMNN diseases was observed for neonatal disorders, which decreased in age-standardised DALY rate by 16·5% (10·6–22·0) and dropped from first ranking in 1990, 2000, and 2010 to second ranking globally in 2023.

Among the leading level 3 causes of DALYs in 2023, the largest health declines between 2010 and 2023—ie, increases in age-standardised DALY rates—were observed for NCD causes, including anxiety disorders

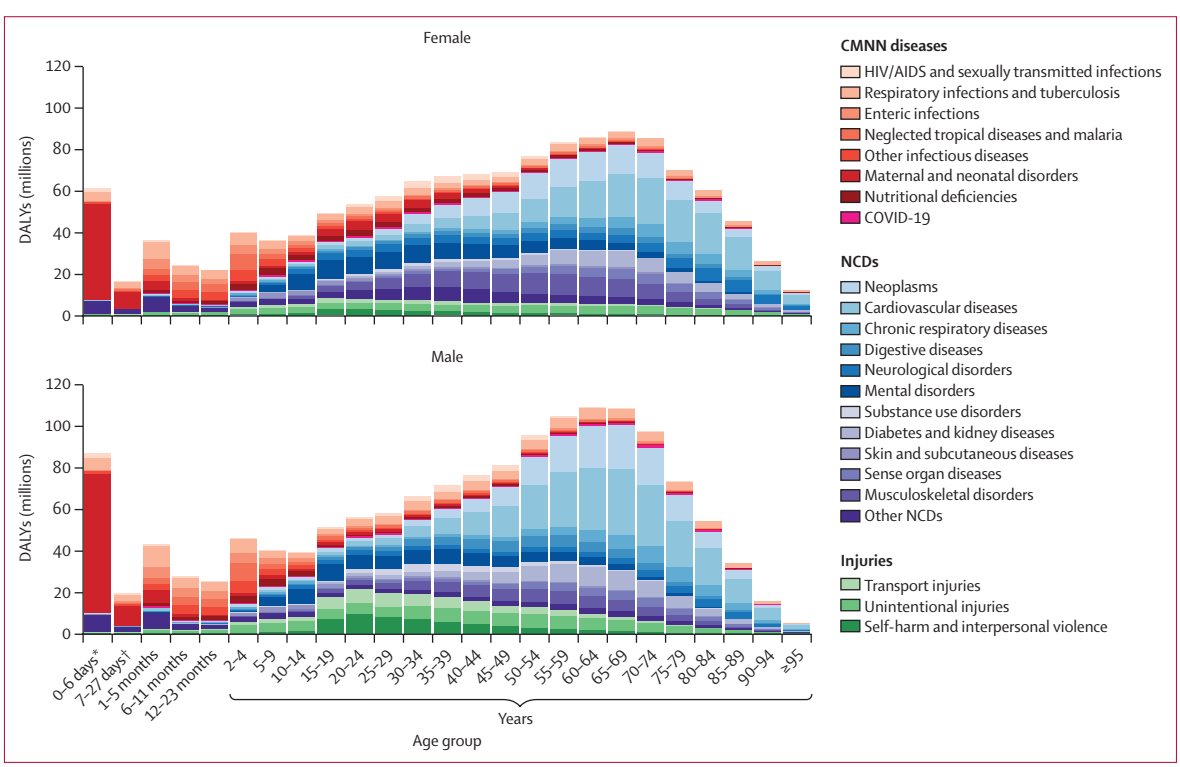


Figure 2: **The distribution of global DALYs across age and sex for GBD level 2 causes in 2023**
CMNN=communicable, maternal, neonatal, and nutritional. DALYs=disability-adjusted life-years. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study. NCDs=non-communicable diseases. *Early neonatal. †Late neonatal.

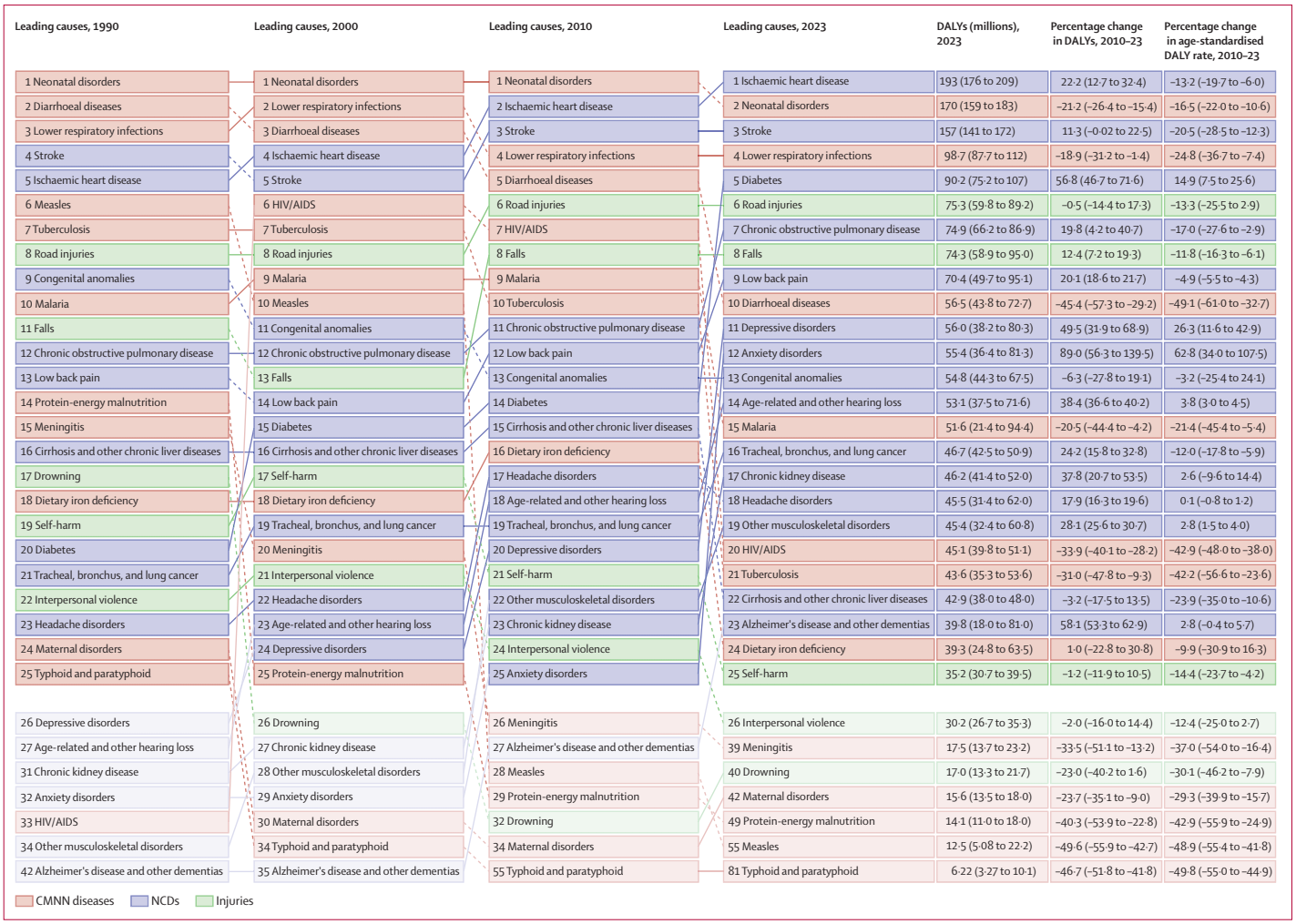


Figure 3: **Leading 25 GBD level 3 causes of global DALYs in 1990, 2000, 2010, and 2023, for both sexes combined, and all ages**
Causes are connected by lines between time periods: solid lines represent an increase or no change in rank, and dashed lines represent a decrease in rank. Faded colours indicate that the cause is not within the top 25 causes of DALYs for that year. Data in parentheses are 95% uncertainty intervals. DALY=disability-adjusted life-year. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study.

with an increase of 62·8% (95% UI 34·0–107·5), depressive disorders (26·3% [11·6–42·9]), and diabetes (14·9% [7·5–25·6]; figure 3). Alzheimer's disease and other dementias also moved into the top 25 causes of DALYs for the first time (non-significant increase in age-standardised rate of 2·8% [–0·4 to 5·7]). With respect to level 3 categories of injury, age-standardised DALY rates did not show a statistical change for road injuries (non-significant decrease of 13·3% (–25·5 to 2·9), but declined for falls by 11·8% (6·1 to 16·3) and self-harm by 14·4% (4·2 to 23·7). DALY counts and age-standardised DALY rates by cause for 2010 and 2023 are presented in appendix 3 (tables S3, S4).

Decomposition of DALYs into YLDs and YLLs

Global all-cause DALYs in 2023 were composed of 990 million (95% UI 756–1280) YLDs (equivalent to 35·4% [29·5–41·5] of 2·80 billion total DALYs; appendix 3 tables S5, S6) and 1·81 billion (1·78–1·84) YLLs (equivalent to 64·6% [59·5–69·5] of total DALYs; appendix 3 tables S7, S8). Global YLDs exhibited a non-significant increase from 786 million (597–1000) in 2010, and YLLs decreased significantly from 1·85 billion (1·84–1·86) in 2010. All-cause, age-standardised YLD rates remained statistically stable between 2010 and 2023, with a non-significant increase of 2·3% (–0·2 to 5·4; appendix 3 table S11). A total of 21 NCDs, three CMNN diseases, and one injury featured within the 25 leading level 3 causes of YLDs globally in 2023 (table 1). Low back pain, depressive disorders, and anxiety disorders were the top three causes of YLDs. Global YLLs decreased by 2·4% (0·9–3·9) between 2010 and 2023, and age-standardised YLL rates decreased considerably by 18·7% (17·5–19·9; appendix 3 table S12). Age-standardised YLD and YLL rates and the number of YLDs and YLLs by

	Percentage of all-cause YLDs		YLDs			Age-standardised rate of YLDs		
	2010	2023	Counts (millions), 2010	Counts (millions), 2023	Percentage change, 2010–23	Per 100 000, 2010	Per 100 000, 2023	Percentage change, 2010–23
Low back pain	7·5% (6·4 to 8·7)	7·1% (6·1 to 8·3)	58·6 (41·4 to 78·9)	70·4 (49·7 to 95·1)	20·1% (18·6 to 21·7)	847·5 (600·4 to 1143·3)	805·9 (569·1 to 1084·1)	−4·9% (−5·5 to −4·3)
Depressive disorders	4·8% (3·8 to 6·1)	5·7% (4·5 to 7·4)	37·5 (25·7 to 51·0)	56·0 (38·2 to 80·3)	49·5% (31·9 to 68·9)	527·6 (361·4 to 717·2)	666·4 (454·6 to 952·5)	26·3% (11·6 to 42·9)
Anxiety disorders	3·7% (2·8 to 4·9)	5·6% (4·1 to 7·8)	29·3 (19·9 to 41·5)	55·4 (36·4 to 81·3)	89·0% (56·3 to 139·5)	415·6 (284·8 to 587·6)	676·6 (440·9 to 989·3)	62·8% (34·0 to 107·5)
Falls	6·2% (5·3 to 7·1)	5·4% (4·6 to 6·1)	48·6 (35·2 to 65·6)	53·1 (38·4 to 72·2)	9·4% (7·2 to 11·5)	708·2 (514·3 to 955·8)	606·7 (438·0 to 822·5)	−14·3% (−15·8 to −12·8)
Age-related and other hearing loss	4·9% (4·1 to 5·8)	5·4% (4·5 to 6·4)	38·4 (27·0 to 51·5)	53·1 (37·5 to 71·6)	38·4% (36·6 to 40·2)	577·4 (409·7 to 775·1)	599·1 (424·5 to 804·9)	3·8% (3·0 to 4·5)
Headache disorders	4·9% (3·8 to 6·0)	4·6% (3·6 to 5·6)	38·6 (26·4 to 52·6)	45·5 (31·4 to 62·0)	17·9% (16·3 to 19·6)	541·3 (370·8 to 736·2)	542·0 (373·4 to 739·2)	0·1% (−0·8 to 1·2)
Diabetes	3·6% (3·2 to 4·1)	4·5% (3·9 to 5·0)	28·5 (20·0 to 38·1)	44·2 (31·0 to 59·7)	55·0% (52·6 to 58·0)	422·5 (296·5 to 565·2)	489·3 (343·3 to 658·9)	15·8% (14·0 to 17·6)
Other musculoskeletal disorders	4·3% (3·3 to 5·5)	4·4% (3·4 to 5·6)	33·6 (23·4 to 45·5)	43·2 (29·9 to 58·3)	28·4% (25·8 to 30·8)	479·1 (332·5 to 647·9)	494·1 (342·4 to 668·7)	3·1% (2·3 to 4·0)
Dietary iron deficiency	4·9% (3·6 to 6·4)	3·9% (2·8 to 5·3)	38·9 (25·0 to 59·0)	39·3 (24·8 to 63·5)	1·0% (−22·8 to 30·8)	565·2 (361·8 to 856·5)	509·4 (321·3 to 818·3)	−9·9% (−30·9 to 16·3)
Gynaecological diseases	2·9% (2·4 to 3·4)	2·9% (2·4 to 3·4)	22·8 (15·4 to 31·9)	28·6 (19·5 to 40·0)	25·6% (22·1 to 29·6)	315·6 (214·2 to 441·6)	341·4 (231·3 to 477·6)	8·2% (6·1 to 10·6)
Oral disorders	2·4% (1·6 to 3·2)	2·4% (1·7 to 3·3)	18·6 (11·2 to 27·4)	23·9 (14·5 to 35·1)	28·8% (24·4 to 33·0)	273·7 (166·0 to 401·4)	272·9 (164·4 to 402·4)	−0·3% (−3·3 to 2·8)
Blindness and vision loss	2·3% (2·0 to 2·8)	2·4% (1·9 to 2·9)	18·4 (12·9 to 26·0)	23·6 (16·3 to 33·5)	28·0% (25·5 to 30·6)	284·5 (198·8 to 399·5)	261·1 (180·3 to 368·9)	−8·2% (−10·4 to −6·1)
Neonatal disorders	2·4% (2·0 to 2·8)	2·4% (2·0 to 2·8)	18·5 (13·8 to 24·1)	23·6 (18·0 to 29·8)	27·8% (17·4 to 37·0)	264·8 (197·8 to 345·4)	304·5 (232·2 to 384·6)	15·0% (5·7 to 23·3)
Osteoarthritis	2·0% (1·2 to 3·8)	2·2% (1·3 to 4·3)	15·7 (7·47 to 33·7)	22·4 (10·7 to 48·2)	42·7% (41·0 to 44·4)	238·9 (114·1 to 513·1)	243·0 (115·8 to 523·5)	1·7% (0·7 to 2·8)
Neck pain	2·1% (1·6 to 2·7)	2·1% (1·6 to 2·6)	16·7 (11·1 to 24·5)	20·7 (13·8 to 30·1)	24·0% (20·9 to 27·3)	237·9 (158·5 to 345·3)	238·3 (158·6 to 346·3)	0·2% (−0·4 to 0·7)
Schizophrenia	1·8% (1·3 to 2·4)	1·7% (1·3 to 2·3)	14·0 (10·3 to 17·7)	17·0 (12·4 to 21·4)	21·1% (19·2 to 22·9)	196·2 (143·7 to 248·3)	197·4 (144·6 to 249·9)	0·6% (−0·1 to 1·3)
Stroke	1·6% (1·3 to 1·9)	1·7% (1·4 to 2·0)	12·6 (9·01 to 16·1)	16·7 (12·0 to 21·2)	31·9% (29·7 to 34·1)	192·8 (137·7 to 245·9)	186·0 (133·8 to 236·4)	−3·6% (−4·9 to −2·3)
Dermatitis	1·7% (1·1 to 2·5)	1·5% (1·0 to 2·2)	13·5 (7·88 to 21·8)	15·2 (8·9 to 24·2)	12·5% (11·0 to 14·4)	198·3 (115·7 to 321·5)	196·3 (114·7 to 316·7)	−1·0% (−1·7 to −0·5)
Chronic obstructive pulmonary disease	1·5% (1·2 to 1·9)	1·5% (1·2 to 1·9)	11·6 (9·61 to 13·3)	15·0 (12·6 to 17·6)	30·0% (26·1 to 33·5)	178·3 (148·7 to 206·1)	166·3 (139·1 to 194·8)	−6·7% (−9·4 to −3·7)
Asthma	1·5% (1·1 to 1·9)	1·4% (1·1 to 1·8)	11·5 (7·26 to 16·2)	14·1 (8·80 to 20·3)	22·6% (18·2 to 26·6)	167·3 (105·4 to 235·3)	173·7 (107·8 to 249·5)	3·8% (0·5 to 7·2)
COVID-19	NA	1·3% (0·6 to 2·5)	NA	12·5 (5·33 to 25·7)	NA	NA	152·0 (64·5 to 313·6)	NA
Alzheimer's disease and other dementias	1·0% (0·7 to 1·2)	1·2% (0·9 to 1·6)	7·69 (5·33 to 9·85)	12·2 (8·52 to 15·6)	58·3% (55·9 to 61·7)	131·6 (91·4 to 168·7)	137·4 (96·3 to 176·7)	4·4% (2·9 to 6·6)
Alcohol use disorders	1·3% (1·0 to 1·6)	1·2% (0·9 to 1·4)	10·3 (7·23 to 14·5)	11·6 (8·08 to 16·5)	12·6% (9·6 to 15·3)	143·4 (101·1 to 202·0)	136·4 (95·2 to 194·5)	−4·9% (−6·7 to −3·1)
Chronic kidney disease	1·0% (0·8 to 1·2)	1·0% (0·9 to 1·3)	7·48 (5·55 to 9·77)	10·3 (7·53 to 13·3)	37·0% (31·4 to 43·3)	114·9 (85·0 to 149·8)	114·5 (84·4 to 148·5)	−0·4% (−4·9 to 3·9)
Ischaemic heart disease	1·0% (0·9 to 1·2)	1·0% (0·9 to 1·1)	8·06 (5·82 to 10·8)	10·0 (7·26 to 13·5)	24·1% (20·8 to 27·4)	123·3 (89·3 to 165·2)	110·2 (80·1 to 147·9)	−10·6% (−12·6 to −9·0)

Data in parentheses are 95% uncertainty intervals. Causes are listed from first to last rank with respect to 2023 YLD counts and percentage of 2023 all-cause YLDs. Count data are presented to three significant figures, and rates are presented to one decimal place. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study. NA=not applicable. YLDs=years lived with disability.

Table 1: **Top 25 leading level 3 causes of global YLDs in 2023 across all ages, for both sexes combined, YLD counts, age-standardised rates, and percentage change between 2010 and 2023**

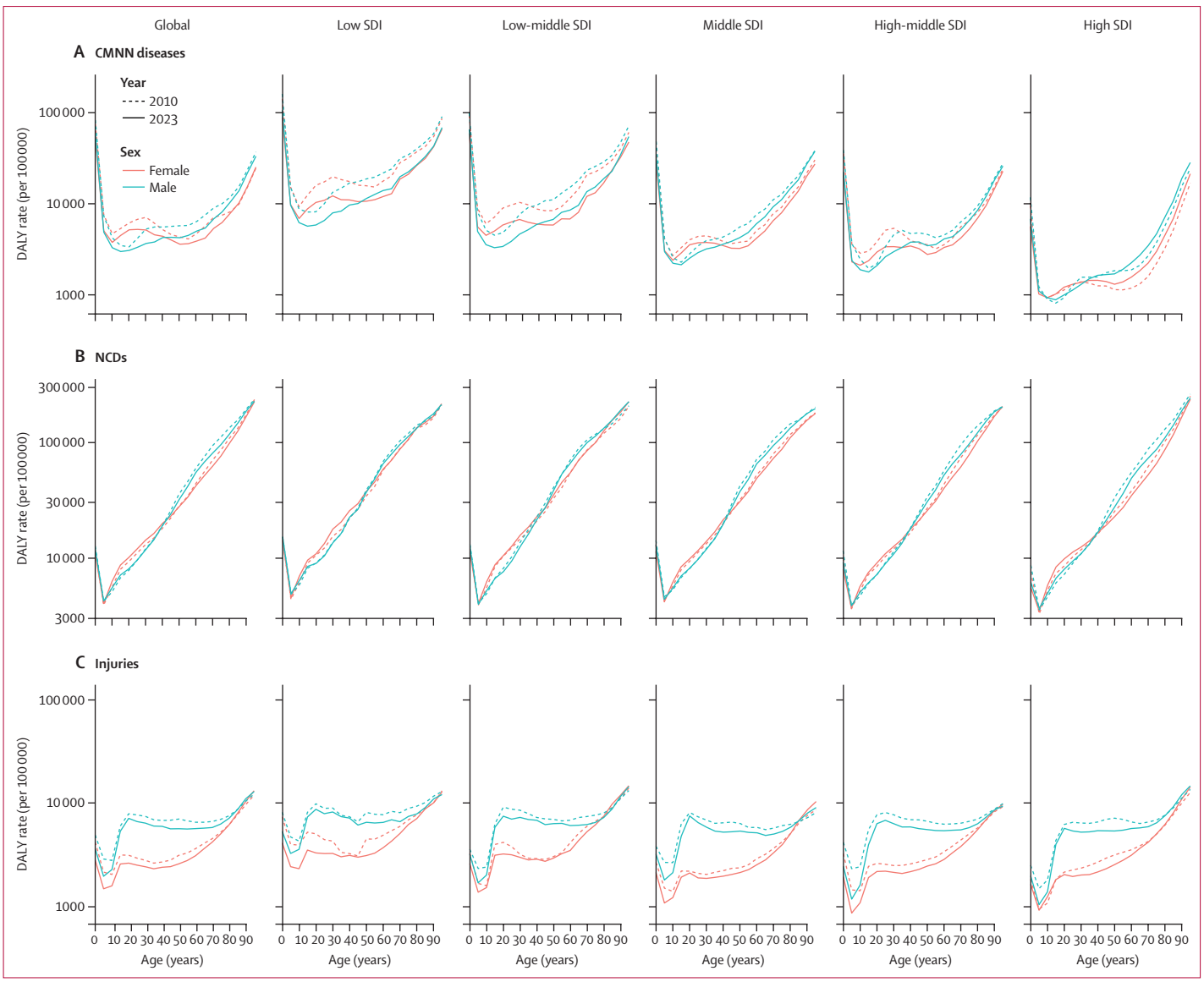


Figure 4: **Age-specific DALY rates for CMNN diseases (A), NCDs (B), and injuries (C), by age, sex, year, and SDI quintile**
The y axis shows DALYs per 100 000 person-years on a logarithmic scale. CMNN=communicable, maternal, neonatal, and nutritional. DALY=disability-adjusted life-year. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study. NCDs=non-communicable diseases. SDI=Socio-demographic Index.

cause and sex for 2010, 2020, and 2023 are in appendix 3 (tables S5–S8).

Trends in DALYs by SDI, location, age, and sex

Trends in DALYs at the global level were informed by complex patterns of cause-specific burden across location, age, and sex. Age-standardised DALY rates for NCDs in males in 2023 ranged from 19 519·6 (95% UI 17 667·9–21 818·2) per 100 000 in the high SDI quintile to 25 205·2 (23 054·5–27 396·0) per 100 000 in the low SDI quintile. In females, age-standardised DALY rates for NCDs ranged from 17 017·8 (14 711·8–20 005·1) per 100 000 in the high SDI quintile to 25 574·4 (22 701·9–28 560·9) per 100 000 in the low SDI quintile (GBD 2023 Results Tool and GBD Compare). Across all SDI quintiles, age-specific DALY rates from NCDs decreased with increasing age from 0–6 days to 5–9 years and then increased gradually with age (figure 4).

Age-standardised DALY rates for CMNN diseases in males in 2023 ranged from 2257·1 (95% UI 2033·9–2553·5) per 100 000 in the high SDI quintile to 19 212·4 (18 052·2–20 819·7) per 100 000 in the low SDI quintile. In females, they ranged from 1909·6 (1655·9–2271·7) per 100 000 in the high SDI quintile to 18 824·3 (17 538·6–20 419·6) per 100 000 in the low SDI quintile (GBD 2023 Results Tool and GBD Compare).

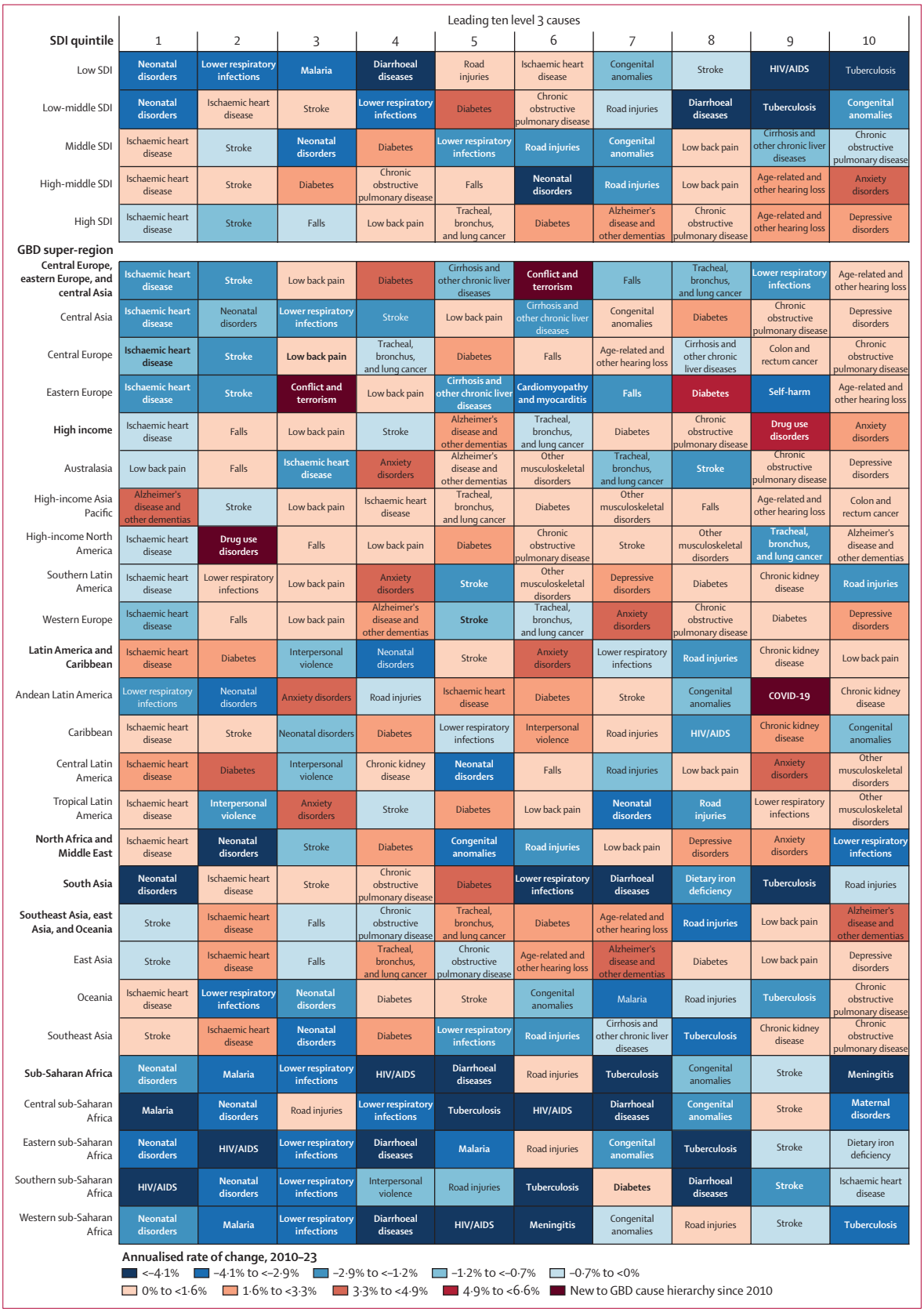


Figure 5: **Leading ten GBD level 3 causes of 2023 DALYs by SDI quintile, GBD region and super-region, and annualised rate of change between 2010 and 2023**
Level 3 causes are ranked by 2023 DALY counts from left (first) to right (tenth) for each GBD region and SDI quintile, with GBD super-regions in bold. DALY=disability-adjusted life-year. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study. SDI=Socio-demographic Index.

	SEV, 1990	SEV, 2010	SEV, 2023	Annualised rate of change, 1990–2023	Annualised rate of change, 2010–23
All risk factors	24·5 (21·7 to 26·0)	24·0 (21·4 to 25·5)	23·6 (20·7 to 25·0)	−0·1% (−0·2 to 0·0)	−0·1% (−0·3 to 0·1)
Environmental or occupational risks	45·6 (40·2 to 49·1)	41·8 (36·0 to 46·3)	37·7 (32·1 to 42·3)	−0·6% (−0·8 to −0·4)	−0·8% (−1·1 to −0·5)
Unsafe water, sanitation, and handwashing	44·4 (29·0 to 53·1)	33·7 (22·2 to 41·1)	28·1 (18·9 to 34·9)	−1·4% (−2·0 to −0·8)	−1·4% (−2·6 to −0·3)
Unsafe water source	44·7 (33·1 to 56·6)	38·7 (25·3 to 52·2)	36·5 (22·4 to 51·3)	−0·6% (−1·4 to 0·1)	−0·5% (−1·7 to 0·7)
Unsafe sanitation	56·9 (52·5 to 60·9)	40·7 (37·4 to 43·8)	30·8 (26·8 to 35·4)	−1·9% (−2·3 to −1·4)	−2·1% (−3·1 to −1·2)
No access to handwashing facility	32·6 (15·4 to 43·8)	25·7 (11·6 to 35·0)	21·4 (10·0 to 29·2)	−1·3% (−2·4 to 0·0)	−1·4% (−3·7 to 0·7)
Air pollution	51·5 (44·4 to 58·5)	45·4 (38·4 to 52·7)	37·6 (31·9 to 44·1)	−0·9% (−1·1 to −0·8)	−1·4% (−1·7 to −1·2)
Particulate matter pollution	56·8 (51·2 to 62·5)	49·5 (44·4 to 54·8)	41·7 (37·0 to 47·0)	−0·9% (−1·1 to −0·8)	−1·3% (−1·5 to −1·1)
Ambient particulate matter pollution	20·0 (16·0 to 25·3)	24·4 (20·1 to 29·2)	28·5 (23·6 to 33·8)	1·1% (0·5 to 1·7)	1·2% (0·9 to 1·5)
Household air pollution from solid fuels	35·5 (29·7 to 41·9)	25·5 (21·1 to 30·4)	16·9 (13·2 to 21·2)	−2·2% (−2·8 to −1·7)	−3·2% (−3·7 to −2·5)
Ambient ozone pollution	16·5 (14·3 to 20·1)	20·9 (18·1 to 25·2)	24·6 (21·6 to 28·8)	1·2% (1·1 to 1·3)	1·3% (1·1 to 1·4)
Ambient nitrogen dioxide pollution	22·3 (0·0 to 50·6)	20·8 (0·0 to 48·3)	14·4 (0·0 to 40·7)	−1·3% (−2·5 to 0·0)	−2·9% (−5·6 to 0·0)
Non-optimal temperature	28·5 (27·8 to 29·6)	33·9 (32·7 to 34·9)	32·2 (31·0 to 33·2)	0·4% (0·2 to 0·5)	−0·4% (−0·6 to −0·2)
High temperature	30·9 (28·7 to 32·9)	40·5 (37·1 to 43·1)	40·4 (37·4 to 43·0)	0·8% (0·7 to 0·9)	0·0% (−0·1 to 0·1)
Low temperature	25·6 (24·5 to 27·3)	26·5 (25·2 to 28·3)	24·2 (22·9 to 26·1)	−0·2% (−0·2 to −0·1)	−0·7% (−0·8 to −0·6)
Other environmental risks	41·9 (14·3 to 51·2)	44·5 (14·0 to 52·4)	41·1 (12·8 to 48·3)	−0·1% (−0·4 to 0·4)	−0·6% (−1·0 to −0·3)
Residential radon	25·7 (0·0 to 37·3)	25·2 (0·0 to 36·8)	25·0 (0·0 to 36·8)	−0·1% (−0·2 to 0·1)	0·0% (−0·2 to 0·1)
Lead exposure	49·2 (8·1 to 60·7)	53·1 (8·4 to 62·1)	48·1 (7·3 to 56·4)	−0·1% (−0·5 to 0·4)	−0·8% (−1·2 to −0·4)
Occupational risks	3·8 (2·4 to 8·2)	3·9 (2·6 to 8·3)	3·8 (2·5 to 8·3)	0·0% (−0·1 to 0·2)	−0·1% (−0·3 to 0·1)
Occupational carcinogens	0·9 (0·7 to 1·6)	1·1 (0·8 to 1·8)	1·1 (0·8 to 1·9)	0·6% (0·4 to 0·7)	0·4% (0·2 to 0·5)
Occupational exposure to asbestos	2·3 (2·2 to 2·4)	2·2 (2·1 to 2·3)	2·0 (1·9 to 2·2)	−0·4% (−0·7 to −0·2)	−0·8% (−1·1 to −0·5)
Occupational exposure to arsenic	0·4 (0·1 to 0·8)	0·5 (0·1 to 0·9)	0·5 (0·2 to 0·9)	0·3% (0·1 to 0·8)	0·1% (−0·1 to 0·5)
Occupational exposure to benzene	0·7 (0·3 to 1·7)	0·9 (0·4 to 2·0)	1·0 (0·5 to 2·1)	0·8% (0·6 to 1·1)	0·7% (0·5 to 0·9)
Occupational exposure to beryllium	0·1 (0·1 to 0·1)	0·1 (0·1 to 0·1)	0·1 (0·1 to 0·1)	0·5% (0·4 to 0·5)	0·3% (0·2 to 0·4)
Occupational exposure to cadmium	0·2 (0·2 to 0·2)	0·2 (0·2 to 0·2)	0·2 (0·2 to 0·2)	0·7% (0·6 to 0·8)	0·4% (0·2 to 0·6)
Occupational exposure to chromium	0·4 (0·4 to 0·4)	0·5 (0·4 to 0·5)	0·5 (0·5 to 0·5)	1·0% (0·9 to 1·0)	0·6% (0·4 to 0·9)
Occupational exposure to diesel engine exhaust	1·7 (1·7 to 1·7)	2·3 (2·2 to 2·3)	2·6 (2·6 to 2·7)	1·3% (1·2 to 1·3)	1·1% (0·9 to 1·2)
Occupational exposure to formaldehyde	0·8 (0·7 to 0·8)	0·9 (0·9 to 1·0)	1·0 (0·9 to 1·0)	0·7% (0·6 to 0·8)	0·4% (0·1 to 0·6)
Occupational exposure to nickel	0·4 (0·1 to 1·3)	0·5 (0·1 to 1·3)	0·5 (0·1 to 1·3)	0·2% (0·0 to 0·7)	0·1% (−0·2 to 0·5)
Occupational exposure to polycyclic aromatic hydrocarbons	0·7 (0·7 to 0·7)	0·9 (0·9 to 1·0)	1·0 (1·0 to 1·0)	1·0% (0·9 to 1·0)	0·7% (0·4 to 0·9)
Occupational exposure to silica	4·1 (1·7 to 9·8)	4·4 (2·1 to 10·0)	4·6 (2·2 to 10·3)	0·3% (0·1 to 0·7)	0·3% (0·1 to 0·5)
Occupational exposure to sulphuric acid	1·0 (0·6 to 2·0)	1·0 (0·7 to 2·0)	1·0 (0·7 to 2·0)	0·2% (0·0 to 0·4)	0·0% (−0·2 to 0·2)
Occupational exposure to trichloroethylene	0·2 (0·2 to 0·2)	0·3 (0·3 to 0·3)	0·3 (0·3 to 0·3)	1·0% (0·9 to 1·1)	0·7% (0·5 to 0·9)
Occupational asthmagens	17·9 (15·4 to 20·9)	18·1 (15·6 to 21·1)	17·7 (15·5 to 20·6)	0·0% (−0·2 to 0·1)	−0·2% (−0·5 to 0·1)
Occupational particulate matter, gases, and fumes	12·3 (0·0 to 73·5)	12·3 (0·0 to 72·0)	11·6 (0·0 to 69·0)	−0·2% (−0·3 to 0·0)	−0·4% (−0·6 to 0·0)
Occupational noise	10·6 (10·2 to 11·2)	10·9 (10·5 to 11·4)	10·7 (10·3 to 11·2)	0·0% (0·0 to 0·0)	−0·2% (−0·2 to −0·1)
Occupational injuries	NA	NA	NA	NA	NA
Occupational ergonomic factors	40·2 (0·0 to 79·6)	39·8 (0·0 to 81·9)	38·2 (0·0 to 82·1)	−0·2% (−0·3 to 0·1)	−0·3% (−0·6 to 0·0)
Behavioural risks	20·2 (16·7 to 22·4)	18·9 (15·9 to 20·9)	17·8 (14·6 to 19·8)	−0·4% (−0·6 to −0·2)	−0·4% (−0·7 to −0·2)
Child and maternal malnutrition	8·8 (4·5 to 14·7)	8·6 (4·5 to 14·3)	8·4 (4·2 to 13·8)	−0·1% (−0·4 to 0·2)	−0·2% (−0·6 to 0·2)
Suboptimal breastfeeding	38·7 (35·3 to 42·9)	33·9 (30·8 to 37·8)	32·3 (29·3 to 35·7)	−0·6% (−0·6 to −0·5)	−0·4% (−0·5 to −0·2)
Non-exclusive breastfeeding	43·7 (30·9 to 58·5)	38·8 (27·6 to 52·4)	35·7 (26·0 to 47·5)	−0·6% (−0·7 to −0·5)	−0·6% (−0·8 to −0·4)
Discontinued breastfeeding	41·8 (40·5 to 43·1)	36·0 (35·1 to 37·0)	34·9 (33·7 to 36·1)	−0·5% (−0·6 to −0·5)	−0·2% (−0·4 to −0·1)
Child growth failure	15·9 (10·1 to 23·0)	12·4 (7·9 to 19·0)	9·0 (5·2 to 14·9)	−1·7% (−2·6 to −1·3)	−2·5% (−4·1 to −1·6)
Child underweight	21·6 (17·4 to 25·3)	17·4 (14·1 to 20·7)	13·6 (10·8 to 16·6)	−1·4% (−1·7 to −1·3)	−1·9% (−2·4 to −1·6)
Child wasting	8·3 (5·6 to 10·5)	8·1 (5·5 to 10·1)	7·1 (4·8 to 9·2)	−0·5% (−0·9 to −0·1)	−1·0% (−2·0 to −0·3)
Child stunting	26·7 (23·7 to 28·9)	21·3 (19·1 to 23·2)	16·6 (14·7 to 18·6)	−1·4% (−1·7 to −1·2)	−1·9% (−2·6 to −1·3)
Low birthweight and short gestation	21·6 (19·0 to 24·4)	22·8 (20·1 to 25·8)	22·8 (20·2 to 25·8)	0·2% (0·1 to 0·2)	0·0% (−0·1 to 0·1)
Short gestation	31·2 (27·2 to 35·2)	32·1 (28·2 to 36·6)	31·8 (27·9 to 36·2)	0·1% (0·0 to 0·1)	−0·1% (−0·2 to 0·0)
Low birthweight	17·6 (16·0 to 19·2)	18·5 (16·9 to 20·3)	18·5 (16·9 to 20·2)	0·2% (0·1 to 0·2)	0·0% (−0·1 to 0·1)

(Table 2 continues on next page)

	SEV, 1990	SEV, 2010	SEV, 2023	Annualised rate of change, 1990–2023	Annualised rate of change, 2010–23
(Continued from previous page)					
Iron deficiency	8·5 (5·9 to 11·5)	7·9 (6·0 to 10·2)	7·3 (5·6 to 9·5)	−0·5% (−1·4 to 0·6)	−0·6% (−1·9 to 0·8)
Vitamin A deficiency	21·9 (0·0 to 38·6)	15·0 (0·0 to 22·9)	8·5 (0·0 to 13·7)	−2·9% (−3·9 to 0·0)	−4·4% (−5·5 to 0·0)
Zinc deficiency	26·4 (0·0 to 41·4)	22·3 (0·0 to 35·2)	18·5 (0·0 to 29·9)	−1·1% (−1·7 to 0·0)	−1·4% (−2·5 to 0·0)
Tobacco use	28·7 (26·8 to 30·8)	24·0 (22·7 to 25·4)	20·9 (19·6 to 22·6)	−1·0% (−1·2 to −0·6)	−1·1% (−1·6 to −0·5)
Smoking	23·4 (20·8 to 26·1)	19·2 (17·6 to 20·8)	16·2 (14·9 to 17·7)	−1·1% (−1·5 to −0·7)	−1·3% (−2·1 to −0·5)
Chewing tobacco	4·1 (2·3 to 6·8)	4·4 (3·3 to 5·9)	3·8 (2·5 to 5·8)	−0·3% (−2·1 to 1·7)	−1·1% (−4·1 to 1·9)
Second-hand smoke	43·6 (40·1 to 47·1)	37·7 (34·8 to 40·7)	33·9 (30·5 to 37·7)	−0·8% (−1·2 to −0·3)	−0·8% (−1·5 to −0·1)
High alcohol use	6·8 (4·9 to 9·5)	6·3 (4·7 to 8·6)	5·7 (4·3 to 7·8)	−0·5% (−1·0 to −0·1)	−0·8% (−1·3 to −0·2)
Drug use	0·6 (0·5 to 0·7)	0·6 (0·4 to 0·8)	0·7 (0·4 to 1·2)	0·7% (−0·4 to 1·5)	1·9% (0·5 to 2·6)
Dietary risks	39·9 (31·2 to 47·2)	38·6 (30·3 to 45·6)	38·4 (28·9 to 45·3)	−0·1% (−0·5 to 0·3)	0·0% (−0·7 to 0·6)
Diet low in fruits	42·9 (34·2 to 49·5)	40·7 (32·9 to 45·0)	40·5 (33·7 to 46·6)	−0·2% (−0·7 to 0·5)	0·0% (−1·1 to 0·8)
Diet low in vegetables	28·9 (17·0 to 36·5)	26·4 (16·0 to 31·4)	26·1 (15·2 to 31·9)	−0·3% (−1·1 to 0·4)	−0·1% (−1·5 to 1·2)
Diet low in legumes	50·9 (0·0 to 67·0)	43·8 (0·0 to 58·7)	42·2 (0·0 to 58·7)	−0·6% (−1·5 to 0·4)	−0·3% (−2·3 to 1·7)
Diet low in wholegrains	40·3 (31·2 to 50·6)	40·1 (31·9 to 49·9)	40·5 (30·9 to 51·4)	0·0% (−0·9 to 1·0)	0·1% (−1·7 to 1·6)
Diet low in nuts and seeds	56·7 (47·3 to 67·3)	45·3 (37·6 to 52·1)	42·0 (31·5 to 53·0)	−0·9% (−1·9 to 0·0)	−0·6% (−2·4 to 1·0)
Diet low in milk	63·1 (58·1 to 72·8)	65·0 (62·0 to 74·3)	65·1 (61·5 to 74·1)	0·1% (−0·2 to 0·3)	0·0% (−0·3 to 0·3)
Diet high in red meat	26·1 (0·0 to 39·6)	26·3 (0·0 to 38·9)	26·7 (0·0 to 40·4)	0·1% (−0·7 to 1·1)	0·1% (−1·7 to 2·0)
Diet high in processed meat	13·0 (9·1 to 17·6)	13·0 (10·5 to 15·7)	13·7 (10·8 to 17·1)	0·2% (−0·9 to 1·1)	0·4% (−1·9 to 2·4)
Diet high in sugar-sweetened beverages	10·2 (4·3 to 18·3)	13·6 (10·3 to 17·7)	16·7 (11·9 to 23·4)	1·5% (−0·4 to 4·3)	1·6% (−1·4 to 5·0)
Diet low in fibre	30·8 (16·7 to 47·5)	25·1 (14·0 to 41·1)	20·7 (9·3 to 35·2)	−1·2% (−3·7 to 1·1)	−1·5% (−5·3 to 1·7)
Diet low in calcium	28·1 (24·1 to 38·1)	22·8 (19·4 to 29·3)	20·3 (17·1 to 26·8)	−1·0% (−1·6 to −0·4)	−0·9% (−1·9 to 0·1)
Diet low in seafood omega-3 fatty acids	44·7 (31·8 to 56·1)	35·0 (21·6 to 46·9)	28·9 (15·4 to 42·9)	−1·3% (−2·9 to 0·1)	−1·5% (−5·2 to 1·1)
Diet low in omega-6 polyunsaturated fatty acids	69·1 (41·2 to 82·8)	61·4 (35·7 to 75·9)	57·8 (34·3 to 73·4)	−0·5% (−1·0 to −0·1)	−0·5% (−1·5 to 0·4)
Diet high in trans fatty acids	47·7 (32·6 to 61·1)	41·9 (29·3 to 54·4)	29·5 (19·8 to 40·2)	−1·5% (−2·8 to 0·0)	−2·7% (−5·6 to 0·6)
Diet high in sodium	41·3 (18·2 to 66·5)	42·0 (19·3 to 69·2)	41·1 (16·6 to 67·2)	0·0% (−1·4 to 1·4)	−0·2% (−2·5 to 1·9)
Intimate partner violence	18·3 (8·4 to 32·5)	17·6 (9·9 to 23·7)	17·4 (11·1 to 21·6)	−0·2% (−1·5 to 1·5)	−0·1% (−1·8 to 1·8)
Sexual violence against children and bullying	12·2 (6·6 to 20·4)	12·6 (7·8 to 18·6)	12·2 (7·5 to 18·0)	0·0% (−1·4 to 1·4)	−0·2% (−2·2 to 1·7)
Sexual violence against children	14·6 (6·9 to 25·0)	14·6 (8·0 to 22·5)	14·7 (8·6 to 22·4)	0·0% (−1·6 to 1·7)	0·0% (−2·2 to 2·4)
Bullying victimisation	5·5 (2·5 to 10·5)	6·3 (3·0 to 11·9)	5·0 (2·5 to 9·2)	−0·3% (−0·7 to 0·2)	−1·9% (−2·6 to −1·0)
Unsafe sex	NA	NA	NA	NA	NA
Low physical activity	16·8 (14·0 to 19·5)	17·3 (14·5 to 20·3)	18·5 (15·6 to 21·5)	0·3% (0·1 to 0·5)	0·5% (0·2 to 0·8)
Metabolic risks	14·3 (12·5 to 16·9)	17·5 (15·9 to 19·2)	20·3 (18·3 to 22·4)	1·0% (0·6 to 1·6)	1·1% (0·3 to 2·0)
High fasting plasma glucose	14·4 (9·5 to 22·9)	15·3 (11·8 to 22·3)	17·6 (13·0 to 24·8)	0·6% (−0·9 to 2·2)	1·0% (−1·2 to 3·3)
High LDL cholesterol	44·6 (35·9 to 54·4)	43·5 (35·8 to 53·2)	44·2 (35·8 to 54·4)	0·0% (−0·8 to 0·7)	0·1% (−1·0 to 1·3)
High systolic blood pressure	27·3 (15·9 to 42·4)	28·4 (22·3 to 36·7)	30·3 (25·0 to 36·0)	0·3% (−1·0 to 1·7)	0·5% (−1·3 to 2·1)
High BMI	13·2 (11·1 to 15·6)	17·2 (15·6 to 18·7)	20·4 (18·6 to 22·5)	1·3% (0·8 to 1·9)	1·3% (0·5 to 2·2)
Low bone mineral density	22·7 (17·3 to 29·3)	21·6 (16·3 to 28·1)	21·1 (16·0 to 27·7)	−0·2% (−0·3 to −0·2)	−0·2% (−0·3 to 0·0)
Kidney dysfunction	2·9 (1·9 to 4·9)	2·9 (1·9 to 4·8)	2·9 (2·0 to 4·9)	0·0% (−0·1 to 0·1)	0·1% (0·1 to 0·2)

Data in parentheses are 95% uncertainty intervals. NA is given to indicate risk factors for which SEVs are not calculated because a direct PAF approach is used—ie, PAFs are calculated directly from the disease rather than generated with the standard set of analytical processes. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study. NA=not applicable. PAF=population attributable fraction. SEV=summary exposure value.

Table 2: **Global age-standardised SEVs in 1990, 2010, and 2023, and annualised rate of change over 1990–2023 and 2010–23, by GBD risk factor**

Age-standardised DALY rates for CMNN diseases decreased between 2010 and 2023 in all SDI quintiles, ranging from a decrease of 34·9% (31·6–38·0) in the low SDI quintile to a decrease of 13·0% (7·2–17·8) in the high SDI quintile. Age-specific DALY rates for CMNN diseases were higher in females than in males in age groups younger than 45 years, and markedly higher among males than females in age groups 45 years and older (figure 4).

Age-standardised DALY rates for injuries in males in 2023 ranged from 4271·2 (95% UI 3792·2–4896·0) per 100 000 in the high SDI quintile to 6401·8 (5445·7–7262·9) per 100 000 in the low SDI quintile. In females, age-standardised DALY rates ranged from 2042·6 (1759·3–2331·2) per 100 000 in the middle SDI quintile to 3381·1 (2789·3–3977·4) per 100 000 in the low SDI quintile (GBD 2023 Results Tool and GBD Compare).

Age-standardised DALY rates for injuries decreased between 2010 and 2023 in all SDI quintiles, ranging from a decrease of 13·5% (10·2–16·1) in the high SDI quintile to a decrease of 20·2% (15·7–23·6) in the high-middle SDI quintile. Across all SDI quintiles, DALY rates for injuries emerged 0–6 days after birth, declined between the age groups of 7–27 days after birth and 5–9 years, and increased with age thereafter. For age 15 years and older, DALY rates for injuries in males remained relatively stable with increasing age, except after about the age of 70 years, when it increased; for females, rates increased steadily with age after 40 years (figure 4).

Drivers of changes in DALYs by location are further illustrated in figure 5, which shows the ten leading level 3 causes of DALYs in 2023 and their annualised rate of change (ARC) between 2010 and 2023 by region, super-region, and SDI quintile. In the low SDI quintile, six of the ten leading level 3 causes of DALYs were CMNN diseases, led by neonatal disorders (92·6 million [95% UI 85·7–100] DALYs), lower respiratory infections (48·1 million [40·2–58·0]), and malaria (41·9 million [17·5–77·3]; GBD 2023 Results Tool). As SDI increased, more NCDs emerged in the top ten leading causes of DALYs (figure 5). In the high SDI quintile, nine of the ten leading level 3 causes of DALYs were NCDs, with the top three causes in total DALYs being ischaemic heart disease (71·0 million [65·7–74·8] DALYs), stroke (49·7 million [45·2–53·2]), and falls (33·1 million [25·6–43·2]). The largest changes in age-standardised DALY rates for ischaemic heart disease between 2010 and 2023 ranged from a non-significant increase of 7·7% (–13·7 to 30·3) in low SDI locations to a decrease of 25·5% (22·9 to 28·1) in high SDI locations (GBD 2023 Results Tool).

The leading level 3 causes of age-standardised DALY rates by location in 2023 are shown in appendix 3 (figure S1). Ischaemic heart disease was the leading cause of age-standardised DALY rates in 73 (35·8%) of 204 countries and territories. COVID-19 was not a leading cause of global DALYs in 2023. In sub-Saharan Africa, neonatal disorders, HIV/AIDS, malaria, and lower respiratory infections were the leading level 3 causes of burden in 27 countries in western and eastern sub-Saharan Africa, with HIV/AIDS leading in all continental countries in central sub-Saharan Africa, bar DR Congo and the Central African Republic. Ischaemic heart disease was the leading cause of burden in ten countries and territories in north Africa and the Middle East, five countries and territories in western Europe, and six countries and territories in central Asia. Stroke was the most burdensome cause in most locations in east Asia (appendix 3 figure S1).

Trends in exposure to risk factors, 2010–23

At level 1 of the risk factor hierarchy (appendix 2 table S15), age-standardised SEVs grew between 2010 and 2023 only for metabolic risks, with an increasing mean ARC of 1·1% (95% UI 0·3–2·0; table 2). Conversely, there were small but significant decreases in SEVs for environmental and occupational risks and for behavioural risks, with ARC decreases of 0·8% (0·5–1·1) and 0·4% (0·2–0·7), respectively. Among specific level 2 risk factors, exposure increased significantly between 2010 and 2023 only for high BMI (ARC 1·3% [0·5–2·2]), kidney dysfunction (0·1% [0·1–0·2]), drug use (1·9% [0·5–2·6]), and low physical activity (0·5% [0·2–0·8]). Level 2 risk factors that showed significant declines in

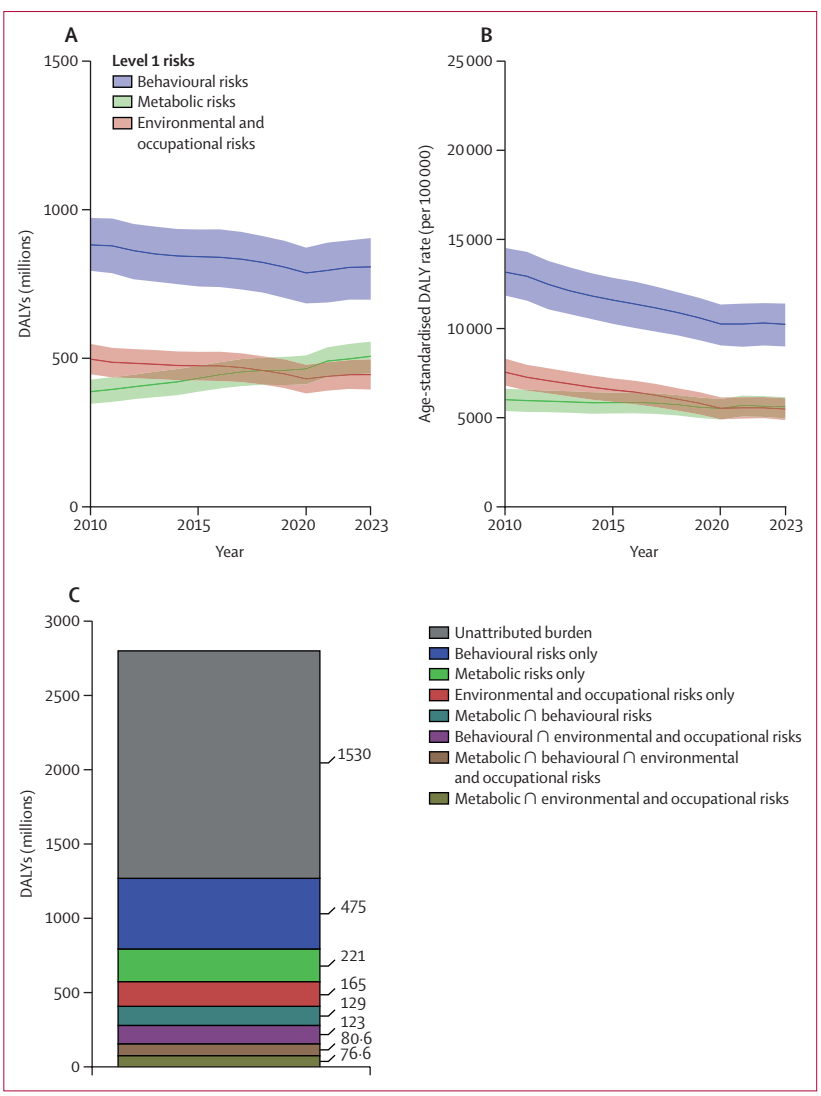


Figure 6: **Global DALYs attributable to GBD level 1 risk factors**
(A) Global DALY counts attributable to level 1 risks, 2010–23. (B) Age-standardised DALY rates attributable to level 1 risks, 2010–23. (C) Global total DALY counts unattributed or attributable to level 1 risk factors, 2023. Mean estimates by level 1 risk factor in panels A and B are represented by coloured lines; the shading indicates 95% uncertainty intervals. For panel C, ∩ refers to a burden that is attributed to two or all three level 1 risk factors (ie, the intersecting set of DALYs that belong to both or all three risk factors). Mean estimates in panels A and B are aggregated to include all DALYs attributable exclusively to the specific level 1 risk factor plus those attributable to the intersection of that risk and one or both of the other level 1 risk factors (ie, for a single year, the DALY counts combined across the three lines sum to more than the total number of attributable DALYs for that year). In GBD 2023, 45·6% of total global DALYs were attributable to risk factors (appendix 3 table S13). DALY=disability-adjusted life-year. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study.

SEVs between 2010 and 2023 included unsafe water, sanitation, and handwashing, with a decreasing ARC of 1·4% (0·3–2·6), air pollution (decrease of 1·4% [1·2–1·7]), and tobacco use (decrease of 1·1% [0·5–1·6]). Results at more disaggregated levels of the risk factor hierarchy reveal that SEVs for some components of air pollution decreased, with household air pollution from solid fuels declining at an ARC of 3·2% (2·5–3·7), while exposure to ambient particulate matter and ambient ozone pollution increased, rising by 1·2% (0·9–1·5) and 1·3% (1·1–1·4), respectively. Age-standardised SEVs and percentage change over time by risk factor and sex are provided in appendix 3 (table S15).

Risk-attributable DALYs by age, sex, and location

For level 1 risks, attributable global disease burden measured in DALY counts was highest in 2023 for behavioural risk factors (808 million [95% UI 697–905] attributable DALYs or 28·9% [25·1–32·0] of 2·80 billion total DALYs in 2023), followed by metabolic risks (507 million [449–556] or 18·1% [16·6–19·7]) and then environmental and occupational risks (445 million [395–496] or 16·0% [14·1–18·0]; figure 6). In aggregate, 1·27 billion (1·18–1·38) global DALYs (45·5% [43·4–47·8] of 2·80 billion total DALYs in 2023) were attributable to all 88 GBD 2023 risk factors combined (appendix 3 table S13). Further disaggregation of risk-attributable burden estimates showed that when ranked by percentage of total DALYs, high SBP was the leading level 3 risk globally in 2023 (8·4% [6·9–10·0] of total DALYs; figure 7; see appendix 3 table S13 for DALYs by outcome). Particulate matter pollution (encompassing both ambient and household air pollution) was the second leading risk (8·2% [6·7–9·7] of total DALYs),

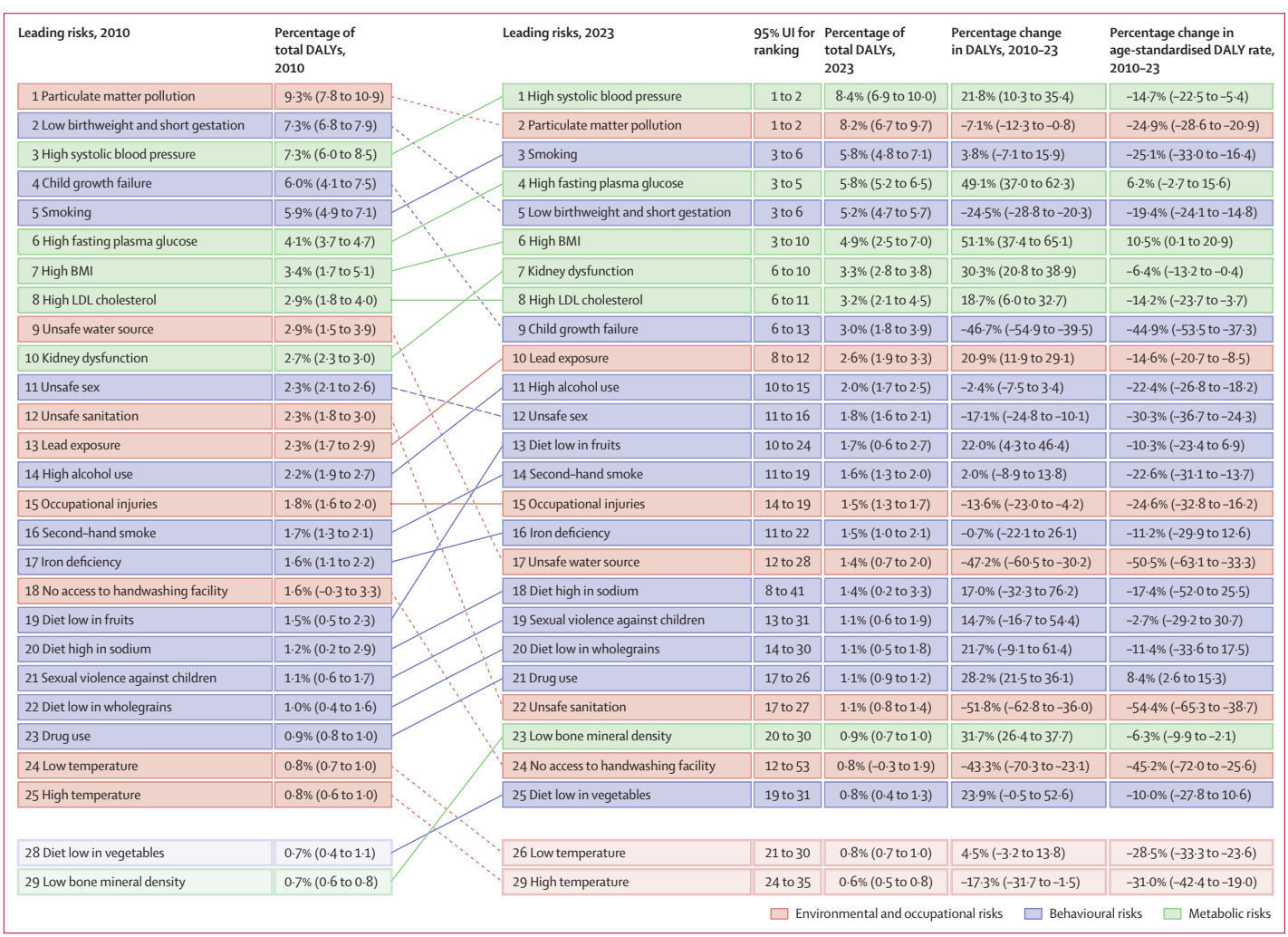
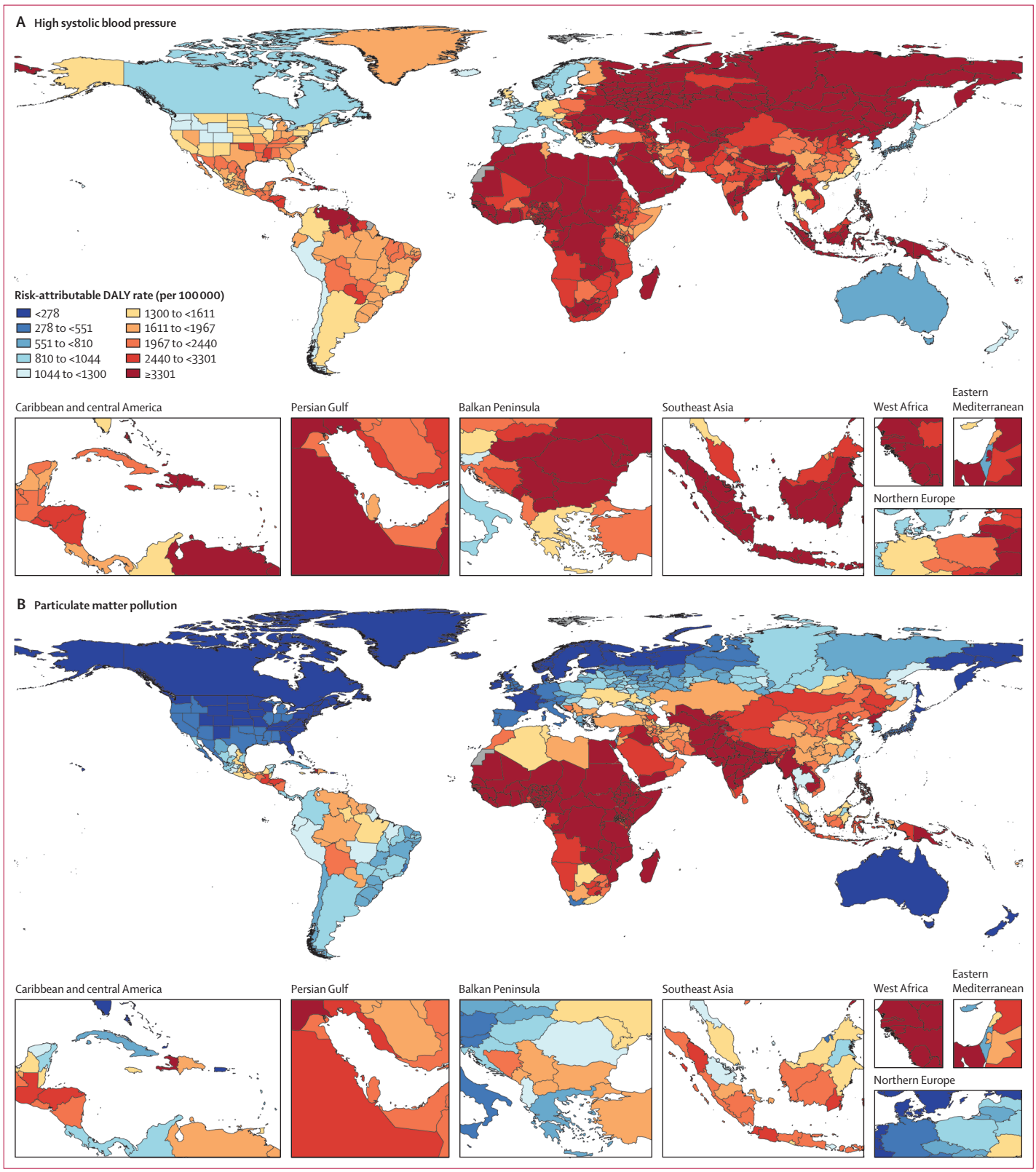


***Figure 7*: Leading 25 GBD level 3 risk factors by attributable DALYs as a percentage of total DALY counts (2010 and 2023), and percentage change in attributable DALY counts and age-standardised DALY rates from 2010 to 2023**

Each column displays the top 25 risks in descending order for the specified year. Risk factors are connected by lines between time periods; solid lines represent an increase or lateral shift in ranking, and dashed lines represent a decrease in rank. Faded colours indicate that the cause is not within the top 25 causes of DALYs for that year. Data in parentheses are 95% UIs. DALY=disability-adjusted life-year. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study. UI=uncertainty interval.



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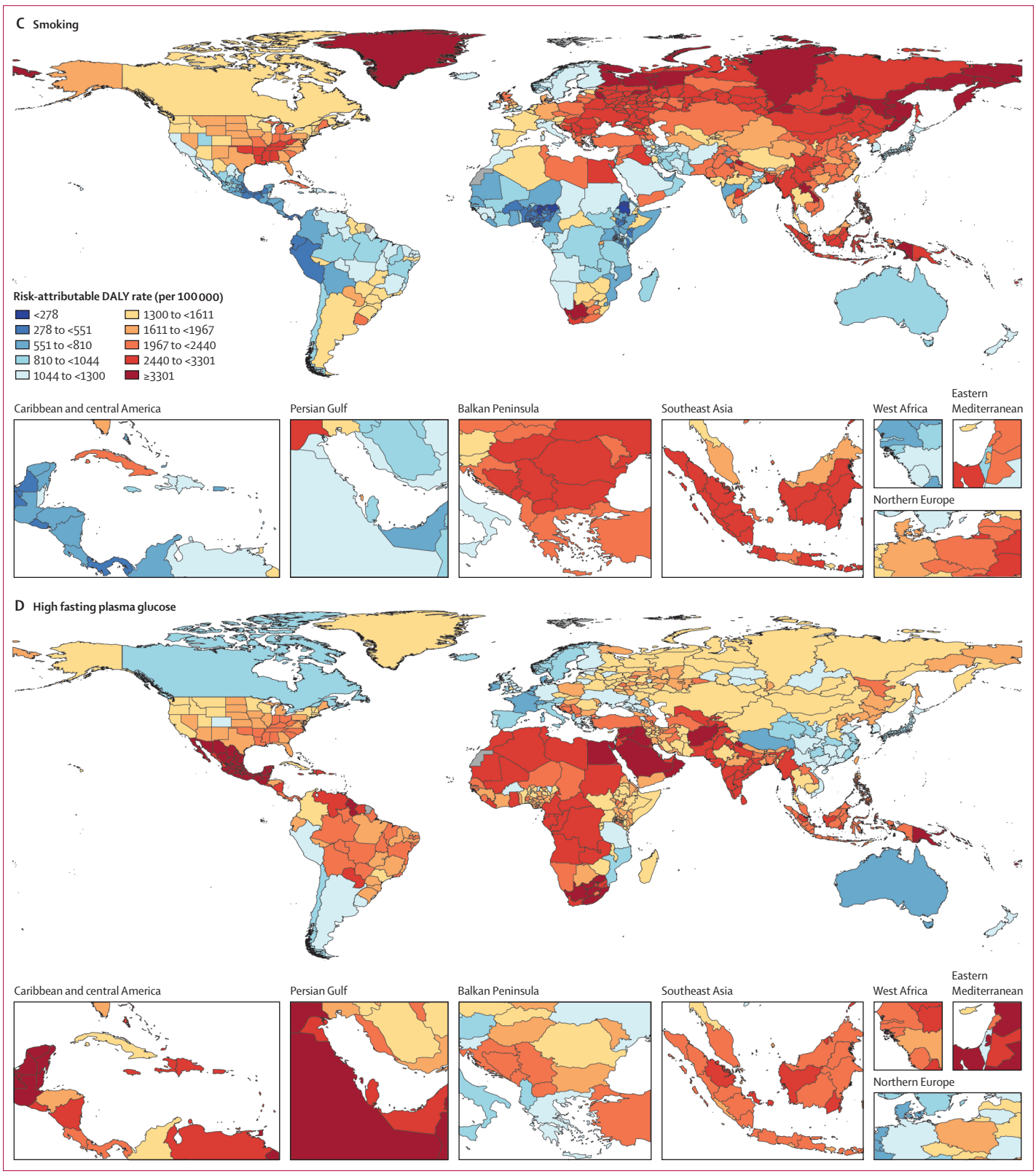

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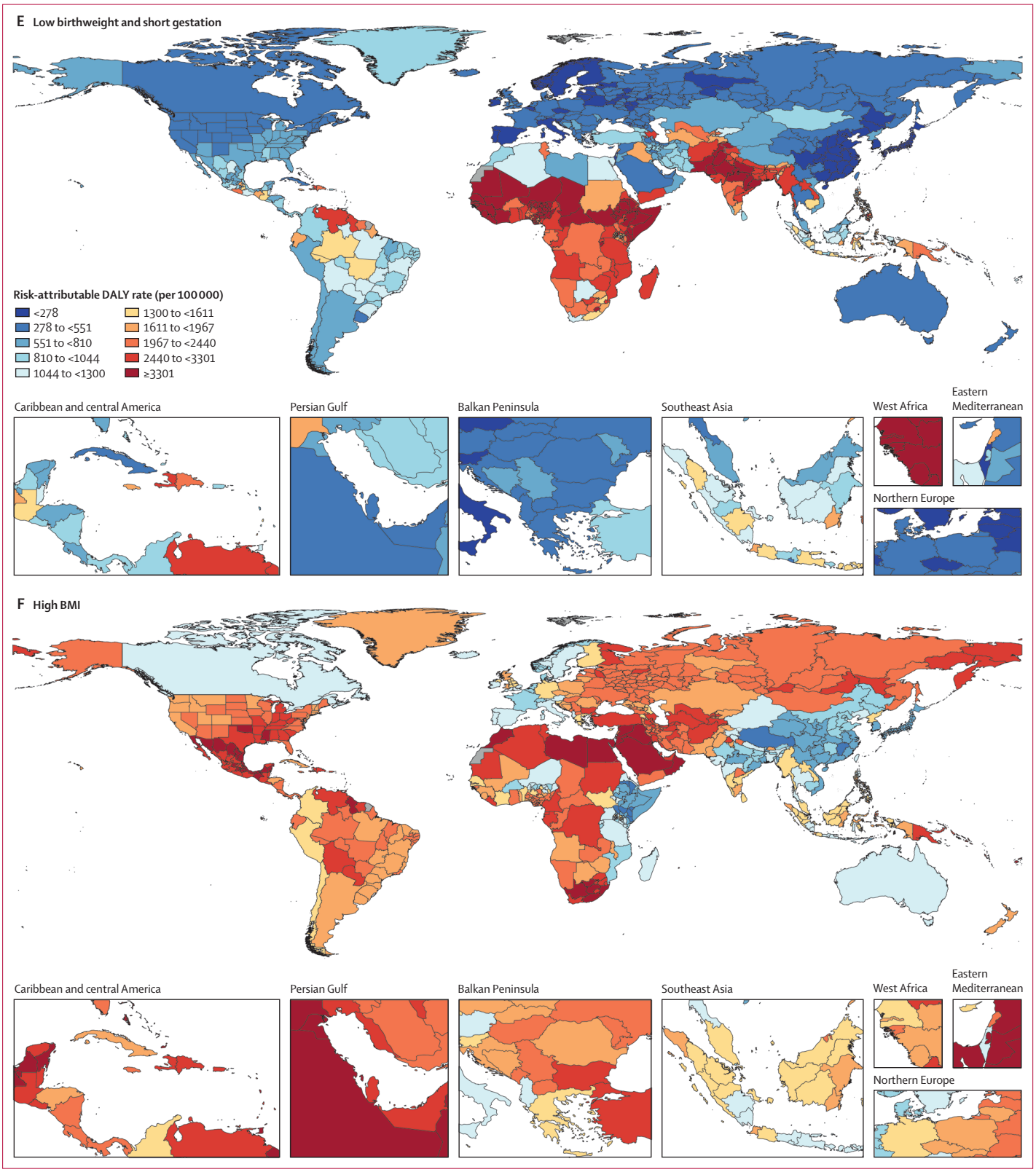

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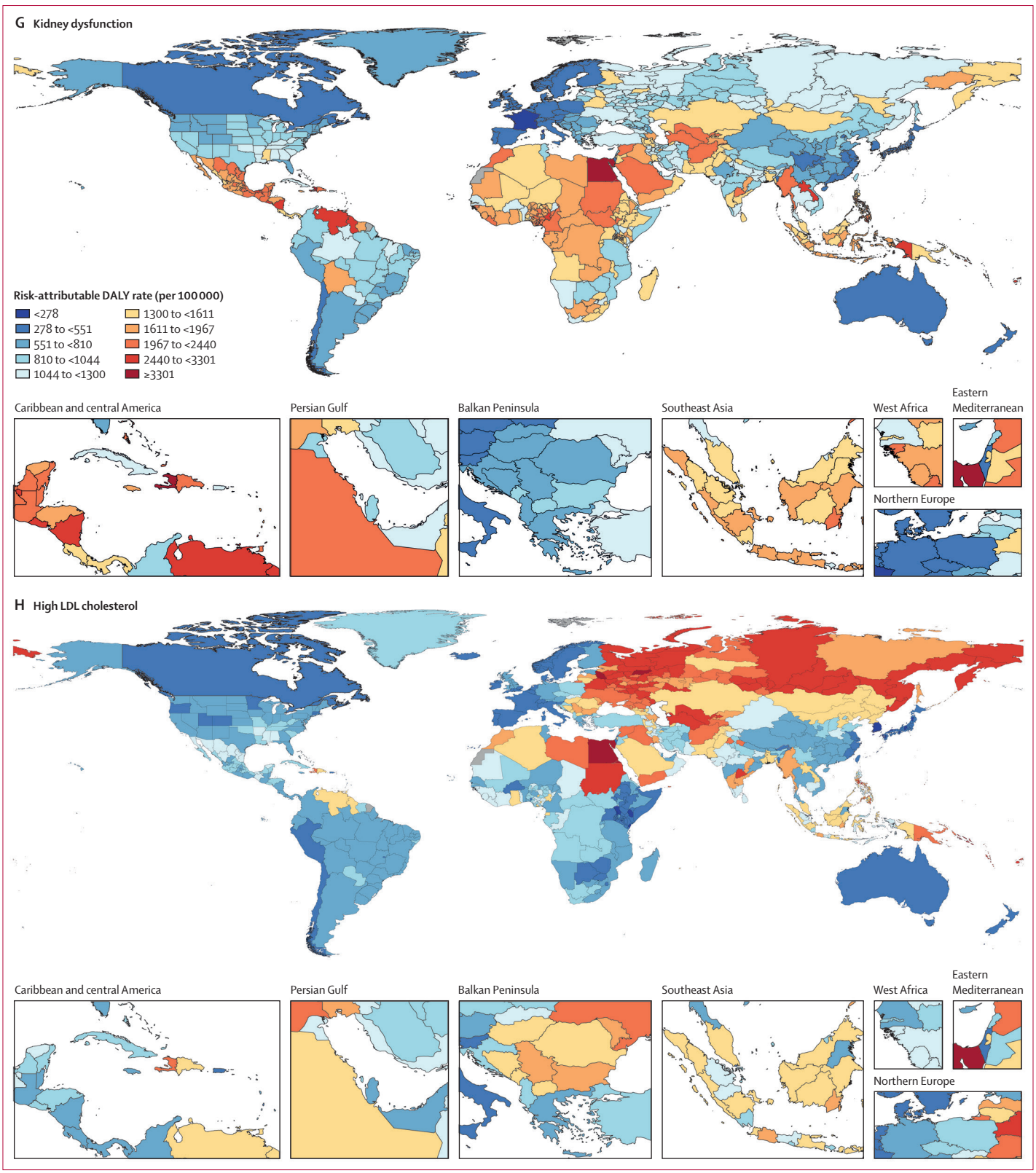

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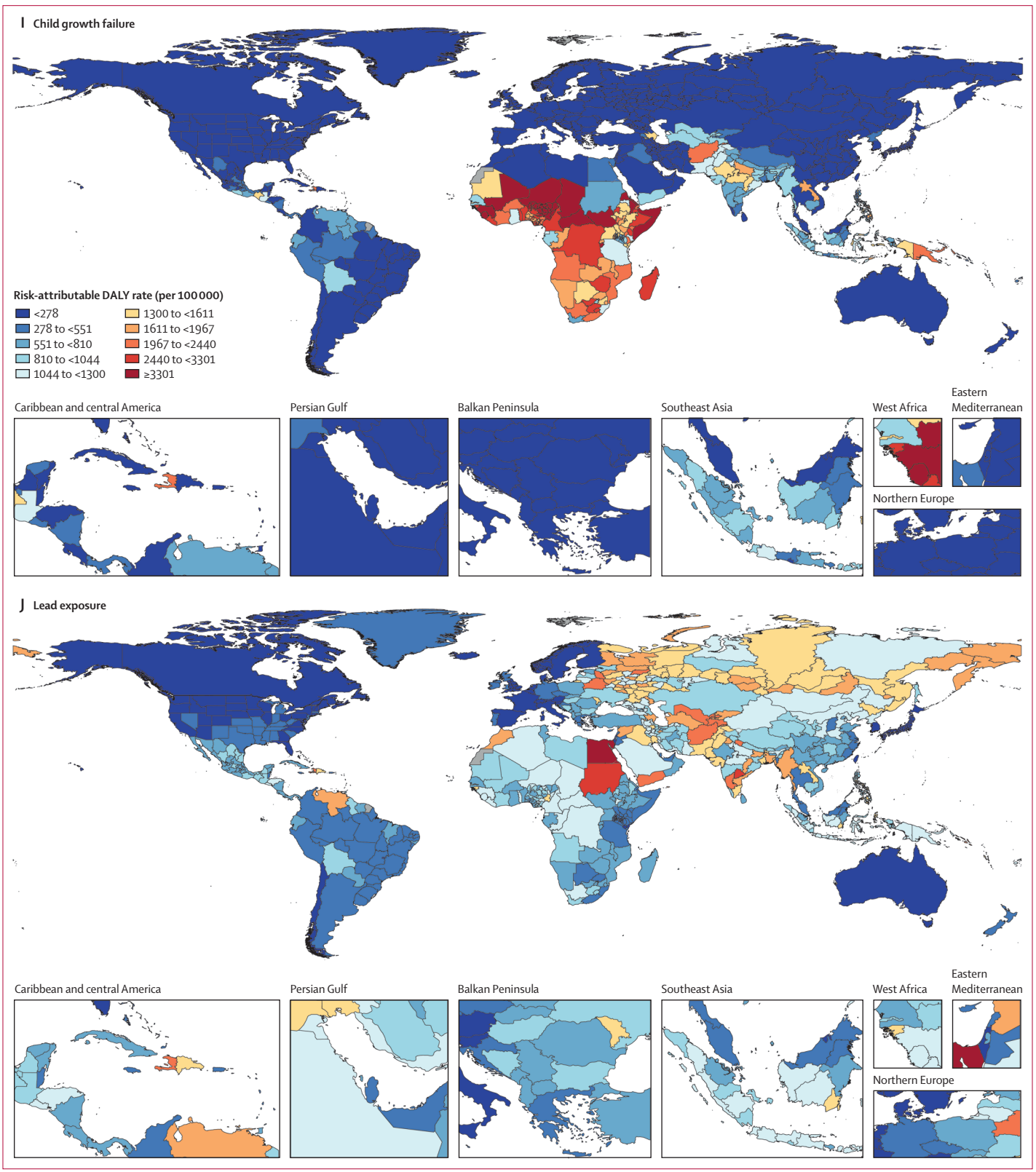

Figure 8: **Age-standardised DALY rate attributable to the ten leading GBD level 3 risk factors, ranked by percentage of total DALY counts, by location, 2023**
High systolic blood pressure (A), particulate matter pollution (B), smoking (C), high fasting plasma glucose (D), low birthweight and short gestation (E), high BMI (F), high LDL cholesterol (G), kidney dysfunction (H) child growth failure (I), and lead exposure (J). Dotted lines indicate disputed territories. DALY=disability-adjusted life-year. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study.

smoking ranked third (5·8% [4·8–7·1]), high FPG ranked fourth 5·8% [5·2–6·5]), and low birthweight and short gestation ranked fifth (5·2% [4·7–5·7]). Of the 25 leading level 3 risk factors in 2023, more than half (13) were behavioural risks.

The contribution of level 3 risk factors to global DALYs in 2023 varied by age (appendix 3 figure S2A–E) and sex (appendix 3 figure S2F–G). Among children younger than 5 years, risks related to child and maternal malnutrition, particulate matter pollution, and unsafe water, sanitation, and handwashing were leading level 3 risk factors, with no metabolic risks among the top ten. For children and adolescents aged 5–14 years, iron deficiency was the leading risk, followed by others related to unsafe water, sanitation, and handwashing, and child and maternal malnutrition. For the age group of 15–49 years, the top two risks were unsafe sex and occupational injuries. Metabolic risk factors gained prominence in this group, with high BMI and high SBP the third-ranked and fourth-ranked risks, followed by high alcohol use. For individuals aged 50–69 years, high SBP and smoking were the top risks, with metabolic risks such as high FPG, high BMI, high LDL cholesterol, and kidney dysfunction also prominent. A similar pattern was seen for individuals aged 70 years and older. The top ten risks for all-age females and males were similar, although smoking was the leading risk for males, but the 12th-ranked risk for females. Additionally, high alcohol use was the ninth-ranked risk factor among males, but for females was not among the top 25 risks. By contrast, unsafe sex and iron deficiency were the ninth-ranked and 11th-ranked risks, respectively, for females, but ranked 19th and 23rd for males.

The 2023 disease burden attributable to risk factors varied considerably by geography, as illustrated by the global distribution of age-standardised risk-attributable DALY rates for all GBD risk factors combined (appendix 3 figure S3) and maps of rates attributable to the ten leading global level 3 risks (figure 8; ranked according to percentage of total DALY counts). Age-standardised attributable DALY rates for high SBP, the leading level 3 risk factor in 2023, were highest in the super-regions of north Africa and the Middle East and central Europe, eastern Europe, and central Asia (figure 8A). At a regional level, high SBP was the leading contributor to burden in central Asia (highest in Tajikistan, at 7298·3 [95% UI 5930·8–8496·6] age-standardised DALYs per 100 000), Oceania (highest in Nauru, at 12 800·7 [10 101·2–15 840·3] age-standardised DALYs per 100 000), north Africa and the Middle East (highest in Egypt, at 8241·6 [6389·3–10 311·6] age-standardised DALYs per 100 000), eastern Europe (highest in Belarus, at 5604·4 [4514·0–6479·7] age-standardised DALYs per 100 000), southeast Asia (highest in Myanmar, at 6429·9 [4736·2–8134·3] age-standardised DALYs per 100 000), central sub-Saharan Africa (highest in the Central African Republic, at 4557·5 [3212·2–6066·3] age-standardised DALYs per 100 000), and western sub-Saharan Africa (highest in Guinea-Bissau, at 5541·2 [4302·6–6899·5] age-standardised DALYs per 100 000; figure 9; appendix 3 table S13). High SBP was the leading contributor to age-standardised burden in the middle, high-middle, and high SDI quintiles and the second-ranked contributor in the low and low-middle SDI groups (figure 9).

Attributable age-standardised 2023 DALY rates per 100 000 for the second leading risk, particulate matter pollution, were highest at the super-region level in south Asia, sub-Saharan Africa, and north Africa and the Middle East (figure 8B), and at the regional level in Oceania (highest in the Solomon Islands, at 10 226·8 [95% UI 8375·4–12 034·4]), south Asia (highest in Bangladesh, at 6095·0 [5340·3–6971·4]), and central, eastern, and western sub-Saharan Africa (highest in the Central African Republic, at 7933·3 [6052·0–9660·4], South Sudan, at 6524·5 [5025·2–7984·6], and Chad, at 7342·7 [5849·1–8652·9], respectively; figure 9; appendix 3 table S13). Particulate matter pollution was the leading level 3 risk factor in the low and low-middle SDI groups and the second leading risk factor in middle and high-middle SDI groups (figure 9). Smoking, the third leading level 3 contributor to global burden (as measured by percentage of total DALY counts), exhibited the highest age-standardised DALYs per 100 000 in central Europe, eastern Europe, and central Asia; southeast Asia, east Asia, and Oceania; north Africa and the Middle East; and south Asia super-regions (figure 8C). At a regional level, smoking was the leading risk in high-income Asia Pacific and western Europe (highest in Brunei, at 1581·3 [1123·5–2185·0] age-standardised DALYs per 100 000, and in Monaco, at 2204·1 [1637·0–2880·9] age-standardised DALYs per 100 000, respectively; figure 9; appendix 3 table S13). Smoking was the third leading risk in the middle SDI group (figure 9).

Global maps of 2023 age-standardised risk-attributable burden for the fourth to the tenth leading level 3 risk factors—high FPG, low birthweight and short gestation, high BMI, kidney dysfunction, high LDL cholesterol, child growth failure, and lead exposure—are shown in figure 8D–J. Of these risks, high FPG was the leading risk factor at a regional level in central Latin America, and high BMI was the top risk in Australasia, southern Latin America, Andean Latin America, and tropical Latin America (figure 9). Notably, in only two of 21 GBD regions were the leading risk factors not reflected in the top ten level 3 risks globally; these were high-income North America (and correspondingly the high SDI quintile), where drug use was the leading risk, and southern sub-Saharan Africa, where unsafe sex was the top risk (figure 9).

See appendix 3 for detailed estimates related to the attributable burden, including relative risks (table S17) and PAFs (tables S13, S14, S16) used to calculate attributable burden, and attributable burden measured

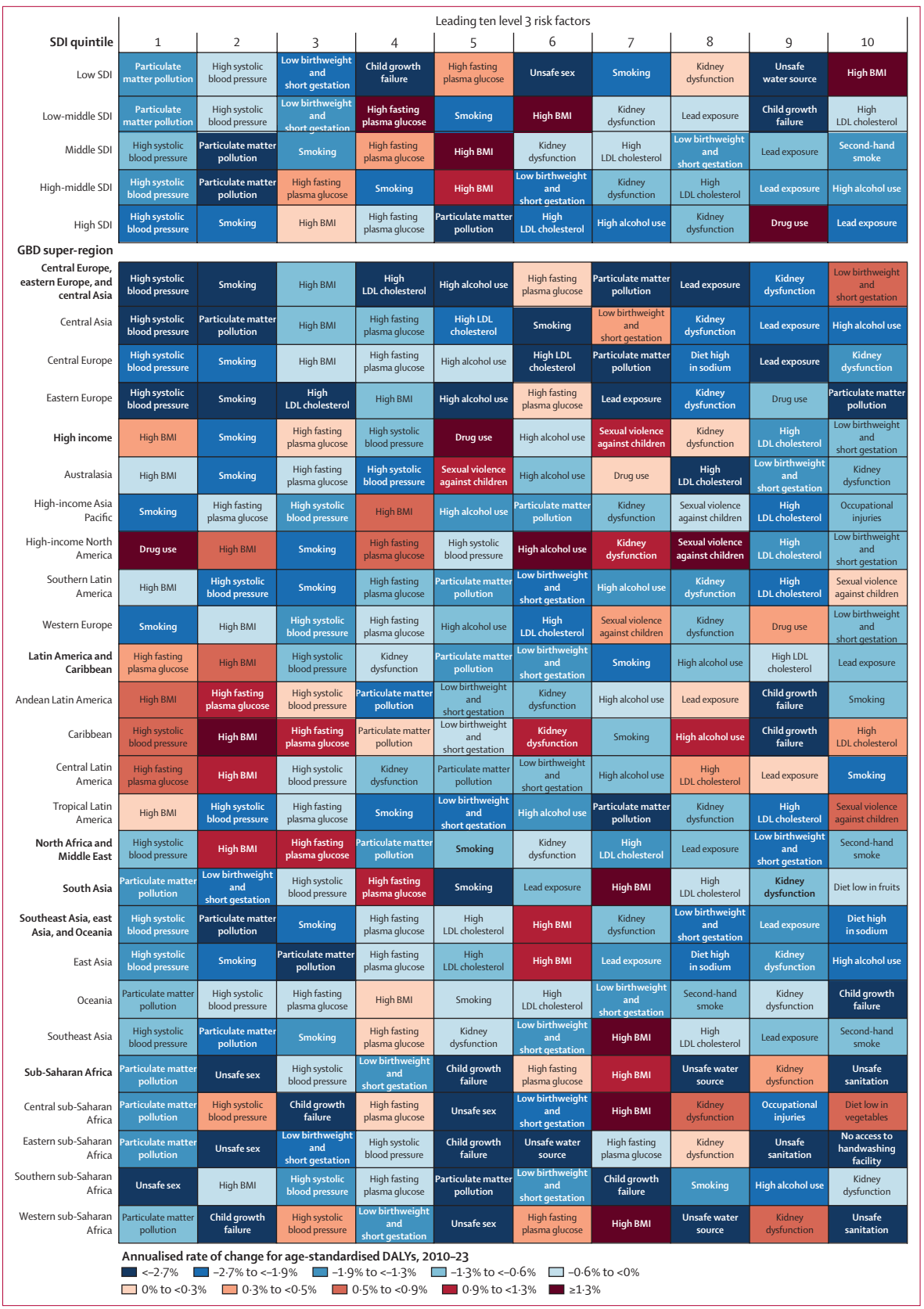

Figure 9: **Leading ten GBD level 3 risk factors for 2023 attributable age-standardised DALY rates by SDI quintile, GBD region and super-region, and annualised rate of change between 2010 and 2023**

For each region and super-region (in bold) and SDI quintile, level 3 risk factors are ranked by attributable age-standardised DALY rates from left (first) to right (tenth). DALY=disability-adjusted life-year. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study. SDI=Socio-demographic Index.

in DALYs (table S13) and attributable deaths (table S14) presented for each risk factor and outcome, across geography and time.

Trends in risk-attributable DALYs, 2010–23

Over the period 2010–23, all-age global DALY counts attributable to behavioural risks declined by 8·4% (95% UI 4·5–13·2), and those attributable to environmental and occupational risks declined by 10·4% (5·3–15·0). Conversely, global counts attributable to metabolic risks increased by 30·7% (24·8–37·3; figure 6; appendix 3 table S13). This seeming contradiction is due largely to the greater impact of metabolic risk factors on increasingly ageing populations, as evidenced by the decrease of 6·7% (2·0–11·0) seen in age-standardised global DALY rates attributable to metabolic risks over the same period. Notably, however, this decline in age-standardised DALY rates for metabolic risk factors was less pronounced than it was for behavioural risks (decline of 22·2% [19·2–25·4]) and environmental and occupational risks (decline of 27·3% [23·4–31·1]; figure 6, appendix 3 table S13). The smaller decline in age-standardised burden attributable to metabolic risks between 2010 and 2023 was due in part to a significant global increase in rates of burden attributable to high BMI, which rose by 10·5% (0·1 to 20·9), and a non-significant increase in high FPG, which rose by 6·2% (–2·7 to 15·6; figure 7). These increases stand in contrast to declining global age-standardised DALY rates over the same period for all other leading 25 level 3 risk factors except drug use, which rose by 8·4% (2·6–15·3; figure 7). The greatest decreases among the 22 other leading level 3 risk factors were for risks associated with unsafe water, sanitation, and handwashing (declines of 54·4% [38·7–65·3] for unsafe sanitation, 50·5% [33·3–63·1] for unsafe water source, and 45·2% [25·6–72·0] for no access to handwashing facility). Other notable declines in age-standardised DALY rates were seen for child growth failure (decrease of 44·9% [37·3–53·5]), unsafe sex (decrease of 30·3% [24·3–36·7]), smoking (decrease of 25·1% [16·4–33·0]), occupational injuries (decrease of 24·6% [16·2–32·8]), and particulate matter pollution (decrease of 24·9% [20·9–28·6]; figure 7; appendix 3 table S13).

Trends in risk-attributable DALYs by SDI and location, 2010–23

Time trends in risk-attributable burden between 2010 and 2023 varied by both SDI level and location, as reflected in ARCs in age-standardised DALY rates attributable to overarching level 1 risk factors (figure 10). For behavioural risk factors, attributable burden generally

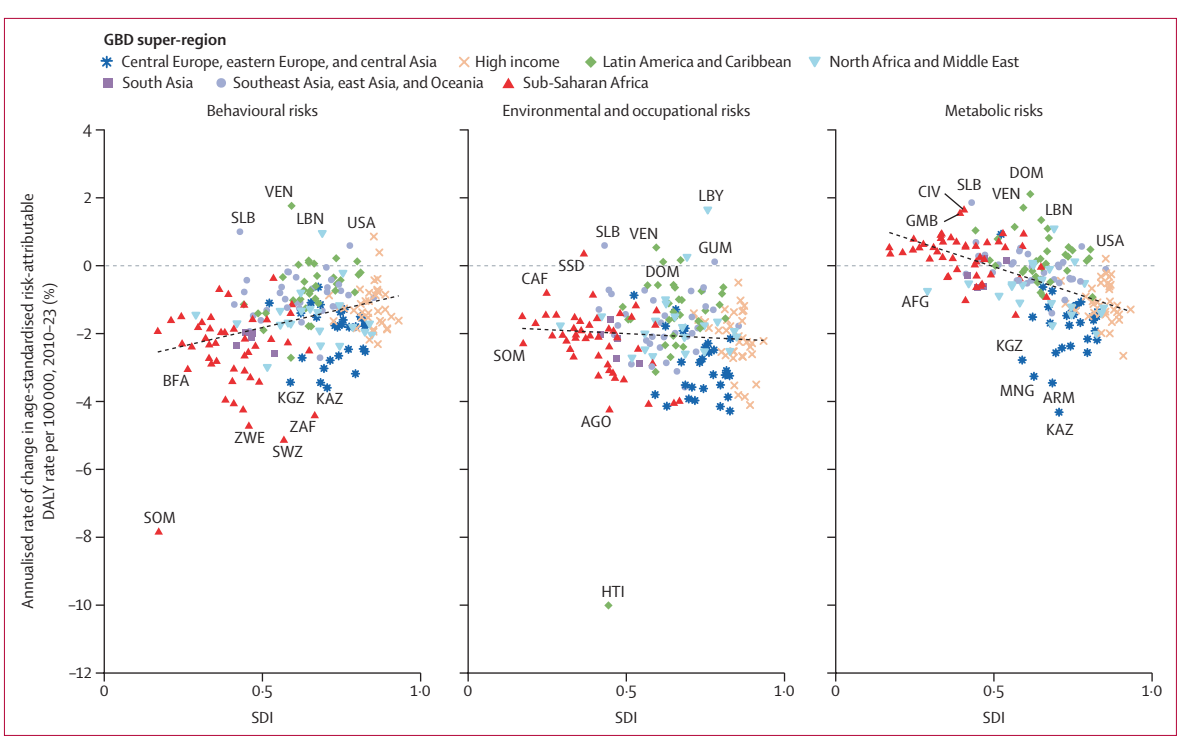

Figure 10: **Annualised rate of change in age-standardised risk-attributable DALY rates by GBD level 1 risk, SDI quintile, and country or territory, 2010–23**
The black dashed lines depict the linear regression line. Country and territory points are categorised by GBD super-region. Selected countries and territories are labelled by International Organization for Standardization 3 codes. AFG=Afghanistan. AGO=Angola. ARM=Armenia. BFA=Burkina Faso. CAF=Central African Republic. CAN=Canada. CIV=Côte D'Ivoire. DOM=Dominican Republic. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study. GMB=The Gambia. GUM=Guam. HTI=Haiti. KAZ=Kazakhstan. KGZ=Kyrgyzstan. LBN=Lebanon. LBY=Libya. MNG=Mongolia. NER=Niger. SDI=Socio-demographic Index. SLB=Solomon Islands. SOM=Somalia. SSD=South Sudan. SWZ=Eswatini. VEN=Venezuela. ZAF=South Africa. ZWE=Zimbabwe.

declined over this period at a slower rate in higher than in lower SDI countries and territories. ARCs were negative in most countries, indicating a decline over time in burden attributable to behavioural risks; however, this burden increased over time in some countries, including Venezuela, the Solomon Islands, Lebanon, and the USA, where age-standardised DALYs attributable to behavioural risks rose by 25·9% (95% UI 15·1–36·1), 13·9% (3·8–25·5), 13·4% (2·9–23·0), and 11·9% (7·6–16·1), respectively (appendix 3 table S13). The rise in behavioural risk-attributable burden in the USA—the only country other than Canada in the high-income super-region that showed such an increase—was driven largely by a 124·2% (96·1 to 157·0) increase in age-standardised burden attributable to drug use, in addition to an increase in attributable burden for intimate partner violence (54·7% [5·8 to 99·2]) and non-significant rise in sexual violence against children (33·5% [–8·4 to 59·3]; appendix 3 table S13). In contrast to the overall pattern for behavioural risks, burden attributable to metabolic risks generally declined at a faster rate with increasing SDI. Approximately half as many countries and territories had positive ARCs (75)—indicating increasing burden attributable to metabolic risks—as negative ARCs (129), with age-standardised DALYs increasing in countries such as the Dominican Republic (31·2% [22·1–42·0]), the Solomon Islands (27·1% [13·6–43·2]), Venezuela (24·6% [18·8–31·8]), Côte d'Ivoire (23·5% [8·2–42·3]), and The Gambia (21·9% [6·7–40·7]; appendix 3 table S13). For environmental and occupational risks, there was minimal association between SDI and rate of change in attributable burden, and ARCs were generally negative.

Disaggregating to a more detailed level of the risk factor hierarchy, figure 9 presents ARCs between 2010 and 2023 for age-standardised DALYs attributable to the ten leading level 3 risk factors, stratified by SDI and GBD region. For countries in low and low-middle SDI quintiles, the greatest ARC declines over time were for child growth failure (in addition to unsafe sex and unsafe water source in the low SDI quintile), whereas the greatest increases were for metabolic risks: high BMI and high FPG. Middle, high-middle, and high SDI quintiles saw the greatest declines in burden attributable to particulate matter pollution, with decreasing burden attributable to smoking also common across these groups. As in the lower SDI regions, the greatest increases in attributable burden in middle and high-middle SDI quintiles were for high BMI and high FPG. In the high SDI quintile, the highest annualised rates of increase were for drug use, along with considerably lower rates of increase for high BMI.

With respect to the three leading 2023 level 3 risk factors globally—high SBP, particulate matter pollution, and smoking—annual rates of age-standardised burden attributable to high SBP declined between 2010 and 2023 in 17 of 21 GBD regions, with the highest rates of decrease in eastern Europe and central Asia (figure 9). Conversely, burden attributable to high SBP increased in the Caribbean and, to a lesser extent, in central and western sub-Saharan Africa. Of the regions in which particulate matter pollution was one of the ten leading risk factors, age-standardised DALYs attributable to particulate matter pollution decreased in nine regions, with the highest rates of decline in eastern Europe, east Asia, and central Europe. Notably, burden attributable to particulate matter pollution rose slightly in Australasia and the Caribbean. Smoking showed attributable burden decreases over time in all regions, with the highest rates of decline in central Asia, eastern Europe, tropical Latin America, and south Asia. Time trends in attributable burden for the third-ranking to the tenth-ranking level 3 risk factors, by region and by SDI, can also be seen in figure 9. Detailed estimates of change over time in attributable DALYs and deaths for each risk factor and outcome—by GBD super-region, region, and country—are available in appendix 3 (table S13).

Discussion

The findings from GBD 2023 highlight the continuing epidemiological transition, with substantial reductions in CMNN disease burden contrasted by a rising burden of NCDs and metabolic risk factors, largely driven by ageing and population growth. Between 2010 and 2023, global age-standardised DALY rates decreased by nearly 13%, despite total DALY counts rising by about 6%. The reduction in CMNN diseases—particularly diarrhoeal diseases, HIV/AIDS, tuberculosis, and malaria, with approximate decreases in age-standardised DALY rates of 49%, 43%, 42%, and 21%, respectively—represents a major global health achievement up to 2023, yet neonatal disorders and lower respiratory infections remain leading causes of burden. NCDs now account for nearly two-thirds of global DALYs, with ischaemic heart disease, stroke, diabetes, and chronic respiratory diseases among the top contributors. Our analysis estimated that about 46% of total 2023 DALYs were attributable to the modifiable risk factors included in GBD 2023, particularly high SBP, particulate matter pollution, and smoking. Notably, age-standardised DALY rates attributable to high BMI, high FPG, and drug use increased, underscoring emerging global health challenges. Although substantial gains in health have been made, these results emphasise the need for risk-factor mitigation and targeted interventions to address the ever-rising burden of NCDs and sustain progress towards reducing the burden of CMNN diseases. Without advances in prevention, early diagnosis, and chronic disease management of NCDs, gains in longevity risk being offset by a rising burden of non-fatal diseases. This underscores the need for health systems and policy makers to prioritise healthy ageing, focusing not only on reducing mortality rates, but also on improving preventive care and disease management.

Moreover, recent budgetary cuts to development assistance are re-ordering the global health system, posing a real and immediate threat to sustaining health gains.[31,32] The evolving situation demands not only targeted policy responses, but also rigorous, objective, ongoing monitoring.

A hallmark of GBD is the continued emphasis on data-driven estimation and ongoing collection and curation of health data. For this cycle of GBD, we added more than 34 000 new inputs of data for disease and injury burden estimation and about 16 000 new inputs for risk factor analysis. These additions represent surveys newly identified through active data seeking; collaborator feedback; expanded use of already-identified surveys and new phases of existing surveys, such as Multiple Indicator Cluster Surveys, available for the first time in this cycle; updates and revisions to reporting time series; and new systematic reviews to identify the latest data reported in the literature. Data updates not only focus on the new estimate years of 2022 and 2023, but also revisit the past, providing additional datapoints on causes and locations where past surveys are newly accessible, or filling in previous gaps in our database. Although differences remain among locations in the total amount of data accessible, we have successfully accessed data inputs from each of 204 countries and territories, including 660 subnational locations, from every year estimated, and for each cause and risk factor. Data inputs by cause and risk factor are detailed in the GBD 2023 Sources Tool, which allows users to explore the full array of data inputs by metric, by disease, injury, or risk, and by location.

We have seen the epidemiological transition continue despite a global financial crisis and the COVID-19 pandemic. Sociodemographic factors such as poverty, education, employment, and social inequalities continue to shape health outcomes by influencing access to health services, nutritional quality, and the ability to engage in preventive health behaviours. These determinants are particularly relevant with respect to the CMNN diseases, for which—despite progress in reducing mortality from infectious diseases and maternal and neonatal conditions—the burden remains disproportionately high in low and middle SDI countries due to persistent disparities in health-care access, vaccination coverage, and nutrition. This pattern can be seen at large geographical scales, as in the Sahel, the semi-arid expanse that includes countries within the GBD regions of central and western sub-Saharan Africa, and Eritrea. Malnutrition, both under-nutrition and the rising prevalence of obesity, represents a double burden of disease, demanding integrated strategies that address food security, health system strengthening, and social policies that promote health equity.

Addressing the global burden of disease requires focused action on key risk factors, particularly overweight and obesity, which have become major drivers of poor health outcomes worldwide. Although obesity rates vary across countries,[33] they are rising in nearly all regions,[34,35] contributing to increased prevalence of diabetes[36] and chronic kidney disease.[37] Effective solutions must extend beyond individual choices to encompass structural determinants, including food availability and affordability, urban design, and public messaging on the health risks of high BMI. Despite no success in reversing obesity trends at the population level, governments and global health organisations must prioritise comprehensive strategies that promote healthier diets and increased physical activity, beginning with early-life interventions. Ischaemic heart disease, the leading cause of DALYs for both males and females globally, is another high-burden disease that requires a redoubling of efforts. As new approaches and innovative strategies for defining and treating coronary artery disease continue to evolve,[38] health policy efforts must prioritise equitable access to prevention, detection, emergency services, and treatment, particularly in under-served and lower-resourced settings. Equitable access to evidence-based treatments should also be part of a broader effort to reduce weight-related disease burden and mortality. For example, a recent study showed that statin therapy was prescribed to less than 10% of eligible individuals for primary prevention of cardiovascular disease in many low-income and middle-income countries.[39] Novel therapies, such as GLP-1 receptor agonists, which have demonstrated effectiveness in managing obesity, type 2 diabetes, and cardiovascular risk, remain largely inaccessible outside high-income countries.[40] There is an urgent need to expand access to established essential medicines, while also improving clinical studies and population-level research for novel treatments globally.[41,42] Beyond obesity, tackling other major modifiable metabolic and behavioural risk factors—including high SBP, tobacco use, and substance use—is crucial. Although tobacco use has declined in high-income regions, it remains alarmingly high in others. Designed to align with the WHO Framework Convention on Tobacco Control, MPOWER measures[43] provide a framework for enacting tobacco control, yet full implementation is needed to accelerate progress. Managing high blood pressure effectively requires widespread access to high-quality primary care, an area in which many health systems still fall short.

Despite substantial declines in exposure due to removal from motor vehicle fuels, lead exposure—recognised since the Roman Empire as a health risk factor[44,45]—persists as an important contributor to cardiovascular disease burden, especially in central and eastern Europe and central Asia. Although these effects largely reflect accumulated bone lead concentrations driven by past exposure before removal of leaded gasoline, lead remains a ubiquitous environmental contaminant. Efforts to

reduce exposure from paint in older houses, contaminated soil, drinking water, battery recycling, electronic waste, spices, cookware, and other consumer products, combined with surveillance to identify highly exposed populations, should be prioritised. Additionally, evidence continues to accumulate for the scope of NCDs affected by exposure to particulate matter air pollution ($PM_{2.5}$), a risk factor for the eight leading causes of death globally, including dementia[46] and type 2 diabetes,[47] which have rapidly increasing mortality rates.[16] Even low levels of $PM_{2.5}$ have been associated with increased dementia risk,[48] and more than a sixth of the global burden of type 2 diabetes was attributable to $PM_{2.5}$ in 2023 (GBD 2023 Results Tool). Although the burden associated with one $PM_{2.5}$ risk factor, household air pollution, has declined dramatically except in sub-Saharan Africa,[49] ambient $PM_{2.5}$ remains the leading global environmental risk factor. It is essential that policy makers align national standards with WHO guidelines and, crucially, develop implementation approaches to reduce exposures and consequent effects on health.[50] The increasing evidence for the involvement of $PM_{2.5}$ in major diseases suggests an opportunity for future research to help identify individuals at high risk and to inform potential prevention options.

GBD 2023 also highlights the staggering increase in the burden of mental disorders globally, the underlying causes, and even temporal trend, of which remain widely debated.[51] There is convincing evidence that the COVID-19 pandemic resulted in secondary deterioration of mental health, leading to an increase in the prevalence of depressive and anxiety disorders.[52] Notably, the largest increases in these disorders were estimated to have occurred following the onset of the COVID-19 pandemic. However, there is also convincing evidence that the prevalence of these disorders has been increasing steadily over the past two decades, especially for some locations within the high-income super-region.[7] There are several competing and complementary theories for this increase, including increases in social media use, cyberbullying, child maltreatment, climate despair, and rising costs of living and income inequality,[51,53] with expanded mental health awareness and increased reporting further highlighting the problem. Meta-analyses suggest significant associations between social media use and symptoms of depression and anxiety, but further research is needed to explore the causal direction.[54] However, the widespread use and influence of social media in many parts of the world might make it difficult to detect its effects at the individual level. Population-level studies are required to determine the relationship between social media use and mental disorders, as well as to design suitable interventions. For example, in Australia, the federal government recently passed a law effectively banning children younger than 16 years from accessing certain forms of social media. This presents a unique opportunity for researchers to further examine the effects of public health policy on social media and its effects on youth mental health. Focused efforts are needed to better understand these drivers and inform policies that can effectively address the growing mental health crisis.

GBD 2023 presents strong evidence for exposure to sexual abuse and intimate partner violence as additional preventable contributors to several mental disorders, notably major depressive disorder and anxiety disorders, as well as a large set of other conditions ranging from maternal disorders to asthma, as well as homicide and suicide (appendix 3 table S13).[27] The highest rates of DALYs attributable to intimate partner violence and sexual violence against children were seen in sub-Saharan Africa, but high rates were also seen in high-income regions, demonstrating that the detrimental effects of sexual and intimate partner violence span across societies, regardless of socioeconomic status. Among reproductive-aged females, intimate partner violence ranked in the top five health risks, with an attributable DALY rate similar to that of iron deficiency, while the global DALY rate attributable to sexual violence against children was similar to that of unsafe sanitation (GBD Compare; appendix 3 table S13). Bullying victimisation also merits discussion as a modifiable risk factor, ranking sixth among the behavioural risk factors in attributable DALYs among young people aged 10–24 years, with highest rates observed in the north Africa and the Middle East and high-income super-regions (GBD Compare). Our estimates highlight specific health outcomes associated with exposure to violence—particularly gender-based violence—and quantify the health burden it engenders, adding further detail to the growing body of data illuminating the high prevalence of gender-based violence.[55,56] Together, these data are a call to action. Compared with other conditions with a similar magnitude of burden, efforts to prevent exposure to violence, as well as address the needs of survivors, have historically been under-prioritised. It is essential to better quantify and understand intimate partner violence and sexual violence against children, especially because both are often hidden and under-reported.

Overall, progress in CMNN diseases has been astounding over the period of study; despite profound setbacks in the form of the COVID-19 pandemic, this progress remains one of the shining achievements of global health. These gains are not unidirectional and are sustained through an imperfect constellation of national and international efforts in prevention, treatment, and cure. In an environment of reduced funds to combat the major sources of communicable disease burden,[57] it is possible that we will see reversals in some of these trends. As we face these challenges and their effects, we believe that there has never been a time in which global health measurement is so important.

There are several limitations to the overall GBD enterprise that provide opportunities to refine and improve the quality and accuracy of the results. The iterative nature of GBD reflects the incorporation of new data sources, methodological improvements, and ongoing efforts to stabilise data and analytical processes. Despite these efforts, challenges persist due to variability in the availability and quality of input data. Inconsistent quality, flawed methodologies, and gaps in the collection of primary data make it difficult to accurately quantify the burden of disease without ongoing and thorough assessments of data quality. Additionally, lags in the availability of data for more recent years further contribute to these challenges. For example, because surveys were delayed due to COVID-19, just 19 STEPS surveys conducted since 2020 have been released to date, only five of which have the individual-level record data necessary to analyse some causes and risk factors. By contrast, the 4-year period before 2020 had more than 41 STEPS surveys. In time, more data will become available for this period, with additional details enriching summary reports, but the typical delays we see in the release of surveys and other datasets were compounded by COVID-19 physical distancing restrictions. To the extent possible, the GBD analytical framework—using a modelled statistical approach to synthesise all evidence available—is designed to account for issues of sparse or missing data and uncertainty arising from a multitude of sources, such as stochastic variation in input data, demographic adjustments, and bias due to input study characteristics. Input bias can be particularly impactful with respect to sex and age metadata related to summary statistics, as reporting of outcomes stratified by age and sex is often not available, requiring processing using age-splitting and sex-splitting algorithms to produce the more granular estimates presented in GBD. However, limitations associated with the quality and methods of primary data collection remain a recurring obstacle and highlight the need to strengthen data collection systems. Fully accounting for the range of uncertainties inherent in burden and risk factor estimation processes remains an ongoing challenge, and uncertainty and statistical variation cannot be eliminated.

There are also limitations specific to GBD disease burden measures. Time-varying differences in disease detection or reporting can bias estimates of prevalence or incidence, making it challenging to accurately quantify changing morbidity over time. Although we use crosswalking and MR-BRT adjustment tools to account for varying case definitions and data collection methods, and have further introduced an advanced DisMod-AT tool that will allow us to more accurately model temporal trends, we acknowledge that YLD trends over time might reflect both true morbidity and detection artifacts. More detailed and improved diagnostic data are therefore essential to more accurately capture changes in morbidity. Temporal trends in causes might also be attenuated due to limitations in the ability of DisMod-MR 2.1 to accurately estimate trends when data are sparse. For most causes that require the prevalence by severity to estimate YLDs, the estimated severity distribution is largely sourced from a small number of survey series conducted in Australia and the USA because of the scarcity of comprehensive data available in other countries. Without more data on severity across geography, there is a potential for bias in YLD estimation—particularly in settings in which access to care, diagnostic practices, and treatment availability differ considerably. However, work to address this concern is currently underway for some causes.[58,59] The quality and accuracy of comorbidity corrections, which are essential to ensure that estimated YLDs are unique to each cause and additive across causes, also require continuous improvement. For GBD 2023, we assumed independent comorbidity—ie, the chance of having a comorbid cause is equal to its prevalence. Assuming independent comorbidity can lead to underestimation of comorbidity, especially for causes such as mental disorders, which have substantial dependent comorbidity, and in turn might overestimate YLDs for some causes. However, in the context of sparse data on joint prevalence and functional health loss from comorbid states across all causes in GBD, the independence assumption is necessary to make estimation possible. Fortunately, simulation testing within epidemiological datasets has suggested accounting for dependent comorbidity has a minimal impact on the overall YLD counts (appendix 1 section 2.10). Limitations related to our estimation of YLLs are discussed in a parallel GBD 2023 publication.[16]

With respect to our risk factor analyses, it is unlikely that our present estimates capture all existing relationships between risk factors and health outcomes and all risk-attributable burden, although with every iteration of GBD we add new relationships and update evidence. Not only are additional risk factors and risk–outcome pairs considered in every round of GBD, so too are mediation relationships. With respect to mediation, we adjusted relative risk estimates for mediation based on the assumption that joint risks are multiplicative, but some combinations of risks might be super-multiplicative or sub-multiplicative. This issue might be particularly relevant to analyses of dietary risk factors that yield protective effects, such as fruit or wholegrain intake, or other coincident exposures, such as $PM_{2.5}$ and high temperatures. More research is needed to better understand mediation effects to fully account for them to more accurately estimate attributable burden for inter-related risk factors; refining our mediation methods remains a continuing priority. With respect to TMRELs, we generally set them to equal to zero for those harmful risks where zero exposure is theoretically achievable or used the data to empirically derive non-zero levels reflecting minimum risk (or used clinical guidance

where data are sparse or biological thresholds are well defined), with monotonically increasing risk functions. For protective risks, we generally set TMRELs at the 85th percentile of exposure in the available data to avoid extrapolating the risk function outside the data-rich range of the available literature, which could lead to exaggerated estimates of attributable burden and implausible levels of consumption. Although evidence suggests that these TMRELs yield accurate estimates of relative risk,[23] further refinements might be needed.

In the present iteration of GBD, our burden-of-proof flexible meta-regression framework more accurately describes the true shape of the risk–outcome relationship rather than imposing log-linearity, systematically trims data outliers, tests and adjusts for bias in the input data, and formally quantifies and incorporates between-study heterogeneity unexplained by individual study design features into a measure of evidence strength that combines effect size and uncertainty accounting for this between-study heterogeneity. This analytical framework, however, has not yet been applied to all risk–outcome pairs because the work remains ongoing. Moreover, because the covariate selection and adjustment methods used to control for bias are data driven and rely on the high-level information that is available about input studies to meta-analyses (eg, which studies were gold standard *vs* not), they are unable to provide a more nuanced understanding of the impact of deviations from the gold standard, beyond testing and adjusting for systematic bias. A final limitation of the present risk analysis is that our assumption that the risk–outcome relationships assessed were constant across location and time (with the exception of relative risk functions involving temperature, which we varied according to annual mean temperature, and the relationship between high BMI and breast cancer, which has been shown to vary between Asian and non-Asian populations[60]) is unlikely to hold true for all cases. Burden-of-proof methods provide an analytical framework to identify variation in risk–outcome relationships by location or other population characteristics, but ultimately to do so will require additional primary studies systematically evaluating differences between population subgroups. We continue to evaluate the available evidence and will incorporate more location-specific or subgroup relative risk estimates as they are identified.

GBD evolves to ensure its scientific findings remain relevant, useful, and timely. With a strong commitment to exploring new scientific horizons and opening new opportunities for research, our goal is to update and publish the next iteration of GBD (GBD 2025) as soon as results are available. In addition to quantifying additional risk–outcome pairs and evaluating potential new metabolic, behavioural, and environmental risk factors, we aim to quantify the attributable burden of low educational attainment in GBD 2025, an effort we acknowledge will be challenging as the effects of education on disease burden are also mediated through numerous other risk factors. We hope to be able to expand to additional social determinants of health in future iterations of GBD. In addition to expanding the scope of GBD, efforts to continually improve the available estimates include incorporating additional health conditions and geographical areas, procuring and assimilating new data, improving methods to correct data discrepancies, and better representing uncertainty in our findings. Additionally, we are transitioning to DisMod-AT, an improved version of DisMod-MR, for most health outcomes. DisMod-AT is anticipated to improve the precision of age and time trends in our prevalence estimates, particularly by integrating the effects of population shocks. We will continue to test and validate DisMod-AT and will remain focused on ensuring harmonisation and consistency in estimates generated using this tool. For GBD 2025, we plan to integrate severity distributions according to levels of health-care access for several conditions. We also plan to account for changes to disease detection and diagnosis across time and location in future GBD iterations. Regarding adjustments to clinical data, future research could be enhanced by integrating alternative causal frameworks and using more granular data on health system usage. Last, there are efforts to improve the methods that account for comorbidities.

This GBD 2023 synthesis of estimates of disease and injury burden and risk-attributable burden provides policy makers, researchers, and public health practitioners with crucial insights to inform global health strategies. It shows a growing and ageing world where progress against CMNN diseases has been remarkable across all SDI levels and where continued progress against NCDs has been modest and outpaced by demographic changes. With focused efforts on prevention, risk mitigation, and more robust health systems, substantial strides can be made towards improving population health and achieving long-term sustainable development targets, as we move ever closer to consensus goals for health and wellbeing impact by 2030. The challenges remain considerable, however, with the potential for reversal of progress on CMNN diseases resulting from new and substantial reduction in funding for global health alongside rises in metabolic disease and risk factors.

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See Online for appendix 4

For collaborator affiliations see appendix 4 (pp 14–74).

Contributors

Please see appendix 4 (pp 74–99) for more detailed information about individual author contributions to the research, divided into the following categories: managing the overall research enterprise; writing the first draft of the manuscript; primary responsibility for applying analytical methods to produce estimates; primary responsibility for seeking, cataloguing, extracting, or cleaning data; designing or coding figures and tables; providing data or critical feedback on data sources; developing methods or computational machinery; providing critical feedback on methods or results; drafting the manuscript or revising it critically for important intellectual content; and managing the estimation or publications process. The corresponding author (S I Hay) and senior authors (K L Ong, D F Santomauro, M Brauer, T Vos, C J L Murray, and E Gakidou) had full access to the data in the study and final responsibility for the decision to submit for publication.

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Data sharing

For detailed information on data sources and estimates, please visit the Global Health Data Exchange GBD 2023 website at http://ghdx.healthdata.org/gbd-2023.

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This study is based on data from Eurostat, Slovenia European Health Interview Survey 2007-2008 and 2014. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This paper uses data from the Cook Islands 2003-2004 and 2013-2015 STEPS surveys, implemented by Ministry of Health (Cook Islands) with the support of the World Health Organization. This paper uses data from the Tanzania - Zanzibar 2011 STEPS survey, implemented by Ministry of Health (Zanzibar) with the support of the World Health Organization. This research used data from the National Health Survey 2009-2010. The author is grateful to the Ministry of Health, Survey copyright owner, allowing him to have the database. All results of the study are those of the author and in no way committed to the Ministry. This research uses data from Add Health, a program project designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris, and funded by a grant P01-HD31921 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development, with cooperative funding from 17 other agencies. Special acknowledgment is due to Ronald R. Rindfuss and Barbara Entwisle for assistance in the original design. Persons interested in obtaining data files from Add Health should contact Add Health, Carolina Population Center, 123 W. Franklin Street, Chapel Hill, NC 27516-2524 (addhealth@unc.edu). No direct support was received from grant P01-HD31921 for this analysis. This study is based on data from Eurostat, Slovakia European Health Interview Survey 2009 and 2014. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This paper uses data from the Rwanda 2012-2013 STEPS survey, implemented by Ministry of Health (Rwanda) with the support of the World Health Organization. HBSC is an international study carried out in collaboration with WHO/EURO. The International Coordinator of the 1997/98, 2001/02, 2005/06 and 2009/10 surveys was Prof. Candace Currie and the Data Bank Manager for the 1997/98 survey was Prof. Bente Wold, whereas for the following survey Prof. Oddrun Samdal was the Databank Manager. A list of principal investigators in each country can be found at http://www.hbsc.org. This paper uses data from the WHO Study on global AGEing and adult health (SAGE). This study is based on data from Eurostat, Latvia European Health Interview Survey 2008 and 2014. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Romania European Health Interview Survey 2008 and 2014. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This paper uses data from the Moldova 2013 and 2021 STEPS surveys, implemented by Ministry of Health (Moldova) with the support of the World Health Organization. This paper uses data from the Cayman Islands 2012 STEPS survey, implemented by Ministry of Health, Environment, Youth, Sports and Culture (Cayman Islands) with the support of the World Health Organization. This paper uses data from the Grenada 2010-2011 STEPS survey, implemented by Ministry of Health (Grenada) with the support of the World Health Organization. This paper uses data from the Nepal 2012-2013 STEPS survey, implemented by the Nepal Health Research Council with the support of the World Health Organization. This publication uses data provided by Statistics Botswana. This paper uses data from the Namibia 2005 STEPS survey, implemented by the Ministry of Health with the support of the World Health Organization. Researchers interested in using TILDA data may access the data for free from the following sites: Irish Social Science Data Archive (ISSDA) at University College Dublin http://www.ucd.ie/issda/data/tilda/ ; Interuniversity Consortium for Political and Social Research (ICPSR) at the University of Michigan http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/34315 Data for this research were accessed via the Irish Social Science Data Archive - www.ucd.ie/issda. The original creators bear no responsibility for analysis or interpretation of them. This analysis is based on the Statistics Canada Canadian Community Health Survey Microdata File which contains anonymized data collected in the 2013-2014 Canadian Community Health Survey. All computations, use and interpretation of these data are entirely that of IHME. This paper uses data from the Kenya 2015 STEPS survey, implemented by Kenya National Bureau of Statistics, Ministry of Health (Kenya) with the support of the World Health Organization. This analysis uses data or information from the LASI Pilot micro data and documentation. The development and release of the LASI Pilot Study was funded by the National Institute on Ageing / National Institute of Health (R21AG032572, R03AG043052, and R01 AG030153). The data used in this paper come from the 2009-10 Ghana Socioeconomic Panel Study Survey which is a nationally representative survey of over 5000 households in Ghana. The survey is a joint effort undertaken by the Institute of Statistical, Social and Economic Research (ISSER) at the University of Ghana, and the Economic Growth Centre (EGC) at Yale University. It was funded by the Economic Growth Center. At the same time, ISSER and the EGC are not responsible for the estimations reported by the analyst(s). This paper uses data from the Bhutan 2014 and 2019 STEPS surveys, implemented by Ministry of Health (Bhutan) with the support of the World Health Organization. This paper uses data from the Uganda 2014 STEPS survey, implemented by Ministry of Health (Uganda) with the support of the World Health Organization. This paper uses data from the Timor-Leste 2014 STEPS survey, implemented by Ministry of Health (Timor-Leste) with the support of the World Health Organization. The CRELES project (Costa Rican Longevity and Healthy Aging Study) is a longitudinal study by the University of Costa Rica's Centro Centroamericano de Población and Instituto de Investigaciones en Salud, in collaboration with the University of California at Berkeley. The original pre-1945 cohort was funded by the Wellcome Trust (grant 072406), and the 1945-1955 Retirement Cohort was funded by the US National Institute on Aging (grant R01AG031716). The study Principal Investigators are Luis Rosero-Bixby and William H. Dow, and co-Principal Investigators Xinia Fernández and Gilbert Brenes. This paper uses data from the Ghana - Greater Accra Region 2006 STEPS survey, implemented by Ghana Health Service with the support of the World Health Organization. This paper uses data from the Myanmar 2014 STEPS survey, implemented by Ministry of Health (Myanmar) with the support

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Those who carried out the original collection and analysis of the Jamaica Survey of Living Conditions bear no responsibility for their further analysis or interpretation. This paper uses data from China Family Panel Studies (CFPS), funded by 985 Program of Peking University and carried out by the Institute of Social Science Survey of Peking University. This paper uses data from the Vietnam 2009 and 2015 STEPS surveys, implemented by Ministry of Health (Vietnam) with the support of the World Health Organization. This paper uses data from the Pakistan 2013–2014 STEPS survey, implemented by Ministry of National Health Services, Regulation and Coordination, Pakistan Health Research Council with the support of the World Health Organization. This paper uses data from WHO's Study on Global Ageing and Adult Health (SAGE). SAGE is supported by the US National Institute on Aging through Interagency Agreements OGHA 04034785; YA1323-08-CN-0020; Y1-AG-1005-0) and through research grants R01-AG034479 and R21-AG034263. Adapted from Statistics Canada, Canada Tobacco, Alcohol and Drugs Survey 2015. This does not constitute an endorsement by Statistics Canada of this product. This study is based in part on data from Eurostat, European Union Labor Force Survey, 1992–2016. The responsibility for all conclusions drawn from the data lies entirely with the authors. This study is based on data from Eurostat, Belgium Health Interview Survey 2008 and 2009. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Cyprus Health Interview Survey 2008–2009. The responsibility for all conclusions drawn from the data lies entirely with the author(s). 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This paper uses data from the Guyana 2016 STEPS survey, implemented by the Ministry of Public Health with the support of the World Health Organization. The MHAS (Mexican Health and Aging Study) is partly sponsored by the National Institutes of Health/National Institute on Aging (grant number NIH R01AG018016) and the INEGI in Mexico. Data files and documentation are public use and available at www.MHASweb.org. The Irish Longitudinal study on Ageing (TILDA) Wave 4, 2016 was accessed via the Irish Social Science Data Archive - www.ucd.ie/issda. The harmonized dataset was downloaded from the GDD website [Global Dietary Database. The Estonian National Dietary Survey 2014. https://www.globaldietarydatabase.org/management/microdata-surveys/657, August 28. 2020]. 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Mabat Youth - First Israeli National Health and Nutrition Survey in 7th-12th grade students 2003-2004. https://www.globaldietarydatabase.org/management/microdata-surveys/180. Accessed September 17, 2020.]. The harmonization of the dataset was jointly performed by the data owner [MABAT Youth First Israeli National Health and Nutrition Survey in 7th-12th grade students 2003-2004. Israel Center for Disease Control, Ministry of Health, State of Israel] and GDD, and the overall process was overseen by GDD. VACS data are owned by the Government of Côte d'Ivoire and made available by the Centers for Disease Control and Prevention through a Data Use Agreement. This paper uses data from the Mongolia 2019 STEPS survey, implemented by the Ministry of Health, Public Health Institute with the support of the World Health Organization. This paper uses data from the Jordan 2019 STEPS survey, implemented by the Ministry of Health with the support of the World Health Organization. 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This study is based on data from Eurostat, Denmark European Health Interview Survey 2015. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Spain European Health Interview Survey 2014. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Finland European Health Interview Survey 2014. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, France European Health Interview Survey 2014. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Hungary European Health Interview Survey 2008 and 2014. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Croatia European Health Interview Survey 2014. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Ireland European Health Interview Survey 2015. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Iceland European Health Interview Survey 2015. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Italy European Health Interview Survey 2015. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Lithuania European Health Interview Survey 2014. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Netherlands European Health Interview Survey 2014. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Norway

European Health Interview Survey 2015. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Poland European Health Interview Survey 2014. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Portugal European Health Interview Survey 2014. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Sweden European Health Interview Survey 2014. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, European Union Statistics on Income and Living Conditions, Cross-sectional Data Collection 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, and 2020. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, European Union Statistics on Income and Living Conditions, Longitudinal Data Collection 2005, 2006, and 2007. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This paper uses data from the Ukraine 2019 STEPS survey, implemented by the Ministry of Health with the support of the World Health Organization. This study is based on data from Eurostat, United Kingdom European Health Interview Survey 2013. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This study is based on data from Eurostat, Luxembourg European Health Interview Survey 2014. The responsibility for all conclusions drawn from the data lies entirely with the author(s). This research uses data from the study on "Understanding the Lives of Adolescents and Young Adults (UDAYA) in Bihar and Uttar Pradesh" which was collected by the Population Council. Data collection funded by Bill & Melinda Gates Foundation and the David and Lucile Packard Foundation. Data for the Seychelles Heart Study IV was provided by the Global Dietary Database and Tufts University in association with the Ministry of Health and University of Lausanne. HBSC is an international study carried out in collaboration with WHO/EURO. The International Coordinator of the 2017/2018 surveys was Prof. Jo Inchley and the Data Bank Manager was Prof. Oddrun Samdal. A list of principal investigators in each country can be found at http://www.hbsc.org . This paper uses data from the Global School-Based Student Health Survey (GSHS). GSHS is supported by the World Health Organization and the US Centers for Disease Control and Prevention. This paper uses data from the Bolivia 2019 STEPS survey, implemented by the Ministry of Health with the support of the World Health Organization. This paper uses data from the Cabo Verde 2020 STEPS survey, implemented by the Ministry of Health, National Institute of Statistics with the support of the World Health Organization. This paper uses data from the WHO Well-being of Older People Study (WOPS) a Study on Global AGEing and Adult Health (SAGE) sub-study. Research reported in this publication was supported by the National Institute on Aging of the National Institutes of Health under Award Number R01AG044917. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. This paper uses data from the Saint Lucia 2019 STEPS survey, implemented by the Ministry of Health with the support of the World Health Organization. This paper uses data from the Viet Nam 2021 STEPS survey, implemented by the Ministry of Health with the support of the World Health Organization. Parts of this material are based on data and information provided by the Canadian Institute for Health Information. However, the analyses, conclusions, opinions and statements expressed herein are those of the author and not those of the Canadian Institute for Health information. The views and opinions of the authors expressed herein do not necessarily state or reflect those of ECDC. The accuracy of the authors' statistical analysis and the findings they report are not the responsibility of ECDC. ECDC is not responsible for the conclusions or opinions drawn from the data provided. ECDC is not responsible for the correctness of the data and for data management, data merging and data collation after provision of the data. ECDC shall not be held liable for improper or incorrect use of the data. This manuscript is based on data collected and shared by the International Vaccine Institute (IVI) from an original study it conducted with support from the Bill and Melinda Gates Foundation (BMGF).

Editorial note: The Lancet Group takes a neutral position with respect to territorial claims in published maps and institutional affiliations.

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