



Institute for Health  
Metrics and Evaluation

# Global Burden of Disease 1990-2021: Implications for surveillance

April 30, 2024

Christopher Murray



# Outline

- **What is the GBD**
- Death registration
- Causes of Death
- Subnational burden experience

# What is the GBD?

- GBD study is a systematic, scientific effort to quantify the magnitude of all major diseases, risk factors and intermediate clinical outcomes.
- **“Rules-based evidence synthesis for global health”**
- The first GBD study began in 1991 for eight regions 106 conditions and ten risk factors, 5 age groups for the year 1990.
- The GBD 2021 estimates for each year from 1990 to the present for 371 diseases and injuries, as well as 3,499 clinical outcomes (sequelae) related to those diseases and injuries, for 204 countries and territories and for subnational units in 21 countries.

## The Global Burden of Disease Study at 30 years

Christopher J. L. Murray<sup>1,2</sup>  

The Global Burden of Disease Study (GBD) began 30 years ago with the goal of providing timely, valid and relevant assessments of critical health outcomes. Over this period, the GBD has become progressively more granular. The latest iteration provides assessments of thousands of outcomes for diseases, injuries and risk factors in more than 200 countries and territories and at the subnational level in more than 20 countries. The GBD is now produced by an active collaboration of over 8,000 scientists and analysts from more than 150 countries. With each GBD iteration, the data, data processing and methods used for data synthesis have evolved, with the goal of enhancing transparency and comparability of measurements and communicating various sources of uncertainty. The GBD has many limitations, but it remains a dynamic, iterative and rigorous attempt to provide meaningful health measurement to a wide range of stakeholders.

The Global Burden of Disease Study (GBD) is a systematic, scientific effort to quantify the magnitude of all major diseases, risk factors and intermediate clinical outcomes in a highly standardized way, to allow for comparisons over time, across populations and between health problems. The first GBD began in 1991 and led to the first results being published in 1993, which documented for eight regions the burden of disease for 106 conditions and ten risk factors, broken down into five age groups for the year 1990. The GBD now provides estimates for each year from 1990 to the present for 371 diseases and injuries, as well as 3,499 clinical outcomes (sequelae) related to those diseases and injuries, for 204 countries and territories and for subnational units in more than 20 countries. The full time series produced in each round of the GBD is updated on an annual basis<sup>1,2</sup>, although the coronavirus disease 2019 (COVID-19) pandemic has delayed the release of the next GBD assessment. Since serialization in 2010, 1,842 publications on the GBD have appeared in the scientific literature.

Although there are many efforts in many countries to measure outcomes relating to single diseases or risks or groups of these, the GBD stands apart because of some core principles consistently applied over the last 30 years. Beginning in 1991, when the first GBD was undertaken as background work for the *World Development Report 1993: Investing in Health*<sup>3</sup>, the GBD was committed to the principles of best estimates, comprehensive accounting, comparable measurement, summary measures of fatal and non-fatal health outcomes and thoughtful and repeated assessment of face validity of findings. In this Perspective, we reflect on lessons learned from 30 years of the GBD. We begin by reviewing the core principles, and then we examine the universe of data for tracking health, the ongoing evolution of the statistical methods to support the GBD, the history of the broader GBD collaboration and some key future directions for the effort.

### Core principles

**Best estimates.** The GBD estimates each quantity of interest for every location. Even when data are highly inconsistent or there are no data for a disease or risk, a best estimate is produced along with our best estimate of uncertainty. The logic is that decisions have to be made, and a best estimate borrowing insight from where data are available is better than no estimate, provided that there is clarity around the level of uncertainty. All too often, ‘no data’ has

been historically equated to ‘no problem’, biasing prioritization and agenda-setting toward diseases, injuries and risk factors for which data have been collected and/or advocacy groups exist. This commitment to best estimates has catalyzed a continuous search for better global data (volume, veracity, variety and timeliness are all prized) as well as continuous efforts for better statistical estimation methods to deal with missing data and conflicting data that inevitably remain. It also sharply distinguishes the GBD from many government or intergovernmental efforts both in health and in other social sectors and remains the most frequently misunderstood part of the GBD.

**Comprehensive accounting.** This second core principle applies across diseases, injuries and risks. Comparable information on the magnitude of different health problems provides an objective framework to help establish health priorities and, importantly, can also provide important insights into what topics may be neglected. In the 1990s, the GBD finding that the burden of mental health disorders was substantial relative to infectious diseases, heart disease and cancer prompted the World Health Organization (WHO) and many countries to devote more policy attention to these neglected problems<sup>4</sup>. A high-level view of the comparative magnitude of health problems has also highlighted the rapidity of the epidemiological transition in many middle-income (and former low-income) countries where the profile of burden has shifted from communicable, maternal, neonatal and nutritional deficiencies to non-communicable diseases and injuries<sup>5</sup>. In more recent years, this principle has had increasing benefits as this comprehensive estimation has become a somewhat unique resource, in allowing the holistic forecasting of population health effects in an ever more rapidly changing and challenged world.

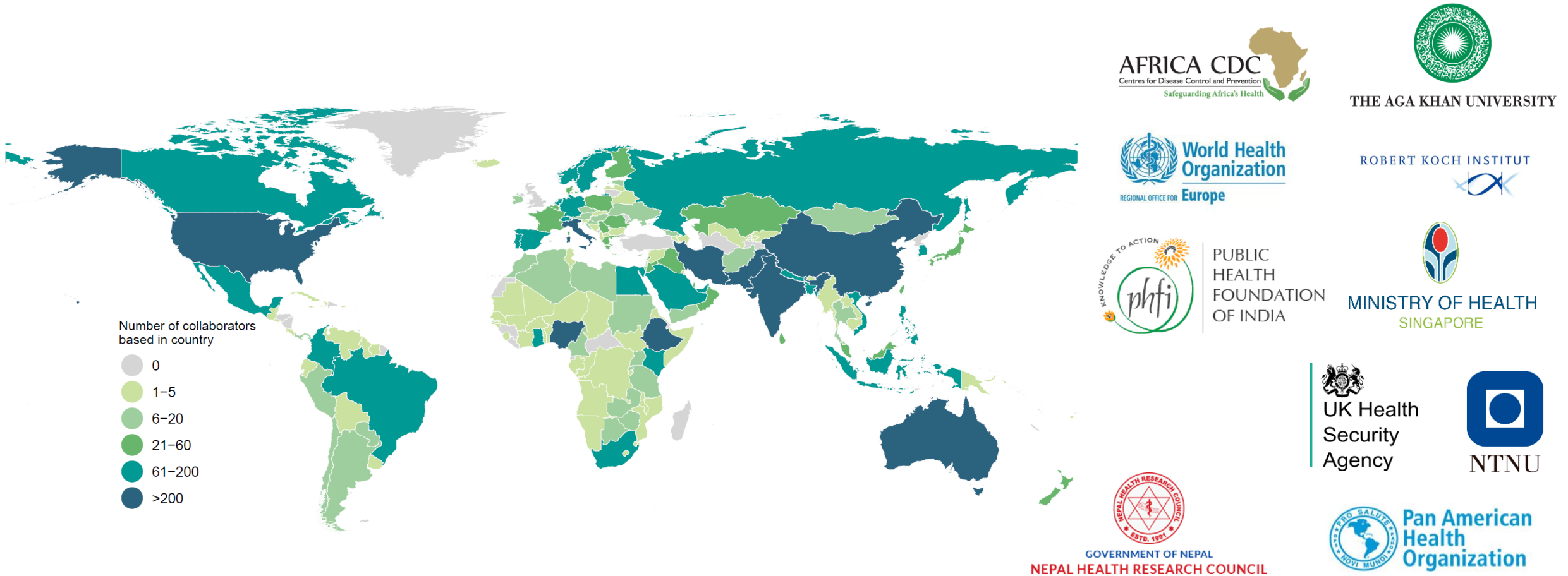
**Comparability of measurement.** Comprehensive accounting requires a focus on comparability of measurement. Many authors and statistical authorities have argued that the most important comparisons are within a country; but, from the beginning of the GBD, we have seen the value of emphasizing comparability over time and across place. Decision-makers who use the GBD results are drawn to understanding why their community may have a larger or smaller burden from a condition or, even more importantly, faster or slower rates of decline or increase in a disease, injury or risk factor.

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Murray CJL. The global burden of disease study at 30 years. *Nature Medicine*. October 2022.

# GBD collaboration

A health metrics ecosystem comprised of over **11,969 Collaborators** in **163 countries and territories**



# Global Health Data Exchange (GHDx)

IHME | GHDx | GBD Compare



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Countries

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About the GHDx

## Global Health Data Exchange

Welcome to the GHDx, the world's most comprehensive catalog of surveys, censuses, vital statistics, and other health-related data. It's the place to start your health data search. Learn more about the catalog in [GHDx Help](#).

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### Countries

Afghanistan

Search

GHDx data source evolution:

NID is a unique identifier for a source of data e.g. FAO Food Balance Sheets would have a unique NID.

Some NIDs cover more than one country and thus produce many data points

# GBD Compare: on-line tools providing access to detailed results, [www.healthdata.org](http://www.healthdata.org)

Home > Data tools and practices > Interactive data visuals >

## GBD Compare

Updated October 15, 2020

### Topics

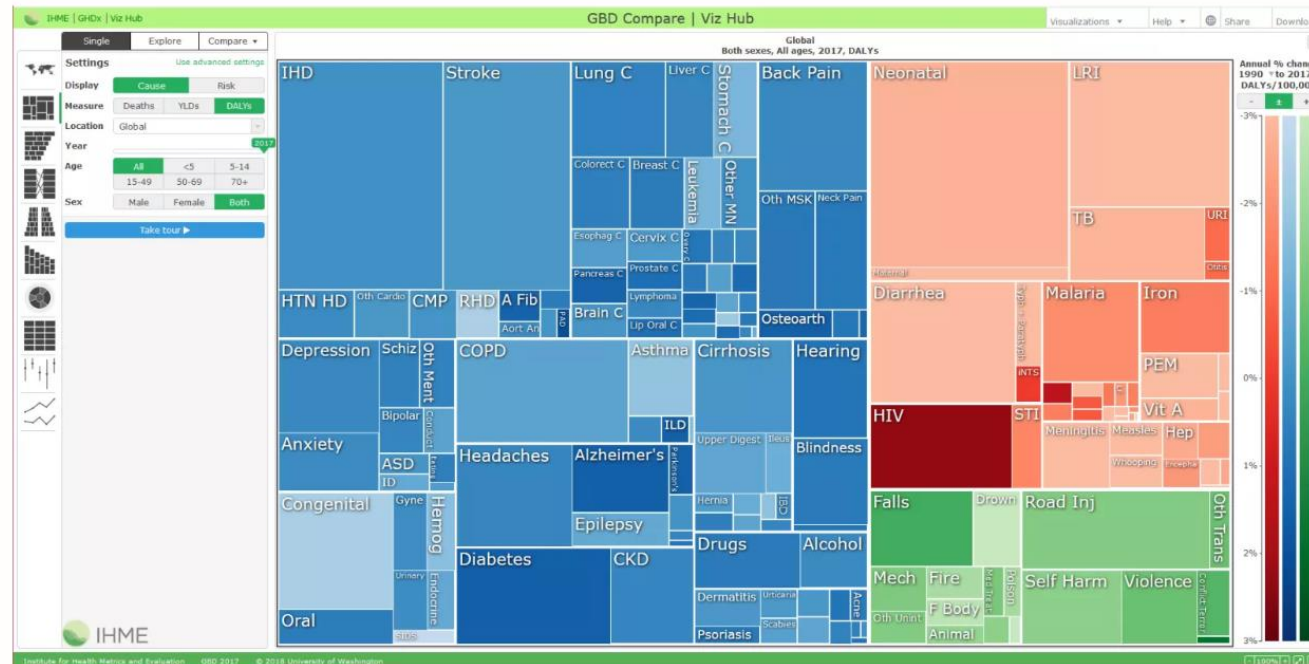
DISABILITY

RISK FACTORS

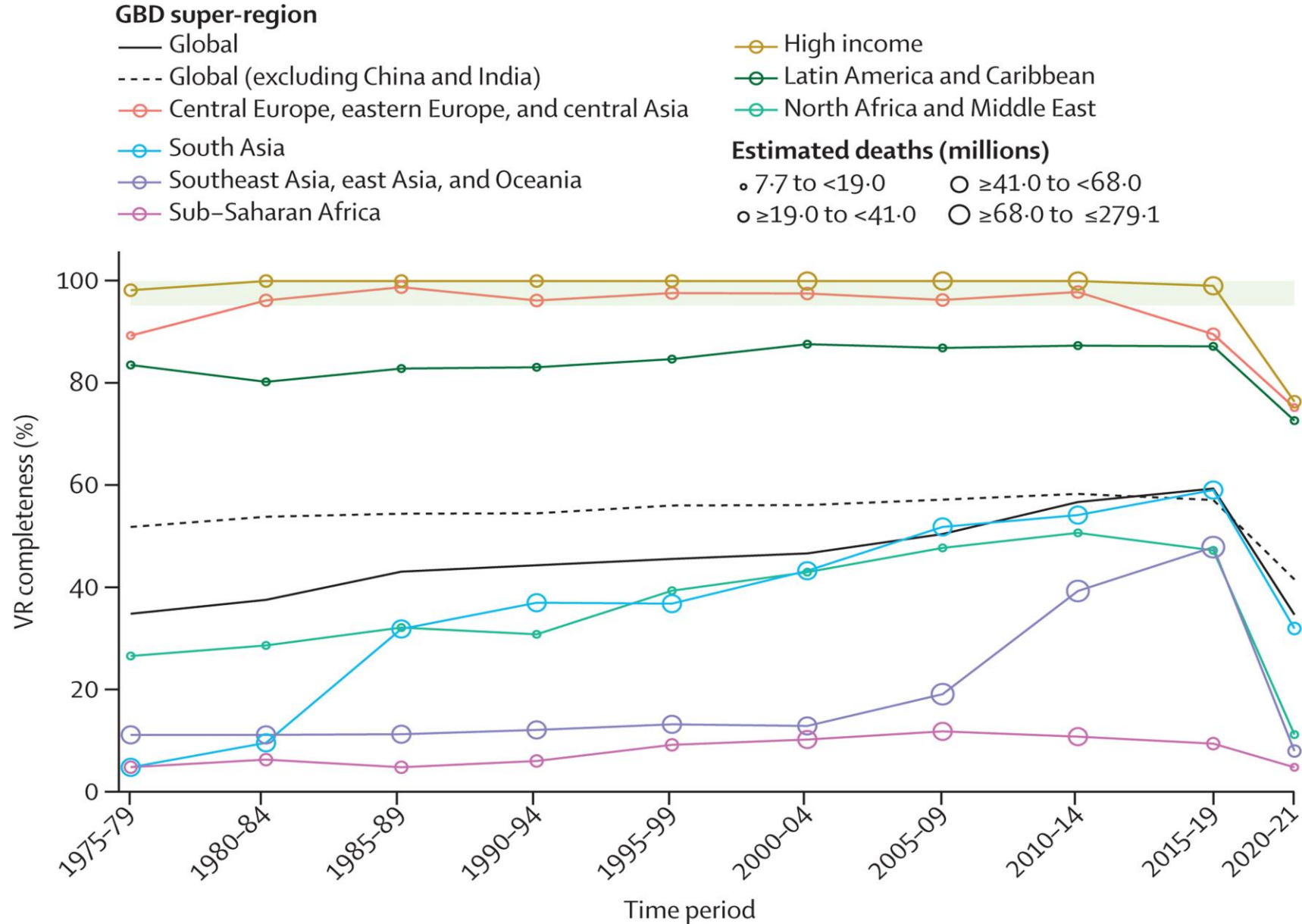
INJURIES

### Locations

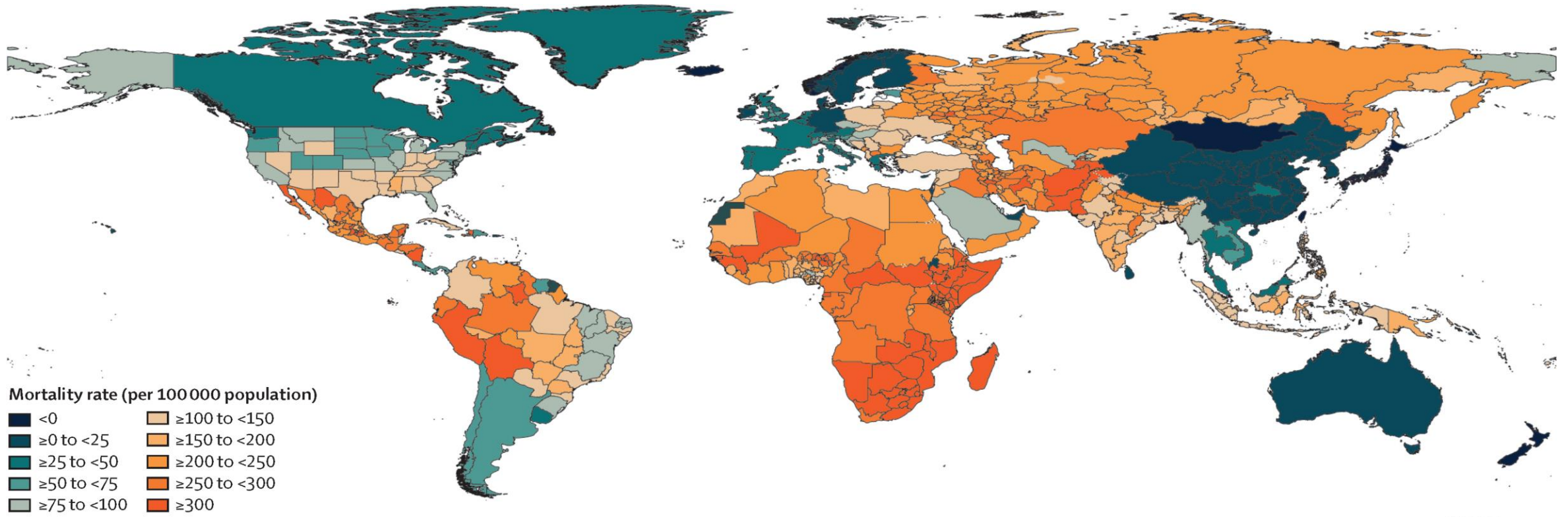
GLOBAL



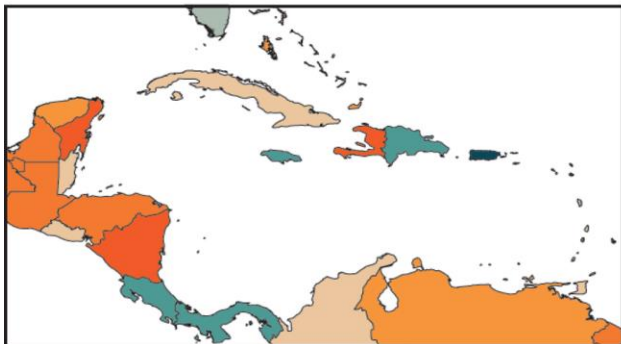
# Completeness of VR systems in GBD super-regions, 1975–2021



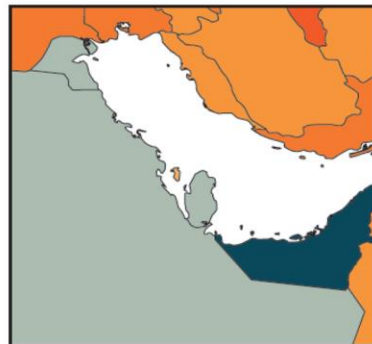
# Global distribution of age-standardised excess mortality rates due to the COVID-19 pandemic, 2020 and 2021 combined



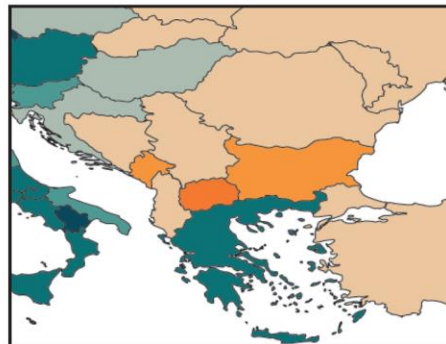
Caribbean and central America



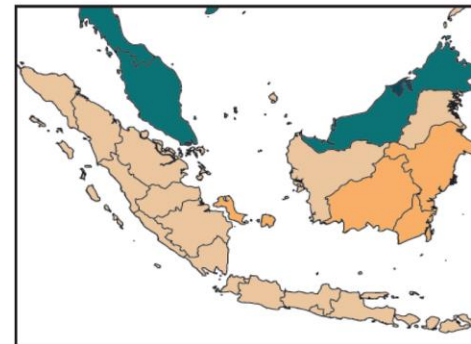
Persian Gulf



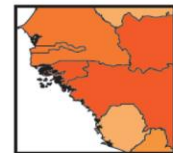
The Balkans



Southeast Asia



West Africa



Eastern Mediterranean

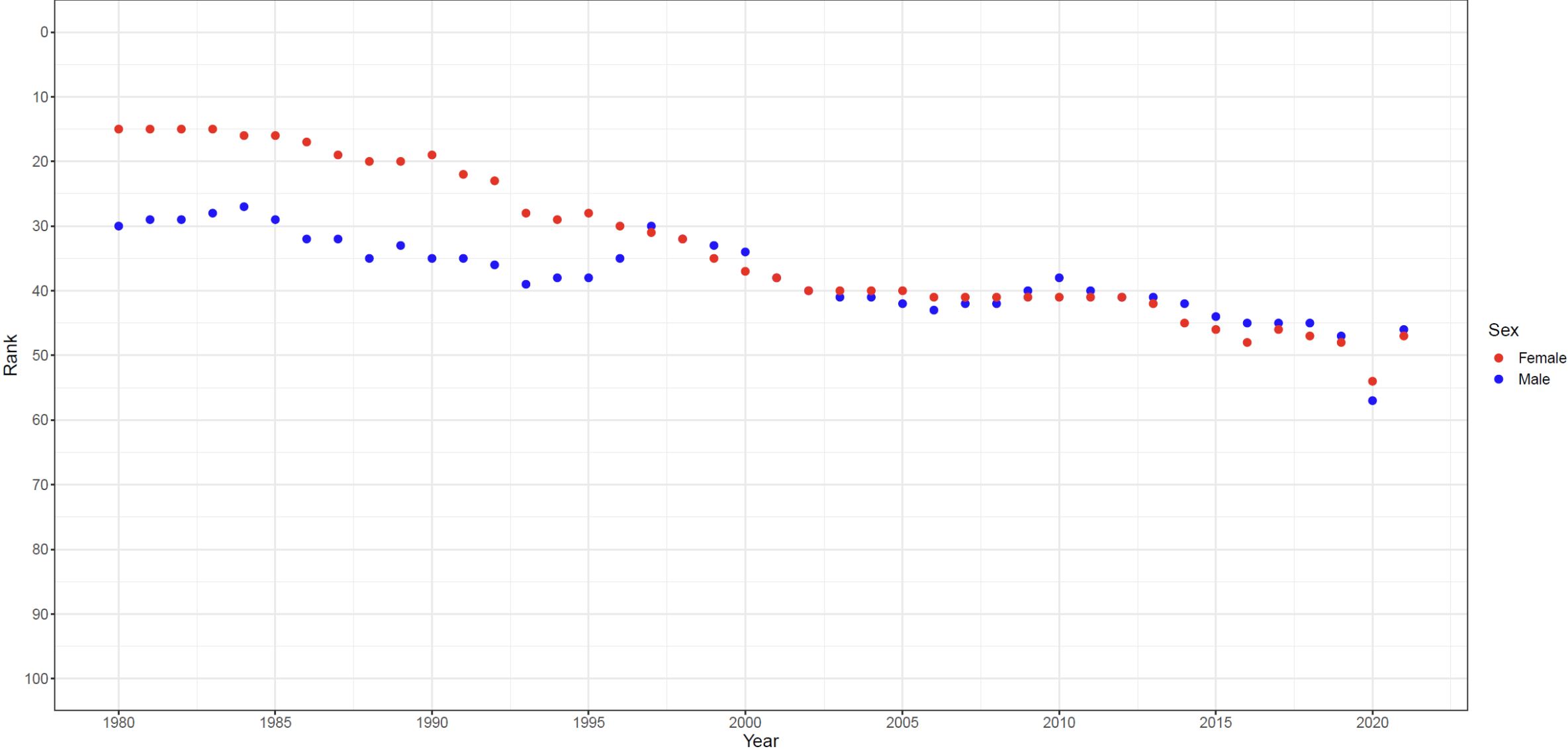


Northern Europe





# US life expectancy rank across 204 countries



# GBD 2021

Six summary capstone papers:

Causes of death and life expectancy decomposition—  
published online April 3

**Full Lancet issue with all six capstone publications  
and a viewpoint will be released May 16**

## Global burden of 288 causes of death and life expectancy decomposition in 204 countries and territories and 811 subnational locations, 1990–2021: a systematic analysis for the Global Burden of Disease Study 2021



GBD 2021 Causes of Death Collaborators\*



### Summary

**Background** Regular, detailed reporting on population health by underlying cause of death is fundamental for public health decision making. Cause-specific estimates of mortality and the subsequent effects on life expectancy worldwide are valuable metrics to gauge progress in reducing mortality rates. These estimates are particularly important following large-scale mortality spikes, such as the COVID-19 pandemic. When systematically analysed, mortality rates and life expectancy allow comparisons of the consequences of causes of death globally and over time, providing a nuanced understanding of the effect of these causes on global populations.

**Methods** The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2021 cause-of-death analysis estimated mortality and years of life lost (YLLs) from 288 causes of death by age-sex-location-year in 204 countries and territories and 811 subnational locations for each year from 1990 until 2021. The analysis used 56 604 data sources, including data from vital registration and verbal autopsy as well as surveys, censuses, surveillance systems, and cancer registries, among others. As with previous GBD rounds, cause-specific death rates for most causes were estimated using the Cause of Death Ensemble model—a modelling tool developed for GBD to assess the out-of-sample predictive validity of different statistical models and covariate permutations and combine those results to produce cause-specific mortality estimates—with alternative strategies adapted to model causes with insufficient data, substantial changes in reporting over the study period, or unusual epidemiology. YLLs were computed as the product of the number of deaths for each cause-age-sex-location-year and the standard life expectancy at each age. As part of the modelling process, uncertainty intervals (UIs) were generated using the 2.5th and 97.5th percentiles from a 1000-draw distribution for each metric. We decomposed life expectancy by cause of death, location, and year to show cause-specific effects on life expectancy from 1990 to 2021. We also used the coefficient of variation and the fraction of population affected by 90% of deaths to highlight concentrations of mortality. Findings are reported in counts and age-standardised rates. Methodological improvements for cause-of-death estimates in GBD 2021 include the expansion of under-5-years age group to include four new age groups, enhanced methods to account for stochastic variation of sparse data, and the inclusion of COVID-19 and other pandemic-related mortality—which includes excess mortality associated with the pandemic, excluding COVID-19, lower respiratory infections, measles, malaria, and pertussis. For this analysis, 199 new country-years of vital registration cause-of-death data, 5 country-years of surveillance data, 21 country-years of verbal autopsy data, and 94 country-years of other data types were added to those used in previous GBD rounds.

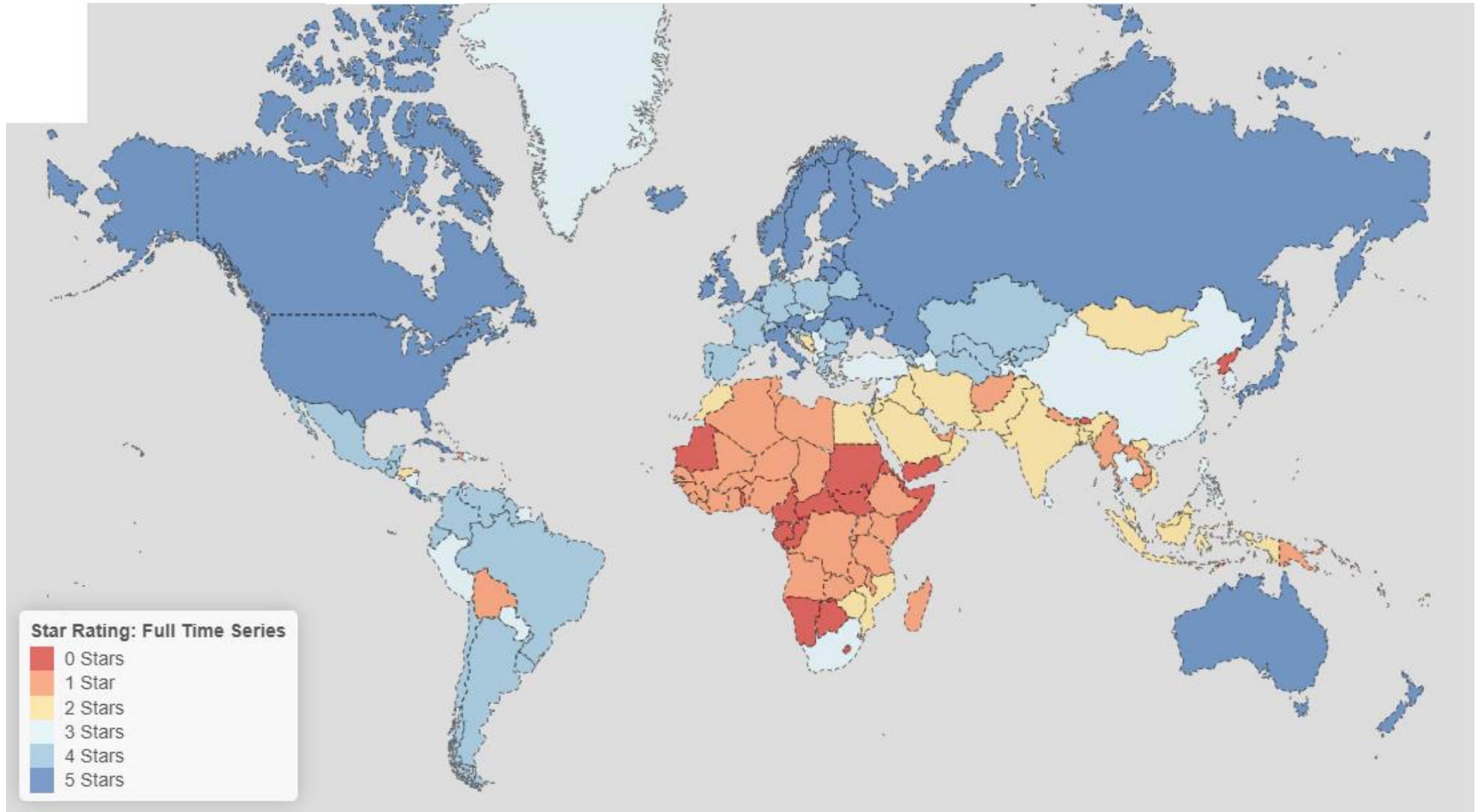
**Findings** The leading causes of age-standardised deaths globally were the same in 2019 as they were in 1990; in descending order, these were, ischaemic heart disease, stroke, chronic obstructive pulmonary disease, and lower respiratory infections. In 2021, however, COVID-19 replaced stroke as the second-leading age-standardised cause of death, with 94.0 deaths (95% UI 89.2–100.0) per 100 000 population. The COVID-19 pandemic shifted the rankings of the leading five causes, lowering stroke to the third-leading and chronic obstructive pulmonary disease to the fourth-leading position. In 2021, the highest age-standardised death rates from COVID-19 occurred in sub-Saharan Africa (271.0 deaths [250.1–290.7] per 100 000 population) and Latin America and the Caribbean (195.4 deaths [182.1–211.4] per 100 000 population). The lowest age-standardised death rates from COVID-19 were in the high-income super-region (48.1 deaths [47.4–48.8] per 100 000 population) and southeast Asia, east Asia, and Oceania (23.2 deaths [16.3–37.2] per 100 000 population). Globally, life expectancy steadily improved between 1990 and 2019 for 18 of the 22 investigated causes. Decomposition of global and regional life expectancy showed the positive effect that reductions in deaths from enteric infections, lower respiratory infections, stroke, and neonatal deaths, among others have contributed to improved survival over the study period. However, a net reduction of 1.6 years occurred in global life expectancy between 2019 and 2021, primarily due to increased death rates from COVID-19 and other pandemic-related mortality. Life expectancy was highly variable between super-regions over the study period, with southeast Asia, east Asia, and Oceania gaining 8.3 years (6.7–9.9) overall, while having the smallest reduction in life expectancy due to COVID-19 (0.4 years). The largest reduction in life expectancy due to COVID-19 occurred in Latin America and the Caribbean (3.6 years). Additionally, 53 of the 288 causes of death were highly concentrated in locations with less than 50% of the global population as of 2021.

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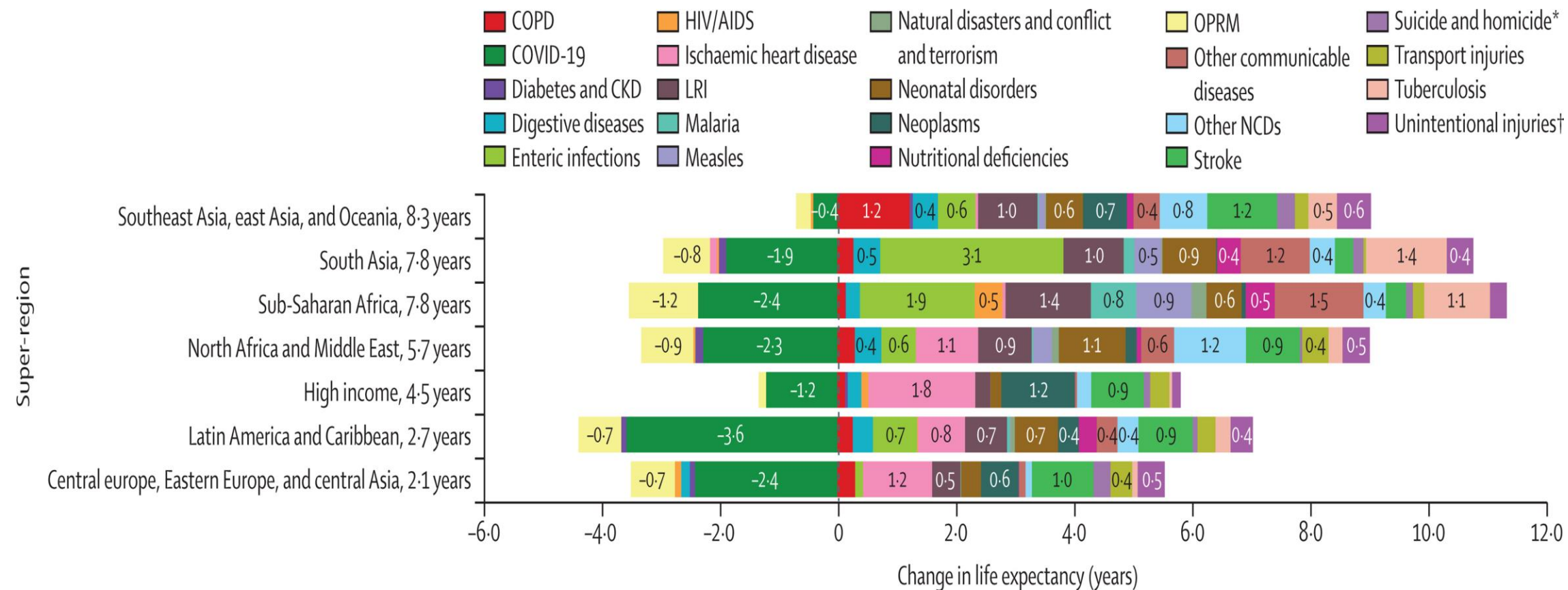
[www.thelancet.com](http://www.thelancet.com) Published online April 3, 2024 [https://doi.org/10.1016/S0140-6736\(24\)00367-2](https://doi.org/10.1016/S0140-6736(24)00367-2)

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# Star Rating of causes of death data from 1980-2021 based quality of assignment of death and completeness



# Change in life expectancy attributable to leading causes of death among super-regions, 1990–2021



# US Burden of Disease and Health Disparities Project

**Goal: Estimate burden of disease and health disparities in the US at the county level, stratified by racial and ethnic population.**

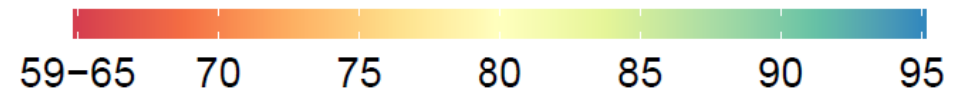
Using the same conceptual approach as the Global Burden of Disease (GBD) Study:

- Focus on all aspects of health loss, and various metrics:
  - *Traditional measures*: mortality, incidence, and prevalence rates
  - *Impact measures*: years of life lost (YLLs), years lived with disability (YLDs)
  - *Summary measures*: disability adjusted life years (DALYs), healthy life expectancy (HALE)
- Consider a wide range of health conditions
- Estimate both exposure to and burden attributable to selected risk factors

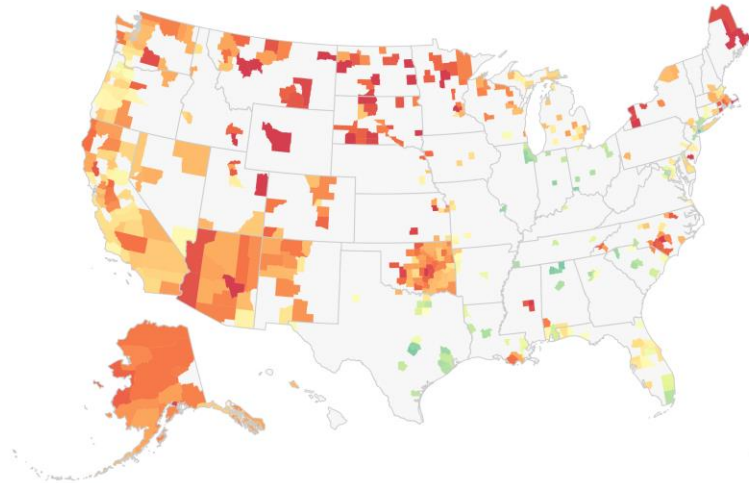
**This project is funded by NIH, and undertaken in collaboration with the NIH US Burden of Health Disparities Working Group**

# County Life Expectancy, 2019

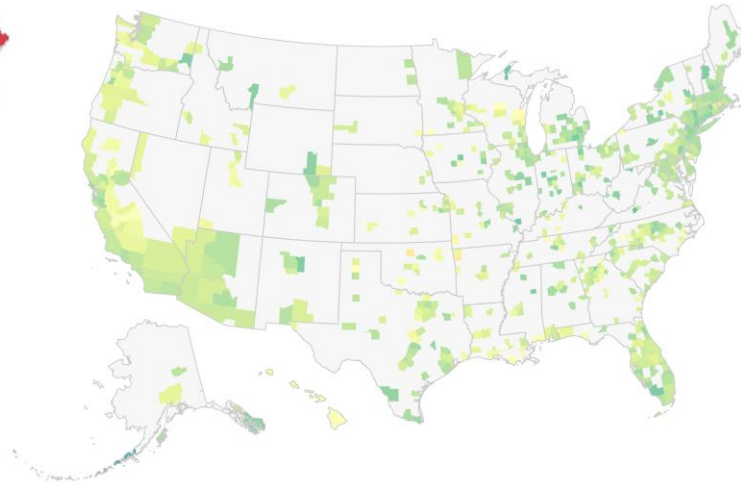
Life expectancy, 2019 (years)



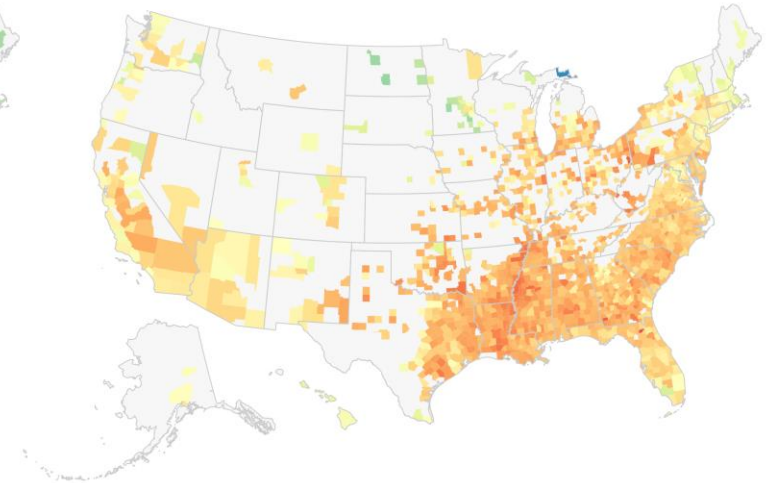
AIAN



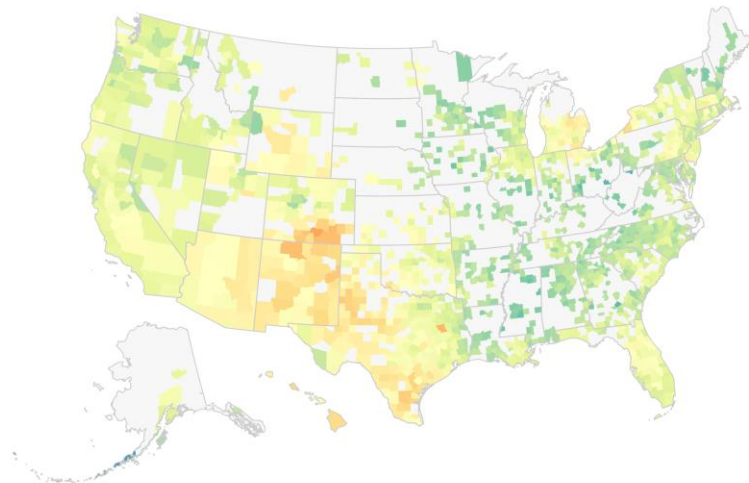
Asian



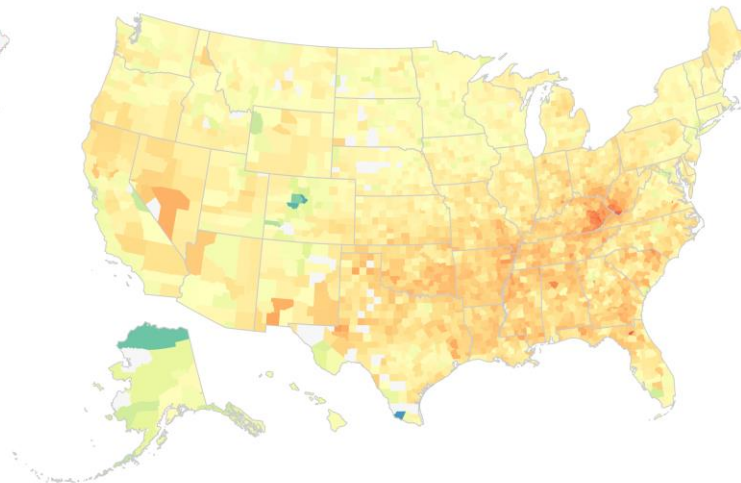
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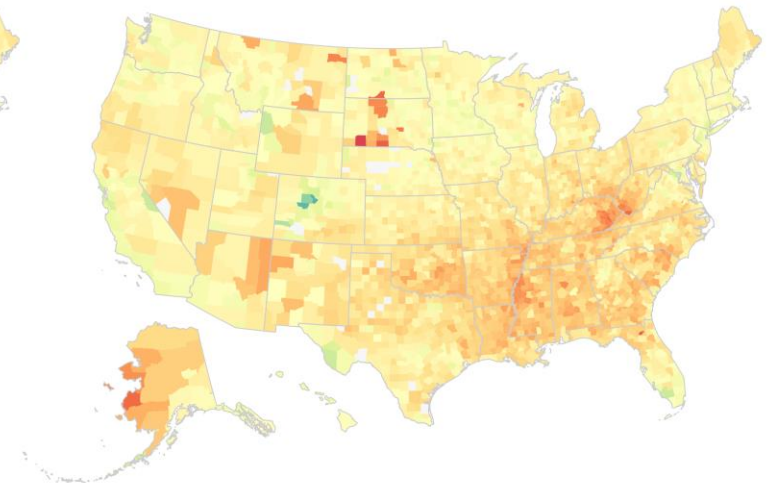
Latino



White

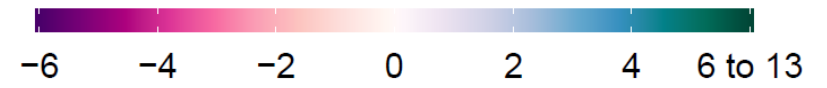


Total

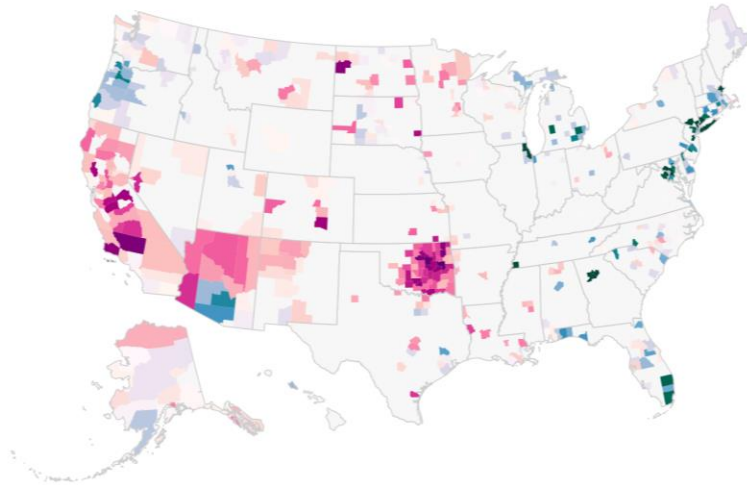


# Change, 2000–19

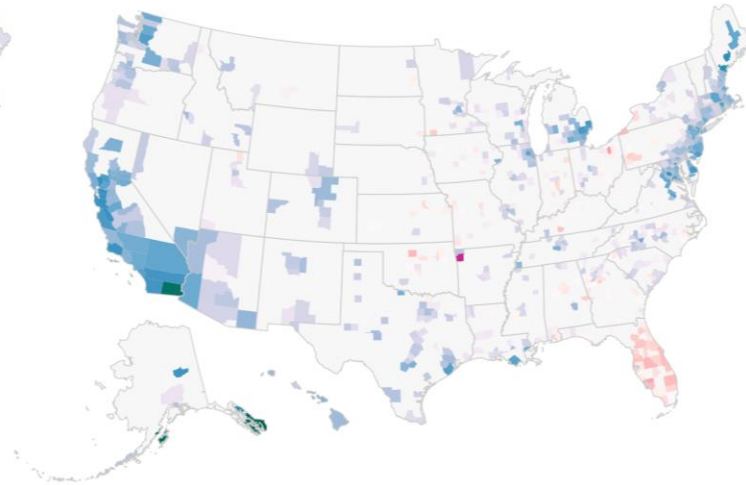
Change in life expectancy, 2000 to 2019 (years)



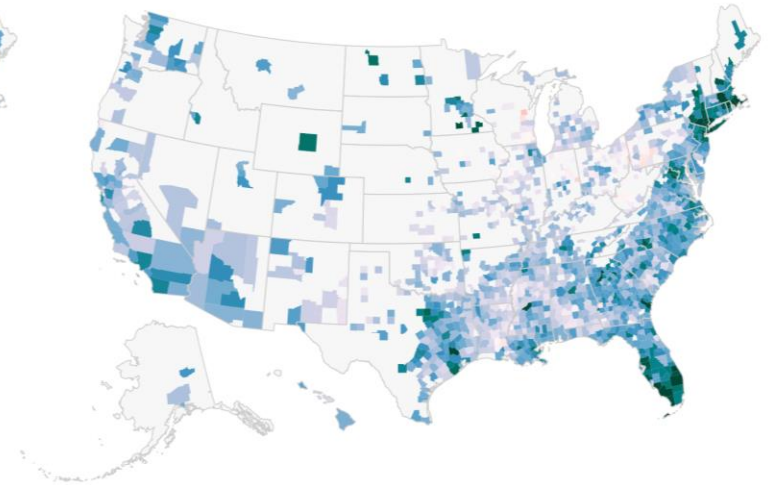
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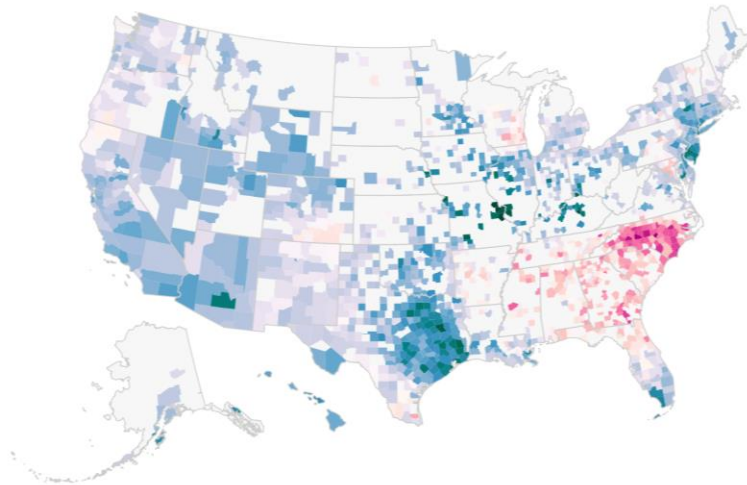
Asian



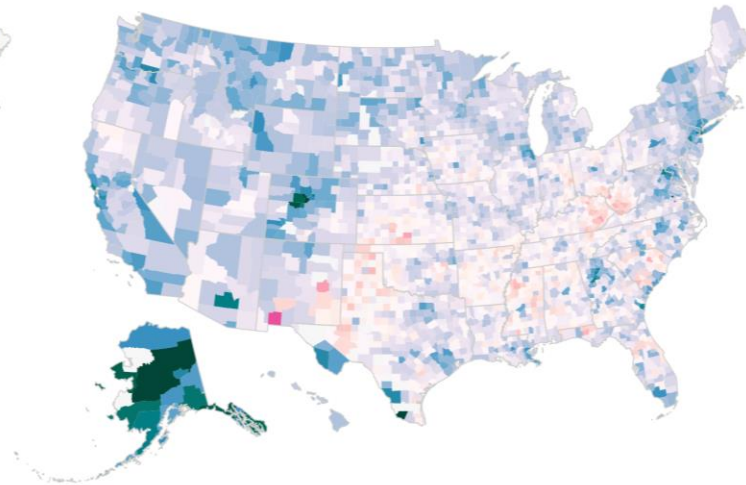
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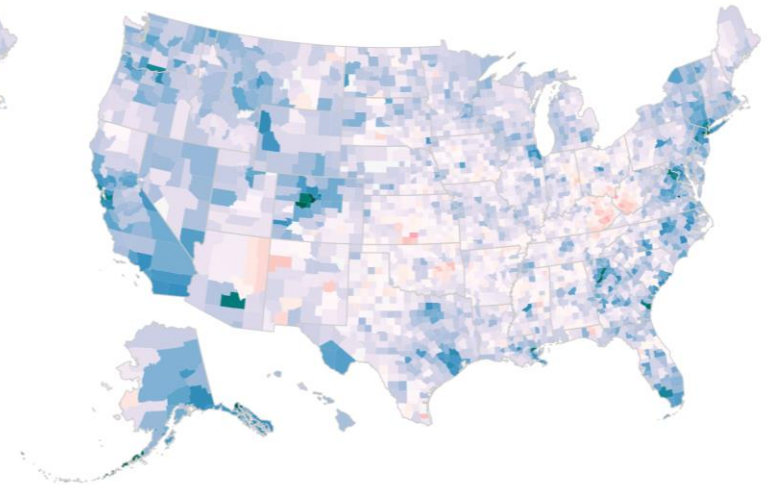
Latino



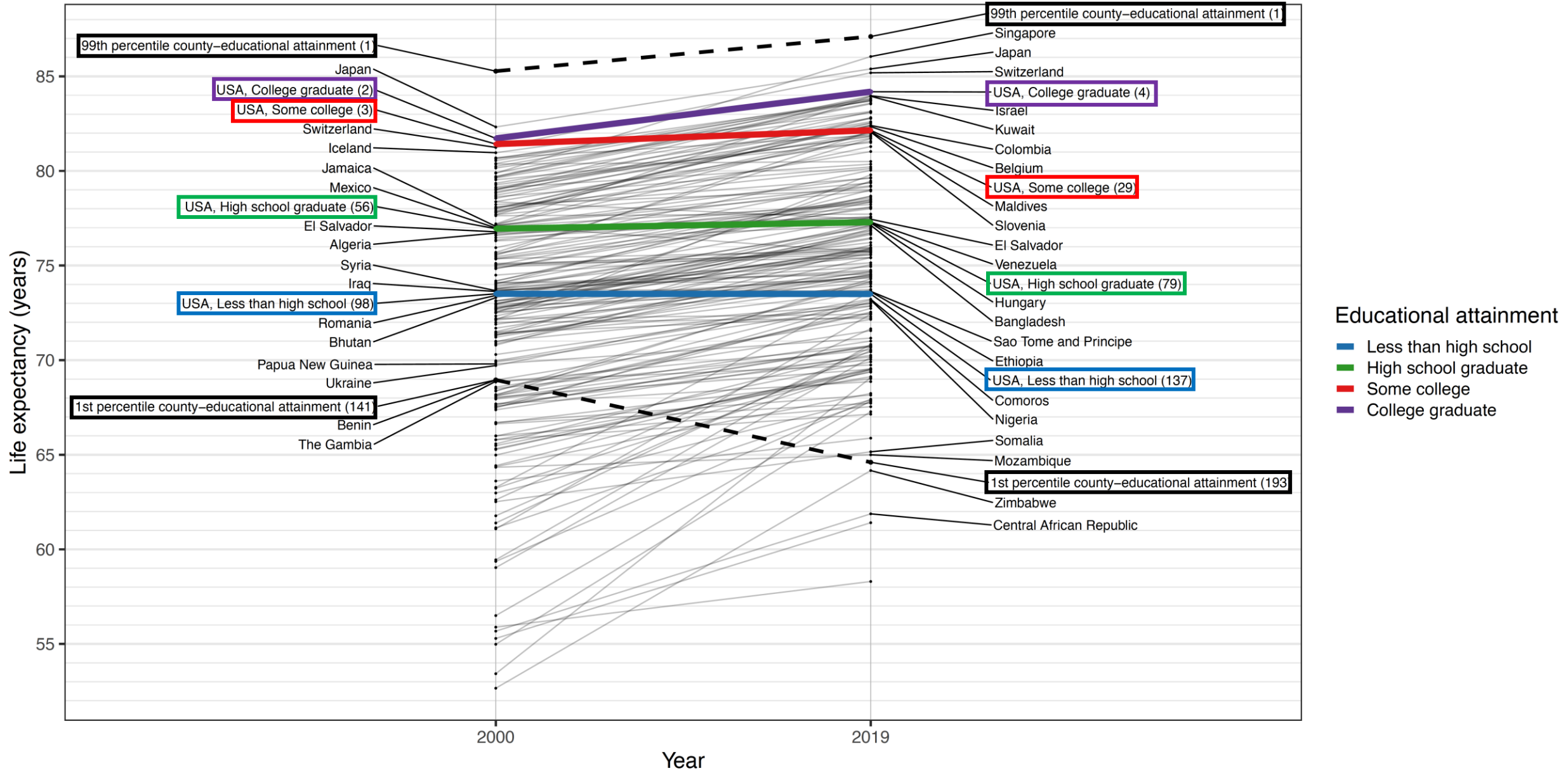
White



Total



# Comparison to Other Countries





# County Mortality Patterns, 2019

All causes

HIV/AIDS and sexually transmitted infections

Respiratory infections and tuberculosis

Enteric infections

Other infectious diseases

Maternal and neonatal disorders

Nutritional deficiencies

Neoplasms

Cardiovascular diseases

Chronic respiratory diseases

Digestive diseases

Neurological disorders

Substance use disorders

Diabetes and kidney diseases

Skin and subcutaneous diseases

Musculoskeletal disorders

Other non-communicable diseases

Transport injuries

Unintentional injuries

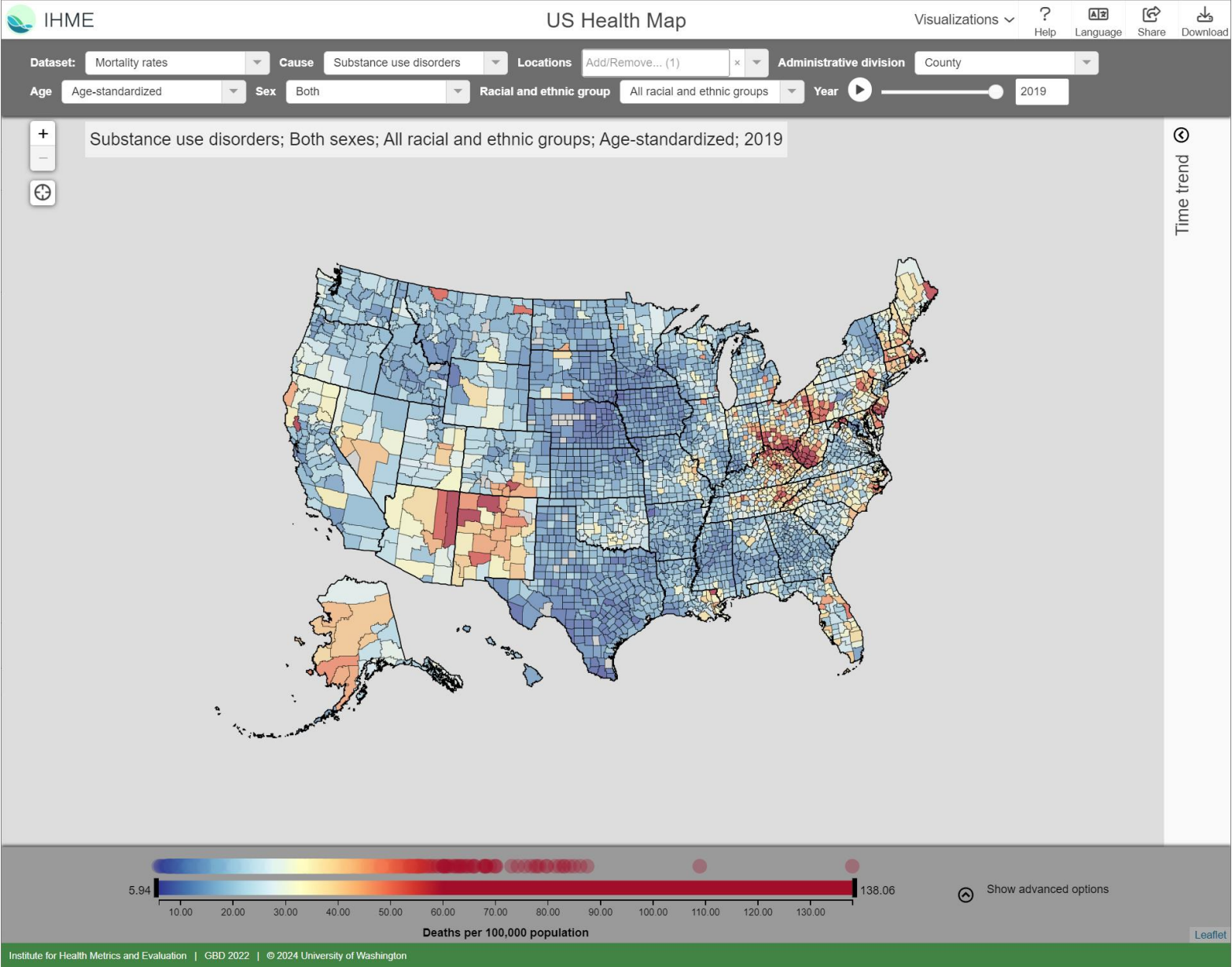
Self-harm and interpersonal violence

Ratio of county mortality to national mortality:



# US Health Map

<https://vizhub.healthdata.org/subnational/usa>



# County Obesity Prevalence (age 20+), 2019

AIAN

Asian

Black

Latino

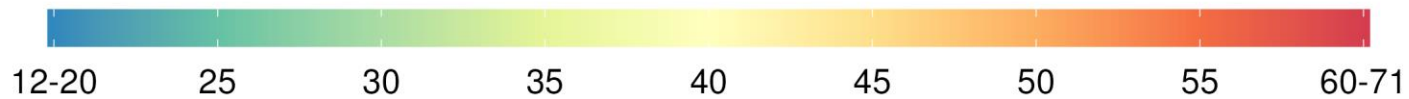
White

Male

Female

Males & Females

Obesity prevalence (%)



12-20

25

30

35

40

45

50

55

60-71