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Avoidable Mortality Across US States and High-Income Countries

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IMPORTANCE Although there are increasing differences in health policy and population health across US states over the past decade, little is known about how US states compare with other countries on avoidable mortality.

OBJECTIVE To compare trends in avoidable mortality across US states and countries in the European Union (EU) and the Organisation for Economic Co-operation and Development (OECD).

DESIGN, SETTING, AND PARTICIPANTS Retrospective, population-based, repeated cross-sectional study comparing changes in avoidable mortality among decedents aged 0 to 74 years in 50 US states (and Washington, DC) and 40 high-income countries between 2009 and 2021. Data analysis was conducted from May to July 2024.

MAIN OUTCOMES AND MEASURES Avoidable mortality comprising both preventable deaths related to prevention and public health and treatable deaths related to timely and effective health care treatment.

RESULTS Between 2009 and 2019, total avoidable mortality increased in all US states (median [IQR], 29.0 [20.1 to 44.2] deaths per 100 000 people), while it decreased in most comparator countries (−14.4 [−28.4 to −8.0]). During this period, variation in avoidable mortality widened across US states (2009: median [IQR], 251.1 [228.4 to 280.4]; 2019: 282.8 [249.1 to 329.5]), but narrowed in comparator countries (2009: 201.5 [166.2 to 320.8]; 2019: 187.1 [152.0 to 298.2]). During the COVID-19 pandemic (2019-2021), avoidable mortality increased for all US states (median [IQR], 101.5 [64.7 to 143.1]) and comparator countries (25.8 [9.1 to 117.7]). The states and countries that experienced the greatest increase in avoidable deaths during the COVID-19 period were those with the highest baseline avoidable mortality (Pearson ρ = 0.86; $P < .001$). Health spending and avoidable mortality have a consistent, negative, and significant association among comparator countries (2019: Pearson ρ = −0.7; $P < .001$) but no statistically significant association within US states (2019: Pearson ρ = −0.12; $P = .41$).

CONCLUSIONS AND RELEVANCE This cross-sectional study found that the stark contrast in avoidable mortality trends between all US states compared with EU and OECD countries suggests that broad, systemic factors play a role in worsening US population health. While other countries appear to make gains in health with increases in health care spending, such an association does not exist across US states, raising questions regarding US health spending efficiency.

Supplemental content

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Despite spending more than any country in the world on health care, life expectancy in the US is comparably worse than that of most other high-income countries and declining both in absolute value and relative rank.[1-3] However, life expectancy across US states varies just as markedly as it does across high-income countries, from 81.8 years in Hawai'i to 74.7 years in Mississippi in 2019—a divergence that has been increasing over time.[4,5] US states vary considerably on policy decisions related to the spending, regulation, and provision of health care; reproductive health; tax policy; social welfare programs; and in relation to crime, poverty, income, and other social determinants of health.[6-11] These differences have increased in the past decade, as major legislation related to social welfare and health care coverage—such as Medicaid expansion or, more recently, abortion rights—are determined at the state level.

As a result, health provision across US states is highly variable, reflecting both differences in public health policies[5] and the constellation of payers that affect health care affordability, access, quality, and health outcomes. Several other high-income countries take different approaches to securing health outcomes through the way they organize health systems as well as through their investments in mitigating social determinants of health.[8] For these reasons, aggregated national data at the US level may obscure different trends across subgroups of states as well as potential successes and failures of health and social policy within the US. A better understanding of mortality differences across US states compared with other countries would be helpful to determine whether poorer population health is a broader systemic problem across all states or a product of worsening poor performance among conditions where state-level policy can delay and even prevent death.

One way to better capture the contribution of state-level policy and its influence on mortality is by examining avoidable mortality. Avoidable mortality is a population health measure that tallies the number of deaths each year in the population younger than 75 years that could have been prevented or avoided through timely and effective health care and prevention.[12] This metric is commonly used by the Organisation for Economic Co-operation and Development (OECD),[13] the European Union (EU),[14] and several nations[15,16] to evaluate the performance of health systems. Avoidable mortality can further be divided into preventable and treatable mortality. Preventable mortality is defined as deaths that may be avoided with effective prevention practices, including through public health and health promotion practices. Examples include vaccine-preventable deaths and road traffic collisions. Treatable mortality is defined as deaths that may be avoided with timely and effective medical care. Examples include deaths from appendicitis or sepsis.[17] Some deaths are considered both preventable and treatable (eg, deaths from cervical cancer, ischemic heart disease, and tuberculosis). In these cases, the death is split so that a proportion is allocated to both categories. Some comparative studies have examined avoidable mortality across high-income countries, including the US[18-20]; however, these predate the years of declining US life expectancy beginning in 2014. Other cross-sectional studies have shown variation across US states, particularly during the COVID-19 pandemic, but not in relation to other countries.[4] To the study investigators' knowledge, there is limited evidence examining how US states compare with other high-income countries on avoidable mortality over the past decade.

Key Points

Question How did avoidable mortality vary across US states compared with 40 high-income countries between 2009 and 2021?

Findings In this retrospective study, between 2009 and 2021, avoidable mortality increased in all US states, primarily due to increases in preventable deaths, while it decreased in comparable high-income countries. Health spending was significantly negatively associated with avoidable mortality for other high-income countries but not across US states.

Meaning Avoidable mortality has worsened across all US states, while other high-income countries show improvement; results suggest poorer mortality is driven by broad factors across the entirety of the US.

Therefore, using data from the US Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO), this study compared avoidable mortality across the 50 US states and Washington, DC, with 40 countries that are part of the EU and/or members of the OECD. More specifically, the study sought to answer the following key questions. First, how did avoidable mortality across US states and other countries change before and during the COVID-19 pandemic, between 2009 and 2019, and 2019 and 2021? Second, to what extent were these changes driven by changes in preventable and/or treatable deaths? Third, given the substantial variation in health care expenditures across US states and EU and OECD countries over time, are there differences in the association between health care expenditures and avoidable mortality in US states compared with other countries?

Methods

Reporting Requirements

We follow the EQUATOR reporting guidelines. This study was approved by the Brown University institutional review board and determined exempt from review and informed consent, as our analysis was of secondary data.

Country Selection

We compared the 50 US states and Washington, DC, with all 40 countries that are member states of the EU and the OECD as of 2019 (eTable 1 in Supplement 1). Just as US states are diverse in their policy environment, economic landscape, and population spread, we chose to include all member states of the EU and OECD to represent diversity across country national income, geography, landmass, and population density, and represent countries that have different levels of national income, health system design, and health expenditures.

Data

Mortality data for countries between 2009 and 2021 were obtained from the WHO Mortality Database.[21] WHO mortality data categorize death counts according to the *International Statistical Classification of Diseases and Related Health Problems, 10th*

Revision (*ICD-10*) chapters by country, year, age group, and sex. We aggregated the number of deaths in each country-year by sex and 5-year age groups, to encompass both sexes and the 0 to 74 years age group after age and sex standardization (not including age 75 years per the OECD/Eurostat avoidable mortality definition).[17]

Mortality data for US states between 2009 and 2021 were obtained from the CDC National Vital Statistics System (NVSS) Multiple Cause of Death restricted-use micro-data files.[22] This dataset contains individual decedent records, including year of death; primary *ICD-10* cause of death; and the decedent's age, sex, and residence. We limited the data to decedents younger than 75 years, also aggregating by 5-year age groups and sex prior to age- and sex-standardization of the mortality rates.

We used population data to calculate mortality rates within countries and US states. Country midyear population estimates by single year of age and sex are from the US Census Bureau International Database Time Series (1960-2023)[23] and from the CDC WONDER Bridged-Race Population Estimates (1990-2020) and Single-Race Population Estimates (2020-2022) for US states.[24,25]

Health expenditures per capita estimates for 2009, 2019, and 2020 represent total all-payer (Medicare, Medicaid, and private) personal health care expenditures per capita by state of residence for US states, compiled by the US Census Bureau and Centers for Medicare & Medicaid Services Office of the Actuary,[26] and total national health expenditures per capita from the WHO Global Health Expenditure Database for comparator countries.[27] This WHO database also supplied exchange rates to convert from local currency and Consumer Price Index values to US dollars (USD), with 2021 as the base year (100 = 2021) used to adjust health expenditures for inflation.[27]

Analysis

We calculated avoidable mortality rates based on the OECD/Eurostat 2022 list of preventable and treatable causes of death. This list was produced by the OECD and Eurostat with an expert group and builds on earlier work completed by researchers.[17] We calculated age- and sex-standardized rates using the US total population as the reference distribution. For both US states and countries, mortality rate estimates were calculated for decedents aged 0 to 74 years in each year by state or country of residence for both sexes. We aggregated death counts for the cohorts in each state or country and year by the broad categories of preventable, treatable, and avoidable deaths. We categorized *ICD-10* codes as preventable and treatable according to the OECD/Eurostat 2022 list, with some *ICD-10* codes counted at 50% as both preventable and treatable (eTable 2 in Supplement 1).[17] Avoidable deaths are the sum of preventable and treatable deaths (eTable 2 in Supplement 1). We evaluated preventable, treatable, and avoidable mortality rates for US states and countries in each year by sex and 5-year age group by dividing these aggregated death counts by midyear population estimates and converting to a rate per 100 000 people (hereafter, per 100 000). We multiplied these crude rates by their respective proportions relative to the US total population distribution in each year, then summed these products to achieve age- and sex-standardized mortality rates. Within the categories of preventable, treatable, and avoidable mortality, we also aggregated death counts by *ICD-10* chapter (eTable 2 in Supplement 1).

We plotted avoidable mortality in 2019 and health care expenditures per capita (in 2021 USD) in the same year. We computed a Pearson correlation coefficient between these variables separately for countries (excluding the US) and for US states to examine the association between health spending and health outcomes. We also plotted these associations for 2009 and 2020. *P* values were 2-sided with α = .05 as the significance threshold.

Analyses were conducted with R and RStudio version 4.3.2 (R Foundation) between May and July 2024.

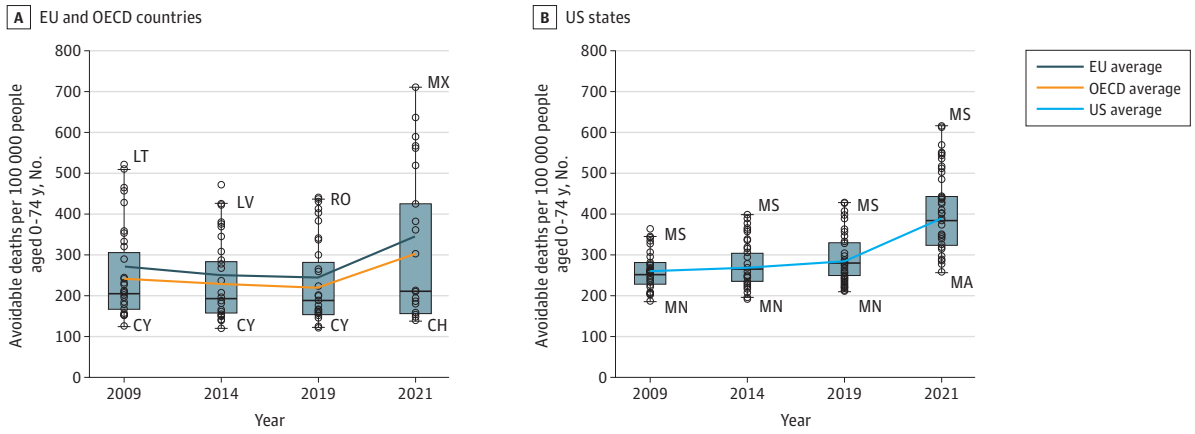
Results

Trends in Avoidable Mortality in US States and EU and OECD Countries, 2009-2019

Between 2009 and 2019, avoidable mortality increased in all US states and Washington, DC (median [IQR], 29.0 [20.1 to 44.2] avoidable deaths per 100 000) (**Figure 1**) (see eFigure 1 in Supplement 1 for complete time series and eFigure 2 in Supplement 1 excluding COVID-19). On average, mean (SD) avoidable mortality increased by 32.5 (18.0) avoidable deaths per 100 000 across the US, although this varied considerably by state, ranging from 4.9 in New York State to 99.6 in West Virginia (**Figure 2**). In contrast, median (IQR) avoidable mortality decreased in most comparator countries (−14.4 [−28.4 to −8.0]), except for Mexico, Turkey, Bulgaria, Canada, Australia, and the UK. EU countries experienced a mean (SD) decrease of 23.9 (29.5) avoidable deaths per 100 000, and OECD countries an average decrease of 19.1 (29.5). Only the 22 states with the greatest increases between 2009 and 2019 increased significantly (eTable 3 in Supplement 1). Declines were significant (eTable 3 in Supplement 1) and most pronounced relative to the start of the period (eTable 4 in Supplement 1) among the Eastern European EU countries (Lithuania, Latvia, Estonia, Hungary), the Republic of Korea, and Ireland. During this period, variation in avoidable mortality widened across US states (2009: median [IQR], 251.1 [228.4 to 280.4]; 2019: 282.8 [249.1 to 329.5]) but narrowed in comparator countries (2009: 201.5 [166.2 to 320.8]; 2019: 187.1 [152.0 to 298.2]).

We disaggregated avoidable mortality changes across US states and countries by changes in preventable (eFigure 3 in Supplement 1) and treatable mortality (eFigure 4 in Supplement 1). In the US, most of the increase in the 2009 to 2019 period was in preventable mortality (preventable change 2009-2019: median [IQR], 24.3 [15.5 to 32.1] preventable deaths per 100 000; treatable change 2009-2019: 7.5 [3.4 to 10.2] treatable deaths per 100 000). Avoidable mortality in US states between 2009 and 2019 was mostly due to increased avoidable deaths from external causes (eg, traffic collisions, homicides, suicides, and drug- and alcohol-related deaths; median [IQR], 15.0 [9.4 to 20.3] deaths per 100 000) (eFigure 5 in Supplement 1), which were mainly preventable (eFigure 6 in Supplement 1). Drug-related deaths were also the main driver of increased avoidable deaths from external causes in the US from

Figure 1. Age- and Sex-Standardized Avoidable Mortality Across US States and European Union (EU) and Organisation for Economic Co-operation and Development (OECD) Countries



Greece, New Zealand, and Norway were excluded due to incomplete data. Belgium, France, Germany, Ireland, Italy, Malta, Portugal, Romania, Slovenia, Turkey, and the UK did not have data points for 2021. For a plot of the complete time series, refer to eFigure 1 in Supplement 1. For a version of these plots excluding tabulations for COVID-19 in 2021, refer to eFigure 2 in Supplement 1. The boxes represent the interquartile ranges and the horizontal lines within the boxes, the medians of the distributions. Labeled data points include the maximum and minimum values in each year. Countries are labeled according to International Organization for Standardization 3166 alpha-2 country codes. States are labeled with their 2-letter abbreviations. For all country and state values, see eTable 3 in Supplement 1.

2009 to 2019, contributing 71.1% of the increase (eFigure 7 in Supplement 1). To a lesser extent, avoidable deaths due to circulatory and respiratory diseases and cancer increased in most states. Notably, most states experienced an increase in treatable mortality related to neoplasms (median [IQR], 0.4 [−0.3 to 1.2]), with few exceptions (eFigure 8 in Supplement 1). However, in most instances, this increase was offset by gains made in preventable mortality for neoplasms (median [IQR], −4.4 [−5.9 to −1.6]), so improvements in avoidable mortality due to neoplasms seemed to be mostly from cancers disposed to prevention (eFigure 6 in Supplement 1).

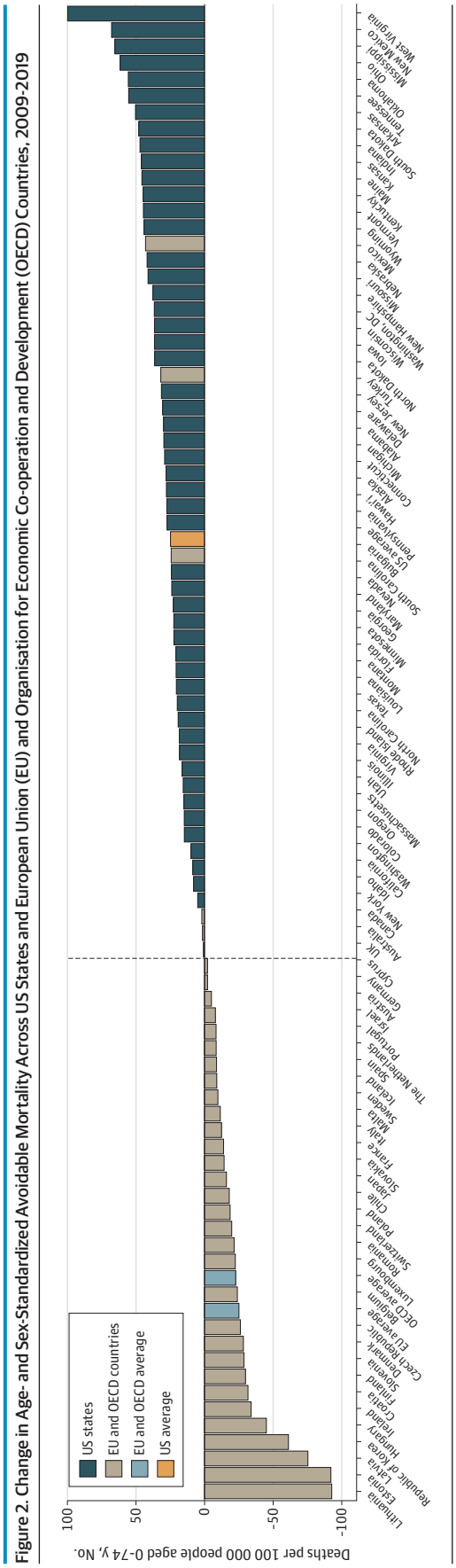
Conversely, most comparator countries made gains in avoidable mortality, predominantly driven by improvements in preventable mortality (median [IQR], −10.6 [−18.0 to −3.3]) and to a lesser extent in treatable mortality (−3.8 [−11.0 to −1.9]). Avoidable deaths from external causes declined in nearly every country except Canada, Turkey, the UK, Mexico, the Netherlands, Australia, and Iceland (median [IQR], −6.1 [−10.5 to −1.8] avoidable deaths per 100 000) (eFigure 5 in Supplement 1). Avoidable deaths due to circulatory and respiratory diseases and cancer also declined. Several countries experienced small increases in preventable mortality from respiratory illnesses (median [IQR], 1.2 [0.8 to 2.3] preventable deaths per 100 000) (eFigure 6 in Supplement 1).

Change in Avoidable Mortality in US States and EU and OECD Countries, 2019-2021

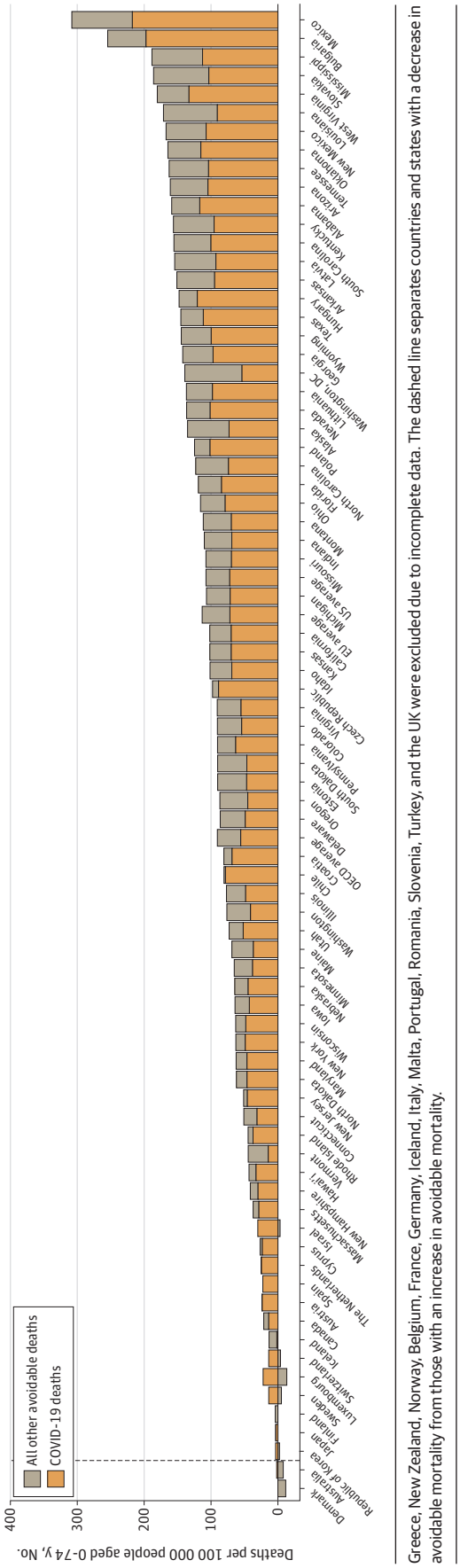
Between 2019 and 2021, avoidable mortality increased for all US states and nearly all comparator countries (**Figure 3**), except for Denmark and Australia. This was driven predominately by COVID-19 deaths, which the OECD/Eurostat list classified as preventable (Figure 3). The rate of avoidable deaths from circulatory system diseases and external causes increased for most states and countries, and treatable mortality gains were offset by preventable mortality increases, which included COVID-19 deaths, for most geographies (eFigure 9 in Supplement 1). Between 2019 and 2021, comparator countries still fared much better than most US states. Avoidable mortality increased significantly for almost all US states from 2019 to 2021, with only some northeastern states (Vermont, New Hampshire, Rhode Island, and Massachusetts) and Hawai'i as exceptions. Conversely, only some Eastern European countries and Chile experienced a significant increase in avoidable mortality over the same period (eTable 4 in Supplement 1). The magnitude of increase in avoidable deaths across states and countries between 2019 and 2021 was strongly associated with baseline avoidable mortality (Pearson ρ = 0.86; $P < .001$) (eFigure 10 in Supplement 1).

Association Between Avoidable Mortality and Health Spending, US States vs EU and OECD Countries, 2009, 2019, and 2020

We examined the association between avoidable mortality and health spending per capita (eTable 5 in Supplement 1) cross-sectionally in EU and OECD countries as well as US states. We found a clear negative association between health expenditures and avoidable mortality across the comparator countries in 2009 (Pearson ρ = −0.64; $P < .001$) (eFigure 11 in Supplement 1), in 2019 (Pearson ρ = −0.7; $P < .001$) (**Figure 4**), and in 2020 (Pearson ρ = −0.68; $P < .001$) (eFigure 12 in Supplement 1). However, across US states, there was no significant association between health expenditures and avoidable mortality in 2009 (Pearson ρ = −0.17; $P = .24$) (eFigure 11 in Supplement 1), in 2019 (Pearson ρ = −0.12; $P = .41$) (Figure 4), or in 2020 (Pearson ρ = −0.09; $P = .52$) (eFigure 12 in Supplement 1).

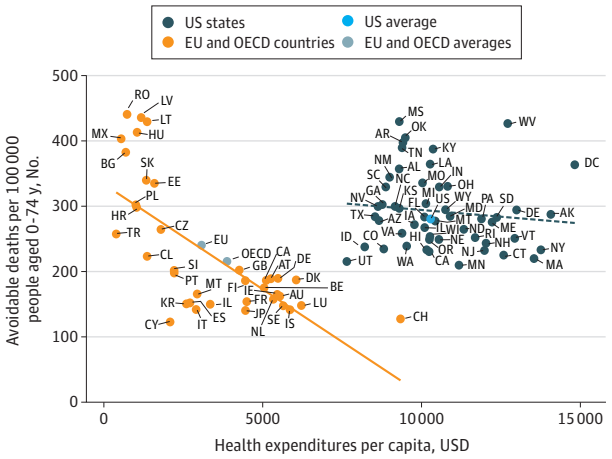


Greece, New Zealand, and Norway were excluded due to incomplete data. The dashed line separates countries and states with a decrease in avoidable mortality from those with an increase in avoidable mortality.



Greece, New Zealand, Norway, Belgium, France, Germany, Iceland, Italy, Malta, Portugal, Romania, Slovenia, Turkey, and the UK were excluded due to incomplete data. The dashed line separates countries and states with a decrease in avoidable mortality from those with an increase in avoidable mortality.

Figure 4. Health Expenditures per Capita and Age- and Sex-Standardized Avoidable Mortality Across US States and European Union (EU) and Organisation for Economic Co-operation and Development (OECD) Countries, 2019



Greece, New Zealand, and Norway were excluded due to incomplete mortality data for 2019. Health expenditures per capita estimates for US states are total all-payer personal health care expenditures per capita by state of residence, compiled by the Centers for Medicare & Medicaid Services and the US Census Bureau.[26] Health expenditure estimates for OECD and EU countries are from the World Health Organization Global Health Expenditure Database, and all health expenditure per capita estimates were adjusted for inflation using the Consumer Price Index (100 = 2021) from the same source.[27] For the US states, Pearson ρ = −0.12 (P = .41). For the countries, Pearson ρ = −0.7 (P < .001). Countries are labeled according to International Organization for Standardization 3166 alpha-2 country codes. States are labeled with their 2-letter abbreviations.

Discussion

Despite spending more on health care than every other high-income country, the US had comparably higher avoidable mortality, which includes deaths that can be avoided through timely prevention and access to high-quality health care. This study, which disaggregated US mortality rates across individual states and 40 EU and OECD countries, observed 5 key findings.

First, between 2009 and 2019, avoidable mortality increased in all US states, while decreasing in most comparator countries. The increase in US states was observed in both preventable and treatable mortality, with external causes of death and circulatory system diseases contributing the most. The stark contrast in prepandemic trends in US states vs comparator countries suggests that there are concerning broad and systemic issues at play.

Second, from 2009 to 2019, the study observed variation in avoidable mortality widening across US states and narrowing in comparator countries. Among comparator countries, those in Eastern Europe improved significantly, albeit having the highest rates of avoidable mortality at baseline in 2009. While the study was unable to determine what accounted for these differences, there were many changes in the policy landscape across these regions that warrant further investigation, such as accession of countries to the EU, which may have led to more policy convergence, particularly around social and economic policies. Conversely, in the US, the growing heterogeneity of state-level policy decisions across this period could have differentially impacted avoidable mortality across states (eg, adoption of Medicaid expansion across states and growing divergence in other areas, such as abortion rights, firearm legislation, and public welfare benefits).[5,28]

Third, with the onset of the COVID-19 pandemic, all countries experienced an increase in avoidable mortality between 2019 and 2021, reversing the downward trend observed in the prior decade. However, US states still fared worse than most of the observed countries. In US states, avoidable mortality continued its upward trend, albeit at a higher relative increase from the trend in the prior decade, and only some northeastern states and Hawai'i had insignificant increases. During this time, avoidable mortality significantly increased for only some Eastern European countries and Chile. The greatest increases in avoidable mortality were also observed in countries and states with higher baseline avoidable mortality, which could indicate that the prior performance of a state or country on population health is associated with its capacity to respond to health care shocks or emergencies. Increases in avoidable mortality, while mostly related to COVID-19 deaths, also occurred in deaths from other causes. This could represent some combination of factors, including (1) a continuation or exacerbation of a secular trend in avoidable deaths preceding the pandemic (eg, in overdose deaths, which increased between 2020-2021), (2) an increase in non–COVID-19 deaths related to disruptions in health service delivery, or (3) an increase in COVID-19 deaths miscoded as other deaths. More work should investigate the extent to which differences in underlying demographics, especially socioeconomic status and the adoption of social and health policies across states and countries, influenced the observed population health outcomes during this period.[9,29]

Fourth, avoidable mortality in the US appears to have been disproportionately driven by preventable mortality, which is influenced by socioeconomic factors and public health policy. This underscores the necessity for a multisectoral approach to improve US population health. For example, policies promoting access to healthy foods, limiting exposure to harmful products, and combating obesity can significantly reduce the risk and incidence of chronic diseases.[30-36] Legislative measures addressing gun violence can lower injury-related deaths.[7,37] Regulations on motor vehicle safety can prevent collisions and deaths.[38-40] These broader determinants of health require coordinated efforts across various sectors and highlight that improvements in preventable mortality can extend far beyond the realm of clinical care.

Fifth, the study observed a consistent, negative, and significant association between health spending and avoidable mortality for comparator countries, but no statistically significant association within US states. While the analysis cannot say anything about the direction of the association, several other studies have shown that higher health spending in the US is likely the product of higher prices, which might explain why the study did not observe greater expenditures to be

associated with lower avoidable mortality rates.[41-43] However, this could also indicate that the US spends more because its population is sicker. While the study cannot determine the underlying mechanisms, the lack of a significant association between health spending and health care outcomes in the US raises questions about the US health care system's overall efficiency.

This study adds to a growing literature examining the comparative position of US mortality with regard to other countries by broadening the outcomes compared to focus on conditions amenable to health treatment and prevention.[1,44-46] The study also extended the comparison to include US states, rather than the US as a whole, better capturing the heterogeneity of outcomes within the country and building on reports that have examined this cross-sectionally.[4,47] Finally, this article explores trends in the pre-COVID-19 and COVID-19 periods, illustrating the variability that exists across these periods. Study findings highlight the influence state-level policies may have on population health within the US.

Limitations

This study has limitations. First, only descriptive comparative findings were presented and causal inferences could not be made. Second, while avoidable mortality better captures variability in health system performance than life expectancy, it is also influenced by factors outside the health system, such as social determinants of health and demographics. Therefore, the observed variability across states and countries cannot be solely attributed to differences in health system performance. Third, the avoidable mortality list makes assumptions about the preventability and treatability of several conditions, such as COVID-19 deaths being entirely preventable and deaths of individuals older than 75 years not being avoidable. While this list is commonly applied across comparator countries, these crude assumptions may not reflect gains (or losses) in life expectancy for certain countries.[17,18,48,49] Fourth, the study relied on death statistics obtained from the WHO Mortality Database and the CDC NVSS, which, although validated, are subject to errors that could potentially skew estimates of avoidable deaths and trends, such as incomplete coding of all deaths in the country. However, for the data included in this study, only Bulgaria (86.5%), Turkey (89.5%), and Cyprus (98.0%) are less than complete.[21] In addition, several countries were missing data from the final year of the study, limiting the size of the comparison group post-2019. Fifth, US state per capita health expenditures may be underestimated, as they exclude some national spending categories, such as administrative costs of private health insurance, government public health activities, and investment in research, structures, and equipment.[26,50]

Conclusions

The findings from this study provide important insights to better understand worsening life expectancy in the US over time. Despite variation in avoidable deaths across US states, the study reveals an increase in avoidable deaths—including both treatable and preventable deaths—and across most causes of illness throughout the US before and during the COVID-19 pandemic. This is in stark contrast to improving trends in EU and OECD countries. Moving forward, US policymakers should more closely examine population health across states in international comparative studies with the US, particularly as health policy and responses to health shocks vary across states.

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Concept and design: Papanicolas, Figueroa.
Acquisition, analysis, or interpretation of data: Niksch, Figueroa.
Drafting of the manuscript: Papanicolas, Niksch.
Critical review of the manuscript for important intellectual content: Figueroa.
Statistical analysis: Niksch.
Administrative, technical, or material support: Papanicolas, Niksch.
Supervision: Papanicolas, Figueroa.

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