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Progress Stalled? The Uncertain Future of Mortality in High-Income Countries

Jennifer Beam Dowd, Antonino Polizzi and Andrea M. Tilstra

Steady and significant improvements in life expectancy have been a bright spot for human progress for the last century or more. Recently, this success has shown signs of faltering in some high-income countries, where mortality improvements have slowed or even reversed since the early 2010s. Combined with the large mortality shock of the COVID-19 pandemic, guaranteed forward progress feels less certain. We review mortality trends in high-income countries since 2000 through the COVID-19 pandemic. While deteriorating mortality in the United States has received the most attention, countries including the United Kingdom, Canada, the Netherlands, Greece, and Germany are also seeing slowdowns. Before COVID-19, these slowdowns largely reflected stalling improvements in cardiovascular disease mortality and increases in deaths from external causes in young and midlife for the worst-performing countries. We discuss prospects for the future of mortality in high-income countries, including lingering impacts of the COVID-19 pandemic, challenges and opportunities related to the obesity epidemic, and emerging reasons for both optimism and pessimism. While biological limits to increased life expectancy may eventually dominate long-term trends, human-made social factors are currently holding many countries back from already achievable best-practice life expectancy and will be key to near-term improvements.

Introduction

The dramatic improvements in global life expectancy over the last century are a significant human achievement (Bongaarts 2006). Life expectancy

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at birth in Europe more than doubled from around 36 years in the mid-nineteenth century to 79.1 years by 2019 (Dattani et al. 2023). Continued linear increases in record life expectancy cast doubt on the notion that we are reaching a natural limit to mortality improvements (Oeppen and Vaupel 2002; Vaupel et al. 2021). Despite this demographic optimism, mortality improvements in some high-income countries showed signs of slowing or even reversing prior to the COVID-19 pandemic. For example, the United Kingdom lost ground relative to other European peers since 2011 (Leon, Jdanov, and Shkolnikov 2019; Polizzi et al. 2024), and, at the extreme, life expectancy in the United States declined for three consecutive years starting in 2014 (Woolf and Schoomaker 2019). On top of these concerning trends, the COVID-19 pandemic caused life expectancy losses larger than had been seen since World War II that persisted in some countries for at least three years (Schöley et al. 2022; Huang et al. 2024). Slowdowns in mortality improvements coupled with the mortality shock of the COVID-19 pandemic raise the question of whether we are entering a new phase of demographic pessimism, with mortality improvements no longer as guaranteed as they once seemed. Amid the sterile statistical analyses, it is easy to forget that shortfalls in achievable mortality improvements have real human consequences. The United States suffered an estimated 11 million excess deaths or "missing Americans" between 1980 and 2019 compared to a scenario with death rates similar to peer countries (Bor et al. 2023). Those "missing" leave behind even greater numbers of bereaved kin (Umberson et al. 2017) and kin never born (Polizzi and Tilstra 2024). Understanding the social and biological drivers of population mortality thus remains one of our most important demographic research imperatives.

In this review, we summarize recent mortality trends in high-income countries, including the impact of COVID-19, and discuss potential drivers of future mortality trends. We see reasons for both pessimism and optimism. Mortality improvements derived from better nutrition and basic public health interventions can take decades to play out due to the impact of gestational and early-life factors on later-life health (Cutler, Deaton, and Lleras-Muney 2006). This "light from a distant star" may explain the consistent life expectancy improvements of recent decades, with additional (and also lagged) contributions from favorable trends in cohort smoking (Preston and Wang 2006). As the benefits of these past improvements fade with dying cohorts, it may be harder to achieve additional mortality gains. In a pessimistic scenario, these cohort trends are compounded by health deterioration in younger cohorts due to adverse trends in obesity and social inequality. We may also see an increased frequency of mortality shocks such as novel pathogens, antimicrobial resistance, and extreme weather. In a more optimistic scenario, new medical and technological advances overcome many of our current health challenges, slow biological aging, and improve health and longevity for generations to come. Increased societal

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wealth and social capital could be used for stronger provision of social and economic security and public investments that improve health. Which of these two scenarios dominates is not entirely under our control, but the recent divergence in mortality trends for some high-income countries suggests that human-made factors are limiting our current life expectancy potential more than biological limits.

Recent mortality trends in high-income countries

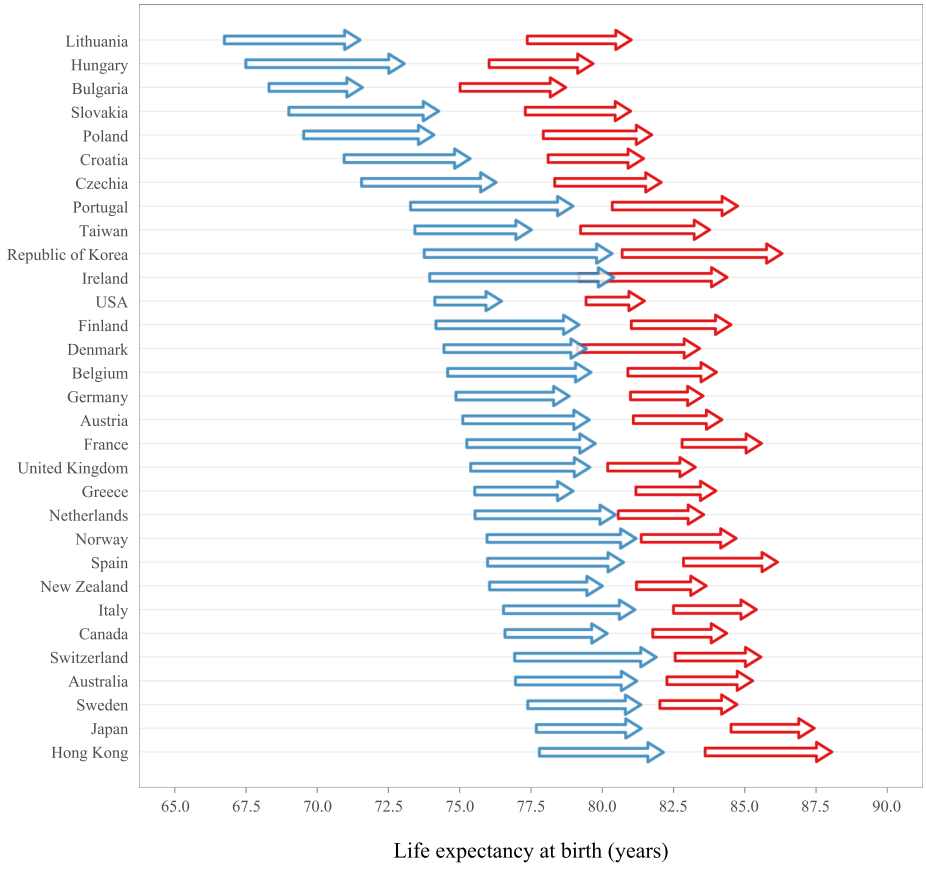
We focus our review on high-income (largely OECD) countries located in Europe, Australasia, and North America with populations greater than five million. Our review primarily focuses on mortality trends since the year 2000. For an overview of mortality in high-income countries prior to 2000, we refer readers to excellent papers by Wilmoth (2000), Bongaarts (2006), and Vallin and Meslé (2004). Life expectancy at birth in 2019 ranged from 71.5 for Lithuanian males to 88.1 for females in Hong Kong (Figure 1 and Table 1). In Figure 1, we see the lower life expectancy gains of countries such as Canada, Greece, and the United States, compared to other countries from 2000 to 2019, as well as the lower average gains for women compared to men in most countries.

The rise in life expectancy during the second half of the 20th century was slower than the first half because large gains from reductions in infant and child mortality had already been reached and further gains could only come from mortality improvements at older ages (Wilmoth 2000). Since the year 2000, the mortality landscape in high-income countries has been less consistent. Many countries continued to see fast mortality improvements in the first decade of the 2000s, but since around 2011 those improvements have slowed considerably, including drops in life expectancy in 2014–2015 (Ho and Hendi 2018) and during the COVID-19 pandemic (Schöley et al. 2022). While the slowdowns in mortality improvements have been most notable in the United States, significant slowdowns have also been seen in other countries, including the United Kingdom (Murphy, Luy, and Torrisi 2019). While there is some consensus that slowdowns in improvements are happening across most high-income countries, the specific countries and patterns that emerge vary depending on the choice of mortality indicators and periods considered.

We summarize recent mortality trends in 31 high-income countries using data from the Human Mortality Database, comparing annual rates of mortality improvement (ROMI) during the periods 2000–2009 and 2010–2019. ROMI is calculated by rearranging a standard growth equation with a constant rate r: $P(t) = P(0)\ e^{rt}$ (Rau et al. 2018). For each period, we obtain r by the following equation: $r = \frac{\ln(\frac{m(t)}{m(0)})}{t}$, where $m(t)$ is the mortality rate at time t. To ensure that mortality improvements (i.e., declines in

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FIGURE 1 Male (blue) and female (red) life expectancy at birth, in 2000 (tail of arrow) and 2019 (head of arrow)



SOURCE: Human Mortality Database, authors' calculations.

mortality rates) always have positive values, we multiply by −1, that is, $-r$ = ROMI. Table 1 shows the ROMI for age-standardized mortality rates by country separately for the two periods, sorted by the smallest to largest growth rates for the 2010–2019 period. We find that most countries (23 out of the 31) had slower rates of mortality improvement in 2010–2019 compared to 2000–2009. The exceptions were Hungary, Sweden, Belgium, Croatia, Denmark, Lithuania, Slovakia, and Hong Kong, which all saw faster improvements in the second period. Countries with the slowest rate of mortality improvements in 2010–2019 included the United States, New Zealand, Greece, the United Kingdom, the Netherlands, Canada, and Germany. The fastest improvements were seen in Korea, Hong Kong, Slovakia, Lithuania, Denmark, Ireland and Portugal. We present figures for combined sexes for parsimony, but sex-specific results can be found in Table A1 in the Supporting Information. In general, rates of mortality

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TABLE 1 Annual rates of mortality improvement (ROMI) 2000–2019.

	2010–2019		2000–2009		Change		Life expectancy		
Country	ROMI	Rank	ROMI	Rank	Δ ROMI	Rank	2000	2010	2019
Republic of Korea	+0.030	1	+0.041	1	−0.011	27	77.3	80.4	83.4
Hong Kong	+0.026	2	+0.018	10	+0.007	3	80.7	82.8	85.1
Slovakia	+0.025	3	+0.015	25	+0.010	2	73.1	75.5	77.7
Lithuania	+0.022	4	+0.003	31	+0.019	1	72.1	73.2	76.4
Denmark	+0.019	5	+0.015	24	+0.004	5	76.8	79.2	81.4
Portugal	+0.018	6	+0.024	3	−0.006	21	76.8	80.1	82.0
Ireland	+0.018	7	+0.035	2	−0.017	31	76.5	80.6	82.4
Norway	+0.017	8	+0.020	9	−0.002	13	78.7	81.0	83.0
Belgium	+0.017	9	+0.016	20	+0.001	7	77.8	80.0	81.8
Finland	+0.017	10	+0.022	6	−0.005	20	77.7	80.0	81.9
Croatia	+0.017	11	+0.010	30	+0.007	4	74.6	76.6	78.4
Sweden	+0.016	12	+0.015	26	+0.001	6	79.7	81.5	83.0
Czechia	+0.016	13	+0.017	16	−0.001	11	75.0	77.6	79.2
Switzerland	+0.015	14	+0.018	14	−0.003	14	79.8	82.3	83.8
Poland	+0.015	15	+0.016	21	−0.001	9	73.7	76.3	77.9
Hungary	+0.015	16	+0.014	27	+0.000	8	71.8	74.5	76.5
Spain	+0.015	17	+0.018	15	−0.003	16	79.4	82.0	83.5
Japan	+0.014	18	+0.017	19	−0.002	12	81.2	83.0	84.5
Australia	+0.014	19	+0.018	11	−0.005	19	79.6	82.0	83.2
France	+0.013	20	+0.017	18	−0.004	18	79.0	81.4	82.7
Taiwan	+0.013	21	+0.023	5	−0.010	25	76.1	79.0	80.6
Italy	+0.012	22	+0.016	22	−0.003	15	79.6	82.1	83.3
Austria	+0.012	23	+0.016	23	−0.003	17	78.2	80.5	81.9
Bulgaria	+0.012	24	+0.018	13	−0.006	22	71.6	73.8	75.1
Germany	+0.012	25	+0.012	29	−0.001	10	78.1	80.1	81.2
Netherlands	+0.011	26	+0.023	4	−0.012	30	78.1	80.8	82.0
Canada	+0.011	27	+0.018	12	−0.007	24	79.2	81.3	82.3
United Kingdom	+0.011	28	+0.022	7	−0.011	28	77.8	80.4	81.4
Greece	+0.009	29	+0.020	8	−0.011	26	78.3	80.6	81.5
New Zealand	+0.007	30	+0.014	28	−0.007	23	78.7	81.1	81.8
USA	+0.005	31	+0.017	17	−0.012	29	76.8	78.7	79.0

NOTE: Data come from the Human Mortality Database and authors' calculations. Change = (ROMI Period 2 − ROMI Period 1).

improvement were lower for women compared to men in 2010–2019, but country rankings were largely consistent.

These results extend a range of previous work documenting slowing mortality improvements since 2000. Murphy and Grundy (2022) reviewed the changes in mortality improvements in high-income countries from 2000 to 2019 with a special focus on the United States and the United Kingdom. Almost all the 19 countries they examined saw a significant decline in their rate of mortality improvement over this period, except for Japan, with the United Kingdom and the United States having the slowest rate

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of recent mortality improvement. Raleigh (2019) found a general pattern of slower life expectancy improvements in the European Union (EU) and several other high-income countries from 2011–2016 compared to 2006–2011. The smallest gains in life expectancy for 2011–2016 were again seen in the United Kingdom and the United States, followed by Greece, Portugal, France, Canada, Germany, Sweden, Australia, and the Netherlands.

Ho (2020) evaluated life expectancy slowdowns in a set of OECD countries by categorizing countries into whether their annualized life expectancy gains were considered low, medium, or high since 2010. The worst performers over this period were the United States, the United Kingdom, Italy, and New Zealand. Japan and Switzerland were among the countries with the highest levels of life expectancy in 2010, but still had the highest rates of improvement, suggesting high performers were not approaching a biological life expectancy limit. The United States had among the lowest starting life expectancy *and* slowest rates of improvement, further disproving the idea that slowdowns are due to a ceiling effect.

Djeundje et al. (2022) took a different approach, examining how countries' mortality improvements after 2011 deviated from forecasts based on data from 1965 to 2010 for ages 50–95, hypothesizing that some slowdowns might have been expected based on past trends. In general, countries with slower mortality improvements after 2011 also did worse than their forecasts would have predicted, particularly for women. Countries that experienced better-than-expected mortality improvements included Denmark and Norway (both sexes) and Sweden, Belgium, and Finland (men only). Women in Greece, Italy, and Spain had the worst performance compared to forecasts, while for men, this was Germany, Greece, Taiwan, and the United Kingdom. Some countries experienced a "double slowdown" in mortality improvements, with both forecasted and additional "unexpected" slowdowns. This double slowdown was seen in Ireland, the United States, and the United Kingdom (both sexes), in the Netherlands, Canada, Taiwan (women only), and in Greece and Italy (men only).

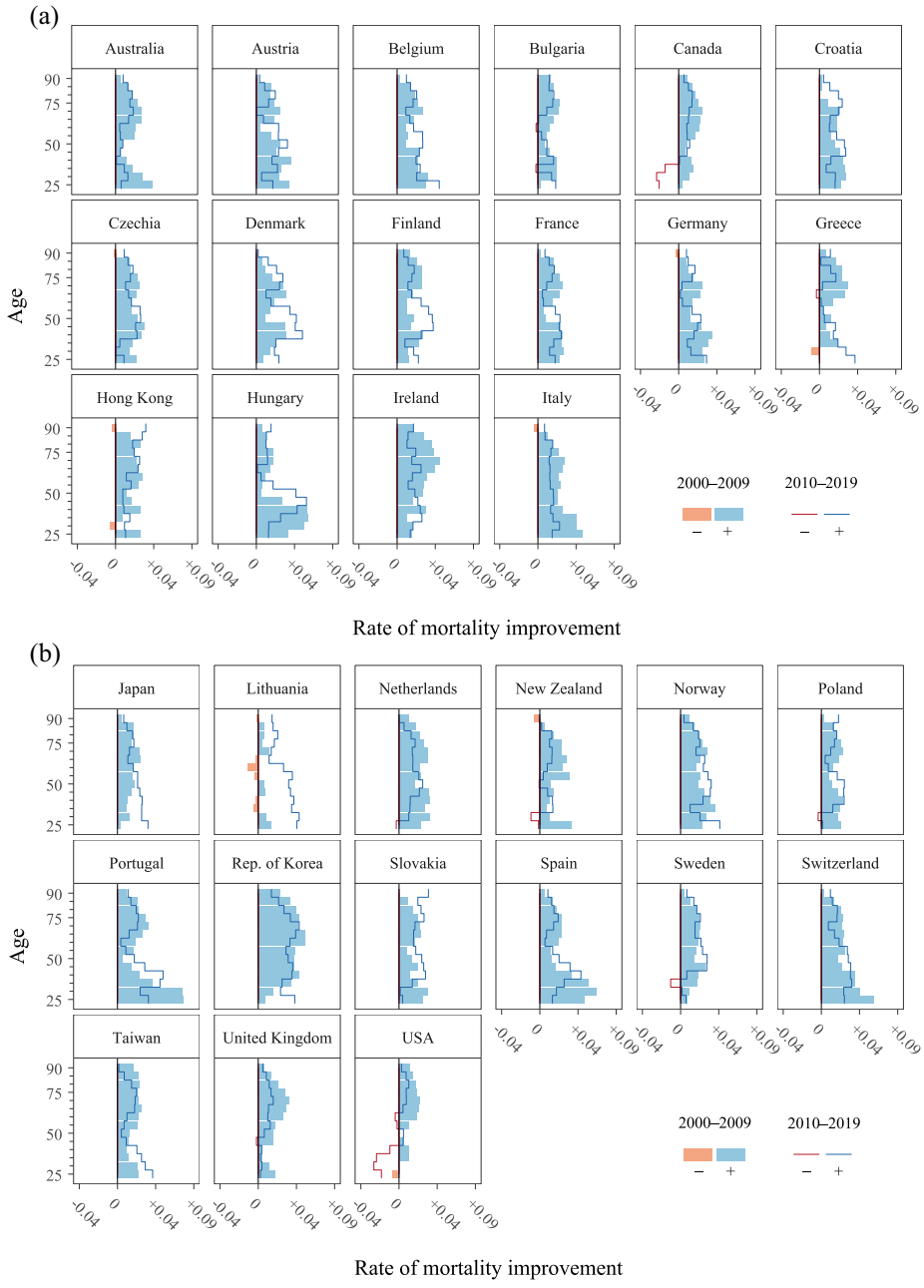
Taken together, there has been a consistent pattern of slowing mortality improvements in many but not all high-income countries since around 2010. While US mortality is consistently falling behind peer countries, emerging poor performers include the United Kingdom, Canada, Greece, Germany, and the Netherlands.

Age contributions to slowdowns

In the United States, rising midlife mortality (roughly ages 40–65) has received significant research attention as a driver of stagnating life expectancy (Harris, Majmundar, and Becker 2021). Looking across our full set of high-income countries, Figures 2a and 2b show rates of mortality improvements (ROMI) in 2000–2009 and 2010–2019 calculated separately

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FIGURE 2 Annual rates of mortality improvement (ROMI) by age, 2000–2009 and 2010–2019: (a) Australia–Italy and (b) Japan–USA



SOURCE: Human Mortality Database, authors' calculations.

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for five-year age groups for ages 25 and over (see Figures A1–A4 in the Supporting Information for patterns for females and males). A positive ROMI value indicates a reduction in mortality rates. The United States was notable for its lack of improvements at younger ages and midlife in 2000–2009, which further deteriorated to become mortality *increases* in 2010–2019 (indicated by left-facing red lines). The improvements in the first decade of the century for the United States were primarily at older ages (indicated by right-facing blue bars), but these also declined substantially after 2010, a pattern also seen in the United Kingdom and Canada (Abrams, Myrskylä, and Mehta 2023; Polizzi and Dowd 2024). The United Kingdom saw a similar but muted pattern of small improvements at younger ages and midlife in the first decade, with almost no improvement after 2010. Canada and New Zealand, two other slow-improving countries, saw some worsening mortality at younger ages.

However, adverse trends in midlife mortality were not universal among poor-performing countries. Greece had slow mortality improvements since 2010, but improvements were larger at young compared to older ages. Reductions in mortality improvements were roughly uniform across ages in the Netherlands, except for around age 50 where faster improvements were seen. Some countries saw *faster* mortality improvements in midlife mortality since 2010, including Norway, Switzerland, Denmark, Finland, and Hungary. In Germany, the changes across age and time suggest a cohort pattern to mortality improvements, with age groups that did relatively well or poor maintaining that pattern aged 10 years later, a pattern also visible in Spain, Hungary, and Portugal. Japan had a unique pattern of some slowing improvements at older age but robust improvements at younger and midlife ages.

Overall, countries with the slowest overall improvements commonly experienced both slowing improvements or worsening mortality under age 55 and the "double jeopardy" (Abrams, Myrskylä, and Mehta 2023) of slowing improvements at older ages, particularly in the United States, New Zealand, the United Kingdom, and Canada.

Causes of death

Much of the existing work on mortality stagnation in high-income countries has focused on the United States relative to other countries (Harris, Majmundar, and Becker 2021; Ho 2022; Woolf 2023; Acosta et al. 2022; Mehta and Myrskylä 2022). This work has tended to highlight the rise in working-age mortality and deaths due to drug overdoses, made famous by Case and Deaton (2015). While considerable additional work has confirmed the sad state of US midlife mortality compared to peers, evidence that "deaths of despair"—i.e., those due to drugs, alcohol, and suicide—are a principal driver of slowdowns (Masters, Tilstra, and Simon 2018) or divergence of the United States from peer countries is weaker. For

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example, Mehta, Abrams, and Myrskylä (2020) showed that slowdowns in cardiovascular disease (CVD) mortality improvements, rather than drug deaths, explained US stagnation compared to peer countries. Ho (2019) found that drug overdose accounted for 12 percent (men) and 8 percent (women) of the 2.6-year average life expectancy gap between the United States and peer countries in 2013, contributing substantially to the growth in these gaps between 2003 and 2013. Barbieri (2019) estimated a similar magnitude of contributions from drug-related deaths (10–15 percent) to life expectancy differences with peer countries, but this fraction was higher for working-age men (up to 38 percent). The level of drug deaths in the United States is an order of magnitude higher than other high-income countries, with age-standardized rates on average 3.5 times higher than peer countries ranging from 1.6 times (compared to Canada) to 28 times higher (compared to Japan) (Ho 2019). Nonetheless, these deaths are not a high enough proportion of overall deaths to explain the substantial slowdowns and divergence of the United States from peers.

Cardiovascular disease accounted for nearly 70 percent of the slowdown in mortality rate improvement between 2001–2011 and 2011–2019 in both the United States and the United Kingdom in Murphy and Grundy's (2022) analysis, with lower respiratory infections and cancers making up sizeable additional portions. Ho (2020) also found that CVD mortality improvements slowed for all countries after 2011 except for Japanese men and Greek women. The United States, Italy, Canada, Ireland, Austria, and the Netherlands had particularly small reductions in CVD mortality since 2010 relative to the previous decade. Smaller CVD mortality improvements contributed most to overall slowdowns *within* countries, but cancer, accidental poisoning, and external causes contributed substantially to differences for males between high and low-performing countries in Ho's analysis, with the highest performing countries protected from mortality increases in accidental poisonings. For females, mental and nervous systems (including Alzheimer's) contributed more to the overall slowdowns, and differences between high- and low-performing countries were attributable to CVD, cancer, influenza, and pneumonia (Ho 2020).

While adverse mortality trends were first noticed in the United States, the slowdowns elsewhere raise the question of whether the United States was the leading edge of a more generalized phenomenon. Recent work has explored mortality slowdowns in other countries. Leon, Jdanov, and Shkolnikov (2019) found that life expectancy since 2011 significantly diverged for England and Wales compared to the median of 22 high-income countries, and this was more pronounced for women. Similar to the United States, they also found higher mortality in midlife compared to peers, a pattern also observed by Dowd et al. (2024). While "despair"-related deaths due to drug overdose, alcohol, and suicide have been trending slowly upward in England and Wales, the levels are still much lower than

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in the United States. Scotland is an exception, with levels of drug overdose mortality in recent years that rival or exceed the United States (Dowd et al. 2023). Polizzi et al. (2024) found that the divergence of life expectancy in England and Wales compared to peer countries since 2011 was driven most by external causes at younger and midlife ages, cardiometabolic mortality at midlife-to-older ages, and dementia mortality at older ages. Murphy, Luy, and Torrisi (2019) examined a range of potential explanations for recent stalls in mortality improvements in the United Kingdom including government austerity measures and cohort and tempo effects but concluded there was no strong evidence for a single explanation, pointing to the confluence of many factors that are difficult to disentangle. Life expectancy improvements in Germany have also lagged peers in recent years, despite its strong economy and well-resourced healthcare system. Jasilionis et al. (2023) recently compared the life expectancy of Germany to six other high-income countries, finding that the gap between Germany and its peers was mostly attributable to CVD mortality at older ages. While the troubling US mortality trends have merited their significant research attention, a better understanding of slowdowns in other countries may shed light on the similarities or differences in patterns across contexts and point to potential mechanisms. At the same time, period mortality measures like life expectancy are subject to tempo biases that can exaggerate year-to-year changes and complicate the investigation of specific mechanisms underlying changes within and across countries (Bongaarts 2006; Luy et al. 2020)

Overall, our analyses and previous studies paint a consistent picture of slowdowns in mortality improvements in most high-income countries since around 2010. For most countries, these slowdowns are happening at older ages (65+) and to a lesser extent midlife (45–64 years). Midlife mortality stands out as an important factor for some countries facing the worst slowdowns, including the United States and the United Kingdom. The slowdowns are largely attributable to slowing improvements in cardiovascular mortality, though for the worst performers, deaths from external causes have played a role. Slowdowns have generally been more noticeable for women compared to men. Finally, while slowdowns are happening in many countries, both the United States and the United Kingdom have lost ground relative to their peers (Leon, Jdanov, and Shkolnikov 2019; Ho 2022).

An unwelcome mortality shock: The COVID-19 pandemic

After a slow-growing decade, there was a glimmer of hope entering 2020, with the United Kingdom seeing its highest annual life expectancy improvements for five years and the United States gaining rather than losing life expectancy (albeit by 0.1 years in 2019) (Kochanek, Xu, and Arias 2020; Office for National Statistics 2020). Sadly, the COVID-19 pandemic

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TABLE 2 Cumulative excess mortality in high-income countries, 2020–2023.

Country	Excess deaths	Excess per 100k	Percent excess above annual baseline
New Zealand	73	1.5	0.2
Denmark	5,657	97.7	10.1
Japan	194,142	153.5	13.7
Sweden	17,382	172.1	19.0
Australia	32,266	126.5	19.2
France	122,931	188.3	19.9
Norway	8,491	156.6	20.5
Canada	64,200	170.1	21.5
Germany	224,147	267.5	23.1
Finland	13,388	241.6	24.0
Republic of Korea	82,596	161.1	26.7
Belgium	29,777	256.9	26.8
Portugal	33,022	323.8	28.6
Switzerland	19,695	227.6	28.6
Hungary	40,694	421.2	30.7
Greece	39,332	377.4	31.0
Ireland	9,926	201.0	31.0
Austria	26,472	293.9	31.6
Netherlands	50,280	293.4	32.0
Spain	150,922	322.8	35.2
Hong Kong	17,410	232.2	35.5
Poland	158,671	419.2	37.4
United Kingdom	232,141	342.0	37.6
Czechia	43,925	410.2	38.1
Italy	252,860	418.2	38.6
United States	1,316,121	397.6	44.4
Croatia	23,905	582.3	45.5
Slovakia	29,636	542.8	54.2
Bulgaria	64,461	927.7	58.7
Lithuania	25,180	925.0	65.7

NOTE: Data come from https://github.com/dkobak/excess-mortality/blob/main/excess-mortality.csv. Data were extracted in December 2023 and presented dates range from June 2023 (Canada) to November 2023 (Denmark). See the Supporting Information for exact dates.

disrupted any chance to see whether this positive trend would continue. In many higher income countries, COVID-19 led to significant life expectancy drops that persisted beyond 2020 (Schöley et al. 2022). Through August 2023, the United States is estimated to have suffered 1.3 million excess deaths since the beginning of the pandemic, which amounts to 44 percent of annual baseline mortality, as seen in Table 2 (Karlinsky and Kobak 2021).[1]

In early 2020, demographers worked quickly to help quantify the potential and realized mortality burden of the COVID-19 pandemic. As early as March 2020, Dowd et al. (2020) highlighted the strong association of

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COVID-19 mortality and older age seen in Italy,[2] drawing attention to the potential role of population age structure in shaping the risk of severe disease and mortality risk both within and across countries as the virus spread globally. Goldstein and Lee (2020) used early pandemic age-specific death rates to estimate the potential life expectancy and years of remaining life lost if the United States reached a million COVID-19 deaths, a number that seemed unfathomable in April 2020 but was eventually surpassed. Their analysis showed that despite deaths occurring at older ages, those dying of COVID-19 would lose an average of 11.7 years of remaining expected life and could not be easily dismissed as deaths that would have happened soon anyway.

Accurately counting COVID-19 deaths was a challenge early on due to a lack of testing and an increased number of deaths occurring at home. Excess mortality, which estimates the number of deaths from all causes that occur above and beyond what would be expected over a similar period, quickly emerged as a preferred mortality metric, especially for high-income countries with good overall death registration (Stokes et al. 2021; Karlinsky and Kobak 2021; Leon et al. 2020; Aburto et al. 2021). This demographic tool was especially useful due to the variation in COVID-19 testing and official recording of deaths across countries. Excess mortality was also an effective way to convey the magnitude of the pandemic to the general public, at a time when some politicians questioned whether people were dying "with" or "of" COVID-19 (Viglione 2020; Richardson 2020; Dowd 2020). In many countries, including the United States, excess mortality exceeded official COVID-19 deaths for much of the pandemic. This was believed to be primarily due to undercounted COVID-19 deaths but could also include indirect deaths due to healthcare avoidance and strain during COVID-19 waves (Stokes et al. 2021; Paglino et al. 2024).

As the pandemic continued, more traditional measures of mortality such as life expectancy at birth were calculated for high-income countries with good death registration and timely release of age-specific death data. Compared to excess mortality, life expectancy accounts for population age structure and is more comparable across countries and time, although as a period measure, its interpretation during mortality shocks is not always intuitive (Heuveline 2023a). Life expectancy drops in 2020 were substantial, and life expectancy declined for 27 out of 29 high-income countries analyzed by Aburto, Schöley, et al. (2022)—all but Denmark and Norway. In most countries, males suffered greater life expectancy loss than females. The biggest losses in 2020 were seen for males in the United States (2.2 years), Bulgaria (1.6 years), Poland (1.5 years), and Spain (1.4 years), and females in the United States (1.65 years) and Spain (1.5 years). While deaths above age 60 comprised the bulk of life expectancy losses for most countries in 2020 the United States and Eastern Europe also saw significant

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contributions from ages under 60. COVID-19 mortality in the United States was notable for not only being high compared to other high-income countries but also for its higher relative burden of mortality for disadvantaged racial/ethnic groups (Aburto, Tilstra, et al. 2022; Andrasfay and Goldman 2021; Aschmann et al. 2022).

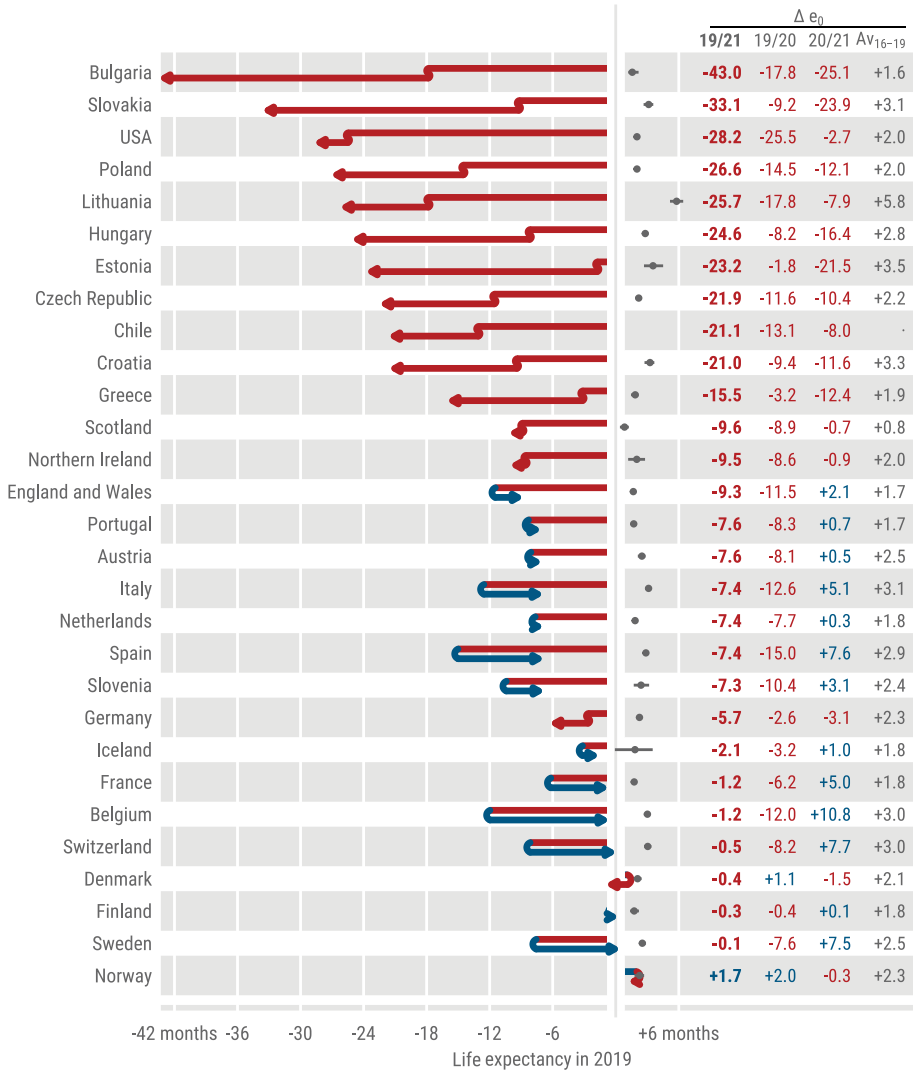
Hopes for mortality improvements were high entering 2021, with the mass roll-out of effective vaccines arriving more quickly than anyone had imagined. Despite these high hopes, 2021 still included the end of very dangerous winter waves in January and February prior to the widespread vaccine roll-out. The emergence of the more transmissible Delta and Omicron variants later in 2021 also led to many more total infections than in 2020, leading to significant mortality despite gains in population immunity.

These countervailing dynamics contributed to a divergence in the mortality experiences of high-income countries in 2021 and beyond (Schöley et al. 2022) (Figure 3). While some countries saw significant life expectancy bounce backs from their severe losses in 2020 (Belgium, Sweden, France, Italy, and Spain), life expectancy in the United States was *worse* in 2021 compared to 2020, as it was also in Germany and Greece. Most Eastern European countries also suffered worse losses in 2021 compared to 2020, with Bulgaria the worst example losing a year and a half in life expectancy in 2020 and over two additional years in 2021. The East–West divide in European pandemic mortality in 2021 was consistent with lower vaccination uptake in Eastern Europe compared to the West, setting back the East–West mortality convergence that had been happening in the last 20 years. Among the countries examined, only Denmark, Finland, and Norway maintained prepandemic levels of life expectancy throughout 2020 and 2021. Despite the life expectancy recoveries of many Western European countries in 2021, no country achieved the life expectancy in 2021 that would have been forecast based on Lee–Carter models without COVID-19 (Schöley et al. 2022). Besides losses, foregone mortality improvements are another aspect of COVID-19 mortality that demographers will continue to track.

The pandemic exacerbated the preexisting mortality vulnerabilities at midlife in the United States, as seen in the substantial contribution of mortality under age 60 to life expectancy losses in both 2020 and 2021 (Aburto, Schöley, et al. 2022; Schöley et al. 2022), which widened the already substantial mortality gap between the United States and peer countries (Heuveline 2023b). The United States also counted more losses in life expectancy due to non-COVID-19 causes than other countries. While some of this was likely undercounted COVID-19, increases in deaths from drug overdose, already at very high levels, increased even more in the United States during the COVID-19 pandemic, a pattern not seen in other countries (Angus et al. 2023; Glei 2022). Differences in vaccine uptake may explain differences compared with peer countries in US mortality in 2021,

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FIGURE 3 Life expectancy changes in 2019–2020 and 2020–2021



NOTE: The countries are ordered by increasing cumulative LE losses since 2019. The two line segments indicate the annual changes in LE in 2020 and 2021. Red segments to the left indicate an LE drop, while gray arrows to the right indicate a rise in LE. The position of the arrowhead indicates the total change in LE from 2019 through 2021. The gray dots and lines indicate the average annual LE changes over the years 2015 through 2019 along with 95 percent CIs. Δe_0 marks the change in period LE over the designated period.
SOURCE: Scholey, J., Aburto, J.M., Kashnitsky, I. et al. Life expectancy changes since COVID-19. *Nature Human Behaviour* 6, 1649–1659 (2022). Reproduced without changes via Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/).

but other factors must have been at play in 2020, such as existing health disadvantages (Pongiglione, Ploubidis, and Dowd 2022), less adherence to nonpharmaceutical interventions, and/or differences in health and social welfare provisions (Woolf, Masters, and Aron 2022).

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The mortality shock of COVID-19 persisted into 2022 due to the highly transmissible Omicron variant, which infected much larger portions of the population than previous waves (Office for National Statistics 2023). The United States suffered over 155,000 confirmed COVID-19 deaths in the first quarter of 2022 alone and over 290,000 excess deaths overall in 2022 (Mathieu et al. 2020; Degtiareva et al. 2024), well after the primary vaccine and booster campaigns were rolled out. Some countries saw the emergence of persistent excess mortality in the summer of 2022 with a higher fraction of non-COVID-19 excess deaths. For example, in 2022, there were 44,255 excess deaths in the United Kingdom, 7.2 percent higher than baseline and which persisted into the first six months of 2023 (Pearson-Stuttard et al. 2024). In the United Kingdom, there was speculation that NHS treatment backlogs and ambulance and emergency room wait times contributed to this excess mortality (Raleigh 2022). Other countries that saw persistent excess emerge in 2022 included Germany, Canada, as well as Finland, Denmark, and Norway, leading to the first drops in life expectancy of the pandemic for the latter three countries (Huang et al. 2024; Burström et al. 2024). Overall in 2022, despite signs of life expectancy gains in many countries, life expectancy had not fully returned to prepandemic levels, showing the persistence of the COVID-19 mortality shock (Huang et al. 2024; Burström et al. 2024). Provisional estimates from 2022 in the United States show that life expectancy increased by 1.1 years from 2021 to 77.5 years, a welcome trend but not close to recouping the losses of 2.4 years since 2019 (Arias et al. 2023). Some countries that saw continued excess mortality in 2023 included countries that did relatively well earlier in the pandemic such as Finland, Ireland, Japan, the Netherlands, Norway, and Sweden (Karlinsky and Kobak 2021). While cumulative excess mortality in these countries was still relatively low (Table 2), this delayed excess mortality could reflect mortality displacement with a larger proportion of surviving frail people who had been well-protected earlier in the pandemic (Luy et al. 2020). Further research is needed to examine this hypothesis and the specific ages and causes responsible for elevated mortality in 2023 and beyond.

Table 2 summarizes estimated cumulative excess mortality from January 2020 to late 2023 for 30 high-income countries, ranked from best to worst on % excess deaths above annual baseline (Karlinsky and Kobak 2021). Karlinsky and Kobak estimated excess mortality compared to a baseline of 2015–2019, accounting for linear time trends and seasonal variation (see the paper for further details). While differences in methodology for estimating expected deaths can impact estimated excess deaths (Aburto et al. 2021), this parsimonious approach allows reasonable comparisons of the COVID-19 mortality experiences across countries and avoids implausible estimates that can emerge from less transparent modeling approaches (Schöley 2021). Countries that avoided significant infections until after population vaccination generally fared well in cumulative excess mortality,

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including Australia, New Zealand, South Korea, and Japan. Japan's low excess mortality is especially impressive, given its high baseline vulnerability to COVID-19 mortality as the world's oldest population (Dowd et al. 2020). Other high-income countries with the lowest excess mortality per capita included Denmark, Norway, Canada, Sweden, France, Ireland, and Switzerland. Consistent with previous life expectancy estimates, Bulgaria and several other Eastern European countries fared the worst. Italy had the highest excess mortality per capita in Western Europe, partly because of its high proportion of older adults. The United States had the worst excess mortality among Western European peers as a percentage of the annual baseline (44.4 percent), worse than Italy and several Eastern European countries. Identifying the key drivers of differences across countries in COVID-19 mortality will be a challenging but important ongoing research agenda (Nuzzo and Ledesma 2023).

The ongoing impact of COVID-19 on population mortality remains an important unanswered question. Despite substantial decreases in morbidity and mortality, COVID-19 has not fallen into predictable seasonal patterns and is still more dangerous than influenza (Xie et al. 2024). Besides continued direct deaths due to COVID-19, sustained excess mortality could arise from longer term impacts of COVID-19 infection on health. In the other direction, COVID-19 may have pulled forward the deaths of the oldest and most frail, resulting in fewer deaths in the next few years. Goldstein and Lee (2024) recently suggested that historically, mortality tends to "bounce back" to its previous trend after a setback rather than shifting to a lower forecasted trend. Whether this "bounce back" pattern will hold for the COVID-19 pandemic will be an important area of investigation for demographers in the years to come.

The future of mortality: Reasons for both optimism and pessimism

The future of mortality trends in high-income countries is uncertain. While demographers have famously debated whether life expectancy improvements will slow due to biological limits (Vaupel et al. 2021; Olshansky and Carnes 2019), our understanding of the current and future social factors holding many countries back from their life expectancy potential may be more important in the foreseeable future (Gutin and Hummer 2021). The factors that impact the pace of improvement in world record life expectancy may be different from those that drive changes in the relative performance of specific countries, such as the notable deterioration of US mortality compared to international peers. On the optimistic side, improvements in medicine and living conditions over the last decades should continue to raise life expectancy. COVID-19 may end up as a period shock rather than a persistently higher mortality risk, with most countries bouncing back to their

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prepandemic trajectory. Pessimistically, the pandemic could have a scarring impact on populations that ripples throughout the life course, layered on top of the prepandemic trends of slowing or reversing life expectancy in some countries. Prepandemic trends in obesity and "despair"-related causes of death may continue to slow improvements or lead to diverging trends across countries. A key question is whether recent slowdowns in mortality improvement in high-income countries will continue, stabilize, or reverse. Predicting the future is hard, and our best guesses will require a better understanding of the factors that are responsible for these trends and how they will coevolve in the future.

Peering into the future: Mortality projections

Projecting the future of mortality trends is not just an academic exercise but has important implications for the planning of pensions and other forms of private and social insurance. Methodological innovations in mortality forecasting in recent years have included machine learning and cohort-based approaches to improve accuracy (Booth and Tickle 2008; Nigri et al. 2019). Despite these advances, most state-of-the-art forecasting methods are extrapolative and assume a continuation of past trends. Thus, by definition, these approaches cannot anticipate dramatic structural changes in mortality due to future technological breakthroughs or novel diseases (Basellini, Camarda, and Booth 2023). While traditional Lee–Carter models did well accurately forecasting US mortality trends since 2000, they did not anticipate a significant slowdown in improvements since 2014 (Basellini, Camarda, and Booth 2023). As mentioned above, since 2010 many high-income countries saw slowdowns in mortality improvements that were significantly worse than those projected by a wide range of forecasting models, especially for women (Djeundje et al. 2022). Despite the drawbacks of extrapolation, as Vaupel et al. (2021) reminded us, "the future may be turbulent, but so was the past," meaning extrapolation may account for unforeseen changes better than we may think. However, such forecasts can differ widely depending on the data used to train the forecasting model and the specific forecasting method used. For example, in a comparison of six extrapolative forecasting methods, the point forecast of US life expectancy in 2050 spanned more than seven years (Vaupel et al. 2021).

Recent population projections from the United Nations Department of Economic and Social Affairs (UNDESA) predict substantial life expectancy improvements in the next 25 years, with life expectancy at birth in Europe and North America estimated to rise from 79.2 in 2023 to 83.4 in 2050 (United Nations, Department of Economic and Social Affairs, Population Division 2024). Like most state-of-the-art forecasting methods, forecasts provided by UNDESA are probabilistic, with the underlying uncertainty quantified using forecast intervals (United Nations, Department of Eco-

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nomic and Social Affairs, Population Division 2024). For example, the 95 percent forecast interval for the US life expectancy in 2050 ranges from 75.6 to 86.5 years for males and from 80.3 to 89.5 years for females. While perhaps providing our best estimates for actuarial purposes, current extrapolative methods are less useful for providing insight into changing mortality dynamics within and across countries.

Alternative approaches to mortality forecasting also have significant limitations. Reliance on expert-based scenarios has tended to produce forecasts that are overly pessimistic (Oeppen and Vaupel 2002). While the incorporation of trends in smoking has been helpful in improving forecasting (Wang and Preston 2009; Janssen, van Wissen, and Kunst 2013), trends in other risk factors, such as obesity, are less straightforward and require strong assumptions about the future of obesity trends and estimation of obesity-attributable mortality (Mehta 2022). For example, Janssen, Bardoutsos, et al. (2021) projected future life expectancy in 18 European countries accounting for changes in smoking, obesity, and alcohol-related mortality, with projections on average more than two years higher by 2065 compared to benchmark Lee–Carter estimates. Projections based on specific causes of death have historically performed poorly due to discontinuous variation in the pace of change for certain causes (Bongaarts 2014). Relatedly, there are both opportunities and challenges inherent to integrating a broader set of life course social and biological exposures into our understanding of population mortality trends (van Raalte 2021). In a recent innovative step towards such integration, Deryugina and Reif combined quasi-experimental estimates of the mortality impact of air pollution in the United States with a new "unified model of cohort mortality" linking individual health across the life course to aggregate mortality trends, estimating that substantial survival benefits from the 1970 Clean Air Act have yet to emerge for affected cohorts (Lleras-Muney and Moreau 2022; Deryugina and Reif 2023). While promising, scaling up such efforts to improve mortality forecasts based on the full range of country and cohort-level exposures would require much additional methodological and data work.

Further advances in mortality forecasting will remain important for societal planning, but we should remain humble about the many sources of uncertainty in those projections. The past is a good predictor of the future—until it is not. In that spirit, we discuss what we see as some of the most salient potential drivers of mortality in the next two decades, both positive and negative but do not draw strong conclusions about how the balance of those forces will translate into specific levels of life expectancy.

Aftershocks of the COVID-19 pandemic

Understanding the reverberations of the COVID-19 pandemic as a critical life course exposure will be a high research priority for population

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scientists. The long-term impacts of the 1918 flu pandemic are still being studied, even though we have much less reliable data from that era. The cohort in utero during 1918 grew up to be in worse health and with lower socioeconomic status (Beach et al. 2022; Palloni et al. 2020), and emerging evidence suggests similar potential from the COVID-19 pandemic. Torche and Nobles estimated a substantial adverse impact of prenatal COVID-19 infection on infant health using a quasi-experimental design (Torche and Nobles 2023), and observational studies found a higher risk of developmental delays in babies whose mothers had a SARS-CoV-2 infection during pregnancy (Edlow et al. 2022; Santos et al. 2023). This early evidence suggests that SARS-CoV-2 infection in utero could have long-term impacts on the health of affected cohorts. To monitor this, Easterlin, Crimmins, and Finch (2021) advocated for cohort studies to develop plans to evaluate the long-term impacts of the pandemic on development and accelerated aging.

COVID-19 infections may also have lasting impacts on the health of people of all ages. Previous infection has been associated with an increased risk of incident CVD for up to a year (Xie et al. 2022). Long COVID can leave people with debilitating symptoms such as chronic fatigue, postexertional malaise, and cognitive and autonomic dysfunction with unknown long-term effects (Klein et al. 2023). Vaccination seems to lower the risk of longer term effects of COVID-19 on health (Yousaf et al. 2023), but it remains to be seen if COVID-19 will persistently raise our health risks above what they were before the pandemic. More positively, the COVID-19 pandemic accelerated the development of mRNA technologies for vaccines and other medical treatments, a big push that could lead to important life-saving breakthroughs in the future (Barbier et al. 2022).

Obesity and cardiovascular disease

The pace of CVD mortality decline has slowed significantly in recent years across most high-income countries, with the United States even seeing increases in some age groups (Lopez and Adair 2019). The reasons for this slowdown are not well agreed upon. Since the slowdown is not most evident in countries with the lowest levels of CVD mortality, reaching a limit for further improvement does not seem a likely explanation. Rising levels of obesity are a prime suspect, with the United States at the leading edge of the trend but with most high-income countries following suit. The obesity epidemic shows no signs of abating and continues to get worse, with 42 percent of US adults classified as obese in data from 2017 to 2020 and a 20 percent prevalence among children aged 2–19 (Mehta 2023). In England, the prevalence of obesity has increased from 15 percent in 1993 to 28 percent in 2019 (Moody 2020), levels that are lower than the United States but higher than most of Europe (Janssen, Bardoutsos, and Vidra

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2020). Japan is one of the few countries that has maintained low obesity levels, still around 5 percent (OECD 2023).

Sharp increases in obesity in the past decades mean that younger cohorts have, on average, an earlier onset and longer duration of obesity across the life course, with subsequent health risks, including a higher probability of severe obesity later in life (Masters et al. 2013; Dowd and Zajacova 2014). The probability of being obese at age 25 years increased by 30 percent for those born between 1955 and 1975 in the United States, an increase that has continued (Reither et al. 2009). Similar increases in exposure to obesity across cohorts have been seen in England (Johnson, Norris, and Hamer 2021; Opazo Breton and Gray 2023).

Estimating population mortality attributable to obesity is difficult as it requires good estimates of the association of obesity and mortality, a relationship that is fraught due to issues such as reverse causality between illness and weight loss (Masters 2023; Alley, Lloyd, and Shardell 2010). Connecting period estimates of individual risk to aggregate trends in cohorts with changing incidence, levels, and durations of obesity is an additional challenge (Alley, Lloyd, and Shardell 2010; Mehta 2022). Olshansky was among the first to propose that rising obesity in the United States would lead to a potential decline in life expectancy (Olshansky et al. 2005), while others were less pessimistic (Preston 2005; Mehta and Chang 2009). With stalling overall and CVD mortality improvements since 2010, the investigation of the impact of rising obesity on population mortality has intensified. Preston et al. (2018) estimated that the increase in obesity between 1988 and 2011 reduced US life expectancy at age 40 by almost one year. If trends in obesity are important drivers of cohort trends in mortality, we may expect to see similar but lagged trends for CVD mortality in countries also suffering from the long-term effects of the obesity epidemic such as the United Kingdom (Wang et al. 2011). Vidra et al. (2019) estimated that the average increase in life expectancy between 1975 and 2012 for 26 European countries would have been 0.78 years higher among men and 0.30 years higher among women if obesity were eliminated, consistent with the later and slower rising obesity epidemic in Western Europe compared to the United States. Despite methodological challenges, continued efforts to account for changing cohort obesity exposures in mortality trends could help build the evidence for (or against) obesity as a major driver of mortality trends within and between countries and better calibrate the magnitude of such effects. Analysis of similar cohort trends in innovation in CVD treatment and prevention such as the use of hypertensive medication or statins could also be fruitful (Murphy, Luy, and Torrisi 2019).

Can the adverse trends in population obesity be reversed? Human genetics have not changed in the last 40 years, pointing to broader social and technological forces that have contributed to our collective weight gain. Reversing these macrolevel trends is not easy, and there is no example of a soci-

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ety that has reversed its obesity epidemic or even halted its growth (Mehta 2023). Mehta argues that while the structural nature of obesity risk has been largely recognized by population health scientists, the evidence base for policies that could reverse these trends needs to be stronger. If successful, structural changes may be best suited for preventing weight gain in younger cohorts, as sustained weight loss for those who are already obese is rare. This reality may be changing given the arrival of GLP-1 agonist drugs for diabetes and weight loss such as Ozempic and Wegovy, which we discuss in a later section. In an optimistic scenario, a combination of improved population-level prevention and effective medical treatment of obesity could turn the tide after decades of collective failure.

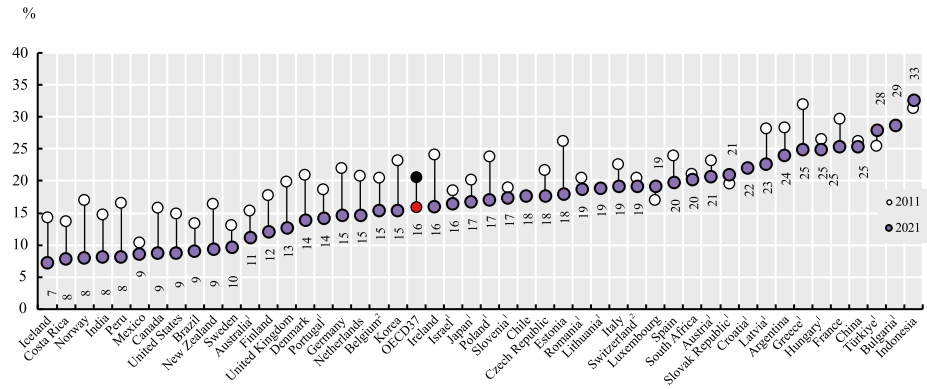
Smoking

Smoking is the health behavior best known for leaving a strong imprint on cohort mortality patterns (Preston and Wang 2006). Declines in smoking contributed to sharp declines in CVD mortality, and mortality forecasts incorporating cohort smoking profiles in the United States projected faster declines in mortality than were projected by the Social Security Administration through 2034 (Wang and Preston 2009). Janssen, El Gewily, et al. (2021) projected declining fractions of smoking-attributable mortality in 29 European countries through 2100, with peak smoking-related mortality for men on average in 1989, compared to 2019 for women. This suggests that lagged trends in cohort smoking could account for some recent slowdowns in CVD mortality improvements for women but not men. Further analysis could explore these dynamics in depth for individual countries. For example, Jasilionis et al. (2023) noted that smoking is unlikely to explain recent CVD mortality slowdowns in Germany as the cohort patterns of lung cancer do not match the pattern of CVD mortality slowdowns. Overall, the poor trends in CVD mortality in the United States and elsewhere—despite expected favorable trends in cohort smoking—add to the puzzle of the most important drivers of recent CVD trends at the population level (Acosta et al. 2022).

While smoking has declined in many countries, there is still substantial variation in smoking across OECD countries that could factor into mortality trends going forward (Figure 4). Current smoking rates in 2021 were notably smaller in the United States (8.8 percent) compared to many European countries (12.7 percent in the United Kingdom and 25.3 percent in France), but whether this advantage will improve relative mortality trends in the United States for future cohorts remains to be seen, especially given the significant lag between smoking behavior and mortality. Regardless, many high-income countries still have considerable room for further reductions in smoking, which could pay dividends for

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FIGURE 4 Population aged 15 and over smoking daily, 2011 and 2021 (or nearest years)



SOURCE: OECD Health Statistics 2023 (https://stat.link/sv7hry).

mortality improvements for decades to come and be especially important to counterbalance the opposing trend of rising population obesity.

The use of vaping or e-cigarettes represents a new potential health risk for younger cohorts, though the long-term health effects are less known (Jonas 2022) and the prevalence of regular use is still low overall (<5 percent in most OECD countries in 2021 (OECD 2023)). On the positive side, vaping can also aid in smoking cessation for existing smokers (Lindson et al. 2024). Increases in cannabis use among younger people could also erode some benefits of reduced smoking, especially with trends towards legalization (OECD 2023; Zuckermann et al. 2021).

Generational health drift

Besides increases in midlife mortality seen in countries like the United States and the United Kingdom (Dowd et al. 2024), there is evidence that younger cohorts in some countries may be in worse health at the same age compared to their predecessors (Zheng and Echave 2021; Bishop, Haas, and Quiñones 2022), a trend that could continue to impact mortality as these cohorts age further. This health deterioration for younger cohorts is seen not only for physical but also mental health, consistent with narratives of rising "despair" and social isolation that may be driving mortality via multiple causes (Gaydosh et al. 2019). While this "generational health drift" (Ploubidis 2023) is most evident in the United States, there is some evidence that other high-income countries may also be experiencing a worsening of cohort health outcomes including for disability (e.g., France) self-rated health (e.g., England) and chronic disease (e.g., England, Sweden, Spain, The Netherlands) (Jivraj et al. 2020; Oostrom et al. 2016; Walter et al. 2016; Gimeno et al. 2024; Cambois, Blachier, and Robine

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2013; Gondek et al. 2021). Olshansky warned of potential deteriorating health for younger cohorts due to the obesity epidemic over 20 years ago (Olshansky et al. 2005). Increased incidence of disability and diabetes in younger cohorts would be consistent with the obesity hypothesis, but we currently lack good evidence of the specific mechanisms driving health deterioration in younger cohorts. While worse health at the same age does not necessarily mean reductions in longevity for younger cohorts, it is still a troubling early sign of how these cohorts might fare in their older high mortality years. In a more pessimistic scenario, the poor current health of these cohorts will reverberate for decades as stalling improvements or reversals in life expectancy, a mirror image of the cohorts from the past century who carried with them the later life benefits of dramatically improved early life conditions (Crimmins 2015). This creates urgency in our work to understand both the social and biological drivers preventing younger cohorts from reaching their health and longevity potential.

Pharmaceutical game changers

While adverse trends in population obesity look stubbornly difficult to change thus far, help may be on the horizon from new pharmaceutical interventions in the form of new GLP-agonist drugs such as semaglutide (Ozempic and Wegovy) and tirzepatide (Mounjaro and Zepound), named the breakthrough of 2023 by Science Magazine.[3] Initially developed for diabetes, these drugs also induce significant weight loss and have been shown to reduce the risk of heart failure, heart attacks, and strokes—even in those without diabetes (Kosiborod et al. 2024; Lincoff et al. 2023), suggesting the drugs may have major benefits that merit broader use. These drugs represent the first significant medical breakthrough in the treatment of obesity, short of the much more invasive bariatric surgery. It is still early days with these drugs, so concerns about potential side effects, the need to remain on the drugs indefinitely, and yet unknown longer term downsides need to be fully explored. Cost and equitable access to these drugs is another important issue since the burden of obesity typically falls disproportionately on those with lower socioeconomic status (McLaren 2007). Historically, new medical innovations have benefited the most socially advantaged groups first, which can increase health inequalities at least in the short term (Chang and Lauderdale 2009; Gutin and Hummer 2021). Despite the high current cost, there are many similar drugs currently in development, so it is likely that the quality of these drugs will improve, and the price will decrease (Sidik 2023). As population health researchers, we are cautiously optimistic that GLP-agonists may be a turning point in our decades-long global obesity epidemic.

While GLP-agonists are getting an outsized share of attention right now, they are only one example of potential other technological breakthroughs including cancer immunotherapy or advances in the biology of

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aging (Campisi et al. 2019) with the potential to change the landscape of human health and longevity. Future gains in life expectancy will increasingly rely on postponing senescent mortality due to biological aging (Bongaarts 2009). The prospects for a dramatic extension of the human lifespan have invited spirited debate (Olshansky and Carnes 2013; De Grey 2013). While we remain agnostic about specific biological limits to human lifespan, we assume that considerable progress in avoidable mortality is still possible and expect that both social and scientific progress will continue to play an important role in this progress. Despite overall optimism about new biomedical technologies, the on-going devastation of the opioid epidemic in the United States is a stark reminder that the incentives of pharmaceutical companies are not always aligned with population health (Van Zee 2009).

Social determinants and "despair"

The continued improvements in life expectancy in top performers, such as Japan, suggest that slowdowns in improvements in other countries are not due to reaching biological limits. This realization, including the stark increases in mortality in the United States from external causes, reminds us that mortality is deeply rooted not only in biology but in social causes that shape human behavior and other proximate causes of health (King, Scheiring, and Nosrati 2022; Gutin and Hummer 2021). The recent mortality crisis in the United States has been likened to that of the mortality crisis in Eastern Europe in the early 1990s as ex-socialist countries transitioned to capitalism, which saw an estimated 7.3 million excess deaths in Eastern Europe (Stuckler et al. 2009; Aburto and van Raalte 2018). Case and Deaton suggest that similar social dislocations resulting from rapid industrial decline have contributed to "despair"-related deaths, especially for the least educated Americans (Case and Deaton 2020). Along with rapid de-industrialization, the past decades have seen dramatic demographic changes in family formation, working lives, and economic opportunity, the health effects of which are only beginning to be explored. Case and Deaton suggest that declines in economic opportunity coupled with declines in marriage and social connectedness have contributed to rising morbidity and mortality in the United States. These social and demographic changes have varied in magnitude and timing across countries, cohorts, and social groups (Sobotka and Toulemon 2008; Zimmermann and Konietzka 2018), so leveraging this variation to empirically test the links between social change and health could be a productive research avenue. Despite a large literature on family, educational, and economic changes across time in Europe, thus far there has been limited attention to the mortality impacts of these changes or their interactions across cohorts (Tosi and Grundy 2021; Einiö, Goisis, and Myrskylä 2019).

Harper, Riddell, and King (2021) note that "'despair' remains a vague term, rarely defined and even less frequently measured". Recent work

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has pushed to better define "despair" as a measurable construct at the individual level and test its association with behaviors that may increase risk of mortality (Shanahan et al. 2019; Gutin et al. 2023). One challenge to the "deaths of despair" narrative is the general absence of similar trends in other countries that have also faced de-industrialization and economic challenges. Partly, this may reflect the unique supply-driven features of the US opioid epidemic, which had its origins in aggressive marketing and changes in prescribing practices of prescription opioids (Currie and Schwandt 2020). While this surge in opioid availability may have lit the match under the tinder of "despair" in the United States, it is not clear that noticeable "despair" mortality trends would have occurred without the specific circumstances of the opioid epidemic (Masters, Tilstra, and Simon 2018). The "despair" narrative is also difficult to reconcile with more complex mortality patterns by race/ethnicity, geography, and specific causes of death within the United States (Harper, Riddell, and King 2021). Thus, the past decade's focus on "deaths of despair" in the United States may have distracted from understanding more fundamental trends, such as stagnating CVD mortality improvements that are affecting all ages and subgroups.

While increasing mortality in the United States has been concentrated among the lowest educated, there is evidence that the health of the least educated in most European countries has improved in recent years and that health inequalities overall have improved or not widened despite the severe financial crises since 2008 (Mackenbach et al. 2018). Further comparative work could help identify social and policy environments that either protect or exacerbate the health and mortality risks associated with economic insecurity and rapid demographic change (King, Scheiring, and Nosrati 2022) as well as the institutional factors that shape the impact of emerging health risks on individuals (Simon and Masters 2024). While the attention to "deaths of despair" and the narrative of younger cohorts suffering from "the loss of dignified and meaningful lives" (Case and Deaton 2020) due to social and economic disruption seems bleak, we should not lose hope. After the staggering losses of life due to the mortality crises of the 1990s, most Eastern Bloc countries have seen dramatic improvements in mortality and declines in deaths due to alcohol and suicide, with younger age groups even now out-performing the United States in all-cause mortality rates (Dowd et al. 2024). After unification in 1990, mortality rates for East Germans dropped close to West German levels very quickly, even at the oldest ages, a striking example of the plasticity of human mortality to social conditions (Caselli et al. 2013). There should be comparative lessons to be learned about how countries have recovered from mortality crises, especially ones rooted in social despair. Cycles of social disruption and economic dislocation do not last forever, but when the tide might turn towards social and economic environments that help us achieve our full population health potential remains to be seen.

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Emerging risks

As with COVID-19, we are unlikely to see our next major threat to population health coming. Pandemic threats from novel pathogens are ever present, but the frequency of major pandemic threats of the magnitude of COVID-19 or worse may be increasing due to human-led environment changes and the risks of zoonotic spillover (Marani et al. 2021). Warming temperatures are increasing the frequency of periods of extreme heat, along with associated increases in mortality (Lüthi et al. 2023). Warming temperatures may also lead to more intense cycles of droughts, floods, storms, and associated natural disasters causing deaths, especially among the most vulnerable groups (Banholzer et al. 2014). While concerning, the estimated mortality impact of pessimistic climate change scenarios thus far is generally not large enough to dramatically alter expected mortality trends (Deschênes and Greenstone 2011). Health behaviors such as smoking, alcohol, and other substance use are strongly socially determined, and we should have humility in predicting future trends, as witnessed by the current long-running and very lethal drug epidemic in the United States. We have seen a concerning increased politicization of science that was amplified during the pandemic (Rekker 2021), especially in the United States, where mortality after the COVID-19 vaccine roll-out was higher for Republicans than Democrats (Wallace et al. 2023). All these potential shocks to our mortality status quo, combined with the fading "starlight" of improving health and living conditions for those born decades ago means we may be facing less reliable mortality improvements in high-income countries.

Conclusions

If the past is any indication, elements of both the optimistic and the pessimistic mortality scenarios will play out in high-income countries over the next few decades. Some past predictions about slowdowns in US life expectancy have seemingly come to fruition (Olshansky et al. 2005), but whether the obesity epidemic was the cause is difficult to confirm. Overall, continued progress in record life expectancy and reductions in old-age mortality fuel optimism (Vaupel et al. 2021). Despite the concerning signs of a slowdown in the last 10 years, it is important to remember that short-term fluctuations in mortality are not uncommon and that longer term trends have been remarkably consistent in high-income countries. Mortality slowdowns during the 1950s and 1960s in the United States and other high-income countries led to speculation that improvements were coming to an end, and fast improvements after that period fed optimism for unstoppable gains (Wilmoth 2000). Similarly, the Netherlands and Sweden faced significant periods of life expectancy stagnation in the 1980s, before progress resumed (Vallin and Meslé 2004). As with fertility booms and busts, demogra-

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phers must be mindful of overreacting to short-term changes. Outside of the United States, mortality improvements in the first decade of this century in high-income countries were still impressive, so whether the second decade is a momentary blip in longer term upward trends remains to be seen.

At the same time, we should remember that falling short of achievable life expectancy is not just bad on paper; it represents thousands or millions of "missing" people in those countries who *could* be alive if mortality rates in their country matched what is currently possible (Bor et al. 2023). The continued life expectancy gains of high-achieving countries like Japan and South Korea show us that there is still much room for improvement. For many countries, social rather than biological constraints on mortality improvements seem most salient. As new mortality threats emerge, we hope that our amazing human capacity for ingenuity, social change, and new scientific discoveries can help us escape the worst-case scenarios and continue to out-perform demographic pessimism as we have in the past.

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Data availability statement

This study uses data from the Human Mortality Database (HMD 2024). Data from HMD are publicly available, under a Creative Commons license CC BY 4.0, from: https://mortality.org. We provide source code through our GitHub repository: https://doi.org/10.17605/OSF.IO/H4AG3

Notes

1 Updated results retrieved from author's GitHub repository at github.com/dkobak/excess-mortality on December 17, 2023.

2 https://x.com/drjenndowd/status/1239150215678103552

3 https://www.science.org/content/article/breakthrough-of-the-year-2023

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