

Letters

RESEARCH LETTER

COVID-19 and Excess All-Cause Mortality in the US and 20 Comparison Countries, June 2021-March 2022

The US experienced high COVID-19 death rates and higher excess all-cause mortality compared with peer countries during 2020.¹ However, an important question is how cross-national differences in mortality shifted during 2021 and 2022 with both widespread availability of vaccination and new variants. We compared COVID-19 and excess all-cause mortality in the US, the 10 most- and least-vaccinated states, and 20 peer Organization for Economic Co-operation and Development (OECD) countries during the Delta and winter Omicron waves.

 [Supplemental content](#)

Methods | Using previous methodology, we compared the US overall, the 10 most- and least-vaccinated states, and the 20 OECD countries with 2021 population exceeding 5 million and greater than \$25 000 per capita gross domestic product ([Supplement 1](#)).¹ US COVID-19 mortality, all-cause mortality, and vaccination data were obtained from the US Centers for Disease Control and Prevention.² For other countries, COVID-19 mortality data were obtained from the World Health Organization, all-cause mortality data from OECD databases, and vaccination data from Our World in Data ([Supplement 1](#)).³⁻⁵ Some mortality data from 2021 and 2022 were provisional.

Each location's COVID-19 mortality rate per capita was calculated over 2 periods: (1) Delta from June 27, 2021 (week 26), to December 25, 2021 (week 51), and (2) Omicron from December 26, 2021 (week 52), to March 26, 2022 (week 12). We estimated excess all-cause mortality by comparing

Table 1. COVID-19 Mortality in the US and Comparison Countries

Country	Vaccination rate, %	COVID-19 mortality per 100 000			Potential US deaths averted, No. (%)		
		Delta	Omicron	Total	Delta	Omicron	Total
New Zealand	75	0.5	3.3	3.7	200 663 (99)	157 236 (94)	357 899 (97)
Japan	80	3	7.4	10.4	192 278 (95)	143 443 (85)	335 721 (91)
Australia	76	4.9	14.2	19.2	185 819 (92)	120 894 (72)	306 713 (83)
Republic of Korea	82	6.1	18.2	24.3	181 927 (90)	107 650 (64)	289 577 (78)
The Netherlands	67	16.6	7.9	24.5	147 061 (73)	141 898 (84)	288 959 (78)
Norway	73	10	18.6	28.7	168 899 (84)	106 280 (63)	275 179 (74)
Canada	77	10.2	20.2	30.4	168 351 (83)	101 049 (60)	269 401 (73)
Switzerland	67	16.4	15.5	31.9	147 757 (73)	116 511 (69)	264 268 (71)
Sweden	70	6.3	31.3	37.6	181 286 (90)	64 167 (38)	245 453 (66)
Ireland	78	20.5	17.2	37.7	134 206 (66)	110 857 (66)	245 063 (66)
France	74	14.6	27.6	42.2	153 765 (76)	76 453 (45)	230 218 (62)
Israel	64	19.4	24.9	44.3	137 898 (68)	85 326 (51)	223 224 (60)
Spain	80	17.7	26.7	44.5	143 348 (71)	79 372 (47)	222 720 (60)
Finland	74	12	35.2	47.2	162 449 (80)	51 097 (30)	213 546 (58)
Belgium	76	25.3	22.5	47.7	118 390 (59)	93 526 (56)	211 916 (57)
Denmark	78	10.9	41.2	52.2	166 026 (82)	31 182 (19)	197 208 (53)
Germany	71	29.6	22.7	52.3	104 041 (51)	92 750 (55)	196 792 (53)
Italy	76	15.2	39	54.2	151 867 (75)	38 609 (23)	190 476 (51)
UK	71	30.1	28.9	59	102 324 (51)	72 176 (43)	174 500 (47)
Austria	74	40.4	24.6	65	68 040 (34)	86 582 (52)	154 622 (42)
US							
10 most-vaccinated states	73	28.1	46.6	74.7	108 916 (54)	13 388 (8)	122 304 (33)
Overall	63	60.9	50.6	111.6			
10 least-vaccinated states	52	86.6	59.4	146	-85 080 (-42)	-29 058 (-17)	-114 138 (-31)

Countries are ordered by total COVID-19 mortality rate from June 27, 2021-March 26, 2022. This includes the Delta (June 27, 2021-December 25, 2021) and winter Omicron (December 26, 2021-March 26, 2022) periods. Vaccination rates reflect the population percentage with 2 or more doses as of January 2022. States include the 50 states and District of Columbia. Potential deaths averted were calculated assuming that the full US had the per capita

COVID-19 mortality rate of the specified country/states during the period of interest. All comparisons between the US and other countries were statistically significant in all periods, as were comparisons between the 10 most-vaccinated and 10 least-vaccinated states and comparisons between state subgroups and other countries ($P < .001$).

Table 2. Excess All-Cause Mortality in the US and Comparison Countries

Country	Vaccination rate, %	Excess all-cause mortality per 100 000			Potential US deaths averted, No. (%)		
		Delta	Omicron	Total	Delta	Omicron	Total
New Zealand	75	-7.6	12.7	5.1	354 910 (108)	110 837 (72)	465 747 (96)
Sweden	70	20.8	11.6	32.4	260 705 (79)	114 455 (75)	375 159 (78)
Belgium	76	36.1	-2.2	33.9	209 740 (64)	160 481 (105)	370 221 (77)
France	74	26.4	10.8	37.2	241 932 (73)	117 271 (77)	359 203 (74)
Canada	77	24.5	13	37.5	248 446 (75)	109 860 (72)	358 306 (74)
Australia	76	9.6	28.6	38.1	297 871 (90)	58 315 (38)	356 186 (74)
Switzerland	67	35.3	3.8	39.1	212 401 (64)	140 586 (92)	352 987 (73)
Spain	80	39.2	3.3	42.5	199 500 (61)	142 251 (93)	341 752 (71)
UK	71	53.2	-4.2	49	153 074 (46)	167 074 (109)	320 148 (66)
Israel	64	29.7	27.8	57.4	231 156 (70)	60 978 (40)	292 134 (61)
Norway	73	45.7	12.4	58.1	177 988 (54)	111 819 (73)	289 807 (60)
Denmark	78	45.7	14.3	60	178 016 (54)	105 494 (69)	283 510 (59)
Germany	71	62.8	0.2	63.1	121 191 (37)	152 333 (99)	273 524 (57)
The Netherlands	67	65.4	-1.8	63.6	112 691 (34)	159 037 (104)	271 728 (56)
10 most-vaccinated US states	73	36.4	28.7	65.1	208 703 (63)	57 997 (38)	266 700 (55)
Italy	76	50.3	20.9	71.2	162 666 (49)	83 790 (55)	246 456 (51)
Austria	74	65.4	7.5	72.9	112 625 (34)	128 245 (84)	240 871 (50)
Finland	74	54.6	27.6	82.2	148 495 (45)	61 429 (40)	209 924 (43)
US overall	63	99.3	46.1	145.5			
10 least-vaccinated US states	52	136	57.3	193.3	-121 749 (-37)	-37 173 (-24)	-158 922 (-33)

Countries are ordered by total excess all-cause mortality rate from June 27, 2021-March 26, 2022. This includes the Delta (June 27, 2021-December 25, 2021) and winter Omicron periods (December 26, 2021-March 26, 2022) periods. Vaccination rates reflect the population percentage with 2 or more doses as of January 2022. States include the 50 states and District of Columbia. Potential deaths averted were calculated assuming that the full US had the

all-cause mortality rate of the specified country/states during the period of interest. All comparisons between the US overall and other countries were statistically significant in all periods ($P < .005$), as were comparisons between the 10 most-vaccinated and least-vaccinated states and comparisons between the 10 least-vaccinated states and all other countries ($P < .001$).

mortality in each period with mortality in 2015-2019, fitting underlying trends using pre-pandemic, out-of-sample validation (Supplement 1).⁶

For each period, we calculated the difference in US deaths if mortality rates of other locations were realized. We used regression models to statistically compare rates across locations (Supplement 1), with significance set at $P < .005$ for 2-sided tests to account for multiple testing. Analyses were conducted in R version 4.0.2 (R Foundation for Statistical Computing). The study was deemed not human subjects research by the Brown University institutional review board.

Results | The US reported 370 298 COVID-19 deaths (112 per 100 000) during the Delta and Omicron waves (61/100 000 and 51/100 000, respectively). COVID-19 deaths per capita in the US overall and in both state subgroups significantly exceeded those of all peer countries during the study period (Table 1). However, there were significantly fewer COVID-19 deaths in the top 10 states by vaccination uptake (73% coverage) at 75 deaths/100 000 compared with the bottom 10 (52% coverage) at 146 per 100 000 ($P < .001$).

US excess all-cause mortality exceeded COVID-19 mortality at 145/100 000 and exceeded peer countries in all periods, as did excess all-cause mortality in the least-vaccinated states (Table 2). However, the 10 most-vaccinated states had excess all-cause mortality comparable with or less than that

of several peer countries over Delta and Omicron combined (eg, Denmark, Germany, the Netherlands, Austria, Italy, Finland). While excess all-cause mortality in the top 10 states significantly exceeded that of many comparators during Omicron, excess all-cause mortality was significantly less than COVID-19 mortality for the top 10 states during this wave (29 vs 47 per 100 000, $P < .001$).

From June 27, 2021, to March 26, 2022, the US would have averted 122 304 deaths if COVID-19 mortality matched that of the 10 most-vaccinated states and 266 700 deaths if US excess all-cause mortality rate matched that of the 10 most-vaccinated states. If the US matched the rates of other peer countries, averted deaths would have been substantially higher in most cases (range, 154 622-357 899 for COVID-19 mortality; 209 924-465 747 for all-cause mortality).

Discussion | The US continued to experience significantly higher COVID-19 and excess all-cause mortality compared with peer countries during 2021 and early 2022, a difference accounting for 150 000 to 470 000 deaths. This difference was muted in the 10 states with highest vaccination coverage; remaining gaps may be explained by greater vaccination uptake in peer countries, better vaccination targeting to older age groups, and differences in health and social infrastructure.

This study also highlights the value of excess mortality in understanding effects of COVID-19. Excess all-cause mortality

began to fall below COVID-19 mortality in several countries and highly vaccinated states during Omicron, perhaps owing to reductions in non-COVID-19 deaths. However, cross-location differences may also reflect differences in COVID-19 death coding.

Limitations include use of some provisional mortality estimates and lack of adjustment by age and comorbidities. Nevertheless, unadjusted estimates remain important, because a country's response to COVID-19 should reflect risks in its population rather than a hypothetical standardized population.

These findings highlight that the US continued to lag peer countries in COVID-19 and excess all-cause mortality, albeit with lower mortality in highly vaccinated states.

Alyssa Bilinski, PhD
Kathryn Thompson, MHA
Ezekiel Emanuel, MD, PhD

Author Affiliations: Department of Health Services, Policy, and Practice, Brown School of Public Health, Providence, Rhode Island (Bilinski, Thompson); Department of Medical Ethics and Health Policy, University of Pennsylvania Perelman School of Medicine, Philadelphia (Emanuel).

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Corresponding Author: Alyssa Bilinski, PhD, Department of Health Services, Policy, and Practice, Brown School of Public Health, 121 S Main St, Office 828, Providence, RI 02903 (alyssa_bilinski@brown.edu).

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Concept and design: Bilinski, Emanuel.

Acquisition, analysis, or interpretation of data: Bilinski, Thompson.

Drafting of the manuscript: All authors.

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1. Bilinski A, Emanuel EJ. COVID-19 and excess all-cause mortality in the US and 18 comparison countries. *JAMA*. 2020;324(20):2100-2102. doi:10.1001/jama.2020.20717
2. Excess Deaths Associated With COVID-19. Accessed May 12, 2022. https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm
3. WHO coronavirus (COVID-19) dashboard with vaccination data. World Health Organization. Accessed October 11, 2022. <http://covid19.who.int/data/>
4. COVID-19 health indicators: mortality (by week). Organisation for Economic Cooperation and Development. Accessed May 12, 2022. https://stats.oecd.org/Index.aspx?DataSetCode=HEALTH_MORTALITY
5. Ritchie H, Mathieu E, Rod s-Guirao L, et al. Coronavirus (COVID-19) vaccinations. Our World in Data. Accessed October 11, 2022. <https://ourworldindata.org/covid-vaccinations>
6. Ruhm CJ. Excess deaths in the United States during the first year of COVID-19: NBER Working Paper 29503. National Bureau of Economic Research. Published November 2021. Accessed November 11, 2022. <http://www.nber.org/papers/w29503>