

## Online Appendix

### Data Availability

#### Data sources

Official reported COVID-19 deaths aggregated in the COVERAGE database (Output\_5.zip Version 395 downloaded May 16, 2022 from <https://osf.io/7tnfh/>. For this analysis the output file with death counts aggregated to 5-year age-groups is used <sup>[20]</sup>.

There are 125 countries in the COVERAGE database (excluding England and United Kingdom). For this analysis, the political units that make up the United Kingdom are treated separately as follows: England and Wales, Scotland, and Northern Ireland.

85 countries have at least one record of cumulative deaths during 2020.

76 countries have a record of cumulative deaths that covers at least 6 months since the first case was detected in the country (per case-data derived from Our World in Data). Countries with an “exposure” of less than 6 months as of the end of 2020 are excluded from the analysis.

The following is the set of 76 countries and economies with official reported deaths used in the analysis: Afghanistan; Albania; Algeria; Argentina; Australia; Austria; Bangladesh; Belgium; Bosnia and Herzegovina; Brazil; Bulgaria; Cameroon; Canada; Chad; Chile; Colombia; Costa Rica; Czech Republic; Denmark; El Salvador; England and Wales; Eswatini; Finland; France; Georgia; Germany; Greece; Guatemala; Haiti; Hong Kong SAR, China; Hungary; India; Indonesia; Israel; Italy; Jamaica; Japan; Jordan; Kazakhstan; Latvia; Lithuania; Malawi; Mauritius; Mexico; Moldova; Nepal; Netherlands; New Zealand; Nicaragua; Nigeria; North Macedonia; Northern Ireland; Norway; Oman; Paraguay; Peru; Philippines; Portugal; Qatar; Scotland; Serbia; Sierra Leone; Slovak Republic; Slovenia; Somalia; Republic of Korea; Spain; Sweden; Switzerland; Togo; Turkey; Ukraine; United Arab Emirates; Uruguay; United States; Vietnam.

**Excess all-cause deaths from vital statistics records**, from the following sources:

Short term mortality fluctuations (STMF) harmonized data series from the Human Mortality Database <sup>[23]</sup>, downloaded February 18, 2022 from <https://www.mortality.org>

For Colombia, Peru, Mexico, Brazil and the USA all cause death data are sources from national statistical authorities.

- For this analysis, the STMF input files are used. These input files cover 38 countries and economies: Australia; Austria; Belgium; Bulgaria; Canada; Switzerland; Chile; Czech Republic; Germany; Denmark; Spain; Estonia; Finland; France; Northern Ireland; Scotland; England and Wales; Greece; Croatia; Hungary; Iceland; Israel; Italy; Republic of Korea; Lithuania; Luxembourg; Latvia; Netherlands; Norway; New Zealand; Poland; Portugal; Russian Federation; Slovak Republic; Slovenia; Sweden; Taiwan, China; United States.
- Russia does not have data for 2020.
- Chile and Germany do not have data for 2015.

Colombia vital statistics tabulations (*Defunciones no fetales*) were compiled by DANE. 2019 and 2020 tabulations are preliminary <sup>[24]</sup>.

Mexico vital statistics microdata are those compiled by INEGI (*Defunciones registradas, mortalidad general*) and cover 2015-2020 <sup>[25]</sup>.

Peru death certificate microdata were compiled by SINADEF <sup>[26]</sup> obtained through the government's open data portal. These data cover 2017-2021.

Brazil vital statistics tabulations are obtained from the Ministry of Health's Sistema de Informação sobre Mortalidade (SIM) data portal <sup>[27]</sup>  
<http://tabnet.datasus.gov.br/cgi/deftohtm.exe?sim/cnv/obt10uf.def>

Together there are 41 countries and economies with excess death estimates: Austria; Belgium; Brazil; Bulgaria; Switzerland; Chile; Czech Republic; Germany; Denmark; Spain; Estonia; Finland; France; Scotland; Greece; Croatia; Hungary; Iceland; Italy; Lithuania; Luxembourg; Latvia; Netherlands; Norway; Poland; Portugal; Slovak Republic; Slovenia; Sweden; Taiwan, Colombia; Peru; Mexico; England and Wales; United States; Australia; Canada; Israel; Republic of Korea; New Zealand.

Of these, four do not have corresponding official death records from the coverage database: Estonia, Croatia, Luxembourg, and Poland.

For all countries, the official COVID-19 death data is drawn from the COVerAGE database and the figures correspond to calendar year 2020. The excess mortality estimates are based principally on all-cause data compiled in the Short Term Mortality Fluctuations (SMTF) database and reported in terms of deaths by week, using weeks as defined by the International Organization for Standardization (ISO) weeks. All ISO weeks start on a Monday and end on a Sunday and thus do not conform precisely to the calendar year. There are 52 ISO weeks in most years but 53 ISO weeks in 2015 and 2020. Including all 53 ISO weeks for 2020 in the excess mortality calculations would result in an overestimate of excess mortality. In order to ensure that the excess mortality calculations are based on an identical number of days in each year, we use the first 52 weeks of each year, excluding week 53 from the calculations for 2015 and 2020 for all cases where the data comes from SMTF. The 52-week ISO year for 2020 thus starts December 30, 2019, and ends December 27, 2020. For the Brazil, Colombia, Mexico, Peru and United States excess mortality estimates, which are based on data sourced directly to national statistical agencies, we use the full calendar year.

The preferred age group categories for the analyses conducted in this paper were as follows: 0-14, 15-44, 45-54, 55-64, 65-74, 75-84, 85+. However, since the reporting of all-cause deaths by age used by the Human Mortality Database is not consistent from country to country (not all countries report death counts tabulated at 5-year intervals or less), successively broader age-groupings are used in cases where the preferred age groups could not be constructed directly from the STMF input data. These countries include the United States, England and Wales, Australia, Canada, New Zealand, Israel and the Republic of Korea. We compute excess mortality rates for all unique country-age group combinations (as shown in Figure 4) but to estimate the age gradient of mortality, we only include countries for which we could construct the preferred age-group categories as described above. Countries for which we could not construct the preferred age-group categories are Brazil, Israel, and New Zealand. To avoid excluding the United States from this analysis, we use mortality data from the CDC which reports deaths for consistent age groups for 2015 through 2020.

Annex Table A1: Age Distribution of Official COVID-19 Deaths and Excess Deaths in 2020 (Data Shown in Figure 2)

Country	GNI per capita (PPP)	World Bank Income Group	Share (%) of official COVID-19 deaths by age group						Share (%) of excess mortality deaths by age group						
			0-44	45-54	55-64	65-74	75-84	85+	0-44	45-54	55-64	65-74	75-84	85+	
Bangladesh	5,180	LMIC	21	25	27	13	9	6							
India	6,930	LMIC	13	19	27	26	12	3							
Guatemala	8,850	UMIC	14	16	25	25	15	5							
Philippines	10,220	LMIC	13	14	24	28	16	6							
Indonesia	11,940	LMIC	22	22	28	15	9	4							
Paraguay	12,760	UMIC	8	9	22	27	23	11							
Peru	12,820	UMIC	8	11	22	27	21	11	5	10	20	26	23	15	
Ukraine	13,510	LMIC	4	8	23	33	26	6							
Moldova	14,280	LMIC	3	8	26	38	20	5							
Georgia	14,930	UMIC	2	6	19	33	30	10							
Brazil*	14,980	UMIC	7	8	16	24	29	17	4	10	15	23	26	22	
Colombia	15,320	UMIC	6	8	18	26	26	16	2	9	19	29	27	15	
Bosnia and Herzegovina	15,700	UMIC	2	5	16	32	32	13							
North Macedonia	16,740	UMIC	4	9	22	34	26	6							
Serbia	17,810	UMIC	2	5	15	35	30	12							
Mexico	19,290	UMIC	10	16	26	27	17	5	5	15	25	28	20	8	
Argentina	22,090	UMIC	4	6	14	25	28	25							
Bulgaria	23,810	UMIC	3	6	18	35	29	9	1	6	14	30	33	15	
Kazakhstan	24,040	UMIC	5	9	25	34	22	6							
Chile	24,480	HIC	4	6	16	25	29	21	2	8	18	27	32	14	
Turkey	26,410	UMIC	3	7	17	30	28	15							
Greece	30,080	HIC	2	5	9	15	25	45	1	2	6	18	43	31	
Slovakia	31,410	HIC	1	3	11	28	36	22	0	3	6	24	48	19	
Hungary	32,630	HIC	2	4	11	25	34	25	1	7	3	32	40	17	
Portugal	35,230	HIC	1	2	5	14	30	50	1	3	4	12	37	42	

Lithuania	37,200	HIC	1	4	13	20	36	27	3	11	17	25	26	17
Israel*	39,780	HIC	2	3	8	21	28	39	0	1	3	10	32	54
Scotland	40,000	HIC	1	2	7	17	34	40	0	4	8	19	30	38
Slovenia	40,060	HIC	1	1	3	12	33	50	0	5	0	13	35	48
Czech Republic	40,260	HIC	1	2	6	23	38	31	0	2	6	17	46	29
Spain	41,790	HIC	1	2	6	14	28	49	1	2	5	11	34	47
Japan	44,260	HIC	1	2	5	16	35	42						
Italy	44,720	HIC	1	2	6	16	35	41	0	1	5	17	33	43
England and Wales	47,880	HIC	1	3	7	15	33	42						
Canada	48,670	HIC	1	1	4	12	25	57						
France	50,130	HIC	1	2	6	17	30	44	0	1	4	12	35	48
Belgium	54,790	HIC	1	1	5	12	15	67	0	2	5	11	36	47
Sweden	56,190	HIC	1	1	4	12	32	50	0	1	6	5	43	45
Germany	57,460	HIC	1	1	5	12	34	47	2	0	4	27	0	67
Austria	57,870	HIC	1	1	5	13	34	47	2	0	8	17	42	31
Netherlands	59,250	HIC	0	1	4	15	37	44	1	3	2	14	43	37
USA	66,120	HIC	3	5	12	21	28	32	7	7	12	21	25	27
Switzerland	69,440	HIC	0	1	3	12	29	55	1	1	2	7	29	60

\* The age groups available to compute excess deaths for Brazil differ from those used in other countries and correspond to the following: 0-39, 40-49, 50-59, 60-69, 70-79, 80+. GNI is from 2019.

Annex Table A2: Hypothetical Age Distribution of Official COVID-19 and Excess Deaths in 2020, Using Country Age-Specific Mortality Rates and the US Population Age Distribution (Data Shown in Figure 3)

Country	GNI per capita (PPP)	World Bank Income Group	Share (%) of official COVID-19 deaths by age group						Share (%) of excess mortality deaths by age group						
			0-44	45-54	55-64	65-74	75-84	85+	0-44	45-54	55-64	65-74	75-84	85+	
Bangladesh	5,180	LMIC	21	25	27	13	9	6							
India	6,930	LMIC	13	19	27	26	12	3							
Guatemala	8,850	UMIC	14	16	25	25	15	5							
Philippines	10,220	LMIC	13	14	24	28	16	6							
Indonesia	11,940	LMIC	22	22	28	15	9	4							
Paraguay	12,760	UMIC	8	9	22	27	23	11							
Peru	12,820	UMIC	8	11	22	27	21	11	5	10	20	26	23	15	
Ukraine	13,510	LMIC	4	8	23	33	26	6							
Moldova	14,280	LMIC	3	8	26	38	20	5							
Georgia	14,930	UMIC	2	6	19	33	30	10							
Brazil*	14,980	UMIC	7	8	16	24	29	17	4	10	15	23	26	22	
Colombia	15,320	UMIC	6	8	18	26	26	16	2	9	19	29	27	15	
Bosnia and Herzegovina	15,700	UMIC	2	5	16	32	32	13							
North Macedonia	16,740	UMIC	4	9	22	34	26	6							
Serbia	17,810	UMIC	2	5	15	35	30	12							
Mexico	19,290	UMIC	10	16	26	27	17	5	5	15	25	28	20	8	
Argentina	22,090	UMIC	4	6	14	25	28	25							
Bulgaria	23,810	UMIC	3	6	18	35	29	9	1	6	14	30	33	15	
Kazakhstan	24,040	UMIC	5	9	25	34	22	6							
Chile	24,480	HIC	4	6	16	25	29	21	2	8	18	27	32	14	
Turkey	26,410	UMIC	3	7	17	30	28	15							
Greece	30,080	HIC	2	5	9	15	25	45	1	2	6	18	43	31	
Slovakia	31,410	HIC	1	3	11	28	36	22	0	3	6	24	48	19	

Hungary	32,630	HIC	2	4	11	25	34	25	1	7	3	32	40	17
Portugal	35,230	HIC	1	2	5	14	30	50	1	3	4	12	37	42
Lithuania	37,200	HIC	1	4	13	20	36	27	3	11	17	25	26	17
Israel*	39,780	HIC	2	3	8	21	28	39	0	1	3	10	32	54
Scotland	40,000	HIC	1	2	7	17	34	40	0	4	8	19	30	38
Slovenia	40,060	HIC	1	1	3	12	33	50	0	5	0	13	35	48
Czech Republic	40,260	HIC	1	2	6	23	38	31	0	2	6	17	46	29
Spain	41,790	HIC	1	2	6	14	28	49	1	2	5	11	34	47
Japan	44,260	HIC	1	2	5	16	35	42						
Italy	44,720	HIC	1	2	6	16	35	41	0	1	5	17	33	43
England and Wales	47,880	HIC	1	3	7	15	33	42						
Canada	48,670	HIC	1	1	4	12	25	57						
France	50,130	HIC	1	2	6	17	30	44	0	1	4	12	35	48
Belgium	54,790	HIC	1	1	5	12	15	67	0	2	5	11	36	47
Sweden	56,190	HIC	1	1	4	12	32	50	0	1	6	5	43	45
Germany	57,460	HIC	1	1	5	12	34	47	2	0	4	27	0	67
Austria	57,870	HIC	1	1	5	13	34	47	2	0	8	17	42	31
Netherlands	59,250	HIC	0	1	4	15	37	44	1	3	2	14	43	37
USA	66,120	HIC	3	5	12	21	28	32	7	7	12	21	25	27
Switzerland	69,440	HIC	0	1	3	12	29	55	1	1	2	7	29	60

\* The age groups available to compute excess deaths for Brazil differ from those used in other countries and correspond to the following: 0-39, 40-49, 50-59, 60-69, 70-79, 80+. GNI is from 2019.

Annex Table A3: Rate of Increase in Risk of Death by Age and Ratio of Mortality Risk Between Age Groups

Country	Official deaths		Excess deaths	
	Exponential rate of increase in risk of death for each year of age	Ratio (MR 75-84/ MR 45-54)	Exponential rate of increase in risk of death for each year of age	Ratio (MR 75-84/ MR 45-54)
Afghanistan	0.06	5.74		
Albania	0.06	5.88		
Algeria	0.08	10.72		
Argentina	0.08	14.89		
Australia	0.16	103.71		
Austria	0.13	50.11	0.10	195.28
Bangladesh	0.04	2.39		
Belgium	0.15	28.08	0.13	52.81
Bosnia and Herzegovina	0.08	15.22		
Brazil	0.07	16.70		
Bulgaria	0.06	9.59	0.07	11.48
Cameroon	0.07	7.73		
Cada	0.15	52.78		
Chad	0.07	5.58		
Chile	0.08	17.96	0.07	14.85
Colombia	0.07	14.63	0.08	14.24
Costa Rica	0.05	7.67		
Croatia			0.10	22.54
Czech Republic	0.11	61.17	0.12	64.18
Denmark	0.13	78.46	0.02	-2.31
El Salvador	0.05	1.62		
England and Wales	0.11	27.90		
Estonia			0.02	-2.26
Eswatini	0.06	4.26		
Finland	0.12	26.90	0.05	5.10
France	0.10	34.25	0.12	87.28
Georgia	0.07	14.21		
Germany	0.12	44.66	0.13	-164.35
Greece	0.09	11.09	0.09	41.67
Guatemala	0.05	4.66		
Haiti	0.05	5.29		
Hong Kong SAR, China	0.12			
Hungary	0.09	21.90	0.08	14.44
Iceland			0.03	12.27
India	0.05	4.03		



Indonesia	0.04	3.02		
Israel	0.10	32.91		
Italy	0.10	39.76	0.11	46.03
Jamaica	0.06	9.42		
Japan	0.10	29.85		
Kazakhstan	0.07	12.00		
Latvia	0.07	12.95	0.06	4.29
Lithuania	0.08	18.85	0.05	4.42
Luxembourg			0.12	-7.52
Malawi	0.06	2.93		
Mauritius	0.03	4.19		
Mexico	0.05	5.53	0.06	7.13
Moldova	0.06	9.75		
Nepal	0.05	7.62		
Netherlands	0.13	72.86	0.12	29.32
New Zealand	0.11	28.02		
Nicaragua	0.06	8.32		
Nigeria	0.06	6.32		
North Macedonia	0.06	9.73		
Northern Ireland	0.12	37.00	0.10	74.72
Norway	0.12	32.03	0.06	11.47
Oman	0.07	18.21		
Paraguay	0.07	10.69		
Peru	0.06	8.17	0.07	10.09
Philippines	0.06	7.94		
Poland			0.10	17.50
Portugal	0.12	39.63	0.11	24.73
Qatar	0.10	52.10		
Scotland	0.11	34.29	0.11	16.75
Serbia	0.07	14.42		
Sierra Leone	0.06	8.29		
Slovakia	0.09	36.46	0.11	48.40
Slovenia	0.14	78.16	0.13	16.23
Somalia	0.14	56.77		
South Korea	0.13	78.62		
Spain	0.11	36.59	0.11	54.12
Sweden	0.13	47.08	0.13	79.55
Switzerland	0.15	96.99	0.15	51.80
Taiwan			0.04	13.73
Togo	0.05	3.22		
Turkey	0.08	18.27		
Ukraine	0.05	8.09		
United Arab Emirates	0.11	26.72		
Uruguay	0.08	23.17		
USA	0.08	14.50	0.06	9.07
Vietnam	0.05	8.74		

