

SUPPLEMENTAL INFORMATION

COVID-19 and All-Cause Mortality in the US and 18 Comparison Countries

Alyssa Bilinski · Ezekiel Emanuel^{1,2}

CALCULATIONS IN TABLES 1 AND 2

Difference in deaths

Let r_i be the death rate of interest (reported COVID-19 deaths or excess all cause mortality) per 100,000 in country i , and d be US deaths over the period of study. Let p be the US 2019 population, $p = 329,064,917$ according to the European Centre for Disease Prevention and Control. We estimate difference in deaths:

$$d - (r_i/100,000) * p \quad (1)$$

Difference in deaths if comparable after some time point

Letting r_{iT} be the death rate per 100,000 in country i between time T and the end of the period of study and d_T be US deaths by time T , we estimate potential difference in deaths since time T :

$$d - (d_T + (r_{iT}/100,000) * p) \quad (2)$$

REGRESSIONS

Table 1

Let d_i be the number of deaths in country i over some time period, and p_i be its population. Assume we have countries $j = 1, \dots, n$ and \mathbf{C} be a $(n-1) \times 1$ vector of country indicator variables with the US omitted as reference category. We assume that $d_i \sim \text{Pois}(\lambda_i)$ and

$$\mathbb{E}[\log(\lambda_i)] = \beta_0 + \beta\mathbf{C} + \log(p_i), \quad (3)$$

where β is $1 \times n-1$ and β_j compares the death rate in country j to the US.

Table 2

Let $d_{i,w,y}$ be the number of deaths in country i at week w in year y , and p_i be its population. Assume we have countries $j = 1, \dots, n$ and \mathbf{C} be an $(n-1) \times 1$ vector of country indicator variables with the US omitted as reference category, \mathbf{W} be a $(W-1) \times 1$ vector of week indicator variables, and \mathbb{I}_{2020} be equal to 1 if the year is 2020 and 0 otherwise. We assume that $d_{i,w,y} \sim \text{Pois}(\lambda_{i,w,y})$ and

$$\mathbb{E}[\log(\lambda_{i,w,y})] = \beta_0 + \beta\mathbf{C} + \gamma\mathbf{W} + \delta\mathbb{I}_{2020} + \alpha\mathbf{C}\mathbb{I}_{2020} + \log(p_i), \quad (4)$$

where α is $1 \times n-1$ and α_j compares excess 2020 mortality in country j to in the US.³

DATA SOURCES

We accessed data on **COVID-19 deaths** from the **European Centre for Disease Prevention and Control COVID-19 database** ([link](#), accessed through R library [sars2pack](#)). We accessed **all-cause mortality data** from country-specific sources (Table S1). We also referenced *The Economist* ([link](#)) and *The New York Times* ([link](#)) excess death GitHubs and associated coverage.

¹Contact: zemanuel@upenn.edu

²Data and code are available on GitHub ([link](#)).

³For estimation strategies, see Weinberger DM, Chen J, Cohen T, et al. Estimation of Excess Deaths Associated With the COVID-19 Pandemic in the United States, March to May 2020. *JAMA Intern Med.* Published online July 1, 2020. doi:10.1001/jamainternmed.2020.3391.

Country	Source	File	Included	Week format	Notes	Link
Australia	Australian Bureau of Statistics	Provisional Mortality Statistics	No		Data only available through May 2020	link
Austria	Statistics Austria	Age-specific death rates in Austria (excl. deaths abroad) by calendar week	Yes	Sunday-Saturday		link
Belgium	Statbel	Number of deaths per day, sex, age, region, province, district	Yes	Daily data, aggregated by week (Monday-Sunday)		link
Canada	StatCan	Adjusted number of deaths, expected number of deaths and estimates of excess mortality, by week	Yes	Monday-Sunday		link
Denmark	Statistics Denmark	DODC1: Deaths per day (experimental statistics) by sex and age	Yes	Daily data, aggregated by week (Monday-Sunday)		link
Finland	Statistics Finland	12ng – Deaths by week according to sex, age and region (Rapid estimate), 1990W01-2020W37*	Yes	Sunday-Saturday		link
France	Insee	Téléchargement des fichiers des décès quotidiens	Yes	Daily data, aggregated by week (Monday-Sunday)	Economist approach for all-cause mortality 2015-17	link , link
Germany	DeStatis	Sterbefälle - Fallzahlen nach Tagen, Wochen, Monaten, Altersgruppen und Bundesländern für Deutschland 2016 - 2020	Yes	Daily data, aggregated by week (Monday-Sunday)	Only available starting in 2016	link
Israel	Ministry of Health	Weekly Epidemiological Reports	Yes	Reports dated Saturday	Received translation assistance	link
Italy	Istat	10 August 2020 – Male, female and total deaths	No		Data only available through June 2020	link
Japan	e-Stat	Current Population Survey / Vital Statistics	No		Data only available through July 2, 2020	link
Netherlands	StatLine	Deaths registered weekly, by sex and age	Yes	Sunday-Saturday		link
Norway	Statistics Norway	07995: Deaths, by sex, age and week. Preliminary figures 2000 - 2020	Yes	Sunday-Saturday		link
South Korea	Statistics Korea	Vital statistics (births/deaths)	No		Received translation assistance; data only available monthly	link
Spain	Instituto Nacional de Estadística	Estimate of Weekly Deaths	Yes	Sunday-Saturday		link
Sweden	Statistics Sweden	Preliminary statistics on deaths in Sweden		Daily data, aggregated by week (Monday-Sunday)		link
Switzerland	Federal Statistics Office	Weekly number of deaths, 2020 & 2010-2019		Sunday-Saturday		link
United Kingdom	Office of National Statistics (GB), National Records of Scotland, Northern Ireland Statistics and Research Agency	Deaths registered weekly in England and Wales, provisional, Deaths involving coronavirus (COVID-19) in Scotland, Weekly death registrations in Northern Ireland, 2020.	Yes	Sunday-Saturday; Monday-Sunday		link , link
United States	Centers for Disease Control and Prevention	Deaths involving coronavirus disease 2019 (COVID-19), pneumonia, and influenza reported to NCHS by week ending date, United States. Week ending 2/1/2020 to 9/19/2020.	No	Monday-Sunday		link

Table S1 – Data sources for all-cause mortality. The "Included" column indicates whether available data met inclusion criteria; if not, this is explained in the "Notes" column. Due to differences in reporting, week definition varies slightly.