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A Two Covid-19 Years Quartile Comparison of Official with Excess Mortality:

Voice and Accountability and the Impact of Vaccines

by

Joshua Aizenman, Alex Cukierman, Yothin Jinjarak, Sameer Nair-Desai, and Weining Xin*

Abstract

We evaluate the quartile ranking of countries during the Covid-19 pandemic using both official (i.e., confirmed) and excess mortality data. Contrasting countries' rankings using these two data sources reveal sharp and systematic differences. In an international sample of more than 190 countries, while higher GDP per capita is associated with a worse mortality ranking when using official Covid-19 mortality, we find the opposite result when using excess mortality data. By the end of 2021, the quartile rankings of three-fifths of the countries in our sample differ when ranked by excess vs. official mortality. On average, countries that are 'doing substantially better' in the excess mortality dataset are characterized by higher urban population shares; higher GDP/Capita; and higher scores on institutional and policy variables. To explain these differences, we perform two sets of regressions using data at the end of 2020 and the end of 2021, in which the ratio of Cumulative Excess to Official Covid-19 mortalities (E/O ratio) is regressed on a large set of covariates. In the first, narrow experiment, we only control for GDP/Capita and vaccination rates. In the second, broad experiment, we add other institutional and policy variables. In the narrow experiment, by December 2021 the E/O ratio was smaller in countries with higher vaccination rates. In the broad experiment, the E/O ratio was smaller in countries with higher degree of voice and accountability. Our results suggest that the arrival of vaccines in early 2021 and voice and accountability had a discernible association with the gap between excess and official mortality.

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* Joshua Aizenman, Economics and SIR, University of Southern California and NBER, Los Angeles, CA 90089-0043, aizenman@usc.edu.

Alex Cukierman, Tel-Aviv University School of Economics, Tel-Aviv, Israel 69978, alexcuk@tauex.tau.ac.il.

Yothin Jinjarak, ERCD and Asian Development Bank, 1550 Metro Manila, Mandaluyong City, Philippines, yothin.jinjarak@vuw.ac.nz.

Sameer Nair-Desai, School of Public Health, Brown University, 121 South Main Street, Providence, RI 02903, sameer_nair-desai@brown.edu.

Weining Xin, International Monetary Fund, 700 19th St NW, Washington, DC 20431, WXin@imf.org.

Note: The views expressed in this paper are those of the authors and do not necessarily represent the views of the IMF, its Executive Board, and IMF management, nor those of the Brown School of Public Health.

Data Availability: Interested readers can find a GitHub repository with the paper's raw data, source code, and analysis at: https://github.com/snairdesai/COVIDMortalities.

1. Introduction

As a benchmark, the paper opens by documenting the remarkable heterogeneity of countries' Covid-19 mortality experiences during the first two Covid-19 years, from 2020-2021. The heterogeneity in countries' performance is illustrated by Figure 1, which displays cumulative official Covid-19 deaths per million for high-, upper-middle, lower-middle, and low-income countries, as well as for the World overall.

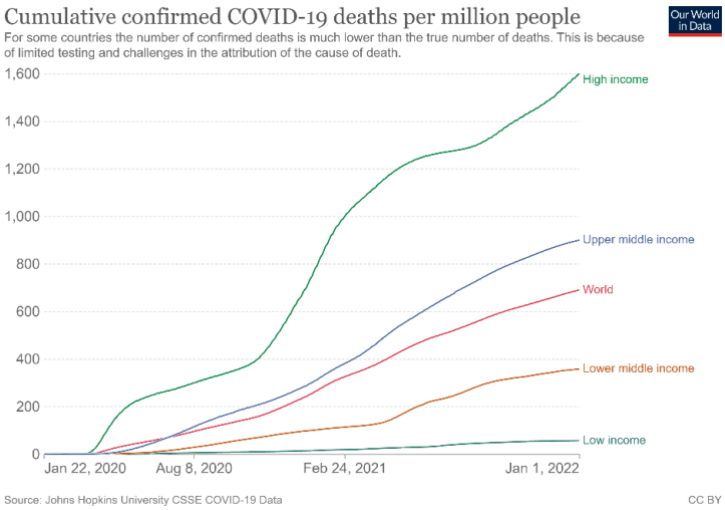

Figure 1: Cumulative official Covid-19 deaths per million, high-, upper-middle, lower-middle, low-income countries, and the World, 2020-2021.

At first glance, one may conclude that higher-income countries experienced a much worse pandemic. However, recent literature suggests that officially reported mortality may not reflect the true distribution of death tolls, since the limitations of official statistics and data infrastructures vary across the globe.[1] Countries have different levels of reporting and testing availability, or disparate definitions of 'Covid-19' deaths. This is due to the different abilities of medical systems to capture the totality of Covid-19 deaths. To gain further insight on data limitations associated with confirmed (i.e., officially reported) Covid-19 counts, we evaluate the quartile ranking of countries using both official and excess Covid-19 mortality data. Contrasting countries' ranking using these two data sources reveals sharp and systematic contrasts in mortality statistics. In particular, while higher GDP per capita is associated with a *worse* mortality ranking (i.e., a quartile with higher mortality) using the official Covid-19 mortality data, we find the opposite result in the excess mortality data — higher GDP per capita is associated with a *better* mortality ranking (i.e., a quartile with lower mortality).

[1] See Karlinsky and Kobak (2021), the Economist article "There have been 7m-13m excess deaths worldwide during the pandemic." Mulligan (2021) concluded that in the US excess mortality is closely related to deaths of despair -- social isolation may be part of the mechanism that turns a pandemic into a wave of deaths of despair.

Figure 2 plots the world excess and the official Covid-19 deaths during the first two Covid-19 years (2020 – 2021). It clearly illustrates the higher mean and standard deviation of excess deaths in comparison to officially reported deaths.

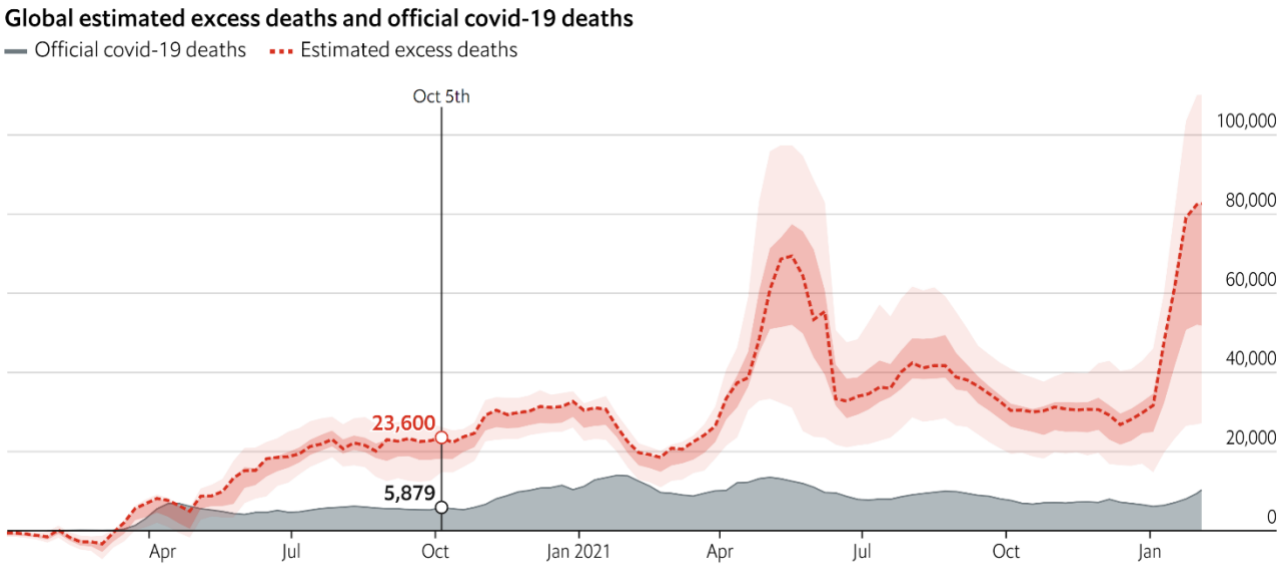

Figure 2: Global estimated excess deaths and official Covid-19 deaths, January 2020 - February 2022. Source: The Economist. February 4th, 2022.

To gain further insight, we perform two sets of regressions, in which the ratio of Cumulative Excess to Official Covid-19 mortalities (E/O ratio) is regressed on a large set of covariates. We focus on more than 140 countries with cumulative excess mortality higher than official mortality, and run our analysis both at the end of 2020 and at the end of 2021. In the first, **narrow** experiment, we control only for GDP/Capita and vaccination rates. In the second, **broad** experiment, we add other institutional and policy variables. In the narrow experiment we find that by December 2021, Cumulative Excess/Official Covid-19 mortality ratios are smaller for countries with higher vaccination rates. In the broad experiment — both at the end of 2020 and at the end of 2021 — a higher urban population share and a higher score on voice and accountability are associated with lower Cumulative Excess/Official Covid-19 mortality ratios, but the vaccination variable at the end of 2021 becomes insignificant — probably due to multicollinearity with the other controls.

We close our analysis by contrasting the quartile rankings between the two data sets at the end of 2021. For 3/5ths of the countries in our sample, quartile rankings differ between the two data sets (e.g., a nation will have a quartile ranking of 3 based on the official mortality data, but a ranking of 1 based on the excess mortality data). We also contrast countries that are ranked substantially better to countries that are ranked substantially worse, based on their excess mortality as compared to their official Covid-19 mortality count. We classify

countries that are "doing substantially better in excess" as any nation in the sample that recorded a ranking of *at least two quartiles better (i.e., ranked in a lower mortality quartile)* when using excess mortalities, as opposed to official mortalities. Conversely, we categorize countries that are "doing substantially worse in excess" as any nation in the sample which recorded a quartile ranking of *at least two worse (i.e., higher mortality)* when using excess mortalities, as opposed to official mortalities. On average, the countries which are 'doing substantially better in excess' are characterized by higher urban population share; higher GDP/Capita; better rule of law, voice accountability, and government effectiveness; and substantially higher vaccination rates.

These results suggest that one should take official Covid-19 mortality counts with a grain of salt, and should supplement this information with excess mortality data. We also find that governance indicators, in particular, voice and accountability, and other structural variables (such as urban population share) may explain the ranking gaps between the two data sets. The arrival of vaccines in early 2021 was also correlated with the gap between excess and official mortality — the strength of this relationship likely varied by country. Notably, the heterogeneous impact of vaccines may also reflect the global shortages of vaccinations, resulting in unequal worldwide vaccination rates.

2. Data

Our full dataset is constructed by supplementing the *Our World in Data* database on Covid-19 with a few other datasets, including the World Development Indicator (WDI) database, the World Governance Indicator (WGI) database (Kraay and Mastruzzi, 2011), and *the Economist*'s tracker for Covid-19 excess deaths. The full dataset covers 170 countries at a weekly frequency from January 1, 2020, to December 31, 2021.

Specifically, from the *Our World in Data*'s Covid-19 database, we use cumulative officially reported Covid-19 mortality counts (per million population), the total number of Covid-19 vaccination doses administered per 100 people in the total population (Mathieu et al. 2021), population density, the share of aged 65+ population, and GDP per capita.

We use the share of urban population from the WDI database; and rule of law, voice and accountability, and government effectiveness from the WGI database. Rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. The voice-and-accountability variable captures perceptions of the extent to which a country's citizens can participate in selecting their government, as well as freedom of expression, freedom of association, and free press. Lastly, government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

We also use cumulative excess mortality per million population from *the Economist*'s tracker for Covid-19 excess deaths, which is calculated by comparing all-cause mortality in a given country and time frame with a historical baseline from prior years. A linear trend is then fit for the year, accounting for long-term increases or decreases in mortality, and a fixed effect is implemented for each week or month up to February 2020 to account for short-term fluctuations.

3. Quartile Evidence Contrasting Official versus Excess Cumulative Covid-19 Mortality, 2020-2021

We start by tabulating the quartile rank order of mortality per million during the first two Covid-19 years (from the beginning of 2020 to the end of 2021) using the two mortality measures, i.e., the official (or reported) mortality and the excess mortality. Next, we describe the large discrepancies of countries' ranking between the two mortality measures. To gain further insight, we present regressions accounting for these differences, and close with discussion and interpretations.

Table 1 reports the average statistics of countries in quartiles of cumulative official Covid-19 mortality per million up to December 31, 2021. Table 2 replicates Table 1, but for excess Covid-19 mortalities. Table 1A, relegated to the appendix, reports the country list within each quartile of official mortality. Table 2A (also in the Appendix) replicates Table 1A, but for excess mortality data. We order the ranks of the quartiles so that a lower quartile consists of countries with lower cumulative mortalities.

Contrasting the average statistics in each quartile of cumulative official Covid-19 mortality per million up to December 2021 (Table 1) with those in the same quartiles of cumulative excess mortality per million in December 2021 (Table 2) reveals disturbing fundamental differences between these two mortality measures and the resulting country quartile rankings.

Table 1 indicates that, on average, higher GDP/capita countries performed poorly relative to low- and middle-income countries in terms of their cumulative official Covid-19 mortality ranking. The best-performing official mortality quartile's average income/capita is the *lowest* (about $7,200) of all quartiles, only 1/3 of that of the higher mortality quartiles. Similar observations apply to measures of institutional quality. Rule of law, voice and accountability, and government effectiveness are significantly higher and positive for the worst-performing quartiles (e.g., the third and fourth quartiles).

Intriguingly, almost the opposite patterns characterize the quartiles of cumulative excess mortality, reported in Table 2. The lowest excess mortality quartile's average income/capita is the *highest* (about $24,400) of all quartiles. Average income/capita in the worst excess mortality quartile is only 3/5 of the average income/capita of the best performing quartile. The quartile with the lowest excess mortality is now characterized by the highest rule of law, voice and accountability, and government effectiveness scores.

Table 1: Average Quartiles Statistics of Cumulative Official Covid-19 Mortality, December 31, 2021

Variable	1st Quartile (Lowest Cum. Mortality)	2nd Quartile	3rd Quartile	4th Quartile (Highest Cum. Mortality)
Population	58162373	68463139	12154505	33903606
Population Density	239	399.2	229.8	104.6
Urban Population Share	44	56.3	66	69
Aged 65+ Population Share	4.5	6.5	9.5	13.9
GDP per Capita (in $1,000)	7.2	20.5	25	22.3
Rule of Law	-0.6	-0.2	0.3	0.2
Voice and Accountability	-0.6	-0.5	0.3	0.5
Government Effectiveness	-0.7	-0.1	0.3	0.2
Vaccinations	33.9	87.9	103.3	117.5

Notes: Each row in Tables 1 and 2 captures *average demographic indicators* within each quartile. Population is calculated as cumulative totals as reported by the United Nations in 2020; population density is calculated as the number of people divided by land area, measured in square kilometers; and gross domestic product is calculated at purchasing power parity (constant 2011 international dollars) – all from OWID. Vaccinations is the number of Covid-19 vaccines administered per hundred population.

Table 2: Average Statistics of Excess Mortality/Millions of Countries in Quartile, December 31, 2021

Variable	1st Quartile (Lowest Cum. Mortality)	2nd Quartile	3rd Quartile	4th Quartile (Highest Cum. Mortality)
Population	40485718	25673282	26800349	69443370
Population Density	491.1	242.5	114.3	122.3
Urban Population Share	62.3	52.1	57.8	62.8
Aged 65+ Population Share	8.4	7.1	7.6	10.9
GDP per Capita (in $1,000)	24.4	16.5	15.6	17.1
Rule of Law	0.4	-0.1	-0.3	-0.2
Voice and Accountability	0.3	-0.2	-0.3	0

Government Effectiveness	0.3	-0.2	-0.2	-0.1
Vaccinatiions	95.8	79.2	74	87.1

These observations raise fundamental concerns about the quality of confirmed (or official) cumulative mortality data in Covid-19 times. It also challenges simplistic interpretations and generalizations, like the notion that on average, OECD countries failed in dealing with Covid-19 challenges relative to low- and middle-income countries. This view is supported by the quartiles' average statistics when measured using official Covid-19 mortality, but is mostly rejected when measured using excess mortality data. The sharp contrast between the two tables suggests that countries which ranked higher in terms of rule of law, voice, accountability, and government effectiveness are also countries where the (mainly positive) gap between the official Covid-19 mortality and the excess mortality is smallest.

4. Statistical Analysis of the Gap between Official and Excess Cumulative Covid-19 Mortality, 2020-2021

To obtain further insight on the gap between official and excess cumulative Covid-19 mortality, we run regressions accounting for the ratio of Cumulative Excess/Official Covid-19 mortalities (henceforth, **E/O ratio**) across countries. These regressions are run for two dates; at the end of 2020, and at the end of 2021. We focus on countries which see higher cumulative excess mortality than official mortality. This is the case for the vast majority of countries. The sample includes more than 120 countries as of end-2020, and more than 140 countries as of end-2021..

Table 3 provides the estimation of the E/O ratio on a set of structural regressors, including the level of income (as measured by GDP per capita), a set of demographic variables including population density, urban population share, aged 65+ population share, and a set of variables from the World Governance Indicators database measuring the quality of governance - including rule of law, voice and accountability, and government effectiveness; as well as a Covid-19 vaccination level (as measured by the number of Covid-19 vaccinations administered per hundred population).

Columns (1) and (3) of Table 3 shows the regression results with only the level of income (as measured by GDP per capita) and the level of vaccination (as measured by the number of Covid-19 vaccinations administered per hundred population), as of end-2020 and end-2021 separately. Results show that, at the end of 2020 and 2021, the associations between E/O ratio and GDP per capita are both negative but statistically insignificant. In 2021, however, as Covid-19 vaccines became widely available throughout the year for a large

number of countries, the association between E/O ratio and the vaccination level in the international sample is significantly negative.[2]

Columns (2) and (4) of Table 3 shows the regression results with the addition of more structural variables. Colum (2) shows that, at the end of 2020, the association between E/O and urban population share is significantly negative while the associations with other indicators are all insignificant. At the end of 2021, as shown in column (4), in addition to the significant and negative association with urban population share, E/O ratio is significantly and negatively correlated with voice and accountability. Notably, the vaccination level that had a significantly negative impact on the E/O ratio at the end of 2021 in column (3) is now insignificant despite of being still negative in the presence of the additional variables above. It is likely that this is due to a high degree of multicollinearity between vaccinations and other controls. Table 3A in the appendix presents a correlation matrix of our core variables which likely confirms these suspicions.

These results show that on average, countries which record higher perceptions of citizens' ability to participate in selecting their government, and rank higher on freedom of expression, freedom of association, and a free media are likely to see a smaller gap between their cumulative excess and official mortality.[3] One possible explanation of this result is that it would be harder for a country with higher perceptions of voice and accountability to manipulate officially reported mortality. Relatedly, countries with a higher urban population share would find it harder to manipulate officially reported mortality because urban populations are likely to have better access to both domestic and international information.

[2] Notably, this finding may also reflect the scarcity of quality vaccinations, and the resultant rationing.
[3] Beyer, Hu and Yao (2022) find similar results on accounting for quarterly GDP growth, that a higher level of voice and accountability is associated with more precise quarterly GDP growth data.

Table 3: Broad Regressions of Cumulative Excess/Official Covid-19 Mortality across Countries with Additional Controls, 2020 and 2021.

	Dependent variable:			
	E/O			
	As of 12/28/2020		As of 12/27/2021	
	(1)	(2)	(3)	(4)
GDP per Capita	-2.6829	2.0157	-0.2222	0.2980
	(2.0413)	(4.0279)	(0.2809)	(0.3966)
Population Density		0.0310		0.0032
		(0.0582)		(0.0062)
Urban Population Share		-5.5658**		-0.7608***
		(2.4446)		(0.2455)
Aged 65+ Population Share		6.1060		0.6140
		(9.3970)		(0.9260)
Rule of Law		-29.0065		-3.5680
		(150.0266)		(13.7032)
Voice and Accountability		-85.4492		-13.6045*
		(79.6006)		(7.0166)
Government Effectiveness		27.1762		3.6186
		(127.2772)		(12.7480)
Total Vaccinations per Hundred Population			-0.2105**	-0.1220
			(0.0813)	(0.0858)
Constant	109.6314**	268.2816*	38.8660***	57.1352***
	(50.6259)	(141.5579)	(6.3376)	(13.8960)
Observations	123	121	147	145
R^2	0.0141	0.0823	0.1004	0.2013
Residual Std. Error	415.9638	415.1160	48.2743	44.8026
F Statistic	1.7275	1.4485	8.0318***	4.2836***
Note:	*,**,*** correspond to 10%, 5% and 1% significance, respectively.			

Table 4 reports the country mortality quartile as ranked by official (or reported) Covid-19 mortality (rows) against mortality quartile as ranked by excess Covid-19 mortality (columns) in a 4 by 4 matrix. The diagonal of this matrix reports 68 countries that are in the same mortality quartile under both the official and excess counts. This represents about 37% of the sample. In contrast, the ranking of countries that are further

away from the diagonal differs more between their official and excess mortality counts. We proceed by focusing on countries whose quartiles differ between these two metrics (official and excess) by at least two quartiles. For example, France ranks in the 4th quartile in terms of official mortality but ranks in the 2nd quartile in terms of excess mortality. Bangladesh is in the 2nd quartile in terms of official mortality but is in the 4th quartile in terms of excess mortality.

Table 4: Country official mortality quartile against excess mortality quartile (end of 2021).

Official Mortality Quartile (R) / Excess Mortality Quartile (C)	*1st Excess Mortality Quartile*	*2nd Excess Mortality Quartile*	*3rd Excess Mortality Quartile*	*4th Excess Mortality Quartile*
1st Official Mortality Quartile	**15 Total Countries:** Australia; Benin; Bhutan; Central African Republic; China; Eritrea; Ghana; Guinea; Hong Kong; Iceland; New Zealand; Papua New Guinea; Sierra Leone; Taiwan; Vanuatu	**19 Total Countries:** Angola; Burkina Faso; Burundi; DR Congo; Cote d'Ivoire; Ethiopia; Guinea-Bissau; Haiti; Laos; Liberia; Madagascar; Mali; Nigeria; Somalia; Tanzania; Timor-Leste; Togo; Uganda; Uzbekistan	**10 Total Countries:** Cameroon; Chad; Republic of Congo; Kenya; Mozambique; Nicaragua; Niger; South Sudan; Tajikistan; Yemen	**1 Total Country:** Sudan
2nd Official Mortality Quartile	**14 Total Countries:** Anguilla; Brunei; Denmark; Dominican Republic; Equatorial Guinea; Japan; Korea; Montserrat; Norway; Qatar; Sao Tome and Principe; Senegal; Singapore; Saint Kitts and Nevis	**11 Total Countries:** Cambodia; Comoros; Finland; Gambia; Lesotho; Malawi; Maldives; Syria; Thailand; UAE; Vietnam	**15 Total Countries:** Afghanistan; Algeria; Egypt; Gabon; Indonesia; Kyrgyzstan; Mauritania; Morocco; Myanmar; Philippines; Rwanda; Saudi Arabia; Venezuela; Zambia; Zimbabwe	**5 Total Countries:** Bangladesh; Djibouti; India; Nepal; Pakistan
3rd Official Mortality Quartile	**8 Total Countries:** Barbados; Canada; Dominica; Luxembourg; Malaysia; Mauritius; Mongolia; Seychelles	**15 Total Countries:** Antigua and Barbuda; Bahrain; Costa Rica; Cyprus; Fiji; Germany; Ireland; Israel; Jamaica; Malta; Oman; Sri Lanka; St. Vincent; Sweden; Switzerland	**11 Total Countries:** Austria; Belize; Cabo Verde; Estonia; Guatemala; Guyana; Honduras; Jordan; Kuwait; Lebanon; Netherlands	**12 Total Countries:** Albania; Azerbaijan; Belarus; Botswana; El Salvador; Iraq; Kazakhstan; Libya; Namibia; South Africa; Swaziland; Turkey
4th Official Mortality Quartile	**No Countries**	**3 Total Countries:** France; Grenada; Uruguay	**12 Total Countries:** Bahamas; Belgium; Chile; Greece; Panama; Paraguay; Portugal; Slovenia; Spain; Trinidad and Tobago; Tunisia; United Kingdom	**31 Total Countries:** Argentina; Armenia; Bolivia; Bosnia; Brazil; Bulgaria; Colombia; Croatia; Czech Republic; Ecuador; Georgia; Hungary; Iran; Italy; Latvia; Lithuania; Macedonia; Mexico; Moldova; Montenegro; Peru; Poland; Romania; Russia; San Marino; Serbia; Slovakia; St. Lucia; Suriname; Ukraine; USA

Table 5 reports the average statistics for countries that are "doing substantially worse in excess" — any countries that recorded a quartile ranking *at least two worse (i.e., higher mortality)* when using excess mortalities as opposed to official mortalities (for example, Bangladesh) — and comparing them to countries that are "doing substantially better in excess" — any countries that recorded a quartile ranking *at least two better (i.e., lower mortality)* when using excess mortalities as opposed to official mortalities (for example, France).

When contrasting countries that are ranked substantially better to countries that are ranked substantially worse in excess mortality as opposed to official mortality, we find that, on average, the 'doing substantially better in excess' countries are: higher urban population share [66% versus 38%]; older (12% versus 4% of aged

65 and older); recording a substantially higher GDP/Capita ($ 29,000 versus $ 3,000); scoring better in rule of law, voice accountability, and government effectiveness; and achieving substantially higher vaccination rates (as measured by the number of Covid-19 vaccinations administered per hundred population) [144 versus 26].[4]

Table 5: Summary Statistics of "Doing Better in Excess" Deaths and "Doing Worse in Excess" Deaths.

Variable	Mean	St. Dev.	Min.	25th Percentile	75th Percentile	Max.
Doing Substantially Better in Excess Mortality						
Population Density	217.05	233.10	1.98	58.00	274.29	664.46
Urban Population Share	66.19	22.09	31.15	48.74	80.93	95.33
Aged 65+ Population Share	11.78	5.12	4.03	7.63	14.88	19.72
GDP per Capita (in $1,000)	29.37	24.06	9.67	15.29	32.71	94.28
Rule of Law	0.76	0.63	-0.26	0.32	1.13	1.79
Voice and Accountability	0.86	0.51	-0.15	0.57	1.22	1.50
Government Effectiveness	0.71	0.72	-0.34	0.21	1.15	1.84
Vaccinations per Hundred Population	144.22	47.41	66.10	102.78	178.83	199.36
Doing Substantially Worse in Excess Mortality						
Population Density	175.31	324.43	11.83	30.49	145.88	1265.04
Urban Population Share	37.95	17.91	16.43	26.04	41.59	77.78
Aged 65+ Population Share	3.87	1.17	2.49	3.10	4.65	5.99
GDP per Capita (in $1,000)	3.18	1.65	0.93	1.72	4.57	6.43
Rule of Law	-0.98	0.49	-1.93	-1.22	-0.57	-0.02
Voice and Accountability	-1.02	0.61	-1.83	-1.42	-0.58	0.15
Government Effectiveness	-0.98	0.70	-2.34	-1.44	-0.66	0.39
Vaccinations per Hundred Population	26.35	33.65	0.00	1.72	47.34	101.80

Note: "Doing Substantially Better in Excess" is the sample of countries that recorded a ranking at least two better quartiles (i.e., quartiles with lower cumulative mortality) when using excess than official mortalities, and "Doing Substantially Worse in Excess" is the sample of countries which recorded a ranking at least two worse quartiles (i.e., quartiles with higher cumulative mortality) when using excess than official mortalities.

These gaps support the view that better governance scores account for the countries with the largest gaps between excess and official mortality. Notably, these characteristics are also associated with higher GDP/Capita, older populations, and in, some experiments, with sufficiently high vaccination levels. The overall positive correlations between these variables, reported in Table 3A (see the Appendix), suggests that without more granular data, we are unable to rank the relative importance of these factors.

5. Concluding Remarks

[4] The association of higher share of aged 65 plus with 'doing better' may reflect higher life expectancy in countries where the older population affords retirement and greater isolation, and higher vaccination rates by the end of 2021.

As the Covid-19 pandemic has caused significant death tolls globally, cross-country analyses and global comparisons have been widely conducted to investigate Covid-19 mortality across many dimensions (i.e., economic, political, social, etc.). With most of these studies relying on official statistics on Covid-19 mortality as reported by countries, the quality of the underlying official mortality statistics plays a critical role in affecting the results obtained. Importantly, there are widely documented limitations in the official mortality statistics that mask the ranking of countries in terms of life preservation. Some of these limitations include differences in countries' capacities to test for Covid-19, determine the cause of death, and disparate definitions of death due to Covid-19.

To investigate the limitations of official Covid-19 mortality, we contrast this measure with excess mortality, which is calculated as the difference of all-cause mortality during the Covid-19 pandemic from a baseline trend modeled from historical mortality data. We show that countries' quartile rankings differ quite substantially between excess and official cumulative mortality. Countries who fare the best in terms of cumulative **excess** mortality record the highest income and institutional quality (as measured by rule of law, voice and accountability, government effectiveness), and countries faring the worse in terms of cumulative **official** mortality share similar characteristics. This evidence is further supported by a simple regression analysis of the ratio of excess to official mortality on country-specific indicators as well as a deeper examination of individual country's quartile movements between measures of official and excess mortality. Specifically, governance variables, in particular, voice and accountability, other structural variables (such as urban population share) explain the ranking gaps between the two data sets.

These results suggest that one should take the official Covid-19 mortality counting with some skepticism and that it should be supplemented by excess mortality data.[5] However, it should be noted that excess mortality data is also subject to limitations that may affect its quality as well. Indeed, some limitations of the official mortality statistics have been mitigated, and therefore, the results in this paper may not solely be attributed to the quality of official mortality statistics (see Whittaker et al. 2021; Helleringer and Queiroz 2021).[6] Notably,

[5] First, the infrastructure needed and capacity to register and report all deaths varies across countries. Second, there are delays in death reporting that make mortality data provisional and incomplete. The extent of the delay and counting capacity varies by country. See Aron et al. (2020) and Adam (2022).

[6] The precision of official COVID-19 mortality statistics is subject to how well-resourced the medical system is, which tends to vary across countries and is likely to improve with learning-by-doing and the mobilization of public resources to the system. Challenges to the official mortality statistics include whether COVID-19 was the cause of death. Such determination is subject to the quality of, among other, to the medical-examiner system and the coroner system. More generally, countries have different systems of issuing death certificates, that involve technocrats, elected officials, and physicians. In the case of COVID-19, the quality of autopsies matters greatly as symptoms of acute respiratory distress inflammatory responses signaling a viral infection needs to be sorted into COVID-19 induced deaths and deaths due to other reasons. See also The Economist (2022).

the growing importance of GDP/Capita and vaccination rates in explaining the cross-country variation of the cumulative excess/official Covid-19 death ratios at the end of 2021 is in line with WHO concerns about the global shortages of vaccinations, resulting in unequal worldwide vaccination rates.

This study has limitations. Firstly, to maximize the sample size, we rely on the mid-point estimates of excess deaths, whose upper and lower bounds vary with the underlying data and models (see Adam (2022) for comparisons). Secondly, our estimation focuses on contrasting Covid-19 excess and official deaths and their linear associations with several controls in a non-experimental setting. Thirdly, the types of vaccination and the variants of concern, both of which have evolved with the pandemic's path, are nuances in the relationships of variables studied. Due to current data limitations, they are currently beyond the scope of our analysis.

6. Appendix

Table 1A: Country List of Quartiles of Cumulative Official Covid-19 Mortality, December 31, 2021

1st Quartile (Lowest Cum. Mortality)	2nd Quartile	3rd Quartile	4th Quartile (Highest Cum. Mortality)
Burundi	Rwanda	Kuwait	Iran
Vanuatu	Korea	Belarus	St. Lucia
China	Senegal	El Salvador	Bolivia
Bhutan	Malawi	Iraq	Panama
New Zealand	Equatorial Guinea	Mauritius	Uruguay
Chad	Gabon	Mongolia	Grenada
Niger	Pakistan	Dominica	Bahamas, The
South Sudan	Gambia, The	Cabo Verde	France
Tanzania	Algeria	Sri Lanka	Serbia
Tajikistan	Japan	Cyprus	Portugal
Benin	Singapore	St. Vincent and the Grenadines	Ecuador
Congo, Democratic Republic of the	Syria	Fiji	Spain
Nigeria	Bangladesh	Oman	Greece
Burkina Faso	Comoros	Canada	Trinidad and Tobago
Sierra Leone	Cambodia	Bahrain	Suriname
Eritrea	Mauritania	Azerbaijan	Chile
Central African Republic	Afghanistan	Libya	Russia
Côte d'Ivoire	Venezuela	Jamaica	Tunisia
Hong Kong SAR	Djibouti	Guatemala	United Kingdom
Guinea	Zambia	Israel	Italy
Togo	Montserrat	Barbados	Mexico
Mali	Egypt	Malta	Paraguay
Nicaragua	Qatar	Malaysia	Ukraine
Taiwan Province of China	United Arab Emirates	Kazakhstan	Moldova
Madagascar	Brunei Darussalam	Turkey	Latvia
Ghana	Norway	Botswana	Belgium
Uzbekistan	Saudi Arabia	Honduras	United States
Lao P.D.R.	São Tomé and Príncipe	Swaziland	Poland
Angola	Finland	Albania	Colombia
Liberia	Lesotho	Ireland	Argentina
Ethiopia	Thailand	Antigua and Barbuda	Slovenia
Mozambique	Vietnam	Netherlands	Armenia
Papua New Guinea	Zimbabwe	Jordan	Lithuania
Congo, Republic of	Anguilla	Germany	San Marino
Yemen	India	Seychelles	Brazil
Haiti	Myanmar	Guyana	Slovak Republic
Cameroon	Dominican Republic	Lebanon	Croatia

1st Quartile (Lowest Cum. Mortality)	2nd Quartile	3rd Quartile	4th Quartile (Highest Cum. Mortality)
Uganda	Nepal	Switzerland	Romania
Sudan	Morocco	Namibia	Czech Republic
Guinea-Bissau	Kyrgyz Republic	Costa Rica	Georgia
Somalia	Philippines	Luxembourg	Macedonia, FYR
Australia	Maldives	Estonia	Montenegro, Rep. of
Timor-Leste	Indonesia	Belize	Hungary
Kenya	St. Kitts and Nevis	Sweden	Bosnia and Herzegovina
Iceland	Denmark	Austria	Bulgaria
NA	NA	South Africa	Peru

Table 2A: Country List of Quartiles of Cumulative Excess Mortality/Millions of Countries, December 31, 2021

1st Quartile (Lowest Cum. Mortality)	2nd Quartile	3rd Quartile	4th Quartile (Highest Cum. Mortality)
Palau	Ireland	Cameroon	Bangladesh
New Zealand	Cyprus	Tajikistan	United States
Australia	Antigua and Barbuda	Afghanistan	St. Lucia
Kiribati	Syria	Kenya	Iran
Marshall Islands	St. Vincent and the Grenadines	Mozambique	Suriname
Nauru	Côte d'Ivoire	Zambia	Argentina
Tonga	Finland	Morocco	Italy
Eritrea	Oman	Rwanda	Colombia
Vanuatu	Fiji	Yemen	Brazil
Samoa	Cambodia	Congo, Republic of	El Salvador
Papua New Guinea	Israel	Kuwait	Libya
Taiwan Province of China	Grenada	Gabon	Botswana
Solomon Islands	Thailand	Panama	Nepal
Seychelles	Nigeria	Mauritania	Pakistan
Iceland	Uruguay	Algeria	India
Montserrat	Tanzania	Austria	Namibia
Korea	Malta	Venezuela	Ecuador
Central African Republic	Jamaica	Belize	Turkey
Japan	United Arab Emirates	Niger	Azerbaijan
Singapore	Liberia	Netherlands	San Marino
Bhutan	Gambia, The	Chile	South Africa
St. Kitts and Nevis	Togo	Bahamas, The	Czech Republic
Barbados	Comoros	Belgium	Latvia
Anguilla	Uzbekistan	Lebanon	Hungary
Turkmenistan	Angola	Kyrgyz Republic	Moldova
Tuvalu	Madagascar	Jordan	Kazakhstan
Hong Kong SAR	Mali	Philippines	Bolivia
China	Guinea-Bissau	United Kingdom	Swaziland
Qatar	Uganda	Cabo Verde	Poland
Sierra Leone	Sweden	South Sudan	Ukraine
Equatorial Guinea	Malawi	Myanmar	Croatia
Malaysia	Haiti	Saudi Arabia	Mexico
Mongolia	Timor-Leste	Greece	Armenia
Norway	Maldives	Portugal	Albania
Mauritius	Lesotho	Nicaragua	Slovak Republic
Brunei Darussalam	Congo, Democratic Republic of the	Spain	Georgia
Benin	Lao P.D.R.	Tunisia	Montenegro, Rep. of
Micronesia	Germany	Trinidad and Tobago	Djibouti
Denmark	Costa Rica	Guatemala	Romania
Dominican Republic	Ethiopia	Chad	Sudan
Luxembourg	France	Indonesia	Peru
Dominica	Somalia	Paraguay	Iraq

Canada	Burkina Faso	Guyana	Belarus
Senegal	Burundi	Zimbabwe	Lithuania
Ghana	Sri Lanka	Slovenia	Bosnia and Herzegovina
Guinea	Bahrain	Honduras	Macedonia, FYR
São Tomé and Príncipe	Switzerland	Estonia	Russia
NA	Vietnam	Egypt	Serbia
NA	NA	NA	Bulgaria

Table 3A: Correlation Matrix of Variables in the Estimation

	Vaccinations	Population Density	Urban Population Share	Aged 65+ Population Share	GDP per capita	Rule of Law	Voice & Accountability	Government Effectiveness
Vaccinations	1.00	0.15	0.51	0.48	0.62	0.57	0.34	0.65
Population Density	0.15	1.00	0.17	0.11	0.22	0.22	0.03	0.21
Urban Population Share	0.51	0.17	1.00	0.41	0.65	0.41	0.27	0.44
Aged 65+ Population Share	0.48	0.11	0.41	1.00	0.43	0.64	0.66	0.65
GDP per capita	0.62	0.22	0.65	0.43	1.00	0.70	0.29	0.69
Rule of Law	0.57	0.22	0.41	0.64	0.70	1.00	0.69	0.93
Voice & Accountability	0.34	0.03	0.27	0.66	0.29	0.69	1.00	0.64
Government Effectiveness	0.65	0.21	0.44	0.65	0.69	0.93	0.64	1.00

	Vaccinations	**Population Density**	**Urban Population Share**	**Aged 65+ Population Share**	**GDP per capita**	**Rule of Law**	**Voice & Accountability**	**Government Effectiveness**
Vaccinations	1.00	0.15	0.51	0.48	0.62	0.57	0.34	0.65
Population Density	0.15	1.00	0.17	0.11	0.22	0.22	0.03	0.21
Urban Population Share	0.51	0.17	1.00	0.41	0.65	0.41	0.27	0.44
Aged 65+ Population Share	0.48	0.11	0.41	1.00	0.43	0.64	0.66	0.65
GDP per capita	0.62	0.22	0.65	0.43	1.00	0.70	0.29	0.69
Rule of Law	0.57	0.22	0.41	0.64	0.70	1.00	0.69	0.93
Voice & Accountability	0.34	0.03	0.27	0.66	0.29	0.69	1.00	0.64
Government Effectiveness	0.65	0.21	0.44	0.65	0.69	0.93	0.64	1.00

Note: Vaccinations is the number of Covid-19 vaccinations administered per hundred population.

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