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Mass Covid-19 Vaccination and Excess Mortality: Direct and Indirect Pathways

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Abstract

The rollout of Covid-19 vaccinations is unprecedented in pace and scope. Over seven billion doses have been administered to date so aggregate effects should have become apparent. This cross-country panel data study relates weekly estimates of excess mortality to the incidence of Covid-19 vaccinations, for the 32 OECD countries with high frequency excess mortality data available. The correlation between excess mortality and vaccination incidence is decomposed into two pathways: one from vaccination via Covid-attributed deaths to excess mortality and a non-Covid pathway that goes directly from vaccination to excess mortality, with Covid-19 deaths held constant. The non-Covid pathway from vaccination to excess mortality appears at least as large as the Covid pathway, and is the larger of the two pathways if lagged effects are captured. In results broken down by age, the effects are not apparent for the youngest age group who, until recently, were not exposed to Covid-19 vaccination.

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J11

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1

I. Introduction

The rollout of Covid-19 vaccinations is unprecedented in pace and scope. In less than 12 months, over one-half of the world's population has had at least one dose of a Covid-19 vaccine, with over seven billion doses administered to date. During October 2021, there were about 25 million new doses per day, with booster shots accounting for an average of 1.5 million of these daily doses.[1]

With such a speedy and far-reaching mass vaccination effort, one would expect to see some aggregate impacts. Yet the data do not seem to show this; in October 2021, daily Covid deaths, worldwide, averaged just over 7000, which is 18 percent higher than they had been in October 2020 before vaccines were in use. Likewise, new cases of Covid-19, worldwide, are seven percent higher than they were 12 months earlier (even more so for September). Studies are beginning to note that aggregate data do not show positive impacts of the mass vaccination effort. For example, Subramanian & Kumar (2021) find higher vaccination rates (as of early September, 2021) are not associated with lower rates of new Covid-19 cases in a cross-section of 68 countries. A panel study of 32 OECD countries compares changes from 2020 to 2021, for each month through to September 2021, and finds that vaccine rollout is unrelated to changes in Covid-19 cases, in Covid-19 deaths or in all-cause mortality (Gibson, 2021).

The result for all-cause mortality is of particular interest, and is the focus of the current study. Whether a death is *with* Covid or *by* Covid is debatable but for all-cause mortality one is clearly either dead or not. However, few countries have timely and reliable data for relating contemporaneous phenomena to all-cause mortality. In this study, I relate weekly estimates of (all-cause) excess mortality to the incidence of Covid-19 vaccinations, for the 32 countries that are in the OECD and also in the Short-term Mortality Fluctuations (STMF) database of Németh et al (2021). These developed countries have high Covid-19 vaccination rates and reliable vital statistics systems providing timely data on deaths. The panel analysis uses weekly data for 2021 through to week 39 (early October).

The correlation between excess mortality and vaccination incidence is decomposed into two pathways: one going from vaccination via Covid-attributed deaths to excess mortality and a non-Covid pathway that goes directly from vaccination to excess mortality, with Covid deaths held constant. This non-Covid pathway may include deaths from vaccine adverse events but also other deaths that exceed what would be expected for the particular week of the year in the particular country. To ensure robustness, two data sources on excess mortality—each using slightly different calculations—are used. The non-Covid pathway from vaccination to excess mortality appears to be at least as large as the Covid pathway, and is the larger of the two pathways if lagged effects are captured. In results broken down by age, the effects are not apparent for the youngest age group who, until recently, were not subject to Covid vaccination.

If mass vaccination reduces Covid-19 deaths but increases other deaths, leaving excess mortality largely unchanged, the rationale for vaccine mandates is undermined and instead it

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[1] Vaccination figures and data on Covid-19 cases and deaths are obtained from the *Our World in Data* (OWID) database (Mathieu et al, 2021).

suggests just targeting groups, like the elderly, for whom vaccination gives highest net benefit.[2] The rapidly waning protection against infection provided by these vaccines also undermines the case for vaccine mandates.[3] Ironically, mass vaccination, even if bad health policy, aids my research design by making it more plausible that correlations between vaccination incidence and excess mortality reveal effects of vaccination. If vaccines had been targeted to the elderly and other Covid-vulnerable groups, correlations between vaccination and death might just be confounding effects of omitted factors, such as frailty. Instead, vaccinating people who don't need it—coercively through mandates in some cases—mitigates bias from any selection effects that may make their way into the aggregate country-by-week data.

The findings reported here may be confronting to some readers, as widespread public relations campaigns mounted by pharmaceutical companies and governments, and sometimes co-opting seemingly independent commentators such as academics, have hammered home the message "Covid-19 vaccines save lives".[4] Yet in the pivotal Pfizer trial, 7% more people died (from all causes) in the vaccinated group than in the control group at the six month mark, after which the trial was unblinded (Doshi, 2021).[5] The results here also are consistent with adverse event analyses, such as Walach et al (2021) who compare the number-needed-to-vaccinate to prevent a death in an Israeli field study (16,000) with the four fatalities per 100,000 Covid-19 vaccinations recorded in the Dutch side-effects register (lareb.nl) and find that for every three deaths prevented by Covid-19 vaccination two are incurred through side-effects. Such studies relying on post-market safety surveillance systems are controversial, partly due to claims of lay people reporting (yet the McLachlan et al (2021) audit shows health professionals make most reports) and also because of debates about inferring causality.[6] The fact that completely different data and methods used here give similar results, albeit without the granularity of seeing which particular adverse effects contribute most to excess mortality, is notable.

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[2] Compared to Covid-19's Infection-Fatality Rate (IFR) for people age 0-34, the IFR for the 65-74 age group is 625 times higher, for 75-84 it is 2125 times higher, and for 85+ it is 7075 times higher (Levin et al, 2020).

[3] Vaccine efficacy (VE) against infection for 3.5 million clients of a large U.S. health insurer fell 10 percentage points per month for the Pfizer vaccine (for Delta variant; eight points per month for other variants), to just 53% if second dose was more than four months ago (Tartof et al, 2021). For 0.62 million U.S. veterans, given either Pfizer, Moderna, or Janssen, VE started at 91-95%; by five months it had fallen to 3% (Janssen), to 50% (Pfizer) or to 64% (Moderna) (Cohn et al, 2021). Amongst 0.23 million people in Qatar, peak VE for the Pfizer vaccine was 78% in the month following the second dose, fell to 23% by the 5th month and zero efficacy cannot be ruled out after six months (Chemaitelly et al, 2021). For 1.7 million people in Swedish nationwide registries, tracked from 12 January to 4 October 2021, peak VE against infection for the Pfizer vaccine was 92% at 2-4 weeks after the second dose, had fallen to 47% by month 4-6, with no effectiveness detected from month 7 onwards, and VE against severe outcomes (hospitalization and death) also fell rapidly; by six months after the second dose zero effectiveness against hospitalization and death cannot be ruled out (Nordström et al, 2021).

[4] For example, journalist Kate MacNamara ("The suffocating spin of NZ's vaccine taskforce" *New Zealand Herald*, 2 November, 2021) shows how the NZ government hired a PR firm to help shape messages about the vaccination program, for supposedly independent academics, who then repeated them in media commentary.

[5] Note that the pivotal trials for the main vaccines used in OECD countries (AstraZeneca, Janssen, Moderna and Pfizer) were not designed to find out whether the vaccines save lives (nor whether they prevent transmission). The primary endpoint was symptoms (even just mild ones) with laboratory-confirmed infection (Doshi, 2020).

[6] The Walach et al paper was first published by the journal *Vaccines* but then withdrawn by the publisher after editorial board members resigned in protest. The retraction was not for the usual reasons of plagiarism or data fabrication but because these board members disagreed with the conclusions. Lyons-Weiler (2021) provides details on this case, and discusses some implications for the safety monitoring of vaccines.

II. Data and Methods

Data on the incidence of Covid-19 vaccination (new doses per million population) and new Covid-19 deaths are from the *Our World in Data* (OWID) database (Mathieu et al, 2021). This updates daily from official government sources in each country. Two excess mortality estimates are used: p-scores from the World Mortality Dataset (WMD) of Karlinsky & Kobak (2021) reported in OWID, and p-scores calculated from STMF data on deaths by week. These p-scores are the percentage by which the number of (all-cause) deaths for each country in each week of 2021 differs from the expected number (based on 2015-19 data) for that week within that country. The expected number of deaths per week used by WMD (and reported in OWID) is based on a regression, while mean deaths per country-week for 2015-19 was used previously. The STMF data provide weekly counts of deaths by age group (WMD data combine all ages) so the p-score was calculated using 2015-19 weekly means by country (how WMD previously calculated it). The correlation between the p-scores from the two sources is 0.97.

Let M_{it} denote excess mortality in country i in week t, V_{it} the incidence of Covid-19 vaccination and C_{it} new deaths from Covid-19 (V_{it} and C_{it} are per million population). The 'Covid pathway' by which vaccination affects excess mortality is $V_{it} \rightarrow C_{it} \rightarrow M_{it}$. The second, direct, pathway is $V_{it} \rightarrow M_{it}$ holding C_{it} constant. Deaths from side effects, such as myocarditis, will contribute to this direct pathway as does any diversion of health system resources into a vaccination drive if that diversion reduces care available for other conditions and leads to deaths. The correlation between V_{it} and M_{it} can be decomposed into the two pathways using a normalized regression coefficient; the change in the dependent variable, in standard deviation units, associated with a one standard deviation change in the independent variable (Blalock, 1964). Using lower case to denote standardized variables, the regression equation is:

$$m_{it} = \beta_{mv} v_{it} + \beta_{mc} c_{it} + \varepsilon_{it} \qquad (1)$$

where ε_{it} is the regression disturbance. The 'Covid pathway' linking V_{it} to M_{it} is given by $r_{vc}\beta_{mc}$ where r_{vc} is the Pearson correlation between V_{it} and C_{it}. The other pathway is shown directly by the regression coefficient β_{mv}. If the regression coefficients are unbiased the decomposition is valid whatever the relationships among the variables (Bowles & Gintis, 2002).
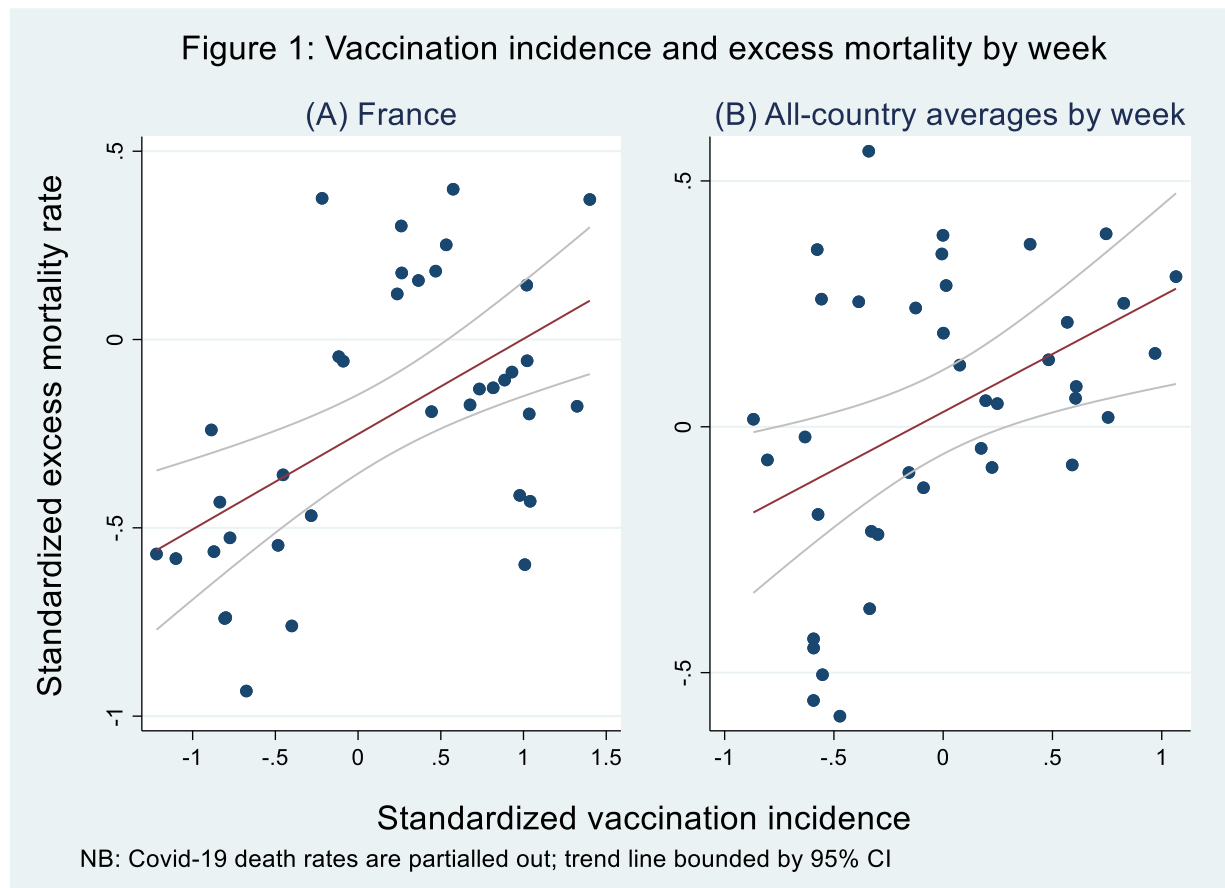
The regression in equation (1) deals with several issues that affect interpretation of data on deaths following vaccination. A typical response to analyses based on the Vaccine Adverse Event Reporting System (VAERS) and similar databases such as EudraVigilance is to mention the *post hoc ergo propter hoc* fallacy: an event (vaccination) may precede another event (death) without being the cause. Defenders of Covid-19 vaccine safety may thus note that some deaths following vaccination should be expected as people are always dying. Yet expected deaths are already accounted for in the excess mortality measure. Equation (1) also shows why a simple regression of excess mortality on vaccination incidence may be uninformative—there will be omitted variable bias. The correlation between v_{it} and c_{it} is negative (specifically, -0.21) while β_{mc} is positive because Covid-19 deaths contribute to excess mortality, so omitting c_{it} from the regression will bias the least-squares estimate of β_{mv} downwards.

Two other features of equation (1) are notable. First, effects are not required to unfold

within a week; c_{it} also reflects accumulated effects of earlier vaccinations. A common timing criteria used in the pandemic was to classify any death within 28 days of a positive PCR test as a Covid-19 death. When lags are introduced below, that same timing is adhered to here, by estimating combined effects of the current week and prior three weeks. Second, the measure of v_{it} is a flow rather than a stock; it is the number of *new* doses per million rather than the stock of all previous doses. The problem for time-series analysis with the accumulated stock measure is non-stationarity: unless another non-stationary time-series is cointegrated (and p-scores are stationary so are not) one may face spurious regression issues. One modelling approach with non-stationary time-series is to first difference the data. The incidence of new doses used here is the first difference of the any-doses stock. Also, the approach used here handles boosters; v_{it} is measured the same whether the 1st, 2nd, 3rd or n^{th} dose is administered. In contrast, analyses of vaccination rates may be affected by changing definitions of what fully-dosed means.

Results

Figure 1 shows the sort of variation the databases reveal, using scatter plots of excess mortality (from OWID) and vaccination incidence (both in standard deviation units). Points in the scatter plots are for different weeks of 2021. Panel A shows results for a single country (France is used as the exemplar) and panel B shows averages across all 32 countries by week. Weeks with a higher vaccination incidence have higher excess mortality rates; the correlation coefficients are 0.54 for France and 0.43 for the all-country averages ($p<0.001$ in both cases).

Figure 1: Vaccination incidence and excess mortality by week

(A) France   (B) All-country averages by week

Standardized excess mortality rate

Standardized vaccination incidence

NB: Covid-19 death rates are partialled out; trend line bounded by 95% CI

The Figure 1 scatter plots show 'within' variation, from differences over time around the mean for a particular country. There is also between-country variation, given the differing experiences of the 32 countries. If country-specific factors are correlated with m_{it} and v_{it}, the least squares estimator of β_{mv} will be biased. For example, a country with an aged population likely has a higher m_{it} and potentially higher v_{it} if they vaccinated faster due to their greater Covid risk for an elderly population. Country-specific intercepts ('fixed effects') are included in equation (1) to deal with this omitted variables bias. These fixed effects also deal with factors, such as variation in population growth rates, that could make the expected number of deaths in each week based on 2015-19 data a poor basis for judging a given number of deaths in 2021 as "excess". The country-specific intercepts soak up these various effects.

Figure 2 shows the two pathways from vaccination to mortality, using OWID p-scores to estimate equation (1) with country fixed effects. A one standard deviation (SD) higher incidence of vaccination is associated with one-seventh (0.14) of a SD higher excess mortality, *ceteris paribus*. Parameter uncertainty (the standard errors) is estimated with a robust sandwich estimator of the variance clustered at country level. This is because the n=1,116 data points are from repeatedly observing 32 countries, which is less informative than 1,116 independent observations (although four-fifths of the variation explained by the regression is from within-country variation); the clustered errors allow for any within-country correlations.[7] For example, the standard error for β_{mv} is 0.038 (95% CI of 0.06 to 0.22); if a robust but not clustered variance-covariance estimator is used, the standard error is just 0.020 (95% CI for β_{mv} of 0.10 to 0.18). The *** used in the figure denotes statistical significance at the $p<0.01$ level.

Figure 2: Decomposition of correlation between vaccination incidence and excess mortality
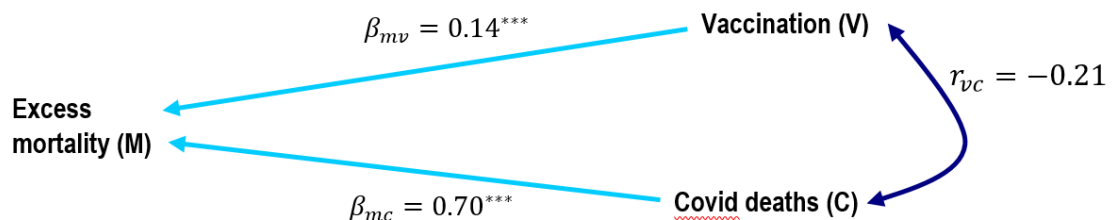
The 'Covid pathway' from vaccination to excess mortality in Figure 2 is given by $\beta_{mc} = 0.70$ (with 95% CI of 0.56 to 0.84) multiplied by $r_{vc} = -0.21$. Thus, a SD higher vaccination incidence is associated with an excess mortality rate that is 0.15 standard deviations lower ($-0.21 \times 0.70 = -0.15$) though the Covid pathway but 0.14 standard deviations higher through the direct pathway. The net effect of these two pathways is to produce, on balance, essentially no correlation between the incidence of vaccination and excess mortality, even though vaccination incidence is correlated with lower Covid-19 death rates.

Two extensions to the basic results are reported in Table 1. The total effect of lags of up to 28 days are reported, and the results with STMF p-scores that allow age-disaggregation are shown. Allowing for lags makes the direct pathway larger, a one (SD) higher incidence of

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[7] The sample size is below n=1248 (39×32) because not all countries had started their vaccination drives by the beginning of 2021, and the reporting of deaths by a few countries is not yet up to week 39 of 2021.

vaccination is associated with one-fifth of a SD higher excess mortality, *ceteris paribus*, when using WMD p-scores (and an almost identical 0.19 SD effect with the STMF all-ages p-scores). The Covid-pathway is somewhat smaller than in the unlagged results, due to the smaller effect of c_{it} on m_{it} (down from 0.70 in the unlagged results to 0.65 with lags, using WMD p-scores). Thus, allowing for lags of up to 28 days, the direct pathway linking vaccination incidence to excess mortality is about one-third larger than the indirect pathway that goes $V_{it} \rightarrow C_{it} \rightarrow M_{it}$.

Table 1: Direct and Indirect Pathways, Allowing for Lagged Effects

| | OWID | -------p-scores from STMF weekly data------- | | | |
	All ages	All ages	Ages 65+	Ages 15-64	Ages 0-14
Vaccination incidence, v_{it}	0.196***	0.186***	0.175***	0.147**	-0.015
	(0.046)	(0.060)	(0.061)	(0.060)	(0.025)
New Covid-19 deaths/million, c_{it}	0.647***	0.631***	0.590***	0.505***	-0.025
	(0.084)	(0.076)	(0.077)	(0.065)	(0.030)
R-squared (within variation)	0.500	0.472	0.438	0.264	0.005
R-squared (overall)	0.654	0.628	0.610	0.485	0.131
Direct non-Covid pathway	0.20	0.19	0.18	0.15	n.s.
Indirect $V_{it} \rightarrow C_{it} \rightarrow M_{it}$ pathway	-0.14	-0.13	-0.12	-0.11	n.s.

Note: Coefficients are the sum of current term and three lags (covering 28 days). Regression models include fixed effects for each country. Standard errors from robust variance-covariance matrix clustered at country level in ( ), ***, **, * denote statistical significance at 1%, 5%, 10% level (n.s.=not significant). Outcome variables and covariates are standardized. The indirect pathway is based on a correlation between vaccination incidence and new Covid-19 deaths per million of -0.21.

In the age-disaggregated results the direct relationship between vaccination and excess mortality is almost as large, at 0.15, for prime-age people (ages 15-64) as the 0.18 SD effect for the elderly (age 65+). The effect of Covid-19 deaths on excess mortality is smaller for the prime-age group than for the elderly (at 0.51 versus 0.59) and there are no apparent effects for excess mortality of the young, reflecting the very skewed age-risk profile of Covid-19.[8] The absence of effects on the youngest age group also reflects the fact that during the period studied (up to early October), there was no widespread rollout of Covid-19 vaccination for young people, although that situation is currently changing. The importance of the direct, non-Covid, pathway for prime-age people also counts against the idea that the correlations may just be due to vaccination of people who already had low life expectancy.

IV. Conclusions

The worldwide mass Covid-19 vaccination campaign – 'a jab in every arm' – has not provided the aggregate health benefits that might have been expected. High frequency and timely excess mortality estimates are unavailable globally but are available for 32 developed (and highly vaccinated) OECD countries studied here. For these countries there is no overall correlation between the incidence of Covid-19 vaccination and excess mortality, repeating a non-effect found when studying changes from 2020 to 2021 for the same month of the year (Gibson, 2021). If mass vaccination truly is cutting the Covid-19 death toll, as is frequently claimed, it presumably is increasing deaths elsewhere to yield this aggregate non-effect.

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[8] Note that v_{it} and c_{it} are not age-specific; age-specific excess mortality is regressed on the all-ages vaccination incidence rate and the all-ages rate of new Covid-19 deaths, as age-specific data are unavailable.

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