Relationship Between Covid-19 Vaccination and All Cause Mortality for the 60+ Cohort in New Zealand. Time Series Analysis

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Abstract

Weekly vaccination numbers in New Zealand were compared to weekly deaths (all causes) for the 60+ age group between 7 March 2021 and 31 October 2021. This period corresponded to the exclusive roll out of the Pfizer Covid-19 vaccine. There were very few cases of Covid-19 active in the community during this period and therefore the effect of the Pfizer Covid vaccination could be studied largely free of the confounding factors of Covid deaths. Time series analysis found a positive effect of vaccination on deaths (all causes) at a lag of one week ($t(33) = 1.74$, $p = 0.045$ one-tailed). Tests showed the results cannot be plausibly attributed to *spurious regression* due to nonstationarity. The analysis found that vaccination was associated with 434 additional all cause deaths during the week following vaccination among individuals aged 60+. This age cohort received a total of 2.8 million vaccine doses during the experimental period. The finding of additional deaths is roughly consistent with available reports of all cause deaths proximate to vaccination that were reported as associated with vaccination.

Background

New Zealand has a population of approximately 5 million. In 2021 starting at the very end of February the New Zealand government began to roll out a Covid vaccination programme for the whole population exclusively using the Pfizer vaccine. New Zealand was in a unique position, in as much as entry into the country was strictly controlled at the border. Active cases arriving in New Zealand were detected through testing and they were confined in managed

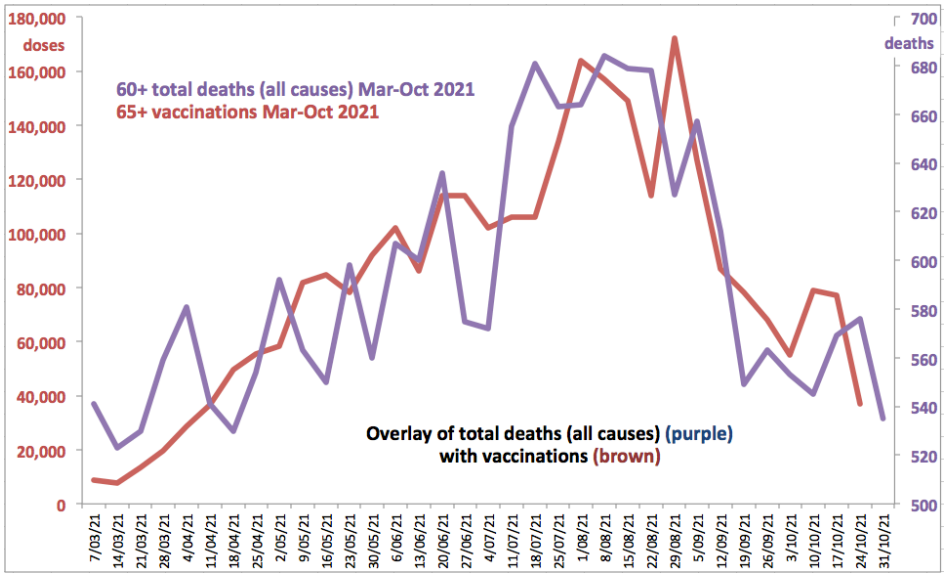
isolation. Data for vaccination and all cause mortality is recorded and published. Thus, uniquely in the world, it was possible to research the effect of Covid vaccination on deaths (all causes) in isolation from confounding factors such as Covid infection and death.

History of Covid cases during the experimental period

Active Covid cases in the community from late February to mid August 2021 were virtually zero. On 10th August, an active case of the Delta variant was detected in the Auckland population. The outbreak was controlled through extensive testing and track and tracing of contacts. Active cases were isolated. However cases rose steadily. By the end of August there were 651 active cases. By the end of September there were 272 active cases which reflected the success of the government's programme of lockdowns, tracing, and isolation. Elimination proved elusive however, and the government shifted its focus to containment, conceding that Delta had come to stay in the community. By the end of October there were 1,753 active cases. There were only three Covid deaths in New Zealand recorded during the experimental period.

Data

60+ Deaths (all causes) and 65+ Vaccinations By Week March - October 2021



Medsafe, the medicines regulatory authority, published weekly data for vaccination by age in graphical form for the period of the study. Separate vaccination information was only available for the 65+ cohort during the experimental period. Total deaths (all causes) data is published by the Department of Internal Affair (DIA) database. Separate information was only available for the 60+ cohort. Totals are by week of death ending Sunday. DIA states: *"An average of 5% of Deaths are registered 2 weeks or more after Date of Death .."* Beginning in late February older people were vaccinated by priority. It was decided to research the effect of vaccination on individuals 60+ years old as these would have been receiving vaccination throughout the experimental period. Our analysis uses vaccination totals divided by 100 to make it easier to explain the regression coefficient. The small discrepancy of 5 years between the vaccination data and the mortality data was judged to have an insignificant impact on the analysis as mortality of the 60+ cohort is fully representative of the 65+ cohort. In other words there is no structural break in mortality data between 60 and 65 years of age.

Subsequent to the initial completion of this analysis in 2021, official figures for vaccination and deaths during the study period have been revised on several occasions. It is apparent that the collection and recording of vaccination status/date data suffered from a number of defects due to delays in reporting and amalgamation of figures, as well as inaccurate record keeping. Death data has been revised a number of times due to delayed reporting. The official death figures for the period are generally published three years in arrears and therefore not currently accessible. Despite these deficiencies in the completeness of published data, it is considered that the analysis of initially published data is in the public interest.

Methods

Time series regression analysis was used to empirically investigate the relationship between weekly deaths (all causes) for individuals age 60 or older and Covid-19 vaccinations the previous week (*vacc*). Data for 36 weeks (weeks ending 7 March 2021 to 31 October 2021) were analyzed. The first weekly observation was lost due to lagging the vaccination totals by one

week, resulting in effective sample size N = 35 observations. The following regression model was estimated using ordinary least squares (OLS):

$$deaths_t = \beta_0 + \beta_1 vacc_{t-1} + \varepsilon_t, \quad t = 2, 3, 4, \ldots, 36 \qquad (1)$$

In Eq. (1) $deaths_t$ is all-cause mortality during week *t.* Weekly *deaths* have been rescaled to facilitate interpretation of its slope coefficient by dividing weekly total deaths by 100. β_0 is the regression intercept. $vacc_{t-1}$ is total vaccinations the previous week. β_1 is the slope coefficient measuring the expected change in *deaths* for a one-unit increase (100 vaccinations) in total vaccinations. The slope coefficient β_1 is hypothesized to have positive sign, indicating a positive association between weekly all-cause mortality and vaccination totals the prior week. The regression error term ε_t is assumed to be an independent and identically distributed, serially uncorrelated normal "white noise" process with mean zero and variance σ^2.

Table 1. OLS regression estimates for all-cause mortality (robust SEs and *t*-ratios)

Regression Coefficient	Coeffic. Estimate	Robust Standard Error (SE) [1]	*T*-ratio[2]	*P* value[3]
Intercept (β_0)	530.800	9.346	65.732	$p < 0.001$
Lag 1 vaccinations (β_1)	.01522	.0101	1.740	$p = 0.0455$

F-statistic: $F(1, 33) = 2.279$ ($p = 0.141$)	Mean (SD) of *deaths* = 543.029 (28.093)
Root MSE = 27.579	R^2 = .0646; Adjusted R^2 = .0363
Sum of squared residuals = 25099.579	Log-likelihood = –164.73

Diagnostics

LM test for no serial correlation[4]: Lags 1–5: $\chi^2(5) = 3.063$ ($p = 0.690$)	KPSS test for stationarity[6]: *Test statistic* = 0.0982 ($p > 0.10$)
LM test for normality[5]: $\chi^2(2) = 1.265$ ($p = 0.531$)	Test for linear functional form[7]: $F(2, 31) = 0.0230$ ($p = 0.977$)

Note: The estimation sample is week ending 7 March 2021 to 31 October 2021, effective $N = 35$. OLS = ordinary least squares. LM = Lagrange multiplier. 1. SEs robust to heteroskedasticity. 2. Robust *t*-ratios ($df = 33$). 3. One-tailed *p* value for lagged vaccinations. 4. Breusch-Godfrey test for no autocorrelation of OLS residuals (null hypothesis H_o: no autocorrelation). 5. Doornik-Hansen test for normality of OLS residuals (H_o: normality). 6. KPSS test for stationarity of regression residuals with H_o: stationarity (10% critical value 0.347). 7. Ramsey's RESET test for linearity of functional form (H_o: linearity).

Results

Results for the OLS estimation of Eq. (1) are presented in Table 1. Consistent with standard practice in applied time series regression analysis (Stock & Watson, 2007; Verbeek, 2012), Table 1 displays standard errors (SEs) and *t* statistics that remain valid in the presence of non-constant variance (heteroskedasticity) of the regression errors ε_t (White, 1980). Such heteroskedasticity violates a key OLS assumption required for valid statistical inference for the estimated regression coefficients. Because heteroskedasticity is pervasive in time series data, and because the robust SEs and *t* statistics remain valid whether or not heteroskedasticity is present, it is standard practice to routinely report robust SEs in applied research. Eq. (1) was estimated using the PcGive 14 module of Oxmetrics 8.1 (Doornik & Hendry, 2013). One diagnostic test (KPSS test) was performed in Stata 16 (StataCorp, 2019).

The results reported in Table 1 indicate a statistically significant positive association between deaths (all causes) and total vaccinations the previous week ($t(33) = 1.74$, $p = .045$ one-tailed). A one-tailed test is appropriate in view of the directional hypothesis of a positive relationship between deaths (all causes) and vaccinations the previous-week.

The estimated slope coefficient for $vacc_{t-1}$ of .01522 indicates that, on average, for each additional 100 vaccinations, all-cause deaths are expected to increase by .01522 the following week or, equivalently, 152.2 deaths per one million additional vaccinations. Thus, the estimated slope coefficient in Table 1 implies that the 2,848,890 total vaccinations during the 35 weeks of the current study was associated with 433.6 additional deaths (all causes) among individuals aged 60 and older.

In the interpretation of quantitative research results it is well known that the substantive importance, or practical significance, of empirical findings is primarily indicated by the magnitude of estimated effects as well as their effect size (ES) rather than by the level of statistical significance. With a large enough sample size, even trivially small coefficients may be found to be statistically significant. The ES for the slope coefficient β_1 is in the medium-to-small range: $f = .303$; this suggests that a larger sample might possibly result in a higher level of statistical significance. The R-squared for the estimated model is small (as shown in Table 1), indicating substantial variation in deaths (all causes) that is not "explained" by previous week vaccination totals alone. But despite the modest R-squared, Table 1 reports a statistically significant and substantively important association between deaths (all causes) and vaccinations the previous week. Substantive importance, or biomedical significance, is suggested by both the ES and the estimated increase in mortality associated with increased lagged vaccinations totals during the 35-week sample period.

The ES measure *f* is the square root of Cohen's f^2 for a regression coefficient (Cohen, 1988), where 0.59, 0.39, and 0.14 are considered large, medium, and small effects, respectively. The latter benchmarks are the square root of those given by Cohen (p. 413) for f^2 (0.35, 0.15, and 0.02, respectively). The ES f may be written as $f = t/\sqrt{df_d}$ which is the *t*-ratio for the regression coefficient divided by the square root of the degrees of freedom for the regression residuals (Darlington and Hayes (2017, pp. 226-28; Grissom & Kim, 2012, p. 322).

Diagnostics

Valid statistical inference regarding the estimated regression coefficients in Eq. (1) requires that the regression errors be stationary (Banerjee et al. 1993; Pickup 2015, p. 29). A TS is defined to be weakly stationary (covariance stationary) if its mean, variance, and autocorrelations are invariant with respect to time origin (Pickup 2015). The relevant condition is weak stationarity of the dependent variable conditional on the explanatory variables—that is, stationarity of the regression errors, not stationarity of the dependent variable itself (Pickup, 2015, p. 24).

A formal test for stationarity that is appropriate for regression residuals is the KPSS test (Davidson, 2019, p. 55; Kwiatkowski, Phillips, Schmidt, & Shin, 1992). The null hypothesis of weakly stationary regression errors was not rejected by the KPSS test (test statistic = 0.0982, $p > 0.10$, 10% critical value .347). The KPSS test was calculated using Stata 16 with the following test options: no trend, calculation of the long-run variance via the Quadradic Spectral kernel, and automatic calculation of bandwidth lags. The results of the KPSS test supports the conclusion that the regression findings in Table 1 cannot be plausibly attributed to "spurious regression" due to nonstationarity (Granger & Newbold, 1986).

Table 1 reports further diagnostic tests (calculated in PcGive 14) to assess whether the assumptions of the regression analysis are satisfied. The results of all diagnostic tests for model adequacy were satisfactory. A key OLS assumption is that the relationship between the explanatory variable and dependent variable(s) is linear. As shown in Table 1, Ramsey's RESET test (Ramsey, 1969) fails to reject the null hypothesis of linearity of functional form, indicating no neglected nonlinearity. The null hypothesis that the regression errors are drawn from a normal distribution was also not rejected (Doornik & Hansen, 2008). No extreme observations (outliers) exceeding three standard deviations of residuals were evident. Finally, the joint null hypothesis of no autocorrelation of regression errors was not rejected for lags 1–5 by the Lagrange multiplier (LM) test (Breusch, 1978); also, none of the individual lag correlations were significant at the 0.05 level.

The regression model in Table 1 was not improved by modification of the model to include up to four additional lags of the explanatory variable ("distributed lag model"); none of the additional lag coefficients approached significance. Modifying the model in Eq. (1) by also adding up to four lags of the dependent variable ("autoregressive distributed lag model") likewise did not result in model improvement; the additional lags were not statistically significant.

Discussion of causality

There is significant weekly variance in deaths (all causes) evident in the source data and prior years which is of course not explained by the effect of vaccination. Variation should be attributed to many other factors such as seasonal flu and climatic factors for example, however there was no surge in flu deaths noted during the 2021 vaccine roll out period. There may have been more alcohol induced deaths due to the prolonged lockdowns, but one would also expect fewer road deaths due to less travel. A study (Pirkis, 2021) finds less suicides than expected during early months of the pandemic in 21 countries including New Zealand. As the 2020 and 2021 lockdowns during our studied periods were very similar, one could expect similar factors to be at work causing variation.

Is the data consistent with adverse effect reporting of mortality proximate to vaccination under the system known in NZ as CARM run by Medsafe? Medsafe reports there have been a total of 75 adverse effect deaths reported in the over 60 age bracket. Medsafe (Medsafe, 2021) has investigated all these deaths, and reports that so far only 1 can be safely attributed to an adverse effect from vaccination. The balance are under investigation.

Schwab et al (2022) performed standard autopsies on 25 persons dying within 20 days of mRNA vaccination. In four patients who received an mRNA vaccination, the researchers identified acute myocarditis without detection of any other significant disease or health constellation that may have caused an unexpected death. The deaths were found to be caused by acute arrhythmia leading to cardiac failure associated with interstitial myocardial T-cell invasion. The effect was most notable on the right side of the heart, which receives blood returned from veins, which is likely to have contained elements of vaccine components.The authors concluded:

"Myocarditis can be a potentially lethal complication following mRNA-based anti-SARS-CoV-2 vaccination. Our findings may aid in adequately diagnosing unclear cases after vaccination and in establishing a timely diagnosis in vivo, thus, providing the framework for adequate monitoring and early treatment of severe clinical cases."

In summary, the prevalence of definitive causal myocarditis symptomatology was 16% among deaths within 20 days of mRNA vaccination. According to CARM data held by Medsafe, up to the end of October 2022, there were 97 deaths reported to CARM proximate to vaccination. Anecdotal reports suggest that because CARM system reporting is voluntary, adverse effects and deaths are grossly under reported. Medsafe itself estimates that only 5% of adverse effects are reported to the CARM system—a factor of 20 (Medsafe, undated). Crucially this statistic points to a great deal of unreliability in the Medsafe figures and conclusions.

Therefore an estimate of the actual total of deaths could be 1940. 16% of 3140 is 310 deaths. In contrast New Zealand Medsafe has admitted that only one death proximate to vaccination can be causally ascribed to the effects of vaccination. If the German experience is being repeated here, there could be 310 deaths from vaccine related myocarditis that have remained undetected and unacknowledged.

The 310 figure is consistent with our analysis which predicts that there have been 434 excess deaths within 21 days attributable to any adverse effects of mRNA vaccination including myocarditis.

Medsafe (2021) has summarised its own data comparing deaths in 2021 to deaths from 2008 to 2019 by cause of death category. This analysis concludes that death rates in 2021 do not differ markedly from historical data. Since the rate of deaths per 100,000 population declined by 10% between 2008 and 2019, this is not the best comparison. Moreover in 2020 the rate of deaths declined to an all time low (Kung et al., 2020) . This is believed to be caused by a positive effect of lockdown on the transmission of infectious diseases. The lockdown conditions in 2021 roughly approximated those in 2020 and therefore we can feel confident that there would be an expectation that 2021 all cause deaths would be at similar levels to 2020. Since 2021 is a year with unique social conditions, a reliable estimate of causality and significance can only be obtained from time series analysis of the 2021 data itself.

Two groups of voluntary health professionals (the NZ Health Forum and NZDSOS) have been running a system of reporting adverse effects of vaccination through websites and social media. Many individuals reporting to these groups indicate that they have previously been advised by their GP or by hospital staff that their adverse effect *must be* unrelated to vaccination. Adverse effects casually classed as unrelated in this way include cardiac arrest, internal bleeding, stroke, other thrombotic events, kidney and liver malfunction, miscarrriages, menstrual disruption, and neurological conditions. The lack of serious consideration of proximate cause by medical professionals in attendance may be due to the fact that an adverse effect data sheet originally issued by Medsafe as a guide for physicians states that there are only 21 known adverse effects of the Pfizer vaccine all of which are mild with the exception of allergic reactions, myocarditis, and pericarditis. This advice sheet has not been updated despite data collected by CARM, VAERS, and Pfizer itself indicating a much broader range range of adverse effects, many of which are serious in nature. NZDSOS have investigated the voluntary self-reports of deaths they have received. So far there have been over 670 reports of death which are suspected by those reporting to be caused or complicated by vaccination. The team has determined that 270 of these are credibly related to vaccination while 400+ cannot yet be determined. These figures are not inconsistent with our finding of 434 excess deaths.

New Zealand is in a unique position, as its 2020 and 2021 lockdowns occurred with very few reported Covid caused deaths (47 in total), only 5 occurrred during the experimental period. Consequently New Zealand all cause deaths aren't muddled or confused by Covid deaths but rather they stand alone. The sudden and concurrent rise and then fall of all cause deaths during the ramp up and tailing off of the vaccine roll out programme is visually apparent and requires an explanation. Our time series analysis shows that all cause mortality rose and fell in conjunction with rising and falling weekly vaccination numbers at a lag of one week consistently across the experimental period. The time series analysis process provides strong support for a causal link between vaccination and a significant portion of all cause 60+ deaths. The T statistic

autocorrelation and heteroskedasticity are within bounds pointing to an absence of other internal factors driving the rise in deaths such as a gradual recovery in deaths to pre-pandemic levels.

Is our estimate of 60+ deaths associated with vaccination a reasonable reflection of total deaths associated with vaccination? Thirty one percent of the death reports associated with vaccination submitted to the voluntary groups did not occur within one to two weeks of the vaccination date. As 670 deaths have been reported to the voluntary groups, we can estimate that deaths immediately proximate to vaccination might be of the order of 462. This figure is not inconsistent with our analysis. Our analysis looked at 60+ deaths. Reports of deaths to both Medsafe and the voluntary groups included deaths in all age ranges. This would mean that our headline figure is an underestimate. Deaths occuring later than one of two weeks after vaccination, but suspected of being related to vaccination, were reported to both Medsafe and the voluntary groups. Our analysis does not disprove any hypothesis that there are other excess deaths caused by vaccination at the weeks more distant from the inoculation date, nor does it shed light on their extent. These would not have been identified by time series anlaysis at a lag of one week and the numbers involved are too low to register as significant at other lags. However their reported existence also implies that our estimate of deaths associated with vaccination is a conservative under estimate. By the time the final ‘deaths (all causes)’ figures appear in print after two years there are small increases in total deaths which have been collated and added. These might also be expected to increase our estimate.

By the end of October 2021, 8.33 billion doses of Covid vaccines had been given worldwide. If it were possible to scale up our results across all types of vaccine and countries, more than 1.3 million deaths might have resulted from Covid vaccination. Current official figures place total deaths from Covid-19 itself at 5.8 million worldwide. The authors suggest there is enough reason presented here to commence further studies of Covid-19 vaccine safety and assess its impact on all cause mortality in different country settings.

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