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Abstract

We investigate the effect of interpersonal and institutional trust on COVID-19 vaccination hesitancy. We ask whether interpersonal and institutional trust predict COVID-19 vaccination delay and refusal. We use an unprecedently rich and representative dataset of over 22,000 New Zealand respondents, sourced from the 2014, 2016, and 2018 General Social Survey. Respondents reported their trust in seven domains: Parliament, police, health, education, courts, media, and the general public. Their survey responses are linked to respondents' later records of COVID-19 vaccinations and their socio-demographic characteristics, as collected in the 2018 census. We find that all measured trust domains exhibit a significant and negative correlation with vaccine hesitancy. As trust increases, vaccination hesitancy decreases and so does the time it takes people to vaccinate. The correlation is strongest for trust in police and interpersonal trust, and weakest for trust in media. By understanding how trust informs vaccination decision-making, we can better prepare for future pandemics and improve public health vaccination campaigns more generally.

JEL-Codes: I120, I180.

Keywords: Covid-19, vaccination, trust, general social survey, GSS.

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Disclaimer: The results in this paper are not official statistics. They have been created for research purposes from the Integrated Data Infrastructure (IDI) and Longitudinal Business Database (LBD), which is managed by Stats NZ. Access to the data was provided by Statistics NZ under conditions designed to give effect to the security and confidentiality provisions of the Data and Statistics Act 2022. Only people authorised by the Statistics Act 1975 are allowed to see data about a particular person, household, business, or organisation, and the results in this paper have been confidentialised to protect these groups from identification and to keep their data safe. The results are based in part on tax data supplied by Inland Revenue to Stats NZ under the Tax Administration Act 1994 for statistical purposes. Any discussion of data limitations or weaknesses is in the context of using the IDI for statistical purposes and is not related to the data's ability to support Inland Revenue's core operational requirements. The opinions, results, recommendations, and conclusions presented in this study are those of the authors, not Statistics NZ.

Competing Interests Declaration: No funding was received for conducting this study; the authors declare no competing or conflicting interests.

1. Introduction

Vaccines have long emerged as an essential and cost-effective public health intervention, playing a pivotal role in safeguarding populations from infectious diseases. Their swift development and deployment against the SARS-CoV-2 virus in late 2020 helped to contain the spread and severity of the COVID-19 pandemic, preventing an estimated 3.2 million additional deaths, 18.5 million additional hospitalisations, and US $1.15 trillion in medical costs in the United States alone (Fitzpatrick, Moghadas, Pandey, & Galvani, 2022). Despite extensive research confirming the safety and efficacy of the COVID-19 vaccinations, vaccine hesitancy remains a significant barrier to achieving sufficient coverage rates and protecting the public's health (Dubé & MacDonald, 2022). Many high-income countries face ongoing vaccine refusal, with 22% of Germans, 19% of Americans, and 15% of Australians having not received a vaccination against COVID-19 (Ritchie et al., 2023). Globally, most countries have not achieved the recommended coverage rate for the initial vaccination protocol (Mathieu et al., 2023) – a coverage rate that can significantly affected the aggregate spread of the disease and is thus important for population health.

As a reminder, for the benefit of future readers, in March 2020 the World Health Organization declared a pandemic in response to the spread of a highly infectious novel coronavirus (SARS-CoV-2) which was first identified in the Chinese city of Wuhan in December 2019. Vaccination development began very quickly, and the first vaccine was authorised for emergency use in the United Kingdom on December 11th 2020 (Ledford, Cyranoski, & Van Noorden, 2020). In Aotearoa New Zealand, the Pfizer-BioNTech vaccine first arrived in February 2021, with the vaccination rollout initially prioritising border workers, frontline healthcare workers, older adults, and those with underlying health conditions (New Zealand Government, 2021; Prickett, Habibi, & Carr, 2021; Steyn et al., 2022). In August 2021, once enough doses were purchased and have arrived, the vaccine was made available to everyone over 18, and within three months, 75% of the eligible population was fully vaccinated (Ministry of Health, 2021). By October 2023, 90.1% of the population was fully vaccinated (Te Whatu Ora, 2023).

Despite the likely importance of trust in determining vaccination acceptance, little empirical research has been undertaken to disentangle the underlying relationship between trust and COVID-19 vaccination decision-making. We hypothesize that trust played a pivotal role in mediating this acceptance of the COVID-19 vaccine.

Achieving a high vaccination coverage likely requires public trust in the safety and efficacy of a vaccine (Dror et al., 2020). Understanding how trust, and what types of trust, mediate vaccination acceptance is therefore essential in addressing vaccine hesitancy. Our research uses a rich and representative dataset from Aotearoa New Zealand (henceforth NZ) of over 22,000 respondents from the General Social Survey (GSS) to determine whether interpersonal and institutional trust are associated with vaccination delay and refusal. Our survey data record self-reported trust in 7 domains: including the police, education system, media, courts, health system, Parliament, and trust in the general public. These trust data were collected in three biennial waves of the GSS between 2014 and 2018; they thus pre-date the vaccination decision, and indeed the COVID-19 pandemic. Each observation from the GSS is then linked to the COVID-19 vaccination records of that individual, as well as to their demographic and socio-economic characteristics obtained from other administrative datasets (including the 2018 census and their tax records).

To determine the effect of trust on vaccination hesitancy, we estimate linear regressions of interpersonal and institutional trust against vaccination status (whether or not the individual was vaccinated by a cut-off date) and their vaccination date. We show that all measured trust domains have a significant, negative correlation with vaccine hesitancy. We further analyse the relative importance of each trust domain in this association with vaccine hesitancy (both refusal and delay), and how sensitive is this association to the inclusion of other demographic and socio-economic covariates

Our trust data was collected between 2014 and 2018, and the vaccination decisions were taken in 2021-2022. This is both a limitation and an advantage of our analysis. On the one hand, our analysis assumes that trust remains consistent over time, at least partially, so that trust measured in 2014-2018 is proximate enough to the level of trust people held in 2020-2022 when they were making their vaccination decisions. On the other hand, this temporal distance is also an advantage, as our measure of trust is not contaminated by people's experience during the pandemic and the myriad ways the global turmoil of 2020-21 including lockdowns, the historically unprecedented government interventions, and the spread of various associated conspiracies, may have impacted their trust levels. Ultimately, this paper aims to improve our understanding of the links between trust and vaccination decision-making, so that we may better prepared for future vaccine hesitancy for other vaccine-preventable diseases.

Below, in Section 2, we summarise the relevant literature, and in Section 3 we describe our dataset. In Sections 4-5, we present our methodology and reports the results from our regression analyses. Finally, we discuss our findings, reflect on their contributions to the literature, and detail some caveats that are pertinent to our analysis.

2. Literature Review

Between 2010 and 2015, it was estimated that vaccines prevented at least 10 million deaths worldwide (WHO, 2020). Despite the crucial role of vaccines in reducing the spread and severity of diseases, vaccine hesitancy remains a key challenge. *Vaccine hesitancy* is defined as the "delay in acceptance or refusal of vaccination despite [the] availability of vaccine services" (MacDonald, 2015, p. 4161). Several factors inform this hesitancy, including demographic characteristics, perceptions of personal responsibility and risk, and the perceived safety and efficacy of each vaccine (Truong, et al., 2022). Even relatively small numbers of vaccine-hesitant people may lead to significant adverse consequences. Research on measles vaccination in the United States, for example, found that a 5% decline in vaccination coverage would triple annual measles cases and result in significant additional mortality and public health costs (Lo & Hotez, 2017).

Vaccines are a very cost-effective health intervention. It was estimated that between 1991-2002, the meningococcal vaccine saved the United States government US$1.4 billion in direct and indirect costs (Ortega Sanchez et al., 2008). Systematic reviews of the cost-effectiveness of vaccinations against COVID-19 confirmed the significant positive economic and health benefits of this intervention (Zhou et al., 2022) (Utami et al., 2022). As such, there is clear economic impetus to understand and address the persistent challenge of vaccine hesitancy.

Trust has been seen as playing a critical role in vaccination decision-making, yet relatively little empirical research has been undertaken to disentangle the underlying relationship between trust and COVID-19 vaccination acceptance (or of other vaccines). Trust is still a contested and ill-defined concept (Levi & Stoker, 2000). A common definition of trust is "a relationship…in which one party accepts a vulnerable position, assuming the best interests and competence of the other, in exchange for a reduction in decision complexity" (Larson et al., 2018, p. 1599). This relationship can exist between two individuals, including between an individual and their social networks (interpersonal trust) and between individuals and

institutions (institutional trust). These institutions can include government agencies, regulatory bodies, and public health institutions (Bornstein & Tomkins, 2015).

The power imbalances and high levels of information asymmetry inherent in health care require patients to hold a high level of trust in the competence of providers and the belief that they will act in their best interest (Cummings, 2014). Both interpersonal and institutional trust are thus vital in influencing whether an individual will adopt a specific health-related behaviour (Calnan & Rowe, 2007).

Larson et al. (2018) identify three trust domains that may influence vaccination acceptance: trust in the safety and efficacy of the vaccines, trust in the individuals who give advice or administer them, and trust in the health system more generally. Put simply, vaccine acceptance requires "trust in the product, provider, and policy maker" (Larson et al., 2018, p. 1601).

There is also emerging evidence that trust in the general public informs vaccination decision-making. A desire to protect one's community is a common motivation to vaccinate, and trust is a crucial determinant of how close one feels to one's community (Heckscher, 2015; Thaker & Menon, 2020). An individual's willingness to observe pro-social health behaviours such as mask-wearing, social distancing, and frequent hand-washing is strongly associated with interpersonal trust (Chuang, et al., 2015; Pagliaro et al., 2021). Latkin (2021) reports that individuals who adhere to these pro-social preventative behaviours express greater trust in the vaccine. The belief that most people are trustworthy is thus relevant to the decision to adhere to health recommendations (Simpson, 2007). Although there is little research into the precise relationship between interpersonal trust and vaccination decision-making, there is robust evidence that individuals are more likely to respect social rules and norms when they trust that others will respect them as well (Lahno, 2004; Scholly, Katz, Gascoigne, & Holck, 2005).

2.1 Measuring Trust

Trust has historically been loosely measured (Larson et al., 2018). A systematic review of trust in vaccines reported that only two quantitative papers (out of 35) used a validated measure of trust (Larson et al., 2018). To standardise trust data around the world, the OECD released guidelines for measuring trust, which describe a well-defined methodological

approach to collecting, describing, and analysing trust data (OECD, 2017b). Following these OCED guidelines, the New Zealand General Social Survey (GSS) uses an eleven-point scale to measure trust with appropriate wording and response format, to ensure the validity of the data collected.[1]

2.2 Institutional and Inter-personal Trust and COVID-19 Vaccination Hesitancy

Extensive international surveys during the course of the pandemic demonstrated a strong, positive correlation between trust in institutions such as the government and national healthcare systems, and an expressed willingness to accept a COVID-19 vaccine (Roy et al., 2022) (Lazarus et al., 2020) (Al-Mohaithef and Padhi, 2020) (Grüner & Krüger, 2021; Lazarus et al., 2020) (Palamenghi et al., 2020) (Wismans et al., 2021) (Troiano & Nardi, 2021) (Allington et al., 2023). A systematic review of COVID-19 vaccine hesitancy across Africa reported a lack of trust in pharmaceutical companies as a key reason for refusing to vaccinate (Ackah et al., 2022). Latkin et al. (2021) documented how widespread mistrust of the pharmaceutical industry in the United States likely contributed to higher levels of mistrust in their ability to distribute safe and effective COVID-19 vaccines. A lack of trust in vaccine manufacturers is especially prevalent in marginalised communities, which have "a deep and justified lack of trust" in clinical research and the healthcare system more broadly (Warren et al., 2020, p. 121).

Although institutional trust is essential in any vaccination program, its importance was heightened during the COVID-19 pandemic. First, institutional trust typically erodes during crises, as vulnerabilities and shortcomings within institutions are exposed (Ervasti, Kouvo, & Venetoklis, 2019; Lee et al., 2020). Second, the exceptionally rapid development and deployment of the vaccine raised doubts whether pharmaceutical companies and regulatory bodies were sufficiently cautious during the rushed approval process (Dror et al., 2020; Kafadar et al., 2022).

Interpersonal trust, in contrast, is not as well understood or studied in the context of health decision-making. Most research focuses on trust in primary care doctors (General Practitioners - GPs) who typically act as trusted messengers in disseminating information and

[1] Despite variation in the collection of trust data, a meta-analysis of experimental studies found a significant positive correlation between self-reported generalised trust and trusting behaviour in empirical settings (Johnson & Mislin, 2011).

boosting trust in any treatment. For example, a cross-sectional survey of American adults found that respondents expressed a higher willingness to accept a COVID-19 vaccination if they thought it would be recommended by their family doctor (Head et al., 2020; Reiter et al., 2020; (Szilagyi et al., 2021)). A Swedish study reported that community trust was more significantly correlated with vaccination behaviour than generalised or institutional trust (Mankell & Abdelzadeh, 2023). Similarly, Jang (2022) reported that individuals with higher interpersonal trust were less likely to report vaccine hesitancy. In contrast, a study of 8,000 American adults found no relationship between stated vaccination intention and general trust or trust in friends, family, and other acquaintances (Szilagyi et al., 2021).

2.3 Factors Affecting Trust and Vaccination Hesitancy

Though interpersonal and institutional trust correlate with individual characteristics, they are also informed by community characteristics and cultural networks/norms (Alesina & La Ferrara, 2002). The precise effect of individual characteristics, such as age, income, and education, remains controversial, though most studies report that age, income, and education all positively correlate with trust, and with vaccine acceptance (Allington et al., 2023; Williams et al., 2022) (Falcone et al., 2022; Jafar et al., 2022).

Women consistently report lower institutional and interpersonal trust than men (Latkin et al., 2021; Williams et al., 2022) (Wang et al., 2021). Being a part of a marginalised community also is associated with lower trust (Alesina & La Ferrara, 2002; Allington et al., 2023). Similarly, individuals who have recently experienced a traumatic event are significantly less trusting (Alesina & La Ferrara, 2000). In the United States, being black or Hispanic strongly correlates with reduced trust in the COVID-19 vaccine and the institutions that promote and provide it (Bogart et al., 2021; Latkin et al., 2021; Warren et al., 2020). Historic neglect or systemic abuse are core reasons for distrust in health systems from marginalised communities (Artuso et al., 2013; Stoler et al., 2021).

NZ is no different. Its health system and other institutions have been associated with historic and ongoing discrimination and marginalisation, disproportionally affecting Māori and Pacific communities (Harris et al., 2006a; Marriott & Sim, 2015). The resulting lack of trust in these institutions likely helps explain lower vaccination rates for these groups (Crengle et al., 2012; Harris et al., 2006b; Megget, 2022; Te Whatu Ora, 2023).

2.4. Our Contribution to the Literature

Given the importance of vaccines, it is critical to understand how trust affects vaccination hesitancy in more detail, in more contexts, and with more reliable data. Our contributions to this literature can be viewed in several dimensions: (1) Unlike almost the whole literature, we study actual vaccination behaviour rather than stated vaccination intention. Intention is usually used in the absence of data on actual vaccination behaviour, and is an imperfect proxy for it. (2) Additionally, we have data on the exact date of the vaccination. As we analyse actual vaccination decisions, we separate vaccination hesitancy into refusal to vaccinate, and delay in getting vaccinated, and analyse both. (3) Our measures of trust, from the General Social Survey (GSS) use a reliable and widely accepted tool to measure trust, collected for a large representative sample of the NZ population. (4) By matching the GSS sample to other administrative records collected by the NZ government, we can include a comprehensive set of demographic control variables, allowing us to control for more variables than is typical. This thus alleviates much of the 'missing variable bias' that possibly plagues this literature. (5) The GSS collects data on general trust and trust in six different institutions including the police, the education system, the media, the courts, Parliament, and the health system. Having an extensive set of trust measures is unusual, and allows us to compare different trust domains. (6) Our trust data is collected pre-pandemic. It is thus unaffected by the shock of the pandemic and the global turmoil associated with the lockdowns that started in March 2020, and continued with other aggressive interventions in the following months and years.

3. Data

3.1 Sample Construction

Our dataset is a combination of the GSS survey and administrative data from Stats NZ Integrated Data Infrastructure (IDI). The trust data is drawn from three biennial waves of the GSS from 2014, 2016, and 2018. The GSS is a repeated, cross-sectional survey providing representative data on the general well-being of New Zealanders (GSS, 2016). Altogether, the three waves of the GSS contain 26,037 observations, with each observation constituting a distinct individual.

Respondents are asked to rate their trust in the general public and in six institutions, which we use as measures of subjective interpersonal and institutional trust. We will refer to these

seven trust areas as “trust domains”. Respondents could select ‘Don’t know’ or ‘Refuse to answer’ for any question in the survey. Respondents were removed if their ethnicity, age, or gender is unknown or if they were younger than 18 on October 10th 2021. With these restrictions, our sample size is 23,539.

To determine vaccination status, we used the Health Service User Database (HSU). The HSU records whether an individual is fully vaccinated, partially vaccinated, or unvaccinated against COVID-19. Individuals who were designated ineligible for vaccination were removed from our sample. We selected a ‘cut-off’ date of October 10th 2021. This date was selected for two reasons. First, it is five weeks after the vaccine was made available to all people in New Zealand over 18 years old, allowing for sufficient time to seek vaccination. Second, vaccine mandates had yet to be announced. As such, vaccination behaviour in this period would reflect genuine vaccine acceptance. People who received at least one vaccination on or before this cut-off date were designated as vaccinated in our data, with the remaining designated as unvaccinated. Of our sample population from the GSS, 92% could be linked with the HSU data.

If a person is vaccinated, we use the COVID-19 Immunisation Register (CIR) to determine the date of each vaccination event. The CIR records the date of the first and second vaccination events, allowing us to analyse how trust might also affect vaccination delay. To account for administrative error in these data, a vaccination event date is switched to NA if; a recorded vaccination event occurred before February 15th 2021 (as COVID-19 vaccinations were unavailable in New Zealand before this date), a vaccination event occurred after June 28th 2023 (after this dataset was finalised), or if the first and second vaccination events share the same date. Given these restrictions, 84% of respondents could be linked to CIR data. 95% of individuals who could not be linked to CIR data were unvaccinated (and thus had no vaccination events in the CIR).

For each person, we source demographic characteristics such as age, sex, and ethnicity from the GSS. These are supplemented by additional social and neighbourhood characteristics sourced from the 2018 Census. We also link our observations to tax records to obtain pre-tax incomes in 2019, and any beneficiary income earned from government support in 2019. A Sample Construction Diagram can be found in Figure A1, while additional details on each data source are available in the following sub-sections and in Table A1, both included in the supplemental materials.

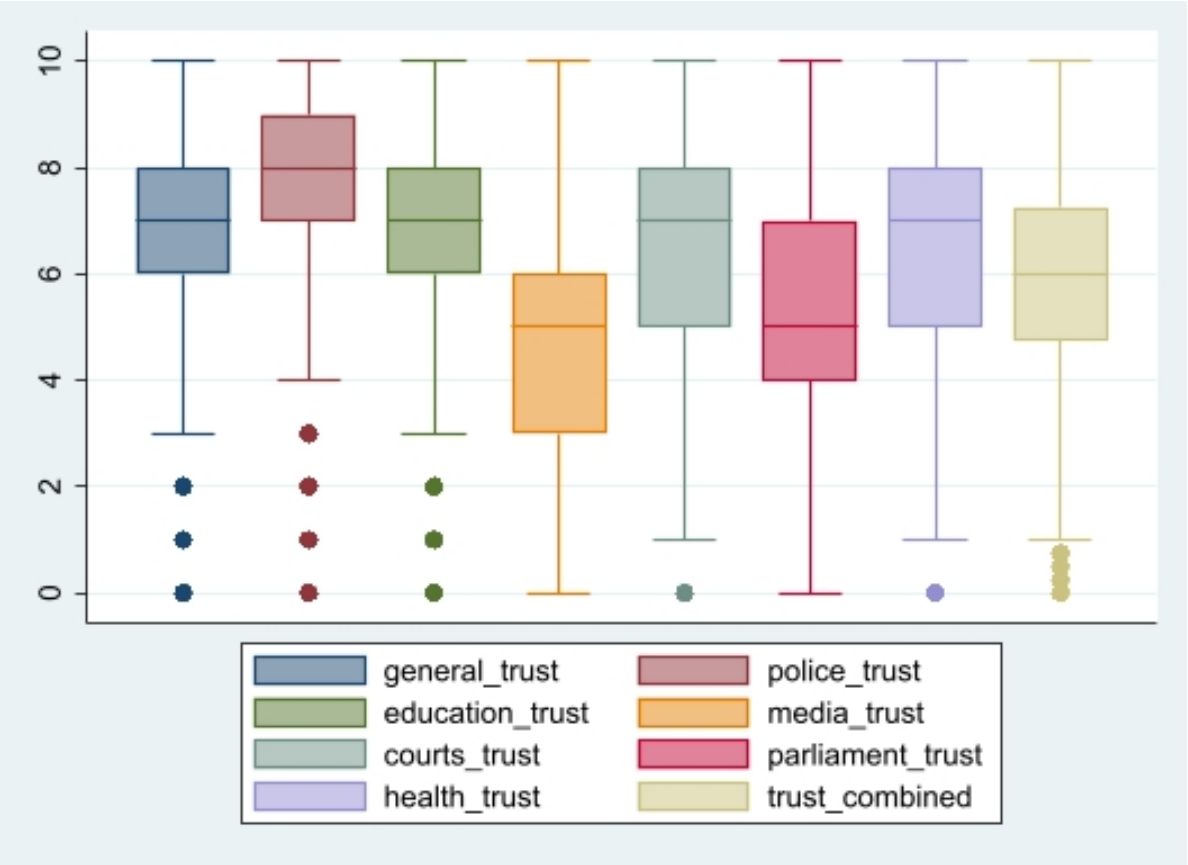
3.2 Subjective Trust Data

Our measure of interpersonal trust comes from the following question in the GSS: *"And now a general question about trust. (0 = means you do not trust an institution at all, 10 = you have complete trust)...on a scale of zero to ten, in general, how much do you trust most people in New Zealand?"* Similarly, our measures of institutional trust come from another GSS question: "*Even if you have had very little or no contact with these institutions, please base your answer on your general impressions of these institutions…on a scale of zero to ten, how much do you trust: - The police? - The education system? - The media? - The courts? - Parliament? - The health system?"*

Both questions remain consistent throughout the three survey waves, and align with the OECD's best-practise guidelines (OECD, 2017a). To streamline the number of trust domains considered in our regression analysis, we constructed a 'composite trust' variable by aggregating trust in the education system, media, Parliament, and courts. These four trust domains were selected based on their high collinearity. Introducing this 'composite trust' variable enables us to reduce the number of variables under examination while retaining pertinent data.

Figure 1 displays the distribution of interpersonal and institutional trust within our sample. Evidently, there is substantial heterogeneity in self-reported trust across the seven domains, with trust in the police attaining the highest average rating of 7.7. In contrast, trust in the media and parliament registers the lowest average score at 4.7 and 5.3 respectively. Despite heterogeneity across the trust domains, trust levels for each domain remain stable across the three survey periods, with low variation in both mean and standard deviation (see supplemental information). As the mean and standard deviation of each trust domain varies, we have transformed the trust values using z-score normalisation so that each domain has a mean of zero and a standard deviation of one.

Figure 1. Distribution of trust by domain



Note: The figure displays the median and interquartile ranges for each trust domain, for our complete sample.

3.3 Vaccination Status

As noted above, we determine a person's "vaccination status" by whether they have received at least one COVID-19 vaccination by October 10th 2021. To be included in the HSU dataset, an individual has to be enrolled with a Primary Health Organization (PHO) or have received public health services between January 1st 2020 and November 1st 2021. Unfortunately, this dataset does not capture the entire NZ population as it excludes people who have not engaged with health services at all during this period. As such, individuals in the HSU are more likely to be vaccinated than the general population (as anyone not included is necessarily un-vaccinated). Migrant departures are also not accounted for, meaning some people may be recorded as 'unvaccinated' but have left NZ instead; though there was little emigration and immigration since March 2020, when borders shut down because of the pandemic. Although NZ's vaccination rollout still faced accessibility inequities (discussed below), it was considered relatively comprehensive by international comparison (Mathieu et al., 2023). The selected date of 10th October 2021 is five weeks after the vaccine was made available to all

New Zealanders. Those five weeks were following several months in which vaccination was made progressively more available to an increasing number of people. By the beginning of September, the vaccinations were very readily available to everyone, with no notable scheduling delays. We therefore assume that five weeks is sufficient for people to access a vaccination centre if they want to, even accounting for potential geographic, language, and other barriers to access. By controlling for variables such as ethnicity, region, and income, we can further ensure that vaccination status on the cut-off date reflects an intentional refusal to vaccinate, rather than a lack of vaccine access.

This cut-off date was also selected because, at this time, there were still no vaccination mandates in place for the general public. The New Zealand government announced vaccination mandates in late October, and these began to be enforced in early November (Trevett, 2021). These required workers in some sectors (principally education and health) to become vaccinated or risk losing their jobs. Individuals who voluntarily pursue vaccination, and those who reluctantly accept it to remain employed, were possibly making their decisions for very different reasons. The coercion inherent in the November employment mandates may have dulled the effect of institutional and interpersonal trust on the vaccination decision. As we are interested in intentional vaccination decision-making, mandates are a confounding factor we want to avoid when trying to understand vaccination refusal.

For our sample, vaccination rates on October 10th 2021, were higher (85%) than that of the entire population (80%), as reported by Webster (2021). This difference is likely explained by the demographic characteristics of the GSS survey, whose respondents are slightly more likely to be European/Pākehā, older, and more educated, all of which increase the likelihood of being vaccinated. Similarly, the HSU dataset only includes individuals who have recently accessed health services and may have excluded the most marginalised members of the community. Finally, the official Ministry of Health statistics include all eligible individuals over 12, whilst our dataset only includes eligible people 18 and over.

We use the vaccination date to indicate vaccination hesitancy. The data also includes vaccination events that occurred overseas; though only if the individual thus vaccinated reported it to the Ministry of Health. Given New Zealand's unprecedently strict closed border policy during this period, we expect the vaccination information recorded in our dataset to be sufficiently similar to the actual vaccination behaviour of our GSS sample, and to the general population more broadly.

3.4 Additional Data

To minimise omitted-variable bias, myriad demographic and neighbourhood characteristics were included in our analysis. Most of these were sourced from the GSS, including age, gender, and reported health status. Age was calculated on October 10th 2021. These data were supplemented by 2018 Census data, which provided information on educational attainment, migrant status, and the neighbourhood's deprivation decile. For annual earnings in 2019, from all sources, we use data from the Linked Employer-Employee Database, which is based on monthly tax reports that employers submit to the Inland Revenue Department.

Table 1 reports summary statistics, while a description of each variable can be found in the supplementary materials. Most of our sample were employed when taking this survey, and the majority voted in the last general election.

Table 1. Descriptive statistics of covariates

Variable	Mean	S.D	Count
Demographics			
Female dummy	0.55		24,000
Age	53.17	18.04	24,000
Total Wages (2019)	48,390	44,178	21,000
Total Earnings (2019)	37,446	46,359	21,000
Total Benefits (2019)	1512	4638	21,000
Employed Dummy	0.95		24,000
Highest Educational Qualification			
Missing qualification info	0.03		24,000
No qualification	0.18		24,000
School qualification	0.3		24,000
Postschool qualification	0.26		24,000
Undergraduate qualification	0.13		24,000
Postgraduate qualification	0.01		24,000
Ethnicity			
European/Pākehā	0.71		24,000
Māori	0.13		24,000
Pacific Peoples	0.05		24,000
Asian	0.09		24,000
MELAA & Other Ethnicity	0.02		24,000
Other Individual Characteristics			
Life satisfaction (higher=more satisfied)	7.70	1.80	23,000
Health status (1=poor, 5=excellent)	3.54	1.01	24,000
Born in NZ Dummy	0.74		23,000
Recent migrant Dummy	0.03		23,000
Medium/Long Term Migrant Dummy	0.22		23,000
Social Characteristics			

Deprivation index (higher = more deprived)	5.58	2.88	23,000
Fear of crime (higher = large effect)	3.22	3.01	23,000
Comfortable/very comfortable being yourself	0.85		23,000
Discriminated against dummy	0.18		23,000

Note: The table above includes all the variables that were included in the regression specifications described below. To adhere to confidentiality requirements enforced by Stats NZ, all counts are randomly rounded to base 1000. Additional variables that we examined, but did not include in the final specifications, as they proved irrelevant, are listed in the appendix

4. Regression Methodology

We hypothesised that individuals with lower institutional and interpersonal trust are more likely to refuse or delay the COVID-19 vaccination. To interrogate this hypothesis, we estimate the following specification:

$$Vac\_Status_i = \alpha + \beta trust\_domain_i + \delta covariates_i + \varepsilon_i \quad (1)$$

For vaccination refusal, $Vac\_Status_i = 1$ if individual *i,* had been vaccinated by October 10th 2021; and 0 otherwise. Although this is a binary outcome, we used a standard linear probability regression for ease of interpretation and to align with the international research. To validate this approach, we also ran logit regression models, with the results reported in the supplemental materials. Our linear regression estimates and standard errors were sufficiently similar to the results we obtained in the logit regression, suggesting that the linear specification remains appropriate.

For vaccination delay, we ran linear regression models on the first and second vaccination event. In this case, Vac_Status_i is assigned a numeric value corresponding with the day of the vaccination event. For example, if an individual receives a vaccination on the 1st May 2021, Vaccination Status is assigned '121'. If an individual receives on the 23rd February 2022, Vaccination Status is assigned '419'. The longer an individual delays receiving the vaccine, the higher this value. $trust\_domain_i$ records the normalised, self-reported trust level for each domain for any individual *i,* and $covariates_i$ are a vector of individual-level controls. Each trust domain is independently regressed in a separate specification.

To determine which covariates to include, we ran test regressions of vaccination delay and refusal on our complete set of controls without any trust variables. Table A4 in the online supplement lists all the covariates we regress and a precise definition of each variable. By

including these control variables in our regressions, we can isolate the independent correlation of the trust measures on vaccination decision-making.

5. Baseline Results

As we are interested in vaccination hesitancy, which encompasses both vaccination refusal and vaccination delay, we report on both of these respective results. Table 2 reports the results of our vaccination acceptance regressions. Column one displays each trust domain's coefficient estimate and the estimated standard errors in a single bi-variate regression with no additional controls, and with only that measure of trust included. Column two includes the same trust variable and our complete set of individual-level controls. Each coefficient represents the change in the likelihood of being vaccinated by October 10th 2021. The trust variables are normalised so that each coefficient is associated with a one standard deviation increase in trust in each domain. A positive coefficient estimate indicates that trust increases the likelihood of being vaccinated against COVID-19. The distribution of trust in each domain, by vaccination status, can be found in Appendix Figure A2.

Table 2: Vaccination status and trust

Variables	(1)	(2)
Interpersonal trust	0.055*** (0.003)	0.026*** (0.003)
Police trust	0.062*** (0.003)	0.040*** (0.003)
Education trust	0.044*** (0.003)	0.034*** (0.003)
Media trust	0.044*** (0.003)	0.034*** (0.003)
Courts trust	0.053*** (0.003)	0.037*** (0.003)
Health trust	0.037*** (0.003)	0.031*** (0.003)
Parliament trust	0.049*** (0.003)	0.039*** (0.003)
Composite trust variable	0.058*** (0.003)	0.046*** (0.003)
Individual-level controls	No	Yes
# of observations	23,000	20,000

Note: Each trust domain is independently regressed against vaccination acceptance. Column 2 includes our complete set of covariates (as described in Table A1). To comply with Statistics NZ confidentiality requirements, the number of observations is rounded to base 3. Standard errors are robust. Significance levels are indicated as follows: *p<0.10, **p<0.05, ***p<0.001.

The results reported in Table 2 reveal statistically significant and positive coefficient estimates for all trust domains, and these are robust to the addition of controls (column 2). Once covariates are included, trust in the public recorded a coefficient of 0.026, suggesting that a one standard deviation increase in interpersonal trust, increases the likelihood of being vaccinated against COVID-19 by 2.6% (it is 5.5% if no additional controls are included).

Notably, the largest coefficient estimate is for trust in the police (0.040), and the smallest is for trust in the courts (0.031), but all are not too dissimilar, and all are clearly statistically significant at p<0.001. All of the coefficient estimates are somewhat larger when no covariates are included (column 1), but the general pattern is still observed. The composite trust variable is also statistically significant and shows that a one standard deviation increase in this aggregate trust measure is associated with a 4.6% increase in the likelihood of being vaccinated.

We next report the results of our vaccination delay regressions, for the first and second vaccination doses (Table 3). As in Table 2, the first column includes the bi-variate results, while the second column includes the final full set of control variables. The coefficient signifies the number of days that an individual will delay their vaccination event for a standard deviation increase in the respective trust measure. As before, the results appear very robust to the inclusion of controls.

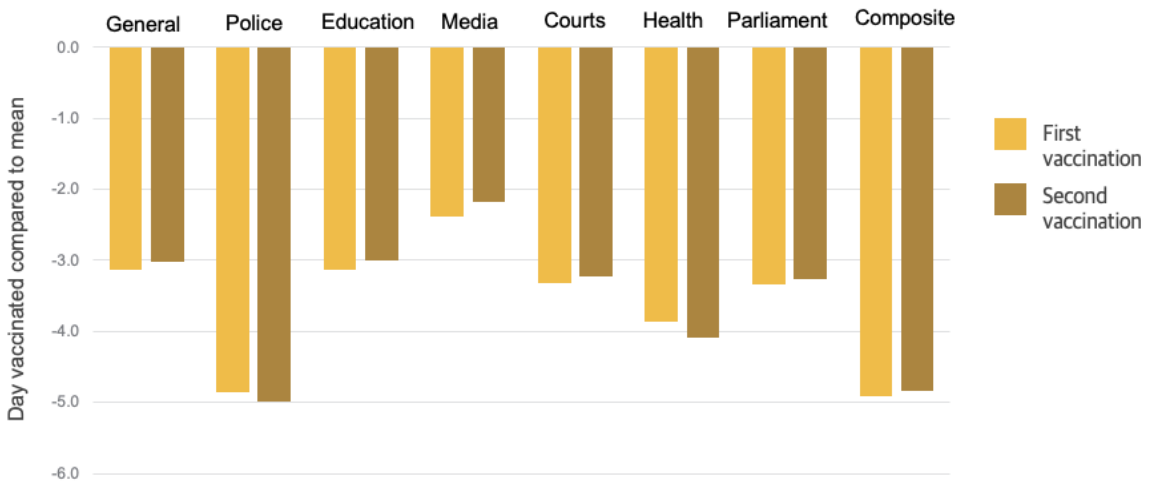
Table 3: First vaccination event and trust in each domain

Variables	(1)	(2)	(3)	(4)
	First vaccination		Second vaccination	
General trust	-7.596***	-3.129***	-7.604***	-3.017***
	(0.413)	(0.427)	(0.435)	(0.435)
Police trust	-8.002***	-4.854***	-8.236***	-4.983***
	(0.414)	(0.427)	(0.435)	(0.434)
Education trust	-4.252***	-3.139***	-4.091***	-3.005***
	(0.421)	(0.430)	(0.442)	(0.434)
Media trust	-3.970***	-2.376***	-3.860***	-2.169***
	(0.405)	(0.415)	(0.424)	(0.429)
Courts trust	-4.790***	-3.318***	-4.564***	-3.234***
	(0.411)	(0.423)	(0.436)	(0.435)
Health trust	-4.477***	-3.859***	-4.679***	-4.093***
	(0.403)	(0.416)	(0.428)	(0.425)
Parliament trust	-4.247***	-3.338***	-3.968***	-3.257***
	(0.401)	(0.421)	(0.426)	(0.435)
Composite trust	-5.305***	-3.955***	-5.043***	-3.789***
	(0.406)	(0.428)	(0.431)	(0.441)
controls	No	Yes	No	Yes
# of observations	21,000	18,000	21,000	18,000

Note: Each trust domain is independently regressed against the day of the first vaccination (columns 1-2) and the second (columns 3-4). Columns 2 and 4 include the complete set of covariates (as described in Table A1). To comply with Statistics NZ confidentiality requirements, the number of observations is randomly rounded to base 3. Standard errors are robust. Significance levels are indicated as follows: *p<0.10, **p<0.05, ***p<0.001.

As in the previous results in Table 2, the results reported in Tables 3 reveal statistically significant coefficients for all trust domains in the predicted direction, and these are robust to the addition of controls. Once the controls are included (columns 2 and 4), trust in the police showed the largest coefficient for vaccination delays for both the first and second vaccine; while trust in the media was estimated to have the weakest effect on both vaccination events. The uniform significance and directionality of the coefficients across the trust variables strengthen the credibility of reported relationships. The results from all our regressions suggest that trust in all domains plays a substantial role in shaping individuals' decision-making regarding whether and when to obtain the COVID-19 vaccination. Figure 2 displays the vaccination event date associated with a one-standard-deviation increase in the respective trust measure and described by how many days that higher standard will be associated with an earlier vaccination day. Line graphs depicting the average trust by vaccination date can be found in the supplementary appendix.

Figure 2. Vaccination delay for first and final vaccination event



Note: the figure displays coefficients from Column 2 in Table 3. It displays the increase in vaccination event date associated with a one standard deviation increase in trust, for each domain. Standard errors are robust. All results are significant at $p<0.001$.

In order to confirm that our results are robust, we ran a series of regressions using alternative specifications. We began by interrogating whether different GSS waves produce different results. Our study is concerned with vaccination decision-making in 2021, and the GSS surveys took place in 2014, 2016, and 2018. A central assumption is, therefore, that both interpersonal and institutional trust levels remain relatively constant over time – i.e., that the trust measures obtained 2-6 years before the pandemic remain a good proxy for trust levels during the pandemic. We have already shown that average trust in each domain remains stable across GSS survey waves. However, as this is a repeated cross-sectional survey and

each observation is a unique individual, we do not know how an individual's trust evolves over time. If trust remains constant over time for the same individual, we expect regression coefficients across all survey waves to remain similar, subject to the sampling constraints. To test this, we estimate our original regressions separately for the 2014, 2016, and 2018 samples. The results for the binary decision to vaccinate are displayed in Table 4, and for the first and second vaccination dates in the supplementary Tables. In table 4, the first column displays the coefficient estimates from our complete sample and the remaining columns display coefficient estimates for each survey wave.

Table 4. Vaccine acceptance and trust, by survey wave

Variables	**Complete sample**	**2014**	**2016**	**2018**
General trust	0.026***	0.023***	0.030***	0.026***
	(0.003)	(0.005)	(0.005)	(0.005)
Police trust	0.040***	0.038***	0.039***	0.043***
	(0.003)	(0.005)	(0.005)	(0.005)
Education trust	0.034***	0.032***	0.033***	0.037***
	(0.003)	(0.005)	(0.005)	(0.005)
Media trust	0.034***	0.032***	0.037***	0.033***
	(0.003)	(0.005)	(0.005)	(0.005)
Courts trust	0.037***	0.037***	0.035***	0.040***
	(0.003)	(0.005)	(0.005)	(0.005)
Health trust	0.031***	0.032***	0.031***	0.029***
	(0.003)	(0.005)	(0.005)	(0.005)
Parliament trust	0.039***	0.039***	0.037***	0.041***
	(0.003)	(0.005)	(0.005)	(0.005)
Composite trust variable	0.046***	0.045***	0.045***	0.047***
	(0.003)	(0.005)	(0.005)	(0.005)
Sample	22,000	7,000	7,000	7,000

Note: The table displays coefficients from a linear regression of vaccination decision on trust domains, for the complete sample and for each survey wave. All regressions include individual-level controls and age covariates. Each trust domain is independently regressed against vaccination status. All columns includes our complete set of covariates (as described in Table A1). Standard errors are robust. Significance levels are indicated as follows: *p<0.10, **p<0.05, ***p<0.001.

For vaccination acceptance, there are only minor differences across survey waves. The existing variation shows that (for most domains) coefficient estimates are larger in 2018 and smaller in 2014. However, overall the coefficients are quite similar across survey waves. The coefficient estimates for vaccination acceptance are all statistically significant at any conventional threshold.

For vaccination delays (for both first and second shots), the coefficient estimates from each survey vary between each year and in comparison to our complete sample. The coefficient magnitudes from our 2014 subsample were the weakest for all trust domains, except trust in the health system for the final vaccination event (which was most significant in 2014). The magnitude and significance of our 2018 survey coefficients indicate that more recent trust data appears to be a somewhat stronger predictor of vaccination delays (compared to earlier trust data). This suggests that a person's self-reported institutional and interpersonal trust levels may slowly change over time; as the temporal gap between the survey and the vaccination decision grows, the correlation between historical and contemporaneous trust level at the time of vaccination may weaken, and consequently, the coefficient estimates associated with the total GSS sample may underestimate the actual effect of trust on vaccination delay.

We also reran our regressions using a dummy variable indicating that an individual had selected 'refuse to answer' for a specific trust question. Across our trust dataset, this occurred for fewer than 1% of survey answers. We hypothesised that these individuals may be so untrusting that they don't feel safe answering how little they trust a domain. No regression coefficients were significant, except trust in the health system. Compared to individuals who answered how much they trusted this domain, those who refused to answer were vaccinated 19.55** (6.695) and 17.41* (7.278) days later for their first and final vaccination. A full set of these regression outputs can be found in the supplementary materials.

Finally, we reran our regressions using a different cut-off date. Our original specification used vaccination status on the 10th October 2021 to determine whether an individual is vaccinated or unvaccinated. Moving this cut-off date forward to the 10th September 2021 increased coefficient magnitudes for all trust domains, whilst moving it back to the 10th November 2021 reduced coefficient magnitudes for all trust domains. Significance levels remained constant. We suspect that the introduction of vaccine mandates on the 11th of October coerced low-trusting individuals to vaccinate (who may not have otherwise vaccinated), thus eroding the correlation between trust and vaccination status. A full set of regression outputs can be found in the supplementary materials.

6. Discussion

Understanding the relationship between trust and vaccination hesitancy is essential to prevent the harm from vaccine-preventable diseases. Our results show that all trust domains have a strong, negative relationship with the propensity to refuse or delay vaccination. Vaccine hesitancy decreases as interpersonal and institutional trust increases. Below, we seek to contextualise these findings by comparing our results to the existing literature, consider potential explanations for them, and briefly discuss the implications for health decision-making. Our discussion will primarily focus on trust in police, general public, and the health system. However, trust in other institutions, while exerting less effect on the decision and timing of vaccination, is still important, and our discussion is quite relevant to these other institutional domains.

We hypothesise that trust in police acts on vaccination hesitancy via two interlinked mechanisms: conspiratorial thinking and trust in authority. General belief in conspiracies significantly correlates with the propensity to delay or refuse vaccination (Bertin, et al., 2020; McCarthy et al., 2022). The sharp rise in conspiratorial thinking during the pandemic makes this particularly relevant for the COVID-19 vaccine, with conspiratorial thinking being a salient determinant of vaccine refusal (Bertin et al., 2020; Islam et al., 2021; van Mulukom et al., 2022). Other papers have found that lower trust in the police is highly correlated with conspiratorial thinking (Bertin et al., 2020; McCarthy et al., 2022). As such, trust in police might partially capture conspiratorial thinking as, unfortunately, the GSS does not directly ask about conspiracies, but our trust measure may denote the likelihood of respondents to believe in conspiracies later, during the pandemic.

We note that trust in media is also typically correlated with conspiratorial thinking (De Coninck et al., 2021; Stojanov & Douglas, 2022) and is generally lower than trust in other institutions in the GSS sample. If a large proportion of the population mistrusts the media, the correlation between trust in media and conspiratorial thinking may weaken (Jennings et al., 2021; Newman & Fletcher, 2017). As such, trust in media may be less relevant to vaccination decision-making as mistrust in this domain is shared broadly by many survey respondents.

The second mechanism by which trust in police may act on vaccination decision-making is as a proxy of trust in authority. Individuals with existing scepticism of those in power may perceive vaccination campaigns as an overreach of the state, even if these were not yet

mandated, and possibly motivated by ulterior motives (such as control, surveillance, or profit). This is closely linked to the concept of reactance, defined as “an individual’s tendency to defend their autonomy when they perceive that others are trying to impose their will on them” (Fasce et al., 2023, p. 1465). This psychological construct is consistently associated with vaccine hesitancy, as individuals stress their right to act contrary to social norms and to recommendations coming from those in authority (Hornsey, Harris, & Fielding, 2018).

New Zealand (like most other high-income countries) observed strict, prolonged, and reoccurring lockdown measures that curtailed individual liberties in unprecedented ways (Baker, Kvalsvig, Verrall, & Wellington, 2020; Prickett, Fletcher, Chapple, Doan, & Smith, 2020). The policy response to the pandemic lockdown required strict adherence, which was enforced, sometimes heavy-handedly, by the police and the courts. Individuals may have chosen to refuse or delay vaccination not due to their concerns about its safety or efficacy, but rather out of objection to perceived violations of civil liberties and government overreach (Colgrove & Samuel, 2022).

Trust in the general public was also significant in predicting vaccination delay. However, it was somewhat less important than institutional trust. General public trust is strongly associated with pro-social behaviours (Bar-Tal, 1976; Padilla-Walker & Carlo, 2014; Pagliaro et al., 2021). Individuals with greater trust in the general public are more likely to cooperate, practise altruistic behaviours, and feel responsible for their community (Padilla-Walker & Carlo, 2014). Interpersonal trust was particularly salient in New Zealand, given the focus on national unity and collective responsibility during the vaccination rollout (Jamieson, 2020). The use of slogans such as ‘unite against COVID-19’ and ‘cover for each other’ in official public health campaigns emphasised the importance of acting to protect one’s community (Beattie & Priestley, 2021). A desire to protect one’s community is a commonly stated reason to vaccinate, and interpersonal trust is a salient determinant of how close one feels to one's community (Thaker & Menon, 2020). This was reflected in vaccination intentions, with half of New Zealanders stating that they would vaccinate to ‘protect their community’ (Thaker & Menon, 2020). We expected that this campaign’s efficacy would be conditional on interpersonal trust levels, with less trusting individuals less likely to vaccinate, *ceteris paribus*. As such, the pro-social act of vaccinating promptly against COVID-19

(particularly by those who face little risk from the disease such as the young and healthy) could be mediated by trust in the general public.

Another important facet to consider is the shift in the levels of trust that may have occurred as a consequence of the pandemic. During the pandemic, trust levels in health institutions shifted dramatically (Bromme, Mede, Thomm, Kremer, & Ziegler, 2022). Some countries, including the United States and Norway, observed a marked increase in trust in health institutions (Brenan, 2020; Skirbekk, Magelssen, & Conradsen, 2023). Conversely, countries such as New Zealand and Poland observed a declining trust in health institutions (Algan et al., 2021; Stasiuk et al., 2021). In 2018, 12.7% of New Zealanders rated their trust in the health system between 0-4; by 2021, this percentage was 17.2% (Stats NZ, 2022). In the NZ case, this decline is significantly greater than for any other trust domain. Consequently, we expect that our health trust data does not reflect as accurately the 2020-21 health system trust levels when the decision to vaccinate was taking place. This concern about the timing of the survey is, of course, true more generally, but it is the health domain that has changed the most.

Another noteworthy caveat is that although the GSS attempts to capture a representative snapshot of New Zealand, it will inevitably be biased towards individuals with greater trust in the government (given that they must interact with a government interviewer to participate in the survey). The target population also excludes New Zealanders who "live in remote areas that are costly or difficult to access" and live in non-private dwellings, such as motels, homes for older adults, prisons, or psychiatric institutions (GSS, 2018). Evidence suggests these groups have lower trust levels, and that they were also less likely to vaccinate than the general population (Vandergrift & Christopher, 2021; Whitehead, Carr, Scott, & Lawrenson, 2022; Zakrison, Hamel, & Hwang, 2004). With our dataset likely skewed towards more trusting and vaccinated individuals, any observed relationship between trust and hesitancy may be weaker and less statistically observable than if we had data for the entire population.

New Zealand adopted a progressive rollout of vaccines, whereby specific populations (such as border workers, health-care providers, people with pre-existing conditions, and older individuals) were eligible to receive the vaccine earlier than the general population. With the available data, we cannot control for many of these factors, so we do not know the approximate date that each individual was eligible to receive the vaccine. We assumed that everyone who wanted to, was able to vaccinate by the cut-off date. For that to be true, the

vaccination must have been accessible, with no barriers to access, including related to distance, income, or ethnicity. There were some accessibility issues during the initial phases of the vaccination rollout (Megget, 2022; Smith, Fereti, & Adams, 2021; Te Whatu Ora, 2023). These included significantly lower Māori and Pacific Peoples coverage, accessibility issues for rural and remote communities, and language and communication barriers for migrants and non-English speakers (Megget, 2022; Whitehead et al., 2022; Whitehead et al., 2021). However, many of these were overcome by more intentional targeting of these populations later on in the rollout once these problems were observed, but well before our cut-off date in October. In addition, by controlling for ethnicity, income, migrant status, and deprivation decile, we can ameliorate the possibility that our results do not account for these challenges.

Our results, and the distinctions made between different trust domains, provide a clear impetus for further research. Future research should seek to understand how sample populations respond to different domains of trust and for different vaccines. It is possible, for example, that the highly politicised and unprecedented nature of the pandemic heightened the importance of trust in authority (police, Parliament, and the courts) for vaccination acceptance, for example. As some vaccines are more politicized (notoriously, the MMR vaccine in the UK, or Polio in Pakistan) it is possible that trust in authority is more important for these, and less for others (e.g., Meningococcal B or Typhoid).

Not much research has quantified the public health and economic consequences of COVID-19 vaccination delay. We suspect that vaccination delays associated with mistrust likely had a considerable adverse effect on both public health and the New Zealand economy. When vaccination efforts in France and Germany stalled for four days in March 2021, it was estimated to have increased the death toll by 2481 and reduced GDP by 0.34% (or more than 8 billion euros) (Gollier, 2021). Modelling from Brazil estimates that if the vaccination rollout had started 30 days earlier (in conjunction with improved distribution), deaths attributable to COVID-19 could have been reduced by approximately 31,657 (Barbosa Libotte, et al., 2022).

Our research shows the critical importance of both interpersonal and institutional trust in vaccination acceptance. However, it does not imply that it is the responsibility of (often marginalised) communities to trust others and the state’s institutions. Often, this lack of trust arose out of a traumatic history of marginalization and discrimination - in Aotearoa New

Zealand, that particularly affected Māori and Pacific Peoples (Graham & Masters-Awatere, 2020; Harris et al., 2006a). Warren et al. (2020) argue that it is the responsibility of institutions to prove their trustworthiness. Efforts to create this trust and address historic abuses are therefore essential for the success of future vaccination campaigns and to support public health efforts more broadly. This clearly requires more than just increasing trust in 'the product, provider, and policy maker.'

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