Will access to COVID-19 vaccine in Aotearoa be equitable for priority populations?

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ABSTRACT

AIM: This research examines the equity implications of the geographic distribution of COVID-19 vaccine delivery locations in Aotearoa New Zealand under five potential scenarios: (1) stadium mega-clinics; (2) Community Based Assessment Centres; (3) GP clinics; (4) community pharmacies; and (5) schools. **METHOD:** We mapped the distribution of Aotearoa New Zealand's population and the location of potential vaccine delivery facilities under each scenario. Geostatistical techniques identified population clusters for Māori, Pacific peoples and people aged 65 years and over. We calculated travel times between all potential facilities and each Statistical Area 1 in the country. Descriptive statistics indicate the size and proportion of populations that could face significant travel barriers when accessing COVID-19 vaccinations. **RESULTS:** Several areas with significant travel times to potential vaccine delivery sites were also communities identified as having an elevated risk of COVID-19 disease and severity. All potential scenarios for vaccine delivery, with the exception of schools, resulted in travel barriers for a substantial proportion of the population. Overall, these travel time barriers disproportionately burden Māori, older communities and people living in areas of high socioeconomic deprivation. **CONCLUSION:** The equitable delivery of COVID-19 vaccines is key to an elimination strategy. However, if current health services and facilities are used without well-designed and supported outreach services, then access to vaccination is likely to be inequitable.

Aotearoa New Zealand has been following an elimination strategy in its fight against COVID-19, with the aim of saving lives and protecting our health services. This strategy has put our country in a relatively good position internationally, with few deaths, low levels of active COVID-19 cases (concentrated predominantly at the border) and only sporadic community transmission since May 2020.[1] As we have seen recently, there is still the risk of an outbreak at any time, especially among communities living and working near international points of entry. However, now that vaccines are available and vaccination has started in Aotearoa New Zealand, we are increasingly relying on our vaccination delivery programme to support our elimination strategy and to reduce morbidity and mortality.

A key challenge in adding a vaccination approach will be achieving the equitable and universal delivery of a vaccine. There are various ways of conceptualising 'fairness' and prioritising vaccine delivery,[2,3] which in turn can have different impacts on COVID-19-related deaths, hospitalisations and ICU admissions.[4] The risk of severe COVID-19 infection, ICU admission and death increases with age and comorbidities.[5,6] Recent international analyses determined that, compared to individuals younger than 54 years old, the risk of mortality is 8.1 times higher among 55–64-year-olds and 62 times higher among those aged 65 and older.[7] Furthermore, data from the United Kingdom indicate that the risk of death from COVID-19 is also associated with lower socioeconomic status and being non-white.[8] Given the stark, persistent and increasing health inequities in Aotearoa experienced particularly by Māori,[9,10] it is essential to ensure that those most at risk of infection, and the members of the community most

vulnerable to COVID-19 severity, are prioritised for vaccine protection, and that every single person in the 'team of five million' has access to the vaccine. A major priority should be to immunise people who might die if they were to contract COVID-19. A secondary aim is to reduce admissions to hospital and to protect the health system. It has been argued that governments should first allocate COVID-19 vaccines not only according to individuals' risk of infection and underlying conditions, but that social vulnerabilities—such as socioeconomic status, high-risk occupations, housing and living conditions, ethnicity and other factors that limit access to healthcare—must also be considered.[3] Described priority populations include migrants, refugees, prisoners, those in residential facilities and people with disabilities. It is particularly important to prioritise Indigenous populations.[11] The transmission of COVID-19 and associated health impacts are likely to be higher among Māori in Aotearoa New Zealand and Indigenous populations elsewhere.[12] Furthermore, in Aotearoa New Zealand it has been estimated that COVID-19 infection fatality rates could be 2.5 times higher for Māori than New Zealand Europeans, and two times higher for Pacific people.[13] Health inequities between Māori and non-Māori are unjust, large, persistent and occur across the life course. Between 1992 and 2016, the Ministry of Health published 107 reports on Māori health and the disparity between Māori and non-Māori outcomes.[14] Māori are disproportionately impacted by poorer access to the social determinants of health, including housing and quality healthcare.[15]

Achieving equitable immunisation necessarily involves balancing the logistical constraints of distributing and administering the time- and temperature-sensitive COVID-19 vaccine with minimisation of the barriers for those who wish to receive it. Vaccinations began in Aotearoa New Zealand with 'Group 1', who include border workers and managed isolation employees (as well as their whānau and close contacts) who are currently exposed to the greatest risk of infection.[16] The next stage is currently targeting Group 2, which includes frontline health workers, older Māori and Pacific people, long-term residential care residents and people in the Counties Manukau District Health Board region aged 65 years and over who have an underlying health condition or disability. The wider rollout of the vaccine will focus on first protecting people at risk of contracting and dying from COVID-19, including all people aged 65 years and over, people with underlying health conditions and disabled people (Group 3), before being made available to the general population aged 16 and over (Group 4).[16] COVID-19 Response Minister Chris Hipkins has previously signalled that the locations used in the vaccine rollout could involve 'mega-clinics' at stadiums, as well as immunisations at general practitioner (GP) clinics, pharmacies, large workplaces, schools and sports grounds.[17] It has now been announced that the location of the vaccination rollout to Groups 2, 3 and 4 will include places of employment, pop-up clinics and usual vaccination services, such as Māori and Pacific providers, GP clinics and community pharmacies.[16]

Internationally, there have been issues ensuring equitable delivery both on a global scale and within countries.[3] The United Nations Secretary-General has called for vaccine equity—that is, ensuring that low-income countries have access to vaccine stocks—to be a moral test for the global community.[18] Despite non-white residents of New York City being hardest hit by the virus, vaccination rates are much higher among white residents.[19] There is a risk that a similar 'white capture' of resources and inequitable access to the vaccine will occur in Aotearoa New Zealand. Barriers to accessing the vaccine that disproportionately affect those who are at the most risk of COVID-19 severity, such as people with underlying conditions and those aged over 65 years old, as well as Māori, Pacific and socioeconomically deprived communities that experience higher levels of chronic disease,[20, 21] will exacerbate key inequities. In fact, the inequitable delivery of vaccines is *likely* if it is based upon the current configuration of health services and facilities. Access to healthcare in Aotearoa New Zealand is inequitable.[20,22–24] This includes the inequitable geographic distribution of health services such as primary care services[23,25,26] and musculoskeletal clinics.[27] Spatial accessibility is not the only barrier to accessing healthcare, particularly for Māori,[28–31] and the inequi-

table distribution of services is confounded by additional factors such as the (in)appropriateness, (un)availability, (in)acceptability and poorer quality care provided by many services. Māori and Pacific people are more likely to experience racism from healthcare providers[32–36] and are also disproportionately affected by cost and transport as barriers to accessing GP services.[37]

The health system will need to work differently to overcome these challenges and achieve equitable vaccine delivery rollout. This paper explores the impact that different scenarios for the location of population-wide vaccine rollout could have on access for geographic areas. We analyse potential accessibility for populations under different vaccine distribution scenarios and discuss the equity impacts.

Methods

Data

The population data used in this analysis is based on 2018 census data at the Statistical Area 1 (SA1) level. This includes information on the usually resident population, as well as the age and ethnicity of residents in each SA1.[38] Ethnicity data in the 2018 census are not prioritised, so individuals who report multiple ethnicities are counted more than once.[39] The 2018 New Zealand Index of Socioeconomic Deprivation (NZDep18) information was accessed from the University of Otago.[38] Geographic data include SA1 address-weighted centroids, developed using the SA1 boundaries[40] and address points[41] datasets. The road network layer used in this analysis was developed by Beere.[42] GPS coordinates were accessed for five types of facilities that could be used as sites of vaccine delivery: (1) stadium mega-clinics[43]; (2) COVID-19 Community Based Assessment Centres (CBACs) as they were located at 24 February 2021[44]; (3) GP clinics[45]; (4) community pharmacies[45]; and (5) schools.[46] These facilities were selected based on recent media comments that they could be used as locations for vaccine delivery.

Analysis

The first stage of the analysis involved mapping the total population for each SA1 in Aotearoa New Zealand. We also mapped the Māori and Pacific populations as well as those aged 65 years and over. We then analysed the geographic distribution of these population subgroups using the Getis-Ord cluster analysis function in ArcGIS 10.7. This indicated where there were clusters of high numbers of a population, and whether those clusters were statistically significant. This approach was taken as it overcomes some issues around mapping of population subgroups, particularly that often large and significant subgroup communities are overlooked if they only make up a small proportion of an area's total population. The second stage of analysis involved calculating the drive times between each SA1 and the nearest of each of the five facilities using Beere's road network[42] and the ArcGIS Origin-Destination Matrix function. Address-weighted centroids were used to represent the 'average' location of populations within each SA1. Finally, we examined the sociodemographic composition of SA1s that were located more than 30 minutes' drive-time from each of the facilities. Although there may be many people who are *willing* to travel significant distances to receive a vaccination, 30 minutes was selected as a commonly used[47] threshold over which the time and financial burden of travel becomes a significant barrier. This is particularly true for individuals and families who face transport related barriers such as a lack of access to a private vehicle, low income to cover transport costs, poor public transport availability or an inability to easily travel due to age, personal mobility levels or other factors.

Results

Figure 1 indicates the geographic distribution of each of the population subgroups, as well as the geographic distribution of high area-level socioeconomic deprivation (NZDep18 quintiles 4 and 5). This indicates the locations of communities that are at risk of COVID-19 severity. These communities are also more likely to be disproportionately impacted by both spatial and non-spatial barriers to vaccine access. Figure 1 indicates that clusters of high Māori populations are mainly in the rural areas of Te Ika-a-Māui (North Island), while high numbers of people aged 65 years and over are spread across rural communities in both Te Ika-a-Māui and Te Waipounamu (South Island). Statistically significant clusters of high Pacific populations are

located in Tāmaki Makaurau (Auckland), Te Whanganui-a-Tara (Wellington), Tokoroa, Paharakeke (Flaxmere) and Kāmoanahaehae (Alexandra, Central Otago). High levels of area-level socioeconomic deprivation are found in both Te Tai Tokerau (Northland) and Tairāwhiti (East Coast), but also in other rural and remote areas of both Te Ika-a-Māui and Te Waipounamu.

Figure 2 displays the geographic distribution of SA1s within travel-time thresholds from the five scenarios of potential vaccine delivery facilities. Figure 2 shows that several areas with significant travel times to potential sites of vaccine delivery are the same areas (seen in Figure 1) that *also* have a high number of Māori, Pacific, older and socioeconomically constrained residents. Table 1 shows the total size and proportion of population groups who live 30 or more minutes from each of the five types of facilities. Although it is to be expected that almost one quarter of the total Aotearoa New Zealand population do not live within 30 minutes of a stadium, our analysis shows that travel barriers to the potential sites of these mega-clinics are likely to disproportionately affect Māori, Pacific people and those aged 65 years and older. Furthermore, similar barriers are likely exist if current CBAC sites were to be converted to vaccination centres. Delivering vaccines in community pharmacies would improve access for the total population, but Māori and older people would again face disproportionate travel burdens. GP clinics appear to provide better access to the total population. However, more than one quarter of the approximately 30,000 people who live 30 or more minutes from a clinic are Māori. The results in Table 1 suggest that delivery through schools would provide vaccine access within 30 minutes to almost all of the population, and that this would be equitable. However, there would likely be logistical challenges involved in delivering COVID-19 vaccines to the general public through all schools. Table 2 shows the socioeconomic composition of areas that are 30 or more minutes travel time from each of the five types of potential vaccine delivery sites. The results in Table 2 suggest that each of the scenarios examined in this research has the potential to disproportionately burden communities living in areas with high socioeconomic deprivation. However, of the people affected by travel burdens under scenarios of vaccine delivery via GP clinics or community pharmacies, more than half live in areas of high socioeconomic deprivation, while less than 10% live in the wealthiest areas of the country.

Discussion

This paper shows five hypothetical scenarios of how the wider public rollout of COVID-19 vaccines could be delivered, and how these different scenarios (if operating alone) may impact upon equity of access to vaccination. Our results suggest that a large proportion of the population could face geographic barriers to receiving a COVID-19 vaccine. Further, a disproportionate impact of vaccine delivery location was seen on access for Māori and older communities as well as people living in areas of high socioeconomic deprivation. Access barriers would likely be more than cumulative for older Māori living in areas of high socioeconomic deprivation. It is likely that, in order to achieve equitable vaccine delivery, outreach services that go beyond the current distribution of health facilities will be needed. Making vaccinations available in all schools would achieve very high levels of geographic coverage in places that local communities are familiar with. However, it is unclear whether all schools have the facilities and capacity to store vaccines. Furthermore, unless delivery is out-of-hours, public immunisations in schools could be disruptive to schooling. Although beginning vaccinations in South Auckland will make the vaccine accessible to some Pacific families, our analysis of population distribution (Figure 1) indicates that there are significant Pacific populations also across Tāmaki Makaurau and around Te Whanganui-a-Tara, as well as in rural areas including Tokoroa, Paharakeke and Kāmoanahaehae.

It is important to note some limitations. Since information on the exact locations of potential vaccination sites has not been made publicly available, this analysis is based on assumptions about where such sites *could* be located. For instance, the list of CBAC locations is regularly updated with 'pop-up' clinics, and so it is possible that pop-up vaccination centres that we have not

Figure 1: The geographic distribution of population groups and area-level socioeconomic deprivation.

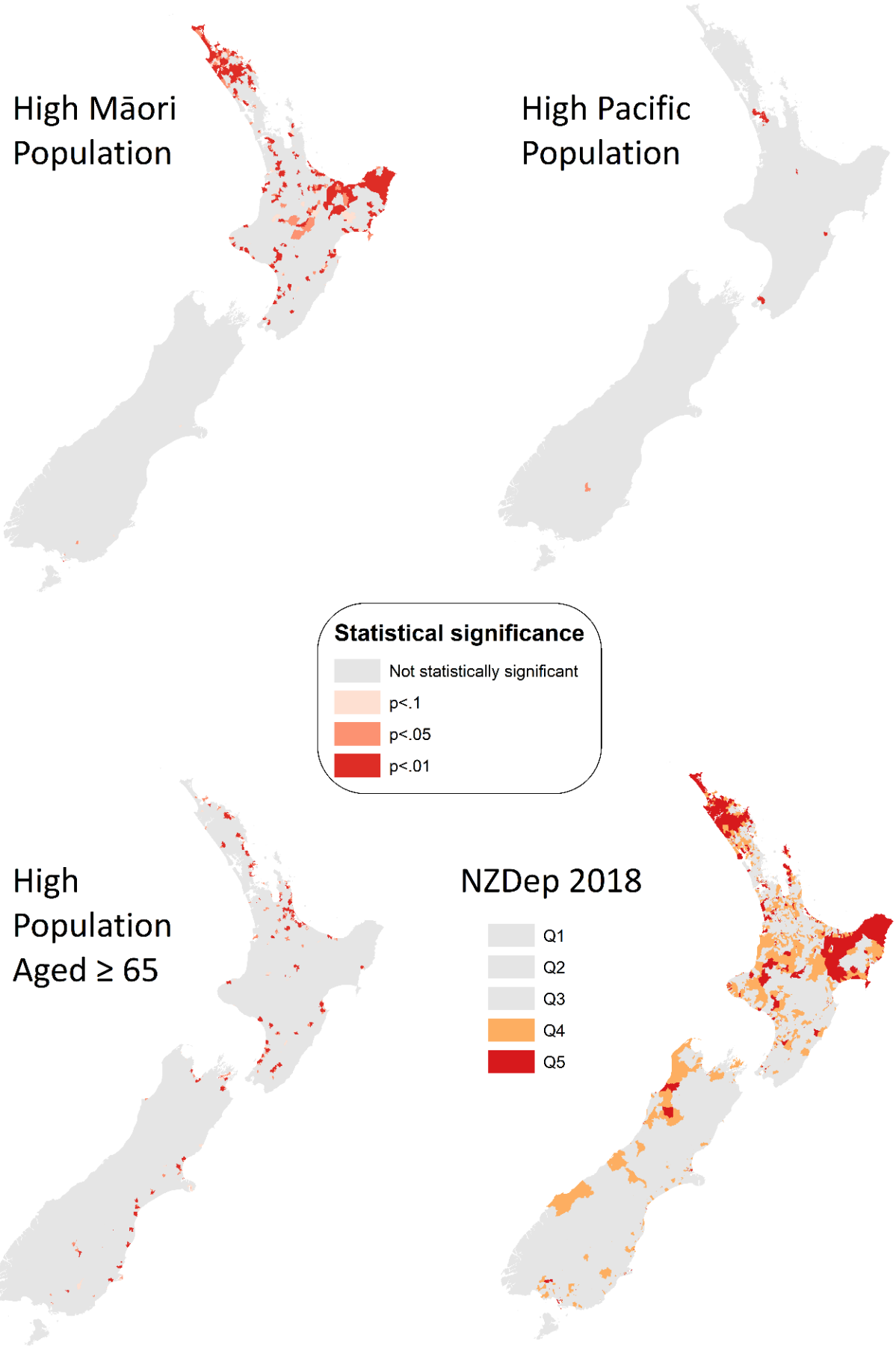


Table 1: The demographic composition of SA1s located 30 minutes or more from facilities that could potentially be used to deliver COVID-19 vaccines.

Population	Total	(%)	≥30min stadium	(%)	≥30min CBAC	(%)	≥30min GP	(%)	≥30min pharmacy	(%)	≥30min school	(%)
Total	4,699,191	100	1,123,947	23.9	993,858	21.1	31,554	0.7	432,372	9.2	2,418	0.1
Māori	775,626	16.5	249,876	32.2	165,939	21.4	8,694	1.1	113,127	14.6	657	0.1
Pacific	381,618	8.1	35,670	9.3	29,931	7.8	639	0.2	14,652	3.8	30	0.0
Over 65	715,137	15.2	221,898	31.0	186,705	26.1	4,752	0.7	82,881	11.6	405	0.1
European	3,297,183	70.2	916,380	27.8	842,847	25.6	24,954	0.8	341,655	10.4	2,052	0.1
Asian	707,610	15.1	46,098	6.5	49,062	6.9	840	0.1	16,677	2.4	60	0.0

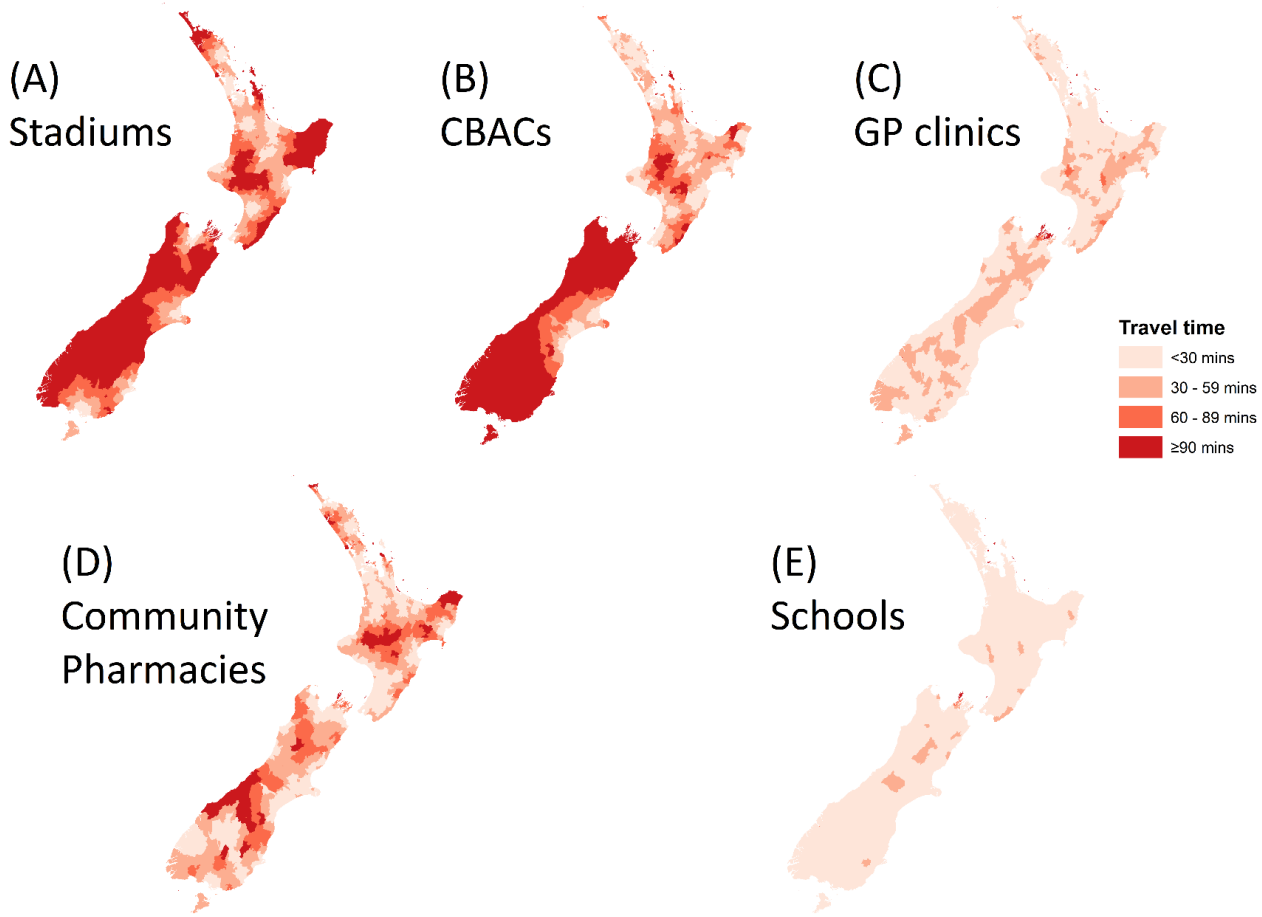
Table 2: The socioeconomic composition of SA1s located 30 minutes or more from facilities that could potentially be used to deliver COVID-19 vaccines.

NZDep18	Total	(%)	≥30min stadium	(%)	≥30min CBAC	(%)	≥30min GP	(%)	≥30min pharmacy	(%)	≥30min School	(%)
Q1	902,997	19.2	152,562	13.6	158,448	15.9	1,326	4.2	36,795	8.5	204	8.4
Q2	915,894	19.5	198,297	17.6	198,885	20.0	6,021	19.1	75,699	17.5	231	9.6
Q3	931,227	19.8	245,838	21.9	215,151	21.6	10,023	31.8	97,950	22.7	1,083	44.8
Q4	956,478	20.4	261,441	23.3	236,622	23.8	6,777	21.5	107,133	24.8	483	20.0
Q5	992,595	21.1	265,809	23.6	184,752	18.6	7,407	23.5	114,795	26.6	417	17.2

mapped may also be used. There are issues with population data from the 2018 census,[48] and the quality of the ethnicity variable has been independently rated as 'moderate'.[49] This means that the results in this paper present population estimates. Furthermore, we were unable to map the geographic distribution of people with underlying medical conditions. However, we have used the best-quality publicly available data to carry out this analysis, and we have mapped the geographic distribution of population groups that have previously been shown to have higher levels of relevant underlying conditions. It should also be noted that some specificity around the locations of population concentrations is lost when data are presented at a national scale. Furthermore, if these geographic modelling approaches are to be applied when planning vaccine rollouts, it is essential to interpret the results within local contexts. Using local knowledge and experiences will help to overcome barriers, such as institutional racism, that would otherwise result in inequitable vaccine rollouts. These challenges mean that our approach is likely to be more appropriate when applied to a local or regional context by iwi, primary health organisations or district health boards (DHBs).

Despite these limitations, our approach highlights the contribution that geospatial analysis can provide to the planning and delivery of health services. Furthermore, it emphasises the need to proactively plan for the equitable provision of vaccination, since different scenarios of delivery, and their potential combinations, can either reduce or increase barriers to equitable access. A social justice approach to achieving vaccine equity within Aotearoa and protecting the health of vulnerable populations needs to be prioritised.[2] Just as some approaches to improving health for the majority of the population can increase inequities,[50]

Figure 2: Travel time to five types of potential vaccine delivery sites.



specific locations for vaccine provision will leave priority groups behind. Further, it is not just geographic barriers that will need to be overcome to ensure vaccination equity. As well as providing clear, culturally safe and effective information and support to reduce vaccine hesitancy, the health system will need to gain the trust of communities who have been impacted by racism, negative previous healthcare experiences and inequitably designed and delivered health services.[31,37] The system to register for, access and receive a COVID-19 vaccine must be simple and safe for all. Furthermore, rather than top-down decision-making around how, when and where COVID-19 vaccines will be delivered, the Government must meet te Tiriti o Waitangi obligations (including for governance and decision-making), work in partnership with Māori and engage effectively with other communities. Frameworks such as He Pikinga Waiora[51] can support the assurance of tino rangatiratanga over the design of programme delivery and the safe and effective provision of vaccines.[2,11] During the first lockdown in 2020, high rates of influenza vaccination were achieved for Māori in several DHB regions—attributed to an approach led by Māori and iwi organisations.[52] COVID-19 vaccine allocation must be transparent, participatory, prioritised according to need and free, in order to also align with international human rights law.[3]

Aotearoa New Zealand's COVID-19 vaccine rollout should be closely governed and monitored, with high-quality data on vaccination rates (by key sociodemographic indicators) collected at a suitable geographic scale to allow for an examination of any variations in coverage rates both within and across regions. If equitable vaccine delivery can be achieved, then the approaches that facilitated it should be used to ensure that *all* health services are delivered equitably. Although protecting the population from COVID-19 is clearly an urgent and essential goal, the persistent health inequities within Aotearoa New Zealand need to be addressed with the same urgency. If a vaccine can be delivered equitably and universally with the entire population able to access it, then so should all health services.

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Nil.

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