Deadly places: The role of geography in Aboriginal and Torres Strait Islander COVID-19 vaccination

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Submitted: 15 February 2023; Revision requested: 30 October 2023; Accepted: 29 December 2023

Abstract

Objective: The objective of this study was to investigate the geospatial distribution of COVID-19 vaccination rates for Aboriginal and Torres Strait Islander Peoples across Local Government Areas in Australia.

Methods: We described the patterns of COVID-19 vaccination across jurisdictions, identified clusters with different levels of vaccination uptake, and assessed the relationship between contextual factors and vaccination (spatial error model, spatial lag model, and geographic weighted regression).

Results: The proportion of the Aboriginal and Torres Strait Islander population that received at least two doses of a COVID-19 vaccine by the last week of June 2022 ranged from 62.9% to 97.5% across Local Government Areas. The proportion of the overall population who is Aboriginal or Torres Strait Islander ($\beta = 0.280$, standard deviation [SD] = 1.92), proportion of the total labour force employed ($\beta = 0.286$, SD = 0.98), and proportion of individuals who speak an Aboriginal or Torres Strait Islander language ($\beta = 0.215$, SD = 0.15) had, on average, the strongest effects on COVID-19 vaccination rates.

Conclusion: Findings underscore the extent to which area-level demographic influence the COVID-19 vaccination for Aboriginal and Torres Strait Islander Australians.

Implications for public health: Findings can inform vaccination strategies that prioritise geographic areas with higher vulnerability to promote equity for Aboriginal and Torres Strait Islander Peoples.

Key words: health disparities, COVID-19, indigenous peoples, vaccine coverage, vaccination

Introduction

Vaccination is a key policy for preventing COVID-19-related severe illness and deaths.[1] Despite initial issues with supply and a slow roll-out compared to other Western countries, Australia has reached one of the highest rates of COVID-19 vaccination globally.[2] It is estimated that over 95% of the population aged 16 years or older has received at least two doses of an approved COVID-19 vaccine, and at least 4 million Australians have already received a fourth dose.[3] The high vaccination coverage has allowed Australia to gradually lift restrictions in social mobility and loosen strict measures of border closures, lockdowns, and contact tracing. While the Australian public health response to COVID-19 based on rigid non-pharmaceutical interventions was mostly successful in reducing or even eliminating community transmission, ensuring high vaccination rates is critical for the long-term management of the pandemic.[2]

Aboriginal and Torres Strait Islander Peoples in Australia experience an increased vulnerability to COVID-19 that stems from the enduring legacies of colonisation and profound racial inequities. The systemic neglect of governments manifested in the under-resourcing of community health organisations, poor housing conditions, and high burden of underlying conditions such as diabetes, cardiovascular, lung, and kidney disease contributes to an increased susceptibility of Aboriginal and Torres Strait Islander Communities to infection and severe illness from COVID-19.[4,5] The continuous experiences of systemic racism by Aboriginal and Torres Strait Islander Peoples in healthcare settings might create even greater racial disparities in COVID-19 outcomes.[6] It is crucial that these differences in risk between Aboriginal and Torres Strait Islander Peoples and the general

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Aust NZ J Public Health. 2024; Online; https://doi.org/10.1016/j.anzjph.2024.100130

population be understood in the context of social, material, political, and environmental determinants of health. Indigenous status or racial identity should not be interpreted as risk factors for COVID-19 in the same sense that poorer health and social outcomes for Aboriginal and Torres Strait Islander populations cannot be simplistically reduced to biological differences.[7,8]

The Aboriginal and Torres Strait Islander Community initial response to the pandemic led primarily by Aboriginal Community Controlled Health Organisations (ACCHOs) has been considered a major victory.[9,10] Less than 100 infections and no deaths were recorded among Aboriginal and Torres Strait Islander populations in the first year of the pandemic.[5] In face of unilateral, centralised, and poorly coordinated measures adopted by governments in Australia, ACCHOs were capable of promoting self-determination through community-based interventions.[11] ACCHOs have been directly involved in coordinating the COVID-19 vaccine roll-out in Communities, developing informative resources that incorporate Aboriginal and Torres Strait Islander Languages and other cultural elements, and providing education about immunisation through different platforms.[12] ACCHOs leverage their unique expertise in effectively communicating health information in a meaningful and culturally secure way to build confidence in COVID-19 vaccines and, ultimately, increase immunisation coverage. The strong advocacy of the ACCHO sector had critical implications for government policy. In Victoria, for instance, Aboriginal health practitioners were included in the roll of professionals allowed to administer COVID-19 vaccines.[13]

However, there is evidence suggesting that Aboriginal and Torres Strait Islander Peoples have lower uptake of COVID-19 vaccination than non-Indigenous Australians.[14] This is particularly concerning considering the easing of social-distancing measures and the rapid transmission and spread of new SARS-CoV-2 variants around the country. Experiences in other countries have demonstrated the likeness of increasing regional disparities in vaccination coverage as COVID-19 vaccines become widely available. For example, data from the United States identified spatial disparities in COVID-19 vaccination across zip-codes, with marginalised and racialised communities presenting lower coverage.[15] Evidence has demonstrated that COVID-19 vaccination strategies targeting vulnerable populations in geographic areas create more equitable access to vaccines than strict age-based approaches that largely benefit the privileged white population.[16] Access to granular area-level data in combination with the use of geospatial techniques can provide a more nuanced understanding of the characteristics of Aboriginal and Torres Strait Islander Communities related to COVID-19 vaccination uptake. Local characteristics such as population density, overcrowding, literacy, and socioeconomic status are known predictors of SARS-CoV-2 infection and could be used to optimise vaccination distribution and uptake.

The main aim of this study is to analyse the spatial variation of COVID-19 vaccination for Aboriginal and Torres Strait Islander Peoples across locations in Australia, in the context of *Deadly* Community leadership and Community strengths. The term "deadly" carries a specific meaning in Aboriginal English: it means excellent, fantastic, or cool. The perspective we adopt in this paper highlights the efforts by Aboriginal Community Controlled Organisations, Indigenous leaders, and communities as a whole to champion and promote vaccination against COVID-19 during an exceptionally challenging and perilous time. By identifying geographies with successful vaccination trajectories, we honour the unwavering determination and leadership of Aboriginal Communities in the pursuit of self-determination, improved health, and survival. We specifically aimed to 1) describe the patterns of COVID-19 vaccination across states, remoteness areas, and Local Government Areas (LGAs); 2) identify clusters of jurisdictions with high or low COVID-19 vaccination coverage; and 3) assess the relationship between Community characteristics and area-level COVID-19 vaccination rates.

Methods

Scale

The main geographic scale utilised for this study was the 2018 LGAs in Australia. LGAs represent an approximation of the smallest geographic areas to local council boundaries within each state and territory, as defined by the Australian Bureau of Statistics (ABS). There were 562 non-overlapping LGAs covering the entire Australian territory in 2018, including 5 unincorporated areas (ABS, 2021a).[17] Non-spatial areas denoting non-usual addresses or migratory—offshore—shipping locations (n = 18) were not considered in the analyses. Temporal trends of COVID-19 vaccination rates were reported for states and territories (Australian Capital Territory, New South Wales, Northern Territory, Queensland, South Australia, Tasmania, Victoria, and Western Australia) and remoteness areas.

Data

Weekly COVID-19 vaccination rates for Aboriginal and Torres Strait Islander Australians were obtained from public reports by the Australian Government Department of Health and Aged Care.[13] Vaccination coverage data are recorded by the Australian Immunisation Register. Data on Indigenous Australians aged 15 years or older who received at least two doses of a COVD-19 vaccine approved by the Therapeutic and Goods Administration were obtained for the period from the first week of November 2021 to the last week of June 2022. Population denominators for jurisdictions were determined based on Australian Immunisation Register (AIR) population counts and refer to the address where people live (registered in Medicare, the Australian publicly funded healthcare insurance scheme) rather than where immunisation services were provided.

Factors

Area-level demographic and socioeconomic statistics for Aboriginal and Torres Strait Islander populations were obtained for each LGA in 2016 from the ABS (ABS, 2016).[18] The Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) provides a measure of the relative general access of the population living in a certain area to social and material resources. The IRSAD score is calculated based on a range of socioeconomic indicators and is standardised against a mean of 1000 with a standard deviation of 100 (as a result, the average Socio-Economic Indexes for Areas score is 1000, and the middle two-thirds of the values fall within a 1-standard-deviation distance from the mean, i.e., between 900 and 1100).[19] Other predictors included the proportion of individuals who speak an Aboriginal or Torres Strait Islander language at home, the proportion of individuals who completed year 12 of schooling or above, the proportion of the total labour force (15 to 64 years old) employed, the proportion of owner-occupied dwellings, the proportion of individuals

living in an overcrowded dwelling (requiring one or more additional bedrooms), and the proportion of the overall population residing in the LGA who is Aboriginal and/or Torres Strait Islander.

Analysis

Choropleth maps were used to describe the geospatial distribution of the dependent variable (cumulative area-level COVID-19 vaccination rates at the last timepoint) and the investigated predictors across LGAs. Global spatial autocorrelation was assessed using Moran's I statistic, which indicates whether the pattern of Aboriginal and Torres Strait Islander COVID-19 vaccination is geographically clustered, dispersed, or random. The summary statistic is represented by a z-score ranging from –1 (perfect dispersion) to +1 (perfect clustering), where 0 is perfect randomness. The cluster and outlier (Anselin Local Moran's I) analysis was used to identify neighbouring LGAs with similar COVID-19 vaccination rates (clusters) and outlier areas with markedly dissimilar values. Clusters are classified into four categories: high-high (LGAs showing high vaccination rates surrounded by LGAs with similarly high values), low-low (LGAs showing low vaccination rates surrounded by LGAs with similarly low values), high-low (indicates an outlier area with high vaccination rates surrounded by low values), and low-high (indicates an outlier area with low vaccination rates surrounded by high values). We specifically examined the contextual characteristics of high-low outliers to explore factors that may contribute to thriving districts with unexpectedly high vaccination rates compared to their neighbouring areas.

We used a spatial error model (SEM) and a spatial lag model (SLM) to examine the relationship between area-level predictors and COVID-19 vaccination rates. SEM and SLM follow an autoregressive process, which extends the traditional linear regression model with a term that accounts for the existing spatial autocorrelation.[20] SEM incorporates spatial effects through the error term by accounting for the dependency error between residuals of neighbouring areas. SLM incorporates spatial dependence by assuming that values of the dependent variable in each locality are directly influenced by the values of their neighbours. The spatially lagged term added by the SLM allows assessment of whether values in neighbouring areas co-vary.

The spatial non-stationarity in the relationships between predictors and the dependent variable was assessed using a geographically weighted regression (GWR) model. GWR models can identify heterogeneous patterns of associations occurring at different geographic units that could otherwise be deemed statistically insignificant in global models. The optimal number of neighbours for each feature in the study area was determined by the golden search method available in ArcGIS Pro. The method incrementally tests different neighbourhood sizes and chooses the option that yields the lowest Akaike information criterion. We examined the spatial autocorrelation of the GWR residuals and the local R^2 using the Global Moran's I test. Clustering of over/underpredictions or local R2 is indicative of remaining spatial effects not fully captured by the predictors included in the model. Analyses were conducted using R package *spdep* and ArcGIS Pro 2.9.0.

Results

The cumulative proportion of the Aboriginal and Torres Strait Islander population that received at least two doses of an approved COVID-19 vaccine by the last week of June 2022 ranged from 62.9% to 97.5% across LGAs (n = 488). Rural areas (outer regional, remote, and very remote) had consistently lower vaccination rates than LGAs located in urban areas (major cities and inner regional) over time. Temporal trends also show a lower uptake in LGAs from Queensland, South Australia, and Western Australia (Figure 1). The Australian Capital Territory, New South Wales, Victoria, Tasmania, and the Northern Territory presented higher uptake of COVID-19 vaccination, with coverage rates above 80%.

The Global Moran's I test detected a positive spatial autocorrelation for COVID-19 vaccination rates and area-level predictors across LGAs (Moran's I = 0.487, $p < 0.001$), indicating the existence of spatial effects and a clustered pattern of COVID-19 vaccination rates for the Aboriginal and Torres Strait Islander Communities in Australia. The cluster and outlier analysis revealed clusters of LGAs with high vaccination rates (high-high) in Tasmania, Victoria, New South Wales, and the north area of the Northern Territory. Clusters of LGAs with low vaccination rates (low-low) were concentrated in Queensland, South Australia, and Western Australia (Figure 2). Outliers with unexpectedly

Figure 1: Cumulative COVID-19 vaccination coverage rates for Aboriginal and Torres Strait Islander Australians across remoteness areas (A) and states and territories (B).

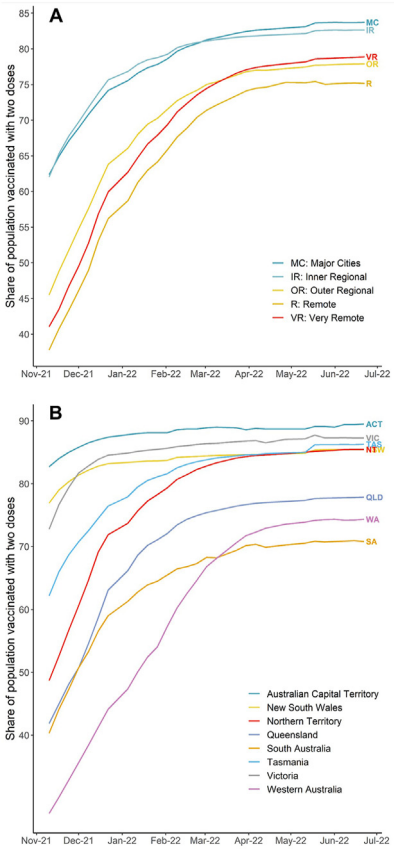
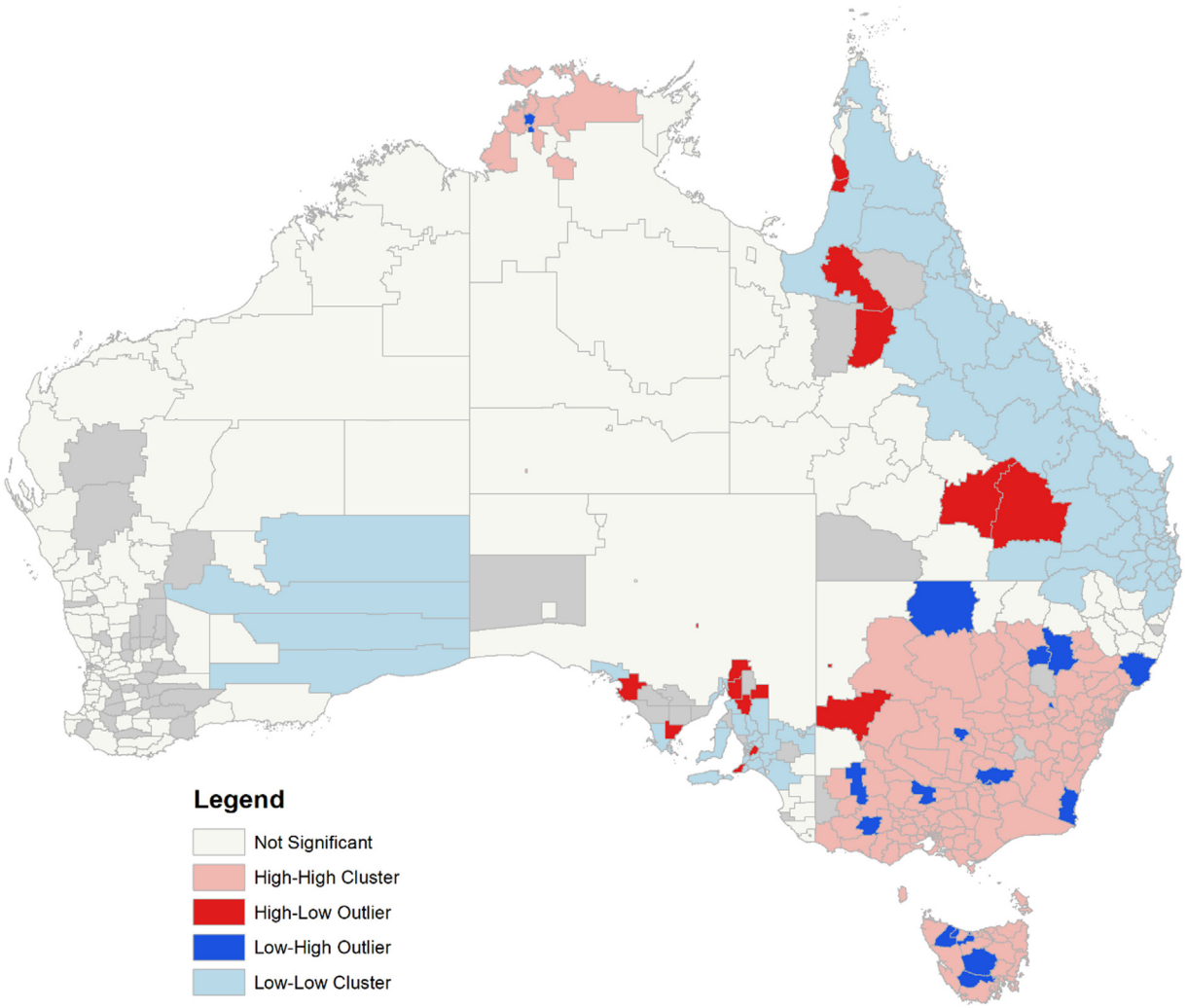


Figure 2: Cluster and outlier analysis of the cumulative COVID-19 vaccination coverage for Aboriginal and Torres Strait Islanders across LGAs. Abbreviation: LGA = Local Government Area.



high vaccination rates near areas with low vaccination rates were identified and described as supplementary materials. Vaccination rates in these locations (high-low) ranged from 84.1% to 94.5%. Nearly all districts were located in rural areas.

The SEM model presented a lower Akaike information criterion than SLM (Table 1). The predictors, IRSAD scores, proportion of owner-occupied dwellings, proportion of individuals who speak an Aboriginal or Torres Strait Islander language at home, and the

Table 1: Global spatial models for the relationship between contextual factors and area-level COVID-19 vaccination rates for Aboriginal and Torres Strait Islander Australians.

	Error model		Lag model		GWR model	
	Estimate (SE)	95% CI	Estimate (SE)	95% CI	50th	IQR
IRSAD	0.02 (0.006)	0.01, 0.03	0.02 (0.006)	0.01, 0.03	-0.010	-0.023, 0.008
Owner (%)	0.11 (0.020)	0.06, 0.15	0.15 (0.023)	0.10, 0.19	-0.059	-0.447, 0.085
Overcrowding (%)	-0.04 (0.032)	-0.09, 0.03	-0.01 (0.038)	-0.08, 0.07	0.129	-0.516, 0.586
Employed (%)	0.02 (0.026)	-0.03, 0.07	0.07 (0.030)	0.01, 0.13	0.286	-0.282, 0.349
Education (%)	0.00 (0.009)	-0.01, 0.02	-0.01 (0.011)	-0.03, 0.01	0.207	-0.105, 0.433
Language (%)	0.09 (0.024)	0.04, 0.14	0.07 (0.028)	0.01, 0.12	0.215	-2.422, 0.678
Population (%)	0.07 (0.027)	0.01, 0.12	0.12 (0.030)	0.06, 0.18	0.280	-0.812, 2.053
AIC	2722.69		2846.436		-	-
R^2	-		-		0.492	0.127; 0.603

IRSAD – Index of Relative Socio-economic Advantage and Disadvantage.
Population – Proportion of Aboriginal and Torres Strait Islander individuals in the population.
IQR: interquartile Range; AIC: Akaike information criterion; GWR: geographically weighted regression; SE: Standard Error.

proportion of the overall population who identify as Aboriginal and/or Torres Strait Islander presented a statistically significant association with COVID-19 vaccination rates in both models. Proportion of the total labour force employed was statistically associated with the outcome in the SLM but not in the SEM.

In the GWR model, the calculated optimal solution for the neighbourhood size was 37 features. The model explained 45% of the variation in the outcome across the LGAs (R-squared and adjusted R-squared were 0.563 and 0.448, respectively). Local R-squared ranged from 0.127 to 0.804 across locations. GWR coefficients show that the effect of area-level demographic and contextual factors on Aboriginal and Torres Strait Islander COVID-19 vaccination varies across locations. Based on the median coefficients of the GWR model, the predictors with the stronger effects on area-level COVID-19 vaccination rates were the proportion of the overall population who is Aboriginal or Torres Strait Islander ($\beta = 0.280$, SD = 1.92), proportion of the total labour force employed ($\beta = 0.286$, SD = 0.98), and proportion of individuals who speak an Aboriginal or Torres Strait Islander language at home ($\beta = 0.215$, SD = 0.15). GWR residuals presented no spatial dependence (Moran's I = 0.05, p = 0.075), indicating that there is no clustering of over-predictions or under-predictions in the model. On the other hand, there was evidence of substantial autocorrelation for the local R-square (Moran's I = 0.95, $p < 0.001$). The model performed poorly mostly in LGAs located in Queensland (supplementary file).

Discussion

This ecological study aimed to examine the geographic variability of COVID-19 vaccination rates for the Aboriginal and Torres Strait Islander population across districts in Australia. We applied geospatial clustering and modelling techniques to identify different patterns of vaccination coverage and to assess the influence of area-level factors on the outcome. Our analysis demonstrates that the cumulative COVID-19 vaccination coverage for the Aboriginal and Torres Strait Islander population by the end of June 2022 varied substantially by state, remoteness area, and LGA. Contextual factors such as the proportion of the overall population who identify as Aboriginal and/or Torres Strait Islander, the proportion of the total labour force employed, and the proportion of individuals who speak an Aboriginal or Torres Strait Islander language at home explained a substantial fraction of the geographic variation of COVID-19 vaccination rates.

To the best of our knowledge, this is the first study to investigate the role of geography in COVID-19 vaccination among Aboriginal and Torres Strait Islander Peoples in Australia. In Aotearoa/New Zealand, areas with higher proportions of the Māori population presented worse access to COVID-19 vaccination services, even though the Māori population are listed as a vaccination priority group.[21] Machado et al. reported a high variation in COVID-19 vaccination coverage across Indigenous health districts in Brazil, reflecting challenges for the vaccination program in regions with higher number of hard-to-reach communities.[22] These findings are aligned with the results reported in this study showing that LGAs located in rural areas present lower levels of COVID-19 vaccination. Disparities in vaccination based on remoteness may be influenced by contextual or geographical factors such as availability or distance to health services and area-level socioeconomic disadvantage. For instance, Aboriginal and Torres Strait Islander households located in remote areas are more likely to be overcrowded, which may contribute to increased risk for COVID-19 transmission.[23] In Australia, Aboriginal and Torres Strait Islander Peoples are more likely to live in non-metropolitan areas than non-Indigenous Australians (in 2021, 37.1% of the Aboriginal and Torres Strait Islander population resided in metropolitan areas compared to 71.7% of the general Australian population).[24]

By 30 June 2022, Australia had registered a total of 8,219 deaths from COVID-19 since the beginning of the pandemic. The number of COVID-19 deaths was more pronounced in areas with higher socioeconomic disadvantaged scores (locations in the most disadvantaged quintile had three times more deaths than locations in the least disadvantaged quintile).[25] Abundant evidence has been produced demonstrating that the most vulnerable communities are the most affected by the COVID-19 pandemic.[26–28] Our findings show that area-level socioeconomic relative advantage and disadvantage are also associated with regional levels of COVID-19 vaccination for the Aboriginal and Torres Strait Islander Peoples. Unequal access to COVID-19 vaccines is detrimental to protecting the communities of the most vulnerable districts in Australia, potentially leading to the exacerbation of existing racial and socioeconomic inequalities in COVID-19-related morbidity and mortality.

Sixteen months after the roll-out of the COVID-19 vaccination in Australia, two-dose coverage rates for the Aboriginal and Torres Strait Islander population in 132 LGAs remain below 80% (a milestone reached by the general Australian population in early November 2021). Our analysis revealed clusters of LGAs with low COVID-19 vaccination in regions of Queensland, South Australia, and Western Australia. These spatial effects seem to follow the first law of geography developed by Tobler in 1970 that states: "everything is related to everything else, but near things are more related than distant things".[29] COVID-19 restrictions were progressively lifted across states in Australia based on the vaccination roll-out for the general population.[5] Meanwhile, several Aboriginal and Torres Strait Islander Communities had not received adequate levels of vaccination, and new SARS-CoV-2 variants spread across the country, quickly escalating the rates of infections.

The lack of transparency in immunisation statistics for Aboriginal and Torres Strait Islander Communities during early stages of the roll-out prevented the diagnosis of the actual vaccination pace and coverage, undermining the development of strategies to fight the pandemic. LGA-level data on COVID-19 vaccination among the Aboriginal and Torres Strait Islander population was only made available by governments from November 2021, eight months after the start of the immunisation program. Transparent and regular reporting of area-level data on immunisation coverage should be a priority—particularly during health emergencies—as it allows ACCHOs and other key local stakeholders to inform their decisions and strategies.

From a health equity lens, it is important to closely examine locations with unexpectedly high vaccination coverage near areas of low vaccination. These areas might present unique local characteristics that have a special role in promoting better health outcomes for Aboriginal and Torres Strait Islander Communities. Machado et al. reported that a number of hard-to-reach Indigenous communities in Brazil reached high COVID-19 vaccination coverage, despite an overall low uptake in these regions.[22] Aboriginal and Torres Strait Islander Communities have a long history of resilience and growth while

overcoming profound adversity.[30] Although we were not able to determine which factors could explain these special cases, community resources, leadership, and cultural connection are likely to have an important influence on population vaccination rates. For instance, we observed that the proportion of individuals who speak an Aboriginal or Torres Strait Islander language at home was strongly associated with COVID-19 vaccination across all global and local spatial models. Connection to traditional languages not only fosters strong cultural identity and promotes wellbeing but also presents an enormous potential for renewed health promotion strategies. Gaborit et al. reported that 50 Aboriginal and Torres Strait Islander languages have been incorporated in 188 COVID-19 health promotion resources.[31] ACCHOs have played a central role in delivering evidence-based and culturally secure COVID-19 health messages to communities, as most of these resources were developed within the context of these services.[12]

The spatial dependence of the local R-square from the GWR model might be indicative of omitted variable bias. Our models did not include potentially relevant factors for Aboriginal and Torres Strait Islander COVID-19 vaccination rates such as access to digital information and population levels of vaccine hesitancy. Li observed that areas in United States with higher levels of digital exclusion had higher COVID-19 infection rates and mortality, in addition to lower vaccination rates.[32] Studies have shown that racial minority groups tend to have higher levels of vaccine hesitancy and lower confidence in COVID-19 vaccines.[33,34] Mosby and Swidrovich described how vaccine hesitancy among Indigenous Peoples from Canada is rooted in memories of racist medical experiments conducted with communities during the 20th century.[35] Similarly, distrust in governmental and medical institutions, fear of side effects, and negative stories on social media seem to play a significant role in driving vaccination hesitancy among Aboriginal Peoples in Australia.[36] Fears and concerns resulting from colonial past experiences forced onto Indigenous communities should be considered and seriously addressed by healthcare providers and not be mistaken for contemporary anti-vax movements that have more recently emerged.[35] Lower vaccination among racial minorities might also be explained by structural barriers such as unequal distribution of doses and lower availability of healthcare facilities that serve as COVID-19 vaccine administration sites in rural areas.[37] Atwell et al. commented on how the discussions around vaccine hesitancy place an excessive responsibility for the success of an immunisation strategy on individuals, when in fact the governments maintain the power to make vaccines accepted and readily accessible for society on the whole.[38] Framing the issue of low vaccination uptake around matters of personal choice systematically overlooks poor management and lack of planning for ensuring that immunisation services reach the most disadvantaged groups in the society.

ACCHOs were pivotal in promoting COVID-19 vaccination uptake and contributing to the broader public health response to COVID-19 in Australia. ACCHOs' leadership and expertise placed Aboriginal and Torres Strait Islander Communities at the forefront of the COVID-19 immunisation campaign. Prioritising vaccination for Aboriginal and Torres Strait Islander populations is imperative not only from an ethical perspective but also from epidemiological, social, and cultural points of view.[39,40] The priority, in this case, should not be restricted to offering the opportunity for Aboriginal and Torres Strait Islander populations to receive the vaccine in the early stages of the roll-out. By actively and continuously identifying districts and communities that require additional vaccination efforts or have an increased vulnerability to COVID-19, vaccination programs can play an important role in promoting social and racial justice. It should be noted that, in addition to sharing similar socio-demographic characteristics, clusters of neighbouring districts reflect socially connected Aboriginal and Torres Strait Islander Communities. Vaccination strategies that target geographic areas with higher vulnerability and focus on providing vaccines to all household members align with Aboriginal and Torres Strait Islander perspectives of collective wellbeing,[41] in addition to impacting SARS-CoV-2 transmission dynamics.

Analyses were limited by the availability of area-level data for Aboriginal and Torres Strait Islander Australians. Important factors for explaining the spatial distribution of COVID-19 vaccination coverage in these populations may not have been included. For instance, this study does not account for population levels of vaccine hesitancy, access to online information, local response to the pandemic, and availability of immunisation services. Vaccination rates may be influenced by the denominator used for each location. Future research may investigate barriers and enablers of vaccination at the Aboriginal Community Controlled Organisations level and post-pandemic vaccination willingness and hesitancy in Aboriginal Communities.

Conclusion

Geographic clusters with distinct levels of COVID-19 vaccination among Aboriginal and Torres Strait Islander populations were identified across Australia. LGA-level characteristics of Aboriginal and Torres Strait Islander Communities such as speaking a traditional language, employment rate, and the proportion of the Indigenous population had, on average, larger associations with COVID-19 vaccination coverage throughout all geographic units. Geography plays an important role in the accessibility and uptake of COVID-19 vaccines among Aboriginal and Torres Strait Islanders. High coverage rates were observed among *Deadly* Aboriginal and Torres Strait Islander Communities, indicating the important role of Community strengths and resilience. This study raises important questions for health surveillance and planning of vaccination strategies that aim to promote racial justice for all Australians.

Funding

There was no funding involved in this study.

Ethics

The data used in this study is publicly available. Therefore, ethics approval was not required.

Conflicts of interest

The authors have no competing interests to declare.

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Appendix A Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.anzjph.2024.100130.