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Summaries

Gaps in measles immunisation coverage for pre-school children in Aotearoa New Zealand: a cross-sectional study

Nienke N Hagedoorn, Andrew Anglemyer, Tony Walls

Measles is a disease caused by a virus that can easily spread from person to person. Children under the age of 5 who have not received a vaccine are at a high risk of getting very sick or even dying from measles. Since the borders in New Zealand have fully opened and the number of measles cases around the world has increased, the chances of measles being imported into New Zealand have also gone up. We found that fewer children are getting vaccinated against measles—in fact, the coverage for the first measles, mumps, rubella (MMR1) vaccine has dropped from 95.1% for those born in 2017 to 88.9% for those born in 2020. This means that there are not enough children under the age of 5 who are protected against measles to stop a potential measles outbreak.

Outcomes and access to angiography following non-ST-segment elevation acute coronary syndromes in patients who present to rural or urban hospitals: ANZACS-QI 72

Rory Miller, Garry Nixon, Robin M Turner, Tim Stokes, Rawiri Keenan, Corina Grey, Yannan Jiang, Andrew Kerr

This study shows that for patients that present to rural hospitals or hospitals without routine access to advanced cardiology interventions with heart attacks, they are less likely to have angiography (an invasive testy to determine whether the arteries that supply the heart are blocked or narrowed) compared to urban hospitals where this was readily available. However, there was no significant difference in the chances of dying between the three groups of hospitals (rural hospitals, smaller urban hospitals or urban hospitals with advanced cardiology intervention) either at 30 days after the heart attack. There was a small increase in the chances of dying after 2 years for patients that presented to rural hospitals, the reasons for this are unclear and not able to be answered by this study.

Exploring the current and future osteoarthritis health service delivery needs in Aotearoa New Zealand

Daniel W O'Brien, Sam Norman, Rebecca Grainger, Richard Ellis, Ben Hudson, Ivana Nakarada-Kordic, J Haxby Abbott

In 2021 the OA Basecamp Symposium was launched in Auckland to bring together clinicians from all disciplines, health delivery organisations, consumers and researchers interested in OA management in Aotearoa New Zealand. The symposium included a co-design workshop to capture views about current and future OA health service delivery. The results highlighted several promising current healthcare delivery initiatives. Health literacy and obesity prevention policies featured in the thematic analysis suggest a lifespan or systemwide approach is needed. Data highlighted a need for reformed systems that enhances hauora/wellbeing, promotes physical activity and facilitates interprofessional service delivery and collaboration across care settings.

Skin-to-deltoid-muscle distance at three recommended sites for intramuscular vaccination in a population with obesity: an observational study

Marjan Doppen, Melissa Black, Irene Braithwaite, Jonathan Bong, Allie Eathorne, Louis Kirton, Stacey Kung, Michaela Walton, Thomas Hills, Mark Weatherall, Richard Beasley, Ciléin Kearns

Guidance on how to choose the site of injection for vaccines given into the deltoid (shoulder) muscle differs internationally. The site of injection affects the distance from the skin to the muscle. Many people with obesity should be vaccinated with a longer needle to ensure the vaccine is injected into the deltoid muscle.

Patient factors associated with appointment non-attendance at an ophthalmology department in Aotearoa New Zealand

Jackie Low, William J Cunningham, Rachael L Niederer, Helen V Danesh-Meyer

Non-attendance to appointments is a common problem for all medical specialist clinics including ophthalmology services, with widespread implications to the patients and the health system. This study aimed to explore and identify patient demographic variables associated with appointment non-attendance in a large public ophthalmology clinic in Auckland, New Zealand. It was observed that ethnicity, age and deprivation score are associated with non-attendance, with Māori and Pasifika ethnic groups, younger patients and patients with a higher New Zealand Deprivation Index score (an area-based measure of socio-economic status) significantly impacted by higher rates of non-attendance. These results suggest that there are critical barriers to accessing eye care that disproportionately affect these at-risk population groups. This study therefore identifies a greater need for our health workforce and health system to further improve on providing better patient care, and develop targeted interventions addressing access barriers for our Māori, Pasifika, young and socially disadvantaged patients.

A critical Tiriti analysis of Te Pae Tata: the Interim New Zealand Health Plan

Ngaire Rae, Heather Came, Leah Bain, Alana McCambridge

The newly reformed health system has stated aims to reflect a Te Tiriti partnership and embed equity. A core marker in measuring progress towards these aims is Te Pae Tata: the Interim New Zealand Health Plan. This paper analysed the Plan from a critical Te Tiriti lens and found good engagement with ōritetanga (equity) and fair to poor engagement on other criteria. A Te Tiriti compliant plan (and health system) will require the Crown to recognise that Māori never ceded sovereignty and treaty principles are not equivalent to the authoritative Māori text.

Investigating attitudes and insights into the global warming impact of inhalers

Matthew J Woodall, John Ma, Kate Emett, Amelia PE Hamblin, Katie Knowles, Tom Hyunwoo Lee, Wilson Mitchell, Wennarator Irae Ofoia, Letoe Renee Topeto, John D Dockerty, Robert J Hancox

Most clinicians and patients are willing to consider changing the type of inhaler they use to protect the environment. The propellants in currently available pressurised respiratory inhalers are potent greenhouse gases, and make up a substantial part of the carbon footprint of health services in New Zealand and many countries. Alternative types of inhaler are available that don't use propellants and have a much lower global warming effect, but these are used less often, despite being equally effective for most people. We asked prescribers and patients whether they would be willing to consider the environmental impact of inhalers when deciding which ones to use. Although everyone agreed that it was most important to have an inhaler that is effective and easy to use, most patients and clinicians were willing to consider the environment in their inhaler choice.

A further look into obtaining informed consent for medical students

Ekta Bagga, Edmund Leung

This paper investigates the understanding of obtaining informed consent for involvement of medical students and adherence to ethical guidelines. The population we investigated were medical students and senior doctors at Taranaki hospital. Based on our results we have complied some recommendations to improve the currently sub-optimal consenting process.

Superheated storms: climate drivers, health effects and responses

Rhys Jones, Alex Macmillan, Alistair Woodward

The first 2 months of 2023 brought unprecedented rainfall and flooding to the North Island of Aotearoa New Zealand, especially Tāmaki Makaurau, the Coromandel, Tairāwhiti and Hawke's Bay. This has triggered a public health crisis and exacerbates the already unacceptable health burden experienced by Māori, Pasifika and other structurally oppressed communities. These storms show us how our climate pollution is driving severe weather, and that every action to recover must also be an action to prevent further devastating events. They also send a clear message that prevention means systemic decolonisation and restoration of Indigenous relationships with the land and waterways.

On 10 January, Cyclone Hale hit hard in the Northeast and was followed several weeks later by an unexpected and unprecedented rainstorm in Tāmaki Makaurau—parts of the city received 3 months' average rainfall in a single day. This caused widespread damage to houses, businesses and vital infrastructure. Shortly after, ex-tropical Cyclone Gabrielle brought further record rains and devastation, especially to the east coast of the North Island. The worst-affected areas of Tairāwhiti and Hawke's Bay experienced large-scale flooding, slips and destructive landslides, with damage often compounded by forestry debris. The floods were remarkable in the volume of rain that fell, the speed with which they occurred, the accompanying wind and uncertainty about the path of the water, leaving little time for early warnings or preparation. In total, there were 11 deaths from drowning and injuries, nearly 225,000 people lost power[1] and thousands were cut off from essential supplies, with many trapped in uninhabitable homes.

Health impacts

It is too soon to determine the full health losses, but it is likely they will be substantial. Previous research in Aotearoa demonstrated that with every heavy rainfall event comes a surge in hospital admissions for children with gastroenteritis.[2] Hawke's Bay is already seeing an increase in cases of leptospirosis resulting from contact with flood waters on livestock farms.[3] In Napier, the wastewater treatment plant was severely damaged by silt, leaving it inoperable with untreated sewage being discharged to the sea. As a result, kaimoana has been dangerous to harvest and beach-swimming unsafe. The current marine heatwave is not only driving storm severity, but also making the consequences worse, because enteric pathogens flourish in warmer waters.

Immediate effects on mental health are often hidden and underestimated. Prone as the East Coast is to catching the tail end of cyclones, residents there were already speaking of feeling "paranoid" about the safety of their families and homes whenever the rain falls, with this chronic level of fear and anxiety affecting their mental health. This is reflected in the research literature about the public health effects of flooding and sea level rise, where post-traumatic stress disorder and psychological effects are major features.[4] Studies of the longer-term effects of flood events like these are very rare and difficult to undertake, likely underestimating the mental and physical health effects. In a United Kingdom exception, more than half of the participants reported that they were experiencing physical and mental health effects attributable to flooding at 4 years following the initial event.[5]

Longer-term effects are to be expected with such widespread damage to housing and other buildings on top of an existing housing crisis. Not all affected buildings have yet been assessed, but by 2 March, 750 buildings had been condemned, while access to more than 3,500 was restricted by damage, and a further 4,600 had possible unseen damage making them unsafe.[6] Many of these are houses in areas where housing quality, availability and affordability are already significant public health issues, for example in Wairoa where over 150 houses were red- or yellow-stickered. For many of the lowest-income families, without insurance, returning to a yellow-stickered home and continuing to live in it as it gets mouldier are the only things they can do, despite serious long-term effects on health

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and safety.

Both short- and long-term effects on health disproportionately affect communities who already face structural disadvantage. Māori, Pasifika, disabled people, low-income households and those living in marginal housing are among those hit hardest by the recent floods and storms. These events also exacerbate inequities for rural communities, in particular the most remote Māori communities, where structural racism, socio-economic deprivation and rurality already intersect to compound health inequities.[7] Climate change is widely acknowledged as a threat multiplier, and is recognised by Indigenous peoples as an intensification of colonialism,[8] and the legacy of privilege and oppression can be clearly seen in the inequitable impacts of these events in Aotearoa.

What's driving these extreme events?

These severe storms show us how climate change-related heating of oceans and air are making storms more frequent and more severe, especially when coupled with La Niña's pattern of warmer oceans and tropical cyclones. In March, the World Weather Attribution group concluded that the very heavy rain associated with Cyclone Gabrielle was now four times more likely and that each storm now brings a third more rain on average than when the world's weather was not affected by our climate pollution, and was 1.2°C cooler.[9]

It's not just the weather, though. Coupled with climate change effects on storms and rainfall are the roles of geography and our land use choices. The North Island's steep hillsides and exposed friable soils make it prone to slips and landslides. Its northern and eastern extremities are frequently in the paths of storms moving south out of the tropics. These risks are amplified by land use, especially the clearance of native forests to be replaced by high emissions livestock farming, and exotic plantation forests, as well as the extension of human settlements into low-lying river valleys and steep, exposed coastal areas.

These environmental transformations that have increased our susceptibility to flood events are a direct legacy of settler colonialism in Aotearoa.[10] The associated marginalisation of Indigenous knowledges and disruption of Māori relationships with the whenua has not only underpinned current risks, but further undermines our ability to prevent and manage worsening threats.

How should we respond?

Global inaction on climate change so far, including here in Aotearoa, means that adapting to the current level of warming is crucial. But adaptation is not just about engineering to protect current static living patterns: social and institutional responses need to work with dynamic land- and water-scapes, and revisit the framing and response to extreme weather. Centralising Māori conceptualisations can help us understand severe weather as dynamic parts of ecological cycles, with potential benefits for humans and the environment (e.g., improving the fertility of soils).[10]

This emphasises the importance of Indigenous worldviews, value systems and knowledges in developing healthy responses to climate change. However, agencies must go further than simply recognising mātauranga Māori; they must uphold the right to self-determination for tangata whenua, so that relationships with whenua can be restored and responsibilities such as kaitiakitanga fulfilled. Iwi- and hapū-led responses have been critical in protecting and supporting communities, both in the immediate period after these events and in the longer-term recovery. An important part of building resilience in future will be growing the capacity of iwi, hapū, marae and other Māori communities, and strengthening Tiriti-based partnerships and local participatory planning.

Cutting our emissions remains the best prevention measure. There is a real risk that attention and resources will now be diverted towards dealing with the escalating effects of the climate crisis, leaving emissions reduction a lower priority. Indeed, there have been explicit calls for such an approach in the aftermath of Cyclone Gabrielle.[11] However, this narrative is ill informed and dangerous. It is akin to furiously bailing water out of a sinking ship while doing nothing to fix the ever-expanding leak. "Business as usual" policies on climate change put the world on track to heat by 3 degrees or more above pre-industrial temperatures by 2100, roughly three times what has occurred so far.[12] The damage caused in New Zealand this year by supercharged storms and floods will be a pale version of what's to come if we continue on our current path.

To be able to manage both mitigation and adaptation, we must reconceptualise climate action. While they are separated in national legislation and policy, they need to be integrated in implementation, avoiding tensions between them,

as well as prioritising responses that address other social justice and health equity goals.

For instance, housing and land use planning requires transformation to tick all boxes for health equity, access, zero emissions and climate change adaptation. A fundamental shift is needed from a market-led approach to a systemic, integrated government- and community-led approach for the provision of healthy homes as a human right. Houses must be built in the right places for access and resilience to severe weather and incorporate zero carbon designs, energy sources and construction. For example, energy-efficient housing powered by subsidised local renewables (like roof-top solar and local wind) reduces emissions and helps address energy poverty, while also buffering against grid-level power outages during extreme weather events. Rural land use and agricultural reforms must also simultaneously reduce dependence on fossil fuels, improve resilience in the face of climate extremes and cut methane emissions.

Notably, many of these climate change mitigation-adaptation strategies have substantial benefits for health and wellbeing, for example due to improved freshwater quality, healthier diets, increased physical activity and healthier indoor environments. If designed in ways that are inclusive and just, with Te Tiriti at the centre, they can also make significant contributions to health equity.

Health professional training and support is also needed, particularly in rural areas, so that we can play our required roles: protecting public health during and in the aftermath of flooding; putting health equity and Te Tiriti at the heart of recovery; and advocating for integrated approaches to healthy, equitable climate action. A recent national survey exposed structural underpreparedness of rural general practices to respond to these role requirements, calling for capacity building and resourcing for both adaptation and mitigation.[13]

The recent superheated storms show us what a terrible race we are in to avoid catastrophic trajectories. They also show us that the current "bread-and-butter" political compromises on climate action ignore the uncompromising nature of climate physics, which isn't waiting for another election. We now have to face up to the need for integrative responses to extreme weather, while also tackling the root causes of climate change. Colonial economic values, governance systems and living practices have driven the climate crisis and underpin our susceptibility to the ensuing storms. We must disinvest from these systems and instead centre Indigenous knowledges and restoration of relationships to address the fundamental causes of public health and ecological crises.

COMPETING INTERESTS
No competing interests.

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AUTHOR INFORMATION
Rhys Jones: Associate Professor, Te Kupenga Hauora Māori, The University of Auckland, Auckland.
Alex Macmillan: Associate Professor, Department of Preventive and Social Medicine, University of Otago, Dunedin.
Alistair Woodward: Professor, Department of Epidemiology and Biostatistics, The University of Auckland, Auckland.

CORRESPONDING AUTHOR
Associate Professor Rhys Jones: Te Kupenga Hauora Māori, The University of Auckland, Private Bag 92019, Auckland. Ph: (09) 923 6278. E: rg.jones@auckland.ac.nz

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Gaps in measles immunisation coverage for pre-school children in Aotearoa New Zealand: a cross-sectional study

Nienke N Hagedoorn, Andrew Anglemyer, Tony Walls

ABSTRACT

AIMS: To evaluate gaps in measles immunisation coverage for children <5 years in Aotearoa New Zealand.

METHODS: In this cross-sectional study, we extracted coverage rates for the first measles, mumps and rubella (MMR1) vaccine and second MMR vaccine (MMR2) from the National Immunisation Register for birth cohorts 2017 to 2020. We described measles coverage rates per birth cohort, and stratified per district health board (DHB), ethnicity and deprivation quintile.

RESULTS: Coverage for MMR1 declined from 95.1% for those born in 2017 to 88.9% for those born in 2020. The coverage for MMR2 was below 90% for all the birth cohorts, with the lowest MMR2 coverage in the birth cohort of 2018 (61.6%). MMR1 coverage was lowest for children of Māori ethnicity and coverage declined over time: 92.8% for those born in 2017 to 78.4% for those born in 2020. Six DHBs had average MMR1 coverage <90% including Bay of Plenty, Lakes, Northland, Tairāwhiti, West Coast and Whanganui.

CONCLUSIONS: Immunisation coverage rates for measles are insufficient to prevent a potential measles outbreak in children <5 years. Concerningly, the coverage for MMR1 is declining, especially in Māori children. Catch-up immunisation programmes are urgently needed to improve immunisation coverage.

Measles is a highly contagious disease resulting from measles virus infection. Since the implementation of measles vaccines in the 1960s, incidence of measles and associated mortality have been largely reduced. Nevertheless, the global number of deaths that were attributed to measles was estimated to be over 140,000 in 2018, mainly occurring in low-income countries in Africa and Asia.[1,2] In particular, unvaccinated children under 5 years of age are at high risk for measles-related complications leading to hospital admission or even death.

Aotearoa New Zealand has notable immunity gaps in the population and the measles immunisation coverage target of ≥95% to prevent measles transmission has not yet been reached. Over the last few decades, following improvements in the national immunisation programme, immunisation coverage has increased (fully immunised at 2 years: 56% in 1992 to 91% in 2019).[3,4] For the birth cohorts of 1980–1999, the historically mediocre coverage rates have created an immunity gap due to insufficient measles immunity. Although catch-up immunisations have been offered, the immunisation coverage numbers for the birth cohorts of 1980–1999 are unclear.[5,6] Furthermore, in 2020 and 2021 New Zealand immunisation coverage rates have decreased relative to previous years (fully immunised at 2 years: 76% in 2020 and 85% in 2021), likely partly due to disrupted routine immunisation programmes early in the COVID-19 pandemic—a development that was also observed in other countries.[7–11] In addition, important differences in immunisation coverage exist between ethnicity groups, with lower coverage in Māori and Pacific peoples.

In 2017, New Zealand received a measles-free status following the absence of local transmission in the previous 3 years. Recent outbreaks in New Zealand have been linked to imported cases, and since a large outbreak in 2019 there have been no measles notifications.[12] Importantly, New Zealand is connected with the Pacific Islands and frequent travel across the Pacific occurs. Following the New Zealand measles outbreak in 2019, measles then spread to Samoa and caused a great impact with 83 deaths in a population of 200,874, of which 87% occurred in children <5 years.[13]

Since April 2022, measles outbreaks have been globally reported and have mainly occurred in Africa and the East Mediterranean region.[14] In July 2022, the New Zealand borders fully opened and, together with increasing measles cases worldwide, the likelihood of imported measles cases has increased. Identification of immunity gaps is important to specifically target public health

resources. Therefore, in this study we aimed to describe gaps in immunisation coverage by ethnicity, socio-economic deprivation and region for measles in New Zealand children under 5 years of age.

Methods

Study design and the New Zealand measles immunisation programme

This was a cross-sectional study using publicly available data from the National Immunisation Register (NIR).[7] This study is exempt of ethics review as the study involved analysis of publicly available data that do not contain any sensitive health information. The data is held and curated by the New Zealand Ministry of Health.

The NIR records immunisation details for children born since 2005. Since 1 October 2020, the New Zealand immunisation schedule recommends that children to receive the first measles, mumps and rubella (MMR1) vaccine at 12 months (circa 95% seroconversion), and the second MMR (MMR2) vaccine at 15 months (circa 99% seroconversion). Prior to 1 October 2020, MMR dose one was administered at 15 months of age and MMR dose two was administered at 4 years of age. Following the measles outbreak in 2019, a measles immunisation campaign was implemented to improve immunisation rates. Activities for this campaign included maximising the uptake of MMR at 15 months and at 4 years with an active recall for children <5 years who had missed either of these two doses, and an MMR 0 dose for babies from 6–11 months old in the Auckland region.

Data collection

We extracted measles coverage rates for the MMR1 vaccine and the MMR2 vaccine for birth cohorts 2017 through 2020 on 22 June 2022. In these cohorts, all included children were offered MMR1. The MMR2 coverage rates, however, were influenced by the programme change in October 2020. Therefore, children who received MMR1 on time at 15 months may not have been offered a second dose before 4 years of age. Stratified data were extracted by prioritised ethnic group, by district health board (DHB) and by socio-economic deprivation quintile (1 to 5) defined by the New Zealand Deprivation Index 2018 (*NZDep2018)*.[15] Deprivation quintile 1 represents areas with the least deprived scores, whereas deprivation quintile 5 represent areas with the most deprived scores. Though DHBs no longer exist as of mid-2022, for ease of interpretation and consistency with historical data, we retain the DHBs. We assessed population density using data from Statistics New Zealand. In addition, we collected data from previous measles outbreaks from the New Zealand Ministry of Health.

Data analysis

Firstly, we described MMR1 and MMR2 coverage rate, and whether the immunisation coverage rate was ≥90%. Although we planned a description of the MMR coverage target of ≥95%, we chose the 90% cut-off as none of the birth cohorts reached the 95% cut-off for MMR2. We combined data for the 2017–2020 birth cohorts, and also presented data for each birth cohort separately. Secondly, we stratified for ethnicity groups and per deprivation quintile. Thirdly, we illustrated MMR1 and MMR2 coverage per DHB using geographical heatmaps. Since DHBs comprise large areas and population density is a risk factor for a future measles outbreak, we performed a subgroup analysis of the 10 Territorial Authorities with the highest population density (Appendix 1). Next, since the Auckland region has the largest population, we performed a more detailed geographic analysis using coverage rates per the 2013 Area Unit (AU). In an urban setting such as Auckland, an AU is generally a collection of city blocks. Lastly, we described the DHBs with highest case and hospitalisation counts in the 2019 measles outbreak.[16] Children with missing data on deprivation quintile (<1%) or whose DHBs were classified “undefined or overseas” (<1%) were excluded from stratified analysis. All analyses were performed in R version 4.2.

Results

Overall MMR coverage

Overall, the coverage for MMR1 was 92.5% and the coverage for MMR2 was 74.6% for children born between 2017 and 2020. The coverage for MMR1 declined from 95.1% for those born in 2017 to 88.9% for those born in 2020 (Figure 1a). The coverage for MMR2 was below 90% for the studied birth cohorts: the lowest MMR2 coverage was observed for the birth cohort of 2018 (61.6%). MMR2 coverage increased for those born in 2019 (72.8%) and in 2020 (80.3%).

Figure 1: MMR1 (A) and MMR2 (B) coverage rates for birth cohorts 2017–2020: overall and per ethnicity. Data shown in Appendix 2.

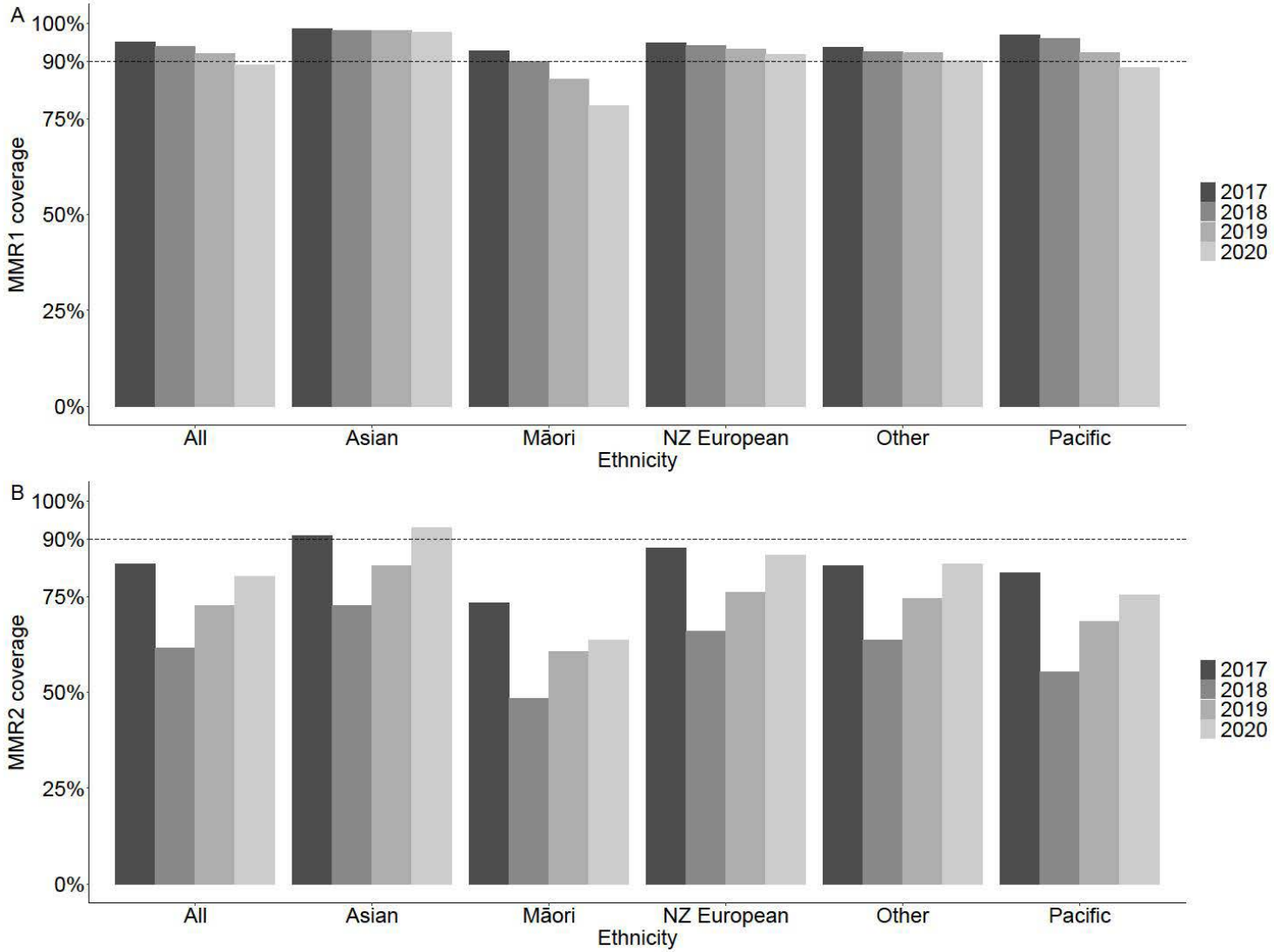
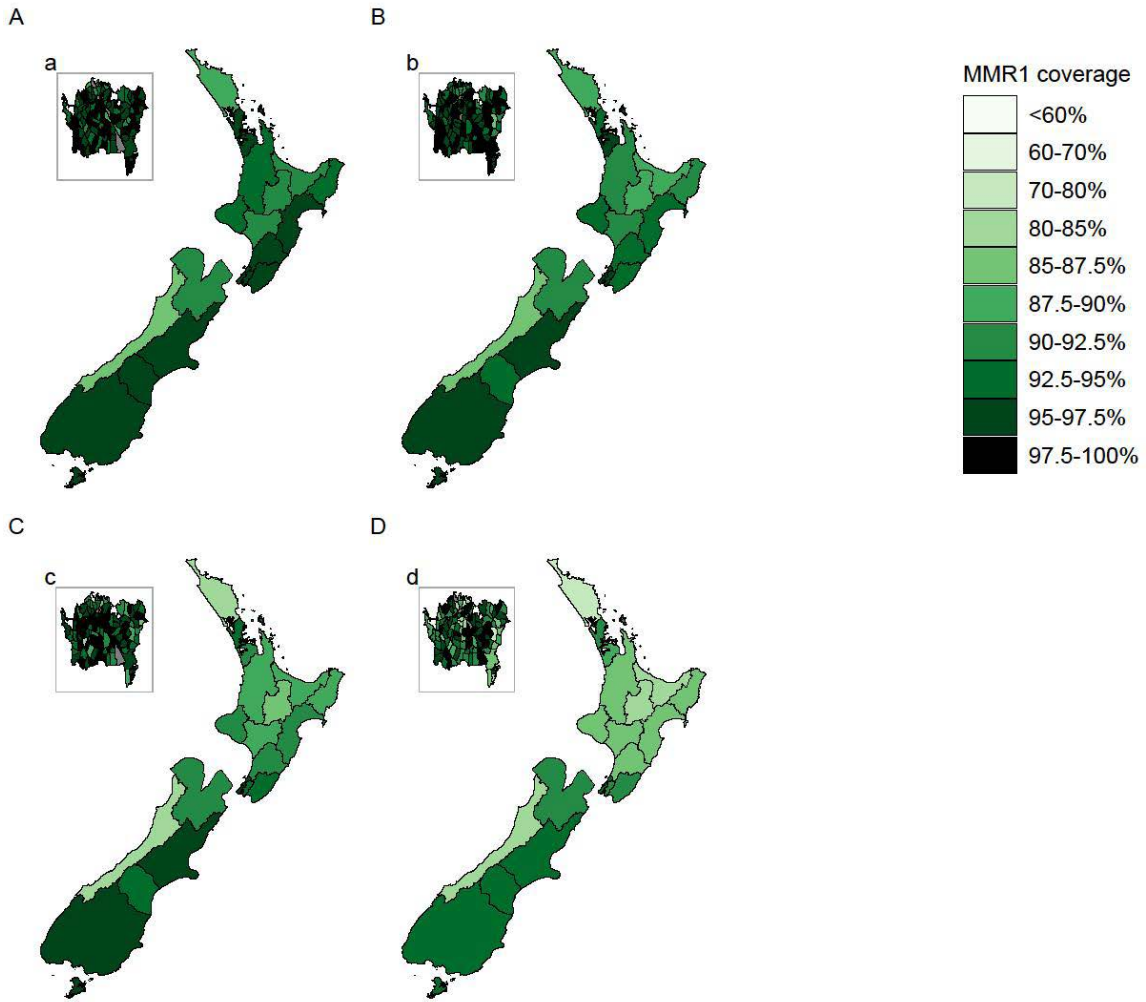
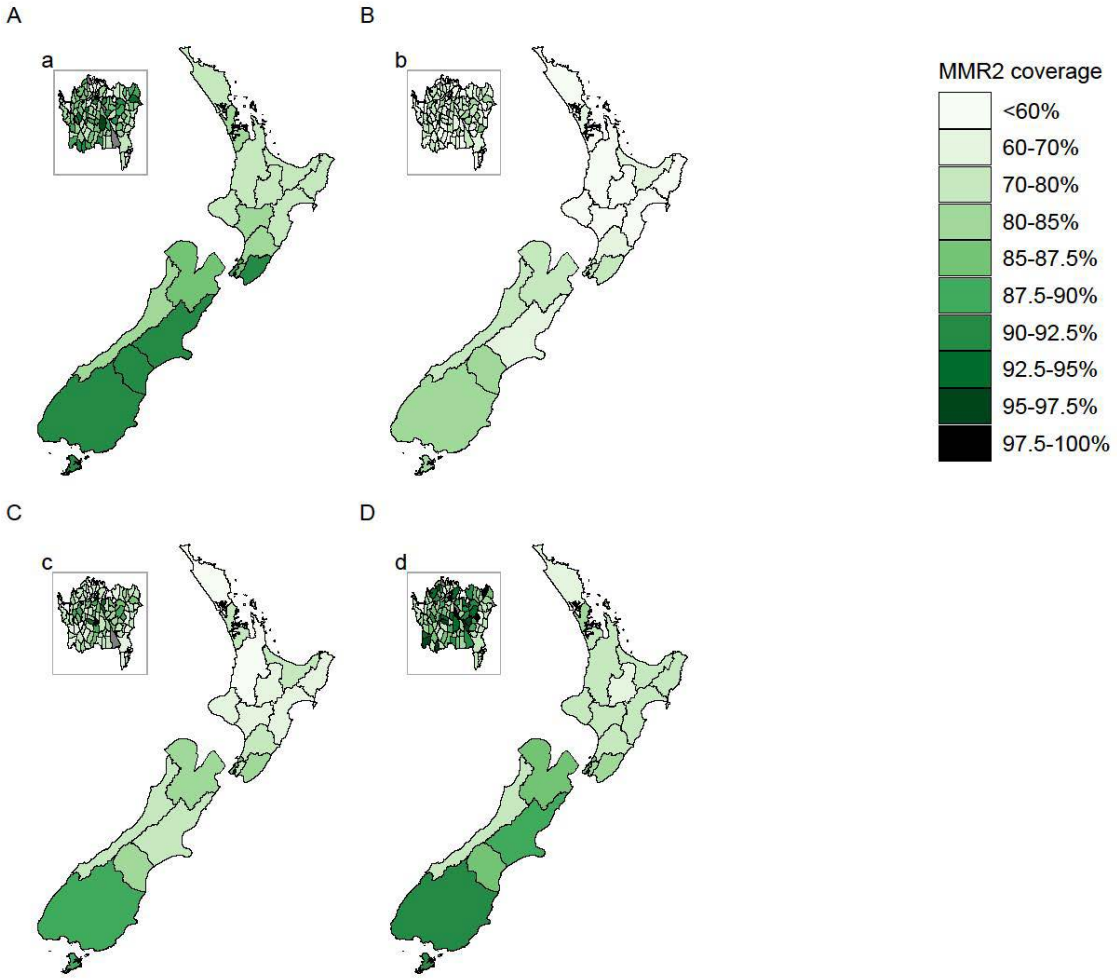


Figure 2: MMR1 coverage per DHB (A: birth cohort 2017; B: birth cohort 2018; C: birth cohort 2019; D: birth cohort 2020) and MMR1 coverage per Area Unit for the Auckland Region (a: birth cohort 2017; b: birth cohort 2018; c: birth cohort 2019; d: birth cohort 2020).



Auckland area units with <10 eligible children are coloured grey.

Figure 3: MMR2 coverage per DHB (A: birth cohort 2017, B: birth cohort 2018, C: birth cohort 2019, D: birth cohort 2020) and MMR2 coverage per Area Unit for the Auckland Region (a: birth cohort 2017, b: birth cohort 2018, c: birth cohort 2019, d: birth cohort 2020).



Auckland area units with <10 eligible children are coloured grey.

Table 1: MMR1 and MMR2 coverage for 10 territorial authorities with highest population density.

Territorial authority	Population density (persons/km2)	Average MMR1 coverage for birth cohorts 2017–2020 (%)	Average MMR2 coverage for birth cohorts 2017–2020 (%)
Hamilton	1,805	**91.3**	**62.8**
Tauranga	1,185	**89.7**	**78.3**
Wellington	747	96.9	90.0
Napier	628	**93.3**	**69.0**
Porirua	349	**94.4**	**77.8**
Kawerau	346	**85.3**	**72.3**
Lower Hutt	298	**94.2**	**81.0**
Christchurch	277	**95.5**	**82.9**
Auckland	271	**93.4**	**73.8**
Palmerston North	269	**93.6**	**80.5**

The coloured boxes represent rank of MMR1 or MMR2 coverage: white represents the highest coverage and red represents the lowest coverage for the 10 territorial authorities.

MMR coverage per ethnicity

Coverage for MMR1 was above 90% in all birth cohorts for children of Asian ethnicity (range 97.6% to 98.4%), NZ European ethnicity (range 91.7% to 94.8%) and children of other ethnicity (range 90.1% to 93.7%) (Figure 1a). MMR1 coverage was lowest for children of Māori ethnicity and coverage declined over time: from 92.8% for the 2017 birth cohort to 78.4% for the 2020 birth cohort. For Pacific children MMR1 coverage was above 90% for those born in 2017 to 2019 (range 92.3% to 97.0%) but was 88.3% for those born in 2020.

MMR2 coverage was <90% for all birth cohorts in each ethnic group, with the exception of children of Asian ethnicity in the birth cohorts of 2017 and 2020 (Figure 1b). For all the ethnicity groups, MMR2 coverage was lowest for the 2018 cohort (NZ European 66.1%; Māori 48.4%; Pacific 55.5%; Asian 72.7%; Other 63.6%). MMR2 coverage increased for all the ethnicities in the birth cohorts of 2019 and 2020, although coverage has not yet reached the 2017 level for children of Māori, Pacific and NZ European ethnicities.

MMR coverage per socio-economic deprivation quintile

MMR1 and MMR2 coverage was lower in the more socio-economically deprived areas compared to less deprived areas (Appendix 3). The difference of MMR1 coverage between the least deprived areas and the most deprived areas increased from 1.7% in birth cohort 2017 to 9.2% in birth cohort 2020. The difference of MMR2 coverage between the least deprived areas and the most deprived areas ranged from 12.5% (birth cohort 2017) to 17.5% (birth cohort 2018), and was around 15% for birth cohorts 2019 and 2020.

MMR coverage per DHB level

Across the birth cohorts, MMR1 coverage decreased in all DHBs (Figure 2). Six DHBs had an average MMR1 coverage <90% (Bay of Plenty, Lakes, Northland, Tairāwhiti, West Coast and Whanganui). None of the DHBs had MMR2 coverage >90% (Figure 3). For the birth cohorts 2017–2020 combined, the lowest MMR2 coverage was observed in Northland (59.1%), Waikato (61.2%) and Lakes (62.1%) (Appendix 4).

MMR coverage for top 10 population density areas

The 10 areas with the highest population density are presented in Table 1. The average MMR1 coverage was below 90% for Kawerau and Tauranga. Apart from Wellington, the other areas all had MMR2 coverage <90%. Average MMR2 coverage was lowest for Hamilton (62.8%), Napier (68.9%)

and Auckland (73.8%).

For all birth cohorts, coverage for Auckland was above 90% for MMR1 (range 92.3% to 96.6%) whereas coverage for MMR2 was below <90% (range 67.4% to 83.7%). MMR1 and MMR2 coverage varied across AUs for Auckland (Figure 2 and Figure 3). For the Auckland area, the number of AUs with MMR1 coverage <90% increased from 2/106 (1.9%) in birth cohort 2017 to 26/106 (24.5%) in birth cohort 2020. For almost all AUs, MMR2 coverage was <90% for those born in 2018 (101/106, 95%) and in 2019 (98/106, 92.5%).

2019 measles outbreak

In the 2019 measles outbreak the Auckland metropolitan area was most affected. The DHBs with the highest measles incidence in the 2019 outbreak included Counties Manukau (measles incidence 202 cases per 100,000; hospitalisation rate 77 cases per 100,000), Northland, Auckland and Waitematā (Appendix 5). In these DHBs, MMR1 coverage decreased across the different birth cohorts. For the 2017 and the 2018 birth cohorts combined, the MMR1 coverage was 93.2% in Counties Manukau, 84.4% in Northland, 95.1% in Auckland and 93.8% in Waitematā. For those born in 2020, MMR1 coverage was 89.2% in Counties Manukau, 77.0% in Northland, 92.2% in Auckland and 90.3% in Waitematā.

Discussion

In this cross-sectional study, we assessed measles vaccine coverage rates in young children in New Zealand. Concerningly, coverage for MMR1 has been declining, especially in Māori children. In addition, MMR1 coverage declined in all DHBs, with six DHBs having average MMR1 coverage <90% for the birth cohorts of 2017 to 2020. Immunisation coverage for measles is therefore insufficient to prevent community transmission in young children.

Globally, the World Health Organization reported that coverage of at least one dose of measles vaccine was 81% in children 2 years of age in 2020. For children in New Zealand born between 2017 and 2020, the MMR1 coverage is 92.5%, which is higher compared to the global average, and is similar to the coverage in other high-income countries (MMR1 93%).[17] In order to prevent measles transmission in New Zealand, the current coverage should be increased to reach the 95% target.

The heterogeneous immunity in the New Zealand population remains a risk factor for any future measles outbreak. Contributing factors to the 2019 measles outbreak included the recent decline in infant immunisation coverage in addition to the immunity gap in young adults, especially those of Māori or Pacific ethnicity.[5] Our study focussed on the description of immunisation coverage in young children as this group is at highest risk for measles-related complications. We acknowledge the lower immunisation coverage in young adults, who may have a key role in the importation and transmission of measles in New Zealand communities. However, these cohorts received MMR vaccines prior to the commencement of the NIR, which makes accurate estimates of coverage challenging. To address the immunity gap in young people both up-to-date immunisation records and the immunisation coverage should be improved.[5,6]

Hayman et al. analysed risk factors for measles up to 2014 in New Zealand, and observed that the greatest measles importation risk is during December in which a high peak of travel occurs. Likewise, measles is probably imported from regions with both high travel rates (e.g., Australia, United Kingdom) and higher measles incidence (e.g., China, Indonesia).[18] During the COVID-19 pandemic, the risk of importing measles had been minimised due to the New Zealand border restrictions. With the opening of the borders in July 2022, together with the recent increase of measles cases in Africa and the East Mediterranean, there is an increased risk of measles importation through international travellers. Besides the risk of importing measles to New Zealand, a measles outbreak could also influence the risk of exporting measles to Pacific islands where health systems are more fragile.

Since the start of the COVID-19 pandemic, many countries have had disruptions of their routine immunisation services. Worldwide, coverage of the first dose of the measles vaccine has fallen about 7% from 2020 compared to 2019.[19] In New Zealand, MMR1 coverage was already declining before 2020, along with a declining trend in coverage for all childhood immunisations that has been observed since 2015.[20] Our study showed that a decreasing trend for MMR1 has been observed in all DHBs, emphasising that a national programme is needed to improve immunisation coverage. In the 2019 measles outbreak, the metropolitan area of Auckland was most affected with over half of the measles cases occurring in Counties Manukau. In children born between 2017 and 2018, the combined MMR1 coverage for Counties Manukau was 93.2% This emphasises that measles immunisation coverage needs to be higher to reduce the chances of

transmission. It should be noted, however, that the immunity gap in adolescents could have played a role in this outbreak. Further, the previous outbreak could have increased the immunisation coverage in this area.

Immunisation coverage for measles varied by ethnicity with highest coverage rates in Asian children and lowest coverage in Māori. Previous research has shown that the higher immunisation rates in Asian children are mainly due to the positive attitude of parents towards timely vaccination of their children.[21] Immunisation coverage for MMR1 decreased by approximately 15% in Māori children comparing those born in 2017 to those born in 2020. This decrease is concerning, and public health resources should focus on improving immunisation coverage in this group in order to achieve equitable health outcomes. For instance, the emergency meningococcal C vaccination programme in 2011 reached equitable and high vaccination coverage.[22] In this programme, vaccination was promoted via various services. Vaccination programmes should include general practice services, community outreach clinics and involvement of Māori health providers.

Ideally, measles immunisation coverage should be >95% to reduce transmission. While, ideally, coverage should be boosted for both MMR1 and MMR2 the focus should initially be on MMR1 to have the greatest impact on preventing community spread of measles. In addition, immunisation programmes should consider focussing on improving coverage for other vaccines as well. Furthermore, healthcare accessibility should be ensured, including cultural safety in health services. Besides improvement of vaccine delivery including consistent involvement of Māori and Pasifika leadership and the use of mobile vaccination clinics, parental attitudes regarding vaccine safety should be addressed using effective communication. This is especially important as about 30% of the New Zealand population has concerns regarding vaccine safety.[23,24]

Strengths of this study include the detailed description of MMR1 and MMR2 coverage for young New Zealand children using high-quality data from the NIR.[25] In addition, we provided detailed geographical analyses of areas with high population density. This study has some limitations. Firstly, we did not study children born in 2021 as not all children in this birth cohort were eligible yet for their first MMR dose at 12 months. Data showing the overall immunisation coverage confirms the ongoing decreasing trend in the 2021 birth cohort.[7] Secondly, our data should be interpreted in light of the MMR programme change in 2020, with the second MMR dose thereafter being given at 15 months instead of 4 years of age. Therefore, children born in 2018 and in 2019 may not have been offered MMR2 before 4 years of age. Thirdly, we acknowledge that occurrence of a potential measles outbreak is also influenced by other factors such as crowding and immunisation coverage rates at children's day cares.

Nevertheless, we focussed our analysis on young children as this group is most vulnerable to measles-related complications or even death.

Conclusions

Immunisation coverage rates for measles are currently insufficient to prevent a potential measles outbreak in children <5 years in New Zealand. Concerningly, the coverage for MMR1 is declining in all regions and especially in tamariki Māori. As young children are at high risk for measles-related complications, we urge the implementation of catch-up immunisation programmes to improve immunisation coverage.

COMPETING INTERESTS
Nil.

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AUTHOR INFORMATION
Nienke N Hagedoorn: Postdoctoral Researcher, Department of Paediatrics, University of Otago, Christchurch, New Zealand.
Andrew Anglemyer: Senior Research Fellow, Health Intelligence Team, Institute of Environmental Science and Research, Wellington, New Zealand; Department of Preventive and Social Medicine, University of Otago, Dunedin, New Zealand.
Tony Walls: Paediatric Infectious Diseases Physician, Department of Paediatrics, University of Otago, Christchurch, New Zealand.

CORRESPONDING AUTHOR
Nienke N Hagedoorn: Department of Paediatrics, University of Otago, Christchurch PO Box 4345, Christchurch 8014, New Zealand. Ph: +64 3 372 6718
E: Nienke.hagedoorn@otago.ac.nz
Tony Walls: Department of Paediatrics, University of Otago, Christchurch PO Box 4345, Christchurch 8014, New Zealand. Ph: +64 3 372 6718.
E: tony.walls@otago.ac.nz

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Appendices

Appendix 1: Territorial authorities in New Zealand.

Appendix 2: MMR1 and MMR2 coverage (%), overall and per ethnicity.

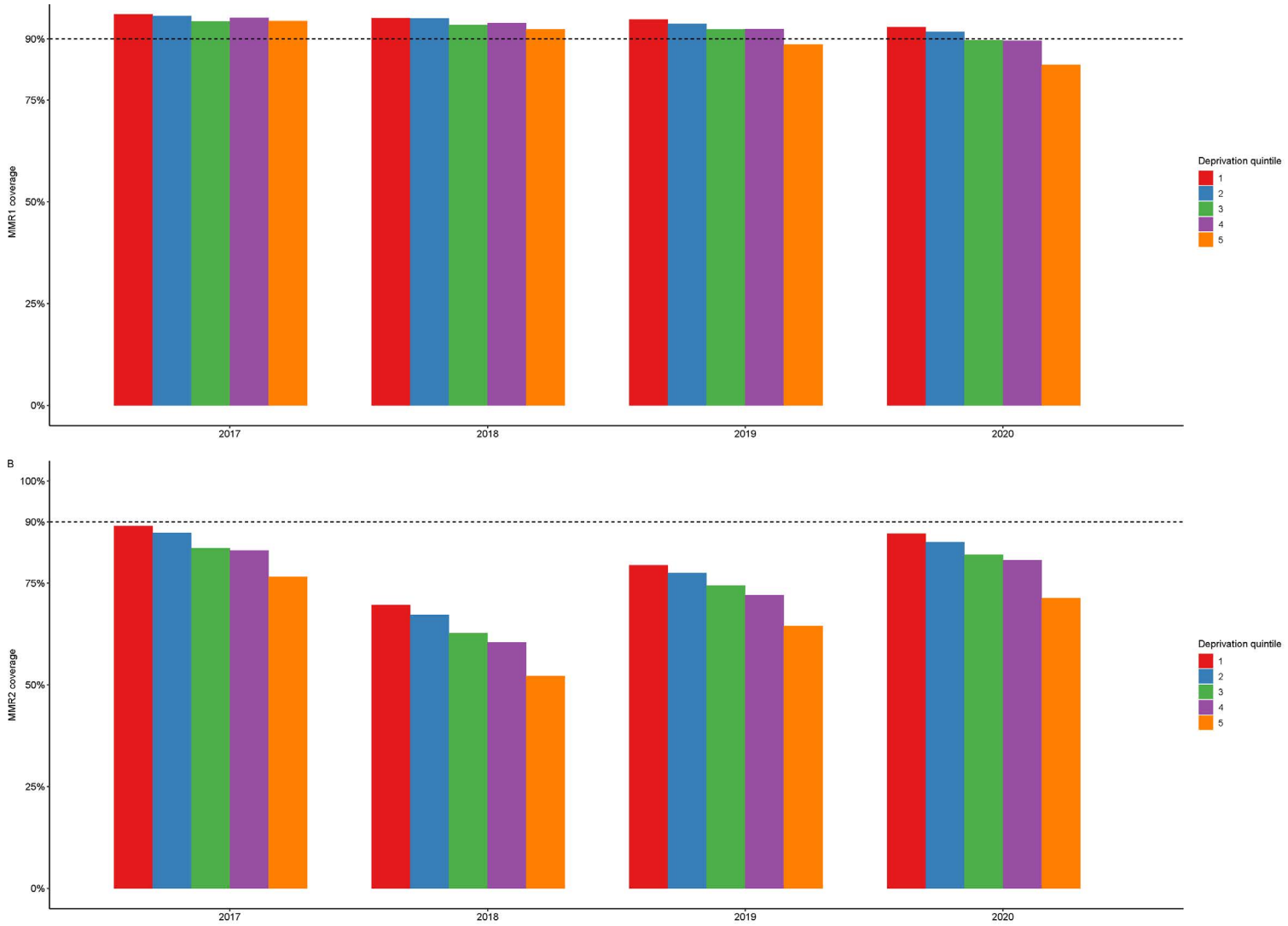
Birth year	MMR1 coverage (%)	MMR2 coverage (%)
2017	95.1	83.5
2018	93.8	61.6
2019	92.1	72.8
2020	89.0	80.3

MMR1 coverage (%) per ethnicity group for birth cohort 2017–2020				
Ethnicity group	**2017**	**2018**	**2019**	**2020**
NZ European	94.8	94.0	93.3	91.7
Māori	92.8	89.9	85.5	78.4
Pacific	97.0	96.1	92.3	88.3
Asian	98.4	98.1	98.0	97.6
Other	93.7	92.6	92.3	90.1
MMR2 coverage (%) per ethnicity group for birth cohort 2017–2020				
Ethnicity group	**2017**	**2018**	**2019**	**2020**
NZ European	87.7	66.1	76.1	85.8
Māori	73.3	48.4	60.8	63.8
Pacific	81.2	55.5	68.5	75.5
Asian	91.0	72.7	83.2	93.0
Other	83.2	63.6	74.5	83.6

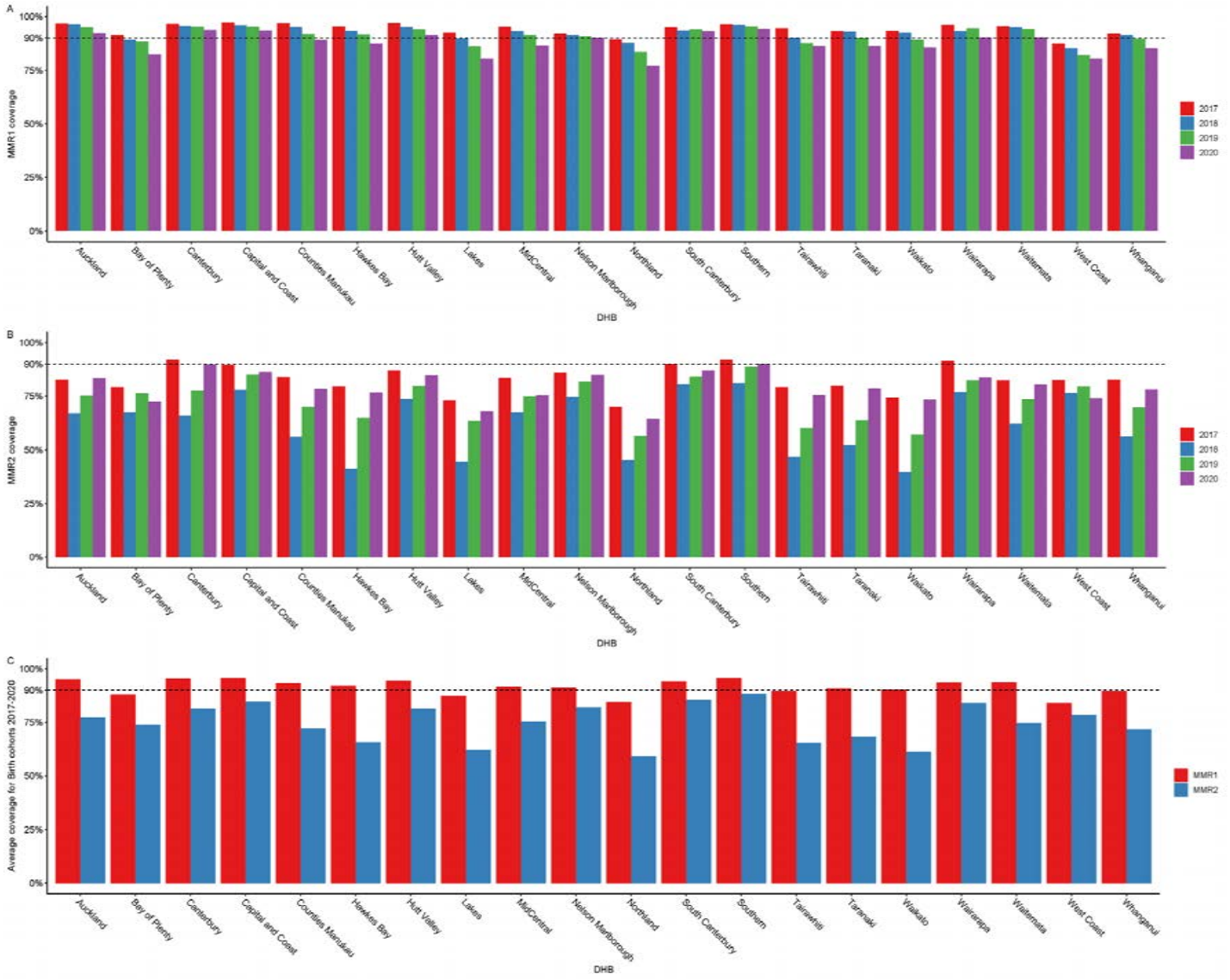
Appendix 3: MMR1 and MMR2 coverage (%) for birth cohorts 2017–2020 per deprivation quintile.

MMR1 coverage (%) per ethnicity group for each birth cohort				
Deprivation quintile	**2017**	**2018**	**2019**	**2020**
1–2	96.1	95.1	94.8	92.8
3–4	95.6	95.0	93.7	91.8
5–6	94.3	93.4	92.3	89.6
7–8	95.2	93.9	92.4	89.5
9–10	94.4	92.3	88.6	83.6
MMR2 coverage (%) per ethnicity group for each birth cohort				
Deprivation quintile	**2017**	**2018**	**2019**	**2020**
1–2	89.0	69.7	79.4	87.1
3–4	87.3	67.2	77.5	85.0
5–6	83.6	62.7	74.4	82.0
7–8	83.0	60.4	72.0	80.6
9–10	76.5	52.1	64.4	71.3

Appendix 3b: MMR1 (A) and MMR2 (B) coverage for birth cohorts 2017–2020 per deprivation quintile.



Appendix 4: MMR coverage (%) per District Health Board. MMR1 (A) and MMR2 (B) coverage for birth cohorts 2017-2020 per District Health Board (DHB), Average MMR1 and MMR2 coverage for birth cohorts 2017-2020 per District Health Board (DHB) (C).



Appendix 5: 2019 measles outbreak: measles rate and hospitalisation rate per District Health Board (DHB) —extracted from WHO report (1).

DHB	Measles cases (laboratory confirmed or epidemiologically linked) (N)	Hospitalised measles cases (N)	Measles rate per 100,000 population	Hospitalisation rate per 100,000 population
Counties Manukau	1,138	435	201.6	77.1
Northland	133	23	70.5	12.2
Auckland	272	108	56.0	22.2
Waitematā	302	128	49.2	20.9
Lakes	30	6	26.2	5.2
Southern	73	6	21.5	1.8
Bay of Plenty	45	19	17.8	7.5
Hawke's Bay	26	8	15.0	4.6
Waikato	51	12	12.0	2.8
Canterbury	44	17	7.8	3.0
Capital and Coast	23	7	7.3	2.2
Hutt Valley	9	1	5.8	0.6
Taranaki	7	3	5.7	2.4
MidCentral	10	0	5.5	0.0
South Canterbury	2	0	3.3	0.0
Wairarapa	1	0	2.1	0.0
Nelson Malborough	1	0	0.6	0.0
Total	2,167	773	45.5	16.2

Ministry of Health – Manatū Hauora [Internet]. Measles and Rubella Elimination in New Zealand, 2021 - Report to the 8th Meeting of the Western Pacific Regional Verification Commission for Measles and Rubella Elimination, 2021. Wellington, New Zealand; 2021.

Outcomes and access to angiography following non-ST-segment elevation acute coronary syndromes in patients who present to rural or urban hospitals: ANZACS-QI 72

Rory Miller, Garry Nixon, Robin M Turner, Tim Stokes, Rawiri Keenan, Corina Grey, Yannan Jiang, Andrew Kerr

ABSTRACT

AIM: This study's aim was to identify differences in invasive angiography performed and health outcomes for patients with non-ST-segment elevation acute coronary syndrome (NSTEACS) presenting to either i) a rural hospital, or an urban hospital ii) with or iii) without routine access to percutaneous intervention (PCI) in New Zealand.

METHODS: Patients with NSTEACS between 1 January 2014 and 31 December 2017 were included. Logistic regression was used to model each of the outcome measures: angiography performed within 1 year; 30-day, 1-year and 2-year all-cause mortality; and readmission within 1 year of presentation with either heart failure, a major adverse cardiac event or major bleeding.

RESULTS: There were 42,923 patients included. Compared to urban hospitals with access to PCI, the odds of a patient receiving an angiogram were reduced for rural and urban hospitals without routine access to PCI (odds ratio [OR] 0.82 and 0.75) respectively. There was a small increase in the odds of dying at 2 years (OR 1.16), but not 30 days or 1 year for patients presenting to a rural hospital.

CONCLUSION: Patients who present to hospitals without PCI are less likely to receive angiography. Reassuringly there is no difference in mortality, except at 2 years, for patients that present to rural hospitals.

In Aotearoa New Zealand, patients who present with non-ST-segment elevation acute coronary syndrome (NSTEACS, which comprises non-ST-segment elevation myocardial infarction [NSTEMI] and unstable angina [UA]) will initially access one of three groups of hospitals: urban hospitals with routine access to percutaneous intervention (PCI), urban hospitals without routine access to PCI and rural hospitals (which also do not have routine access to PCI).[1] Australasian consensus guidelines recommend that most patients with NSTEACS, especially those at high or intermediate risk of mortality, receive "an invasive strategy of angiography with coronary revascularisation" within 72 hours.[2]

There are nine urban hospitals in New Zealand that have routine access to PCI. Hospitals that don't have routine PCI capabilities typically have catchments that include smaller regional or rural areas. Compared with major urban areas, these smaller catchments include a higher proportion of Māori, who have poorer cardiovascular outcomes than NZ Europeans.[3,4] Rural hospitals are typically staffed by generalist doctors and nursing teams, have fewer resources and are at a distance from urban hospitals with specialists or associated services (40 minutes to 4 hours by road from urban hospitals with routine access to PCI).[5] Patients with NSTEACS who present to urban hospitals without routine access to PCI may be cared for by cardiology specialists or general physicians.

Stable patients who present with NSTEACS to hospitals without routine access to PCI will receive initial treatment and if clinically stable, are usually admitted to that hospital while awaiting transfer for angiography. Unstable patients or patients at rural hospitals with fewer resources may require early transfer to a larger hospital. For rural hospitals whose primary referral hospital does not have PCI capabilities, patients may undergo several transfers to receive definitive treatment.

The aim of this study was to determine if there were differences in invasive angiography performed and clinical outcomes, including mortality, associated with the category of hospital of presentation (rural hospitals or urban

hospitals with or without routine access to PCI) for patients with NSTEACS.

Methods

All first admissions for patients aged 20 years or older with NSTEACS between 1 January 2014 and 31 December 2017 to a publicly funded New Zealand hospital were included in the study.

Registries

The All New Zealand Acute Coronary Syndrome Quality Improvement (ANZACS-QI) programme is a clinically led initiative. Its primary aim is to "support appropriate, evidence-based management of ACS… regardless of age, sex, ethnicity, socioeconomic status, or rural or city dwelling".[6]

This study used the ANZACS-QI programme's *ACS Routine Information cohort*, which incorporates the Ministry of Health's National Minimum Dataset for Hospital Admissions (NMDS) and the National Mortality Collection, which are linked using the patient's encrypted national health index (NHI). The NMDS includes information for all public hospital admissions (including all hospitals considered in this study) and the mortality collection contains information regarding deaths. All New Zealand residents aged 20 years or older who are admitted to hospital with a primary or secondary ICD-10 code consistent with ACS (I20.0, I21.x, I22.x) are included in this cohort.[6] The mortality collection contained all deaths until 31 December 2018, which was at least 1 year after the last admission to hospital.

Hospitals of presentation

Hospitals were identified using the facility code assigned by the New Zealand Ministry of Health – Manatū Hauora (Table 1) and divided into three urban-rural hospital categories:

1. Urban hospitals with routine access to PCI (urban hospitals with PCI),
2. Urban hospitals without routine access to PCI (urban hospitals without PCI) and
3. Rural hospitals.

Three hospitals did not easily fit within these categories. Tauranga and Nelson have PCI-capable angiography suites but do not have reliable after-hours access to these. They were considered urban hospitals with PCI for the purposes of this analysis, as there would be few exceptions to not being able to offer PCI for patients with NSTEACS within 3 days. Greymouth Hospital was considered a rural hospital due to its distance from and the logistical challenges associated with accessing a hospital with PCI, in addition to an increasingly rural generalist workforce.[7] These groupings are consistent with previous studies.[1]

Patients were assigned to the first hospital of presentation. To account for the movement of patients with NSTEACS between hospitals to receive PCI or other investigations or treatments, admissions were bundled into group inter-hospital transfers as part of the same episode of care.[1,8]

Data collected

Age, sex, prioritised ethnicity (using the New Zealand Ministry of Health's protocols),[6] NZ Deprivation Index 2013 (NZDep2013) deciles, admission to hospital with either MI or heart failure in the last 5 years, non-cardiac Charlson Comorbidity Index score and type of NSTEACS (NSTEMI or UA) were collected from the *ACS Routine Information cohort* for the patient's first ACS admission. The Charlson Comorbidity Index is a method of predicting mortality by weighting comorbid conditions and is widely used in health research.[9] The non-cardiac Charlson score excludes congestive heart failure.[1,9]

Outcome measures

The following outcome measures were considered: 30-day and 1-year all-cause mortality; angiography performed within 30 days and 1 year; and readmission to hospital within 1 year with heart failure, major adverse cardiac event (MACE) or major bleeding. MACE was defined as: acute myocardial infarction, cardiac arrest, cardiogenic shock, ventricular arrythmia (ventricular tachycardia or fibrillation), high-grade atrioventricular block requiring intervention or emergency coronary revascularisation. To determine 2-year all-cause mortality, only patients with at least 2 years of follow-up were considered.

All definitions and ICD-10 codes are shown in Appendix 1.

Statistical analysis

Data were summarised using mean and standard deviation (SD) for continuous data and frequency and percentage for categorical data in total and by category of hospital.

Logistic regression, modelled separately for each outcome, was used to estimate odds ratios (OR) with 95% confidence intervals (95% CI) comparing urban hospitals without access to PCI

Table 1: The classification of New Zealand public hospitals into urban hospitals with routine access to percutaneous intervention (PCI), urban hospitals without routine access to PCI and rural hospitals.

Group	Hospital
Urban hospital with routine access to percutaneous intervention (PCI)	Middlemore; Auckland City; North Shore; Waitakere; Waikato; Tauranga; Wellington; Hutt; Nelson; Christchurch; Dunedin
Urban hospital without routine access to PCI*	Whangārei; Whakatāne; Rotorua; Gisborne; Taranaki Base; Whanganui; Palmerston North; Hawkes Bay; Masterton/ Wairarapa; Blenheim (Wairau); Timaru; Southland/Kew
Rural hospitals	Kaitaia; Rawene (Hokianga); Bay of Islands; Dargaville; Thames; Taupo; Hāwera; Taumarunui; Te Kuiti; Tokoroa; Kaikōura; Te Nīkau (Greymouth); Westport/Buller; Ashburton; Oamaru; Lakes District; Dunstan; Clutha Health First; Gore

* Some hospitals in this group may have had access to diagnostic invasive angiography or limited access to PCI. Some hospitals (e.g., Whangārei) have opened an angiography suite after the conclusion of the study period.

and rural hospitals to urban hospitals with access to PCI (the reference group).

Unadjusted mortality comparing the hospital types was visualised using Kaplan–Meier curves. Cox proportional hazard ratios were then used to estimate hazard ratios (HR), with 95% confidence intervals, comparing hospital type. All patients were followed for at least 1 year after admission and patients were "right-censored" if they had not died by the end of the study period.

For all outcome measures, the following variables were considered as potential confounders within the models: sex, ethnicity, age, type of NSTEACS, prior heart failure, prior acute myocardial infarction, socio-economic deprivation and non-cardiac Charlson score. For the mortality- and readmission-related outcomes, the variable angiography performed within 1 year was considered a potential confounder. Additionally, readmission to hospital with MACE, major bleeding or heart failure within 1 year were considered for mortality related outcome measures.

The linearity for any continuous variable was assessed and complex associations were dealt with by categorising the variable. Age was categorised into the following groups: 20–44 years, 45–59 years, 60–69 years, 70–89 years and 90+ years. Backwards elimination was used to reduce the number of variables in the models; however, important confounders were retained regardless of significance. Likelihood ratio tests were used to assess the significance of each variable ($p<0.05$) in the model. Only *a priori* interactions (age, ethnicity and socioeconomic deprivation) were investigated.

Data manipulation, analysis and visualisation were done in the open-access R statistical programming language (version 4.1.1) using the R-Studio integrated data environment (IDE) (22.02.3 Boston, MA).[10]

Ethics

ANZACS-QI is part of the Auckland University-based Vascular Informatics Using Epidemiology and the Web (VIEW) study. The VIEW study was approved by the Northern Region Ethics Committee in 2003 (AKY/03/12/314), with subsequent amendments to include the ANZACS-QI registries. There are annual approvals by the National Multi-Region Ethics Committee since 2007 (MEC07/10/EXP).[6]

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Results

There were 42,923 patients with a diagnosis of NSTEACS who presented to New Zealand public hospitals between 2014 and 2017. Table 2 describes the characteristics of the included patients. Most patients (62.4%) presented to urban hospitals with access to PCI, nearly a third (29.1%) to urban hospitals without PCI and 8.4% to rural hospitals. Compared to patients who presented to urban hospitals with PCI, a higher percentage of patients

who presented to urban hospitals without PCI and rural hospitals were Māori (8.1%, 15.8% and 14% respectively) and lived in the most deprived quintile (24.1%, 33.9% and 28.3%). Patients were followed for a median of 3.2 years (interquartile range 1.8 to 4.8), with 40,272 (93.8%) followed for at least 2 years.

Table 3 presents the number, percentage, unadjusted and adjusted odds ratios (OR) for each outcome grouped by hospital type. Adjusted OR are shown in Figure 1. Compared to patients presenting to urban hospitals with PCI, those who present to rural hospitals had lower odds of receiving angiography within 30 days (0.76, 95% CI: 0.70 to 0.83) and 1 year (OR 0.82, 95% CI: 0.75 to 0.90), as well as increased odds of death at 2 years (OR 1.16, 95% CI: 1.05 to 1.29) but not at 30 days or 1 year. Urban hospitals without PCI similarly had reduced odds of receiving angiography at 30 days (OR 0.70, 95% CI: 0.66 to 0.73) and 1 year (OR 0.75, 95% CI: 0.71 to 0.79) but no increase in the odds of dying. There was, however, a small increase in the odds of readmission with MACE within 1 year of admission (OR 1.10, 95% CI: 1.03 to 1.16). Full model outputs are included as Appendix 2.

Figure 2 shows the unadjusted Kaplan–Meier survival curve for mortality over the 6 years of the study and demonstrates that survival for patients who presented to rural compared with urban hospitals (with or without PCI) was reduced from 1 year following admission. There was weak evidence of increased adjusted risk of dying for patients who presented to rural hospitals (hazard ratio (HR) 1.06, 95% CI: 1.00 to 1.13), as shown in Figure 3. Unadjusted HR are presented in Appendix 3. Adjusting for hospital category, Māori (HR 1.34, 95% CI: 1.27 to 1.43) and Pasifika (1.17, 95% CI: 1.07 to 1.27) had increased risk of dying compared with European/Other.

Model diagnostics

For all models, age had a non-linear association with the outcome so was modelled categorically. There were no important interactions identified. The proportional hazards assumption was violated for some variables in the Cox proportional hazards model, however, graphical inspection of the scaled Schoenfeld residuals showed that this was due to very small departures from proportional hazards being shown as "significant" due to the large sample size.[11] Including these as stratified variables in the model did not change model interpretation (Appendix 4).

Discussion

This nationwide study describes the outcomes for patients who presented to public hospitals in New Zealand with NSTEACS based on the type of available specialist and interventional resources of the hospital that the patient first presented to. The main findings were that patients presenting to rural hospitals and urban hospitals without access to PCI were less likely to receive angiography at both 30 days (OR 0.75 and 0.82 respectively) and 1 year (0.70 and 0.76 respectively, however, there is no difference in mortality at 30 days or 1 year. Patients that presented to rural hospitals had slightly higher odds of dying at 2 years (OR 1.16) compared to patients that presented to urban hospitals. Patients that presented to urban hospitals without access to PCI were more likely to be readmitted with a MACE within 1 year of admission (OR 1.10) compared to the other two hospital types.

Angiography performed

That patients who presented to hospitals without access to PCI (both urban and rural) were less likely to receive angiography, which is consistent with other studies for patients who presented to the same hospital groupings with ST-segment elevation myocardial infarction (STEMI).[1] These patients had not only reduced access to angiography during the index admission, but the time to angiography was significantly longer.[1] The finding is also consistent with previous Australian and New Zealand studies of all ACS events, where "smaller" or non-urban hospitals had reduced rates of angiography and PCI.[8,12,13]

This is especially problematic in New Zealand given the higher percentage of Māori who present to rural hospitals and urban hospitals without access to PCI. It is well established that Māori patients with ACS have been shown to have reduced access to angiography and revascularisation and subsequently have poorer outcomes. The geographic inequities in access to optimal care that we have identified compound these inequities resulting from historical and ongoing colonisation and racism.[14,15]

Mortality

Similar to a recent study that found no difference in mortality for patients with STEMI that present to New Zealand rural and urban hospitals without PCI,[1] reassuringly there were few differences found in the mortality between the three groups of hospitals included in this study.

Table 2: Demographic information for patients with non-ST-elevation acute coronary syndrome (NSTEACS) to New Zealand public hospitals between 2014 and 2017 by hospital type: urban with routine access to percutaneous intervention (PCI); urban without routine access to PCI; and rural hospitals.

	Total	**Urban with PCI**	**Urban without PCI**	**Rural hospitals**
	42,923	**26,800 (62.4%)**	**12,497 (29.1%)**	**3,626 (8.4%)**
Age in years Mean (standard deviation)	71.1 (13.2)	71.0 (13.4)	71.2 (12.9)	71.5 (12.6)
Gender				
Female	16,939 (39.5%)	10,323 (38.5%)	5,141 (41.1%)	1,475 (40.7%)
Male	25,984 (60.5%)	16,477 (61.5%)	7,356 (58.9%)	2,151 (59.3%)
Ethnicity				
European/Other	33,824 (78.8%)	20,568 (76.7%)	10,216 (81.7%)	3,040 (83.8%)
Māori	4,645 (10.8%)	2,166 (8.1%)	1,970 (15.8%)	509 (14%)
Pasifika	2,012 (4.7%)	1,800 (6.7%)	157 (1.3%)	55 (1.5%)
Indian	1,403 (3.3%)	1,312 (4.9%)	83 (0.7%)	8 (0.2%)
Other Asian	1,039 (2.4%)	954 (3.6%)	71 (0.6%)	14 (0.4%)
NZDep2013 quintile*				
1	6,246 (14.6%)	4,861 (18.1%)	999 (8%)	386 (10.6%)
2	7,373 (17.2%)	5,133 (19.2%)	1,851 (14.8%)	389 (10.7%)
3	8,534 (19.9%)	5,513 (20.6%)	2,268 (18.1%)	753 (20.8%)
4	10,381 (24.2%)	6,201 (23.1%)	3,111 (24.9%)	1,069 (29.5%)
5	10,342 (24.1%)	5,073 (18.9%)	4,242 (33.9%)	1,027 (28.3%)
Missing	47 (0.1%)	19 (0.1%)	26 (0.2%)	2 (0.1%)
Prior AMI†	3,692 (8.6%)	2,375 (8.9%)	1,070 (8.6%)	247 (6.8%)
Prior heart failure	4,556 (10.6%)	2,931 (10.9%)	1,264 (10.1%)	361 (10%)
Non-cardiac Charlson Score				
0	30,096 (70.1%)	18,563 (69.3%)	8,921 (71.4%)	2612 (72%)
1–2	9,878 (23%)	6,273 (23.4%)	2,822 (22.6%)	783 (21.6%)
3+	2,949 (6.9%)	1,964 (7.3%)	754 (6%)	231 (6.4%)
NSTEACS Type				
Unstable angina	11,800 (27.5%)	6,604 (24.6%)	4,050 (32.4%)	1,146 (31.6%)
NSTEMI	31,123 (72.5%)	20,196 (75.4%)	8,447 (67.6%)	2,480 (68.4%)

* New Zealand Deprivation Index 2013
† Acute myocardial infarction

Table 3: Number, percentage, unadjusted and adjusted odds ratios (and 95% confidence intervals) for access to angiography and health outcomes for patients that presented to either urban hospitals i) with (reference group) or ii) without routine access to percutaneous intervention (PCI) or rural hospitals with non-ST-segment elevation acute coronary syndrome (NSTEACS). Odd ratios were adjusted for sex, ethnicity, age, type of acute coronary syndrome, prior heart failure, prior acute myocardial infarction, socio-economic deprivation and non-cardiac Charlson score.

	Total	Urban hospital with PCI	Urban hospital without PCI	Rural hospital
Angiography performed within 30 days	24,438 (56.7%)	15,876 (59.2%)	6,583 (52.7%)	1,979 (54.6%)
Unadjusted OR*			0.77 (0.73, 0.80)	0.83 (0.77, 0.89)
Adjusted OR			0.69 (0.66, 0.73)	0.76 (0.70, 0.83)
Angiography performed within 1 year	25,720 (59.9%)	16,494 (61.5%)	7,100 (56.8%)	2,126 (58.6%)
Unadjusted OR*			0.82 (0.79, 0.86)	0.89 (0.83, 0.95)
Adjusted OR			0.75 (0.71, 0.79)	0.82 (0.75, 0.90)
Readmission within 1 year with				
Heart failure	4,621 (10.8%)	2,886 (10.8%)	1,342 (10.7%)	393 (10.8%)
Unadjusted OR			0.99 (0.93, 1.06)	1.01 (0.90, 1.12)
Adjusted OR			1.00 (0.92, 1.08)	1.03 (0.91, 1.16)
MACE†	7,423 (17.3%)	4,576 (17.1%)	2,246 (18%)	601 (16.6%)
Unadjusted OR			1.06 (1.01, 1.13)	0.97 (0.88, 1.06)
Adjusted OR			1.10 (1.03, 1.16)	0.99 (0.90, 1.09)
Major bleeding	1,819 (4.2%)	1,156 (4.3%)	506 (4%)	157 (4.3%)
Unadjusted OR			0.94 (0.84, 1.04)	1.01 (0.85, 1.19)
Adjusted OR			0.94 (0.84, 1.05)	1.01 (0.84, 1.20)
30-day mortality	2,513 (5.9%)	1,570 (5.9%)	729 (5.8%)	214 (5.9%)
Unadjusted OR			0.99 (0.91, 1.09)	1.01 (0.87, 1.16)
Adjusted OR			1.01 (0.91, 1.12)	1.02 (0.86, 1.19)
1-year mortality	6,853 (16.0%)	4,286 (16.0%)	1,981 (15.9%)	586 (16.2%)
Unadjusted OR			0.99 (0.93, 1.05)	1.01 (0.92, 1.11)
Adjusted OR			1.00 (0.93, 1.07)	1.04 (0.93, 1.16)
2-year mortality‡	9,483/40,272 (23.5%)	5,908/25,193 (23.5%)	2,720/11701 (23.2%)	855/3378 (25.3%)
Unadjusted OR			0.98 (0.93, 1.03)	1.09 (1.01, 1.18)
Adjusted OR			0.97 (0.91, 1.04)	1.16 (1.05, 1.29)

* Odds ratio

† Major adverse cardiac event, defined as: acute myocardial infarction, cardiac arrest, cardiogenic shock, ventricular arrythmia (ventricular tachycardia or fibrillation), high grade atrioventricular block requiring intervention or emergency coronary revascularisation.

‡ There were 1,607, 796 and 248 patients who had their admission with non ST-segment elevation within 2 years of the study period finishing in urban hospitals with PCI, urban hospitals without PCI and rural hospitals respectively.

Figure 1: Adjusted odds ratios and 95% confidence intervals for patients that first present with non-ST-segment acute coronary syndrome to urban hospitals with routine access to percutaneous intervention (urban hospital with PCI), urban hospitals without routine access to PCI (urban hospital without PCI) and rural hospitals. All odd ratios were adjusted for sex, ethnicity, age, type of acute coronary syndrome, prior heart failure, prior acute myocardial infarction, socio-economic deprivation and non-cardiac Charlson score.

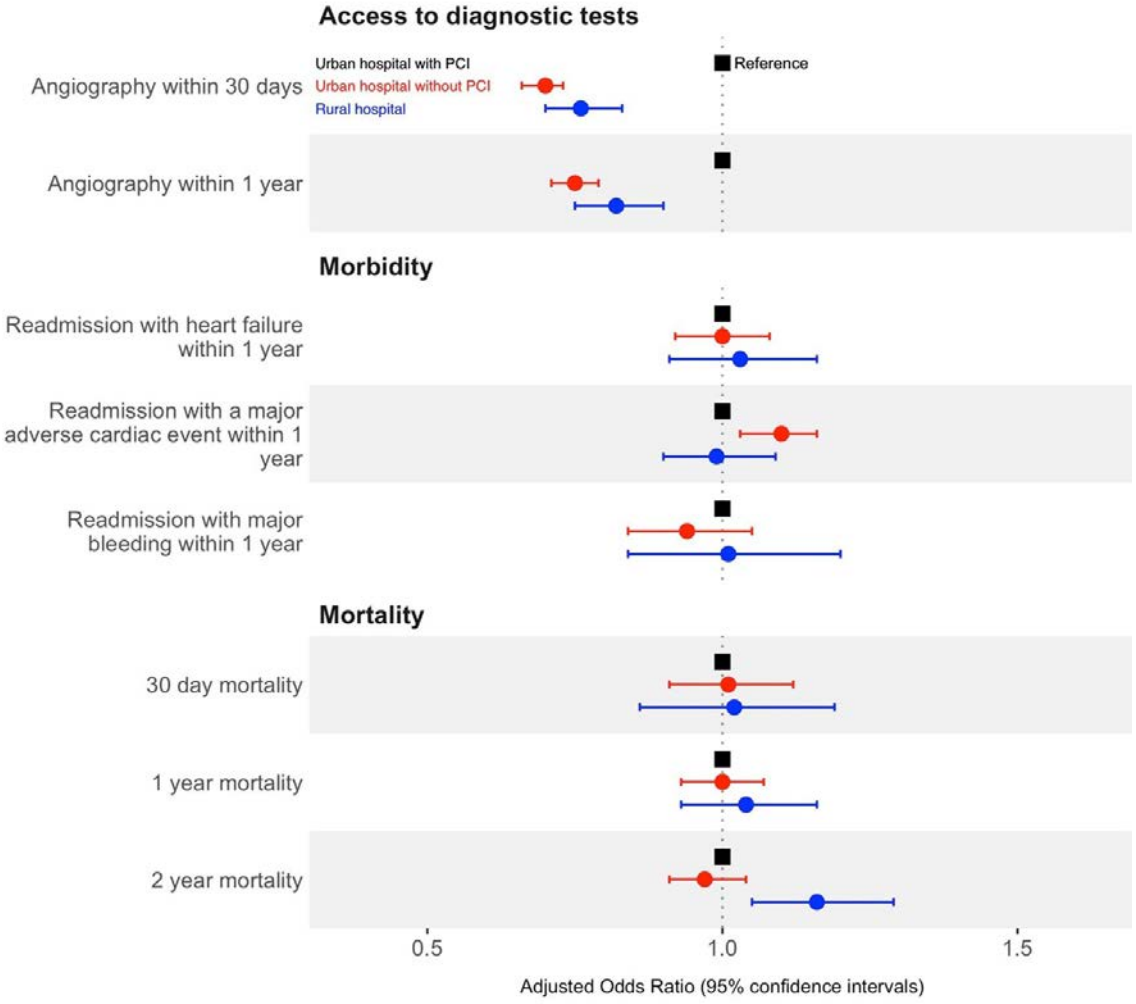
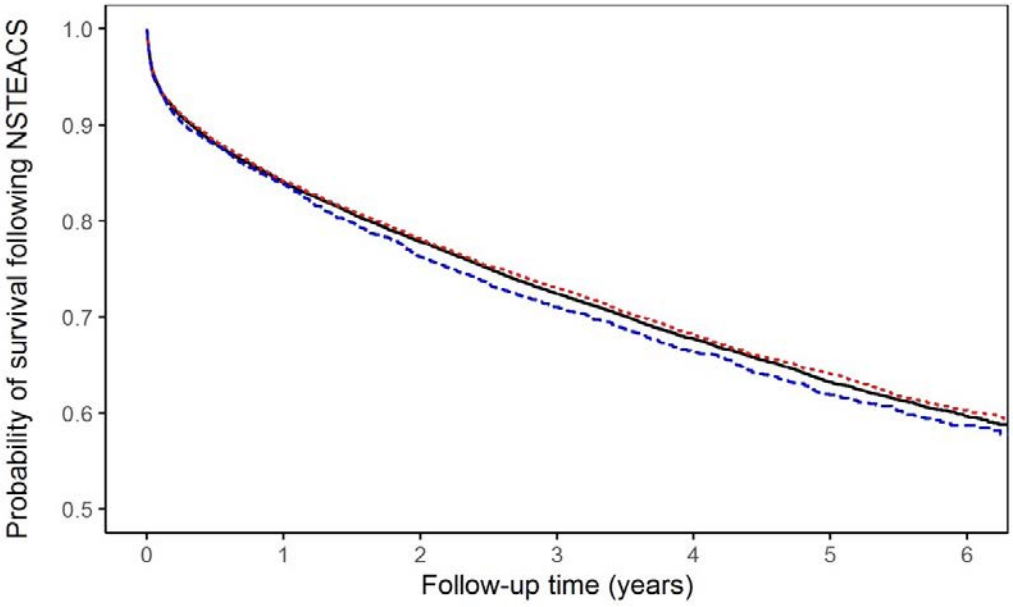


Figure 2: Unadjusted Kaplan–Meier survival plot demonstrating the probability of survival following non-ST-segment elevation acute coronary syndrome (NSTEACS) for patients that present to urban hospitals with routine access to PCI (urban hospital with PCI), urban hospitals without routine access to PCI (urban hospital without PCI) and rural hospitals.



Number at risk

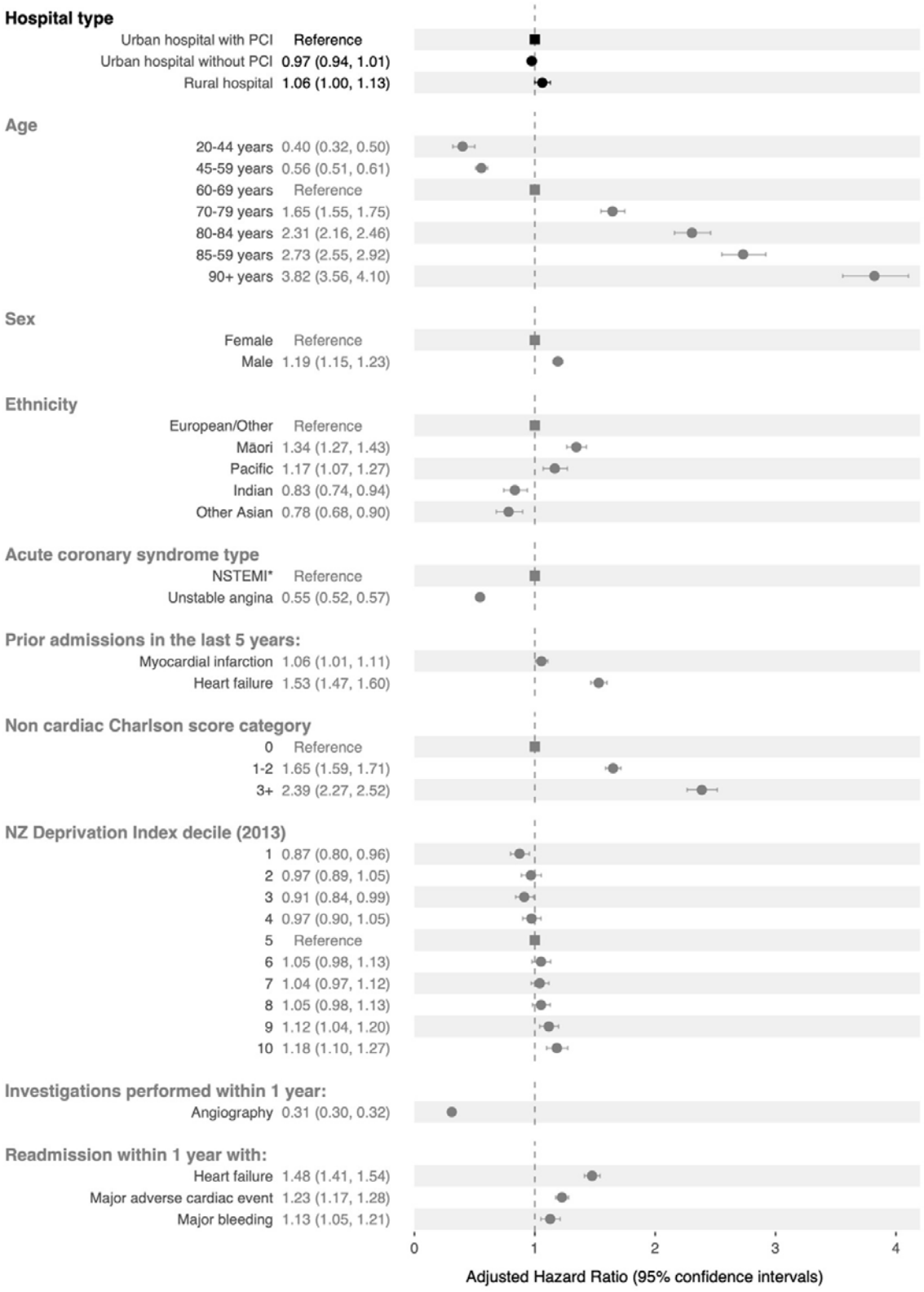
Urban hospital with PCI	26781	22497	19269	14246	9852	5723	2192
Urban hospital without PCI	12471	10495	8962	6630	4485	2626	1005
Rural hospital	3624	3038	2521	1815	1222	728	272

Cumulative number of patients censored

Urban hospital with PCI	0	0	1607	5420	9020	12603	15905
Urban hospital without PCI	0	0	796	2603	4371	6001	7507
Rural hospital	0	0	248	800	1292	1717	2147

Hospital Type: Urban hospital with PCI; Urban hospital without PCI; Rural hospital

Figure 3: Adjusted hazard ratios and 95% confidence intervals for mortality following non-ST-segment elevation acute coronary syndrome for patents that present to New Zealand urban hospitals with routine access to PCI (urban hospital with PCI), urban hospitals without routine access to PCI (urban hospital without PCI) and rural hospitals. All hazard ratios are adjusted for all presented covariables. Unadjusted hazard ratios are presented in Appendix 3.



Historically, differences in mortality have been large, with up to a 300% increase in the odds of dying for patients that presented to an urban hospital without PCI compared with a hospital that had within the same district.[16] Since this time, reflective of increased risk reduction measures,[6,17] as well as improved access to interventional practice and development of regional networks, the incidence, prevalence, hospitalisation and mortality rates from ischaemic heart disease in New Zealand have decreased. Although, as it is with our data, for Māori and Pasifika these remain disproportionately high.[4,17] International rural mortality rates following acute coronary syndrome vary according to the definition of "rural" that is used.[13,18–20] Mortality rates for Indigenous peoples from other countries are consistently higher than non-Indigenous peoples.[21]

However, this study did demonstrate a small increase in 2-year mortality following admission for patients who present to rural hospitals compared to both types of urban hospitals. We are unaware of any recent New Zealand-based studies that have demonstrated a mortality difference between urban hospitals with PCI and hospitals without PCI, and none that differentiate rural from urban hospitals.

The reason for the small difference in delayed mortality demonstrated for rural hospitals in this study is not known but does not appear to be related to reduced access to angiography. Patients that present to urban hospitals without PCI have similar odds of angiography being performed as rural hospitals but do not demonstrate the same increase in 2-year mortality. Possible explanations include reduced access to primary care, secondary prevention and cardiac rehabilitation.

Secondary prevention therapies are considered critically important and are strongly recommended in all international guidelines, with emphasis on cardiac rehabilitation and the prescription of evidence-based therapies: anti-platelet therapy, statins, beta-blockers and renin-angiotensin antagonists.[2,22]

In New Zealand, there is evidence of reduced prescribing of these evidence-based therapies for NSTEACS in patients who are Māori or Pasifika, female, present to hospitals outside main centres[1] and live in the most deprived areas.[23,24] Our results showed that compared with major urban hospitals, a higher percentage of patients that present to rural hospitals were Māori and live in more deprived areas. Therefore, a reduction in the prescription and maintenance of appropriate secondary prevention medicine may account for some of the increased risk of 2-year mortality.

Referral to cardiac rehabilitation services has been shown to reduce future cardiac events, and death, following an admission with IHD.[12] Within New Zealand, patient referral and attendance of cardiac rehabilitation services are well below international standards in many regions, but there is yet to be analysis based on the geographic location of the patient.[25,26] There is clear evidence internationally that access to all phases of cardiac rehabilitation is reduced for patients that live in rural and remote areas.[27–29] The reliance on group sessions in central locations reported in the New Zealand literature may mean that rural residents find it difficult to access cardiac rehabilitation sessions, representing a potential gap in the system and missed opportunities for evidence-based care.[26]

Strengths and limitations

This study is the first to differentiate patients with NSTEACS that present to New Zealand rural hospitals, as opposed to any hospital without PCI routinely available. A key strength of this study is the ability to identify all patients with NSTEACS diagnosis codes admitted to New Zealand public hospitals and follow these patients using linked national mortality and hospitalisation datasets to ascertain investigations and outcomes that occurred after the admission. This linkage is not possible in many countries on a national scale.[17]

The major limitation is that the cohort of patients that present to rural hospitals may not represent those that live in rural places. Approximately 19% of the New Zealand population live in rural areas,[3] but only 8% of the cohort that was admitted with NSTEACS presented to a rural hospital. This finding may be attributed to rural patients living closer to an urban hospital, patient preference or ambulance service destination policies.[1,30] A study using the geographic location of the patient is planned to understand the effect of rurality on the outcomes of NSTEACS as well as explore differences between rural Māori and non-Māori peoples.

A further limitation is that apart from angiography, the investigations and treatments that occurred during or after the NSTEACS admission were not considered. This includes revascularisation procedures, and these will be examined in more detail using the ANZACS-QI CathPCI cohort.[6] Additionally, inconsistency in the clinical coding, particularly in rural hospitals where anecdotally

this task is frequently performed by clinicians or clerical staff without formal training, may have influenced the results. It was not possible to differentiate between type 1 and type 2 acute myocardial infarction (AMI) from the available data.

Patients who received investigations in private facilities, underwent CT coronary angiography instead of invasive angiography, died prior to reaching hospital or who received treatment or died overseas were unable to be accounted for. This may differ between urban and rural areas.

Implications

The ability to track mortality and access to interventions over time is an important function in registries such as ANZACS-QI, especially for rural populations. In New Zealand, health outcome data are routinely reported by regions, usually encompassing rural and urban areas. This can miss urban-rural variation, which can be larger than the variation between regions.[3]

The large improvement seen in the care for patients with NSTEACS is largely attributable to the success of ANZACS-QI and the implementation and monitoring of targeted policy and procedures by PCI centres to ensure that the wider population they serve has equitable access to services.[6] While mortality is similar across the three groups of hospitals, this study demonstrates that equitable access to angiography is still not being achieved for patients initially admitted to rural and urban hospitals without PCI. Improving complex inter-hospital transfer policies should be a priority as Te Whatu Ora and Te Aka Whai Ora become more established.

The factors that contribute to the higher rate of delayed mortality for those who present to rural hospitals and for Māori should be identified and eliminated. This may include improving access to and ongoing use of proven secondary prevention therapies.

Conclusion

This study has demonstrated that patients presenting to rural or urban hospitals without PCI are less likely to receive angiography. Reassuringly there were no increased odds of 30-day or 1-year mortality, but patients who initially present to rural hospitals do have a small increase in the odds of dying that becomes apparent at 2-years post admission. There is a higher risk of mortality for Māori and Pasifika. This may reflect poorer access to evidence-based cardiac rehabilitation and secondary prevention.

COMPETING INTERESTS
Nil.

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AUTHOR INFORMATION
Rory Miller: Rural Doctor and Senior Lecturer, Department of General Practice and Health, University of Otago, Dunedin, New Zealand.
Garry Nixon: Rural Doctor and Professor of Rural Health, Department of General Practice and Health, University of Otago, Dunedin, New Zealand.
Robin M Turner: Professor of Biostatistics, Biostatistics Centre, University of Otago.
Tim Stokes: Professor of General Practice, Department of General Practice and Rural Health, University of Otago, Dunedin, New Zealand.
Rawiri Keenan: Medical Research Centre, University of Waikato, Hamilton, New Zealand; Department of General Practice and Rural Health, University of Otago, Dunedin, New Zealand.
Yannan Jiang: Senior Research Fellow – Statistics, Department of Statistics, The University of Auckland, Auckland, New Zealand; National Institute for Health Innovation, School of Population Health, University of Auckland, Auckland, New Zealand.
Corina Grey: Public Health Physician, Department of General Practice and Primary Healthcare, The University of Auckland, New Zealand.
Andrew Kerr: Cardiologist, Cardiology Department Middlemore Hospital, Middlemore, New Zealand.

CORRESPONDING AUTHOR
Dr Rory Miller: Department of General Practice and Rural Health, University of Otago, PO Box 56 Dunedin 9054, New Zealand. E: Rory.miller@otago.ac.nz

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Appendices

Appendix 1: International Classification of Diseases (10th edition) codes for clinical variables and outcomes.

Acute coronary syndrome (ACS)	
ST-elevation myocardial infarction (STEMI)	I210-I213, I220, I221, I228, I229
Non-ST-elevation myocardial infarction (NSTEMI)	I214, I222
Myocardial infarction (MI), unspecified	I219
Unstable angina (UA)	I200
Heart failure	
	I50, I500, I501, I509, I110, I130, I132
Major adverse cardiac event (MACE)	
Cardiac arrest	I460, I461, I469
Cardiogenic shock	R570, T810
Ventricular arrythmia	I470, I499
Ventricular fibrillation	I490
High grade atrioventricular block requiring intervention	I441, I442
Acute myocardial infarction	I210, I211, I212, I213, I220, I221, I228, I229, I214, I222, I219
Emergency coronary revascularisation	3821500, 3821800, 3821801, 3821802, 3530400, 3530500, 3531000, 3531001, 3531002, 3830000, 3830300, 3830600, 3830601, 3830602, 3830900, 3831200, 3831201, 3831500, 3831800, 3831801, 3849700, 3839701, 3839702, 3839703, 3839704, 3839705, 3839706, 3849707, 3850000, 3850001, 3850002, 3850003, 3850004, 3850300, 3850301, 3850302, 3850303, 3850304, 9020100, 9020101, 9020102, 9020103, 3863700
Major bleeding (a transfusion must be administered to be considered as major bleeding)	
	H356, H431, I312, I600-I629, I850, I983, K226, K250- K256, K260-K266,K270-K276, K280-K286, K290, K2921, K2931, K2941, K2951, K2961, K2971, K2981, K2991, K3182, K5522, K5703, K5711, K5713, K5721-K5723, H5731, K5733, K5743, K5751, K5753, K5781, K5783,K5791, K5791, K625, K661, K920-K9222, M2500-M2509, R040-R042, R048, R049

Appendix 2: Angiography within 30 days of NSTEACS.

Full logistic regression output for each outcome measure.
Urban hospital with PCI = Urban hospital with routine access to percutaneous intervention
Urban hospital without PCI = Urban hospital without routine access to PCI
NSTEMI = Non-ST-segment elevation myocardial infarction
NZ = New Zealand

Term	Odds ratio	Standard error	P-value	95% confidence interval
Hospital type				
Urban hospital with PCI	Reference			
Urban hospital without PCI	0.69	0.03	<0.01	0.66, 0.73
Rural hospital	0.76	0.04	<0.01	0.7, 0.83
Age				
20–44 years	1.08	0.08	0.33	0.92, 1.27
45–59 years	1.23	0.04	<0.01	1.14, 1.33
60–69 years	Reference			
70–79 years	0.57	0.03	<0.01	0.54, 0.61
80–84 years	0.22	0.04	<0.01	0.2, 0.24
85–59 years	0.05	0.05	<0.01	0.05, 0.06
90+ years	0.01	0.11	<0.01	0.01, 0.01
Sex				
Female	Reference			
Male	1.44	0.02	<0.01	1.37, 1.51
Ethnicity				
European/Other	Reference			
Māori	0.76	0.04	<0.01	0.7, 0.82
Pasifika	0.63	0.06	<0.01	0.57, 0.71
Indian	0.92	0.07	0.21	0.8, 1.05
Other Asian	0.91	0.08	0.23	0.78, 1.06
Acute coronary syndrome type				
NSTEMI	Reference			
Unstable angina	0.59	0.03	<0.01	0.56, 0.62
Non-cardiac Charlson score category				
0	Reference			
1–2	0.42	0.03	<0.01	0.39, 0.44
3+	0.22	0.05	<0.01	0.2, 0.25

Appendix 2 (continued): Angiography within 30 days of NSTEACS.

Term		Odds ratio	Standard error	P-value	95% confidence interval
NZ Deprivation Index decile (2013)					
1		1.07	0.06	0.30	0.94, 1.20
2		1.21	0.06	<0.01	1.08, 1.37
3		0.96	0.06	0.48	0.86, 1.07
4		1.10	0.06	0.09	0.98, 1.22
5		Reference			
6		0.93	0.05	0.15	0.83,1.03
7		0.86	0.05	<0.01	0.77, 0.95
8		0.90	0.05	0.03	0.81, 1.00
9		0.90	0.05	0.05	0.82, 1.00
10		0.76	0.05	<0.01	0.69, 0.84
Prior admissions in the previous 5 years:					
	Heart failure	0.38	0.04	0.00	0.35, 0.41

Appendix 2a: Angiography within 1 year of NSTEACS.

Term	Odds ratio	Standard error	P-value	95% confidence interval
Hospital type				
Urban hospital with PCI	Reference			
Urban hospital without PCI	0.75	0.03	<0.01	0.71, 0.79
Rural hospital	0.82	0.04	<0.01	0.75, 0.9
Age				
20–44 years	1.04	0.08	0.68	0.88, 1.22
45–59 years	1.26	0.04	<0.01	1.16, 1.37
60–69 years	Reference			
70–79 years	0.57	0.03	<0.01	0.53, 0.6
80–84 years	0.21	0.04	<0.01	0.2, 0.23
85–59 years	0.05	0.05	<0.01	0.05, 0.06
90+ years	0.01	0.1	<0.01	0.01, 0.01
Sex				
Female	Reference			
Male	1.47	0.02	<0.01	1.4, 1.54

Appendix 2a (continued): Angiography within 1 year of NSTEACS.

Term	Odds ratio	Standard error	P-value	95% confidence interval
Ethnicity				
European/Other	Reference			
Māori	0.76	0.04	<0.01	0.7, 0.83
Pacific	0.63	0.06	<0.01	0.56, 0.7
Indian	0.9	0.07	0.15	0.79, 1.04
Other Asian	0.94	0.08	0.42	0.8, 1.1
Acute coronary syndrome type				
NSTEMI	Reference			
Unstable angina	0.7	0.03	<0.01	0.66, 0.74
Non-cardiac Charlson score category				
0	Reference			
1–2	0.43	0.03	<0.01	0.4, 0.45
3+	0.22	0.05	<0.01	0.2, 0.25
NZ Deprivation Index decile (2013)				
1	1.07	0.06	0.31	0.94, 1.2
2	1.21	0.06	<0.01	1.08, 1.37
3	0.96	0.06	0.44	0.85, 1.07
4	1.09	0.06	0.12	0.98, 1.22
5	Reference			
6	0.94	0.05	0.25	0.84, 1.05
7	0.88	0.05	0.02	0.8, 0.98
8	0.88	0.05	0.02	0.8, 0.98
9	0.9	0.05	0.04	0.81, 0.99
10	0.77	0.05	<0.01	0.69, 0.85
Prior admissions in the previous 5 years				
Heart failure	0.39	0.04	<0.01	0.36, 0.43

Appendix 2b: Readmission with heart failure within 1 year of admission with non-ST-elevation myocardial infarction.

	Odds ratio	Standard error	P-value	95% confidence interval
Hospital type				
Urban hospital with PCI	Reference			
Urban hospital without PCI	1	0.04	0.92	0.9, 1.1
Rural hospital	1.03	0.06	0.62	0.9, 1.2
Age				
20–44 years	0.54	0.16	<0.01	0.4, 0.7
45–59 years	0.58	0.07	<0.01	0.5, 0.7
60–69 years	Reference			
70–79 years	1.56	0.05	<0.01	1.4, 1.7
80–84 years	2.34	0.06	<0.01	2.1, 2.6
85–89 years	2.45	0.06	<0.01	2.2, 2.8
90+ years	2.61	0.07	<0.01	2.3, 3
Sex				
Female	Reference			
Male	1.06	0.03	0.1	1, 1.1
Ethnicity				
European/Other	Reference			
Māori	1.59	0.06	<0.01	1.4, 1.8
Pasifika	1.45	0.08	<0.01	1.2, 1.7
Indian	1.19	0.1	0.08	1, 1.4
Other Asian	0.85	0.13	0.23	0.7, 1.1
Acute coronary syndrome type				
NSTEMI	Reference			
Unstable angina	0.71	0.04	<0.01	0.7, 0.8
Prior admissions in the previous 5 years				
Myocardial infarction	1.12	0.05	0.03	1, 1.2
Heart failure	3.39	0.04	<0.01	3.1, 3.7

Appendix 2b (continued): Readmission with heart failure within 1 year of admission with non-ST-elevation myocardial infarction.

	Odds ratio	Standard error	P-value	95% confidence interval
NZ Deprivation Index decile (2013)				
1	1.06	0.09	0.5	0.9, 1.3
2	0.84	0.09	0.05	0.7, 1
3	1.03	0.08	0.75	0.9, 1.2
4	1.02	0.08	0.84	0.9, 1.2
5	Reference			
6	1.03	0.08	0.68	0.9, 1.2
7	1.17	0.07	0.03	1, 1.3
8	1.09	0.07	0.21	1, 1.3
9	1.28	0.07	<0.01	1.1, 1.5
10	1.15	0.07	0.05	1, 1.3
Non-cardiac Charlson score category				
0	Reference			
1–2	1.63	0.04	<0.01	1.5, 1.8
3+	1.67	0.06	<0.01	1.5, 1.9
Investigations performed within 1 year				
Angiography	0.74	0.04	<0.01	0.7, 0.8

Appendix 2c: Readmission with major adverse cardiac event within 1 year of admission with non-ST-elevation acute coronary syndrome.

	Odds ratio	Standard error	P-value	95% confidence interval
Hospital type				
Urban hospital with PCI	Reference			
Urban hospital without PCI	1.1	0.03	<0.01	1.03, 1.16
Rural hospital	0.99	0.05	0.79	0.9, 1.09
Age				
20–44 years	0.75	0.09	<0.01	0.62, 0.89
45–59 years	0.85	0.04	<0.01	0.78, 0.93
60–69 years	Reference			
70–79 years	1.12	0.04	<0.01	1.04, 1.2
80–84 years	1.4	0.05	<0.01	1.28, 1.54

Appendix 2c (continued): Readmission with major adverse cardiac event within 1 year of admission with non-ST-elevation acute coronary syndrome.

	Odds ratio	Standard error	P-value	95% confidence interval
Age (continued)				
85–89 years	1.95	0.05	<0.01	1.76, 2.17
90+ years	2.02	0.06	<0.01	1.78, 2.3
Sex				
Female	Reference			
Male	1.08	0.03	0.01	1.02, 1.14
Ethnicity				
European/Other	Reference			
Māori	1.07	0.05	0.15	0.98, 1.17
Pasifika	1	0.07	0.99	0.87, 1.14
Indian	1.07	0.07	0.33	0.93, 1.24
Other Asian	0.85	0.09	0.08	0.71, 1.02
Acute coronary syndrome type				
NSTEMI	Reference			
Unstable angina	1.24	0.03	<0.01	1.17, 1.31
Prior admissions in the previous 5 years				
Myocardial infarction	1.67	0.04	<0.01	1.54, 1.82
Heart failure	1.39	0.04	<0.01	1.28, 1.51
NZ Deprivation Index decile (2013)				
1	1.03	0.07	0.66	0.9, 1.17
2	0.98	0.06	0.79	0.87, 1.11
3	1.07	0.06	0.25	0.95, 1.21
4	1.01	0.06	0.85	0.9, 1.14
5	Reference			
6	1.09	0.06	0.14	0.97, 1.22
7	1.09	0.06	0.15	0.97, 1.21
8	1.03	0.06	0.58	0.92, 1.15
9	1.1	0.06	0.08	0.99, 1.23
10	1.12	0.06	0.05	1, 1.26

Appendix 2c (continued): Readmission with major adverse cardiac event within 1 year of admission with non-ST-elevation acute coronary syndrome.

		Odds ratio	Standard error	P-value	95% confidence interval
Non-cardiac Charlson score category					
0		Reference			
1–2		1.38	0.03	<0.01	1.29, 1.47
3+		1.51	0.05	<0.01	1.36, 1.67
Investigations performed within 1 year					
	Angiography	2.86	0.04	<0.01	2.67, 3.07

Appendix 2d: Readmission with major bleeding within 1 year of admission with non-ST-elevation acute coronary syndrome.

	Odds ratio	Standard error	P-value	95% confidence interval
Hospital type				
Urban hospital with PCI	Reference			
Urban hospital without PCI	0.94	0.06	0.28	0.8, 1.1
Rural hospital	1.01	0.09	0.93	0.8, 1.2
Age				
20–44 years	0.49	0.22	<0.01	0.3, 0.7
45–59 years	0.7	0.09	<0.01	0.6, 0.8
60–69 years	Reference			
70–79 years	1.26	0.07	<0.01	1.1, 1.4
80–84 years	1.39	0.08	<0.01	1.2, 1.6
85–89 years	1.28	0.1	0.01	1.1, 1.6
90+ years	1.19	0.12	0.16	0.9, 1.5
Ethnicity				
European/Other	Reference			
Māori	1.24	0.08	0.01	1.1, 1.4
Pasifika	1.41	0.11	0	1.1, 1.7
Indian	0.93	0.15	0.64	0.7, 1.2
Other Asian	1.1	0.16	0.55	0.8, 1.5
Acute coronary syndrome type				
NSTEMI	Reference			
Unstable angina	0.97	0.06	0.56	0.9, 1.1

Appendix 2d (continued): Readmission with major bleeding within 1 year of admission with non-ST-elevation acute coronary syndrome.

	Odds ratio	Standard error	P-value	95% confidence interval
Prior admissions in the previous 5 years				
Myocardial infarction	1.07	0.08	0.44	0.9, 1.2
Heart failure	1.22	0.07	0.01	1.1, 1.4
NZ Deprivation Index decile (2013)				
1	0.99	0.12	0.93	0.8, 1.3
2	0.83	0.12	0.13	0.6, 1.1
3	0.92	0.12	0.49	0.7, 1.2
4	0.95	0.11	0.63	0.8, 1.2
5	Reference			
6	1.04	0.11	0.69	0.8, 1.3
7	0.91	0.11	0.39	0.7, 1.1
8	0.99	0.1	0.96	0.8, 1.2
9	1.11	0.1	0.33	0.9, 1.4
10	1.15	0.11	0.18	0.9, 1.4
Non-cardiac Charlson score category				
0	Reference			
1–2	1.53	0.06	<0.01	1.4, 1.7
3+	2.27	0.08	<0.01	1.9, 2.7
Investigations performed within 1 year				
Angiography	1.49	0.06	<0.01	1.3, 1.7

Appendix 2e: 30-day mortality.

	Odds ratio	Standard error	P-value	95% confidence interval
Hospital type				
Urban hospital with PCI	Reference			
Urban hospital without PCI	1.01	0.05	0.878	0.91, 1.12
Rural hospital	1.02	0.08	0.843	0.86, 1.19
Age				
20–44 years	0.27	0.35	<0.01	0.13, 0.5
45–59 years	0.51	0.13	<0.01	0.4, 0.65
60–69 years	Reference			

Appendix 2e (continued): 30-day mortality.

	Odds ratio	Standard error	P-value	95% confidence interval
70–79 years	1.5	0.08	<0.01	1.28, 1.76
80–84 years	1.89	0.09	<0.01	1.59, 2.25
85–59 years	1.99	0.09	<0.01	1.67, 2.37
90+ years	2.74	0.09	<0.01	2.29, 3.29
Sex				
Female	Reference			
Male	1.28	0.05	<0.01	1.17, 1.39
Ethnicity				
European/Other	Reference			
Māori	1.23	0.08	0.014	1.04, 1.45
Pasifika	1.28	0.11	0.024	1.03, 1.59
Indian	1	0.15	0.997	0.74, 1.33
Other Asian	0.91	0.17	0.568	0.63, 1.26
Acute coronary syndrome type				
NSTEMI	Reference			
Unstable angina	0.25	0.08	<0.01	0.21, 0.29
Non-cardiac Charlson score category				
0	Reference			
1–2	1.37	0.05	<0.01	1.24, 1.52
3+	2.02	0.07	<0.01	1.77, 2.3
NZ Deprivation Index decile (2013)				
1	0.84	0.12	0.152	0.66, 1.06
2	0.89	0.11	0.307	0.71, 1.11
3	0.85	0.11	0.133	0.69, 1.05
4	0.94	0.1	0.529	0.76, 1.15
5	Reference			
6	1.17	0.1	0.103	0.97, 1.41
7	0.9	0.1	0.249	0.74, 1.08
8	1.01	0.09	0.921	0.84, 1.21
9	1.19	0.09	0.062	0.99, 1.43
10	1.23	0.1	0.035	1.02, 1.49

Appendix 2e (continued): 30-day mortality.

	Odds ratio	Standard error	P-value	95% confidence interval
Readmission with following NSTEACS				
Heart failure	0.16	0.11	<0.01	0.13, 0.2
Major adverse cardiac event	0.44	0.09	<0.01	0.37, 0.53
Major bleeding	0.14	0.26	<0.01	0.08, 0.22
Angiography performed	0.13	0.07	<0.01	0.11, 0.15
Prior admissions in the previous 5 years				
Prior heart failure	1.7	0.06	<0.01	1.52, 1.9

Appendix 2f:1-year mortality.

	Odds ratio	Standard error	P-value	95% confidence interval
Hospital type				
Urban hospital with PCI	Reference			
Urban hospital without PCI	1	0.04	0.97	0.93, 1.07
Rural hospital	1.04	0.06	0.49	0.93, 1.16
Age				
20–44 years	0.34	0.2	<0.01	0.23, 0.5
45–59 years	0.51	0.08	<0.01	0.43, 0.59
60–69 years	Reference			
70–79 years	1.56	0.05	<0.01	1.41, 1.73
80–84 years	2.04	0.06	<0.01	1.82, 2.28
85–59 years	2.25	0.06	<0.01	2.01, 2.53
90+ years	3.74	0.06	<0.01	3.3, 4.23
Sex				
Female	Reference			
Male	1.27	0.03	<0.01	1.19, 1.35
Ethnicity				
European/Other	Reference			
Māori	1.26	0.06	<0.01	1.13, 1.41
Pasifika	1.28	0.08	<0.01	1.1, 1.49
Indian	0.86	0.1	0.16	0.7, 1.06
Other Asian	0.91	0.12	0.41	0.71, 1.14

Appendix 2f (continued):1-year mortality.

	Odds ratio	Standard error	P-value	95% confidence interval
Acute coronary syndrome type				
NSTEMI	Reference			
Unstable angina	0.39	0.04	<0.01	0.36, 0.42
Non-cardiac Charlson score category				
0	Reference			
1–2	1.76	0.03	<0.01	1.64, 1.88
3+	3.08	0.05	<0.01	2.8, 3.39
NZ Deprivation Index decile (2013)				
1	0.86	0.08	0.08	0.74, 1.01
2	0.96	0.08	0.56	0.82, 1.11
3	0.81	0.08	<0.01	0.7, 0.94
4	0.93	0.07	0.35	0.81, 1.08
5	Reference			
6	1.15	0.07	0.04	1.01, 1.31
7	1.03	0.07	0.64	0.91, 1.17
8	1.05	0.06	0.44	0.93, 1.19
9	1.13	0.07	0.07	0.99, 1.28
10	1.28	0.07	<0.01	1.12, 1.47
Readmission with following NSTEACS				
Heart failure	1.64	0.04	<0.01	1.51, 1.78
Major adverse cardiac event	1.3	0.04	<0.01	1.19, 1.41
Major bleeding	1.15	0.07	0.05	1, 1.32
Angiography performed	0.18	0.04	<0.01	0.17, 0.2
Prior admissions in the previous 5 years				
Prior heart failure	1.77	0.04	<0.01	1.64, 1.92

Appendix 2g: 2-year mortality.

	Odds ratio	Standard error	P-value	95% confidence interval
Hospital type				
Urban hospital with PCI	Reference			
Urban hospital without PCI	0.97	0.03	0.44	0.91, 1.04

Appendix 2g (continued): 2-year mortality.

	Odds ratio	Standard error	P-value	95% confidence interval
Rural hospital	1.16	0.05	<0.01	1.05, 1.29
Age				
20–44 years	0.39	0.16	<0.01	0.28, 0.53
45–59 years	0.52	0.07	<0.01	0.46, 0.59
60–69 years	Reference			
70–79 years	1.64	0.05	<0.01	1.5, 1.8
80–84 years	2.35	0.05	<0.01	2.12, 2.6
85–59 years	2.84	0.05	<0.01	2.56, 3.16
90+ years	5.04	0.06	<0.01	4.48, 5.68
Sex				
Female	Reference			
Male	1.3	0.03	<0.01	1.23, 1.38
Ethnicity				
European/Other	Reference			
Māori	1.4	0.05	<0.01	1.27, 1.55
Pasifika	1.31	0.07	<0.01	1.14, 1.51
Indian	0.85	0.1	0.09	0.7, 1.02
Other Asian	0.87	0.11	0.2	0.7, 1.07
Acute coronary syndrome type				
NSTEMI	Reference			
Unstable angina	0.4	0.04	<0.01	0.37, 0.43
Non-cardiac Charlson score category				
0	Reference			
1–2	1.92	0.03	<0.01	1.8, 2.05
3+	3.8	0.05	<0.01	3.46, 4.18
NZ Deprivation Index decile (2013)				
1	0.92	0.08	0.24	0.79, 1.06
2	1.01	0.07	0.87	0.88, 1.17
3	0.87	0.07	0.05	0.76, 1
4	0.96	0.07	0.57	0.84, 1.1
5	Reference			
6	1.17	0.06	0.02	1.03, 1.32

Appendix 2g (continued): 2-year mortality.

	Odds ratio	Standard error	P-value	95% confidence interval
NZ Deprivation Index decile (2013) (continued)				
7	1.05	0.06	0.47	0.93, 1.18
8	1.14	0.06	0.04	1.01, 1.28
9	1.26	0.06	<0.01	1.11, 1.42
10	1.38	0.06	<0.01	1.22, 1.57
Readmission with following NSTEACS				
Heart failure	2.32	0.04	<0.01	2.14, 2.51
Major adverse cardiac event	1.44	0.04	<0.01	1.34, 1.56
Major bleeding	1.33	0.06	<0.01	1.17, 1.51
Angiography performed	0.21	0.03	<0.01	0.19, 0.22
Prior admissions in the previous 5 years				
Prior heart failure	1.93	0.04	<0.01	1.78, 2.08

Appendix 3: Unadjusted and adjusted hazard ratios (HR) and 95% confidence intervals (95% CI) for mortality following non-ST-segment elevation acute coronary syndrome for patents that present to New Zealand urban hospitals with routine access to PCI (urban hospital with PCI), urban hospitals without routine access to PCI (urban hospital without PCI) and rural hospitals. Hazard ratios are adjusted for age, ethnicity, acute coronary syndrome type, prior admission with myocardial infarction or heart failure, non-cardiac Charlson score category, New Zealand Deprivation Index decile (2013), angiography performed within 1 year and readmission within 1 year with heart failure, a major adverse cardiac event or major bleeding.

	Urban hospital with PCI	Urban hospital without PCI	Rural hospital
Unadjusted HR (95% CI)	Reference	0.89 (0.95, 1.0)	1.05 (0.99, 1.11)
Adjusted HR (95% CI)	Reference	0.97 (0.94, 1.01)	1.06 (1.00, 1.13)

Appendix 4: Stratified Cox proportional hazard model output. Age, ethnicity, acute coronary syndrome type, prior admissions to hospital with myocardial infarction, non-cardiac Charlson score category, angiography performed within 1 year and readmission within 1 year due to heart failure, major adverse cardiac event and major bleeding were stratified due to violating the proportional hazard assumption using the quantitative Schoenfeld test.

	Hazard ratio	95% confidence interval	Standard error	P-value
Urban hospital without PCI	0.99	(0.95, 1.03)	0.02	0.57
Rural hospital	1.07	(1.00, 1.14)	0.03	0.05
Prior heart failure	1.58	(1.51, 1.66)	0.02	<0.01
NZ Deprivation 2013 (NZDep2013) decile 1	0.90	(0.82, 0.99)	0.05	0.04
NZ Deprivation 2013 (NZDep2013) decile 2	0.97	(0.89, 1.06)	0.05	0.50
NZ Deprivation 2013 (NZDep2013) decile 3	0.91	(0.84, 1.00)	0.04	0.04
NZ Deprivation 2013 (NZDep2013) decile 4	0.97	(0.90, 1.06)	0.04	0.54
NZ Deprivation 2013 (NZDep2013) decile 6	1.05	(0.97, 1.13)	0.04	0.25
NZ Deprivation 2013 (NZDep2013) decile 7	1.02	(0.95, 1.10)	0.04	0.56
NZ Deprivation 2013 (NZDep2013) decile 8	1.06	(0.99, 1.15)	0.04	0.10
NZ Deprivation 2013 (NZDep2013) decile 9	1.11	(1.03, 1.20)	0.04	<0.01
NZ Deprivation 2013 (NZDep2013) decile 10	1.14	(1.05, 1.24)	0.04	<0.01
Male	1.25	(1.20, 1.30)	0.02	<0.01

Exploring the current and future osteoarthritis health service delivery needs in Aotearoa New Zealand

Daniel W O'Brien, Sam Norman, Rebecca Grainger, Richard Ellis, Ben Hudson, Ivana Nakarada-Kordic, J Haxby Abbott

ABSTRACT

AIM: Osteoarthritis (OA) affects the wellbeing of one in 10 people in Aotearoa New Zealand, yet current healthcare delivery for these people is fragmented, un-coordinated and inconsistent. How current and future needs should be addressed has not been systematically explored. This study aimed to describe the views of interested people from the health sector regarding current and future OA health service delivery in the public health system in Aotearoa New Zealand.

METHOD: Data were collected via a co-design approach within an interprofessional workshop at the *Taupuni Hao Huatau Kaikōiwi: Osteoarthritis Aotearoa New Zealand Basecamp* symposium and analysed using direct qualitative content analysis.

RESULTS: The results highlighted several promising current healthcare delivery initiatives. Health literacy and obesity prevention policies featured in the thematic analysis suggesting a lifespan or systemwide approach is needed. Data highlighted a need for reformed systems that enhances hauora/wellbeing, promotes physical activity, facilitates interprofessional service delivery and collaborates across care settings.

CONCLUSION: Participants identified several promising healthcare delivery initiatives for people with OA in Aotearoa New Zealand. Public health policy initiatives are needed to reduce osteoarthritis risk factors. Developing future care pathways should support the diverse needs within Aotearoa New Zealand, coordinate and stratify care, value interprofessional collaboration and practice, and improve health literacy and self-management.

Globally, osteoarthritis (OA) is a leading cause of chronic pain and disability.[1,2] In Aotearoa New Zealand, OA affects one in 10 people and prevalence is predicted to increase by 76% in the next 20 years due to obesity and population demographics and to drive healthcare costs up by 86%.[3,4] The rising burden of OA will place greater demand on clinical services.[4–6] OA can affect all aspects of a person's sense of hauora (health), including hinengaro (mental and emotional), tinana (physical) and whānau (social).[7–10] International OA clinical management guidelines recommend people with OA should have access to care that provides appropriate person-centred education, exercise and weight loss (if applicable) before employing pharmacological or surgical management.[12] In contrast to these recommendations, OA management in Aotearoa New Zealand has been described as fragmented and regionally variable,[5,13–15] but little research has been undertaken on service delivery for people living with OA in Aotearoa New Zealand.

In December 2020, a transdisciplinary committee formed to improve collaboration between stakeholders interested in OA management in Aotearoa New Zealand. This group aimed to advocate for a National Model of Care for OA, similar to an initiative in Australia.[16] This committee delivered the *Taupuni Hao Huatau Kaikōiwi: Osteoarthritis Aotearoa New Zealand Basecamp* symposium in Auckland on 10 July 2021, with the aims of bringing together clinicians from all disciplines, health delivery organisations, consumers and researchers with a particular interest in managing OA in Aotearoa New Zealand, and developing a list of national priorities in OA research and innovative health delivery (https://events.otago.ac.nz/2021-osteoarthritis-basecamp/). The symposium was open to anyone in Aotearoa New Zealand with interest in OA healthcare. It brought together a national audience (n=82) of health professionals (dietitians, general medical practitioners, nurses, orthopaedic surgeons, physiotherapists, podiatrists, psychologists, rheumatologists, sports medicine physicians and clinical exercise physiologists), researchers (across fields from basic science to clinical trials) and health funders

(services managers, policy workers).

Given the diverse sector representation, the *Taupuni Hao Huatau Kaikōiwi: Osteoarthritis Aotearoa New Zealand Basecamp* symposium provided an opportunity to share ideas and experiences, raise questions and expand thinking about how OA research and healthcare service delivery can be improved. The symposium's morning sessions included presentations from national and international OA experts on best practice evidence about service delivery and research. The afternoon sessions included two interactive workshops which aimed to explore beliefs about national priorities in OA research and innovative OA health delivery in Aotearoa New Zealand from the perspective of actively engaged sector stakeholders. This manuscript presents the findings from the workshop about innovative OA health delivery in Aotearoa New Zealand.

Aim

To describe the views of interested people from the health sector about current and future OA health service delivery in the health system in Aotearoa New Zealand, including what works well, the barriers to service improvements, and priorities for OA health improvement initiatives.

Methods

Study design

We used a co-design approach,[17] informed by a realist philosophical lens, a qualitative descriptive methodology and thematic analysis to explore the current and future OA health service delivery need in Aotearoa New Zealand.[18] This participatory framework supports an interdisciplinary, collaborative design process to ensure that outcomes reflect real, rather than assumed, requirements and offer innovative strategies to resolve complex problems.[19,20]

Participants

Everyone who attended the 2-hour workshop at the *Taupuni Hao Huatau Kaikōiwi: Osteoarthritis Aotearoa New Zealand Basecamp* symposium in 2021 was invited to participate in the study. Attendance at the workshop was optional. People attending the workshop could choose for their data to be excluded from the analysis by drawing a small square on the back of their Post-it™ Notes. However, no one decided to do this.

Data collection

Ethics approval was obtained for the study from University of Otago Human Ethics Committee (D21/222). The participant information form was provided to all symposium registrants 1 week before the symposium. Written consent was obtained at the workshop.

Participants (attendees) worked in small groups (between four and eight people). An additional group of seven attended a pre-conference workshop at the University of Otago Medical School (Dunedin) on 24 June 2022. Participants were asked to brainstorm responses to questions about health service delivery for people with OA in Aotearoa New Zealand. Participants wrote their responses as bullet points on Post-it™ Notes. After 10–15 minutes, facilitators asked one group member to place all Post-it™ Notes on a wall-mounted poster for other attendees to see and consider. The facilitator then led discussion of the collective responses and then guided the groups to move to the next question. Table 1 lists the research questions participants discussed and responded to.

For Questions 1 and 2, participants were asked to position their responses (Post-it™ Notes), after which they spent 10 minutes reading and reflecting on the group's ideas. Then the facilitator led a group discussion on the themes represented, using co-design facilitation to generate participatory thematic analysis. Participants then went to the poster and organised the Post-it™ Notes into themes generated.

For Question 3, participants were asked to position their responses (Post-it™ Notes) on a journey map.[21] The journey map, conceived *a pri-*

Table 1: Workshop questions.

1) What currently works well in the management of OA in the Aotearoa New Zealand public healthcare system?
2) What are some of the challenges (or barriers) to health delivery improvement initiatives for people with OA in Aotearoa New Zealand?
3) What are key priorities for New Zealand healthcare delivery improvement initiatives for OA management in the Aotearoa New Zealand public healthcare system?

Figure 1: The OA journey map with Post-it™ Notes *in situ*.

ori by the researchers, represented the continuum of care in a person's OA management. It included four subheadings or key touch points in the OA management journey (pre-OA, early identified OA, community and primary care, secondary care) under which the Post-it™ Notes could be placed (Figure 1) and the fifth subheading (lifespan or systemwide) placed at the bottom that spanned the whole journey map.

Data analysis

All written material generated during the workshop (Post-it™ Notes) was photographed *in situ*, collected, and used as the primary data source. All data were transferred into an Excel (Microsoft, 2022) spreadsheet, with each Post-it™ Note response in a cell. All responses were analysed using direct qualitative content analysis.[22] Analysis for Question 1 concluded with code grouping and naming; thematic analysis was conducted by the participants for Question 2, in the first instance, and code-grouping by the researchers was conducted independently *post hoc*. Since participants were asked to assign their responses to subheadings in the journey map for Question 3, we used these subheadings to frame the data analysis of this question. Thematic analysis of Question 3 was conducted by the researchers. Analysis of common responses across the journey map further informed the construction of the fifth subheading (lifespan or systemwide approach). The frequency of responses was not quantified because our goal was to capture the breadth of the data from workshop participants.

Two research team members (DOB and SN) collaboratively coded the responses (data) and then grouped codes that appeared conceptually connected. Next, these groups were named and presented to all research team members for feedback and refinement. To strengthen trustworthiness, results were continuously discussed between the research team with different competence and perspectives in triangulation between researchers.[23] A third team member (HA) reviewed the data, coding, code grouping and, for Question 3, conducted thematic analysis. Themes and sub-themes emerging from the coded data were returned to DOB and SN; these were discussed, and a working version was confirmed in a consensus meeting. Next, these themes and sub-themes were presented to all research team members for feedback before confirming a final version.

Results

Fifty-two people attended the 2-hour workshop. Participants came from various clinical (dietetics, general practice, nursing, orthopaedic surgery, physiotherapy, podiatry, psychology, rheumatology, sports medicine and clinical exercise physiology), health research and health funding backgrounds across Aotearoa New Zealand (Table 2). We have presented our results as they relate to the workshop questions and present data codes in "*italics*". Names representing categories of grouped data are presented <u>underlined</u>. Themes and sub-themes are capitalised.

Table 2: Participant characteristics.

	No.	%
Total participants	52	
Completed demographics form	34	65
Sex		
Female	23	44.2
Male	13	25.0
Unknown	16	30.8
Primary occupation		
Person with osteoarthritis	0	0.0
Māori health advocate	0	0.0
Health organisation or policy professional	7	13.5
Research academic	1	1.9
Healthcare provider	30	57.7
Physiotherapy	19	36.5
Orthopaedic surgeon	8	15.4
Dietician	1	1.9
General practitioner	1	1.9
Exercise provider	1	1.9
Missing	14	26.9
Secondary occupation*		
Person with osteoarthritis	8	15.4
Māori health advocate	1	1.9
Health organisation or policy professional	6	11.5
Research academic	1	1.9
Healthcare provider	8	15.4
Physiotherapy	5	9.6
Registered nurse	2	3.8
Other; not stated	1	1.9
Missing	14	26.9

* More than one secondary occupation could be selected.

What works well in the management of OA in the public healthcare system?

Participants offered that OA management worked well when services work better together and focussed on building a healthcare service for all.

Work better together

OA management worked well when new pathways were developed with a "*national perspective*" that "*recognised the need for change*", "*reduced professional hierarchies*" and developed and supported "*triage clinics*". Furthermore, they reported that these changes had fostered a "*willingness to share between groups, programmes and institutions*" and greater "*intersectoral collaboration*". Additionally, participants valued "*engaging with local and international research*" to support a move towards a more collaborative model of care.

Building a healthcare service for all

Participants believed that they had seen improvements in several areas of healthcare delivery, including cultural awareness, healthcare provider education, technological integration, and the implementation of a range of OA management programmes. Codes included "*awareness of the need to build Māori health access*", more significant "*Iwi and Māori consultation*", and "*recognition of the value of equity*" and the "*patient voice*". They also reported improvements in "*health workforce and undergraduate training*" and believed the "*quality of care for people was improving*". Participants also valued "*increased investment in digital health models*" and "*technology advancement funding*" as new initiatives improving OA management. Lastly, participants stated the benefit of the emergence of OA management programmes, including the Mobility Action Programme (MAP), Good Life with Arthritis: Denmark (GLA:D), Accident Compensation Corporation (ACC) injury prevention programmes, the Bay of Plenty Community Orthopaedic Triage Service (COTS) and the Canterbury Initiative.

What are the barriers to effective service delivery for people with OA?

Participants offered barriers or challenges, which they collaboratively analysed to the following themes (with *example data codes)*: culture (*institutional and clinician bias/racism; people's motivation to take self-responsibility*); resources (*limitations of DHB* [district health board] *capacity; workforce to meet requirements; primary allied health services not funded; funding*); accessibility (*postcode healthcare; inequities; ethnicity and poverty*); healthcare education (*undergraduate training*); focus of care (*low prioritisation of OA; clinician-centred vs patient-centred*); patient knowledge (*common myths and misconceptions; poor patient awareness of treatment options*); siloed (*working in silos; lack of continuity in services*); evidence-based practice (*fewer evidence-based programmes in hospital and the community; data—access, outcomes*).

Post hoc, we (DOB, SN) organised these into three code groups: 1) Knowledge and expectations, 2) Inequitable access to care, and 3) Patient- and whānau-(un)centred care.

1. Knowledge and expectations: Participants reported many challenges related to patient knowledge, health literacy and expectations. They referred to "*a lack of understanding of OA in the general population*" and limited knowledge of treatment options available ("*population education*") and stated that more standardised resources and guidelines were needed. They also noted a "*lack of patient-friendly resources*" and "*poor or inconsistent patient messaging*". Furthermore, participants identified the key barriers to the efficacy of existing clinical services as "*patient adherence*", "*unrealistic expectations*" and "*cultural differences*".
2. Inequitable access to care: The data highlighted participants' concern about the inequitable access to OA management services in Aotearoa New Zealand in two categories: *funding* and *access*. Tensions with the funding of OA management in Aotearoa New Zealand included competition, real or perceived, to financing between "*public, private and ACC*", between "*primary and secondary care*" (primary care being perceived as the more poorly funded) and compared to other long-term conditions such as cancer or diabetes ("*low prioritisation at a DHB/MoH* [Ministry of Health] *level*"). Participants also identified variability in access caused by "*postcode healthcare*", "*limited local resources (affordable pools or gyms)*" and a "*lack of access to weight management services and appropriate advice*".
3. Patient- and whānau-(un)centred care. Participants referred to the structure and culture of the health system and limited interprofessional collaboration, or

working in silos, as system-level barriers to healthcare delivery. Specifically, critical barriers were "*clinician-centred service design*", "*institutional bias and racism*", a "*one-size-fits-all approach*", and "*a lack of authentic Māori engagement*". Moreover, some participants referred to "*orthopaedics as the gate-keepers of referral to other programmes*" and "*a lack of buy-in from GPs and orthopaedics for non-surgical approaches*".

What are the key priorities for improvement initiatives for OA management in the Aotearoa New Zealand public healthcare system?

Table 3 shows key data codes for current Aotearoa New Zealand health delivery improvement initiatives participants were aware of or involved in, alongside potential future health delivery priorities for OA. Table 4 shows the themes, sub-themes, and key data code groups generated from the "key priorities for improvement" data.

Pre-OA

Participants' responses highlight the value of injury prevention programmes and the many existing programmes that aim to increase physical activity, public education about OA and the benefits of exercise and physical activity (Table 3). Many responses regarding future healthcare delivery priorities, public health initiatives, health system changes and more robust methods of addressing obesity were considered by the researchers to be relevant beyond the "pre-OA" phase, so they were also carried through to the "lifespan or system-wide" axis of the journey map.

The codes and code groupings converged on two key themes (with sub-themes): a public health approach (sub-themes: policy, urban design, health literacy and prevention action); and health delivery approach (sub-themes: health system redesign, guidelines/pathways, and enabling providers).

Early OA

Data coded about the priorities for managing early OA were summed up with the notion that knowledge is power (Table 3). Participants listed resources and activities that would improve health literacy and knowledge about OA, both for patients and the public. They also wrote about the need for early screening to ensure appropriate access to patient pathways and that, in some instances, clinical services reprioritisation was needed (physiotherapy). Regarding future healthcare delivery priorities, participants wrote about needing to help patients self-manage their OA more effectively and enhance education via digital platforms, such as *Health Navigator*. Some suggested a more stratified, interprofessional approach to early management, matching patient need to available clinical services.

The codes and code groupings again converged on two key themes (with sub-themes): a public health approach (sub-theme: health literacy); and health delivery approach (sub-themes: health system redesign, guidelines/pathways, and enabling providers).

Community and primary care

The need for cohesive care across community and primary care OA management was prominent in the data, highlighting the need for greater accessibility, suggesting more use of technology and service hubs to reduce inequity of access for Māori and rural regions. More integrated and inclusive models of care, including Māori health models and Māori-led health services, were suggested. Again, the codes and code groupings converged on two key themes (with sub-themes): a public health approach (sub-themes: health literacy, programme action); and health delivery approach (sub-themes: health system redesign, guidelines/pathways, and enabling providers).

Secondary care

A range of data codes reflected access constraints and mapped ways to increase capacity—such as increasing workforce, surgical capacity, separating acute trauma capacity from elective surgery capacity, models bridging primary to secondary care or deploying allied health providers in secondary care, utilising private providers—and pathways to enable these. They reflected a need to redesign aspects of system flow to reduce delays for appropriate orthopaedic review, to avoid delays due to competing services (e.g., trauma surgery), and to identify non-surgical candidates and provide access to other services. The health delivery approach theme was most prominent; as well as the sub-themes of health system redesign, guidelines/pathways, and enabling providers, additional sub-themes of increasing capacity and new interventions were identified.

Table 3: Key data codes of current initiatives in Aotearoa New Zealand and future OA health delivery priorities.

Osteoarthritis journey map							
Pre-OA		**Early OA**		**Community and primary care**		**Secondary care**	
Current	**Future**	**Current**	**Future**	**Current**	**Future**	**Current**	**Future**
*FIFA 11+ *Netball Smart *ACC Warm-up *Green Prescription *Māori Swim Club *Tai chi *Positive Parenting Active Lifestyle *ACC – Live Stronger for Longer	*More cycle lanes *Sugar tax *Exercise parks with gear *Free public exercise classes *Greater hauora/ wellbeing focus *Early integration of care pathways	*Arthritis New Zealand *Health Navigator *Greater early identification resources *GP education *Early screening *Accessible patient pathways *Clinical services reprioritisation	*Early education and support at first diagnosis *Health Navigator *Stratification of care delivery *Greater use of pharmacy dietetics and nursing	*Mobility Action Programme (MAP) *Good Life with Arthritis: Denmark (GLA:D *Community Orthopaedic Triage Service (COTS) *Green Prescription *Physio Fit *Never 2 Old *Tame the Beast (pain programme) *Appetite for Life (health eating) *Arthritis NZ *My Joint Pain NZ *Arthritis IQ	*More telehealth *Regional satellite clinics *Rural hubs *Integrate Māori health models *Marae-based welling being hubs *Health care run by Māori for Māori *More dietitians and health coaches *ACC engagement	*Optimisation of surgical access *Greater funding of surgical care *Post-operative pathways planning *Implementation of pain management pathways	*Greater connection with primary care pathways *Enforcement of conservative care before secondary care
Lifespan or systemwide approach							
* A greater hauora/wellbeing focus * Increasing physical activity at all ages and stages * An interprofessional approach to care (especially dietary management) * Better connection of healthcare services across the four stages of the osteoarthritis journey map							

ACC = Accident Compensation Corporation; FIFA = International Federation of Association Football; GP = general practitioner; NZ = New Zealand.

Table 4: Themes, sub-themes, and key data codes generated from the "key priorities for improvement" data.

Theme	Sub-theme	Appeared in journey map axis	Code groups
Public health approach	Policy	Pre-OA; Lifespan or system-wide	Policies; obesity
	Urban design	Pre-OA; Lifespan or system-wide	Encouraging activity; policies
	Health literacy	Pre-OA; Early identification; Community and primary Care; Secondary care; Lifespan or system-wide	Patient culture; health literacy; education; patient support;
	Action	Pre-OA; Community and primary Care	Injury prevention action; funding allocation
Health delivery approach	Health system redesign	Pre-OA; Early identification; Community and primary care; Secondary care; Lifespan or system-wide	Funding allocation; health system focus; accessibility; multi-disciplinary treatment; culturally appropriate healthcare; non-surgical management programmes
	Guidelines/pathways	Pre-OA; Early identification; Community and Primary care; Secondary care; Lifespan or system-wide	Care pathways; pathway stratification; multi-disciplinary treatment
	Enable providers	Pre-OA; Early identification; Community and primary care; Secondary care	Encouraging activity; patient support; health professional culture; culturally appropriate healthcare
	Increasing capacity	Community and primary care; Secondary care	Surgical flow resourcing; funding allocation; care pathways; pathway stratification; non-surgical management programmes; multi-disciplinary treatment

OA = Osteoarthritis

Lifespan or systemwide

The researchers considered several responses in the above four phases of the journey map relevant beyond the phase in which participants posted them, so they were also carried through to the "lifespan or systemwide" axis of the journey map. Data codes relating to this question clustered in four groups within this fifth element of the journey map. These were called: 1) *a greater hauora/wellbeing focus*, 2) *increasing physical activity at all ages and stages*, 3) *an interprofessional approach to care*, and 4) *better connection of healthcare services across the four stages of the osteoarthritis journey map* (Table 3). Interpretation of the participants' data suggested moving to a more holistic, person-centred approach to OA management, focussing on hauora/wellbeing. The public health approach theme suggested interventions that increase physical activity and reduce obesity. The health delivery approach theme suggested a redesign to better integrate health services (i.e., prevention, early identification and management, community and primary care, and secondary care) and enable a broader range of healthcare professions to contribute to managing OA.

Summative themes

Across all axes of the journey map, the codes and code groupings converged on two key themes (each with four sub-themes): a public health approach (sub-themes: policy, urban design, health literacy and programme action); and a health delivery approach (sub-themes: health system redesign, guidelines/pathways, enabling providers and increasing capacity) (Table 4).

Discussion

To our knowledge, this is the first study to explore priorities for health service delivery improvement initiatives for OA; while it has focussed on the Aotearoa New Zealand context, it offers international relevance. During the *Taupuni Hao Huatau Kaikōiwi: Osteoarthritis Aotearoa New Zealand Basecamp* symposium 2021, participants offered their informed views on OA care across the continuum, including current approaches that work well, barriers to care and current and future priorities. Participants cited the strengths of the existing services as a willingness to work together and develop services fit for all New Zealanders. Key barriers were poor knowledge and expectations, inequity of care and lack of patient- and whānau-centred care.

Participants offered recent positive changes to OA management in Aotearoa New Zealand, including steps to improve collaboration across primary and secondary services (e.g., triaging systems such as the Bay of Plenty COTS), an appreciation for the need to develop health delivery fit for all (especially for Māori) and the success of more person-centred interprofessional approaches to care (i.e., MAP). However, our findings suggest that these initiatives are not yet ubiquitous or comprehensive enough. Previous literature has called for management across the disease continuum,[24] to change the narrative and improve patient and public understanding of the disease,[25,26] and develop patient-centred health service delivery approaches that acknowledge the diversity of Aotearoa New Zealand and partner with Māori to meet service need.[7,8] These are critical areas to address in the Aotearoa New Zealand health system.

Analysis of the findings suggests there may be a need for a comprehensive, cohesive and equitable model of OA care. Given the symposium's aims and the participants' decisions to attend, this finding is not surprising. A comprehensive and equitable OA service reflects recommendations for best-practice OA management.[13,27–29] While the data did not explicitly state a need to implement consistent national pathways or systems across Te Whatu Ora (the Aotearoa New Zealand public healthcare system), this imperative was implied in the statement of the workshop questions and the symposium's broader kaupapa, and mirrors the intent of the current national health reform's goals.[30] Secondly, there was a call for improving health literacy at all stages of the patient journey. Patient education is universally regarded as a cornerstone of OA management.[12]

Three recommended goals for the future health delivery for people with OA can be constructed from the analysis of our findings: first, the conceptualisation of OA management as a continuum so that injury prevention, obesity reduction and physical activity are actively considered along with primary and secondary care services. Second, establishing an evidence-informed model of care that guides the development and implementation of clinical services across the clinical course of (long-term) musculoskeletal conditions. The third is the development of clinical hubs or programmes for Māori hauora that specifically meet the needs of Māori.

This study's strengths are that it captured the perspectives of a broad range of people actively

engaged in helping people with OA management in Aotearoa New Zealand, including research, and that we used methodologies suited to the nature of the research questions and the data, which provided an acceptable level of academic rigour.[17] The main limitations were that data were collected from people whose attendance at the symposium suggested that they are actively invested in OA management in Aotearoa New Zealanc; hence, their beliefs and attitudes may not reflect those of the wider population. Furthermore, there was no consumer input into the data or the data analysis (aside from health delivery stakeholders who secondarily identify as having OA), meaning a valuable perspective is missing and future studies are needed to explore this perspective. Lastly, data collection using Post-it™ Notes lacks the contextual richness of, for example, in-depth interview methodologies, meaning there is the risk of misinterpretation of short sentences. However, as most of the authors contributed to the running of the workshops (BH did not participate), this risk is reduced. Health resources are finite; hence, the next phase of our kaupapa (project) includes a prioritisation study aiming to capture stakeholder beliefs on which services for people with OA merit greatest investment. Furthermore, we will recruit people living with OA.

Conclusion

Our study identified several promising healthcare delivery initiatives for people with OA in Aotearoa New Zealand. Furthermore, our analysis recognised factors that could enhance OA care across the lifespan, including a greater focus on prevention, hauora/wellbeing rather than the disease, incorporation of a wider range of healthcare professionals, addressing capacity constraints, the potential value of a model of OA care or pathway that is evidence based and integrates healthcare from OA prevention to secondary care. Yet, more work is needed to prioritise what stakeholders consider to be high-value care, and any model of OA care or pathway would need to acknowledge and support the diversity of needs within Aotearoa New Zealand and place value on interprofessional collaboration and practice, and improvements in health literacy and self-management.

COMPETING INTERESTS
Nil.

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AUTHOR INFORMATION
Daniel W O'Brien: Senior Lecturer, Department of Physiotherapy, Auckland University of Technology, Auckland.
Sam Norman: Teaching Assistant, Department of Physiotherapy, Auckland University of Technology, Auckland.
Rebecca Grainger: Professor, Rheumatology, University of Otago, Wellington.
Richard Ellis: Associate Professor, Department of Physiotherapy, Auckland University of Technology, Auckland.
Ben Hudson: Head of Department, Department of Primary Care and Clinical Simulation, University of Otago, Christchurch.
Ivana Nakarada-Kordic: Senior Lecturer, Good Health Design, Auckland University of Technology, Auckland.
J Haxby Abbott: Professor, Department of Surgical Sciences, University of Otago, Dunedin.

CORRESPONDING AUTHOR
Dr Daniel W O'Brien: Department of Physiotherapy, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand.
E:dobrien@aut.ac.nz

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Skin-to-deltoid-muscle distance at three recommended sites for intramuscular vaccination in a population with obesity: an observational study

Marjan Doppen, Melissa Black, Irene Braithwaite, Jonathan Bong, Allie Eathorne, Louis Kirton, Stacey Kung, Michaela Walton, Thomas Hills, Mark Weatherall, Richard Beasley, Ciléin Kearns

ABSTRACT

AIM: Worldwide, immunisation guidelines variably locate the deltoid injection site based on anatomical landmarks. This may influence the skin-to-deltoid-muscle distance and therefore the needle length required to achieve intramuscular injection. Obesity is associated with increased skin-to-deltoid-muscle distance, but it is unknown whether the injection site location chosen in individuals with obesity impacts the needle length required for intramuscular injection. The aim of the study was to estimate the differences in skin-to-deltoid-muscle distance between three different vaccine injection sites recommended by the national guidelines of the United States of America (USA), Australia and New Zealand, in obese adults. The study also explored i) the associations between skin-to-deltoid-muscle distance across the three recommended sites with sex, body mass index (BMI), and arm circumference, and ii) the proportion of participants with a skin-to-deltoid-muscle distance >20 millimetres (mm), in whom the standard 25mm needle length would not ensure deposition of vaccine within the deltoid muscle.

METHOD: Non-interventional cross-sectional study in a single site, non-clinical setting in Wellington, New Zealand. Forty participants (29 females), aged ≥18 years, with obesity (BMI>30 kilograms [km]/m^2). Measurements included distance from acromion to injection sites, BMI, arm circumference, and skin-to-deltoid-muscle distance measured by ultrasound at each recommended injection site.

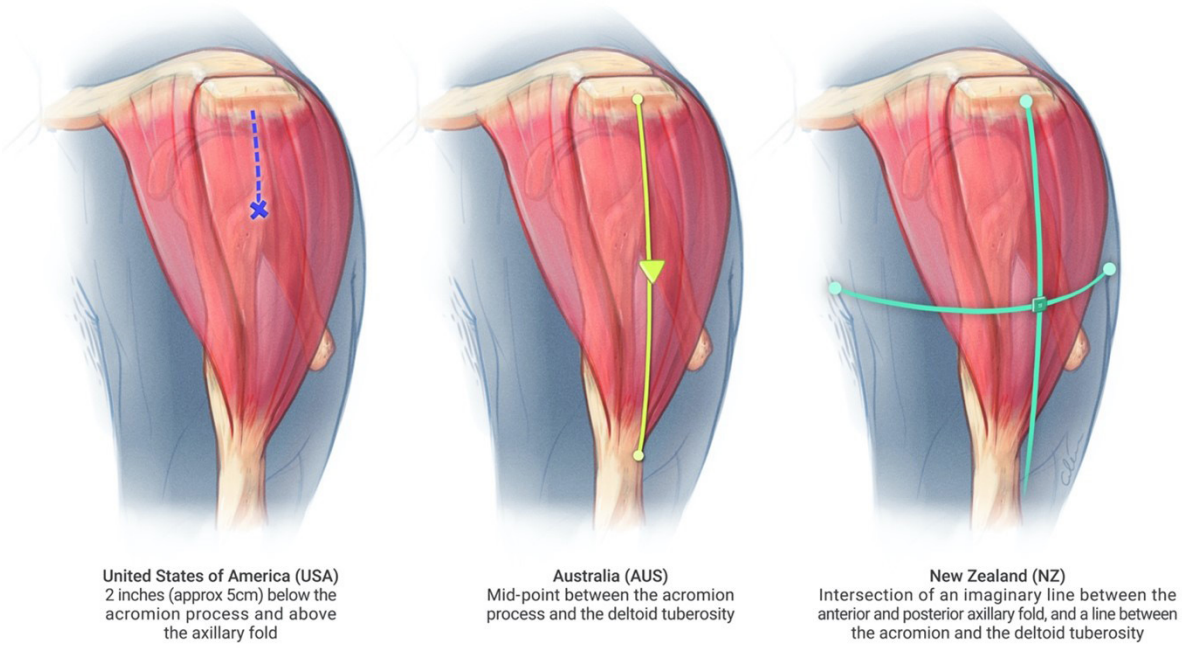
RESULTS: Mean (SD) skin-to-deltoid-muscle distances for USA, Australia and New Zealand sites were 13.96mm (4.54), 17.94mm (6.08) and 20.26mm (5.91) respectively, with a mean (95% confidence interval) for the distance between Australia minus New Zealand -2.7mm (-3.5 to -1.9), P<0.001; and USA minus New Zealand -7.6 mm (-8.5 to -6.7); P<0.001. Skin-to-deltoid-muscle distance was greater in females and was positively associated with BMI and arm circumference. The proportions with a skin-to-deltoid-muscle distance >20 mm were 45%, 40% and 15% for the New Zealand, Australia and USA sites respectively. However, the sample size was relatively small, limiting interpretation in specific sub-groups.

CONCLUSION: There were marked differences in the skin-to-deltoid-muscle distance between the three recommended injection sites studied. When choosing the required needle length to achieve intramuscular vaccination in obese vaccine recipients, consideration needs to be given to the injection site location, sex, BMI and/or arm circumference, as these factors all influence the skin-to-deltoid-muscle distance. A standard needle length of 25mm may be insufficient to ensure deposition of vaccine into the deltoid muscle in a substantive proportion of adults with obesity. Research is urgently required to determine anthropometric measurement cut-points that can be used to enable appropriate needle length selection to ensure intramuscular vaccination.

Messenger ribonucleic acid (mRNA) vaccines developed to protect against SARS-CoV-2 infection are only approved for intramuscular administration.[1,2] A needle of sufficient length to penetrate through the skin and subcutaneous tissue is needed to reach the deltoid muscle (the skin-to-deltoid-muscle distance), which is the preferred injection site.[3] It has been suggested that penetration of the deltoid muscle by 5 millimetres (mm) is required to ensure intramuscular deposition of the vaccine.[4] With national rates of adults with obesity above 40% in the United States of America (USA),[5] and around a third in Australia[6] and New Zealand,[7] it is important to choose an appropriate needle length for this demographic. Published data report that a standard needle length (25mm) is suitable for most people with a body mass index (BMI) <25 kilograms [kg]/m2.[4,8] However, progressively higher BMIs increase the likelihood of requiring a longer-than-standard needle length for deltoid intramuscular injection.[8–10]

Worldwide, immunisation guidelines vary in their instructions on how to choose the correct

Figure 1: Deltoid intramuscular injection site definitions for the United States of America (USA), Australia and New Zealand. These result in different locations for intramuscular injection. Medical illustration is by Dr Ciléin Kearns.



needle length based on BMI and body weight, or contain non-specific terms such as "larger arms".[11–13] An accurate measurement of BMI for a vaccine recipient is not always readily available and the interpretation of arm size is subjective, resulting in an increased risk of inappropriate needle length choice and subcutaneous vaccine delivery. An observational study of a SARS-CoV-2 mRNA vaccine, administered with needles of different lengths at the discretion of the vaccinator, did not demonstrate a difference in immunogenicity between those vaccinated with a needle of sufficient versus insufficient length to achieve intramuscular deposition of vaccine.[14] However, there is evidence that intramuscular injection results in significantly better immune response compared to subcutaneous delivery of influenza and hepatitis B vaccines.[15] Further, there is high-grade evidence that subcutaneous administration of different vaccine types (adjuvanted, live virus and non-adjuvanted) is associated with increased local side effects including abscess and granuloma formation, compared to intramuscular delivery.[15–17]

The location of the deltoid intramuscular injection site is defined variably between countries based on anatomical landmarks (Figure 1). In the USA, the recommended injection site is 2 inches (approximately 5 centimetres [cm]) below the acromion process and above the axillary fold.[13] In Australia, the site recommended for injection is the midpoint between the acromion process and the deltoid tuberosity.[11] In New Zealand, the site recommended is at the intersection of the axilla line (an imaginary line connecting the most superior point of the anterior and posterior axillary fold), and an imaginary line connecting the acromion and the deltoid tuberosity.[18]

Current guidance on needle length choice does not account for potential variation in skin-to-deltoid-muscle distance across the length of the deltoid muscle. In two studies,[19,20] a statistically significant difference in mean skin-to-deltoid-muscle distance between injection sites was reported in individuals with a low/normal BMI of approximately 20kg/m^2. With the relatively small skin-to-deltoid-muscle distances in this population, the absolute differences were not clinically important for intramuscular injection needle length recommendations. Whether the same variability in skin-to-deltoid-muscle distance exists in a population with obesity is unknown, yet highly relevant since they are at risk of subcutaneous injection from insufficient

needle length. If within-subject differences in skin-to-deltoid-muscle distance at larger BMIs are of the same relative magnitudes to that reported by Nakajima et al.,[18,19] the injection site chosen may alter the required needle length. It is therefore important to understand in adults with obesity the difference in skin-to-deltoid-muscle distance between recommended injection sites worldwide to help inform correct choice of needle length.

The objective of this study was to estimate the differences in skin-to-deltoid-muscle distance between three different vaccine injection sites recommended by national guidelines in the USA, Australia and New Zealand. The study also aimed to explore if any identified differences in skin-to-deltoid-muscle distance between the three recommended injection sites differed by sex, BMI or arm circumference.

Subjects

Eligible participants were 18 years or older, of any ethnicity, with a BMI of 30kg/m^2 or more, who provided informed consent prior to participation. Recruitment took place by direct invitation of potential participants on the Medical Research Institute of New Zealand (MRINZ) database and by advertisement on social media. No stopping criteria applied, provided participants did not withdraw consent before completion of their study visit.

Materials and methods

This was a single-site non-interventional cross-sectional study conducted at the MRINZ in Wellington, New Zealand. All investigations were completed in a single visit of approximately 45 minutes after obtaining informed consent.

Participant date of birth was used to determine age. Participant self-reported ethnicity, side of non-dominant arm and comorbidities were recorded. Ethnicity is reported as prioritised ethnicity using Level 1 codes, a method of reducing multiple ethnicities for analysis in the health and disability sector, which is used in the Statistics New Zealand Census.[21] Participant height and weight were measured by using a calibrated stadiometer and body scale (BWB-800, Wedderburn, New Zealand). Derived BMI was calculated.

Participants were instructed to expose their non-dominant arm and hang it relaxed by their side. First, the acromion process was identified by palpation and a mark was placed with an indelible pen (point A), followed by a mark on the skin corresponding with the deltoid tuberosity (point D). The USA injection site (point USA) was identified and marked by measuring 5cm inferior to point A, followed by the Australian injection site (point AUS) at the exact midpoint between the point A and point D, and the New Zealand injection site (point NZ) at the intersection of the axilla line (an imaginary line connecting the most superior point of the anterior and posterior axillary fold), and an imaginary line connecting point A and point D (Figure 1). All markings were checked by a second investigator before the distances were measured (in cm) between all points.

For each participant, with the shoulder in anatomical position and elbow passively flexed and slightly pronated, three ultrasound images displaying the skin, subcutaneous tissue and fascia and the deltoid muscle were captured and saved using a high-frequency (13-6 MHz) linear transducer (Sonosite X-Porte, Fujifilm, Japan), after using sufficient water-soluble ultrasound transmission gel as an acoustic standoff. The middle of the ultrasound probe was placed at the marked injection site, with minimal pressure, at a 90-degree angle with the skin, in the coronal plane. Penetration depth setting was increased as required to ensure a sufficient volume of the deltoid muscle was displayed. Ultrasound images were obtained by trained clinical staff (LK, SK). Measurements of the distance (in mm, to the nearest whole mm) between the skin and the fascia of the deltoid muscle were performed by a radiology registrar (JB). For each participant, two consecutive measurements of arm circumference were performed at point USA, point AUS and point NZ with their shoulder in 90 degrees passive abduction.

The primary outcome was the difference in skin-to-deltoid-muscle-distance (in millimetres) between three different sites recommended for intramuscular vaccination. The secondary outcomes included i) associations between skin-to-deltoid-muscle distance across the three recommended injection sites, with sex, BMI and arm circumference, and ii) the proportion of participants with a skin-to-deltoid-muscle distance >20mm, in whom the standard 25mm needle length would not ensure deposition of vaccine within the deltoid muscle.

Sample size

The sample size was based on publications by Nakajima et al.,[19,20] with a view to detect a difference of 0.6mm with 80% power and a two-sided type I

error rate of 5%, and further increased to allow for four explanatory degrees of freedom (distance from acromion, sex and arm circumference). An analysis was undertaken after recruitment of 40 participants to assess the size of the paired SD, which was sufficient to end recruitment at this point.

Data analysis

Continuous data were described by mean and standard deviation (SD), median and inter-quartile range (IQR) and minimum (min) to maximum (max). Proportions were described by counts and proportions expressed as percentages. On the scatter plot, linear regression lines are shown. The estimates of the associations between skin-to-deltoid muscle distance are by mixed linear models with fixed effects for measurement site, sex and arm circumference or BMI; together with associated interaction terms and, as random effects, the individual participants with unstructured variance-covariance correlation structures for the repeated measurements. The difference in paired proportions was estimated by appropriate categorical data models for the proportion of participants with skin-to-deltoid-muscle distances above nominated thresholds.

A threshold of $p<0.05$ was used to determine if between-site differences in mean skin-to-deltoid-muscle distance were statistically significant. The primary comparisons used the New Zealand definition of injection site as the reference level and compared this to the Australia and USA sites (Hypothesis 1). The secondary analyses included a one degree of freedom test using the ordinal rank of the distance from the acromion process as a predictor to explore if skin-to-deltoid-muscle distance increases as the distance increases (Hypothesis 2). To explore the possibility that the difference in skin-to-deltoid-muscle distance between sites differed by sex (Hypothesis 3), BMI (Hypothesis 4), and arm circumference (Hypothesis 5) were explored using mixed linear models with main effects and interaction terms for each of these possible effect modifying predictors. A comparison of the paired proportions was done by a generalised mixed linear model (Hypothesis 6). SAS version 9.4 was used for statistical analyses.

Ethical approval

This study was approved by the Northern B Health and Disability Ethics Committee (REF: 2022 EXP 12121). All participants provided written informed consent prior to participation.

Results

There were 29 female and 11 male (n=40) participants with a mean (SD) age of 52.0 (16.3) years. There were no missing data. Demographic and anthropometric data are shown in Table 1. Mean (SD) BMI was 36.8 (5.0) kg/m^2 and the mean (SD) skin-to-deltoid-muscle distance for the USA, Australia and New Zealand sites were 13.96 (4.54), 17.94 (6.08) and 20.26 (5.91) mm respectively. Note that a recommended needle length is one that is 5mm greater than the skin-to-deltoid-muscle distance. Using prioritised ethnicity, 90% of participants were European, 5% were Māori, 2.5% were Pasifika, and 2.5% were of Middle Eastern/Latin American/African ethnicity. Respiratory disease was the most common comorbidity, being present in 70%, followed by cardiovascular disease in 27.5% and diabetes in 5% of the study population. This table also shows variability in the distances to injection sites in relation to anatomical landmarks recommended by the Australian and New Zealand guidelines and the summary data of the arm circumference measured at each injection site.

Differences in skin-to-deltoid muscle distance between recommended injection sites

The estimates of the differences between skin-to-deltoid-muscle distance ultrasound measurements between injection sites are displayed in Table 2. There was an interaction between site of measurement of skin-to-deltoid-muscle distance and sex, P-interaction 0.035; the sex-specific differences are also shown. The interpretation is that skin-to-deltoid-muscle distance is larger for the New Zealand than the Australia and USA sites and that these differences between injections sites are in turn larger for men compared to women.

Skin-to-deltoid-muscle distance in relation to anthropometric measurements

Distance from acromion

When the three measurement sites are treated as ordinal scale variables one unit apart in the order of increasing distance from the acromion (USA then Australia then New Zealand sites), the estimate of increase in skin-to-deltoid-muscle distance per “unit” increase in measurement site is 3.1mm (95% CI 2.7 to 3.6).

Table 1: Demographic data and anthropometric measurements (n=40).

Variable (n=40)	Mean (SD)	Median (IQR)	Min to max
Age (years)	52.0 (16.3)	53.5 (38.5 to 66.5)	23 to 81
Height (metres)	1.68 (0.08)	1.66 (1.61 to 1.72)	1.56 to 1.83
Weight (kg)	104.2 (21. 5)	97.3 (89.9 to 111.9)	76.8 to 176.8
BMI (kg/m^2)	36.8 (5.0)	35.9 (33.8 to 38.4)	30.2 to 54
Distance acromion to USA site (cm)	5 (0)	5 (5 to 5)	5 to 5
Distance acromion to Australian site (cm)	9.64 (1.19)	9.7 (8.7 to 10.5)	7.2 to 12.2
Distance acromion to New Zealand site (cm)	11.76 (1.53)	11.65 (10.95 to 12.95)	8.7 to 14.7
Distance acromion to deltoid tuberosity (cm)	19.13 (2.37)	19.35 (17.5 to 21)	13.5 to 24.4
Arm circumference USA site (cm)	43.08 (4.88)	42.6 (39.5 to 45.3)	36.8 to 61
Arm circumference Australian site (cm)	41.75 (4.74)	41.25 (38.55 to 44.40)	34.7 to 60
Arm circumference New Zealand site (cm)	41.18 (4.76)	40.15 (38.15 to 44.15)	34.1 to 59.6
Skin-to-deltoid-muscle distance USA site (mm)	13.96 (4.54)	12.5 (10.55 to 17.65)	6.7 to 23.3
Skin-to-deltoid-muscle distance Australian site (mm)	17.94 (6.08)	15.95 (13.05 to 22.55)	8.8 to 32.7
Skin-to-deltoid-muscle distance New Zealand site (mm)	20.26 (5.91)	18.7 (15.65 to 25.40)	9.6 to 32.1

BMI = body mass index; USA site = injection site as recommended in the USA, Australian site = injection site as recommended in Australia; New Zealand site = injection site as recommended in New Zealand; IQR = interquartile range.

Table 2: Estimates of the skin-to-deltoid-muscle distance measured by ultrasound between the New Zealand and USA and New Zealand and Australian injection sites for the overall study sample and by sex.

	Estimate (mm) (95% CI)	P-value
All participants (n=40)		
Difference in skin-to-deltoid-muscle distance: Australia-New Zealand	-2.7 (-3.5 to -1.9)	<0.001
Difference in skin-to-deltoid-muscle distance: USA-New Zealand	-7.6 (-8.5 to -6.7)	<0.001
Sex specific		
Female (n=29)		
Australia minus New Zealand	-2.1 (-3.0 to -1.3)	<0.001
USA minus New Zealand	-7.2 (-8.1 to -6.3)	<0.001
Male (n=11)		
Australia minus New Zealand	-4.3 (-5.8 to -2.2)	<0.001
USA minus New Zealand	-9.0 (-10.6 to -7.3)	<0.001

USA = injection site as recommended in USA, Australia = injection site as recommended in Australia, New Zealand = injection site as recommended in New Zealand.

Figure 2: Linear regression plot showing skin-to-deltoid-muscle distance in relation to a) arm circumference per injection site, b) arm circumference per sex, c) BMI per injection site, and d) BMI per sex. For all charts, values in the dashed area where skin-to-deltoid-muscle distance is greater than 20mm represent measurements indicating the participant would have required a needle longer than the standard 25mm in order to achieve deltoid muscle deposition of at least 5mm.

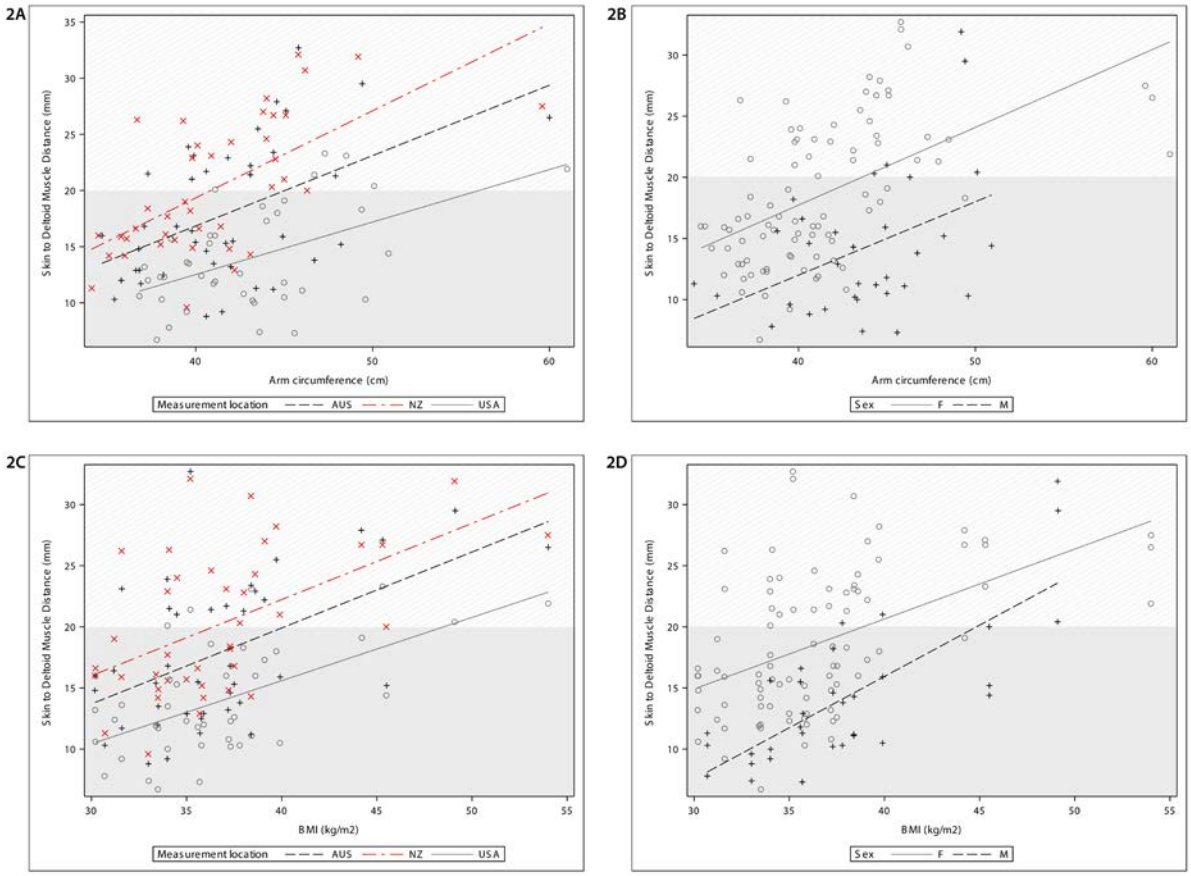


Table 3: Paired contingency table for participants with a skin-to-deltoid-muscle distance >20mm (requiring a needle length >25mm to penetrate deltoid muscle) by measurement site.

Comparator measurement site	**New Zealand measurement site (n=40)**		**Total n/40(%)**
Australia	**>20mm**	**<20mm**	
>20mm	16	0	16 (40)
<20mm	2	22	24 (60)
Total n/40 (%)	**18 (45)**	**22 (55)**	
USA			
>20mm	6	0	6 (15)
<20mm	12	22	34 (85)
Total n/40 (%)	**18 (45)**	**22 (55)**	

USA = deltoid intramuscular injection site as recommended in USA; Australia = deltoid intramuscular injection site as recommended in Australia; New Zealand = deltoid intramuscular injection site as recommended in New Zealand.

Arm circumference

Increasing arm circumference was associated with greater skin-to-deltoid-muscle distance for all three injection sites (Figure 2a and Figure 2b) independent of sex (p=0.56), measurement site (p=0.30), or the combination of sex and measurement site (p=0.39). The estimated coefficient (95% CI) was 0.77 (0.51 to 0.97) mm increase in skin-to-deltoid-muscle distance per 1cm increase in arm circumference.

BMI

There was a positive association between skin-to-deltoid-muscle distance and BMI for all three injection sites (Figure 3c and Figure 3d), independent of sex (p=0.33), or measurement site (p=0.27) or the combination of sex and measurement site (p=0.10). The estimated slope (95% CI) was 0.65 (0.40 to 0.90) mm increase in skin-to-deltoid-muscle distance per unit increase in BMI.

Proportions of participants with skin-to-deltoid-muscle distance greater than 20mm and 33mm

The two standard needle lengths in New Zealand are 25mm and 38mm. After allowing for 5mm penetration into the deltoid muscle these needle lengths correspond to skin-to-deltoid-muscle distances of 20mm and 33mm. No participant had a skin-to-deltoid-muscle distance of greater than 33mm at any measurement site, and so based on this sample no participant would require a needle length greater than 38mm. The counts and proportions of participants with a skin-to-deltoid-muscle distance greater than 20mm, and therefore needing a needle length of greater than 25mm, including cross-classification by measurement site, are shown in Table 3. These proportions were 45% for the New Zealand, 40% for the Australian and 15% for the USA measurement sites respectively. The differences in paired proportions (95% CI) were USA versus New Zealand, 30% (15.8 to 44.2), p<0.001, and Australia versus New Zealand, 5% (-1.8 to 11.8), p=0.15.

Discussion

This study has identified that in adults with obesity, defined as a BMI above 30kg/m^2, there are marked differences in the skin-to-deltoid-muscle distance measured at three recommended sites for deltoid intramuscular vaccine injection. The magnitude of the differences was of clinical importance, with the New Zealand site having a mean skin-to-deltoid-muscle distance approximately 6mm and 4mm greater than the recommended sites in USA and Australian guidance respectively. Skin-to-deltoid-muscle distance was greater in females, and participants with greater BMI and larger arm circumference were likely to have greater skin-to-deltoid-muscle distances. These findings suggest that when choosing the appropriate needle length to achieve intramuscular injection in a population with obesity, consideration needs to be given to the specific deltoid injection site selected, as well as the sex, BMI and/or the arm circumference of the individual.

The mean skin-to-deltoid-muscle distance (SD) was 14.0mm (4.5), 17.9mm (6.1) and 20.3mm (5.9) at the recommended USA, Australian and New Zealand injection site respectively. These measures can be considered in relation to the standard 25mm needle used for intramuscular injection of vaccine in clinical practice. A threshold of 20mm between skin and deltoid muscle allows 5mm penetration of a standard 25mm needle into the deltoid muscle. Our findings suggest that the proportion of adults with obesity that may require a longer-than-standard (>25mm) needle to achieve intramuscular delivery was 45%, 40% and 15% for the New Zealand, Australian and USA injection sites respectively. In the context of mass vaccination, this suggests that a substantive proportion of adults require longer-than-standard needles for vaccines that require intramuscular delivery, and that this proportion is greater for vaccination guidance recommending injection sites more distal from the acromion such as Australia and New Zealand. This finding highlights the importance of awareness among vaccine administrators and vaccine recipients to consider using or requesting a longer needle to ensure intramuscular vaccine delivery. This is relevant not only for the mRNA vaccines being administered in global efforts to alleviate the burden of the COVID-19 pandemic,[22] but also the numerous other vaccines recommended for intramuscular injection.[11,15]

Sex is also an important determinant of skin-to-deltoid-muscle distance and may help inform needle length choice. The mean skin-to-deltoid-muscle distance measurements were greater for females, whereas the differences in skin-to-deltoid-muscle distance between the three studied injection sites were larger for males. The current study found a positive association between skin-to-deltoid-muscle distance and each of arm circumference and BMI. The estimated increases in skin-to-deltoid-muscle distance per 1cm in arm circumference, and one unit in BMI were 0.77mm

and 0.65mm respectively. For example, a 6.5cm increase in arm circumference and a 7.7 unit increase in BMI correspond to an extra 5mm skin-to-deltoid-muscle difference. Both measurements could be used in practice to predict an individual's skin-to-deltoid-muscle distance to inform needle length choice, however, measuring one's arm circumference may be preferred. Arm circumference is quick, non-invasive, easy to learn, does not require a calculation and may provoke less stigmatisation compared to using BMI to predict skin-to-deltoid-muscle distance. These findings support the derivation and use of different sex-based BMI and arm circumference thresholds for recommending standard or longer needle length for intramuscular injection. This study was not large enough to determine thresholds of arm circumference or BMI, with adequate sensitivity and specificity, that might also determine appropriate needle length.

This study shows that skin-to-deltoid-muscle distance increases at injection sites more distal from the acromion process, and closer to the deltoid tuberosity, which is consistent with findings from other clinical studies.[5,19,20] Injection sites further from the acromion process reduce the risk of the needle hitting the axillary nerve and posterior circumflex humeral artery.[19]

Limitations

Our results may not be generalisable to populations with different age ranges, ethnicities and comorbidities, characteristics that may influence body fat and muscle distributions.[23] Our study did not include children and disproportionately included those with respiratory disease comorbidities, which reflects our institution's participant database. Studies with larger sample sizes in different populations are needed to enable predictive models for an individual's skin-to-deltoid-muscle distance to be derived. This study had insufficient power to provide estimates of the arm circumference and BMI cut-points where a needle longer than the standard 25mm length is required to ensure intramuscular delivery of a vaccine in the deltoid muscle.

Conclusion

There were marked differences in the skin-to-deltoid-muscle distance between the three recommended injection sites studied in a population with obesity. When choosing the required needle length to achieve intramuscular vaccination in obese vaccine recipients, consideration needs to be given to the injection site location, sex, BMI and/or arm circumference, as these factors all influence the skin-to-deltoid-muscle distance. A standard needle length of 25mm may be insufficient to ensure deposition of vaccine into the deltoid muscle in a substantive proportion of adults with obesity. Research is urgently required to determine anthropometric measurement cut-points that can be used to enable appropriate needle length selection to ensure intramuscular vaccination.

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AUTHOR INFORMATION
Marjan Doppen: Medical Research Institute of New Zealand, Medical Research Institute of New Zealand Private Bag 7902, Wellington 6242, New Zealand.
Melissa Black: Medical Research Institute of New Zealand, Medical Research Institute of New Zealand Private Bag 7902, Wellington 6242, New Zealand.
Irene Braithwaite: Medical Research Institute of New Zealand, Medical Research Institute of New Zealand Private Bag 7902, Wellington 6242, New Zealand.
Jonathan Bong: Capital and Coast District Health Board, 69 Riddiford Street, Newtown, Wellington 6021, New Zealand.
Allie Eathorne: Medical Research Institute of New Zealand, Medical Research Institute of New Zealand Private Bag 7902, Wellington 6242 New Zealand.
Louis Kirton: Medical Research Institute of New Zealand, Medical Research Institute of New Zealand Private Bag 7902, Wellington 6242, New Zealand; Capital and Coast District Health Board, 69 Riddiford Street, Newtown, Wellington 6021, New Zealand.
Stacey Kung: Medical Research Institute of New Zealand, Medical Research Institute of New Zealand Private Bag 7902, Wellington 6242, New Zealand.
Michaela Walton: Medical Research Institute of New Zealand, Medical Research Institute of New Zealand Private Bag 7902, Wellington 6242, New Zealand.
Thomas Hills: Medical Research Institute of New Zealand, Medical Research Institute of New Zealand Private Bag 7902, Wellington 6242, New Zealand; Auckland District Health Board, Level 7/214 Green Lane West, Greenlane, Auckland 1051, New Zealand.
Mark Weatherall: University of Otago Wellington, 23A Mein Street, Newtown, Wellington 6242, New Zealand.
Richard Beasley: Medical Research Institute of New Zealand, Medical Research Institute of New Zealand Private Bag 7902, Wellington 6242, New Zealand; Capital and Coast District Health Board, 69 Riddiford Street, Newtown, Wellington 6021, New Zealand.
Ciléin Kearns: Medical Research Institute of New Zealand, Medical Research Institute of New Zealand Private Bag 7902, Wellington 6242, New Zealand.

CORRESPONDING AUTHOR
Dr Ciléin Kearns: Medical Research Institute of New Zealand, Private Bag 7902, Wellington 6242, New Zealand. Ph: 64-4-805 0232, Fax: 64-4-389 5707, Twitter: @artibiotics, E: cilein.kearns@mrinz.ac.nz

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Patient factors associated with appointment non-attendance at an ophthalmology department in Aotearoa New Zealand

Jackie Low, William J Cunningham, Rachael L Niederer, Helen V Danesh-Meyer

ABSTRACT

AIM: Appointment non-attendance is a problem for medical outpatient clinics, which can result in interruption of continuity of care and poor health outcomes for patients. Furthermore, non-attendance creates a significant economic burden to the health sector. This study aimed to identify factors that are associated with appointment non-attendance in a large public ophthalmology clinic in Aotearoa New Zealand.

METHODS: This study was a retrospective analysis of clinic non-attendance within Auckland District Health Board's (DHB) Ophthalmology Department between 1 January 2018 to 31 December 2019. Demographic data collected included: age, gender and ethnicity. Deprivation Index was calculated. Appointments were classified as new patients and follow-ups, and acute or routine. Categorical and continuous variables were analysed using logistic regression to assess likelihood of non-attendance. The research team's expertise and capacity align with the CONSIDER statement guidelines for Indigenous health and research.

RESULTS: In total, 52,512 patients were scheduled to attend 227,028 outpatient visits, of which 20,580 visits (9.1%) were not attended. Median age of patients who received one or more scheduled appointments were 66.1 years (interquartile range [IQR] 46.9–77.9). Fifty-one point seven percent of patients were female. Ethnicity comprised 55.0% European, 7.9% Māori, 13.5% Pacific peoples, 20.6% Asian and 3.1% Other. Multivariate logistic regression analysis for all appointments showed that males (odds ratio [OR] 1.15 p<0.001), younger patients (OR 0.99 p<0.001), Māori (OR 2.69 p<0.001), Pacific peoples (OR 2.82 p<0.001), higher deprivation status (OR 1.06 p<0.001), new patient appointments (OR 1.61 p<0.001) and patients referred to acute clinics (OR 1.22 p<0.001) were more likely to not attend appointments.

CONCLUSIONS: Māori and Pacific peoples disproportionately experience higher rates of appointment non-attendance. Further investigation of access barriers will enable Aotearoa New Zealand health strategy planning to develop targeted interventions addressing unmet patient needs of at-risk groups.

Non-attendance to appointments, also referred to as missed appointment, "no-shows" or "DNAs" (Did Not Attend), are a common problem for all medical outpatient clinics with rates between 5% to 55%.[1,2] Non-attendance has widespread implications for the individual, health system and society. Most importantly for patients, non-attendance may result in delayed diagnosis and treatment and inferior health outcomes. Reasons for non-attendance are likely multifactorial, but it has been suggested that non-attendance is a surrogate of a damaged relationship between the patient and the health system. For the health system, non-attendance results in inefficiency. The economic cost to the health system is also significant. In the United Kingdom (UK), non-attendance to general practice appointments is estimated to cost approximately £162 million each year,[3] while overall missed appointments in the United States (US) costs more than $150 billion per year.[4]

There is a paucity of data exploring non-attendance outside of and within ophthalmology outpatient clinics.[5–12] The aim of this study was to identify patient characteristics associated with appointment non-attendance in a large-public ophthalmology clinic in Aotearoa New Zealand.

Methods

This was a retrospective study with institutional audit approval for analysis of de-identified visit data. The methods of this study adhered to the tenets of the Declaration of Helsinki and was examined and approved by Auckland Health Research Ethics Committee (#AH24132). A de-identified list of all patients who were

scheduled to attend outpatient ophthalmology clinic appointments at Auckland District Health Board (DHB), specifically Greenlane Clinical Centre based in Central Auckland and Waitākere Public Hospital based in West Auckland, between 1 January 2018 to 31 December 2019 were retrieved from the hospital records (catchment population numbers are 1,053,939 for Auckland and Waitematā DHBs combined based on 2018 New Zealand Census). Non-attendance was defined as any scheduled appointment that was not attended by the patient, or not cancelled or rescheduled before the time of the appointment by the clinic or patient.

Variables

Demographic information retrieved included: age, gender, ethnicity recorded in the National Health Index (NHI) health system, address and attendance or non-attendance to the appointment. Gender was categorised as either male, female or other (in the data identified as gender diverse, gender unknown or gender unspecified).

Ethnicity classification was based on the New Zealand Census Level 1 ethnicity categories. These included European, Māori, Pacific peoples, Asian and Other. The "Other" category included Middle Eastern, Latin American, African (MELAA), and patients that identified as Other ethnicity.

New Zealand Deprivation (NZDep) Index, an area-based measure of socio-economic status (SES) with a scale ranging from 1 (least deprived) to 10 (most deprived), was linked to each patient address using ArcGIS Pro, a geographic information systems (GIS) software. A spatial join was performed between the dataset of geocoded patient addresses with a dataset of meshblock codes retrieved from Statistics New Zealand (smallest geographic unit for which statistical data are reported) associated with a NZDep Index value based on nine Census variables from the 2018 New Zealand Census. This allowed for analysis of deprivation status for each patient.

Non-attendance numbers were recorded for gender, age in 20-year age bands, ethnicity and deprivation index, scheduled outpatient and acute referral clinic, new appointments and follow-ups.

Statistical analysis

Data were collected in an Excel spreadsheet and analysed in STATA version 15 (StataCorp, College Station, TX, USA). Categorical values are reported as n (%) and continuous variables as median (interquartile range [IQR]). Values for patient demographics were recorded as a proportion of the total number of patients, while all non-attendance data were analysed and reported as a proportion of the total number of appointments. A logistic regression was performed to compare the likelihood of non-attendance between gender, age, ethnicity and NZDep Index for all appointments. Odds ratio (OR) values for each comparison group can be calculated from the reported group as the inverse of the reported group OR value (i.e., 1/OR). A separate logistic regression analysis was performed for patients who had two or more missed appointments to assess multiple clinic visit non-attendance. A p value of <0.05 was considered statistically significant.

Indigenous health and research capacity

The expertise of the research team in Māori and Pacific health covers adequate representation and research capacity in line with the consolidated criteria for strengthening the reporting of health research involving Indigenous peoples (CONSIDER) statement guidelines.[13] The research team consists of two members who have been involved in the Royal Australian and New Zealand College of Ophthalmologists (RANZCO) Māori and Pasifika Committee, with one current member and one formerly the chair, who consult extensively with Māori. Although there was no direct consultation or partnership with Māori during the research conduct process, the research team aimed to utilise research approaches to support Indigenous health advancement in this study. The consultation and guidance of one of the members (William Cuningham), who is of Samoan ethnicity amongst one of few Māori and Pacific ophthalmologists in Aotearoa New Zealand, enhanced research conduct for this study in alignment with Pasifika priorities. He is also a current board member of The Fred Hollows Foundation New Zealand focussed on eradicating preventable blindness in the Pasifika population. Another member (Rachael Niederer) is one of four RANZCO ophthalmologists engaged with Kapo Māori developing the Te Tiriti Action Plan to address Māori eye health inequities. The research team have been involved with extensive research and internationally recognised publications in ophthalmology, including exploring health disparities and ethnicity related issues in ophthalmology in Aotearoa New Zealand.

Results

During the 2-year time period between 1 January 2018 and 31 December 2019, 52,512 patients were scheduled to attend 227,028 outpatient visits. The median number of outpatient visits per patient was 3 [IQR 1–5]. Demographics of patients who received one or more outpatient scheduled appointments are presented in Table 1. Of the patients who were scheduled to attend ophthalmology clinics, 51.7% were female, 48.3% were male, and less than 0.1% self-identified as other gender; median age was 60.5 years [IQR 34.7–74.6], non-Europeans comprised 55.0% with Māori comprising 7.9% and Pacific peoples 13.5%. The median NZDep Index was 6 [IQR 3–8].

The overall non-attendance rate for the entire cohort was 20,580 visits (9.1%) but varied across individual demographic characteristics and clinic and appointment type (see Table 2). All demographic variables were significantly associated with greater probability of non-attendance. The non-attendance rate for males was 9.8% compared to females (8.4%, $p<0.001$), and Other gender (8.7%) was proportionally similar to that of male and female across all scheduled appointment visits. Patients under the age of 40 had the highest non-attendance rate, with highest non-attendance at age 20–30 years at 28.0% (see Figure 1). With respect to ethnicity, European ethnicity and Asian ethnicity (5.8% and 6.7% respectively) had the lowest rate of non-attendance, with rates for Māori being 21.1% and Pacific peoples 20.3%. Non-attendance increased with NZDep Index and the rate was three times greater for the lowest, compared to the highest, index (5.9% for NZDep Index 1 compared to 17.7% for NZDep Index 10, see Figure 2). Non-attendance was greater for acute referral clinics (14.4%) compared to non-acute scheduled clinic (8.9%), and for new patient appointments (15.0%) compared to follow-up appointments (8.2%).

Results of univariate and multivariate analysis are presented in Table 3. All variables were significant predictors of clinic non-attendance. Results of the multivariate regression model adjusted for all covariates, including age, gender ethnicity and deprivation status. The multivariate analysis showed that males and younger patients, ethnicity other than European and Asian, higher deprivation status, new patient appointments and acute referral clinics were more likely to be non-attenders. The odds ratio of non-attendance for Māori was 2.7 ($p<0.001$) and 2.9 ($p<0.001$) for Pacific peoples compared to European ($p<0.001$) when controlled for gender, age, deprivation index, and type of clinic visit.

A sub-analysis of patients who missed two or more appointments (n=4,969, 4.5%) revealed that the same variables remained significant predictors of non-attendance (see Table 4).

Table 1: Patient demographics.

	Patients n=52,512
Gender	
Male	25,366 (48.3%)
Female	27,139 (51.7%)
Other	7 (0.0%)
Age	Median 60.5 [IQR 34.7–74.6]
Ethnicity	
European	27,343 (55.0%)
Māori	3,933 (7.9%)
Pacific peoples	6,686 (13.5%)
Asian	10,218 (20.6%)
Other	1,532 (3.1%)
NZDep Index	Median 6 [IQR 3–8]

Table 2: Clinic non-attendance numbers based on patient demographics and appointment type.

	Clinics not attended
Gender	
Male	10,834 (9.8%)
Female	9,744 (8.4%)
Other	2 (8.7%)
Ethnicity	
European	7,222 (5.8%)
Māori	3,103 (21.1%)
Pacific peoples	5,932 (20.3%)
Asian	2,779 (6.7%)
Other ethnicity	683 (11.1%)
Unknown ethnicity	861 (7.9%)
Type of clinic	
Scheduled outpatient clinic	19,891 (8.9%)
Acute referral clinic	689 (14.4%)
Type of appointment	
New patient	4,528 (15.0%)
Follow-up	16,052 (8.2%)

Figure 1: Bar graph illustrating the percentage of clinic non-attendance by age.

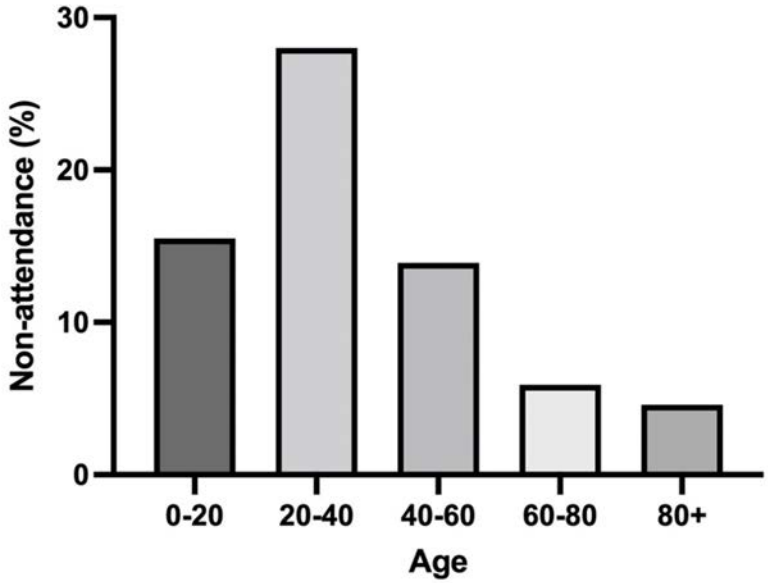

Figure 2: Bar graph illustrating the percentage of clinic non-attendance by New Zealand Deprivation (NZDep) Index.

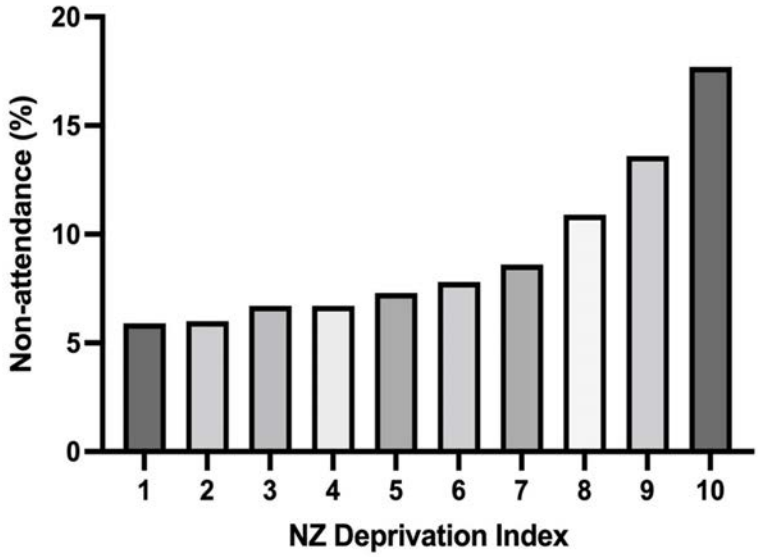

Table 3: Predictors of clinic non-attendance.

	Univariate		Multivariate	
	OR (95% CI)	**p value**	**OR (95% CI)**	**p value**
Female	0.84 (0.82–0.87)	<0.001	0.87 0.84–0.90)	<0.001
Age	0.98 (0.98–0.98)	<0.001	0.99 (0.99–0.99)	<0.001
Ethnicity*				
Māori	4.34 (4.14–4.54)	<0.001	2.69 (2.57–2.82)	<0.001
Pacific peoples	4.13 (3.98–4.28)	<0.001	2.82 (2.70–2.94)	<0.001
Asian	1.167 (1.12–1.22)	<0.001	0.93 (0.89–0.98)	0.003
Other	2.02 (1.86–2.20)	<0.001	1.44 (1.32–1.56)	<0.001
NZDep Index	1.16 (1.15–1.16)	<0.001	1.06 (1.05–1.07)	<0.001
Acute referral clinic	1.71 (1.58–1.86)	<0.001	1.22 (1.11–1.32)	<0.001
Follow-up visit	0.51 (0.59–0.52)	<0.001	0.62 (0.60–0.65)	<0.001

Abbreviation: OR = Odds Ratio. ORs were calculated using a logistic regression model.
Note: *Compared to European.

Table 4: Predictors of multiple clinic visit (≥2) non-attendance.

	Univariate		Multivariate	
	OR (95% CI)	**p value**	**OR (95% CI)**	**p value**
Female	0.82 (0.77–0.87)	<0.001	0.83 (0.78–0.89)	<0.001
Age	0.99 (0.99–0.99)	<0.001	0.99 (0.99–0.99)	<0.001
Ethnicity*				
Māori	3.94 (3.59–4.32)	<0.001	2.94 (2.66–3.24)	<0.001
Pacific peoples	4.58 (4.25–4.94)	<0.001	3.49 (3.21–3.80)	<0.001
Asian	1.02 (0.92–1.12)	0.756	0.89 (0.81–0.98)	0.017
Other	1.94 (1.64–2.29)	<0.001	1.59 (1.34–1.88)	<0.001
NZDep Index	1.17 (1.15–1.18)	<0.001	1.07 (1.06–1.08)	<0.001

Note: *Compared to European.

Discussion

To our knowledge, this first study of this size to report on ophthalmology outpatient clinic non-attendance in Aotearoa New Zealand. This study identified an overall non-attendance rate of 9.1%, with previous ophthalmology studies reporting rates between 5.5% to 17.2%.[9,10,12,14] We observed an increased likelihood of non-attendance for those who are younger, male gender, self-identified as Māori or Pacific peoples, and those with higher NZDep score. These demographic factors associated with higher rate of non-attendance are consistent with previous studies in different specialty outpatient clinics in Aotearoa New Zealand.[5,6,8,11]

The most striking finding of the present study was the impact of ethnicity on non-attendance with Māori demonstrating an OR of 4.34 times, and 4.13 times for Pacific peoples (p<0.001). In the multivariate analysis which adjusted for age, gender and NZDep scale, non-attendance rates remained significantly higher at 2.69 times for Māori of 2.82 for Pacific peoples (p<0.001). This suggests that there are critical barriers to accessing public outpatient eye care that disproportionately impact Māori and Pacific peoples. This is particularly relevant as burden of eye disease is disproportionately distributed to ethnic and racial minorities.[15–18]

While this is the first study to systematically review attendance to general ophthalmology clinics in Aotearoa New Zealand, a similar inequity in attendance was observed in diabetic screening in the Wellington area between 2006 and 2015. In that study, the overall non-attendance rate was 27.9% for new appointments, but patients who identified as Pacific peoples had non-attendance rate of 44.0% and Māori of 31.7%.[19] In a 1-year retrospective cross-sectional study in an academic ophthalmology department in the US, a 16.4% non-attendance rate was identified with the OR for Black Americans being 2.6 times compared to White Americans (p<0.001).[20] Other studies have also demonstrated significantly greater risk of non-attendance for Native American peoples and Indigenous Australians.[15,16,21,22]

Higher rates of non-attendance among Māori and Pacific peoples are not limited to ophthalmology. Other researchers who have identified that race and ethnicity were strongly associated with non-attendance with higher non-attendance rates generally for Indigenous peoples.[1,23]

Potential reasons for non-attendance among different racial or ethnic populations have been explored and are likely multifactorial. Research focused on Indigenous people in colonised nations has identified that addressing health outcomes, such as non-attendance, requires moving beyond individualistic approaches and addressing the wider issues in relation to the inequities in the social determinants of health.[24–30] The healthcare system in Aotearoa New Zealand provides free outpatient public hospital services. However, there has been criticism that the health service is

designed in the framework of European biomedical paradigm with this structure disadvantaging Māori.[26]

In a systematic review, Graham et al. identified three core themes that may explain the higher non-attendance in Māori and Pacific peoples: organisational structure, staff interactions, and practical barriers.[26] These core themes underpin the ongoing negative health experiences that Māori patients and their whānau (family) face.

"Organisational structures" refers to experiences of both explicit and implicit racism within the healthcare system. In multiple studies, Māori patients and whānau report that their wider spiritual and cultural practices were devalued within the mainstream health system.[26,31–33] In addition, a lack of understanding of rongoā (traditional medicinal applications and treatment) created an additional barrier with healthcare professionals and vice versa a lack of understanding from the patient about what their medical team is attempting to convey.[34] In Aotearoa New Zealand, we have recently seen the establishment of Te Aka Whai Ora – Māori Health Authority to work alongside Te Whatu Ora – Health New Zealand, Aotearoa New Zealand's largest public health employer, with the aim to develop systems and improve organisational structures to improve health inequities affecting Māori.[35,36] Locally, Auckland DHB has also initiated the Kaiārangi Nāhi rōpū and Pacific Planned Care Navigation services assigning a team of clinical nurse specialists with the task of improving the long waiting times for Māori and Pacific peoples on the surgical waitlist.[37] As well as supporting patients, this program collects invaluable data to identify where the systems are failing.

Previous negative staff interactions with healthcare professionals can cause reluctance to attend appointments.[38] Evidence suggests that Māori were aware of negative perceptions by health professionals and reported more actively hostile experiences in their interactions leads to mistrust.[39] One potential antidote is to improve representation within the medical workforce—healthcare for Māori by Māori. RANZCO and other medical colleges across Australasia have recently made changes to their selection processes to improve Indigenous representation amongst their respective workforces. However, even with these changes medical colleges are a long way from achieving proportionality. For example, in Aotearoa New Zealand only 5% of 147 vocationally trained ophthalmologists identify as Māori or Pacific peoples based on the 2018 New Zealand Medical Workforce Survey,[40] when these groups make up close to one quarter of the total Aotearoa New Zealand population.[41]

Poor communication between the referring health practitioner and patient is associated with initial appointment non-attendance.[42] This, in turn, negatively impacts health literacy, as patients are less aware of the importance and relevance of attending their scheduled appointment and less likely to utilise health services.[43]

In comparison to initial patient appointments, we observed lower rates of non-attendance for follow-up appointments. This suggests that patients are less likely to miss appointments once they are under the care of the ophthalmologist, which is consistent with previous studies in various specialist outpatient clinics.[12,44,45] This also suggests that the care provided by ophthalmologists, including explaining the patient's eye condition to them and emphasising the importance of follow-up in a way that is understood and taken on board by the patient, positively contributes to enhancing ongoing patient care and reducing the likelihood of non-attendance to follow-up appointments.

Practical barriers include financial costs, transportation issues and practicalities such as organising leave and/or childcare as obstacles to accessing clinics, attending appointments during working clinic hours, and receiving appropriate levels of healthcare. Public transports options were identified as being insufficient or impossible, particularly for new mothers.[26,46–48] Another practical barrier observed is that, although the public eye services at Greenlane Clinical Centre and Waitākere Hospital are free to patients, patients are required to pay for parking at these facilities. The costs incurred for parking create a financial burden affecting many, particularly those with a high NZDep Index score.

These practical barriers are also relevant in explaining the increased non-attendance observed with increasing NZDep Index. Once adjustment was made for ethnicity, NZDep status had an OR of 1.06 (95% CI=1.05–1.07). Other studies have found that lower socio-economic status (SES), lower median household incomes or other surrogate variables for SES—such as zip codes—were significantly associated with non-attendance.[1,49,50] Reasons for non-attendance in higher NZDep status are likely to be multi-factorial but social and financial barriers, transport, childcare, and less flexibility with time off work are relevant variables.[4,51,52] Transport has been identified in multiple studies to be a significant contributor to non-attendance.[26,52]

Other demographic variables that our study identified to be associated with non-attendance were age and gender. Age, which is inversely proportional to the probability of non-attendance, is corroborated by other investigators.[1,53] Younger patients may not be as adherent to their appointments due to more fixed obligations, such as getting time off during working hours.[10,54] We also note that Māori and Pacific peoples are more likely to be affected by various eye diseases, namely keratoconus and diabetic retinopathy, more aggressively and at a younger age compared to the general population, potentially compounding the reasons to not attend and downstream health consequences for these groups.[55–57] While the present study identified male gender as being a predictor of non-attendance, this is not a consistent finding in other studies.[1,58]

Other factors that have been shown to be related to non-attendance include forgetting to attend the appointment, not receiving the appointment or being unable to reach the clinic to cancel the appointment.[43,59] The non-attendance dataset encompasses all appointments that were not attended, cancelled or rescheduled by the patient, but did not consider the possibility of the patients who may have attempted to reschedule or cancel their appointment and were unable to. A recent study conducted in Dunedin Hospital, exploring communcation systems between the patient and hospital, reported that some participants found that it was difficult to contact the hospital to cancel or reschedule their appointments.[7] These factors suggests that improvements in communication systems and better access to the clinic appointment schedulers may be an important intervention.[60]

This study has several limitations. The retrospective aspect of the study prevents conclusion regarding causal relationships between variables. It is an analysis of a single ophthalmology department based across two locations. Furthermore, the accuracy of the data is dependent on the information entered at the time of scheduling. Patients who did not show are not contacted to verify the accuracy of the entered information. Another limitation is that the study used patient ethnicity data recorded on the NHI health system, which may not accurately reflect the individual's ethnicity that they self-identify with. Similarly, for some individuals the area-based measure of SES may not be an accurate representation of their NZDep status; we acknowledge there are patients who live in lower socioeconomic deciles who are not socially or economically deprived.

In summary, non-attendance is a significant barrier to providing timely, high-quality eye care. The greatest impact of non-attendance is on Māori and Pacific peoples, further exacerbating pre-existing inequalities in healthcare. This present study identifies that non-attendance is a significant problem and implies a greater need for our health workforce and health system to further improve on providing better patient care for our Māori and Pasifika, young and socially disadvantaged patients. Further research, which should incorporate kaupapa Māori (knowledge, skills, attitudes and values underpinning and guiding Māori society) approach, need to be undertaken to identify strategies to address the multi-faceted and complex factors.[61–63] This may facilitate the development of targeted interventions at the patient, clinic, and health system levels to address these barriers and thereby improve healthcare delivery, health outcomes, and resource management.

COMPETING INTERESTS
Nil.

AUTHOR INFORMATION
Jackie Low: Department of Ophthalmology, The University of Auckland, Auckland, New Zealand.
William J Cunningham: Department of Ophthalmology, Auckland District Health Board, Auckland, New Zealand; Eye Institute, Auckland, New Zealand.
Rachael L Niederer: Department of Ophthalmology, The University of Auckland, Auckland, New Zealand; Department of Ophthalmology, Auckland District Health Board, Auckland, New Zealand.
Helen V Danesh-Meyer: Department of Ophthalmology, The University of Auckland, Auckland, New Zealand; Eye Institute, Auckland, New Zealand.

CORRESPONDING AUTHOR
Professor Helen V Danesh-Meyer: Department of Ophthalmology, The University of Auckland, Auckland, New Zealand; Eye Institute, Auckland, New Zealand. E: h.daneshmeyer@auckland.ac.nz

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A critical Tiriti analysis of Te Pae Tata: the Interim New Zealand Health Plan

Ngaire Rae, Heather Came, Leah Bain, Alana McCambridge

ABSTRACT

The current health reforms in Aotearoa New Zealand are being described as "transformational". Political leaders and Crown officials maintain the reforms embed a commitment to Te Tiriti o Waitangi, address racism and promote health equity. These claims are familiar and have been used to socialise previous health sector reforms.

This paper interrogates claims of engagement with Te Tiriti by undertaking a desktop critical Tiriti analysis (CTA) of Te Pae Tata: the Interim New Zealand Health Plan. CTA follows five stages from orientation, close reading, determination, strengthening practice, to the Māori final word. The determination was done individually and a consensus was negotiated from the indicators; silent, poor, fair, good, or excellent.

Te Pae Tata proactively engaged with Te Tiriti across the entirety of the plan. The authors assessed Te Tiriti elements of the preamble, kāwanatanga and tino rangatiratanga as "fair", ōritetanga as "good" and wairuatanga as "poor".

Engaging more substantively with Te Tiriti requires the Crown to recognise that Māori never ceded sovereignty and treaty principles are not equivalent to the authoritative Māori text. Recommendations of the Waitangi Tribunal WAI 2575 and Haumaru reports need to be explicitly addressed to allow monitoring of progress.

The publicly funded health system in Aotearoa New Zealand is currently experiencing the largest reforms in a generation. The Health and Disability System Review[1] identified concerns about equity, efficiency, financing and sustainability across the entire health system. These concerns were amplified by the Waitangi Tribunal[2] through the Health Kaupapa Inquiry (WAI 2575). They recommended overhauling the primary healthcare system and creating a stand-alone Māori Health Authority.

The reforms were enabled through the Pae Ora (Healthy Futures) Act 2022. This legislation centralised publicly owned health services and established Te Whatu Ora (Health New Zealand), Te Aka Whai Ora (Māori Health Authority) and the Public Health Agency, all of which report to the reconfigured Minister of Health.

Te Tiriti o Waitangi is the foundational document of the colonial state of New Zealand that articulates the relationship between the Crown and hapū (sub-tribes).[3] Te Tiriti comprises of five elements: the preamble, three written articles and an oral article. These elements express the responsibility of the Crown to govern non-Māori, reaffirm Māori tino rangatiratanga (self-determination and authority) as articulated in He Whakaputanga o Te Rangatiratanga o Nū Tīreni (the Declaration of Independence). Te Tiriti also granted Māori the same rights and privileges as British subjects and granted religious and cultural freedom. The Waitangi Tribunal[4] has confirmed rangatira (chiefs) did not cede sovereignty in negotiating Te Tiriti. However, ethnic health inequities[5] continue to occur, fuelled by ongoing breaches of Te Tiriti.[2]

The creation of new health entities will not necessarily address the cultural change required to transform a broken system or eradicate institutional racism.[6,7] Rae et al. (2022)[8] in their critical Tiriti analysis (CTA) of the Pae Ora (Healthy Futures) Bill showed fair engagement with most elements of Te Tiriti. There were promising shifts in power-sharing within the Bill but only partial fulfilment of Te Tiriti responsibilities. To date, the reforms have been the subject of only limited scholarly debate.[9]

Te Pae Tata is the first New Zealand Health Plan published under the Pae Ora legislation and outlines the first 2 years of operation.[10] This document is the opportunity for the New Zealand Government to articulate how they will engage with Te Tiriti after the WAI 2575 Waitangi Tribunal[2] report. Given the strategic importance of Te Pae Tata, this paper addresses a gap in the literature about how the current health reform documentation aligns with Te Tiriti.

Methods

CTA is a methodological approach that emerged from the experience of presenting evidence to the Waitangi Tribunal.[11] CTA is a desktop review of policy that provides no commentary on the mana of the document authors or the organisation that publishes it. Instead, it is a contribution to the ongoing critical reflection on policymaking with the intention to strengthen practice to improve health outcomes.

CTA is a collaborative process that involves five stages. Stage one is a high-level orientation to the identified policy document, observing how it talks about Te Ao Māori, Te Tiriti and equity. The second stage involves a close reading examining how the text addresses the five elements of the Māori text. In stage three the authors independently make a determination against a set of indicators adapted from the work of Came et al. (2020)[11] to then develop a collective assessment. Stage four offers constructive suggestions about how the document could be strengthened, drawing on literature and the expertise of the authors. CTA embeds Māori engagement throughout, but the fifth stage is when Māori author(s) make a final overall determination of the extent the document has engaged with Te Tiriti.

This CTA has been performed by Māori, Pasifika and Pākehā critical scholars with a background in public health and a commitment to racial justice and Te Tiriti. No ethical approval was required.

Results

Te Pae Tata: Interim New Zealand Health plan 2022[10] will henceforth be referred to as the Plan.

Stage one: orientation

The Plan was jointly developed by Health New Zealand and the Māori Health Authority with support from the Ministry of Health. There is a commitment to "*building a health system that embeds Te Tiriti o Waitangi as its foundation*" (p17). This involves putting Te Tiriti first, enacting Te Tiriti "principles and articles" to improve Māori health, changing how the system works to address "bias and discrimination", sharing leadership between the Crown and Māori for decision making and resources, and for whole of system accountability for Māori health equity (p17).

The Plan explicitly frames the responsibility for monitoring Te Tiriti obligations with the Māori Health Authority and Māori. The introduction states "(f)or Māori particularly we will embed Te Tiriti o Waitangi by growing Māori leadership, workforce and services" (p8). Furthermore, the plan prioritises actions "*Te Whatu Ora can take direct ownership of and which Te Aka Whai Ora will hold us to account for delivering*" (p77).

There are explicit attempts to ensure the visibility and application of Te Tiriti across the document, for example the provision of a table describing the application of Te Tiriti within the Plan, however, the Tiriti preamble is absent.

Stage two: close reading

Preamble

The Plan describes (p13) the special Māori-Crown relationship and the kaitiaki (stewardship) responsibility the Crown has assumed over the health system. The Crown presupposes the senior role in the relationship and paternalistically talks of enabling Māori to exercise authority so Māori can live and flourish as Māori. The Plan indicates the quality of Māori-Crown relationships will be measured over time by both parties.

The Plan was jointly developed but is situated within the Crown system. The Plan does not disclose where or how the independent sovereign voices of Māori are represented within this document. Hapū are the Tiriti partners of the Crown, but within the new health structures, hapū are frequently subsumed under iwi-partnership boards, which are themselves a Crown construct.

Kāwanatanga

The Plan references section 6 of the Pae Ora Act 2022 as to how it intends to give effect to its Te Tiriti obligations, referring to "*the principles of Te Tiriti as articulated by the courts and the Waitangi Tribunal*". It also references He Korowai Oranga (Māori health strategy),[12] which the Waitangi Tribunal (2019) found did not uphold Te Tiriti. The Plan notes the detail of how the Crown intends to meet the non-legislative recommendation of WAI 2575 in Whakamaua: Māori Health Action Plan.[13]

The Plan proposes establishing iwi-Māori partnerships, and that the Māori Health Authority will enhance Māori leadership within the health system. The Plan indicates the Māori Health Authority will have an important role in developing "*the next Hauora Māori Strategy in partnership with iwi, hapū, whānau and Māori communities*" (p13).

Tino rangatiratanga

The terms tino rangatiratanga, which is in

the Māori text of Te Tiriti, and mana motuhake (autonomy) are used once in the Plan. The use of the term "their" in relation to Māori across the document implies authorship lies with non-Māori. Although it is unclear how Māori influenced the Plan and its priorities, the mechanism iwi-Māori partnership offers may enable local expressions of tino rangatiratanga. It is unclear how collective Māori aspirations will be achieved at a national level other than through Crown entity the Māori Health Authority.

The Plan consistently speaks to the importance of mātauranga Māori. The Plan promises that iwi and hapū will have resources to develop health services to meet the health aspirations of their community. Yet, plans to address the historic under-investment in Māori health noted by the Waitangi Tribunal (2019) are absent. The measures of Māori wellbeing (p17) are rich in possibility if accountability measures are robust and monitored. The Māori Health Authority and Health New Zealand (two Crown entities) will measure performance and outcomes.

Māori leadership and health workforce participation are significant themes across the Plan and are critical to successful implementation. For Māori aspirations to be achieved, non-Māori will need to change. Education is one critical step, but this will need to be embedded in policy, practice and leadership.

Ōritetanga

Action on the wider determinants of health is critical to improving health equity, an area of public health that has historically lacked investment (WHO Commission on Social Determinants of Health, 2008). Limited detail is provided regarding how the social, cultural and commercial determinants of health will be addressed.

The Plan has a stated commitment to delivering high-quality "*culturally and clinically safe, effective, whānau-centred, accessible, timely and efficient care*" (p16). It articulates the importance of addressing racism, discrimination and ableism. However, details of how this will be realised are vague.

Wairuatanga

The Plan does not explicitly speak of wairuatanga or tikanga. The importance of rongoā services is occasionally mentioned.

Stage three: determination

Indicator 1 we assessed as "fair" due to the ongoing assumption that the Crown is the senior treaty partner and lacking a collective independent Māori national voice within the Plan.

Indicator 2 we rated "fair" because the Plan refers to treaty principles (rather than the Māori text alone) and although Māori were involved, it was unclear how and to what extent.

Indicator 3 we graded as "fair" due to the consistent theme of Māori leadership despite tino rangatiratanga being missing from the discourse.

Indicator 4 we rated "good" due to the significant emphasis on equity.

Indicator 5 we rated "poor" because of limited engagement with wairuatanga and tikanga.

Table 1: Critical Tiriti analysis determination of Te Pae Tata against indicators.

Critical Tiriti analysis indicators	Silent	Poor	Fair	Good	Excellent
Recognition that policy preserves Māori interests and contributes to peace and good order			x		
Evidence of Māori presence and leadership in kāwanatanga.			x		
Evidence of the influence of Māori chiefly authority, values and worldviews.			x		
Māori exercising the rights and privileges of citizenship.				x	
Recognition of wairuatanga and tikanga.		x			

Discussion

Stage four: strengthening practice

The Plan is explicit in its engagement with Te Tiriti (rather than the Treaty), naming this as a core priority and also identifying how other priorities will give effect to Te Tiriti. However, it also makes regular reference to Treaty principles. Te Tiriti is a one-page document that has existed since 1840, therefore the continuing obfuscation created by use of principles as interpretations of the original document should be abandoned. Direct engagement with the Māori text is required.

The crucial roles of the Māori Health Authority and iwi-Māori partnership boards in upholding Te Tiriti are named within the Plan. Importantly, these boards are structured to ensure hapū, as the Crown Tiriti partner, are at the decision-making table. Feedback from iwi-Māori boards about whether they can fulfil their roles and receive the required support is one measure of Te Tiriti engagement. It is important that Te Tiriti implementation and decolonisation of the health system is the responsibility of the entire health sector workforce and leadership.

Under WAI 1040 the Waitangi Tribunal[4] found Ngāpuhi never ceded their sovereignty. This has clear implications for leadership of the health system that are not addressed within the Plan. Māori leadership is required at all levels, from hapū to independent Māori leadership at a national level from within and outside of the Crown. How to implement WAI 1040 within the health sector should be addressed.

The Plan identifies that addressing racism and discrimination is crucial to Māori receiving quality health care. It also identifies the need for staff professional development on Te Tiriti, mātauranga Māori and "*taking steps to address bias in decision-making*".[14] Measures of this could specify targets (e.g., percentages of staff trained) at all levels of the health system including health leadership.

The Plan has gaps in several areas. For example, addressing the determinants of health is critical to successfully addressing health inequities; this important area of public health deserved more exploration within the Plan. The Plan is silent in relation to historic and contemporary breaches of Te Tiriti, for instance the systemic under-funding of Māori health. The addition of an appendix that explicitly shows how the Plan will address the recommendations of the WAI 2575 stage one report and the Haumaru Covid report[15] would strengthen accountability to Te Tiriti. To facilitate transparency in policy development we recommend the inclusion of a methodology section in the Plan, including references, to demonstrate the steps and people involved in its development.

Wairuatanga was not mentioned in the Plan. Mason Durie[16] has always argued that wairuatanga is central to hauora for Māori. Demonstrating a holistic view of health should explicitly include wairuatanga both in text and explanation through Te Āo Māori worldview concepts.

The limitations of, and future directions for, CTA

The critical Tiriti analysis process reviews a final policy document. What is not visible to the reviewers are the negotiations and decisions leading to the prioritisation about what gets included or excluded within the document. The intentions or aspirations of the authors are also unknown and remain hidden.[11] The future research priorities for CTA include the ongoing development of a community of learning through the establishment of a dedicated CTA website, and the consideration of how CTA can be used to prospectively inform the development of policies, curriculum and legislation.[17]

Conclusion

Stage five: Māori final word

Decolonisation often involves challenging and fundamentally altering the structures and systems that maintain the status quo and exert control.[18] While the Māori Health Authority may be able to mitigate harm to Māori, there is a risk of causing harm in the future if the leadership and strategy of the entire health system continue to follow similar patterns and approaches that have historically disadvantaged Māori. The true transformative potential of the Māori Health Authority will depend on its consistent ability to operate within this complex environment and influence the operationalisation and achievement of the health system with reference to documents such as Te Pae Tata.

It is important to approach iwi-Māori partnership boards as outlined within Te Pae Tata with a critical perspective. These boards operate within and are funded by a colonial power structure, and their connections to Pae Ora legislation are

defined, monitored and governed by the Crown. Given this, it is doubtful that mana motuhake and rangatiratanga as outlined in Te Tiriti will be achieved.

Notwithstanding the risk of the dismantling of the Māori Health Authority by subsequent governments, accountability for iwi-Māori partnership boards ought to include, reflect and fulfil the aspirations of hapū and whānau within their rohe. In the current era of multimillion-dollar post-settlement governance entities, partnership boards must be accountable for demonstrating their mandate to represent those they claim to serve while also serving as the Crown's preferred funding disbursement entity. It is important to find a balance between those iwi and entities that have been successful in the past, and hapū (or other iwi not recognised by Crown processes) that have the potential to be truly innovative. Lessons should be learned from brutal treaty settlement processes and their flawed voting, recognition practices and divide and rule tactics.[18] The Māori Health Authority, as a Crown agent, must navigate these challenges while also mandating, monitoring and governing its own people through the iwi-Māori partnership board recognition process.

COMPETING INTERESTS
Nil.

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AUTHOR INFORMATION
Ngaire Rae: PhD Candidate, Department of Public Health, Faculty of Health and Environmental Sciences, Auckland University of Technology, Auckland, New Zealand.
Heather Came: Associate Professor, Department of Public Health, Faculty of Health and Environmental Sciences, Private Bag 92006, Auckland University of Technology, Auckland, New Zealand.
Leah Bain: Director, Kōpū Consulting Ltd, Wellington, New Zealand.
Alana McCambridge: Senior Policy Analyst, New Zealand Public Health Association, Wellington, New Zealand.

CORRESPONDING AUTHOR
Heather Came: Associate Professor, Department of Public Health, Faculty of Health and Environmental Sciences, Private Bag 92006, Auckland University of Technology, Auckland, New Zealand. Ph: 021 539063. E: heather.came@aut.ac.nz

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Investigating attitudes and insights into the global warming impact of inhalers

Matthew J Woodall, John Ma, Kate Emett, Amelia PE Hamblin, Katie Knowles, Tom Hyunwoo Lee, Wilson Mitchell, Wennarator Irae Ofoia, Letoe Renee Topeto, John D Dockerty, Robert J Hancox

ABSTRACT

INTRODUCTION: Inhalers are commonly used in the management of respiratory diseases. The propellants used in pressurised metered dose inhalers (pMDIs) are potent greenhouse gases and carry a substantial global warming potential. Dry powder inhalers (DPIs) are propellant-free alternatives that have fewer consequences on the environment, while being equally effective. In this study, we assessed patients' and clinicians' attitudes towards choosing inhalers that have a lesser environmental impact.

METHODS: Surveys of patients and practitioners were undertaken in primary and secondary care settings in Dunedin and Invercargill. Fifty-three patient and 16 practitioner responses were obtained.

RESULTS: Sixty-four percent of patients were using pMDIs, while 53% were using DPIs. Sixty-nine percent of patients believed that the environment is an important consideration when switching inhalers. Sixty-three percent of practitioners were aware of the global warming potential of inhalers. Despite this, 56% of practitioners predominantly prescribe or recommend pMDIs. The 44% of practitioners who mostly prescribe DPIs were more comfortable doing so based on environmental impact alone.

CONCLUSION: Most respondents believe global warming is an important issue and would consider changing their inhaler to a more environmentally friendly type. Many people were not aware that pressurised metered dose inhalers have a substantial carbon footprint. Greater awareness of their environmental impacts may encourage the use of inhalers with lower global warming potential.

Obstructive airway diseases, including asthma and chronic obstructive pulmonary disease (COPD), affect over 800,000 people in New Zealand and are major contributors to morbidity and mortality.[1] Inhaled medication is the mainstay of treatment for most patients.[2–4] There are three main types of inhalers available: pressurised metered dose inhalers (pMDIs) use a propellant to aerosolise the medication; dry powder inhalers (DPIs) contain a compacted drug powder that is broken up by inspiratory pressure when inhaled; and soft mist inhalers (SMIs) convert a liquid form of the medication into a fine spray under an external pressure.[5,6]

Most medication classes are available in both pMDI and DPI preparations, and studies show that these have comparable efficacies in the management of asthma and COPD in both routine day-to-day use and in emergency settings.[7–10] SMIs may achieve more efficient drug delivery and greater symptom improvement in patients with COPD compared to pMDIs, but fewer medications are available in this form.[11]

Patient factors, such as ease of use and effectiveness, are the most important consideration when choosing which type of inhaler to use: for example DPIs may not be suitable for those who cannot generate an adequate inspiratory pressure such as young children or elderly patients.[12] However, DPIs are associated with lower rates of errors concerning inhaler technique than pMDIs.[13] Similarly, most patients quickly master the correct inhaler technique for SMIs.[14] Cost is another consideration: while DPIs tend to be more expensive than pMDIs, most are fully subsidised in New Zealand.[15] Beyond these considerations, clinicians' prescribing appear to be mostly guided by familiarity, local protocols and availability, reflected by the considerable variation in the use of pMDIs and DPIs worldwide: 70% of inhalers prescribed in England are pMDIs, compared to only 10% in Scandinavian countries.[16] In New Zealand, there has been a decrease in the proportion of pMDIs from 75% of dispensed inhalers in 2017 to 66% in 2020.[15]

Another factor that should be considered when choosing the right inhaler is the environmental impact.[17] The healthcare sector in OECD countries

is estimated to contribute 3–8% of the nation's total greenhouse gas emissions, and inhaled therapy makes up a substantial proportion of this.[18–20] The propellants presently used in pMDIs are hydrofluorocarbons (HFCs), which are potent greenhouse gases.[21] They are currently responsible for 3.5% of the carbon footprint of the United Kingdom's National Health Service. Overall, these propellants are estimated to contribute 0.03% of global greenhouse gas emissions.[22,23] The global warming potential of one 200-actuation pMDI canister is equivalent to driving 290 kilometres in a small car.[23] Although there are substantial differences in the global warming potential of different propellants and the quantity contained in different inhaler brands, all current pMDIs have a much greater carbon footprint than DPIs or SMIs.[17] DPIs and SMIs do not contain propellants and have an approximately 95% lower carbon footprint.[24,25]

A 2017 study performed in London found that 80% of patients and 68% of physicians believed that the carbon footprint of inhalers was important.[26] There is no research looking at the opinions of prescribers and patients regarding changing inhalers for environmental reasons in New Zealand. We investigated the factors that patients and practitioners consider when making decisions relating to inhalers.

Methods

A quantitative and qualitative study was performed. We invited patients and practitioners aged 18 years or over in Dunedin or Invercargill who use, prescribe or give advice on inhalers. Patients were recruited from medical centres, hospital outpatient waiting rooms, and inpatient wards. Practitioners were contacted by email and by phone. Additionally, QR codes linked to a digital version of our questionnaire were placed in waiting areas in medical centres and hospitals. Demographic information about age, gender, ethnicity, patients' location, disease and highest level of education, and practitioners' role and country of training was collected. Ethnicity and gender questions were based on the 2018 and 2023 New Zealand Census.[27,28] Separate questionnaires were created for patients and practitioners using Qualtrics^{XM} (Seattle, WA, USA) software, using both open-ended and structured answers (see Appendix). Questionnaires were completed online or on paper and took 5 to 10 minutes to complete. A chart was used to identify the types of inhalers.[29] A brief explanation of the effects of HFC inhaler propellants on the environment was provided towards the end of these questionnaires.[30]

Analyses were performed using GraphPad Prism 9.4.1 (GraphPad Software Inc., California, USA). Data values are expressed as mean ± standard error of the mean (SEM). Data distributions were tested for normality using a D'Agostino-Pearson test. Normally distributed measures were compared using unpaired student's t-Tests. Non-parametric measures were compared using a Mann–Whitney U test or one-way analysis of variance (ANOVA) on ranks followed by *post hoc* Dunn's multiple comparisons tests. Categorical outcomes were compared using a Chi-squared test. Statistical significance was determined as a two-sided p-value <0.05.

Informed consent was given verbally or in writing. The study was approved by the University of Otago Ethics Committee.

Results

Fifty-three patients and 16 practitioners were included (Figure 1, Table 1).

Thirty-four (64%) patients were currently using a pMDI, 28 (53%) a DPI, and 8 (15%) an SMI. Seventeen (32%) were using multiple types of inhalers. There were no differences in types of inhalers between diseases. Most patients were "somewhat satisfied" or "satisfied" with their inhalers. There was little difference in satisfaction between those only using pMDIs (75%) versus DPIs (89%).

Factors influencing patients' willingness to change inhaler type

The most important factor for patients changing an inhaler was symptom relief, with 47/53 (89%) of people rating this as "somewhat agree" or "strongly agree". Most patients also considered ease of use 37/53 (70%), environmental impact 36/53(68%) and cost to the healthcare system 26/53 (49%) to be important, although symptom relief scored more highly than any of these (Figure 2).

Forty-four out of 53 (83%) of patients agreed or strongly agreed that global warming is an important issue and 35/53 (66%) considered the environmental impact of the healthcare that they receive. 26/53 (49%) of patients reported being aware that inhalers had some form of environmental impact.

Patients who consider the environmental impact of their healthcare were more likely to rank the environmental impact of inhalers as important than those who did not (p=0.040). There

Figure 1: Exclusion criteria. Three hundred and twenty-five hospital patients and 42 GP practices were approached to partake, as well as emails circulated to paediatricians, respiratory consultants and nurses, and registrars. After excluding participants due to no inhaler use, those that declined and those that did not complete the questionnaire fully, 53 patient and 16 practitioner responses were analysed.

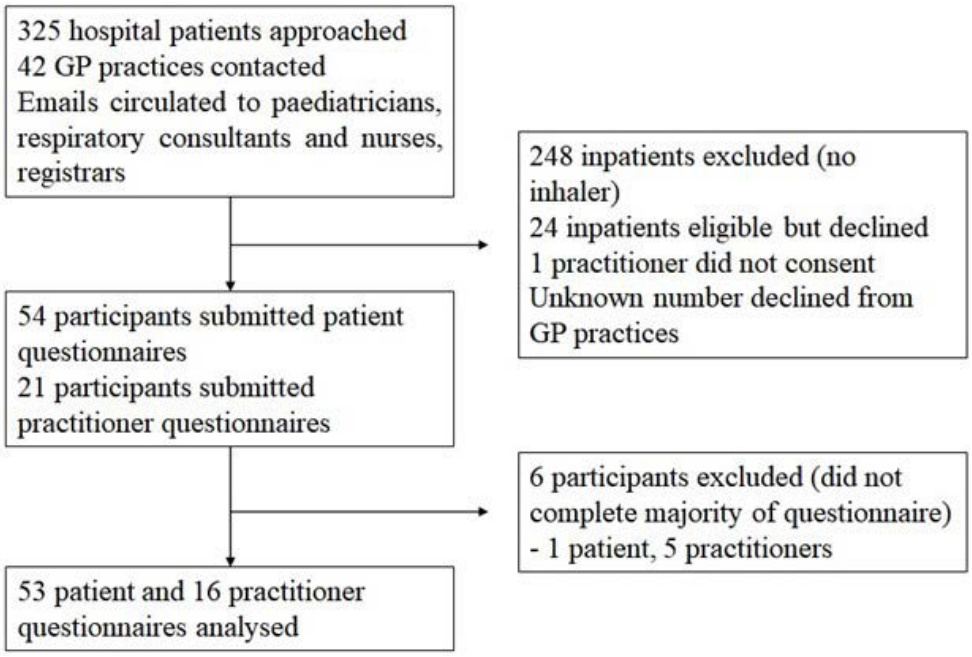


Table 1: Participant demographics.

Patient demographics		**Total n=53 (%)**	**Practitioner demographics**		**Total n=16 (%)**
Diagnosis	Asthma COPD Other Unsure	28 (53) 16 (30) 8 (15) 5 (9)	**Role**	GP Respiratory physician Paediatrician Registrar Senior nurse	5 (31) 2 (13) 4 (25) 3 (19) 2 (12)
Age	18–25 26–35 36–45 46–55 56–65 66–75 76–85 86+	8 (15) 1 (2) 3 (6) 4 (8) 9 (17) 9 (17) 14 (26) 5 (9)	**Age**	18–25 26–35 36–45 46–55 56–65 66–75 76–85 86+	0 (0) 5 (31) 2 (13) 5 (31) 3 (19) 1 (6) 0 (0) 0 (0)
Gender	Male Female	24 (43) 29 (55)	**Gender**	Male Female	8 (50) 8 (50)
Ethnicity (by priority)	NZ European Māori Pasifika Other	46 (87) 5 (9) 0 (0) 2 (4)	**Ethnicity (by priority)**	NZ European Māori Pasifika Other	13 (69) 1 (6) 1 (6) 1 (6)
Location	Inpatient Outpatient Community	35 (66) 7 (13) 11 (21)			

COPD = chronic obstructive pulmonary disease; GP = general practitioner.

Figure 2: Patient factors determining willingness to change. Patients were asked to rate how willing they were to change their type of inhaler if their doctor suggested it based on these factors. Factors were rated: 1=strongly disagree, 2=somewhat disagree, 3=neutral, 4=somewhat agree, 5=strongly agree. The numbers in the bars are the percent of participants selecting that option. Participants re-scored Environmental Impact after reading information about the environmental impact of different inhaler types. Scores for symptom relief were higher than the scores for other factors ($p<0.05$ by one-way ANOVA on ranks test).

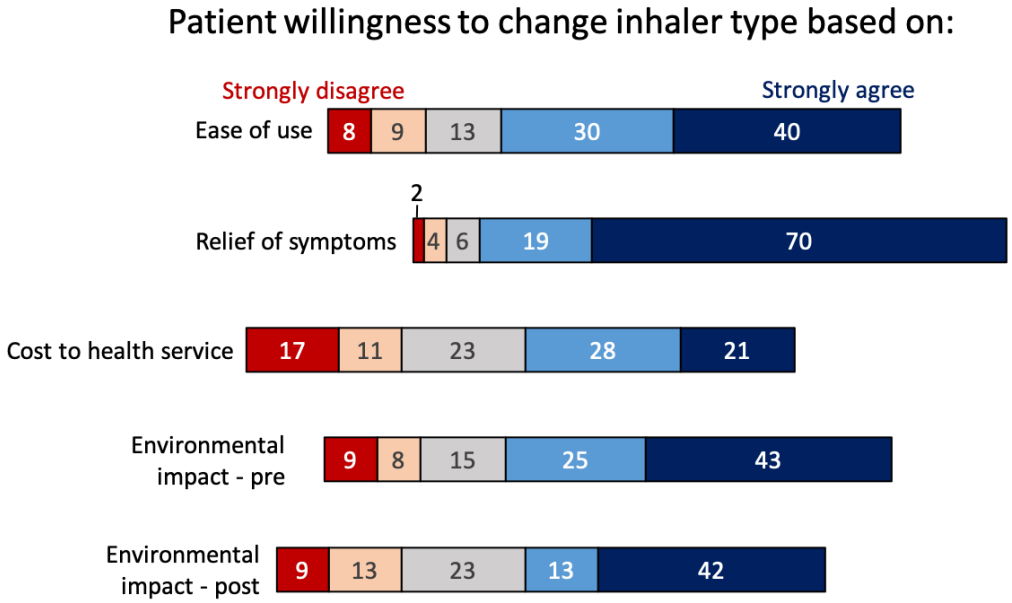
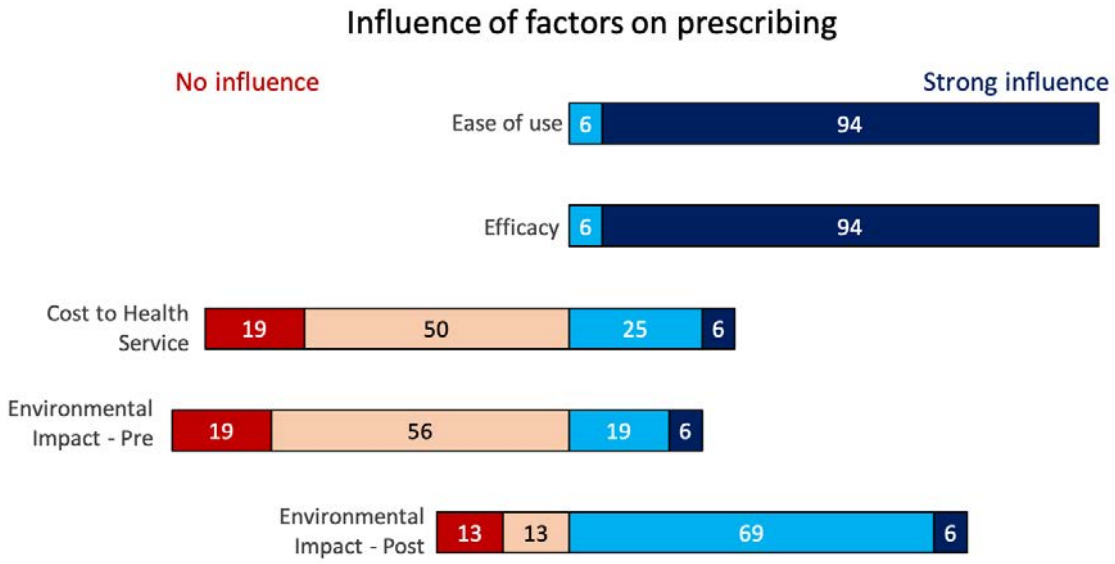


Figure 3: Factors influencing prescription or recommendation of inhaler type**.** Practitioners were asked to score the influence each factor (Ease of Use, Symptom Relief, Cost to Healthcare System, and Environmental Impact) had on their overall decision to prescribe or recommend an inhaler type to their patients: 1=no influence, 2=slight influence, 3=some influence, or 4=strong influence. The numbers in the bars are the percent of participants selecting that option. Participants re-scored Environmental Impact after reading information about the environmental impact of different inhaler types. Scores for ease of use and efficacy were higher than cost or environmental impact ($p<0.05$ using a one-way ANOVA on ranks test). After reading information on the environmental impact of different inhalers, the importance of the environment scored higher than before ($p<0.05$).



were no substantial or statistically significant differences between those concerned about global warming or aware of the environmental impact of inhalers, or between age, gender or disease. After information was provided on the environmental impact of inhalers, there was no appreciable difference in the willingness to consider the environment when choosing inhalers.

Factors influencing practitioners' willingness to change inhaler type

All practitioners rated symptom relief and ease of use as having "some influence" or a "strong influence" in their decision of inhaler type. These were more important than both environmental impact and cost to the healthcare system (Figure 3).

Twelve out of 16 (75%) of practitioners believed global warming to be "very" or "extremely" important, but only 10 were aware of the difference in global warming potential between pMDIs and DPIs. After being given information about the environmental impact of the different types of inhalers, the number of practitioners who said that the environment would have either some influence or a strong influence on their prescribing increased from four (25%) to 12 (75%) (p=0.029). Practitioners' concerns around DPIs included some patients not being able to use them due to their age or severity of disease, their ease of use, not wanting to change inhalers if patients had stable disease control on pMDIs, patient preference and a lack of familiarity with DPIs.

Discussion

We found that most patients and practitioners are willing to consider environmental impacts when choosing their inhalers once they had been made aware of the differences between inhaler types. Most patients expressed willingness to change their inhaler based on environmental considerations if their doctor recommended it.

As expected, the priorities for both patients and practitioners are ease of use and efficacy or symptom control. Most people who were unwilling to change their inhaler for environmental reasons indicated that they feared their disease would get out of control. However, DPIs have been shown to be as effective as pMDIs in controlling symptoms of both asthma and COPD, and improvements in quality of life and clinical outcomes have been observed when switching asthma and COPD patients from pMDIs to DPIs.[7–10,31] Furthermore, while the use of a short-acting beta-agonist pMDI with a spacer is currently the first-line intervention for acute severe bronchospasm, a review of 23 randomised trials found that the administration of short-acting beta-agonist through DPIs was as effective in treating acute severe asthma as pMDI therapy, both with and without a spacer.[2–4,32] Therefore, there may be scope for many patients to change to DPIs without compromising symptom relief and disease control. On the other hand, young children may not be suitable for DPI therapy due to the intricacies of their use and the lack of evidence in this age group.[33] All paediatricians in this study said that they prescribe pMDIs most frequently. Older children have been shown to use DPIs effectively and may be suitable for a trial of DPI therapy, but there are few studies of this.[33] Future reductions in the environmental impact of pMDI use in this age group could eventually be achieved through the use pMDI propellants with a lower global warming potential. These are currently being developed, but it will be several years before these become available.[17,34]

Most participants thought that global warming was an important issue, and two thirds considered the environmental impact of the healthcare they receive. However, only half of the participants were aware of the impact that inhalers have on the environment. Educating patients about this issue to increase awareness may influence future healthcare decisions to reduce global warming and environmental harm. However, we did not find that providing brief written information on the global warming potential of different inhalers made any immediate difference to patient attitudes to inhaler choices.

The wider environmental impact of inhaled treatment is less well understood. Although pMDIs have much greater overall global warming effects due to their hydrofluorocarbons propellants,[7–10,24] the full life cycle of DPIs may have greater impacts on fossil depletion, terrestrial acidification, freshwater and marine eutrophication and ecotoxicity, and the formation of photochemical oxidants due to the use of greater amounts of plastic and raw materials in their manufacture.[24] Future improvements in inhaler manufacture and reuse/recyclability of these inhalers may reduce these impacts.[17] However, none of these are as urgent as reducing the global warming potential of inhalers in the face of the current climate emergency. Another drawback is that many DPI inhaler devices are patented, making it more difficult to replace them with cheaper

generic drugs, although most classes of drug now have several alternative preparations. As noted above, new propellants with a lower global warming potential may eventually make pMDIs an environmentally friendly and cost-effective choice.

Most hospital-based physicians and nurse specialists were aware of the difference in global warming potential between inhaler types, although providing written information did appear to increase the influence of environmental impacts of their inhaler choices. Ease of use and efficacy of the inhaler are the most important factors to consider when choosing inhalers. However, switching patients from pMDI- to DPI-based maintenance therapy reduces the annual inhaler carbon footprint by 55% without loss of asthma control.[10] Good disease control is important for environmental as well as clinical reasons: suboptimal disease control resulting in overuse of relieving medications may contribute to two thirds of greenhouse gas emissions from inhalers.[35]

To our knowledge, this is the first New Zealand study into environmental influences on inhaler prescribing and patient preferences regarding inhaler choices. Strengths include using both quantitative and qualitative techniques to gain a greater understanding of these factors. Interviewer bias was minimised by using standardised questionnaires, however, we did not validate the questionnaires and having multiple interviewers meant that it is possible that there were subtle differences in how participants were asked the questions. Social desirability bias may have resulted in a higher estimate of participants that consider the environment to be an issue compared to the actual population. Many patients were excluded for practical reasons (such as infection control or frailty), and we recruited only a small proportion of the practitioners that we approached. Other limitations of this study include an overrepresentation of inpatients, and the single-area setting (Southern), which led to a mostly older patient group with a higher proportion of NZ Europeans than the whole of New Zealand.[36] This is important because Māori and Pacific people experience a higher burden of respiratory disease. It would be informative to investigate these issues with different age and ethic patient groups and a larger sample of practitioners. We also need research on the efficacy of DPIs in young children and more data on their use in acute asthma exacerbations. In the meantime, more education on the environmental impact of inhalers may facilitate a change in prescribing habits for older children and adults.

Conclusion

With climate change having become a global emergency, it is important to explore how the healthcare sector can reduce its carbon footprint. This study indicates that many patients and practitioners are willing to consider changing to less environmentally damaging inhalers.

COMPETING INTERESTS
Nil.

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AUTHOR INFORMATION
Matthew J Woodall: Trainee Intern, Department of Preventive & Social Medicine, Dunedin School of Medicine, University of Otago, Dunedin, New Zealand.
John Ma: Trainee Intern, Department of Preventive & Social Medicine, Dunedin School of Medicine, University of Otago, Dunedin, New Zealand.
Kate Emett: Trainee Intern, Department of Preventive & Social Medicine, Dunedin School of Medicine, University of Otago, Dunedin, New Zealand.
Amelia PE Hamblin: Trainee Intern, Department of Preventive & Social Medicine, Dunedin School of Medicine, University of Otago, Dunedin, New Zealand.
Katie Knowles: Trainee Intern, Department of Preventive & Social Medicine, Dunedin School of Medicine, University of Otago, Dunedin, New Zealand.
Tom Hyunwoo Lee: Trainee Intern, Department of Preventive & Social Medicine, Dunedin School of Medicine, University of Otago, Dunedin, New Zealand.
Wilson Mitchell: Trainee Intern, Department of Preventive & Social Medicine, Dunedin School of Medicine, University of Otago, Dunedin, New Zealand.
Wennarator Irae Ofoia: Trainee Intern, Department of Preventive & Social Medicine, Dunedin School of Medicine, University of Otago, Dunedin, New Zealand.
Letoe Renee Topeto: Trainee Intern, Department of Preventive & Social Medicine, Dunedin School of Medicine, University of Otago, Dunedin, New Zealand.
John D Dockerty: Associate Professor, Department of Preventive & Social Medicine, Dunedin School of Medicine, University of Otago, Dunedin, New Zealand.
Robert J Hancox: Professor, Department of Preventive & Social Medicine, Dunedin School of Medicine, University of Otago, Dunedin, New Zealand.

CORRESPONDING AUTHOR
Robert J Hancox: Professor, Department of Preventive & Social Medicine, Dunedin School of Medicine, University of Otago, Dunedin, New Zealand.
E: bob.hancox@otago.ac.nz

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Appendices

Appendix 1: Patient Questionnaire

Demographics

Where are you completing this survey?

- Hospital inpatient ward
- Hospital outpatient clinic
- GP practice
- Other, please specify

What age bracket do you belong to?

- 18–25
- 26–35
- 36–45
- 46–55
- 56–65
- 66–75
- 76–85
- 85+

What gender do you identify with?

- Male / Tāne
- Female / Wāhine
- Another gender / He ira kē anō

To which ethnicities do you belong? (please select all that apply)

- Māori
- NZ European
- Samoan
- Cook Islands Māori
- Tongan
- Niuean
- Chinese
- Indian
- Other; please specify

What is your highest level of education?

- No qualification
- Secondary school qualification
- Tertiary level qualification or above

Respiratory conditions

What condition are you using your inhaler for?

- Asthma
- Chronic Obstructive Pulmonary Disease (COPD - Emphysema/Chronic Bronchitis)
- Other; please specify
- Unsure

Using the pictures on the next page, which type of inhaler(s) are you currently using? (Please write down the assigned numbers)

Using the pictures on the next page, which type of inhaler(s) have you used in the past? (Please write down the assigned numbers)

There are two main types of inhaler devices that can deliver medicines to achieve good control of your breathing. Most medicines are available in each of the two types of inhaler.

Pressurised Metered Dose Inhalers (pMDI) are also called aerosol inhalers. When the inhaler is

pressed a measured dose of medicine is released through the mouthpiece via a

propellant/carrier.

Dry Powder Inhalers (DPI) are breath activated inhalers with no propellants/carriers added to

the medicine.

Do you regularly use a spacer with your inhaler(s)?

- Yes
- No

If you have been a user of Dry Powder Inhaler (DPI), please comment on your experience, e.g.

ease of use

How often do you routinely use your inhaler(s)?

- 3+ daily
- 1–2 times daily
- 2–3 times weekly
- Once a week or less
- Only when needed. If so, how often would this be?

Please rate your level of satisfaction with your current inhaler(s).

- Extremely dissatisfied
- Somewhat dissatisfied
- Neither satisfied nor dissatisfied
- Somewhat satisfied
- Extremely satisfied

I would be willing to change my inhaler type if my doctor suggested it based on:

	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
Ease of use	○	○	○	○	○
Relief of symptoms	○	○	○	○	○
Environmental impact	○	○	○	○	○
Cost to healthcare system	○	○	○	○	○

What issues do you see to changing your type of inhaler?

Please select the most appropriate option:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I think that global warming is an important issue	○	○	○	○	○
I consider the environmental impact of the healthcare that I receive	○	○	○	○	○
I am aware that some inhaler types have a greater impact on global warming than others	○	○	○	○	○

Environmental impact

Pressurised metered dose inhalers (pMDIs) use compounds called hydrofluorocarbons (HFCs) to deliver the medicine in your inhaler. These HFCs are very potent greenhouse gases, with emissions from one puff of an inhaler being equivalent to driving 1.5 km in a family car. Dry powder inhalers (DPIs) don't contain HFCs and are up to 200 times better for the environment.

Switching to a DPI can help reduce the impact of global warming whilst maintaining good control of your breathing.

Given this information, how much would the environmental impact of certain inhalers influence the decision to change to another type?

- None at all
- A little
- A moderate amount
- A lot
- A great deal

Please explain why you would/would not be comfortable switching to a more environmentally friendly inhaler alternative:

Thank you for completing this survey. Do you have any further comments? If so, please write them below:

Appendix 2: Practitioner Questionnaire

Demographics

What is your role?

- General Practitioner
- General Physician
- Respiratory Physician
- Paediatrician
- Registrar
- Nurse Practitioner
- Clinical Nurse Specialist
- Nurse Educator
- Registered Nurse
- Other; please specify

What gender do you identify with?

- Male / Tāne
- Female / Wāhine
- Another gender / He ira kē anō

To which ethnicities do you belong? (please select all that apply)

- Māori
- NZ European
- Samoan
- Cook Islands Māori
- Tongan
- Niuean
- Chinese
- Indian
- Other; please specify

Where have you spent the majority of your time working/training?

- New Zealand
- Other; please specify

Respiratory conditions

What conditions do you regularly prescribe or give recommendations about inhalers for? (please select all that apply)

- Asthma
- Chronic Obstructive Pulmonary Disease (COPD)
- Other; please specify

What type of inhaler do you most frequently prescribe or give advice on? A picture of all available inhalers is found on the next page. (choose one)

- Pressurised Metered-Dose Inhalers (pMDIs)
- Dry Powder Inhalers (DPIs)
- Soft Mist Inhalers (SMIs)
- Tablets/Aerolisers
- Other; please specify

How heavily do the following factors influence your prescribing *(if a prescriber)* or recommendations *(if not a prescriber)* of inhalers?

	No influence	Very little influence	Some influence	Strong influence
Ease of use	○	○	○	○
Efficacy	○	○	○	○
Global warming potential	○	○	○	○
Cost to healthcare system	○	○	○	○

Are you aware that some inhalers have a greater impact on global warming than others?

- Yes
- No

How comfortable would you be changing/ recommending changing a patient's inhaler from a pMDI to DPI solely for environmental reasons?

- Extremely uncomfortable
- Somewhat uncomfortable
- Neither comfortable nor uncomfortable
- Somewhat comfortable
- Extremely comfortable

How much of an issue do you think that global warming is?

- Not at all important
- Slightly important
- Moderately important
- Very important
- Extremely important

Environmental impact

Pressurised Metered Dose Inhalers (pMDIs) use hydrofluorocarbons (HFCs) to deliver each dose. HFCs are very potent greenhouse gases, with emissions from one puff of an inhaler being equivalent to driving 1.5 km in a family car. Dry Powder Inhalers (DPIs) do not contain HFCs and are therefore up to 200 times better for the environment. Switching to a DPI can help reduce the impact of global warming whilst maintaining good symptom control.

Given this information, how much would the environmental impact of pMDIs influence your decision to change your patient's inhalers to a DPI?

- No influence
- Very little influence
- Some influence
- Strong influence

Please explain why the environmental impact of pMDIs would/would not influence your choice of inhaler

What factors would discourage you from **switching** a patient's inhaler to a DPI?

What factors would discourage you from **prescribing** a DPI to someone who is not already on an inhaler?

Thank you for completing this survey. Do you have any further comments? If so, please write them below:

A further look into obtaining informed consent for medical students

Ekta Bagga, Edmund Leung

We read the recent article by Bhoopatkar et al., *Adherence to a national consensus statement on informed consent: medical students' experience of obtaining informed consent from patients for sensitive examinations,*[1] with great interest but also serious concerns regarding the quality and outcome of the findings.

Bhoopatkar et al.'s paper assesses two of the principles set out in the consensus statement: 1) whether signed consent was obtained before sensitive examinations on anaesthetised patients, and 2) whether informed consent was documented when performing sensitive examinations on conscious patients. It is a prospective survey over an underpowered sample size, and it carries an associated type II error: combination of a small cohort selection, inherent variability or bias in the data (participants are aware of the well-publicised paper on consent by Bhoopatkar) and potential random sampling error obscuring the population effect. Secondly, the study is largely based on students' recollection and asks them if, prior to sensitive examinations, consent was documented for conscious patients and signed consent obtained in advance for anaesthetised patients. Responses were not cross-checked with patient files and it remains possible that medical staff on the team did in fact document consent or subsequently obtain verbal/signed consent prior to the medical student being asked to perform sensitive examinations. Bhoopatkar et al.'s paper reports no incidents of continuing examination despite patient refusal or physical withdrawal.

Despite limitations, the study shows serious shortcomings in obtaining consent. Following this, we undertook a snapshot survey at Taranaki Hospital to audit the adherence of students and senior medical officers (SMOs).

Anonymous e-surveys for medical students and SMOs was created based on the 19 principles derived from Bagg et al.'s[2] national consensus statement on the guidelines for medical students and obtaining informed consent, prepared by the Auckland and Otago Medical Schools, Chief Medical Officers at district health boards, the New Zealand Medical Students' Association and the Medical Council of New Zealand. We considered both sensitive and non-sensitive consent issues. The survey was distributed by email and was open for 3 weeks. Two reminder emails were sent. Responses were based on a five-point Likert scale, ranging from: "always" (100% of the time), "most of the time" (75% of the time), "usually" (50% of the time), "rarely" (25% of the time) and "never", or not applicable (N/A).

Out of 35 Year 5 and 6 medical students, 24 responded (68.5% response rate). Out of 120 invited SMOs, 66 responded (55% response rate). Full results are shown in the appendices.

Our study's results are better than Bhoopatkar et al. in terms of our 75% full student compliance to the consensus statement regarding obtaining signed consent prior to sensitive examinations, whereas in Bhoopatkar et al.'s study full compliance rates ranged from 12.5% to 36.4% for rectal, breast and genital exams, with the exception for pelvic exams which was 84.7%. Our study shows similar deficiencies in documentation of obtaining consent in conscious patients with only a 24% student compliance, which is slightly better than Bhoopatkar et al.'s results ranging from 16.7% to 22% full compliance for rectal, breast and genital exams with the exception of pelvic exams, which are 30.6% (not in labour) to 32.7% (in labour). As Bhoopatkar et al. pointed out, one reason the compliance rates for consent of pelvic exams is much higher than other sensitive exams could be due to the distribution of mandatory stickers at the start of student's Obstetrics & Gynaecology rotation. These stickers are placed on the operative consent sheet and already include a pro-forma statement for obtaining consent for a pelvic exam. Without these signed stickers, the student is not able to begin the pelvic exam.

Our results show consenting processes for medical student involvement are still not done well. Students indicated they often failed to document consent for medical student involvement in patients' notes. Students felt SMOs were not making it clear that patients can refuse student involvement, or explaining the extent to which students are involved, or taking proper

measures when involved in the care of a patient who cannot consent. SMOs were found to be less likely to clarify with a patient that they could refuse student involvement, or explain student access to patient records, or take sufficient measures to gain consent in those patients who were unable to verbally do so.

Participants' comments provided insight into student and SMO attitudes towards obtaining consent and their understanding of the consensus statements:

> *"Asking for consent is to me less important than the need to make it implicitly understood to patients that medical students are a part of their clinical teams… [they need] to be involved to a certain degree without the need for specific consents." – Medical student*

> *"There is usually an implied consent that students and doctors in training will be involved in medical care, if you are getting your care at a teaching hospital. Obviously any time it involves a sensitive exam we would get extra consent." – SMO*

This study shows that there is a need for better education for both doctors and medical students regarding their responsibilities in gaining and ensuring appropriate consent for medical student involvement in patient care, and also a need to ensure that patients are better informed through signage and leaflets that they are entering a teaching hospital and medical students will be part of their medical team. We acknowledge that due to our small sample size, our study is also underpowered and has limited generalisability and applicability. However, the results pertaining to obtaining signed consent for sensitive examinations under anaesthesia are better than the results from Bhoopatkar et al.'s study. A reason that may explain the better compliance of consent for Taranaki Hospital is that it has a specific question in its consent forms that asks patients if they agree to medical students performing sensitive examinations; this must be ticked yes or no. It serves also as a reminder for the SMO to include medical students while consenting for the operation or procedure. A standardised surgical consent form for all hospitals could therefore prove useful.

Further suggestions to improve consenting rates include those listed below. We acknowledge a patient's right to refuse student involvement and our suggestions reflect this sentiment:

1. A team auditing process to ensure the consent forms are being properly documented is important. Currently, we are performing a retrospective audit of 100 forms to evaluate how often doctors "skip" the medical student consent question at Taranaki Hospital.
2. Checking if consent for students to participate in the surgery should be part of the standard pre-op checklist and WHO "time out" process at the start of the surgery.
3. Medical students should be mandated to complete an online module about consenting prior to clinical placement. An educational module on consent will provide students with more confidence to ask for consent. Gaining consent would be an educational experience for medical students. Ultimately, gaining consent for medical student involvement in patient care lies with the registered healthcare professional.
4. Both our and Bhoopatkhar et al.'s studies show SMOs are not clear on the standards contained in the Consensus statements for consent to student involvement. This could be both because they are unaware that such statements exist or are unclear on the requirements and execution of the principles. Consenting guidelines from Te Kaunihera Rata o Aotearoa Medical Council of New Zealand[3] and the Health and Disability Commission,[4] are clear that the responsibility of consent for medical student involvement in patients' care lies with the SMO and that consent must be gained from patients by SMOs. It may be beneficial for SMOs to undertake a workshop on obtaining consent in a non-coercive manner for the involvement of medical students and doctors in training. This would aid in clarifying the legal responsibilities for obtaining consent, streamlining the obtainment of consent so SMOs feel at ease consenting, and would also help shift attitudes to better appreciate the need for a good consent process. A 3-yearly refresher course should be recommended to all relevant staff who consent patients.
5. A statement should be added in patient appointment letters advising patients of their rights to all or partial involvement of medical students. Taranaki Hospital intends to increase the presence of posters in clinical areas advertising the rights of patients with

respect to informed choice for student participation.

6. Following on from the success of the consent stickers in Obstetrics & Gynaecology, mandatory stickers with a pro-forma statement for consent for sensitive examinations should be distributed to students in other rotations where sensitive examinations are likely, such as General Surgery or General Medicine.

In conclusion, Bhoopatkar et al.'s paper highlighted serious issues in obtaining consent for students. Some of the issues are relevant to house surgeons and non-training grade doctors. Despite the limitations of the published article, lessons are identified. Interventions can be introduced to improve compliance of consent—for better patient care and training of our next generations of doctors.

COMPETING INTERESTS
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AUTHOR INFORMATION
Ekta Bagga: University of Auckland, Department of Medicine, Faculty of Medical and Health Sciences, 85 Park Road, Grafton, Auckland 1010, New Zealand.
Edmund Leung: Taranaki Hospital, 23 David Street, New Plymouth 4310, Taranaki, New Zealand.

CORRESPONDING AUTHOR
Ekta Bagga: University of Auckland, Department of Medicine, Faculty of Medical and Health Sciences, 85 Park Road, Grafton, Auckland 1010, New Zealand. E: ektabagga12@gmail.com

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Appendix A: Survey results for medical students, rounded to the nearest whole digit

Responses=24

Question	All of the time	Most of the time	Usually	Rarely	Never	Not applicable
Do you think your workplace environment is taking appropriate measures to ensure consent for the presence of medical students is gained? (i.e., appropriate policies, signage, pamphlets/posters, appropriate section on surgery forms for medical student observation, routinely mentioning that students may be involved in patient care.)	5 (21%)	13 (54%)	4 (17%)	2 (8%)	0	0
Do you think your supervising clinicians take appropriate measures to ensure patients are consenting to medical student involvement? (e.g., asking for consent for students to perform history/exam, introducing students on ward rounds/pre-op area, etc.)	2 (8%)	17 (71%)	3 (13%)	2 (8%)	0	0
Do you think you take appropriate measures to ensure patients have consented to student involvement?	5 (21%)	14 (59%)	4 (17%)	0	0	1 (4%)
Do you think your fellow medical student peers take appropriate measures to ensure patients have consented to student involvement?	1 (4%)	18 (75%)	4 (17%)	0	0	1 (4%)
Do you actively assess how comfortable patients and whānau are with the involvement of students in their care? (i.e., if you percieve patients are uncomfortable with student care, you excuse yourself.)	15 (63%)	7 (29%)	2 (8%)	0	0	0
Do you regularly document in patients' notes after having obtained consent and becoming involved in their care? (i.e., documenting that you gained consent to perform an exam/place an IV line/ bag-masking under anaesthesia, etc.)	3 (13%)	3 (13%)	1 (4%)	13 (54%)	2 (8%)	2 (8%)
Do you think supervising clinicians make it clear that patients have a right to deny medical student involvement?	3 (13%)	7 (29%)	10 (42%)	3 (13%)	0	1 (4%)
Do you think appropriate measures are taken at your workplace to consent patients who are not fluent in English for student involvement? (i.e., with an interpretor.)	1 (4%)	2 (8%)	1 (4%)	6 (25%)	2 (8%)	12 (50%)

During the consent process, do you think patients are properly informed about the extent and nature of student involvement? (i.e., simply observing vs assisting in procedures.)	3 (13%)	6 (25%)	10 (42%)	4 (17%)	0	1 (4%)
For patients who are unable to consent i.e., are under anaesthesia/non-verbal/underage etc, do you think appropriate measures are taken to gain consent for medical student involvement from legal respresentatives/ caregivers/family members?	2 (8%)	5 (21%)	5 (21%)	4 (17%)	1 (4%)	7 (29%)
At your workplace, do you think consent for medical students to perform examination or procedures is asked in a non-coercive way? (i.e., patient should be fully dressed and asked prior to the procedure.)	4 (17%)	14 (58%)	5 (21%)	0	0	1 (4%)
Have you ever performed/or been asked to perform a sensitive examination or procedure (i.e breast, rectal, vaginal) while the patient is under anesthesia and has NOT given prior SIGNED consent?	0	0	0	3 (13%)	18 (75%)	3 (13%)
In home visits to patients, is consent sought from the patient for you to enter the room/ house?	7 (29%)	3 (13%)	2 (8%)	1 (4%)	0	11 (46%)
During the consent process, has a clinician ever explained to the patient that medical student involvement may include the student accessing confidential patient files?	1 (4%)	1 (4%)	0	6 (25%)	12 (50%)	4 (17%)
Have any of your medical student peers at your workplace ever disclosed any patient information on social media, even without any specific identifying information?	0	0	0	2 (8%)	18 (75%)	4 (17%)

Appendix B: Survey results for SMOs, rounded to the nearest whole digit

Responses=66

Question	All of the time	Most of the time	Usually	Rarely	Never	Not applicable
Do you think your workplace environment is taking appropriate measures to ensure consent for the presence of medical students is gained? (i.e., appropriate policies, signage, pamphlets/posters, appropriate section on surgery forms for medical student observation, routinely mentioning that students may be involved in patient care.)	14 (21%)	35 (53%)	10 (15%)	4 (6%)	0	3 (5%)
Do you think you take appropriate measures to ensure patients are consenting to medical student involvement? (e.g., asking for consent for students to perform history/exam, introducing students on ward rounds and in the pro-op area, etc.)	25 (38%)	34 (52%)	6 (9%)	0	0	1 (2%)
Do you think your fellow clinician peers take appropriate measures to ensure patients have consented to student involvement?	7 (8%)	31 (47%)	14 (21%)	0	0	14 (21%)
Do you think you make it clear that patients have a right to deny medical student involvement?	23 (35%)	19 (29%)	11 (17%)	10 (15%)	2 (3%)	1 (2%)
Do you take appropriate measures to consent patients who are not fluent in English for student involvement? (i.e., with an interpretor.)	13 (20%)	15 (23%)	5 (8%)	7 (11%)	4 (6%)	22 (33%)
During the consent process, do you make sure the patients are properly informed about the extent and nature of student involement? (i.e., simply observing vs assisting in procedures.)	27 (41%)	23 (35%)	8 (12%)	5 (8%)	2 (3%)	1 (2%)
For patients who are unable to consent i.e., are under anaesthesia/non-verbal/underage etc, do you take appropriate measures to gain consent for medical student involvement from legal respresentatives/caregivers/family members?	16 (24%)	5 (8%)	12 (18%)	4 (6%)	4 (6%)	25 (38%)
When consenting patients for medical students to perform examination or procedures, do you ask in a non-coercive way? (i.e., patient should be fully dressed and asked prior to the procedure.)	31 (47%)	14 (21%)	7 (11%)	0	1 (2%)	13 (20%)

Do you ever ask medical students to perform a sensitive examination or procedure (i.e breast, rectal, vaginal) while the patient is under anesthesia without prior SIGNED consent?	0	1 (2%)	0	1 (2%)	50 (76%)	14 (21%)
During the consent process, do you explain to the patient that medical student involvement may include the student accessing confidential patient files?	3 (5%)	7 (11%)	4 (6%)	23 (35%)	23 (35%)	6 (9%)

Acute visual change as first symptom of B-cell prolymphocytic leukaemia

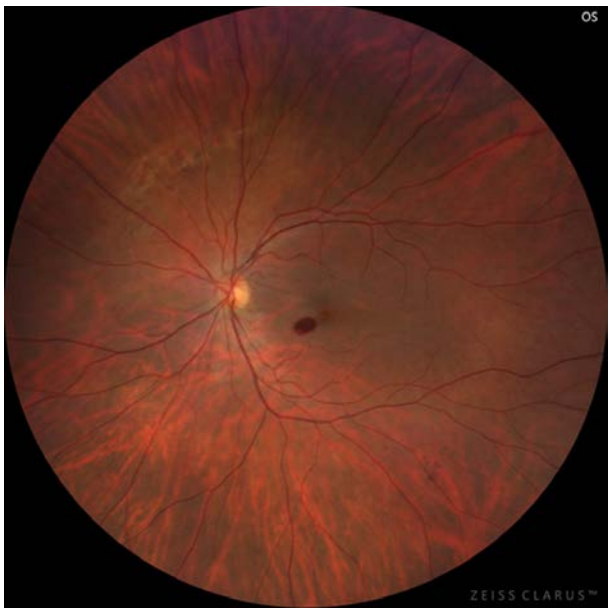
Luke Hawley, Oscar Eaton, Louis S Han

Visual changes are a common presentation to the emergency department and appropriate work-up is paramount. This case shows how fundoscopy findings alone alerted the medical practitioners to a life-changing, exceedingly rare systemic illness. Preretinal haemorrhages form between the hyaloid face and the inner limiting membrane of the retina, and may occur in cases of diabetes, trauma or older age.[1] However, in younger patients it is an uncommon clinical finding. This is the first reported case of B-cell prolymphocytic leukaemia (B-PLL) presenting with visual symptoms.

Case report

A 39-year-old Caucasian man presented to the emergency eye clinic with left eye visual field changes. Initially it was described as a haze with shimmering lights, which then progressed to a small central scotoma (blind spot). The patient had no other associated ocular symptoms nor a history of trauma. However, on further questioning, he reported an unintended weight loss of 20 kilograms over the prior 2 months. This was attributed to a loss of appetite since starting a new medication (methylphenidate).

Figure 1: Colour fundus photo of the left eye showing an oval-shaped pre-retinal haemorrhage inferonasal to the fovea.



At presentation, his Snellen visual acuities were 6/4.5 in the right, and 6/7.5 in the left eye. The slit-lamp exam revealed a small oval-shaped pre-retinal haemorrhage inferonasal to the fovea in the left eye, as seen in the figure.

The differential diagnosis for a young patient with a preretinal haemorrhage includes trauma, valsalva retinopathy, retinal arteriolar macroaneurysm and blood disorders. As there was no history of valsalva maneuver nor hypertension, coupled with a suspicious weight loss history, further investigations were carried out. The full blood count revealed microcytic anaemia, thrombocytopenia, leukocytosis and lymphocytosis.

The blood film showed primitive atypical lymphoid cells with flow cytometry confirming a clonal population of B-cells.

Subsequent investigations with haematology included a bone marrow biopsy, cytogenetics and next-generation sequencing, leading to the final diagnosis of B-PLL with TP53 mutation. The patient has since undergone chemotherapy with rituximab and bendamustine with good clinical response.

Discussion

As mentioned previously, preretinal haemorrhages in young patients are uncommon and usually due to trauma, valsalva or malformation of the retinal vasculature.[2] However, in this case, further investigations revealed systemic B-PLL .

Ocular involvement of leukaemia—such as preretinal haemorrhages—can occur due to direct leukaemic infiltration or as a result of abnormal blood components, such as thrombocytopaenia and leucocytosis.[3] Although very uncommon, these signs can precede other systemic features.[3]

B-PLL is a rare, highly aggressive disorder

and carries a poor prognosis. It is described as a mature lymphoid malignancy and accounts for approximately 2% of all lymphoid leukaemia only when combined with T-cell prolymphocytic leukaemia.[4]

B-PLL is separate from chronic lymphocytic leukaemia in several ways including physical signs, morphology, cell markers and clinical progression. B-PLL usually affects elderly patients above 70 years of age, and the common presentation involves splenomegaly without lymphadenopathy. Anaemia and thrombocytopenia are seen in at least 50% of cases.[5] Despite active treatment, median survival in these cases is 3 years.[6] It is exceedingly rare for patients to present with isolated ocular manifestations of this disease. Most reported cases are linked to chronic myelogenous leukaemia (CML)[7] and at time of submission this is the only case of B-PLL presenting this way.

This case highlights the importance of thorough investigative work as well as high clinical suspicion for other diagnoses when clinical history does not match presentation. In this case, the patient was diagnosed before any systemic features of the disease and was able to start treatment promptly, hopefully aiding with better prognosis.

COMPETING INTERESTS

There are no competing interests to declare. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images.

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We would like to thank our patient who has provided written consent for medical information to be published in this manuscript.

AUTHOR INFORMATION

Dr Luke Hawley: Non-Training Registrar, Department of Ophthalmology, Dunedin Public Hospital, Southern District Health Board.

Dr Oscar Eaton: Non-Training Registrar, Department of Ophthalmology, Dunedin Public Hospital, Southern District Health Board.

Dr Louis Han: Registrar, Department of Ophthalmology, Christchurch Public Hospital, Canterbury District Health Board.

CORRESPONDING AUTHOR

Dr Luke Hawley MBChB, BSc: Department of Ophthalmology, Dunedin Public Hospital, Southern District Health Board, 201 Great King Street, Central Dunedin, Dunedin 9016, New Zealand. E: Lhaw026@aucklanduni.ac.nz

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Amoebic colitis masquerading as inflammatory bowel disease for a decade

Sailish Honap, Simon Anderson

Entamoeba histolytica colitis is a classical inflammatory bowel disease (IBD) mimic. Although early misdiagnosis is common, diagnostic delay for a decade, including prolonged immunosuppressive therapy, is rare.[1] Here we report the unusual case of a young patient who was diagnosed with IBD and inadvertently treated with combination immunosuppression. We present several clinical practice points, which are particularly pertinent for those practicing IBD in the developed world, where amoebiasis is non-endemic and risk of misdiagnosis is high.

A previously healthy 32-year-old Caucasian male initially presented in 2009 with an 8-week history of bloody diarrhea and abdominal pain. Travel history was not documented but stool microscopy and culture, and HIV serology were negative. Colonoscopy showed severe ulcerative rectosigmoiditis, histologically consistent with ulcerative colitis. The disease followed an insidious, relapsing-remitting course for several years with partial benefit from topical and oral 5-aminosalicylates.

A colonoscopy triggered by symptom deterioration in 2017 showed severe, discrete, pancolonic ulceration and reclassification to Crohn's disease was made based on endoscopic appearances. Histologically, IBD subtype was equivocal but negative for infection. Treatment was escalated to combination azathioprine and weekly adalimumab, and while there was some symptomatic benefit, reassessment colonoscopy in 2018 showed persistent inflammation (Figure 1a) and biopsies revealed multiple amoebae. A short metronidazole course for the presumed superadded infection led to symptom resolution for 9 months before symptoms returned in 2019, with severe colonic inflammation and deep ulcers (Figure 1b). Repeat biopsies, positive for amoeba (Figure 1c), were reviewed in a multidisciplinary team meeting. Immunosuppression was discontinued, and further metronidazole and paromomycin led to complete symptom resolution, endoscopic healing, amoebic clearance, and no recurrence with a 2.5-year follow-up (Figure 1d–f). Close questioning a decade later revealed a history of extensive travel prior to 2009, including rural areas in South America and the Indian sub-continent, which are endemic for amoebiasis.

This case demonstrates several learning points. First, the challenge of diagnosing amoebic colitis in non-endemic regions due to low prevalence and index of suspicion, and similar clinicopathological features to IBD. It should be suspected in all patients presenting with diarrhoea and epidemiological risk factors, and it demonstrates that a travel history is critical in all patients. Second, our patient had negative stool microscopy throughout. Stool antigen/PCR and serum antibody tests are recommended for diagnosis, carrying significantly higher sensitivity and specificity than microscopy and culture.[2,3] Finally, that combining a nitroimidazole and a luminal agent, such as paromomycin or diloxanide furoate, is necessary to eliminate intestinal colonisation, to minimise risk of disease relapse.[2,5] Asymptomatic amoebiasis may be treated with a luminal agent alone. Failure to recognise infection and subsequent treatment with immunosuppression, particularly corticosteroids, can lead to life-threatening progression and dissemination.[4] Our patient's poor response to multiple IBD treatments, and subsequent ulcer healing with antibiotics and discontinued immunosuppression, suggest amoebic colitis from the outset, rather than IBD.

Figure 1: Endoscopic and histological features of amoebic colitis before and after treatment.

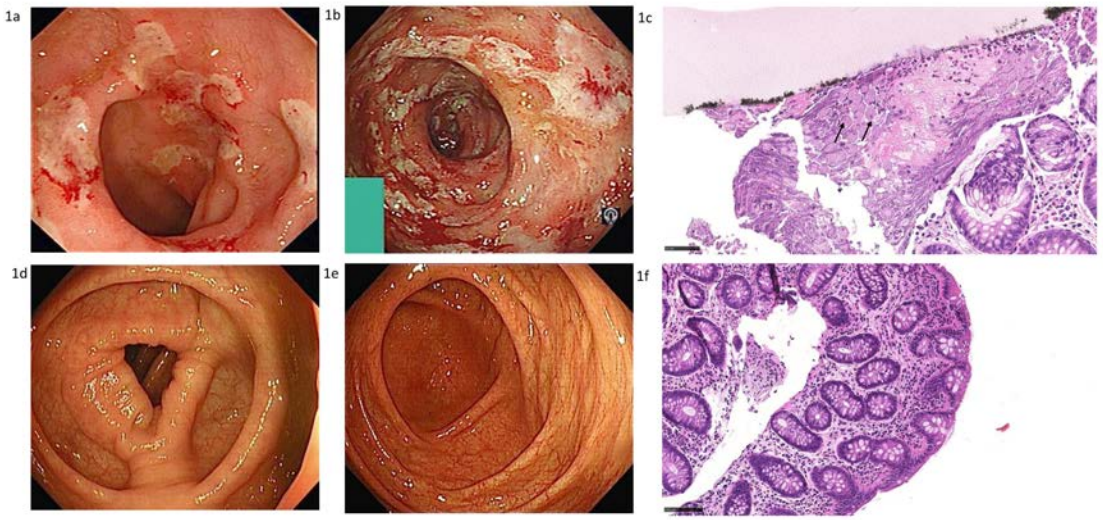

Figure 1 (a) colonoscopy revealed multiple discrete ulcers and yellow exudates with normal intervening mucosa in 2017, with disease relapse in 2019 (b) and more extensive disease due to persistent intestinal colonisation. Histology (c) shows a chronic inflammatory infiltrate with trophozoites of *Entamoeba histolytica* (arrowed). This was eventually treated with paromomycin. Repeat endoscopy one year after treatment showed endoscopic remission and mucosal healing (d) and (e). Colonic biopsies showed clearance of amoeba (f).

Table 1: Suggested adult treatment regimens for symptomatic and asymptomatic amoebiasis.

Symptomatic/invasive intestinal amoebiasis				
Drug	**Dose**	**Route**	**Frequency**	**Duration**
Metronidazole	800mg	Oral	TDS	5–10 days
OR				
Tinidazole	2g	Oral	OD	3–5 days
AND				
Paromomycin	25–35/kg/day	Oral	Three divided doses	5–10 days
OR				
Dioloxanide furoate	500mg	Oral	TDS	10 days
Asymptomatic amoebiasis				
Drug	**Dose**	**Route**	**Frequency**	**Duration**
Paromomycin	25–35/kg/day	Oral	Three divided doses	5–10 days
OR				
Dioloxanide furoate	500mg	Oral	TDS	10 days

Abbreviations: g = gram; TDS = three times daily; OD = once daily.

COMPETING INTERESTS
SH has served as a speaker, a consultant, and/or advisory board member for Pfizer, Janssen and Takeda. SHCA has no conflicts of interest. This article received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

AUTHOR INFORMATION
Sailish Honap: IBD Centre, Guy's and St Thomas' Hospitals NHS Foundation Trust, London, United Kingdom; School of Immunology and Microbial Sciences, King's College London, United Kingdom.
Simon Anderson: IBD Centre, Guy's and St Thomas' Hospitals NHS Foundation Trust, London, United Kingdom.

CORRESPONDING AUTHOR
Dr Sailish Honap: IBD Centre, 1st Floor College House, South Wing, St. Thomas' Hospital, Westminster Bridge Rd, London SE1 7EH, United Kingdom. Ph: 020 7188 2497. E: shonap@nhs.net

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Biomarkers in the early prediction of rescue therapy in acute severe colitis—a single-centre retrospective study

Kevin YY Chen, Sota Kamiya, Sarah Yap, Hamish Neave, Russell S Walmsley, Cameron Schauer, Nathan SS Atkinson

Acute severe colitis (ASC) from Inflammatory Bowel Disease (IBD) is a medical emergency that is difficult to predict outcome. Hospitalisation rates for IBD are high in OECD countries and in New Zealand, this contributed to an estimated cost of $17 million NZD from 2001 to 2013.[1] Intravenous corticosteroid therapy remains the first-line treatment for ASC. However, 26% of cases fail steroid treatment and require rescue therapy according to a recent Auckland study.[2] The Day 3 Oxford Criteria is an older composite prediction tool that defines steroid failure to direct rescue therapy but its predictive value is controversial in the biologics era.[3,4] Therefore, recent studies have been focused on biomarkers such as C-reactive protein/albumin ratio (CAR) or faecal calprotectin (fCal) to provide earlier rescue therapy prediction.[5–7]

The multi-centre cohort study on ASC from 2016 to 2019 across all three district health boards (DHBs) in Auckland showed significantly less need for rescue therapy in first-line intravenous hydrocortisone treatment compared to intravenous methylprednisolone.[2] We present a subsequent retrospective study based on the data from one of the DHBs to examine the predictive value of CAR and fCal for rescue therapy in ASC.

Methods

Cases of ASC admissions to North Shore hospital as defined by Truelove and Witts criteria in the Waitematā DHB protocol were identified in the study by Schauer et al. between June 2017 and June 2018.[2,8] This cohort was retrospectively examined for their age, gender, ethnicity, smoking status, type of IBD, admission C-reactive protein (CRP), admission albumin, admission fCal or recent fCal within 4 weeks prior to admission. CAR was calculated from admission CRP and albumin. The primary outcome was the need for rescue therapy defined as cases that required rescue biologic agents, cyclosporin or colectomy. The Day 3 Oxford Criteria is part of the protocol to guide rescue therapy, but recordings of its utility were not consistently found in the retrospective data.[3] The length of stay (LOS) was recorded as a secondary outcome.

Continuous data are presented as means with standard deviations if variables have normal distribution, otherwise presented as medians and interquartile ranges. Bivariate analyses were carried out for all variables in relation to the need for rescue therapy. This is done individually using the appropriate statistical tests (Table 1) via the Statistical Package for the Social Sciences. If a biomarker was found to be significantly different between rescue and non-rescue groups, Area under the Receiver operating characteristic analysis was used to evaluate the optimal cut-off and multivariate analysis through multiple logistic regression was performed to verify statistical significance when potential confounding variables are included. Linear regression was performed for each biomarker in relation to LOS.

Results

There were 108 cases (63% men; mean age 39.9 years) included in the analysis (Table 1). All cases had admission CRP and albumin for CAR calculation but only 35 cases (32.4%) had an admission or recent fCal. Demographic variables are comparable between the fCal group and the overall cohort. There are 22 cases (20.4%) that needed rescue therapy and out of these, five cases (4.6%) had colectomy. The demographic variables were similar between the rescue and non-rescue groups while the median LOS is understandably longer in the rescue group ($p<0.01$).

The median CAR is 1.12 (IQR 0.50–3.92) in the rescue group, which is significantly higher than the non-rescue group median CAR of 0.51 (IQR

0.16–1.87), p=0.03 (Figure 1). This finding is confirmed in the multivariate analysis involving age, gender, ethnicity, smoking status and type of IBD, p=0.03. CAR has a significant positive linear relationship with LOS (r=0.45, p<0.01). The optimal CAR cut-off for our cohort is 0.62 with a positive likelihood ratio of 1.56, p<0.05.

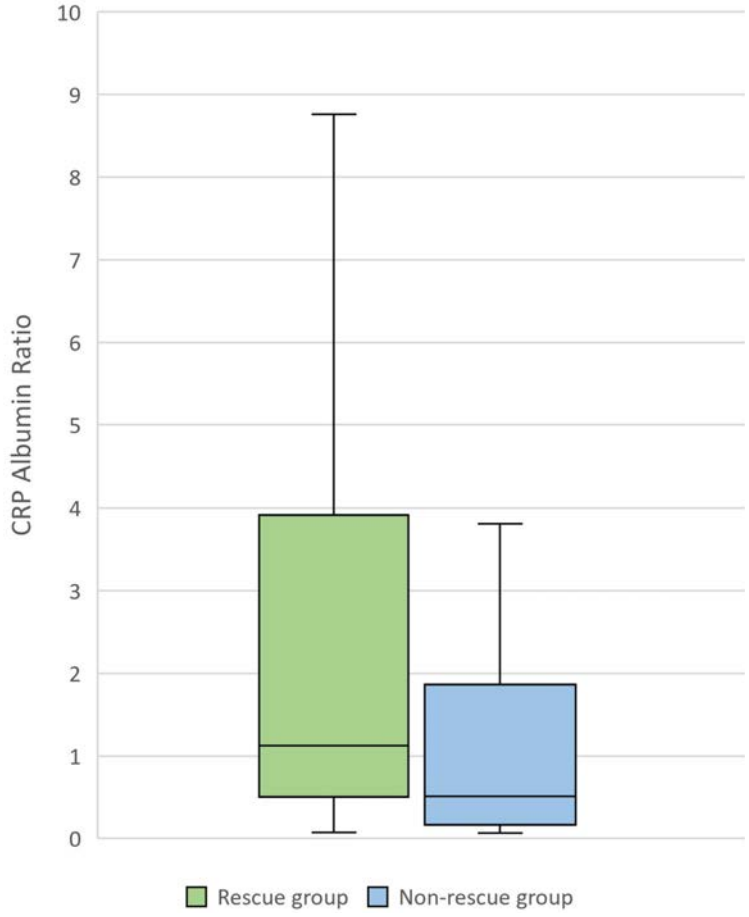
The median fCal between the rescue group (1,180mcg/g, IQR 234–3,860) and the non-rescue group (1,090mcg/g, IQR 244–3658) were not significantly different in our cohort, p=0.96. This was the case even if admission fCal (p=0.88) and recent fCal (p=0.68) were analysed separately. The fCal also did not have any significant correlation with LOS.

Table 1: Demographic, biochemical and outcome variables.

	Overall (n=108)	Rescue (n=22)	Non-rescue (n=86)	p	fCal group (n=35)
Mean age +/- SD	39.9 +/- 18.7	39.3 +/- 16.5	40.1 +/- 19.3	0.86[t]	36.5 +/- 17.7
Male gender	68 (63.0%)	16 (72.7%)	52 (60.5%)	0.42*	22 (62.9%)
Ethnicity					
NZ European	73 (67.6%)	13 (59.1%)	60 (69.8%)	0.33*	25 (71.4%)
Māori or Pacific	8 (7.4%)	3 (13.6%)	5 (5.8%)		2 (5.7%)
Asian	17 (15.7%)	5 (22.7%)	12 (14.0%)		6 (17.1%)
Other	10 (9.3%)	1 (4.5%)	9 (10.5%)		2 (5.7%)
Smoking status					
Current	17 (15.7%)	3 (13.6%)	14 (16.3%)	1.00*	4 (11.4%)
Ex-smoker	27 (25.0%)	6 (27.3)	21 (24.4%)		10 (28.6%)
Never	64 (59.3%)	13 (59.1%)	51 (59.3%)		21 (60.0%)
Type of IBD					
UC	45 (41.7%)	12 (54.5%)	33 (38.4%)	0.26*	17 (48.6%)
Crohn's	63 (58.3%)	10 (45.5%)	53 (61.6%)		18 (51.4%)
Median CAR (IQR)	0.68 (0.21–2.44)	1.12 (0.50–3.92)	0.51 (0.16–1.87)	0.03#	0.76 (0.16–3.36)
Median LOS (IQR)	4 (2–7)	6.5 (3–13.75)	4 (2–6.75)	<0.01#	5 (2.5–7)
Need for rescue therapy	22 (20.4%)	22 (100%)	0 (0%)		9 (25.7%)

t Unpaired t-Test
* Fisher's exact test
# Mann–Whitney U test

Figure 1: C-reactive protein albumin ratio distribution between rescue and non-rescue groups.



Discussion

In this study, we confirm that admission CAR is a useful early prediction tool for rescue therapy in ASC. This is supported by previous studies and the optimal cut-off for CAR is likely between 0.5 to 1.5.[5,6] CAR is also validated as a marker of disease severity in chronic IBD as well as a prognostic marker in a wide range of critical illnesses such as malignancy and sepsis.[9,10] Therefore, its use needs to be interpreted appropriately in distinct clinical contexts.

In comparison, fCal in this study did not demonstrate significant correlation with the need for rescue therapy. This is despite its established role as a disease activity marker in IBD and other studies demonstrating its predictive value in ASC.[5,7,11] The lack of significant correlation may be attributable to our relatively small group of cases that had admission or recent fCal. The collection of fCal on admission for ASC is part of the protocol and the paucity of data within this cohort highlights the need for clinicians to emphasise its importance with patients and nursing staff.

Limitations of the study include the small group of cases that had fCal and its retrospective design. Strengths include a pragmatic study design with well-defined variables as well as the consistency of a protocol on ASC in this single-centre study. The cohort is reflective of the real-world IBD population and gives the study generalisability. Further studies with larger prospective fCal data or longitudinal follow-up data after admission for ASC will be valuable in this area.

COMPETING INTERESTS
Nil.

AUTHOR INFORMATION
Dr Kevin YY Chen: Chief Medical Resident, Te Toka Tumai Auckland, Auckland.
Dr Sota Kamiya: House Officer, Te Whatu Ora Te Tai Tokerau, Whangārei.
Dr Sarah Yap: House Officer, Te Whatu Ora Waikato, Hamilton.
Mr Hamish Neave: Statistician, Research and Knowledge Centre, North Shore Hospital, Auckland.
Associate Professor Russell S Walmsley: Consultant Gastroenterologist, Department of Gastroenterology, Te Whatu Ora Waitematā, Auckland.
Dr Cameron Schauer: Consultant Gastroenterologist, Department of Gastroenterology, Te Whatu Ora Waitematā, Auckland.
Dr Nathan SS Atkinson: Consultant Gastroenterologist, Department of Gastroenterology, Te Whatu Ora Waitematā, Auckland.

CORRESPONDING AUTHOR
Dr Kevin YY Chen: Chief Medical Resident, Directorates of Adult Medical Services, Community and Long Term Conditions, Cancer and Blood. Te Toka Tumai Auckland, New Zealand.
E: kevin.chen@middlemore.co.nz

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Limited sequence magnetic resonance imaging appears reasonable for the evaluation of stroke-like symptoms

Rachel E Matthews, Karim M Mahawish

Stroke-like symptoms are a frequent cause of presentations to hospitals.[1] Prompt neurovascular imaging is essential to assist with diagnosis,[2] and to identify the cohort most likely to benefit from hyperacute therapies. While stroke treatment is associated with improved patient outcomes and reduced overall hospital costs,[3] diagnostic imaging is the fastest-growing expenditure in healthcare.[4]

Magnetic resonance imaging (MRI) provides greater sensitivity and specificity for the diagnosis of ischaemic stroke than computed tomography (CT),[5] however, it is resource intensive and can result in a bottleneck in the inpatient journey. Protocols of MRI sequences in the work-up of stroke vary between centres. Some of these sequences may contribute little to diagnostic clarification, and increase both resource utilisation and healthcare costs. There are some reports of stroke centres effectively using more selective MRI sequences in the evaluation of stroke.[6,7]

In September 2019, a short stroke protocol (SSP) was introduced at Palmerston North Hospital Te Whatu Ora, which limited MRI sequences to axial T2 fluid attenuation inversion recovery, and susceptibility and diffusion-weighted imaging. While CT is the preferred imaging modality for stroke patients, MRI is used in cases of diagnostic uncertainty or where infarct localisation is considered necessary to aid management. The authors hypothesised that the SSP obtained sequences most helpful in diagnosis, and would result in more efficient healthcare delivery, without compromising patient care.

The primary aim of this study was to determine if SSP is associated with a difference in length-of-stay (LOS) or in hospital admission costs compared to standard MRI protocol. The secondary aim was to explore any differences in the safety outcomes for 1) readmissions with a neurological diagnosis, or 2) death, in the subsequent 6 months.

Methods

We performed a retrospective cohort study of patients admitted to Palmerston North Hospital between September 2019 and September 2021 with an initial clinical impression of stroke or transient ischaemic attack (TIA). Patients were identified using electronic databases and included if they underwent an MRI (standard protocol or SSP) during their index admission. Patients were excluded if the MRI was for an indication other than a working diagnosis of stroke/TIA (e.g., evaluation of an intracranial mass seen on CT).

Baseline demographic data including age, ethnicity and co-morbidities were obtained from electronic clinical records. The final diagnosis was obtained by review of electronic discharge summaries. This was divided primarily into stroke (including TIA), and non-stroke pathologies (e.g., migraine, functional neurology, delirium, peripheral vertigo, etc). Data on LOS, survival and readmissions with a neurological diagnosis at 6 months were also obtained using electronic records.

MRI scans were coded as SSP or non-SSP by reviewing PACS imaging and the radiology report. We also recorded any additional sequences obtained (e.g., angiography). The time taken to perform each scan was obtained by the difference in timing between the first and last images displayed on PACS. Admission costs were provided by the analytics and financial advisory department at Palmerston North Hospital.

Continuous variables are presented as means (SD) for normally distributed data and median (interquartile range) for non-normally distributed data. Categorical data are presented as absolute numbers and frequencies. T-test and Wilcoxon Rank-Sum tests were used to test for associations for normally distributed and non-parametric continuous data respectively. Logistic and quantile regression (since outcome data were non-normally distributed) were used to test for associations. Only 1.9%

of the data were missing (considered missing at random); we used complete case analysis in this project. All statistical analysis was performed using STATA BE/17. This quality improvement project was exempt from requiring ethical approval. This manuscript was written in accordance with SQUIRE guidelines.[8]

Results

One-hundred and two patients were eligible for inclusion. Eighty-five patients (84%) underwent routine MRI, and 17 SSP. One patient was planned for standard MRI protocol but switched to SSP due to claustrophobia, and was included in the SSP cohort.

Baseline characteristics were generally well balanced (Table 1), though there was a significantly higher proportion of patients with a history of ischaemic heart disease in the SSP cohort (35% vs 11% respectively, p=0.009).

Rates of discharge diagnosis of stroke were similar between groups (58.8% vs 52.7%, p=0.33). Of note, no patients in the SSP cohort had a final diagnosis of TIA, compared to 17 (20%) in the standard cohort. There was no significant difference between LOS in days between SSP and standard MRI cohorts (4 vs 5, p=0.40).

Imaging duration was significantly less in the SSP cohort compared to the standard cohort, even after multivariable regression adjusted for potential confounders identified in the univariate analysis (12 minutes vs 24 minutes, p=0.001), Figure 1. Admission costs were equivalent in both groups. There was no significant difference in readmissions with a neurological diagnosis or mortality at 6 months between cohorts (Table 2).

Discussion

In this study, the use of the SSP (with high yield limited sequences) was associated with reduced imaging time and therefore MRI resource use when used as part of an inpatient workup for stroke, without an apparent sacrifice of diagnostic yield or adverse patient outcomes. An intangible strength of the short stroke protocol may be better acceptability to patients (particularly those with claustrophobia).

Strengths of this study include the face validity of the methodology. Other limited MRI sequence publications have focussed on utility in decision making for reperfusion treatment. Our study is original in that it evaluates the use of SSP versus standard care for stroke/TIA admissions.

Limitations of this study include low patient numbers, preventing our ability to draw further inferences on admission costs and safety outcomes. Limitations of our statistical analysis included the potential for type I error inflation due to multiple statistical testing, meaning that significant findings may be spurious. Further, the modest sample size may mean non-significant findings may represent type II error. The retrospective cohort design with

Table 1: Baseline characteristics.

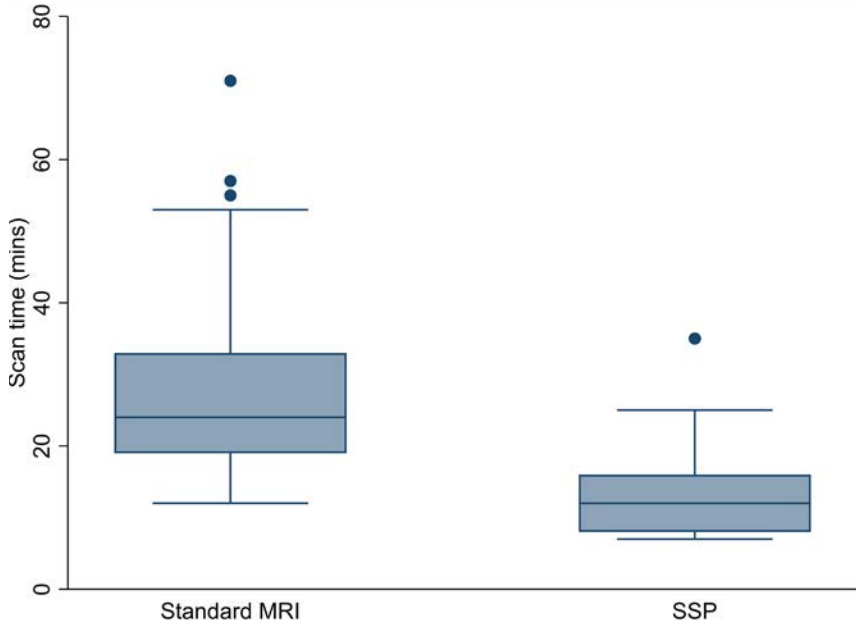
Variable	SSP (n=17)	Standard MRI (n=85)	P-value
Age (SD)	68 (12)	64 (14)	0.29
Ethnicity NZ European Māori Pacific Islander Asian	 11 5 0 0	 65 16 1 2	0.52
Male (%)	8 (47)	37 (44)	0.79
Smoking (%)	2 (12)	8(9)	0.9
Diabetes (%)	8 (47)	29 (34)	0.31
Atrial fibrillation (%)	0 (0)	15 (18)	0.06
Ischaemic heart disease (%)	6 (35)	9 (11)	0.009
Previous stroke (%)	7 (41)	17 (20)	0.06

Table 2: Outcome analysis.

Variable	SSP (n=17)	Standard MRI (n=85)	P-value	*Adjusted P-value
Final diagnosis TIA (%)	0	17 (20)	0.14	-
Final diagnosis stroke (%)	10 (58.8)	44 (52.7)	0.6	0.34
Imaging duration in minutes (IQR)	12 (8–16)	24 (19–33)	<0.001	0.001
Length of stay in days (IQR)	4 (3–6)	5 (3-10)	0.40	0.30
Admission cost	$7,359	$7,261	0.94	0.9
Alive at 6 months (%)	14 (82)	81 (95)	0.054	0.14
Readmission (%)	2 (12)	14 (17)	0.63	0.31

*Adjusted for age and history of ischaemic heart disease/stroke/atrial fibrillation.

Figure 1: Scan time between groups.



no control over why patients received limited versus more extensive imaging may bias results. Further, the multivariate adjustment should be treated with caution due to low numbers in the SSP group.

The authors anticipated a higher number of SSP scans completed, however, electronic records had inaccurate coding of the type of MRI scan performed. The SSP cohort in our study had a greater disease burden and fewer TIA patients, which may have contributed to the neutral primary outcome findings. Therefore, we suggest a larger study be performed before changes to MRI protocols are adopted at other centres for the work-up of stroke or TIA.

COMPETING INTERESTS
Nil.

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AUTHOR INFORMATION
Dr Rachel E Matthews: Advanced Trainee in General and Geriatric Medicine, MidCentral Health, Palmerston North, New Zealand.
Dr Karim M Mahawish: Consultant Stroke Physician, Counties Manukau District Health Board, Auckland, New Zealand.

CORRESPONDING AUTHOR
Dr Karim M Mahawish: Auckland University of Technology, School of Clinical Sciences, Private Bag 92006, Auckland 1142, New Zealand.
E: kmahawish@doctors.org.uk

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N.Z. Medical Women's Association

NZMJ, 1923

The medical women of New Zealand have banded themselves together to form an association, and the first annual meeting was held in Canterbury College, at Christchurch, on 21st February 1923. There was a small but enthusiastic gathering. Apologies were received from other members who had found it, impossible to be present but who wished the association well.

The Christchurch Vice-President (Dr. Baker) was in the chair. Dr. Siedeberg furnished a report of the year's work.

The need for such an association was first felt in 1921, when one of the senior medical women received an invitation from the Victorian Medical Women's Society to attend their annual meeting in Melbourne, and to send on the names of other ladies who, being members of the British Medical Association, were eligible to be invited. The lady to whom this was sent found herself in a dilemma, as she realized that, although there were over 60 medical women in New Zealand, she scarcely knew a dozen of them. In some cases their names were not known to her, and there was no easy way of finding them out; others had married and the husband's name was unknown; others had left New Zealand; and a few had died. As each year was adding to the list it was obvious that it would soon become impossible to trace them.

A meeting of Dunedin ladies was therefore held on 27th October, 1921, and it was decided to form a Women's Association. There were present:—Drs. Bathgate, Irwin, Nees, Moody, Whyte, Stevenson and Siedeberg, who was voted to the chair. An apology was received from Dr. Day.

It was decided to circularise all the medical women and invite membership. This was done and about 17 members responded. After that, during 1922, a few meetings were held of the Dunedin Division, at one of which Dr. Whyte read a paper on "Vitamines." Seven members were present and an animated discussion followed.

At one of the meetings a letter was received from Dr. Isabel Crosby, stating that the Canterbury Women Graduates Association had asked her to supply information regarding appointments in the Canterbury district for which women doctors were eligible, and she wished to know if the Medical Women's Association would supply the information. Through our Christchurch Vice-President (Dr. Baker) this was attended to.

At this meeting, also, it was decided that, as Dr. Siedeberg had been invited to speak at Waimate at the unveiling of the statue of the late Dr. Margaret Cruickshank, she should, on behalf of the Medical Women's Association, present a tribute from them in the shape of a laurel wreath. This was done on 25th January, and as an Association we feel proud that one of our sex had so won the love and esteem of those with whom she worked that they desired to honour her memory in this way. The statue is a beautiful one, standing 17 feet high, the figure itself being 9 feet.

The proposed constitution was then read and discussed. It was based on that of the British Medical Women's Association.

The following are the aims and objects of the Association:—

(a) To hold meetings at which papers will be read, and other matters of interest to medical women discussed.

(b) To further the interests of medical women in New Zealand and to promote social professional intercourse between members.

(c) To keep a list of members and the maintenance of an up-to-date list of openings for medical women, such as public appointments vacant, practices for sale, favourable places for starting practice, and posts as assistants and *locum tenetes*.

(d) On request, the Association will form local divisions in any centre where five or more members reside.

(e) To grant out of the funds of the Association, sums of money for any purpose of direct interest to the medical profession in such manner as may from time to time be determined.

(f) To contribute to any benevolent fund out of which may be made donations to deserving members of the Association, or to subscribe to a charitable or benevolent fund which would have the approval of this Association.

(g) To acquire by purchase, donation, bequest or otherwise, a library or other material of use to the Association.

(h) To accept any gift, endowment, or bequest made to or for the Association, and to carry out any trusts attached to such gift, endowment or bequest, provided that in such case the Association shall only deal with the same in such manner as allowed by law.

(i) To elect honorary members when thought fit.

Emphasis was laid upon the fact that membership of this Association was in no way expected to take place of membership of the New Zealand Branch of the British Medical Association, but it was hoped that members would subscribe to both Associations.

The subscription was fixed at 10s. 6d. entrance fee, and 10s. 6d. annual subscription.

The smallest number who can constitute a Division was fixed at five.

Membership is open to any medical woman registered in New Zealand, and any woman residing in New Zealand who possess a medical qualification entitling her to registration in the British Medical Register.

A general meeting shall be held annually at the time and place of the Annual Meeting of the New Zealand Branch of the British Medical Association.

The question of affiliation with the Medical Women's Federation of Great Britain, and through it, with the International Association of Medical Women was discussed. Dr. Ada Paterson had been present at one of the meetings of the London Association, and while there had been asked if we had an Association in New Zealand. The advantages of forming one and through it of getting into touch with the Associations of different countries were laid before her.

Dr. Siedeberg then read a report of the International Association of Medical Women, held at Geneva in September, 1922. At this meeting 17 different countries were represented, Great Britain and America each sending five representatives. The subjects discussed were: "Venereal Disease in its Relation to the State," "The White Slave Traffic," "Cocaine and Other Drug Traffic." The great value of the social functions was stressed, and a banquet at which the 19 official representatives in turn made a short speech, was considered the crowning point of the Union. The advantages to New Zealand members of being affiliated with such an international association, were obvious to all, and it was unanimously decided to take steps towards affiliation.

The following office-bearers were appointed for 1923:—President, Dr. Siedeberg; Vice-Presidents, Drs. Northcroft, Bathgate and Baker; Council, Drs. Paterson, Irwin, Bennett and Gunn; Hon. Secretary, Dr. Marion Whyte.

After the meeting, Dr. Eleanor Blake entertained the members at a luncheon in Ballantyne's Tea Rooms, and all present felt that this was only the first of many pleasant re-unions in the future.

The following have expressed their intention of becoming members:—Drs. Bathgate, Baker, Chapman, Crosby, Dunne, Day, Hastings, Irwin, Morgan, Northcroft, Nees, Roper, Sands, Siedeberg, Stevenson, Woodhouse, Whyte, Paterson, Gunn, Platts-Mills, Bennett, Cameron, Fitzgerald, Bell.