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Are the government's intended health indicators the accountability measures the New Zealand health system urgently needs?

Workplace wellbeing in emergency departments in Aotearoa New Zealand 2020

The Spanish Flu pandemic and stable New Zealand suicide rates: historical lessons for COVID-19

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The carbon footprint of cataract surgery in Wellington

Matthew Latta, Caroline Shaw, Jesse Gale

The health sector contributes around 5% of New Zealand greenhouse gas emissions and must be part of the de-carbonisation of the economy. Cataract surgery is our most common operation, with around 30,000 operations each year. We estimated the carbon footprint of cataract operations in Wellington at two public and two private hospitals and found an average of 152 kgCO2e from each operation. Procurement was the biggest contributor to the footprint, so efforts to reduce the emissions from cataract surgery should focus on reducing consumption of disposable materials.

Does the National Immunisation Register stack up? Quantifying accuracy when compared to parent-held health record books

Hannah Chisholm, Janine Paynter, Esther Willing, Nikki Turner, Anna S Howe

The National Immunisation Register (NIR) is an important tool for the provision of clinical services, national immunisation programme evaluation and immunisation research in New Zealand. This study aimed to examine, describe and quantify the extent of discrepancy in the NIR compared to Well Child Tamariki Ora parent-held health record books (Health Books). Overall, NIR performance was high, with NIR performance higher for National Immunisation Schedule (NIS) vaccines compared with non-NIS vaccines.

The wellbeing and health needs of a cohort of transgender young people accessing specialist medical gender-affirming healthcare in Auckland

Jeannie Oliphant, Daniel Barnett, Jaimie Veale, Simon Denny, Bridget Farrant

High levels of distress are experienced by young transgender people in Aotearoa New Zealand. This speaks to an urgent need to upskill primary care on the health needs for young transgender people and provide clear referral pathways to access specialist gender-affirming healthcare services. Urgent access to mental health support that is competent to meet the needs of young transgender people is needed.

Paediatric exploratory ingestion presentations to Christchurch Hospital emergency department during 2019

Aditya Raina, Brennan Carne, Roshit Bothara, Andrew McCombie, Paul Gee, Laura Joyce

111 children under 7 years of age presented to Christchurch Hospital emergency department during 2019 after having ingested medications or other potential toxins (paediatric exploratory ingestions (PEIs)). This accounted for 1.2% of all paediatric presentations. This is a reduction compared to 1999. 2 year olds were most likely to present with PEIs., while children of Asian and Pacific ethnicities were less likely to present with PEIs. Paracetamol most the most commonly ingested substance. There has been a worrying increase in ingestions of dangerous drugs such as morphine.

Mapping prevalence and patterns of use of, and expenditure on, traditional, complementary and alternative medicine in New Zealand: a scoping review of qualitative and quantitative studies

E Lyn Lee, Jeff Harrison, Joanne Barnes

Traditional, complementary and alternative medicine (TCAM) is a broad term used to describe the health products, preparations, practitioners and practices that have a long history of use in traditional medicine systems and/or those that are not typically part of dominant "conventional medicine" systems. TCAM is used by people of all ages, ethnicities and with various health conditions in New Zealand. Available studies in New Zealand exploring TCAM use are mostly small and localised (eg, use of TCAM by patients attending one hospital in Auckland). There are limited national data on TCAM use; the most recent study on dietary supplement use was a nutritional survey done in 2008/9. Given TCAM's popularity as a healthcare choice, reliable, current national data on TCAM use are needed in New Zealand.

Vitamin D deficiency, supplementation and testing: have we got it right in New Zealand?

Mark J Bolland, Alison Avenell, Andrew Grey

We tracked rates of vitamin D prescriptions in New Zealand between 2003 and 2019, finding that they increased 14-fold to more than 1 million prescriptions/year in 2019. Even though vitamin D tablets are cheap (less than 50c/tablet), the medication costs alone for vitamin D in 2019 were more than $1 million. To find out whether the increasing amount of vitamin D supplementation had actually prevented consequences of vitamin D deficiency, we tracked the annual numbers of hospital admissions in New Zealand for the consequences of vitamin D deficiency (rickets and osteomalacia). Despite the dramatic increase in prescriptions for vitamin D, the number of hospital admissions for rickets, osteomalacia, and unspecified vitamin D deficiency remained small and stable, between 10 and 20 cases/year. Lastly, we assessed vitamin D measurements in Auckland in two time periods, 2002 and 2003 and 2009 and 2019, finding that vitamin D results increased between the two periods, partly as a result of increasing vitamin D prescriptions, but importantly, most tests in the later time period simply identified individuals with normal levels. Collectively, these results suggest that guidance and practice around vitamin D in New Zealand should change, because the costs of increasing vitamin D supplementation and poorly targeted testing could be better spent on different approaches to prevent osteomalacia and rickets

Publicly reported health performance measures 2010–2020

Colin F Thompson

New Zealand DHBs are required by legislation to publish performance measures as part of their accountability to the public. Measures represent many areas of DHB operations in prevention, community care, hospital care and rehabilitation but cannot cover every situation. This study has shown how in one DHB their usefulness has been further limited by a lack of continuity, uncertain accuracy, questionable effectiveness or clinical relevance and by few being clearly associated with outcomes most important to patients. Performance measurements can be important tools for increasing healthcare productivity, but they also need to be evaluated for their potential to cause a range of unintended consequences or even harm.

Balloon aortic valvuloplasty for severe aortic stenosis: single-centre contemporary patterns and experience

Ammar Alsamarrai, Tom Kai Ming Wang

Aortic stenosis is narrowing of the main valve of the heart, and it is the most common valve problem in the developed world. The best treatment for this condition is to replace it with an artificial heart valve. Because this is major operation, it is not suitable in people who have generally poor health. One alternative is to put a small balloon through the valve and inflate it open. Our study demonstrates that this procedure is generally safe and is effective in the short-term.

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Are the government's intended health indicators the accountability measures the New Zealand health system urgently needs?

Murray Horn, Graham Scott, Des Gorman

We have embarked on another expensive and disruptive reform of our health system. The government's 12 Heath System Indicators are intended to "measure and report how well our health and disability system is doing for New Zealanders."[1] If so, they will measure any benefits that the reforms generate and will be a useful input into the accountability framework required to produce these benefits. Indeed, in his announcement on 6 August 2021, Minister of Health Andrew Little said the Health System Indicators would be used to hold government to account and ensure it delivers more equitable healthcare for all New Zealanders.[2]

An effective accountability framework is necessary for successful reform

Ensuring delivery of the government's priorities will also require those responsible for managing and providing care to be similarly accountable. Health spending represents a large and growing share of public expenditure, so there must be some assurance that the money is spent on what the government and ultimately Parliament intended. However, the health system is populated with people who have considerable discretion and who are likely to be more concerned about their accountability to peers, patients and communities than some remote official or minister.

Part of the answer is striking the right balance between top-down accountability to Parliament, horizontal accountability between decision-makers and their peers and bottom-up accountability to the people and communities the system serves. We have not got this balance right yet and are lurching from the extensive decentralisation of the 2000 reforms to an almost complete recentralisation. Having abolished the Health Funding Authority in 2000, the proposal now is to re-establish a similar organisation with even greater scope and powers.

The proposed Health System Indicators essentially attend to top-down accountability. In this case, they need to be measures of progress that have the greatest impact on prioritised ambitions; the degree of progress required to achieve the desired impact need to be identified; and there must be clarity about the consequences of under- or over-achievement.

Delivering benefits from health system reforms is difficult, as our history demonstrates.[3] The underlying "political economy" of healthcare helps ensure that providers of existing services delivered in existing ways are in a strong position to protect themselves if funding becomes tight and to capture new funding.[3] Simply delivering "more of the same" is not going to result in more equitable or affordable healthcare or significant improvements in the government's six priorities. However, this is likely unless providers have a strong incentive to change the way services are designed and delivered and believe these changes are consistent with their professional obligations.

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Using indicators as goals to drive accountability is risky but manageable and the alternative is likely to be worse

Using indicators as goals to drive accountability has obvious risks, like unintended consequences and crowding out what is valuable but hard to measure.[4] For example, planned-care waitlists can be manipulated at the expense of both healthcare quality and cost. Consequently, we are also interested in how an indicator was met. The stronger the incentive to deliver the required goal, the higher the risk.

These risks can be minimised. The answer is in adopting measures to reduce the scope for manipulation and in the application of judgement in making an assessment and, when the risk is hard to control, in using "lower powered" incentives, such as earned autonomy.

Moreover, the alternative is neither attractive nor risk free. Ineffective accountability will inevitably result in yet another failed reform and generate additional risks to healthcare quality and cost.

The introduction of a primary care capitation in 2001, without any accountability for better outcomes, is illustrative. Capitation creates a financial incentive to both enrol as many patients as possible in a practice and reduce the cost to serve them. New Zealand Medical Council data show that the average general practitioner (GP) has given up almost a day per week in their usual practice since then and has reduced their after-hours and on-call commitments from an average of ten to four hours per week. Subsequent national health surveys have shown that the single biggest cause of unmet need in primary care is now the availability of the GP that the person wants to see. The reduction in after-hours care from GPs is associated with a subsequent proliferation of urgent care clinics, fragmenting primary care and increasing demands on emergency departments. Although the causal relationship between capitation and these effects is conjectural, the association is predictable given the financial incentive that capitation without accountability creates.[5]

A shift to indicators is a deliberate departure from the past

Helen Clark's government introduced ten "health targets" with accompanying "goals" and a quarterly assessment of district health board (DHB) achievement on the Ministry of Health website. Performance against goals was decidedly mixed during a period of increased health expenditure relative to GDP and, by different measures, reduced health system productivity.[6]

John Key's government sought to strengthen accountability by reducing the number of targets to six and increasing public transparency by publishing DHB performance quarterly in the mainstream media. Within six years, all four non-process outcomes were at least within one percentage point of target at the national level. Progress against the two process targets (smoking advice and CVD/diabetes checks) was not as strong. The track record of process measures (activity or outputs versus valuable outcomes) in health system funding innovations is generally poor.[4,5,7,8]

The current government's 12 high-level indicators have no goals, and the Minister of Health has made it clear that "they are not about incentivising with funding or pointing the finger if targets are not met – they are neither a carrot nor a stick."[2]

If there is no sense of what is required and no consequence for lack of measured progress, then the future will not differ much from the past given the strong incentives in the system to deliver more of the same.[3] Indeed, indicators that lack goals and consequence suggest that reformers have yet to work out how accountability will meaningfully work down, across and up the large and complex public health and disability system.

The six government priorities

Electoral competition is partially based on what different parties promise to deliver once in power. It is, therefore, not surprising that different governments have different health priorities and seek to convince voters that healthcare will actually improve under their watch.

However, improving total health system performance should be a common objective

because it allows more of any government's priorities to be delivered for a given budget. This suggests that government priorities are best grounded in something like the widely accepted "Triple Aim" (as recommended by the government's relevant expert working group).[9] Without this or another holistic perspective, it is not clear that these high-level indicators are either necessary or sufficient for total system performance improvement. Chasing a changing list of targets will likely pull resources from neglected but equally important outcomes. For example, the current indicators do not address outcomes for those with disabilities.

The way such priorities are defined is important. Ideally these should be priority *outcomes* a government seeks to deliver expressed in measurable terms.[5,8] The critical requirement is to assess the efficacy of measures/indicators by reference back to these priority outcomes to identify which are having the greatest impact.

"Improving wellbeing" is cited in three of the six priorities. Wellbeing might be best seen as keeping more people healthier for longer, which enhances their participation and independence. Participation and independence are quantifiable and particularly important for assessing the performance of the disability system.

Taking this view, "improving child wellbeing" would be more about ensuring children's health leaves them well placed to participate fully at school. The before-school check programme was structured to assess this fitness and so could be used as a success measure. That would show which high-level indicators make the most sense. Many indicators seem too narrow to reflect the desired outcome for the associated demographic (eg, the proposed ambulatory-sensitive hospitalisation (ASH) indicator seems to be about just keeping children out of hospital).

The most notable departure from previous governments' targets is the inattention to wait-times, both for cancer treatment (both Clark and Key) and shorter stays in emergency departments (Key). The proposed elective (or planned care) indicator is the closest the intended indicators come, and that falls back to a comparison with "the agreed number of events in the delivery plan." Whether that means shorter wait times for electives depends on the delivery plan, which is likely to be set with some confidence that whatever number is "agreed" will be achieved. For a system that requires rationing,[3] reducing wait times for treatment is a priority for the public, so this omission is surprising.

The twelve high-level indicators

Turning to the indicators, the two ASH rate indicators are interesting because recent and yet to be published analysis of this measure in two patient cohorts in Auckland shows that avoidable hospital admissions are more closely related to social deprivation factors than they are to the number of GPs per capita. Wider social determinants are also likely to be important to the achievement of most of the other government priorities. This suggests that the government should be looking to managers of the health system to identify actions within their plans to work with other agencies to address these upstream factors (as Canterbury's System Level Measure Improvement Plan currently does). This is inherently transformative and will require more effective collaboration across agencies, with the budgeting, commissioning and funding plans and accountability arrangements necessary to support and incentivise such collaboration.[5]

The "strong and equitable public health system" indicators are "number of days spent in hospital for unplanned care" and "people who had surgery or care that was planned in advance, as a percentage of the agreed number of events in the delivery plan." Neither indicator really focuses on equity. Given the Minister's emphasis on improving equity, it would have been better if an equity lens was applied generically (eg, by requiring a reduction in the variability of outcomes across population groups).

The "financially sustainable health system" indicators are "net surplus/deficit as a percentage of revenue" and "budget versus actuals variance as a percentage of budget." Financial sustainability has little to do with any single year's budgetary outcome. This was a chance to significantly lengthen the financial horizon of health managers and better align their financial incentives with the desire to strengthen prevention as well as the role of primary care (and hopefully to work with others to

modify the important social determinants of wellbeing).[5] The indicators that really matter for financial sustainability are more like those that drive decisions at ACC. Their focus on controlling their future claims liability gives them a strong financial incentive to invest in prevention, early treatment and rehabilitation back to work or independence. Contrast that with the health system where the focus is to manage this year's health costs within this year's health budget, something these intended indicators only reinforce.

Balancing centralised and distributed accountability

Our final observation is that the publication of the indicators is premature. The government is yet to design the institutional arrangements beyond the broad brushstrokes of abolishing DHBs, public health organisations (PHOs) and alliances and creating Health New Zealand . Those arrangements will determine what system of accountability will operate in detail and how goals are best expressed, developed and assessed.

Designing effective accountability processes will be largely about the allocation of decision rights, funding models and flows of information. The contribution of any particular indicators will depend on how these arrangements work within the context of the total system architecture and whether they are co-created with clinicians and consumers who accept the resulting measures as meaningful and legitimate.

The latter is essential in the design of locality networks within the current reforms. These will only succeed if the initiative lies with professionals and community groups to agree on the contribution they will make to improve local service design and delivery. Central agencies will have to provide the infrastructure, support and models of funding that promote and support innovative "local solutions to meet local need."[5] Voluntary organisations, iwi providers and others are not going to be commissioned by a middle manager from a government agency.

The way forward

The New Zealand health system is reasonably characterised as being increasingly unaffordable and unfair. Reform is needed, and that must include meaningful accountability measures, supported by the right incentives, to encourage the changes in service design and delivery necessary for a fairer and more financially sustainable system.

The government intends that their new indicator framework can be used to hold itself, and presumably those who provide health and disability services, to account for making progress towards achieving its six system priorities. However, an over-reliance on a centralised and top-down approach—especially one with the current definition of priorities and associated indicators, a lack of goals or targets to define what degree of progress is expected or required and the consequence-free nature of its application—means it is unlikely we will get the accountability so badly needed to really shift the dial on the issues of equity and affordability.

Finally, reformers first need to develop system architecture that will facilitate desirable, enduring and comprehensive improvements in the health and disability system and only come back to target and indicator settings when they have built such a system.

Competing interests:
Nil.

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The carbon footprint of cataract surgery in Wellington

Matthew Latta, Caroline Shaw, Jesse Gale

ABSTRACT

INTRODUCTION: Efforts to improve the sustainability of ophthalmic care require methods to measure its environmental impact and a baseline measurement to compare against in the future. We aimed to measure the carbon footprint of cataract surgery in Wellington.

METHODS: We used Eyefficiency, an application using established footprinting methods, to estimate the emissions produced by phacoemulsification surgery in two public and two private hospitals. We measured (1) power consumption, (2) procurement of disposable items and pharmaceuticals, (3) waste disposal emissions and (4) travel (other potential sources were excluded). Where possible we used New Zealand emissions coefficients.

RESULTS: We recorded data from 142 cataract surgeries. The average emissions produced by cataract surgery in the region was estimated to be 152kg of carbon dioxide equivalent. This is equivalent to 62L of petrol and would take 45m^2 of forest one year to absorb. The great majority of emissions were from procurement, mostly disposable materials, and the second greatest contribution was from travel (driving).

CONCLUSION: Estimating the carbon footprint of cataract surgery is becoming easier, but improved methods for measuring the footprint of procured supplies are needed. There are significant opportunities for emissions reduction in the most common surgical procedure in New Zealand.

Climate change is the largest global health threat in the 21st century,[1,2] and there is broad support for urgent action to mitigate climate change though emissions reduction, even among ophthalmologists.[3–5] The healthcare sector is a major source of physical waste and greenhouse gas emissions.[6] In New Zealand and Australia, healthcare accounts for around 10% of national economic activity and contributes around 5% of total greenhouse emissions, which is more than aviation.[7,8] The National Health Service of England's target is for their healthcare sector to be carbon neutral by 2040,[9] and recently the New Zealand Government announced its entire public sector will move to achieve carbon neutrality by 2025 (the details for district health boards have not yet been announced).[10]

Due to both high surgical volumes and considerable disposable consumption, cataract surgery is the greatest source of emissions within ophthalmology. Attempts to derive a carbon footprint of cataract surgery have shown widely divergent results in different countries: in Cardiff, United Kingdom (UK), the estimated footprint was 182kgCO_2e,[11] whereas the footprint of the Aravind Eye Care System (AECS) of Southern India was only 6kgCO_2e.[12] This vast difference between the UK's and India's surgery footprints has been attributed to AECS reusing most items (including blades and tips), recycling much of their waste and having high time efficiency and throughput, reduced power consumption and cheaper locally-sourced surgical materials. There are also some differences in how the AECS and UK footprints were calculated.[13]

In this cross-sectional study, we aimed to estimate the carbon footprint of cataract surgery in all hospitals in the Wellington region, New Zealand (two public and two private participated). This was to establish a baseline measure or benchmark for future sustainability auditing, to engage

local stakeholders and to consider avenues for improvement. A secondary aim was to compare public and private hospitals and areas of relative strength and weakness.

Methods

Approvals

The study protocol was ethically approved as a Minimal Risk Health Application by the University of Otago Human Ethics Committee (Health): reference HD20/092. Management of all three public hospitals and all three private hospitals in the Wellington region agreed to participate. Wellington Regional Hospital and Kenepuru Community Hospital, both of Capital & Coast District Health Board, and Bowen Hospital and Southern Cross Hospital Wellington all participated. Hutt Hospital of Hutt Valley District Health Board and Boulcott Hospital both agreed to participate but were then excluded because the volume of cataract surgery in the study period was insufficient (fewer than 15 cases). In a memorandum of understanding, the results for each hospital were kept anonymous and were not permitted to be used in marketing.

Study design

The primary researcher (ML) attended as many operating lists containing cataract surgery as possible at all four hospitals between November 2020 and January 2021, collecting up to 40 cases from each hospital from the widest possible range of surgeons.

Broadly speaking, to estimate the greenhouse gas emissions footprint of surgery involves firstly determining the scope of what is included in the estimate; secondly, measuring the included emissions sources; and finally, applying relevant emissions factors to each source to determine the overall emissions. The method used was based on previously published methods,[11,12] which were available through the Eyefficiency application. Eyefficiency can be used to record events in theatre for testing the efficiency of processes, but by entering more details about consumption, travel and waste, it can also estimate carbon footprints. We used Eyefficiency to record case timings and as a guide to understand sources of emissions, but we modified the footprinting inclusions, exclusions and emissions coefficients, as described below.

Carbon footprinting: inclusions and exclusions

We included all elective phacoemulsification with lens implant operations, including complicated cases, as well as the possible additions of suture removal, bleb needling and intravitreal or subtenon injection. We excluded all larger combined surgeries, such as cataract surgery with planned vitrectomy or trabeculectomy or iris suturing. Bilateral cases were performed and measured as two separate cases. The main opportunity for reduced emissions with bilateral surgery was reduced patient travel. There were no manual cataract extractions (without phacoemulsification) during the study. Operations under local or general anaesthetic (<5 in total) were both included, and although the additional time of general anaesthesia was recorded, the additional waste from the anaesthetic could not be measured.

The list of potential sources of greenhouse gas emissions is long. The factors that were included as contributing to the carbon footprint of cataract surgery were: (1) power supply of the hospital, (2) travel for patients and staff in the theatre, (3) procurement of disposable items, pharmaceuticals and solutions and tubing and tips for the phacoemulsification device and (4) waste disposal. This was approximately in line with the similar study from India.[12]

We excluded the construction and provisioning of the hospital. In the UK study, emissions related to information technology, stationery, linen and laundry were calculated to be less than 0.5% of the total, so we excluded them from our analysis.[11] We also excluded capital items, such as instruments, operating microscope and phacoemulsification device, and more peripheral sources of emissions that surround the cataract surgery system, such as food for staff and patients, other human resources around the hospital such as security and reception, scientific activities and background knowledge and training underlying the operation. We also excluded perioperative clinic appointments as there was very little variation between surgeons or hospitals in having one preoperative and two postoperative visits, although this would be a modifiable aspect of travel emissions in cataract surgery.

We measured the emissions from the sterilisation of instruments in one hospital (using British emissions coefficients) and found they were less than 0.25% of total emissions. As the amount was very small and we were uncertain about the accuracy of British coefficients in New Zealand, we decided to exclude this source of emissions.

Carbon footprinting: emission measurement

Electricity consumption

Energy use was calculated by taking the average monthly power consumption of each hospital or surgical unit; and taking a proportion of the power consumption based on the floor space allocated to ophthalmic surgeries; and the proportion of the week scheduled for cataract surgery. In keeping with previous methods, we assumed that $1m^2$ of operating theatre used twice the energy as the average floor space of the hospital, and that all hospitals had equivalent electricity sources from the national grid.[11]

Travel data

Travel methods were collected from all operating theatre staff and the first 10 patients at each hospital: all drove. Private vehicle was then assumed to be the mode of travel for all other participants. Driving distances were calculated to the suburb level to maintain privacy. Emissions from staff travel were divided across the whole operating list. Calculations used the fuel performance of an average New Zealand car (2010 Toyota Corolla 1.6L engine).[14]

Procurement data

The cost of pharmaceuticals and medical equipment per cataract operation were calculated with data collected from theatre managers. As described above, we excluded procurement of other items such as information technology, food and drink, linen and stationery, as they were <0.5% of emissions in the UK study.[11] Procurement costs were converted to emissions using publicly available emissions coefficients ($NZD were converted into £GBP of 2011, when the emission coefficient was calculated).[15] These emissions coefficients are aggregated estimates across broad sectors: the average emissions per £GBP spent on pharmaceuticals or medical supplies. A more detailed product lifecycle analysis for quantifying the footprint of each consumable item was not possible.

Waste data

Some hospitals recycled, and any emissions from recycled waste were not recorded. All other waste went to landfill, and we used New Zealand emissions coefficients to calculate the emissions from transport and degradation of this waste. The weight of waste going to landfill after each case was measured with an electronic spring scale. In hospitals with recycling, landfill waste was predominantly non-recyclable plastics, so we used an emission coefficient for plastic in landfills. For hospitals that did not recycle, where landfill waste was mixed with more paper, we used an emission coefficient for general waste. Wellington landfills perform gas recovery, which mitigates emissions from anaerobic degradation of organic waste (not present in theatre waste), and this reduced the emission coefficient we used for general waste.

Carbon footprinting: emissions coefficients

Each source of emissions was measured in the relevant units: kilowatt hours (kWh) of electricity, kilometres (km) of driving, dollars of procured supplies ($NZD converted to £GBP of 2011), kilograms (kg) of landfill waste and tonne kilometres (tkm) for freight. These measures were converted to greenhouse gas emissions ($kgCO_2e$) using emissions coefficients (Table 1). Where possible, we used New Zealand emissions coefficients sourced from the Ministry for the Environment.[14] Where local information was unavailable, we used the same international and UK coefficients that were used in similar studies.[15]

Results

We collected data on 142 cataract operations from the three months of November 2020 through January 2021: 40 from Southern Cross Hospital Wellington, 41 from Bowen Hospital, 39 from Kenepuru Community Hospital and 22 from Wellington Regional Hospital. Eleven of the 17 consultant surgeons in the region were operating during data collection.

At the two private hospitals, the average number of cataract operations per session was 10.1, whereas the average number of

cataract operations per session at the two public hospitals was 3.4. Simple cataract surgery was less common at the public hospitals, particularly Wellington Regional Hospital, as there were many other types of surgery and combined surgery.

Table 2 summarises the emissions results. The average footprint of cataract surgery was 151.9kgCO_2e. The proportions attributed to electricity use, travel, procurement of supplies and pharmaceuticals and waste disposal are also shown in Figure 1.

As shown in Table 2, cataract surgery at public hospitals had a slightly smaller carbon footprint than at private hospitals (145.2 kgCO_2e compared to 158.6 kgCO_2e). Travel emissions per case were lower in private hospitals, primarily due to longer lists of cataract operations (less staff travel per case). Procurement emissions were lower in public hospitals as perhaps they had greater bargaining power or economies of scale for negotiating lower costs per case. Pharmaceutical costs were higher in private hospitals because more surgeons used medication not funded by the national medicines and devices funding agency (PHARMAC), such as ketorolac, and because more surgeons used postoperative antibiotic drops.

The waste produced by each operation had an average mass of 1.32kg. The hospital with the lowest average waste (1.14kg) was a public hospital that did not recycle, and the hospital with the highest average (1.51kg) was the other public hospital, which did recycle. Paradoxically, the public and private hospitals that recycled both had heavier waste bags than their counterparts, despite some waste being diverted to recycling. The majority of the mass was from residual or collected irrigation fluid (balanced salt solution), gloves and gowns and soft plastic packaging for sterile single use items. The cassette and tubing for the phacoemulsification device were not recyclable, partly due to the fluid with biological material within them. At hospitals that recycled, the contents of the waste bags were mostly non-recyclable soft plastics, and in hospitals that didn't recycle, the waste was a more heterogeneous mixture of paper and different plastics

Discussion

We found an average of 151.9kgCO_2e of emissions from cataract surgery in Wellington, not including perioperative clinic visits. This footprint is similar to that of an economy ticket on a one-hour flight, or combustion of 62L of petrol, and would take 45m^2 of forest one year to absorb. By extrapolating this across the approximately 30,000

Table 1: Carbon emissions coefficients.

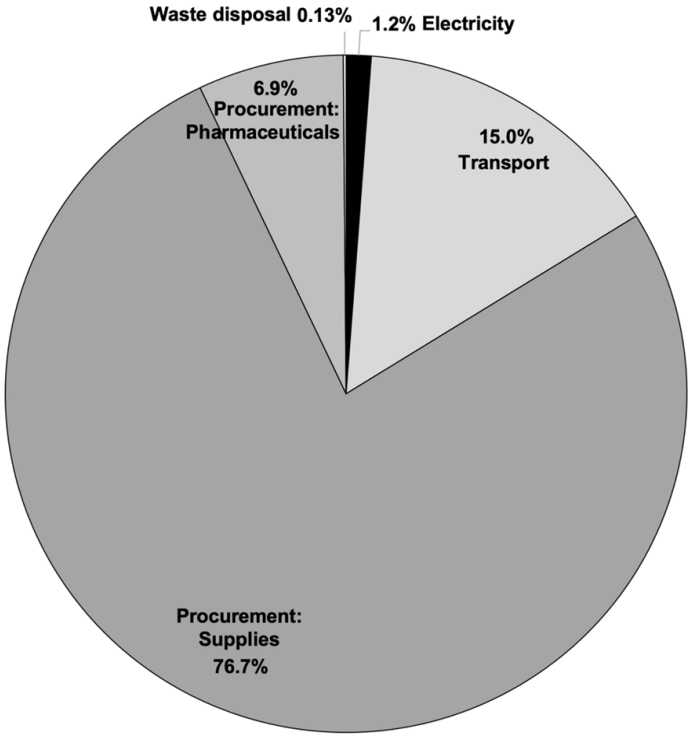
Power	**EC to convert kWh to kgCO_2e**	**EC reference**
Electricity	0.101	NZ
Transport	**EC to convert km to kgCO_2e**	**EC reference**
Car	0.238	NZ
Procurement	**EC to convert 2011 £GBP to kgCO_2e**	**EC reference**
Pharmaceuticals	0.59	UK[11]
Medical equipment	0.54	UK[11]
Landfill	**EC to convert kg waste to kgCO_2e**	**EC reference**
Plastic	0.008934	UK[15]
General waste	0.311	NZ
Waste freight	0.135 kgCO_2e per tkm	NZ

EC: emission coefficient. NZ: New Zealand. UK: United Kingdom. The ECs for plastic in landfill and procurement of medical supplies were sourced from the UK[11,15]. All other ECs are from New Zealand.[14]

Table 2: Carbon emissions (footprint) attributed to one phacoemulsification and lens implantation surgery in Wellington ($kgCO_2e$).

	Overall (all 4 hospitals)		Public (2 hospitals)		Private (2 hospitals)	
Electricity consumption	**kWh**	**$kgCO_2e$**	**kWh**	**$kgCO_2e$**	**kWh**	**$kgCO_2e$**
	17.8	1.8	17.1	1.7	18.5	1.9
Travel (per case)	**km**	**$kgCO_2e$**	**km**	**$kgCO_2e$**	**km**	**$kgCO_2e$**
Patient	48	11.4	51	12.2	45	10.7
Staff	48	11.4	72	17.2	23	5.5
Total	96	22.8	123	29.4	68	16.2
Procurement	**$NZD**	**$kgCO_2e$**	**$NZD**	**$kgCO_2e$**	**$NZD**	**$kgCO_2e$**
Medical equipment	486	116.5	412	98.8	560	134.2
Pharmaceuticals	40	10.5	57	15.0	23	6.0
Total	526	127.0	470	113.8	583	140.2
Waste disposal		**$kgCO_2e$**		**$kgCO_2e$**		**$kgCO_2e$**
Waste emissions		0.191		0.184		0.198
Waste freight		0.013		0.022		0.004
Total	1.32 kg	0.204	1.33 kg	0.206	1.32 kg	0.203
Total	151.9 $kgCO_2e$		145.2 $kgCO_2e$		158.6 $kgCO_2e$	

Figure 1: The proportion of the average carbon footprint attributed to each source of emissions.



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cataract operations performed in New Zealand each year, we estimate this surgery creates 4,500 tonnes of CO_2e a year, which would take 134ha of forest growing for the year to absorb.

This footprint for cataract surgery in Wellington compares well to that found for Cardiff, UK, in 2012, which was 20% greater (182kgCO_2e) when calculated using the same method.[11] However, much of this difference could relate to the UK study including of both preoperative and postoperative clinic visits (ie, increased travel and increased electricity use in clinics). The very low footprint of 6kgCO_2e for phacoemulsification surgery at AECS highlights just how widely the relevant factors can vary.[12] Several reasons contribute to this huge difference: at AECS there is local production of many instruments and intraocular lenses; nearly every item is re-used to some extent; and much of the waste is locally recycled. There are also efficiencies of throughput that contribute to lower transport costs for staff.

Emissions from travel were similar in Wellington (18kgCO_2e) and Cardiff (23kgCO_2e). In our study there were fewer emissions from travel in the private sector (Table 2), due to longer operating lists (ie, staff travel was distributed over more cases). Travel distances for both staff and patients at public and private hospitals were similar. The main reasons for longer operating lists in the private sector were less-complex cases, fewer combined surgeries or non-cataract surgeries, fewer general anaesthetics, the absence of trainee surgeons who take longer to operate and lower turnaround time with less administration required by the operating surgeon. Notably, we did not find any staff or patients using public or active transport across 61 individuals asked.

The majority of emissions were from procurement (83.8%), mostly surgical supplies such as gauze, dressings, gowns and gloves, blades, lens implants, tubing and tips. The emission coefficient converted the costs of procured supplies into emissions, based on international data for the production and supply of medical equipment in general from 2011.[15] Therefore, in our study the emissions from procurement mostly reflect the costs, rather than a careful analysis of product lifecycles. These costs relate to bulk purchasing deals and negotiations with suppliers, and differences in price in different markets probably account for greater emissions from procurement in New Zealand than UK.[11] This is a major source of error in our study: one hospital could demand sustainable supply chains for disposable items, and may pay a greater price for those supplies, and the emission coefficient would incorrectly estimate that the emissions were greater. This decoupling of emissions and price will be a challenge for sustainability auditing in the future. Likewise, when all medical devices, including surgical supplies, become bulk-purchased by PHARMAC, New Zealand's medicines and devices funding agency, their cost will reduce but the level of emissions *per se* that they generate will not change. A more complete method for assessing the footprint of procured supplies is needed.

Emissions from power consumption (1.8kgCO_2e) were very low compared to the UK (66kgCO_2e), due to a few reasons: (1) the UK study included perioperative visits and potentially included power use in the clinics and larger areas of the hospital; (2) British hospitals often use coal boilers for central heating; (3) renewable energy (predominantly hydro) accounts for 82% of New Zealand's electricity supply, compared to just 47% of the UK's.[16] The UK emission coefficient indicates that electricity use in the UK generates nearly six times more carbon dioxide emissions than in New Zealand. New Zealand government policy aims to increase the renewable energy sector to the theoretical maximum by 2030.

Although waste disposal was a minor source of emissions, it was a significant mass and large volume per case (one full rubbish bag that weighed 1.32kg on average). Two hospitals recycled but also had a somewhat greater mass of non-recyclable waste, which could be related to other factors such as larger bottles of irrigation fluid, more assisting surgeons with extra gloves and gowns, or differences in the packaging of supplies. Recycling resulted in a different type of waste going to landfill: more non-recyclable plastic and less paper. And the different emission coefficient for this plastic waste in landfills reduced estimated emissions by 96% in hospitals that recycle. Despite recycling, we estimate the total

amount of landfill waste created in New Zealand from cataract surgery to be around 40 tonnes per year. Incineration without energy recovery would produce a great deal more emissions per kilogram of waste.

A major implication of this study is that procurement is the best target for reducing emissions. Reducing procurement emissions starts with partnership with suppliers and understanding the sustainability of supply chains and product lifecycles. A recent survey found that many of the re-use and recycling practises of India would be acceptable to American surgeons if cost and safety were maintained.[13,17] There is a strong appetite for more sustainable, less wasteful surgery, but cataract surgeons, at least in the United States (US), feel a lack of agency.[17] As well as industry, agencies that regulate doctors and hospitals are seen to represent barriers to change and barriers to avenues for effecting change. In New Zealand, PHARMAC's upcoming role in bulk-purchasing surgical supplies represents a major opportunity both to improve measurement of emissions related to procurement and to leverage reductions in emissions during contract negotiations.

Large hospitals, as major employers and the destination for thousands of people every day, could improve the sustainability of transport systems by targeting reductions in their own transport emissions. Innovative approaches include partnerships with local government to further subsidise public transport for patients and employees (eg, the Business EcoPass initiative in Boulder County, Colorado, US). Hospitals could also provide facilities and advocate for better and safer active transport (eg, cycling and walking).[18] Active transport also improves health in the community by increasing physical activity, reducing air pollution and injury and improving mental health.[18,19] Reducing demand for healthcare through better population health is one of the key principles of a low-carbon healthcare system.[5]

In December 2020, the New Zealand Government announced that the public sector will become carbon neutral by 2025.[10] The public hospital systems within district health boards were to be included in principle with further announcements of their dates of inclusion in the year to come. Initially, this will mean a commitment to offsetting carbon emissions, but the longer-term implications will include the budgeting of emissions and procurement of low-emissions services and supplies.

This study had limitations. The most obvious is the calculation of emissions from procured products, which was based on one British emission coefficient that did not incorporate more modern manufacturing or consider the procured materials used in Wellington. Here a product lifecycle analysis of surgical supplies was not possible, but it would form an important part of future research. Likewise, a more granular approach to measuring patient and staff behaviour will help motivate change, such as by capturing variations in the use of consumables or travel and follow-up patterns.

Another weakness is the possibility of selection bias due to the incomplete sample of cataract surgeries performed during the study period. We quickly reached 40 cases from private hospitals without sampling cases from all surgeons, whereas at Wellington Regional Hospital (one of the public hospitals in our sample) we could not reach 40 cases in the time available, despite including nearly every cataract operation. Our methods did not detect any substantial differences between surgeons, and so although the non-random sampling of operations could lead to a non-representative sample, we do not think this led to systematic errors in our estimations of emissions.

To conclude, this study has created a starting point for improving the sustainability of cataract surgery in New Zealand and offers a benchmark for comparison with other hospital systems. Improved methods will be needed to accurately measure how surgical products affect carbon footprints. Our results highlight how working with industry suppliers is perhaps the most effective first step. Central government policy will create high-level and top-down changes, but changes in the behaviour of individual surgeons will also be required. Due to its high volume, cataract surgery is a good early target for meaningfully reducing emissions in New Zealand's healthcare system.

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Does the National Immunisation Register stack up? Quantifying accuracy when compared to parent-held health record books

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ABSTRACT

AIM: The National Immunisation Register (NIR), which is derived from general practice management systems, is an important tool for the provision of clinical services, national immunisation programme evaluation and immunisation research in New Zealand. However, the accuracy of the NIR data has not yet been quantified. This study aimed to examine, describe and quantify the extent of discrepancy in the NIR compared to Well Child Tamariki Ora parent-held health record books (Health Books).

METHOD: Immunisation data for vaccinations given between birth and four years old for children born between 2006 and 2019 were compared between the Health Books and the NIR. Health Book records were used as the reference standard to calculate performance measures: sensitivity, specificity, positive and negative predictive values for the NIR.

RESULTS: Overall, NIR performance was high: sensitivity ranged from 90% to 93%, specificity from 78% to 85%, the positive predictive value from 91% to 94% and the negative predictive value from 77% to 84%. NIR performance was higher for National Immunisation Schedule (NIS) vaccines compared with non-NIS vaccines.

CONCLUSION: This study indicates the NIR data accuracy generally performs well compared with international equivalents, especially for NIS vaccine records. Further work is required to ascertain why discrepancies between the Health Books and NIR continue to occur, with particular attention to important subgroups and translating records across from migrant populations. Also, future work is required to understand the accuracy of vaccination records for groups who experience lower-quality healthcare and a higher burden of infectious diseases.

Vaccinations have produced some of the largest gains in the history of public health interventions. Timely, complete and safe immunisation requires reliable and complete vaccination records at the individual level. Accurate and meaningful evaluation of the coverage, effectiveness and safety of the National Immunisation Schedule (NIS) vaccines also depends on reliable and complete vaccination records at the population level.[1] In Aotearoa New Zealand, there are two sources of immunisation records: each child's Well Child Tamariki Ora parent-held health record book (Health Book) and the National Immunisation Register (NIR), which is automatically fed data every night from the practice management system (PMS) of immunisation providers. Health Books were the only source for immunisation records until the rollout of the NIR. A Health Book is given to parents upon the birth of a child and contains child health and development information.

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A section on vaccination in each Health Book allows vaccinators to record details of vaccinations given as per the routine New Zealand childhood NIS, as well as any other preschool vaccinations given as required or privately purchased. When a child is immunised overseas, their Health Book is retrospectively filled out in general practice upon sighting proof of vaccination documentation. Written records in Health Books are seen as the reference standard to which NIR records can be compared because Health Book records are written directly by the vaccinator at the time of vaccination and the Health Book Immunisation Certificate is necessary documentation for enrolment at early childcare centres and school.

The NIR is a computerised information system developed to hold vaccination details of children in New Zealand from six weeks to 12 years (and some adult vaccines) (Figure 1) and has been comprehensively used to record vaccination details for all children in New Zealand born since 2006.[1] The NIR is a valuable resource, but there are probably differences between the NIR and the records in each child's Health Book, and the degree of error is currently unknown. Validation research internationally and locally has found varying levels of misclassification in electronic registries.[2–6] Recording errors have the potential to result in bias results: for example, a small study in New Zealand indicated that the NIR may overestimate the number of children meeting national milestone targets.[5] Our study proposed to examine, describe and quantify the extent of the error in the NIR using Health Books as a reference standard.

Methods

Study population

The inclusion criteria were children born between 2006 and 2019 with vaccination data recorded in their Health Book for vaccinations given from birth until 4 years of age, and where the parent or legal guardian believes the recorded vaccination data is a true record of the vaccinations the child has received. Parents and caregivers of child participants were recruited as a convenience sample via the University of Auckland intranet, posters at appropriate venues (eg, Dunedin kindergartens and Allied Health Plus primary health organisation general practice clinics in Auckland), social media (eg, targeted Facebook advertisements), use of Well Child Tamariki Ora and immunisation provider networks (eg, the Health Book provider newsletter and vaccinator education mailing lists, posters at the New Zealand Immunisation Conference) and word of mouth.

At first contact, parents and caregivers were provided with either a paper or electronic participant information sheet and consent form. Participation required parents and caregivers to return a completed, signed consent form and submit a picture of the vaccination page of their child's Health Book. Children aged 8 to 14 years had to sign an assent form if they agreed to participate. These documents were submitted either electronically by email (as a scanned or photographed image) or in person as an original hardcopy. In acknowledgement of their time, all guardians who returned participant data and completed recruitment went into the draw to win one of five $100 gift cards to be spent at selected grocery stores, pharmacies and stationery shops. NIR records were identified for each child using their unique National Health Index (NHI) identifier. Subsequently, each child participant was assigned a unique study ID to preserve anonymity, and this was used across all data sources.

Well Child Tamariki Ora parent-held health record books

Data elicited for this study was sourced from the "Immunisation record" section of each Health Book. Relevant fields included vaccine, batch, site, date given, sign/stamp and notes.

National Immunisation Register

Individual-level vaccination data was extracted from the NIR using each child's NHI identifier. Relevant fields included the NHI, vaccination date, vaccine, vaccine dose, antigen and batch number. Live NHIs were provided to the Ministry of Health Analytical Services team for the data extraction. Demographic information on each child was also requested. Relevant fields included children's sex, date of birth, ethnicity, New Zealand Index of Deprivation 2013 decile and district health board of residence.

Figure 1: New Zealand National Immunisation Schedule (NIS) for childhood vaccines between 2006 and 2019.

NIS Childhood vaccines	6 weeks	3 months	5 months	10 months	15 months	4 years	11 or 12 years
February 2006 – May 2008	DTaP-UPV Hib-Hep B MeNZB	DTaP-UPV Hib-Hep B MeNZB	DTaP-UPV Hib-Hep B MeNZB	MeNZB	Hib-PRB MMR	DTaP-IPV MMR	Tdap-IPV
June 2008 – June 2011	DTaP-IPV-HepB/Hib PCV7	DTaP-IPV-HepB/Hib PCV7	DTaP-IPV-HepB/Hib PCV7		Hib-PRP MMR PCV7	DTaP-IPV MMR	Tdap HPV4 (females only)
July 2011 – June 2014	DTaP-IPV-HepB/Hib PCV10	DTaP-IPV-HepB/Hib PCV10	DTaP-IPV-HepB/Hib PCV10		Hib-PRP MMR PCV10	DTaP-IPV MMR	Tdap HPV4 (females only)
July 2014 – June 2017	DTaP-IPV-HepB/Hib PCV13 RV5	DTaP-IPV-HepB/Hib PCV13 RV5	DTaP-IPV-HepB/Hib PCV13 RV5		Hib-PRP MMR PCV13	DTaP-IPV MMR	Tdap HPV4 (females only)
July 2017 – 2019	DTaP-IPV-HepB/Hib PCV10 RV1	DTaP-IPV-HepB/Hib PCV10 RV1	DTaP-IPV-HepB/Hib PCV10		Hib-PRP MMR PCV10 VV	DTaP-IPV MMR	Tdap HPV9

DTaP-IPV: diphtheria, tetanus, acellular pertussis, inactivated poliovirus vaccines.
Tdap-IPV: diphtheria, tetanus, acellular pertussis, inactivated poliovirus vaccines.
DTaP- IPV-HepB/Hib: diphtheria, tetanus, acellular pertussis, inactivated poliovirus, hepatitis B and *Haemophilus influenzae* type b vaccines.
Tdap: diphtheria, tetanus, acellular pertussis vaccines.
Hib-Hep B: Haemophilus influenzae type b and hepatitis B vaccine.
Hib-PRP: Haemophilus influenzae type b polyribosylribitol phosphate vaccine.
MeNZB: A strain-specific group B meningococcal vaccine.
MMR: measles, mumps, rubella vaccine.
PCV7: 7-valent pneumococcal conjugate vaccine.
PCV10: 10-valent pneumococcal conjugate vaccine.
PCV13: 13-valent pneumococcal conjugate vaccine.
RV5: pentavalent rotavirus vaccine.
RV1: monovalent rotavirus vaccine.
HPV4: quadrivalent human papillomavirus vaccine .
HPV9: 9 valent human papillomavirus vaccine.
VV: varicella vaccine (chickenpox; varicella-zoster virus).

Although the NIR has a field allowing for the indication of high-risk schedules for at least Prevenar and influenza, validation of this variable could not be established as this information is not indicated in Health Books. (High risk schedules are schedule modifications for high-risk groups: for example, additional doses of an already scheduled vaccine or another vaccine, like the 23-valent pneumococcal vaccine for selected high-risk groups such as those with primary immune deficiency or human immunodeficiency virus.) Therefore, this study defines NIS vaccines as the routine New Zealand childhood immunisation schedule vaccines. Any vaccines outside of this definition were considered non-NIS vaccines. Some non-NIR vaccines, such as for rotavirus, have become NIS vaccines over the study period. These changes have been accounted for by comparing NIS with the date of vaccine administration.

Statistical analysis

Vaccination data from the Health Books were entered into an Excel spreadsheet with only the study ID to identify each participant. Records from Health Books were entered by two researchers (AH and HC) and checked by a third (JP). NIR and NHI data were merged with this reference standard data by unique study IDs. Vaccination records were excluded if they occurred after 60 months of age (this was to allow for flexibility in later delivery of the four-year milestone age vaccines). Records were also excluded if they were administration artefacts of the NIR, rather than a vaccine record (eg, records of vaccine declines).

Participant characteristics were described as number and percentage for the total population. Discordance between the Health Book records and the NIR records were investigated and described as percentage of misclassified vaccination events and types of errors found: for example, incorrect vaccine type or date, or missing events. Observed agreement, sensitivity, specificity and positive and negative predictive values were used as an index of agreement between the NIR and the Health Books. These measures perform best as a first step to quantify agreement between measures and have been used in previous literature on this topic.[7]

Results were presented by both total records and NIR vaccination records. This was because the authors noted substantial differences in recording concordance between NIR vaccination records and non-NIR vaccination records. All statistical analyses were undertaken using SAS Enterprise Guide (9.4) statistical software (SAS Institute Inc., Cary, NC, USA). This study was approved by the Health and Disability Ethics Committee: ethics reference number 19/CEN/51.

Results

One hundred and one participants were initially recruited, but three were excluded due to data quality concerns (Figure 2). After application of exclusion criteria (Figure 2), the total number of vaccination records was 1,641.

Characteristics of the study participants are summarised in Table 1. Of the 98 participants, most were European (75.5%), with 14% identifying as Māori, 9% as Asian and 1% as Pacific Island. Two-thirds lived in low deprivation areas (deciles 1–4), and a third lived in medium to high deprivation areas (deciles 5–10). Although nearly three-quarters of participants were from the Auckland area, there was participation from around the country. Seventeen percent resided in the South Island.

Most vaccination records (85%) were present in both the Health Book and the NIR (Table 2). The remaining 15% were recorded in either the Health Book or the NIR. Most NIR vaccination records were present in both the Health Book and the NIR. However, only a minority (5%) of the non-NIS vaccinations were recorded in both the Health Book and the NIR. Almost three-quarters of the non-NIS vaccinations were recorded in the Health Book only, and the remaining quarter were recorded in the NIR only.

The agreement between the Health Book and NIR records for both the recorded date and vaccine was high (Table 3). The date and vaccine record agreement for NIS and non-NIS vaccines was similarly high; however, the number of non-NIS vaccination records was small. Appendix Table 1 presents the non-NIS vaccine records by the data source. Influenza was the only non-NIS vaccine to be recorded by both

sources; however, the majority of influenza vaccine records were contained in the NIR only. Influenza was also the only non-NIS vaccine to be recorded by the NIR only. Of the non-NIS vaccines recorded in Health Books only, varicella and rotavirus vaccines (before their introduction to the NIS) were the most common. Appendix Table 2 presents the comparison of vaccines for each data source where vaccine type did not match. The greatest discrepancy was for PCV10 and PCV13; this was most probably due to NIS changes in pneumococcal vaccine brand/valency and general practice vaccine stock. General practices could have used up previous pneumococcal vaccine stock before distribution of the new pneumococcal vaccine. Alternatively, vaccinators may have incorrectly recorded the PCV brand/valency administered.

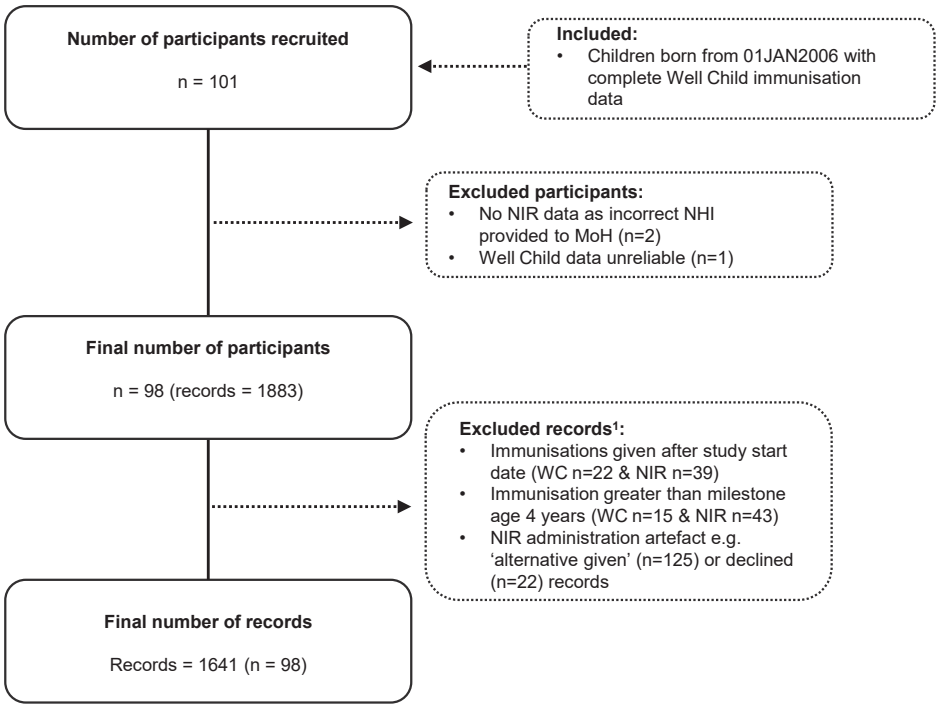
The predictive accuracy of the NIR compared with the Health Books is reported in Table 4. The NIR had the greatest sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) for the NIR vaccination records. For the total records, the NIR demonstrated high sensitivity (92%) and high specificity (81%). The PPV (92%) and NPV (80%) were also high. The NIR had the lowest accuracy for non-NIS vaccinations, and this may in part be due to the small number of records.

Discussion

The results of this study indicate the NIR replicates information in Health Books with a high level of accuracy for NIS vaccines: sensitivity, specificity, positive predictive value and negative predictive value estimates were 85% and above.

In international comparisons, the NIR generally performs well. The NIR demonstrated greater sensitivity than the Ontario Health Insurance Plan database by approximately 11%.[2] The NIR had substantially less error than the Boston Immunization Information System where chart records were used as the comparison; date agreement for the NIR was 97% compared with 66% for the Boston Immunization Information System.[4]

Figure 2: Study flowchart.



WC Well Child, NIR National Immunisation Register;
[1] May not add up due to participants meeting more than one exclusion criteria;

Locally, our study indicated a higher level of accuracy than the Reynolds et al (2014) study that compared records of the completion of the five-month vaccination target in the NIR to the PMS records. However, the Reynolds et al study had a small sample restricted to only one general practice. Reynolds et al reported that the PMS recorded 9.7% greater immunisation levels compared with the NIR. In contrast, our study found very high sensitivity and positive predictive value for the NIS vaccination records in the NIR compared to the Health Books.

The reasons for discordance between the NIR and Health Book vaccination records may include: vaccinators entering data into the incorrect field in the PMS; IT errors in the translation of vaccination records from the PMS to the NIR or in the centralised recordings of the NIR; or failures to enter vaccination records into the PMS. However, the time-consuming nature of transcription from overseas vaccination records may account for some discordance. Although country of birth was not available for study participants, children born overseas are less likely to have a record in the NIR compared with New Zealand-born children.[8] International records must be added by providers, and frontline providers may prioritise the simpler approach of adding an entry into the Health Book over the complexity of entering international records into the NIR.

This is the first study to the authors' knowledge that describes the extent of NIR error for non-NIS vaccination records in New Zealand. The number of non-NIS vaccination records was considerably lower than the number of NIS vaccination records. Most non-NIS vaccine records were recorded in Health Books only. Influenza was the only exception, where the NIR contained more records than the Health Books. Although the NIR is not designed or intended for recording non-NIS vaccine records, accurate records of non-NIS vaccines (especially those with known associations and significant adverse events following immunisation, such as for rotavirus) are essential for safety monitoring activities. In addition, silent inequities are possible where inaccurate records in non-NIS vaccinations exist. For example, those most at risk may not be receiving non-NIS vaccinations. Misclassi-

Table 1: Demographics of Health Book study participants.

	Total cohort	
	n	**(%)**
Total	98	(100.0)
Sex		
Female	54	(55.1)
Male	44	(44.8)
Prioritised ethnicity		
Māori	14	(14.2)
Pacific Island	1	(1.0)
Asian	9	(9.1)
European	74	(75.5)
Area level deprivation		
1–2 (lowest)	39	(39.7)
3–4	26	(26.5)
5–6	15	(15.3)
7–8	10	(10.2)
9–10 (highest)	8	(8.1)
District health board		
Northland	1	(1.0)
Waitematā	26	(26.5)
Auckland	35	(35.7)
Counties Manukau	10	(10.2)
Waikato	2	(2.0)
Bay of Plenty	2	(2.0)
Hawke's Bay	1	(1.0)
Mid Central	3	(3.0)
Whanganui	1	(1.0)
Canterbury	3	(3.0)
Southern	14	(14.2)

Table 2: Immunisation records by record source.

Total			Scheduled vaccination			
			Yes		No	
Source	**n**	**(%)[1]**	**n**	**(%)[1]**	**n**	**(%)[1]**
Both	1,066	(85)	1,060	(93)	6	(5)
NIR only	90	(7)	66	(6)	24	(21)
Health Book only	95	(8)	11	(1)	84	(74)

NIR: National Immunisation Register.

[1] Column percentage.

Table 3: Immunisation date and vaccine agreement by immunisation schedule for records contained in both sources.

Total			Scheduled vaccination			
			Yes		No	
	n	**(%)[1]**	**n**	**(%)[1]**	**n**	**(%)[1]**
Date agreement						
Yes	1,034	(97)	1,028	(97)	6	(100)
No	32	(3)	32	(3)	0	(0)
Vaccine agreement						
Yes	1,007	(94)	1,001	(94)	6	(100)
No	59	(6)	59	(6)	0	(0)

[1] Column percentage.

A third had a recorded date one day earlier in the NIR and a third had a day or two later recorded in the NIR, with a range between -295 and 247 days.

Table 4: Predictive accuracy of the National Immunisation Register compared to the Well Child Tamariki Ora parent-held health record books (Health Books).

	Total[1]		Scheduled vaccination			
			Yes[2]		No[3]	
	Estimate	**(95% CI)**	**Estimate**	**(95% CI)**	**Estimate**	**(95% CI)**
Sensitivity	0.92	(0.90, 0.93)	0.99	(0.98, 1.00)	0.07	(0.02, 0.12)
Specificity	0.81	(0.78, 0.85)	0.85	(0.82, 0.89)	0.04	(0.00, 0.12)
Positive predictive value	0.92	(0.91, 0.94)	0.94	(0.93, 0.96)	0.20	(0.06, 0.34)
Negative predictive value	0.80	(0.77, 0.84)	0.97	(0.96, 0.99)	0.01	(0.00, 0.03)

[1] n=1,641.

[2] n=1,526.

[3] n=115.

fication of vaccination status for non-NIR vaccines is a concern. Estimates of vaccine effectiveness are an important component of the negotiation to move a non-NIR vaccine onto the NIR. NIR data are utilised for studies of vaccine effectiveness, and underestimation of vaccination status may result in reduced vaccine effectiveness estimates.[9] Also, misclassification could result in missed or slower recognition of adverse events following vaccination, particularly if these events are rare.

The high sensitivity and specificity reported for NIS vaccinations is encouraging. Our results indicate that national milestone reporting, vaccine effectiveness estimates and safety research using historical NIR data is probably relatively accurate. The lack of substantial ethnic and socioeconomic diversity in the study sample prevents any comment on the accuracy of milestone reporting for equity. Although our non-NIS vaccine sample size was small, our results indicate a propensity for non-NIS vaccine exposure misclassification using historical NIR data. We recommend caution be exercised for non-NIS vaccine research using historical NIR data for exposure misclassification. We recommend researchers explore the implications of exposure misclassification on study outcomes. A larger study is needed to determine the extent of non-NIS vaccine misclassification in the NIR.

Our study sample was small and obtained through convenience sampling. One implication of this is that there were several family clusters. Sibling records are subject to similar demographic characteristics and behaviours of parents and general practice providers. Thus, these have the potential to bias our parameter estimates. Our sample was not representative of the New Zealand paediatric population over the study period. New Zealand Europeans, children living in low-socioeconomic deprivation areas and the Northern District Health Board region were over-represented in our sample. Demographic characteristics may have influenced the completeness of records in both the NIR and the Health Books. There are well-established disparities in the quality of healthcare received between Māori and non-Māori and low- and high-socioeconomic deprivation populations in New Zealand; this may have implications for the quality of vaccination records and the PPV and NPV as they are sensitive to the characteristics of the population in which they are measured.[10,11] Investigation of demographic inequalities in NIR vaccination records is an important concern to be addressed in future research. We acknowledge Health Book records are probably not without error and that this could bias the results, but it is unclear in which direction. Completion of each Health Book is influenced by the nature of the healthcare appointment (opportunistic vaccination or scheduled immunisation appointment or immunisation outreach service), whether the Health Book is lost and whether the parent/caregiver remembers to bring it to the appointment or at a later time for updating. However, less than 7% of records were recorded in the NIR only, indicating that this source of error was unlikely to have significantly affected parameter estimates. Some aspects of the process of recording vaccination events are common to Health Book and PMS records and, therefore, are subject to some of the same omission or misclassification errors. It is not possible to determine whether or to what extent this occurred in our study. Population groups with high mobility and/or poor healthcare access are more likely to have incomplete Health Book vaccination records. However, we expect the completeness of Health Book records in our study to have been high, as inclusion criteria stipulated that guardians needed to believe their children's Health Books were an accurate record of the vaccinations received during childhood. Although it could be argued that sensitivity and specificity were used as a proxy for agreement, these measures represent an initial inquiry and, together with the relatively small sample size, are associated with limitations such as overestimation of agreement.

Conclusion

This study compared two methods of registering vaccination. Neither method is perfect, but each likely has different types of errors. The results of this work indicate the NIR data accuracy generally performs well compared with Well Child Tamariki Ora parent-held health record books (Health Books), especially for NIS vaccine records.

To the authors' knowledge, this is the first study in New Zealand to have also looked at non-NIS vaccination records. Description and quantification of the error in the NIR can be used to improve the accuracy of immunisation research in New Zealand.

We recommend further validation research be undertaken, in particular for non-NIS vaccines and for Māori, Pacific and low-socioeconomic deprivation groups. If a new NIR is established, validation of this system will be necessary also.

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Appendix

Appendix Table 1: Vaccines of non-scheduled immunisations by record source.

Vaccines	Both		NIR only		Health Book only	
	n	(%)[1]	n	(%)[1]	n	(%)[1]
Influenza	6	(100)	24	(100)	4	(5)
Bexsero—MenB					5	(6)
PCV7					4	(5)
Hep A					1	(1)
Menactra					4	(5)
Pneumococcal					1	(1)
Rotavirus					28	(33)
Typhoid					1	(1)
Varicella					36	(43)

NIR: National Immunisation Register.

[1] Column percentage.

Appendix Table 2: Comparison of vaccines for each source where vaccine type did not match.

	Health Book vaccine								
NIR vaccine	**DTaP-IPV**	**DTaP-IPV-Hib**	**DTaP/Hib**	**Hep B**	**Hib-Hep B**	**PCV10**	**PCV13**	**PCV7**	**pneumococcal**
Pertussis, Polio, Hep B, Hib containing									
DTaP-IPV		3							
DTaP-IPV-Hep B/Hib	3								
HepB-Paed	1			2	1				
Hib			1						
Pneumococcal									
PCV10							26	10	
PCV13						7			
PCV7						3	1		1

NIR: National Immunisation Register.

Competing interests:
All authors have been involved in research utilising NIR data for vaccine effectiveness, safety and coverage studies. Additionally, Nikki Turner is a GP.

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URL:
www.nzma.org.nz/journal-articles/does-the-national-immunisation-register-stack-up-quantifying-accuracy-when-compared-to-parent-held-health-record-books

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The wellbeing and health needs of a cohort of transgender young people accessing specialist medical gender-affirming healthcare in Auckland

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ABSTRACT

INTRODUCTION: Increasing numbers of young people are seeking gender-affirming healthcare in Aotearoa New Zealand, and although international studies report health and wellbeing benefits of early medical intervention, we have no published reports on the impact of health services in this country.

METHODS: Transgender young people accessing a specialist service providing medical gender-affirming healthcare were invited to take part in a survey about their health and wellbeing.

RESULTS: High or very high psychological distress levels were reported by 74% of respondents, with 39% being unable to access mental health support when needed.

DISCUSSION: Although the proportion of transgender young people with high or very high levels of psychological distress was five times greater (74%) than for the general population of young people (14.5%) in Aotearoa New Zealand, it was not as large as the proportion found for transgender young people in a community study (86%) in which an unmet need for hormones was reported by 29%. This highlights the need for clear referral pathways to access specialist gender-affirming healthcare services in order to reduce disparities in mental health outcomes.

In the last 10 years there has been a notable increase in the numbers of young people seeking transgender care through health services in Aotearoa New Zealand and internationally.[1] *Transgender* is an umbrella term used to refer to people whose gender differs from their sex assigned at birth. Although the true prevalence of people who identify as transgender is unknown, data from Youth'12, a nationally representative survey of secondary school students conducted in 2012, indicated that 1.2% of students identified as being transgender and 2.5% of students were not sure.[2]

Existing data suggest that transgender young people face a range of issues, especially discrimination and even violence, that impact on their mental health and wellbeing.[3–5] Data from the Youth'12 survey identified significant wellbeing disparities between transgender and cisgender school students with regard to depressive symptoms, suicide attempts and school bullying.[2] Furthermore, transgender young people have reported significant barriers to accessing appropriate healthcare at both primary and secondary care levels.[1] There is evidence from international studies that early medical intervention during puberty may have a positive impact on future health and wellbeing outcomes,[6–8] and although Aotearoa New Zealand has some well-established gender-affirming healthcare services, we have no information on the impact these services have for transgender young people in this country.

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Primary healthcare services that are confident providing transgender young people with care and clear pathways for accessing a range of specialist services, including medical, surgical and psychosocial supports, are fundamental to the provision of good healthcare.[9] To gain a better understanding of the issues, gaps and strengths of existing health services, and with the aim of improving the health and wellbeing outcomes for transgender young people, this study surveyed a cohort of transgender young people accessing specialist medical gender-affirming healthcare in Aotearoa New Zealand.

Aims

- To assess the health and wellbeing of transgender young people who are engaged with specialist gender-affirming health services across the Auckland region.
- To support the improvement of the health and wellbeing outcomes for transgender young people by identifying issues, gaps and strengths in current gender health services.

Methods

The Centre for Youth Health is an Auckland regional service that offers publicly funded specialist medical gender-affirming healthcare for those aged under 20 years in the Auckland and Waitematā district health boards (DHBs) and those under 25 years in Counties Manukau DHB. Mental health for all clients is assessed as part of routine care, and referrals for support are arranged if required. All current clients and new referrals, regardless of how long they had been accessing care, were eligible and invited to enrol in this study, with the exception of those aged under 14 years, who were not eligible to give consent. Written consent was obtained and participants were invited to complete an online survey containing previously validated questions drawn from a variety of sources, including basic demographic data, body satisfaction scores and questions from existing youth health surveys (Youth'12) and adult health surveys (New Zealand Health Survey). Psychological distress was measured using the Kessler Psychological Distress Scale (K10),[10] a 10-item anxiety and depression questionnaire that asks about participants' emotional state in the past four weeks.

This article presents findings for the first 100 participants of this study. Recruiting started in September 2017 and the 100th participant was recruited in October 2019. Although the survey invited participants to self-describe their gender, for the purposes of analysis their responses were grouped into "trans female," "trans male" and "non-binary."

Statistical analysis

Contingency tables of participants' responses were analysed using Fisher's exact test to assess whether there were statistically significant differences in responses between trans female and trans male participants. Non-binary participants were excluded from these analyses due to low numbers in this group. Fisher's exact test was used due to low counts in some combinations of responses. When responses related to psychological distress were analysed, the K10 scores were dichotomised and the relative risks of "high" and "very high" distress were calculated. A score of 12 or more indicated the presence of high levels of psychological distress, and a score of 20 or more indicated very high levels. Risk ratios (RRs) were calculated to compare trans female and trans male participants, with trans female participants as the reference group. RRs higher than 1 indicate a higher risk in trans male participants than trans female participants, and RRs below 1 indicate a lower risk in trans male participants compared to trans female participants. RRs were calculated based on the ratio of incidences between the two sets of participants. The level of statistical significance was set at 0.05. For analyses that were not grouped by gender identity, the non-binary participants were included. All analyses were performed using R version 3.6.1.[11]

Ethics approval was granted by the Health and Disability Ethics Committee 16/CEN/147.

Results

Over the first 25 months of the study, 147 young people were invited to take part. Six declined and 100 (71%) of those who consented completed the survey.

There was a range of descriptors that participants used to describe their gender,

but when grouped into three categories, there were more participants identifying as trans male (65%) than trans female (31%) and only four (4%) who identified as non-binary. Table 1 compares demographic data between trans female, trans male and non-binary respondents. The age range was 14 to 23 years with no difference in mean ages. There was a high rate of multiple ethnicities reported, with 142 selections made by 100 participants. When asked to identify their main ethnic group, there were significant gender differences, with more trans females being Māori and Pasifika and more trans males being NZ European.

Trans female respondents reported an awareness of their gender identity earlier, with 55% being aware of their identity before puberty compared to 35% of trans males and none of the non-binary participants. The majority of respondents had started on gender-affirming hormones and most had socially transitioned to live in their gender some or all of the time.

Mental health

Of the 78 participants who answered the questions on psychological distress, almost three out of four (74%) had survey scores that indicated that they had experienced high or very high psychological distress within the past four weeks, with no difference between trans female and trans male respondents.

Within the past year, over half of respondents had deliberately self-harmed (56%) or had seriously thought about committing suicide (59%). Of concern, there were 15 (15%) young people who had attempted suicide within the past year. High rates of self-harm, 63% and 45%, and suicidal ideation, 63% and 48%, were reported by trans males and trans females, respectively, with no statistically significant difference between the two groups (Table 2). Twenty-six percent of trans males and 29% of trans females reported ever having attempted suicide.

Participants were asked whether they had been unable to access mental health support when needed at any time in the past year, and 39% overall (trans females 45%, trans males 35%) indicated that was true for them. The most common reasons given for being unable to access support were: not wanting to make a fuss (19%), not knowing how to (18%), hoping that the problem would get better (17%), feeling too scared (16%), not wanting parents to know (12%) and cost (12%). Those respondents with high or very high levels of psychological distress were significantly more likely (RR 1.34, 95% CI: 1.05–1.72) to have been unable to access mental health care when needed (p=0.03).

Family and school

Most participants experienced a positive family environment. The majority reported that family members cared about them a lot (71%), although fewer (56%) reported that their families were supportive of their gender identity a lot (Table 3). Those participants who indicated that their families were supportive of their gender identity were 24% less likely (RR 0.76, 95% CI: 0.59–0.98) to report high levels of psychological distress (p=0.04).

Just over half the participants were still at school (55%), and although most of those respondents felt part of their school (71%) and safe at school most or all of the time (82%), almost half (49%) reported having experienced bullying within the past year, with 7% at least once a week or more often (Table 3). Those participants who reported that they had experienced bullying within the past year at school were slightly more likely (RR 1.45, 95% CI: 1.02–2.06) to report high levels of distress (p= 0.07), but this finding was not statistically significant.

General health

Two thirds of respondents reported their health as being good, very good or excellent (75%). Almost all participants (95%) had a primary care health team or medical centre that they accessed for general healthcare (Table 4). Only 14% reported that they had been unable to access healthcare in the past year when needed. The given reasons included: not knowing how to, unable to get transport, difficulty getting an appointment, hoping the problem would get better and cost. When asked, “How comfortable were you discussing trans-related healthcare with your general practitioner (GP) or usual doctor?” 64% of participants (73% trans female, 61% trans male) felt comfortable or very comfortable. However, less than a third of participants (30%) felt that their GP or usual doctor had enough knowledge about

Table 1: Demographic data for participants grouped according to gender identity.

	Trans female N=31 (%)	Trans male N=65 (%)	Non-binary N=4 (%)	p-value
Mean age (range)	18 (14–23)	19 (14–23)	18 (16–19)	0.008
Main ethnic group				
NZ European	12 (39)	56 (86)	3 (75)	<0.001
Māori	6 (19)	1 (2)	0	
Pasifika	8 (25)	0	0	
Asian	2 (6)	0	1 (25)	
Other	3 (11)	8 (12)	0	
Sex assigned at birth				
Male	31 (100)	-	0	-
Female	-	65 (100)	4 (100)	
Awareness of gender identity				
Before puberty	17 (55)	24 (35)	0	0.007
During puberty	11 (35)	35 (55)	1 (25)	
After puberty	3 (10)	6 (10)	3 (75)	
Living in gender				
No	7 (22.5)	2 (3)	2 (50)	<0.001
Some of the time	7 (22.5)	12 (19)	2 (50)	
All of the time	17 (55)	51 (78)	0	
Currently taking puberty blockers				
Yes	21 (68)	32 (49)	1 (25)	0.131
No	10 (32)	33 (51)	3 (75)	
Currently taking oestrogen				
Yes	16 (52)	-	0	-
No	15 (48)	-	4 (100)	
Currently taking testosterone				
Yes	-	36 (56)	0	-
No	-	29 (44)	4 (100)	
Currently taking no medications, but want to start				
Yes	4 (3)	6 (9)	3 (75)	0.007
No	27 (97)	59 (91)	1 (25)	

trans healthcare, and 26% had to educate their doctor about trans health. In addition, 29% of participants had not talked to their GP or usual doctor about their gender identity (Table 4).

Discrimination

Participants were asked whether they had ever been treated unfairly or differently compared to other people, with 94% of trans females and 89% of trans males answering yes. Gender identity was identified as being the most common reason for discrimination for trans females (61%) and trans males (72%), with physical appearance (52% and 57%) and sexual orientation (40% and 46%) also common for trans females and trans males, respectively. The most common places participants experienced discrimination were school, the streets or public places and shops or restaurants. Of concern, in the past year 48% of trans females and 49% of trans males had experienced verbal abuse and 6% of trans females and 8% of trans males had experienced physical abuse because of being transgender.

Trans male, trans female and non-binary respondents who indicated they had experienced discrimination due to their gender identity in the past year were more likely (RR 1.20, 95% CI: 0.90–1.64) to report high levels of psychological distress, but this finding was not statistically significant (p=0.189). Those respondents who experienced verbal abuse within the past year were slightly more likely (RR 1.17, 95% CI: 0.90–1.51) to report high levels of distress (p=0.261), but this was not statistically significant either. Only two respondents who reported a history of physical abuse within the past year answered the K10 questions, so further analysis was not possible.

Table 2: Mental health characteristics grouped according to gender identity.

Psychological distress	**Trans female N=28 (%)**	**Trans male N=47 (%)**	**Non-binary N=3 (%)**	**RR (TF vs TM—TF as baseline) 95% CI for RR (p-value for the RR)**
None / low / moderate	7 (25)	13 (28)	0	0.96 (CI: 0.73–1.27) (p=0.816)
High / very high	21 (75)	34 (72)	3 (100)	
Self-harm	**Trans female N=31 (%)**	**Trans male N=65 (%)**	**Non-binary N=4 (%)**	
Not at all	17 (55)	24 (37)	3 (75)	1.40 (CI: 0.91–2.15) (p=0.106)
Yes, at least once	14 (45)	41 (63)	1 (25)	
Suicidal ideation				
Not at all	16 (52)	24 (37)	1 (25)	1.30 (CI: 0.87–1.96) (p=0.183)
Yes, at least once	15 (48)	41 (63)	3 (75)	
Suicide attempt				
Not at all	22 (71)	48 (74)	4 (100)	0.90 (CI: 0.45–1.79) (p=0.765)
Yes, at least once	9 (29)	17 (26)	0	

TF: Trans female. TM: Trans male.

Table 3: Reported family and school environment characteristics grouped according to gender identity.

Family N=100	**Trans female N=31 (%)**	**Trans male N=65 (%)**	**Non-binary N=4 (%)**	**RR (TF vs TM—TF as baseline) 95% CI for RR (p-value for the RR)**
Cares about you				
Some / a little	10 (32)	18 (28)	1 (25)	1.07 (CI: 0.80–1.42) (p=0.65)
A lot	21 (68)	47 (72)	3 (75)	
Supportive of being trans				
Some / a little	12 (39)	28 (43)	2 (50)	0.97 (CI: 0.67–1.41) (p=0.88)
A lot	17 (55)	37 (57)	2 (50)	
School N=55	**Trans female N=15**	**Trans male N=38**	**Non-binary N=2**	
Feel part of school				
Yes	10 (67)	27 (70)	2 (100)	1.07 (CI: 0.71–1.61) (p=0.756)
No	5 (33)	11 (30)	0	
Feel safe at school				
Most / all of the time	14 (93)	29 (76)	2 (100)	0.82 (CI: 0.65–1.02) (p=174)
About half or less of the time	1 (7)	9 (24)	0	
Bullying—how often				
Not in past 12 months or ever	9 (60)	18 (47)	1 (50)	1.32 (CI: 0.66–2.62) (p=0.429)
Once / twice / once a week or more often	6 (40)	17 (53)	1 (50)	

TF: Trans female. TM: Trans male.

Table 4: Primary healthcare provision for transgender young people grouped according to gender identity.

Comfortable talking to GP or usual doctor about trans healthcare	**Trans female N=30 (%)**	**Trans male N=64 (%)**	**Non-binary N=4 (%)**	**RR (TF vs TM—TF as baseline) 95% CI for RR (p-value for the RR)**
Very comfortable / comfortable	22 (73)	39 (61)	2 (50)	1.46 (CI: 0.75–2.90) (p=0.252)
Very uncomfortable / uncomfortable	8 (27)	25 (39)	2 (50)	
GP or usual doctor had enough knowledge about trans health	**Trans female N=31**	**Trans male N=63**	**Non-binary N=4**	
Yes	7 (23)	21 (33)	1 (25)	1.11 (CI: 0.52–2.35) (p=0.800)
No	5 (16)	18 (29)	1 (25)	
Don't know	19 (61)	24 (38)	2 (50)	
Had to educate your GP or usual doctor about trans health	**Trans female N=31**	**Trans male N=64**	**Non-binary N=4**	
Yes	7 (23)	19 (30)	0	0.87 (CI: 0.53–1.44) (p=0.620)
No	10 (32)	20 (31)	1 (25)	
Don't know	7 (23)	6 (9)	0	
Haven't talked to GP about gender	7 (23)	19 (30)	3 (75)	

Body satisfaction

Participants were asked questions about how they felt about their bodies (Table 5). With regards to their voice, 68% of trans females and 82% of trans males indicated not feeling positive about the sound, and 74% and 88% respectively reported that they would like to alter the sound. Those participants who indicated that they didn't like the sound of their voice were much more likely (RR 1.68, 95% CI: 1.09–2.59) to report high levels of psychological distress (p=0.004).

Only one trans female and four trans male respondents indicated that they already had chest surgery, but 77% of trans females and 100% of trans males reported that this was important to them. None of the participants had received genital surgery. Although fewer participants reported that genital surgery would be important compared to chest surgery, 80% of trans females and 56% of trans males indicated that genital surgery was important to them.

Discussion

Transgender young people engaged with gender-affirming care in Auckland experience high levels of psychological distress, with 74% reporting high or very high distress levels. This is less than the 86% of young people in the Counting Ourselves survey,[12] a large online community survey of transgender people in Aotearoa New Zealand, but five times higher than the general population of young people (14.5%), as reported in health surveys.[13] It is encouraging that the young people accessing gender-affirming care experienced less psychological distress than the transgender young people in the community study, of whom 29% reported an unmet need for hormones.[12] School surveys in Aotearoa New Zealand have also identified much higher rates of poor mental health than their cisgender peers: trans students were more than three times as likely to report significant depressive symptoms (41.3% vs 11.8%).[2] These findings point to a clear need for young people to have greater access to transgender-competent mental health care.

In this study there was no difference in the rates of distress between trans females and trans males, and although the Counting Ourselves survey found higher rates of distress in trans men, they also found higher rates in younger participants overall.[14]

Negative mental health outcomes are strongly related to the widespread experience of gender minority stressors,[15] and high levels of gender-based discrimination were reported in this study. Discrimination can be experienced in many forms, but as one participant explained, "It's not super obvious, just kind of side-long looks and being ignored." To address these stressors, structural change is needed at the government level to breakdown the stigma and discrimination that transgender young people face and signal that discrimination against trans people is unlawful. Change is also need at the social level by resourcing stigma-reduction measures led by trans people.[12]

Family and school connectedness have been shown to be strongly protective factors against experiencing distress for trans young people,[16] and in this study having family that were supportive of your gender identity was associated with a 25% lower rate of psychological distress. This finding suggests that initiatives to support families to understand and support their transgender young people are important for addressing these serious mental health inequities.

Poor access to mental health care was associated with higher levels of distress in this study. Primary care is well placed to assess mental health and facilitate referral for support, provided that transgender young people feel comfortable to disclose their concerns. Providing education resources for primary care clinicians is necessary, so that they have the skills to address trans health needs, particularly given the increasing demand for gender-affirming healthcare and the near universal access to this part of the health sector. In this study, 29% of participants hadn't talked to their GP about their gender identity and only 30% felt that their GP had enough knowledge about trans health.

Access to secondary healthcare services, including voice therapy and gender-affirming surgeries, was also important. Respondents who did not feel comfortable with the sound of their voice were significantly more likely to report high levels of psychological distress. Provision of voice

Table 5: Reported levels of body satisfaction grouped according to gender identity.

Body satisfaction	Trans female N=30 (%)	Trans male N=64 (%)	Non-binary N=4 (%)	RR (TF vs TM—TF as baseline) 95% CI for RR (p-value for the RR)
Had chest surgery	1 (3)	4 (6)	0	-
Chest surgery important*				
Quite a lot / very much / completely true	23 (77)	64 (100)	1 (25)	
Not at all / a bit	7 (23)	0	3 (75)	
Genital surgery important				
Had genital surgery	0	0	0	
Quite a lot / very much / completely true	24 (80)	36 (56)	0	2.19 (CI: 1.02–4.71) (p=0.026)
Not at all / a bit	6 (20)	28 (44)	4 (100)	
	Trans female N=31 (%)	**Trans male N=65 (%)**	**Non-binary N=4 (%)**	
Voice—like sound				
Quite a lot / very much / completely	10 (32)	12 (18)	0	1.20 (CI: 0.92–1.58) (p=0.149)
A bit true / not at all	21 (68)	53 (82)	4 (100)	
Voice—like to alter the sound				
Quite a lot / very much / completely	23 (74)	57 (88)	3 (75)	0.48 (CI: 0.20–1.15) (p=0.116)
A bit true / not at all	8 (26)	8 (12)	1 (25)	

*RR could not be calculated due to the 100% for trans males.

therapy is inconsistently funded, with publicly funded access in some district health boards but not others. Equitable access to this important aspect of gender-affirming healthcare is urgently required. However, because almost all participants felt that accessing chest surgery was important, the statistical power to detect a difference between the two groups was low, so no evidence of a difference in psychological distress between those who did and did not want to access chest surgery could be detected.

A limitation of this study was that the survey only captured information from one point in time for the participants and was not able to report on whether levels of psychological distress improved after accessing gender-affirming healthcare. The very large disparity between levels of distress for participants in both this study and the Counting Ourselves survey compared to the general population of young people suggests that broader social determinants, such as discrimination and gender minority stress, might also be important contributors to these disparities, alongside the barriers to accessing gender-affirming care. Change is urgently needed so that all transgender young people in Aotearoa New Zealand can thrive and achieve their full potential. The findings of this study cannot be generalised to all young trans people in Auckland or Aotearoa New Zealand. Nevertheless, these findings represent over 70% of the young people aged over 13 years who had accessed a specialist service providing medical gender-affirming healthcare in Auckland over a two-year timeframe (2017–2019).

Conclusion

This is the first study to explore the wellbeing of a cohort of transgender young people accessing specialist medical gender-affirming healthcare in Aotearoa New Zealand. Our findings indicate that, while high levels of psychological distress are being experienced, they are not quite as high as those experienced by transgender young people in a community study where an unmet need for care was reported.

Education for primary care on the health needs of transgender young people, clear referral pathways for accessing specialist gender-affirming healthcare services and increased access to mental health support are urgently needed to address the high levels of psychological distress reported by transgender young people.

Competing interests:
Nil.
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Paediatric exploratory ingestion presentations to Christchurch Hospital emergency department during 2019

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ABSTRACT

AIM: To quantify and describe presentations to a New Zealand tertiary hospital emergency department (ED) associated with paediatric exploratory ingestions (PEIs) during 2019 in comparison to 1999.

METHODS: A retrospective descriptive study was conducted of PEI presentations by children under 7 years of age to Christchurch Hospital ED between 1 January and 31 December 2019. Data were studied for demographic and management details and compared to data from 1999.

RESULTS: There were 111 PEI presentations in children under 7 years during 2019, out of 9,445 presentations for this age group (1.2%). The estimated incidence of PEIs was 223.8 per 100,000. PEI presentations relative to total paediatric presentations had reduced compared to 1999 (X2=94.7, p<0.001). Two year olds were most likely to have PEIs (odds ratio (OR)=15.01, 95% confidence interval (CI)=6.78, 33.22). Children of Asian (OR=0.50, 95% CI=0.26, 0.95) and Pacific (OR=0.34, 95% CI=0.12, 0.93) ethnicity were less likely to present with PEIs. Paracetamol was the most commonly ingested substance (15.3%), followed by opioids (11.7%).

CONCLUSION: Paediatric presentations due to exploratory ingestions reduced between 1999 and 2019. However, there was a concerning increase in ingestions of medications like opioids that have a significant risk of toxicity at low doses.

Emergency department (ED) presentations for paediatric exploratory ingestions (PEIs) are common.[1] The ingestion of harmful substance(s) is one of the most common causes of injury in children.[2] Unintentional poisoning and foreign-body ingestion in children result in significant morbidity and mortality internationally.[3–4] Thousands of hospitalisations in New Zealand occur each year due to unintentional childhood poisonings. Of these, some have resulted in significant harm, as there are a number of medications, often described as "one pill can kill," that have the potential for significant toxicity at low doses.[3]

There is no consistent definition for PEIs in the literature; this study defines PEIs as ingestion of non-food items that children find in their environment as a part of investigative behaviour. These do not include ingestions with the intent of self-harm or ingestions where an incorrect dose of intended medications was administered by an adult.

There is evidence that suggests that children are most likely to have PEIs between the ages of 6 months and 6 years, as this period encompasses the stage of exploratory development. Children ingest a variety of substances, including medications and other non-edible foreign bodies, like coins, pins, button batteries, magnets and other household items.[1,4]

A 1999 study in Christchurch Hospital, New Zealand, by Dillon and Gee found that paracetamol was the most commonly ingested substance in those children presenting to ED.[1] Similarly, another New

Zealand-based study that investigated childhood and adolescent poisonings reported to the National Poisons Centre between 2000 and 2009 found that 86% of poisonings were reported in children under 5 years old, and the substances most implicated in the reports were therapeutic agents (medications).[3] More recent New Zealand-based research studying enquiries to the National Poisons Centre in 2018 found that paracetamol was the most reported substance in all calls, as well as the most searched substance on the website (TOXINZ).[5]

Although past literature has shown that paracetamol is often implicated in PEIs, the research by Dillon and Gee found that there is likely to be variation in the substances implicated in PEIs over the course of time.[1] Hence, there is a need for current research that quantifies and describes types of paediatric exploratory ingestion presentations to inform clinical management and future public health initiatives.

Methods

Study design

A retrospective descriptive study was conducted on data of paediatric exploratory ingestion presentations to Christchurch Hospital ED between 1 January and 31 December 2019. Results of this study were compared to the 1999 study by Dillon and Gee.[1]

Setting

Christchurch Hospital is a tertiary level hospital in Canterbury, New Zealand, which covers a population of approximately 550,000. The emergency department at Christchurch Hospital is the sole major acute referral centre in the region, with over 100,000 presentations each year.[6]

The model of care for paediatric presentations at Christchurch Hospital involves initial assessment and management in the ED, and then admission to Children's Acute Assessment (CAA) for children who require >4 hours of observation/care. Those requiring admission >12 hours are transferred to the paediatric medical ward. Children requiring infusions such as N-acetylcysteine (NAC) or high levels of observation are admitted to the Paediatric High Dependency Unit (PHDU).

Participants

Initially, data were extracted from the Canterbury District Health Board (CDHB) data warehouse for patients aged under 14 years who had an arrival complaint of "alcohol/drug intoxication or withdrawal, overdose of drug, ingestion of potentially harmful entity or noxious inhalation" or a discharge diagnosis of "Poisoning caused by drug AND/OR medicinal substance (disorder) or Drug overdose (disorder)." However, no PEIs were found in those aged 7 years or older. Therefore, the cut-off age for participants was set at <7 years. At Christchurch Hospital, patients who are not admitted to inpatient wards do not receive formal ICD (or similar) coding. Therefore, for patients who are not admitted, arrival complaints are recorded by experienced ED triage nurses, and discharge diagnoses are recorded by ED medical staff. All PEI presentations to ED by patients under 7 years of age during 2019 were studied and compared with data from all paediatric presentations during 2019. Presentations that were classified as deliberate self-harm or alcohol and substance abuse (intentional rather than exploratory) were excluded from the PEI group.

Data collection

Data were extracted from routinely collected administrative data and medical notes from Christchurch Hospital's electronic medical record system. The variables included were age, gender, ethnicity, admission status, triage code, time of presentation, time to presentation, substance ingested, place of access to substance, adverse effects from substance, management during presentation and follow-up/sequalae. Ethnicity data accessed in this study are parent or guardian reported and are routinely collected by experienced ED administrative staff. Each PEI patient's index of deprivation was determined using their residential addresses. New Zealand index of deprivation is displayed as deciles 1–10. Here decile 1 represents least deprived scores and decile 10 represents most deprived scores.[7]

Analysis method

Collected data under each variable were coded into sub-groups for analysis. Simple descriptive statistical analysis was undertaken. This allowed factors around PEIs to

be compared as percentages alongside the results of the 1999 study.[1] The 1999 paper examined presentations in <6 year olds over a six-month period, whereas this paper looked at patients <7 years of age in 2019. Therefore, a chi square test for independence was used to compare the proportions of these groups presenting with PEIs. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated by comparing PEIs to other paediatric presentations in 2019. Statistical Packages for Social Sciences version 26 (SPSSv26, IBM, Armonk, NY) was used for analyses.[8] Canterbury population data for 1999 and 2019 were not available. Therefore, to estimate the incidence of PEIs per Canterbury population in 2019, 2018 census data by Stats NZ were used.[9]

By using CDHB population data from an Official Information Act request (reference #10466), a chi square test for goodness of fit was performed to compare PEI ethnicity as a proportion of the total population of children aged 0–4 years in CDHB. [10] Data were available for 0–4 and 5–9 age groups but not for the 0–6 age group. Since the majority of PEIs in this study were in the 0–4 age group, numbers were approximated using data for the 0–4 age group.

To analyse PEIs relative to CDHB population in terms of index of deprivation, data for the Canterbury population were obtained by contacting Environmental Health Indicators New Zealand (EHINZ).[7] The exact deprivation data for Canterbury children under 7 years of age were not available, so PEIs were compared to deprivation data for Canterbury children under 6 years of age using a chi square test for goodness of fit.

Ethics

This study was granted ethical approval under the Minimal Risk Health Research University of Otago Human Ethics Application (No. H20/109). In addition to ethical approval, CDHB locality authorisation and Māori consultation were undertaken. The project was consequently approved by both CDHB and the local iwi.

Results

In total, there were 111 PEI presentations in children aged under 7 years to Christchurch Hospital ED during 2019. This accounted for 1.2% of total ED paediatric presentations (9,445) of children under 7 during 2019. Using data from the 2018 census, the estimated incidence of PEIs in children under 7 in 2019 was 223.8 per 100,000.[8]

Fifty-six males and 55 females presented with PEIs during 2019, with no significant gender difference when compared to all other paediatric presentations (Table 1). In terms of age, for exploratory presentations, 2 year olds presented most commonly (44.1%), followed by 1 year olds (21.6%); whereas for other paediatric presentations, <1 year olds presented most commonly (30.2%), followed by 1 year olds (20.5%). Compared to <1 year olds, 2 year olds were most likely to have PEIs ($p<0.05$), followed by 1 year olds ($p<0.05$) and 3 year olds ($p<0.05$), whereas 4, 5 and 6 year olds were not significantly more likely to present with PEIs.

Of patients who presented with PEIs, 58.6% were European, 27.0% were Māori, 9.9% Asian, 3.6% Pacific and 0.9% other ethnicities. This was similar to the proportions of ethnicities represented in other paediatric presentations. Relative to children of European ethnicity, Asian ($p<0.05$) and Pacific ($p<0.05$) children were less likely to present with PEIs, whereas children of Māori and other ethnicities were not significantly less likely to present with PEIs. A chi square test for goodness of fit that compared the observed ethnicities of presentations to the expected percentages of ethnicities in the CDHB general population in ages 0–4 (Appendix Table 1) demonstrated that Māori children were overrepresented in PEIs and Asian children were underrepresented. Children of Pacific and other ethnicities were represented at an expected rate in PEIs.

The majority (81.1%) of the exploratory presentations had a triage code of three, with 13.5% being coded at higher priority (ie, triage one or two). Comparatively, 66.8% of other paediatric presentations were coded as triage three, with 7.6% being coded at a higher priority. Using triage one as the reference group, there were no significant differences between PEIs and other paediatric presentations in terms of triage. Of the exploratory presentations, 56.8% were admitted to hospital. This was similar to

admission rates of other paediatric presentations (Table 1).

Children from an address with a higher level of deprivation were not more likely to present for PEIs than children from an address with a lower level of deprivation, even after the data were adjusted for rates of deprivation among children aged 0–5 in the CDHB (55.5% PEI presentations vs 59.3% of all CDHB children aged 0–5 were within deciles 1 to 5, p=0.40).

Among those admitted to hospital for exploratory ingestion (63 patients), only seven patients had a length of stay greater than 24 hours (Table 2). Ninety-seven percent of patients with PEIs attended ED between 08:00–00:00hrs, with only three presentations being between 00:00–08:00hrs (Table 2). Fifty-six percent of patients presented within two hours of ingestion; however, in 20.7% of cases, this variable was not recorded.

Paracetamol was the single most commonly ingested substance (15.3%), followed by opioids, which accounted for 11.7% of cases. Of note, 18.0% of the cases involved ingestion of a medication that had the potential to affect the central nervous system (CNS), including psychiatric medications, benzodiazepines, zopiclone and other CNS medications (Table 3). There were four cases where patients had ingested more than one medication, four cases of ingesting essential oils and two cases of ingesting plants. There were no exploratory alcohol or cannabis ingestions. Twenty-three-point-four percent involved other substances, including ointments, cleaning liquids, batteries (three ingestions) and other household items. Most (87.4%) of the patients had gained access to the substances at home, six patients accessed them at a grandparent's house and eight at other places.

Among the 63 patients who were admitted, there were eight admissions for ingesting paracetamol, seven for opioids, two for non-steroidal anti-inflammatory drugs (NSAIDs), five inclusive of benzodiazepines and zopiclone, six for psychiatric medications, four for other CNS medications, five for cardiac medications, three for multiple medications, three for essential oils, two for plant-based products, eight for other medications and ten for other substances.

Most patients who presented with PEIs either had no symptoms (66 patients) or minor symptoms such as nausea, vomiting, abdominal pain, diarrhoea or cough (18 patients). Twenty-seven patients had concerning symptoms that had the potential to affect their airway, breathing, circulation or neurological status. Examples of these symptoms included agitation, unsteadiness, lethargy, drowsiness or slurred speech. There were no significant cardiovascular or renal complications, no requirements for respiratory support or narcotic antagonists and no deaths from PEIs.

Thirteen-point-five percent of patients with PEIs were assessed and discharged; 79.3% were observed and given symptomatic treatment, such as anti-emetics; 3.6% had NAC and another 3.6% had activated charcoal (Table 3). Eighty-nine-point-two percent of patients did not require formal paediatric follow-up, four were followed-up as paediatric outpatients and eight by other agencies.

The proportion of PEI presentations decreased from 120 out of 3,085 (3.9%) in 1999 to 111 out of 9,445 (1.2%) in 2019 (X^2=94.7, p<0.001). The proportion of PEIs that were paracetamol ingestions in 2019 was approximately half compared to 1999 (Table 4). However, there was a significant increase in the proportion of PEI presentations for opioids and other drugs that have the potential to affect the CNS.

Discussion

ED presentations for PEIs at Canterbury Hospital reduced over the 20-year period between 1999 and 2019. Increased awareness of the risks, safety packaging of medications and effective National Poisons Centre advice may be possible explanations for this reduction of PEIs.

In this study, European and Māori children accounted for more PEIs compared to Asian and Pacific children. Previous literature suggests the factors implicated in greater PEIs include increased accessibility of medications to children, differing levels of knowledge about medication toxicity, poorer home environment, differences in medical care and a lack of information resources.[11–12] However, there was no significant difference

Table 1: Demographics, admission status and triage coding with odds ratios and 95% confidence intervals of PEIs compared to other paediatric presentations in 2019.

	Exploratory ingestions (%)	Other paediatric (%)	Odds ratio (95% CI)
Total	111 (100)	9,334 (100)	
Gender			
Male	56 (50.5)	5,197 (55.7)	1.00 (Reference)
Female	55 (49.5)	4,137 (44.3)	0.81 (0.56, 1.18)
Ethnicity			
European	65 (58.6)	4,457 (47.8)	1.00 (Reference)
Asian	11 (9.9)	1,504 (16.1)	**0.50 (0.26, 0.95)**
Māori	30 (27.0)	2,227 (23.9)	0.92 (0.60, 1.43)
Pacific	4 (3.6)	809 (8.7)	**0.34 (0.12, 0.93)**
Other	1 (0.9)	337 (3.6)	0.20 (0.03, 1.47)
Admissions			
No	48 (43.2)	3,915 (41.9)	1.00 (Reference)
Yes (total)	63 (56.8)	5,419 (58.1)	0.95 (0.65, 1.38)
Children's Acute Assessment	45 (40.5)		
Paediatric High Dependency Unit	13 (11.7)		
Ward	4 (3.6)		
Emergency department	1 (0.9)		
Age (years)			
<1	7 (6.3)	2,819 (30.2)	1.00 (Reference)
1	24 (21.6)	1,915 (20.5)	**5.05 (2.17, 11.74)**
2	49 (44.1)	1,315 (14.1)	**15.01 (6.78, 33.22)**
3	18 (16.2)	1,036 (11.1)	**7.00 (2.91, 16.80)**
4	6 (5.4)	849 (9.1)	2.85 (0.95, 8.49)
5	4 (3.6)	768 (8.2)	2.10 (0.61, 7.18)
6	3 (2.7)	632 (6.8)	1.91 (0.49, 7.41)

Table 1: Demographics, admission status and triage coding with odds ratios and 95% confidence intervals of PEIs compared to other paediatric presentations in 2019 (continued).

	Exploratory ingestions (%)	Other paediatric (%)	Odds ratio (95% CI)
Triage code			
1	1 (0.9)	91 (1.0)	1 (Reference)
2	14 (12.6)	618 (6.6)	2.06 (0.27, 15.87)
3	90 (81.1)	6,237 (66.8)	1.31 (0.18, 9.53)
4	5 (4.5)	2,275 (24.4)	0.20 (0.02, 1.73)
5	1 (0.9)	113 (1.2)	0.81 (0.05, 13.05)

Results in bold include statistically significant numbers.

Table 2: Arrival time, time between exposure and arrival and admission length for PEI patients in 2019.

	Exploratory ingestions (%)
Total	111 (100)
Arrival time	
08:00–16:00hrs	52 (46.8)
16:00–00:00hrs	56 (50.5)
00:00–08:00hrs	3 (2.7)
Time between exposure and arrival	
<1hr	26 (23.4)
1–2hrs	36 (32.4)
2–3hrs	11 (9.9)
3+hrs	15 (13.5)
Unknown	23 (20.7)
Length of stay for admitted patients	
0–4hrs	16 (14.4)
5–8hrs	21 (18.9)
9–12hrs	7 (6.3)
13–24hrs	12 (10.8)
25–48hrs	5 (4.5)
>48hrs	2 (1.8)
Not admitted	48 (43.2)

Table 3: Substances ingested, severity of clinical course and management of PEIs in 2019.

	Exploratory ingestions (%)
Total	111 (100)
Substance ingested	
Paracetamol	17 (15.3)
Non-steroidal anti-inflammatory drugs	6 (5.4)
Opioids	13 (11.7)
Cardiac medications	5 (4.5)
Psychiatric medications	6 (5.4)
Benzodiazepines and zopiclone	9 (8.1)
Other central nervous system medications	5 (4.5)
Multiple medications	4 (3.6)
Plant	2 (1.8)
Essential oils	4 (3.6)
Other medications	14 (12.6)
Other substances	26 (23.4)
Severity of clinical course	
Nil symptoms	66 (59.5)
Minor symptoms	18 (16.2)
Symptoms of concern	27 (24.3)
Management	
Assessment and discharge	15 (13.5)
Assessment, observation and symptomatic management	88 (79.3)
Activated charcoal	4 (3.6)
N-acetylcysteine	4 (3.6)

in PEI presentations between children living in high- vs low-decile areas in CDHB. Alternatively, there may have been protective factors present in other households that reduced PEIs.

This study found PEIs to be most common among 2 year old children. A previous study on paediatric emergency presentation with acute poisoning also found a peak among 2 year old children.[13] The reasons for this are multifactorial and relate predominately to development milestones, the environment and parental supervision. Children approaching 2 years of age become increasingly exploratory and inquisitive, which is aided by their greater mobility and dexterity.[14]

In 2019, ED presentations due to paracetamol ingestions had decreased compared to 1999, but there were more benzodiazepine, opioid and psychiatric medication ingestions.[1] This information suggests there was an increase in the availability of opioids and medications that affect the CNS to Canterbury children. Although it seems that safety and awareness around paracetamol storage may have improved, it is important to consider that other more harmful medications came into play over these 20 years.

In 2018, there were two studies (Koren and Nachmani in the United States; Wright and Falkland in Australia) that updated lists of drugs which one to two standard doses of could be fatal to a toddler—"one pill can kill."[15–16] These lists include opioids, cardiac medications, diabetes medications and psychiatric medications such as antipsychotics and antidepressants. Approximately 34.2% of PEIs in this study included medications (cardiac medications, opioids and medications affecting the CNS) present on the one pill can kill lists.[15–16] This is concerning, given the previous literature by the Child and Youth Mortality Review Committee (CYMRC) found that opioids accounted for a high rate of mortality in young people due to unintentional poisonings.[17] Hence it is imperative that safety measures, such as increased awareness of potential toxicity and further child-proofing of these medication, are implemented to prevent PEIs with these medications as they can be potentially fatal.

Many commonly ingested substances have an unpalatable taste, and with increased safety methods having been incorporated into household items and medicines over the years, it is uncommon for significant amounts of any substance to be ingested. Hence PEIs are more likely to be poison scares rather than actual poisonings.[18] In this study, the majority of PEIs were triage three, meaning that these were not deemed to be immediately life-threatening. The fact that most patients experienced no symptoms or only minor symptoms during admission further indicates that the PEIs were relatively non-severe.

Only a small proportion of patients received NAC, the antidote for paracetamol toxicity or activated charcoal. This study showed the single most commonly ingested substance was paracetamol, yet few received NAC or activated charcoal,

Table 4: Comparison of substances ingested in percentages between 2019 and 1999.[1]

Substances	1999 (%)	2019 (%)
Paracetamol	32.5	15.3
Non-steroidal anti-inflammatory drugs	3.3	5.4
Opioids	Nil reported	11.7
Cardiac medications	3.3	4.5
Psychiatric medications	1.7	5.4
Benzodiazepines and zopiclone	4.1	8.1
Plant	11	1.8
Essential oils	5.8	3.6

suggesting that insufficient quantities were ingested to cause hepatotoxicity warranting active management. Dillon and Gee in 1999 found that 12% of children presenting with PEIs were treated with activated charcoal, whereas 88% received no decontamination.[1] Our study shows that the percentage treated with activated charcoal had declined markedly in 2019 compared to 1999. The reduction in active gastrointestinal decontamination likely reflects medical awareness that it is rare for PEIs to result in significant toxicity, and that the risks of the decontamination procedure may outweigh the risk of poison exposure.[1,18,19] In the last 20 years it has been recognised that children have a lower risk than adults of paracetamol toxicity for equivalent doses per weight. This is due to immature liver biotransformation enzymes. This has raised the dose thresholds to investigate and to treat children with paracetamol ingestions.[20-21]

Dillon and Gee also reported that 28% of PEIs were admitted to hospital, and that the majority were admitted for less than six hours.[1] Admission rates in 2019 for PEIs were double that reported in 1999, but of those admitted the majority (58.7%) were admitted for eight hours or less. The increased admission rate but comparable length of admission compared to 1999 may in part be due to the shift away from active gastrointestinal decontamination procedures towards observation followed by discharge. However, there was no significant difference in admission rates between PEIs and other paediatric presentations, suggesting that, of all the paediatric presentations, PEIs are not disproportionately admitted. In this study, the majority of those patients admitted went to CAA rather than PHDU. This further indicates the majority of PEIs seen in this study were low severity, which is consistent with the literature reporting the rarity of toxicity in PEI.[1,18]

Strengths and limitations

This study was conducted at Christchurch Hospital, which is a tertiary centre in New Zealand covering a large population. However, being a single-centre study, its generalisability may be affected by some likely variation in population demographics throughout New Zealand. Also note that exact comparable data for the 0–6 age group were unavailable for ethnicity and level of deprivation, and therefore numbers were estimated using available data.

Conclusion

The findings of this study are reassuring. Paediatric presentations due to exploratory ingestions in Canterbury reduced between 1999 and 2019. In Canterbury, most PEI presentations were in children 2 years of age. The majority of ingestions occurred at home, were low severity and did not require gastrointestinal decontamination. The decrease in paracetamol presentations over the years could be due to improved parental awareness and better National Poisons Centre triage. Unfortunately, the proportion of presentations with other, potentially more harmful medications, like opioids and psychiatric medications, increased. These medications are included on one pill can kill lists. Therefore, there is a need for increased awareness and safety around storage of these medications.

Appendix

Appendix Table 1: PEI ethnicity as a proportion of total population in children aged 0–4 years in CDHB.

Ethnicity	Observed N (%)	% expected[a]	Difference in observed % and expected %	p-value[b]
Māori	30 (27.0%)	18.3%	+8.7%	0.02
Pacific	4 (3.6%)	5.3%	-1.7%	0.43
Asian	11 (9.9%)	17.7%	-7.8%	0.03
Other	66 (59.5%)	58.6%	+0.9%	0.85

[a] Expected % based on CDHB Official Information Act request reference #10466 using ages 0–4.

[b] p-values based on chi square test for goodness of fit for each ethnicity.

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Mapping prevalence and patterns of use of, and expenditure on, traditional, complementary and alternative medicine in New Zealand: a scoping review of qualitative and quantitative studies

E Lyn Lee, Jeff Harrison, Joanne Barnes

ABSTRACT

AIM: Traditional, complementary and alternative medicine (TCAM) is a popular healthcare choice worldwide. The extent of data available on TCAM, including prevalence and patterns of use in New Zealand, is unknown. This scoping review aims to map the existing research describing the use of TCAM (including prevalence, access, expenditure and concurrent use with conventional medicines) in New Zealand.

METHOD: Research databases (MEDLINE, EMBASE, AMED, IPA (International Pharmaceutical Abstracts), CINAHL, PsycINFO and Scopus) and grey literature (Google Scholar and New Zealand government and relevant organisations' websites) were searched for studies published before 7 June 2019. Studies reporting on the prevalence and/or exploring aspects of TCAM use were included in this review.

RESULTS: In total, 72 studies were reviewed. Available data suggest that TCAM use is widespread among New Zealanders, and some consumers pay large sums of money out-of-pocket. A wide range of TCAM practices and products is used by people of all ages and ethnicities and with various health conditions. There is some evidence of consumers using TCAM concurrently with conventional medicines. Studies were generally small, localised and conducted in sub-populations (e.g., specific age groups, health conditions). Different TCAM definitions, data collection tools, methods and prevalence measurement were used across studies, thereby limiting the comparability of data locally and internationally.

CONCLUSION: A considerable number of studies/reports on TCAM use are available. Still, there is a lack of comprehensive, nationally representative data on prevalence and patterns of use of TCAM, including its use in relation to conventional medicine(s) in New Zealand.

Health products, preparations, practitioners and practices collectively referred to as "traditional, complementary and alternative medicine" (TCAM) are used extensively worldwide.[1,2] TCAM approaches are used by at least 80% of member states across all World Health Organization (WHO) regions and, in some regions, traditional (Indigenous) medicine is the only source of primary healthcare.[2] A systematic review of studies exploring TCAM use among general populations across 15 developed or developing countries reported a 12-month prevalence of use of one or more TCAM approaches ranging from 9.8% to 76%; similarly, 12-month prevalence of visits to one or more TCAM practitioners ranged from 1.8% to 48.7%.[3] The prevalence and

patterns of TCAM use vary across countries due to differences in TCAM availability, affordability, regulations, cultural and historical significance, and conventional healthcare system advancement.[1,2]

The WHO defines *traditional medicine* (TM) and *complementary/alternative medicine* (CAM) separately and acknowledges that, in many countries, the terms are used interchangeably. The WHO definition of TM states: "Traditional medicine has a long history. It is the sum total of the knowledge, skill, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness."[2] In some contexts, TM is described as a subset of CAM (health knowledge, beliefs, preparations and practices that usually sit outside the dominant health system), and vice versa. The term *integrative medicine* (IM, or integrative health) is also now used in the context of TCAM and refers to the coordinated use of both conventional and TCAM approaches in a patient-focused manner to achieve the best possible health and wellbeing outcomes for individual patients.[4] Definitions and terminology for TM, CAM and IM are not universally relevant, or accepted, and continue to evolve; similarly, products and practices included under the different terms vary across different studies exploring prevalence of use.

In New Zealand, TM preparations and practices include those used in rongoā Māori, the traditional medical system of Māori, as well as those used in traditional Pasifika medicine, of which there are several systems. In addition, numerous other TCAM approaches are available: CAMs/natural health products (NHPs) are sold in pharmacies, supermarkets, health food stores and through online outlets, and TCAM practices/therapies can be accessed through TCAM practitioners, such as herbalists, homoeopaths, naturopaths, traditional Chinese medicine and traditional Ayurvedic medicine practitioners.[5]

This work is a comprehensive review of research exploring the use of TCAM in New Zealand, including prevalence of use, access, expenditure, reasons for use and user and health practitioner perspectives. This paper, the first in a series of three, reviews research relating to the prevalence of use of TCAM, use of TCAM with conventional medicines and expenditure on TCAM products/preparations and practices.

Methods

This scoping review adopted a systematic process to identify relevant studies and summarise results.

The operational definition used for TCAM in this review was: "all health systems, modalities, and practices not typically considered part of conventional Western medicine that are used for health maintenance, disease prevention, and treatment."[6] This included:

- TCAM products/preparations
    - Complementary medicines—includes, but is not limited to, products or preparations described as natural health products, complementary/alternative medicines/remedies, dietary supplements, nutraceuticals and/or traditional medicines (products or preparations used in traditional medicine systems, such as rongoā Māori, or traditional Chinese medicine)
- TCAM practices
    - Complementary therapies/practices—including but not limited to mind–body therapies (e.g., hypnotherapy, yoga), manipulative/body-based methods (e.g., osteopathy, chiropractic) and energy therapies (e.g., reiki, therapeutic touch)
    - Traditional medicine practices—such as traditional Chinese medicine, Ayurvedic medicine, rongoā Māori as well as other treatments, such as acupuncture, cupping

Chiropractic and osteopathy are regulated in New Zealand, but these health practitioners are included in this review as they are not necessarily considered part of mainstream medicine in this country.

This review included studies/reports on the prevalence and/or examination of any aspects of TCAM use across any

subpopulation in New Zealand and health practitioners' perspectives on consumers' TCAM use. This review excluded studies/reports on: the benefits/harms of TCAM or specific TCAM products/therapies; the effectiveness of TCAM; the use of vitamins/minerals for prevention/treatment of medically diagnosed deficiencies/disorders (e.g., folic acid for prevention of neural tube defects); the use of TCAM for recreational purposes; letters to editors, commentaries and editorials.

The following electronic databases were searched from their inception to 7 June 2019 using systematic literature search strategies: MEDLINE; EMBASE; AMED; IPA (International Pharmceutical Abstracts); CINAHL; PsycINFO; Scopus. Grey literature was searched through Google Scholar's and New Zealand government and relevant organisations' websites using keywords. Reference lists of included studies were hand-searched to capture any additional relevant publications.

Search terms comprised combinations of subject headings and keywords related to three key concepts: (1) complementary and alternative medicine, (2) prevalence/utilisation and (3) New Zealand. The search strategy for MEDLINE is available on request from the authors. Search results were exported to a reference manager software (EndNote), duplicates were removed and studification (grouping publications from the same study) was done. The study selection comprised title and abstract screening then full-text screening. One reviewer (ELL) assessed study eligibility; a second reviewer (JB) was consulted when necessary. Data were extracted from the included studies by one researcher (ELL) and checked by a second researcher (JB). A data-extraction form was developed by the authors to extract general information about each study (e.g., author, publication year, participant characteristics, study design, methods) and specific information relevant to the review questions (e.g., TCAM terminologies and definitions used, aspects of TCAM use explored, key outcomes).

The extracted data were analysed, and tables depicting the study characteristics, including data collection tools and methods, participant characteristics (age, location, ethnicity, health status), settings and outcomes are presented. Studies included in this review were conducted at different time points; therefore, expenditure on TCAM expressed in New Zealand dollars was adjusted to 2020 using the Reserve Bank of New Zealand's calculator.[7] Current values (year 2020) accounting for inflation are in parenthesis. The Preferred Reporting Items for Systematic Review and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) checklist was used to guide reporting of this study.[8]

Results

Identification of studies

In total, 72 records (studies/reports) met the inclusion criteria. The screening and selection process is summarised using a PRISMA flow diagram (Figure 1).[9]

Characteristics of included studies

Studies were conducted from two perspectives: (1) health practitioners (TCAM[10–15] and conventional medical practitioners[14,16–23]); (2) population (including non-users and consumers of TCAM).[18–20,24–81] A table summarising the characteristics of the 72 included studies is available from the authors on request.

Definitions and descriptions of TCAM terms

Twenty studies[10–13,15,25,39,40,49,50,54,58,70,71,73,75–77,79,80] investigated a specific TCAM practice (e.g., chiropractic, osteopathy) or product/substance (e.g., melatonin, fish oil) only. The remaining studies examined non-specific TCAM use. Multiple studies[21,35,44,45,47,48,51,55–57,61–64,68] used an operational definition for TCAM. The TCAM term used in some studies was described; it was unclear if the description was used as an operational defintion.[14–17,19,27–29,41,43,78] The terms most commonly used were "complementary and alternative medicine" (to describe all TCAM approaches including products and practices) and "dietary supplements" (to describe products). However, the definitions adopted for each term differed across studies and ranged from broad concepts inclusive of various products/practices (e.g., spiritual healing, massage) to tighter concepts with additional criteria limiting the products/practices included (Table 1). Less frequently used terms were "non-prescription health supplements," "alternative therapist" and "unconventional practitioner."

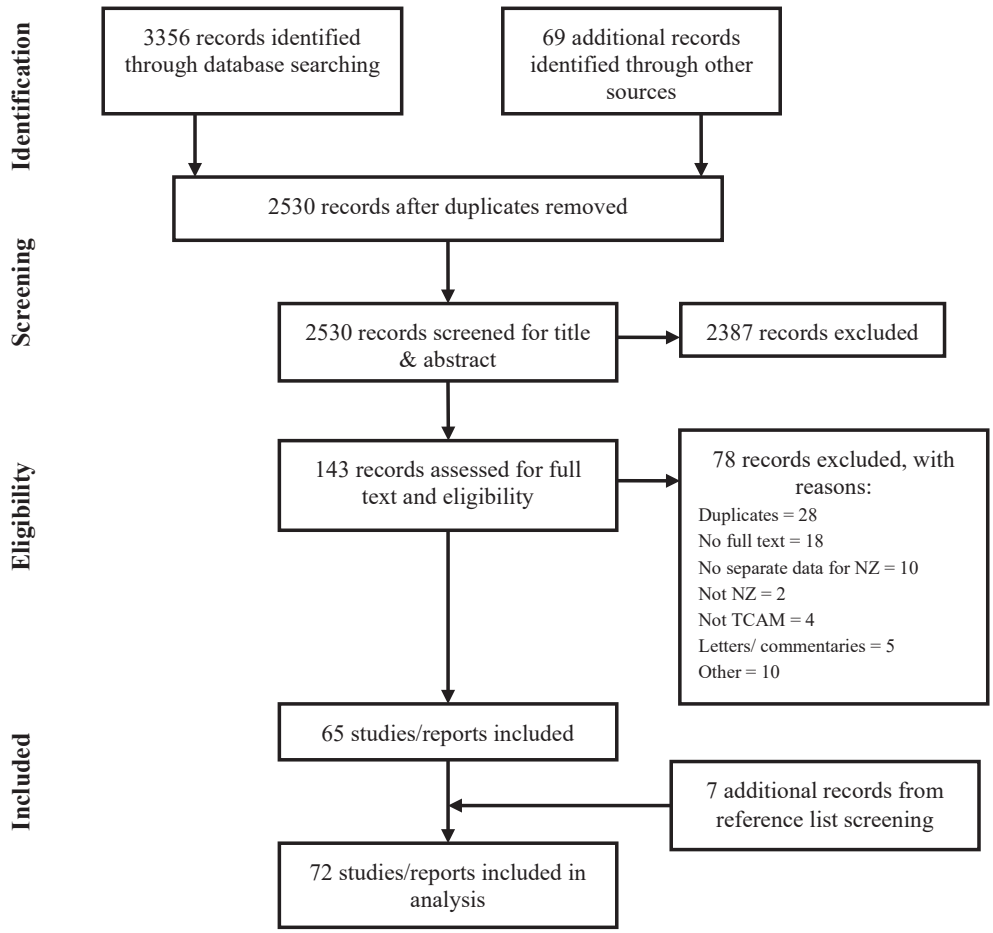
Types of TCAM explored in included studies

The types of TCAM included in studies exploring consumer use can be broadly categorised into "practices" and "products." As individual types of products were usually not defined, and as questionnaires were not appended in most publications, it is unclear whether products such as herbal remedies reported by consumers were accessed through practitioners or self-prescribed. For studies that explored the use of products and did not indicate access through practitioners, these are categorised under products.

Studies/reports from the consumers' perspective were conducted using quantitative, qualitative or mixed-methods approaches. Quantitative studies mainly examined a variety of TCAM practices,[25,43,47,59–62,64] products[18,24,29,36,38,41,42,44–46,48,51,52,55–58,72] or products and practices.[19,20,26–28,31,33,35,37,53,78] Several studies investigated participants' use and experiences with a single TCAM practice, such as osteopathy,[40] traditional Pacific healers[49] and chiropractic.[77,80] Qualitative studies mostly explored consumers' experiences with a specific TCAM practice, such as acupuncture,[39,71] massage therapy,[75,76] rongoā medicine,[50] traditional Chinese medicine[54] and traditional Tongan healing.[30]

The classification of TCAM products and practices varied across studies, which made direct comparison difficult. For instance, herbal products were analysed and reported in multiple ways: collectively as a product category,[55] and/or as individual herbs/active ingredients.[44] Categories were also sometimes incorrectly defined: for instance, one study regarded garlic, a botanical product, as an individual ingredient, "garlic," and did not code it under the category "botanical product."[56] In addition, TCAM practices, such as acupuncture, were analysed sepa-

Figure 1: PRISMA flow diagram of literature search and study selection process.



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rately from traditional Chinese medicine,[47] when in reality some acupuncture practices originated from and may be considered a component of traditional Chinese medicine. Some studies grouped TCAM products and practices based on their intended use/function: for example, "antioxidants,"[33] "joint treatment" and "treatment to increase immunity."[44] Some TCAM products or practices included in the studies were not distinct: for instance, "cleanser,"[44] "detoxification,"[33, 35] "lifestyle,"[53] "heat treatment."[78]

The scope and range of TCAM products and practices differed between studies and were diverse. A table of the more than 70 terminologies used to describe or identify specific TCAM practices or products is available from the authors on request. Most studies included products such as vitamins, minerals, herbal remedies and essential fatty acids and practices such as chiropractic, osteopathy, homeopathy and naturopathy. Some TCAM practices included less frequently were reflexology,[26,31,35,53] kinesiology, crystal healing, bloodletting and rebirthing.[43]

Prevalence of use

Thirty-eight studies reported data on the prevalence of use of one or more TCAM practices or products/preparations among consumers. Most studies reported prevalence in terms of lifetime use,[18,20,27,28,35,42,44,52,78] previous 12-months use[41,43,45,47,48,55,56,61,62,64] or both.[19,25,53]

Nationally representative general population studies

Nine studies/reports relating to three nationally representative studies reported prevalence of use. Data were derived from three government health surveys: the New Zealand Health Survey (NZHS),[47,61,62] New Zealand (Adult or Children) Nutrition Survey (separate surveys for adults and children),[45,48,55–57] and New Zealand Mental Health Survey (NZMHS) (Supplementarty Table 1).[64] The first two surveys examined TCAM use for any health reason, whereas the NZMHS explored TCAM consultations specifically for mental health problems. The New Zealand (Adult or Children) Nutrition

Table 1: CAM definitions/descriptions used across studies.

Reference No.	Author, publication Year	TCAM definition used in study
Term: complementary and alternative medicine, complementary medicine		
63	Brown, 2010	"[T]reatments that are not usually considered mainstream, regardless of whether provided within or outside the publicly funded health system, and whether delivered by **conventional** or CAM-only health practitioners."
64	Browne, 2006	CAM was categorised as part of the "non-health sector," which: "included any other type of healer such as a herbalist or homeopath, participation in an Internet support group, or participation in a self-help group," but **excluded visits to conventional practitioners.**
21	Hadley, 1988	"[T]herapies not usually offered by legally registered practitioners," but included chiropractic and osteopathy as an exception.
61	Ministry of Health, 2008	Excludes chiropractor and osteopath in their scope of CAM and reports the use of these two practices separately.
44	Nicholson, 2006	CAMs (products) were defined by indicating the access type (non-prescription) and the locations to purchase (health food store, supermarket or from alternative medical magazines and catalogues).

Survey included the use of products (dietary supplements) only, and the other surveys (NZHS and NZMHS) included TCAM practices only. All studies presented prevalence in terms of previous 12-months use, except the New Zealand Children Nutrition Survey 2002, where the prevalence of use over the previous 24 hours was reported. The New Zealand Adult Nutrition Survey 1997 reported both previous 12-months use and previous 24-hours use.

As these surveys were heterogenous in the methods and definitions used, an overall prevalence range is not reported. Two surveys were repeated across two time periods, which enabled an analysis of usage trends. Based on the New Zealand Adult Nutrition Surveys in 1997 and 2008/9, the prevalence of dietary supplement use over the previous 12 months reduced slightly from 59% to 47.6% respectively. From the NZHS in 2002/3 and 2006/7, the prevalence of CAM practitioner consultations over the previous 12 months were 23.4% and 18.2% respectively, although the later survey excluded chiropractors and osteopaths and reported use of these practitioners separately (Table 2). The 2002/3 NZHS reported that Māori and Pacific healers were consulted by 0.9% and 0.2% of respondents, respectively, corresponding to 6.0% of Māori respondents and 4.6% of Pasifika respondents.[62] Self-treatment with rongoā Māori or Pacific medicine(s) were not explored.

Other studies: non-nationally representative, or nationally representative sub-populations

The remaining 29 studies reported on the prevalence of TCAM use among consumers in specific ethnic populations, with certain medical conditions or in particular healthcare settings and locations across New Zealand (Supplementary Table 1).

Six studies explored TCAM use among children: two explored the use of TCAM products and practices,[26,28] two included TCAM practices only,[59, 60] one included TCAM products only[52] and one explored a single TCAM practice (traditional Pacific healers).[49] In a study involving children with dyspraxia, 100% reported the use of at least one "food supplement" (not further defined).[26] Of the remaining studies, prevalence of lifetime TCAM use ranged from 29% among children hospitalised due to acute illness[28] to 70% among children attending general practitioner or paediatric diabetes outpatient clinics in Christchurch.[52]

Among studies that explored TCAM use in adults, eleven included TCAM products and practices,[19,20,27,31,33,35,37,44,46,53,78] ten included TCAM products only[18,24,29,36,38,41,42,51,58,72] and two included TCAM practices only.[25, 43] There is substantial variation in the reported prevalence of use of TCAM products/practices across studies. For instance, the prevalence of lifetime TCAM products and practices use ranged from 56.1% among adults presenting to emergency care in North Shore Hospital, Auckland,[53] to 91% among inpatients in Gisborne Hospital.[35]

For TCAM subcategories, vitamins and minerals were most commonly reported, although the prevalence of use varied considerably as the definitions, study populations and prevalence periods differed across studies. Prevalence of use of herbal products[29]/therapies[35]/supplements[37]/extracts[41]/mixtures[53]/medicines[78]/remedies[19] (not defined in respective studies) also differed across studies. Lifetime use of 47% was reported among inpatients in a hospital,[35] and previous 12-months use of 15.1% and 4.4% were recorded among patients with Crohn's disease[41] and adults presenting to a hospital emergency care centre,[53] respectively.

Several studies reported consumers' use of traditional Māori[20,44] or Pacific medicine[28,49] or both.[35] In a study of attendees to a hospital emergency department, more than half (51.7%) of those who used traditional Māori treatment (7.3% of CAM users) grew or collected the plants and made the treatment themselves.[44] Use of traditional medicine is not exclusive to specific ethnic groups. Among inpatients at Gisborne hospital, 13% of non-Māori respondents reported having used rongoā Māori.[35]

TCAM use with conventional medicine

Many patients consider TCAM a safe choice and would take conventional medicines concurrently. Four studies explored the concurrent use of TCAM with conventional medicine.[44,52,65,79] Two quantitative studies reported the extent of TCAM use with conventional medicines among consumers.[44,52] In a survey involving hospital emergency department attendees, around

Table 2: Prevalence of TCAM use derived from nationally representative general population data.

Reference no.	Author, publication year	Title	Data source	Sample size	Age (years)	Data collection	TCAM categories	Prevalence 12-month use (%)
56	**Russel, 1999**	**NZ Food: NZ People. Key results of the 1997 National Nutrition Survey**	New Zealand Adult Nutrition Survey 1997	4636	≥15	Interviewer administered – Participants are asked to state type of supplements used	Dietary supplements • Vitamin and/or mineral supplement use • Multivitamin and/or mineral • Vitamin B complex • Vitamin C • Iron Other dietary supplements • Garlic • Oils[1] • Botanical products[2]	59 51 19 10 7 4 29 9 6 5
48	Smith, 2005	Dietary supplements: Characteristics of supplement users in New Zealand						
45	Parnell, 2006	Dietary supplements: Prevalence of use in the New Zealand population						
57	**Ministry of Health, 2003**	**NZ Food NZ Children: Key results of the 2002 National Children's Nutrition Survey**	New Zealand Children Nutrition Survey 2002	3275	5 – 14	Interviewer administered – 24-hour diet recall	Dietary supplements • Multivitamins and minerals • Vitamin C • Meal replacement	5.4* 2.1* 2* 0.8*
45	Parnell, 2006	Dietary supplements: Prevalence of use in the New Zealand population						

Table 2: Prevalence of TCAM use derived from nationally representative general population data (continued).

Reference no.	Author, publication year	Title	Data source	Sample size	Age (years)	Data collection	TCAM categories	Prevalence 12-month use (%)
55	University of Otago & Ministry of Health, 2011	A Focus on Nutrition: Key findings of the 2008/09 New Zealand Adult Nutrition Survey	New Zealand Adult Nutrition Survey 2008/9	4721	≥15	Interviewer administered – Asked participants to state type of supplement or provide supplement container to interviewer	Dietary supplements • Oils[3] • Multi-vitamins/ multi-minerals • Herbal plus supplements[4] • Single vitamins • Botanicals[5] • Multi-vitamins • Glucosamine/ chondroitin • Single minerals • Multi-minerals	47.6 16.4 14.8 10.1 8.6 8.5 6.4 6.2 5.8 1.5
62	Ministry of Health, 2004	A Portrait of Health: Key results of the 2002/03 New Zealand Health Survey	New Zealand Health Survey 2002/3	12929	≥15	Interviewer administered – Asked participants if they had seen certain health care providers or workers	Complementary and alternative healthcare providers/workers • Massage therapist • Chiropractor • Osteopath • Homeopath or naturopath • Acupuncturist • Spiritual healer • Herbalist • Traditional Chinese medicine practitioner • Māori traditional healer • Aromatherapist • Feldenkrais or Alexander teacher • Pacific traditional healer • Other	23.4 9.1 6.1 4.9 4.5 2.6 1.9 1.8 1.4 0.9 0.7 0.2 0.2 1.3
47	**Pledger, 2010**	**Health service use amongst users of complementary and alternative medicine**						

Table 2: Prevalence of TCAM use derived from nationally representative general population data (continued).

Reference no.	Author, publication year	Title	Data source	Sample size	Age (years)	Data collection	TCAM categories	Prevalence 12-month use (%)
61	**Ministry of Health, 2008**	**A Portrait of Health: Key results of the 2006/07 New Zealand Health Survey**	New Zealand Health Survey 2006/7	12488 (adults) 4921 (children)	≥15	Interviewer administered – Asked on a specified list of practitioners with other option	Complementary or alternative healthcare workers (exclude chiropractor and osteopathy) • Massage therapist • Homeopath or naturopath • Acupuncturist • Spiritual healer • Traditional Chinese medicine practitioner • Herbalist • Māori traditional rongoā healer • Aromatherapist • Pacific traditional healer • Chiropractor (adults) • Osteopath (adults) • Chiropractor & osteopath (children)	18.2 55.8† 25.8† 18.5† 9.1† 6.7† 6.5† 3.2† 2.3† 1.4† 5.4 4.4 3.0
64	**Browne, 2006**	**Twelve-month and lifetime health service use in Te Rau Hinengaro: The New Zealand Mental Health Survey**	New Zealand Mental Health Survey 2003/4	12992	≥16	Interviewer administered – Select from a list of care or treatment providers	Non-health sector[6] • Complementary or alternative medicine • Human services	3.6 2.5 1.6

Parnell, W.R. (2006) reports data from both the New Zealand Adult Nutrition Survey 1997 and Children Nutrition Survey 2002
*Prevalence of use over the previous 24 hours
†Percentage - of those adults who saw a complementary or alternative health care worker in the previous 12 months
[1]includes evening primrose, cod liver, and halibut liver
[2]includes herbal remedies, brewer's yeast, spirulina, and acidophilus.
[3]includes fish oils, omega 3 products (alone or plus omega 6 and 9), flax/linseed oil, evening primrose oil
[4]herbal-plus (vitamin and/or mineral) – includes echinacea plus vitamin C, gingko plus multi-vitamins/multi-minerals, nettle plus B vitamins and iron
[5]includes garlic, echinacea, gingko, ginseng, guarana; plant extracts (from, eg, parsley, thistle, hops, motherwort); roots (of, eg, ginger, gentian, black cohosh); seaweeds and algae (eg, kelp, spirulina)
[6]Non-health sector included (1) human services sector (religious or spiritual advisors, social workers or counsellors in any setting other than a specialty mental health setting) and (2) complementary or alternative medicine sector (which included any other type of healer such as a herbalist or homeopath, participation in an Internet support group, or participation in a self-help group)

one-quarter of CAM users were taking conventional medicines concurrently, and one user experienced serotonin syndrome associated with concurrent use of paroxetine and St. John's wort.[44] Among children attending general practitioner or paediatric outpatient clinics in Christchurch, approximately one-fifth (18%) had used both TCAM and conventional medicines concurrently and did not disclose their CAM use to their physicians.[52]

Interviews with Māori regarding Māori health and wellbeing revealed that the use of rongoā is perceived to be compatible with use of Western medicines.[79] An exploratory study of patients with gout found that various therapies, such as Epsom salts, glucosamine, cod liver oil, chondroitin and kawakawa, are used complementary to prescribed conventional medications.[65]

Cost of TCAM

Table 3 summarises the findings from four studies that reported consumers' monthly spending on TCAM products and/or practices.[29,33,42,78]

Two studies explored the costs from health practitioners' perspectives. Massage therapists reported a median of 16–20 hours of client care per week and most frequently charge NZD 60/hour (NZD 72/hour).[15] Chiropractors in New Zealand indicated that the average number of adjustments visits per week they performed was 142, and that on average one-third of their practices were related to Accident Compensation Corporation (ACC) insurance claims.[13]

Discussion

This scoping review mapped publicly available evidence from studies/reports exploring the prevalence of use of TCAM in New Zealand.

Substantial evidence exploring TCAM use exists, but information from robust nationally representative studies is limited, as these studies have not comprehensively assessed the prevalence of use of both TCAM practices *and* TCAM products used in self-care. The New Zealand Adult Nutrition Survey 2008/9[55] and the NZHS 2006/7[61] explored the use of dietary supplements only (47.6%) and TCAM practitioners only (18.2%), respectively. This suggests that, although the 12-month prevalence of use of any TCAM in New Zealand is unknown, it was at least 47.6% in 2008/9.

Research indicates that a broad range of TCAM practices and products is used by people of all ages and ethnicities and with various health conditions. New Zealanders access these products and practices through multiple avenues, including conventional medical practitioners, and pay substantial sums of money out-of-pocket. Collectively, this indicates that there is a sizable demand for and use of TCAM among New Zealanders.

Several gaps were identified in the data: there are no current, nationally representative and comprehensive data on the prevalence of use of TCAM products and practices among patients/consumers in New Zealand, including the types of TCAM products/practices used, how they are accessed, and patterns of use of TCAM alongside conventional medicine. There are also substantial gaps in data on direct and indirect personal and government expenditure on TCAM products/practices, including government-funded treatments such as those covered by ACC and Work and Income New Zealand (WINZ).

Data indicate that the prevalence of visits to TCAM practitioners over the previous 12 months in New Zealand is comparable to that reported in national surveys from the USA (16.2%),[82] UK (12.1%)[83] and Canada (12.4%).[84] The overall use of TCAM (products and practices) in New Zealand (at least 47.6% in 2008/09) is similar to that in developed countries, such as the USA (~30%)[85] and Australia (63.1%).[86] Despite evidence of a high prevalence of use of TCAM products in New Zealand, there are yet no specific regulations governing the quality, efficacy and safety of these products. Many herbal and homeopathic products are exempt from the requirements of the Medicines Act 1981.[87] TCAM products do not have a specific regulatory framework in New Zealand; most are captured by the Dietary Supplements Regulations 1985, but these regulations do not require assessment of quality, efficacy and safety of TCAM products prior to marketing.[88] Thus, there are no assurances about product content and, therefore, pharmacological activity. Instances of adulteration, including with added conventional pharmaceutical ingre-

Table 3: Cost of TCAM reported in studies.

Reference No	Author (Year)	Year of study	Population	Perspective	Indicator(s)	Cost (reported in study)	Estimated cost 2020
[29]	Bacon, 2011	2006–2007	Men >40 years old with no known medical illness	Consumer	Supplements	Median cost/month = NZD 20	Median cost/month = ~NZD 25
[33]	Chrystal, 2003	2001	Cancer patients	Consumer	CAM therapies (products and practices, including visits and travel to CAM practitioners)	Median cost/month = NZD 55	Median cost/month = ~NZD 80
[42]	Mengelberg, 2018	2015	Adults >18 years old	Consumer	Supplements	31.7% of respondents spent between NZD 0–19/month	31.7% of respondents spent between ~NZD 0–20/month
[78]	Chan, 2014	Not reported	Patients with gout	Consumer	CAM (products and practices)	Mean cost/ month = NZD 29.10	Mean cost/ month = ~NZD 31*
[13]	Holt, 2009	2007	Chiropractors	Health practitioner	Chiropractic treatment	Average proportion of practice from ACC insurance claims (range) = 32% (0–90%)	Not applicable
[15]	Smith, 2011	2008	Massage therapists	Health practitioner	Massage therapy	Most frequent client fee/treatment = NZD 60/hour	Most frequent client fee/ treatment = ~NZD 72/hour

ACC = Accident Compensation Corporation.
*Year of publication used to calculate cost adjustment.

dients, have occurred in TCAM products distributed in New Zealand.[89,90] Some TCAM products distributed in New Zealand are produced to Good Manufacturing Practice (GMP) standards; however, there is no straightforward way for health professionals and consumers to identify these products (unless a product holds an overseas authorisation, for example, is a listed/registered medicine on the Australian Register of Therapeutic Goods[91]). In New Zealand, the Natural Health and Supplementary Products Bill was introduced in 2011 with the intention of regulating NHPs, including requiring manufacturers to produce their products according to GMP standards and to provide bibliographic and/or traditional-use evidence to support claims of health benefits.[92] However, the Bill lapsed in 2017 without being implemented.[93]

Many types of conventional practitioners in New Zealand are required to comply with standards of practice[94,95] and a codes of ethics[96] around recommending/using TCAM products/practices in their practice. Some clinical practice guidelines review evidence of, and include recommendations on, TCAM use for treatment of disease (e.g., use of acupuncture for smoking cessation[97]). Of practitioners typically considered to be TCAM practitioners in New Zealand, only chiropractors and osteopaths are regulated under the Health Practitioners Competence Assurance (HPCA) Act 2003.[98] Applications for traditional Chinese medicine practitioners and Western medical herbalists to be regulated under the Act were made in 2010 and 2015, respectively; discussions are ongoing.[99] New Zealand has a unique traditional medicine system (rongoā Māori)[100] founded on Indigenous medical practices handed down through generations of practitioners. Rongoā Māori is a traditional healing system developed and formulated in Māori culture, and which includes physical, emotional, family and spiritual aspects of health; it may involve use of rongoā rākau (preparations of native plants) and other substances of natural origin, as well as mirimiri (massage) and karakia (prayer), as part of an holistic healing approach.[100] Māori traditional healers are the holders of traditional knowledge of the harvesting, preparation and use of these medicinal products. This knowledge is often unique to the practitioner and differs between iwi depending on their geographical area and the teaching of their ancestors; in this regard, they are the holders of the "intellectual property" of these preparations. New Zealand is constitutionally a bi-cultural country and a multi-ethnic society;[101] in addition to rongoā Māori, traditional Pasifika medicine, and imported traditional medicine systems from other cultures, such as traditional Chinese medicine and Ayurvedic medicine, are also present. Currently, access to some TCAM (e.g., acupuncture, rongoā services) is government funded.[100,102] Government-funded rongoā Māori providers are required to adhere to the rongoā standards, Tikanga ā-Rongoā.[103] Intentions to regulate TCAM products, practices and/or practitioners in New Zealand would need to account for, and carefully consider, the impact on and protection of mātauranga Māori[97], the broad range of existing products/practices/practitioners and the impact on funding, as well as the practice of TCAM, as part of the wider New Zealand healthcare system.

Despite consumers' beliefs in TCAM as a natural and, therefore, safe healthcare option, adverse events can occur with the use of TCAM, including when its used together with conventional medicine. TCAM is frequently self-selected by consumers and is obtained outside the conventional healthcare system. Therefore, consumption/use is often unknown to conventional medical practitioners, unless its use is disclosed by the consumers themselves. Consumers choose to use TCAM for numerous reasons, and the conditions of use, including disclosure to health practitioners, will be explored and discussed in a later paper in the series.

Globally, a uniform definition for TCAM does not exist, despite efforts towards reaching a consensus.[104,105] Hence it is not surprising that studies in New Zealand use a wide range of TCAM terms and definitions. Although the New Zealand Ministerial Advisory Committee on Complementary and Alternative Health in 2004 agreed to adapt the definition from the United States National Center for Complementary and Alternative Medicine (now the National Center for Complementary and Integrative

Health),[5] few New Zealand studies did so. Depending on how TCAM is defined and operationalised, prevalence estimates can vary considerably. In a systematic review, prevalence of use rates were inflated when studies included "prayer" as a TCAM approach in their operational definition.[3] Numerous New Zealand studies did not report (using) an operational definition, which implies that participants' responses were based on their own understanding or interpretation of TCAM (or other terms used in the respective studies); such an approach is not standardised and is susceptible to underreporting or overreporting. Most studies also utilised different data collection tools, methods and prevalence measurements (e.g., lifetime, previous 12 months, 2 weeks, 2 months, during illness), adding to the challenges in aggregating data and comparing them locally and internationally.

Reliable nationally representative data on prevalence, patterns of use, expenditure and modes of access to TCAM products and practices (including where therapies are provided by conventional health practitioners or funded by the Ministry of Health, ACC or WINZ) are needed in New Zealand. A robust, comprehensive study on prevalence of TCAM use in New Zealand would need to include a standardised TCAM definition, scope and measurement of prevalence of use. It should collect respondents' National Health Index (NHI) numbers (a unique identifier for every person who uses health and disability support services in New Zealand) to allow for data integration and linkage across studies/databases. Data collected from the survey would serve as a useful resource at a population level for monitoring trends in TCAM use, alone and in conjunction with conventional medicine(s). Data on prevalence indicate not only the breadth of TCAM use in New Zealand, but also, to some extent, patients' unmet healthcare needs within the current publicly funded healthcare system. Therefore, any change in TCAM regulations would need to consider the impact on the allocation of public healthcare resources and funding. A substantial prevalence of use could also prompt the initiation of an in-depth review on the safety and efficacy of TCAM. Hence a comprehensive understanding of the extent, scope and patterns of TCAM use in New Zealand, together with evidence-based information on safety and efficacy, could contribute to informing government healthcare policy and decision-making.

This scoping review provides an overview and understanding of data on use of and access to TCAM in New Zealand and has identified gaps in knowledge for future studies. The work has several strengths and limitations. First, no formal evaluation of the quality of evidence was undertaken for the included studies. Also, information was gathered from a range of study designs and methods, restricting comparability across studies. A comprehensive search strategy was developed and used, but given the lack of standardisation in TCAM terminologies, some studies may have been missed. Another limitation is the use of a single reviewer for screening and data extraction, which may have introduced bias.

Conclusion

Numerous, typically small, localised studies exploring TCAM use in New Zealand are available; however, there is a lack of comprehensive, nationally representative data on prevalence and patterns of use of TCAM, including use in relation to conventional medicine(s). Existing data have been collected using various methods, limiting the comparability and further analysis. There is evidence of substantial use of TCAM among patients/consumers of different ages and ethnicities and with diverse health conditions. Given the high prevalence of use and ongoing lack of regulation, reliable, current, nationally representative data on prevalence of use of all TCAM products/preparations and practices/therapies is warranted for New Zealand.

Supplementary material

- Supplementary Table 1: Prevalence of TCAM use from other (non-nationally representative, or nationally representative sub-populations) studies.

Competing interests:
JB has received fees, honoraria and travel expenses from the Pharmaceutical Society of New Zealand (PSNZ) for preparation and delivery of continuing education material on complementary medicines (CMs) for pharmacists (2013, 2015); provided consultancy to the Pharmacy Council of New Zealand on Code of Ethics statements on CMs (unpaid) and competence standards (paid); was a member of the New Zealand Ministry of Health Natural Health Products (NHPs) Regulations Subcommittee on the Permitted Substances List (2016–2017) for which she received fees and travel expenses. JB has a personal viewpoint that generally supports regulation for CMs.

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The prevalence of individuals at high risk of true resistant hypertension and obstructive sleep apnoea in a New Zealand cohort

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ABSTRACT

AIMS: To determine the prevalence of individuals at high risk of true resistant hypertension (tRHT) in Dunedin-based adults <60 years diagnosed with hypertension and pharmacologically managed with three or more antihypertensive medications (ie, apparent resistant hypertension (aRHT)); to describe characteristics of those with aRHT; and to investigate the association between tRHT and obstructive sleep apnoea in the group.

METHODS: Participants with aRHT were recruited and data collected using standardised equipment and methodology. Characteristics were reported using descriptive statistics. The proportion (with 95% confidence intervals) of individuals at high risk of tRHT in individuals with aRHT was calculated.

RESULTS: Twenty-five aRHT individuals participated (17 males; group mean age 51.8±8.9 years; body mass index 33.6±6.2 kg/m^2). Measures (mean ±SD) for neck circumferences for males were 41.9±4.9cm, females 37.3±3.1cm; waist circumferences for males were 108.4±15.2cm, females 105.2±17.3cm. Group systolic and diastolic 24h ambulatory blood pressure (mmHg) were 148.9±20.5 (95% CI: 140.4 to 157.4), 88.2±14.6 (95% CI: 82.2 to 94.2); office blood pressure were 140.8±18.3 (95% CI: 133.2 to 148.3), 83.5±12.1 (95% CI: 78.5 to 88.5). The prevalence of individuals at high risk of tRHT was 88% (95% CI: 69% to 98%); proportion of obstructive sleep apnoea (OSA) risk among tRHT group was 86% (95% CI 65%to 97%).

CONCLUSIONS: The prevalence of individuals at high risk of both tRHT and OSA risk was large in Dunedin-based adults diagnosed with aRHT. Anthropometric assessments indicated high abdominal and visceral adiposity. Group mean blood pressure values exceeded New Zealand's hypertension diagnostic value, suggesting uncontrolled RHT.

Hypertension is one of the key risk factors for cardiovascular disease.[1,2] In New Zealand Māori have the highest level of risk for hypertension of all ethnic groups.[3] Although the first line of treatment for hypertension is medication, blood pressure (BP) is controlled by medications alone in only a fraction of patients.[4] Resistant hypertension (RHT) is a subset of hypertension, defined in the Scientific Statement of the American Heart Association[4] as "BP remaining above the goal BP in spite of concurrent use of three or more antihypertensive agents, including a diuretic."[4] Currently RHT is recognised as an increasingly common clinical problem, and higher fatal event rates have been identified in RHT compared to hypertension.[5] Ambulatory BP over 24h (24h ABP) is recommended to exclude the "white coat/pseudo" (higher clinic BP and normal day-to-day BP), or to "mask" (normal clinic BP and higher day-to-day BP) effects and diagnose RHT, which can be termed as "true RHT" (tRHT).[6] RHT diagnosed but not excluding white coat/pseudo or masked hypertension is termed "apparent

RHT" (aRHT). Use of country-based, recommended BP diagnostic values and 24h ABP to estimate the prevalence in the relevant population may be important for accessing relevant healthcare and, thereby, to help reduce morbidity and mortality risk.

Based on the BP diagnostic value 140/90 mmHg,[7] the estimated global prevalence of aRHT among populations with hypertension is 14.7%, and the estimated prevalence of tRHT is 10.3%.[8] On this basis the prevalence of tRHT among the population with aRHT can be calculated as approximately 70%.

Studies that have investigated the prevalence of any type of RHT are limited to Western Pacific (n=4) and Oceania (n=1) geographic regions.[8] There are currently no published data on the prevalence of any type of RHT in New Zealand. Māori have a 15% higher use of antihypertensive medication compared to New Zealand Europeans,[3] and thus RHT could be high in Māori.

Obstructive sleep apnoea (OSA) and RHT have a close, and strong, bidirectional relationship: each compounds the other.[4,9] In New Zealand, as in many other countries, OSA remains under-diagnosed.[10] Approximately 70%–80% of adults diagnosed with OSA also have RHT, and 30%–50% with RHT have OSA.[9] Thus studies are needed to determine the prevalence of tRHT and its association with OSA in New Zealand.

The aims of this study were, firstly, to explore the prevalence of individuals at high risk of tRHT in a sample population with aRHT, and secondly to describe the characteristics of the study group in order to determine whether a high risk of OSA is associated with individuals at high risk of tRHT in a New Zealand cohort. The outcomes of the study may be beneficial to improve diagnosis, as well as access to healthcare and associated healthcare costs.

Methods

This observational study was registered in the Australia New Zealand Clinical Trial Registry (ACTRN12618001110279p) and ethics approval was obtained from the Health and Disability Ethics Committees, New Zealand Ministry of Health (18/CEN/141).

Study setting and population

The study participants comprised Dunedin-based adults 60 years and younger diagnosed with aRHT.

Inclusion and exclusion criteria

Adults aged 18–60 years diagnosed with primary hypertension and managed pharmacologically with three or more antihypertensive medications, referred to as "aRHT," were included. Individuals were excluded (not referred by clinicians as potential study participants) if they were diagnosed with acute or chronic kidney disease, had a metabolic disorder such as Cushing's syndrome, were critically ill or were pregnant.

Sample size

The population was drawn from the Ministry of Health Pharmaceutical Collection Warehouse, via the Best Practice Advocacy Centre (bpac), New Zealand. That database revealed 559 adults in Dunedin under 60 years with hypertension and pharmacologically managed with three or more antihypertensive medications (aRHT). To estimate the prevalence with precision of a 5% margin of error for that finite population size, 228 participants would have been required. A pragmatic decision was made to undertake the study with an adjusted sample size by using an approximated prevalence of 10% and a 10% margin of error. Under these assumptions, the required sample size was estimated to be 35, requiring 70 invitees with an estimated 50% response rate.

Recruitment procedure

The cohort was recruited through general practitioner (GP) referrals and advertising posters. Twenty-five individuals who fulfilled the inclusion criteria consented to participating in the study. After providing informed consent, participants' demographic data, general health and social habits, self-reported physical activity level, adherence to medications (Morisky Medication Adherence Scale), quality of life (SF-36) and OSA risk (Epworth Sleepiness Scale (ESS) and STOP-BANG questionnaire) were obtained and recorded. The measurements shown in Table 1 were obtained using standardised, calibrated equipment and guidelines.

Outcome measures

The primary outcome, 24h ABP, was recorded using an Ultralite 90217A ABP

monitor and 92506 ABP Report Management System (Spacelab Healthcare, WA, USA) in accordance with the instructions in the user manual. The device was fitted to each participant on completion of their questionnaires and anthropometric measurements. The devices were removed at the same time the following day, after recording for 24 hours (day and night). Office/clinic BP was measured at the first visit in accordance with the American Heart Association/American College of Cardiology (AHA/ACC) 2017[1] guidelines using an Omron digital BP monitor (HEM 7322, Netherlands).

Secondary outcomes

Scores for ESS and STOP-BANG questionnaires were used to determine levels of excessive daytime sleepiness and risk of OSA. Levels of physical activity and sleep parameters were captured by the ActiGraph GT3XPB, Activitrax monitor (Pensacola, Florida, USA) over a seven-day period in accordance with the instructions in the user manual. The device, an activity monitor fitted on the non-dominant wrist of each participant, was worn continuously for seven days and nights to record their activity and sleep data (Table 1). Each participant completed a six-minute walk test (6MWT) to determine their cardio-respiratory fitness. The short form 36 (SF-36) was administered to determine participants' quality of life. Collection of anthropometric data (Table 1) followed the protocols documented in the Exercise and Sports Science Australia (ESSA) manual and used standardised calibrated equipment (eg, Seca 876 weighing scale, Seca 217 stadiometer, Seca 201 anthropometric measuring tape) (Table 1).

Statistical analysis

Statistical Package for Social Sciences (SPSS) (IBM SPSS version 25.0 for Windows, NY, USA) was used to analyse the data.[11] Characteristics of the sample were reported as means for continuous data and as percentages for categorical data. The proportion with tRHT in the sample population with aRHT was calculated with confidence intervals. Scatterplots were used for BP values and sleep scores to determine the existence of any associations between the variables. The scatterplots did not show a relationship, and thus the correlational analysis was not conducted. Cross-tabulation was used to determine the relationship between tRHT diagnosis and risk of OSA.

Results

Characteristics of the population with RHT

The participants' mean age was 51.8±8.9 years (range 34–60 years). The majority (n=18: 72%) identified as New Zealand Europeans, two as Māori (8%) and the rest as other ethnicities. On average, the participants had been treated for 5.2±2.2 years for hypertension and the mean number of prescribed medications was 3.2±0.7. The participants showed good adherence (80%) to medication according to the Morisky Medication Adherence Scale.[12] The majority (n=16: 64%) of participants were non-smokers. Twenty (80%) were consumers of alcohol (mean number of drinks per week 8.6±12.7) and 18 (72%) were coffee drinkers (mean number of cups 2.5±2.6 per day). Ten participants (40%) used medication for hyperlipidaemia, seven (28%) had diabetes and four (16%) had both conditions. Two had previously had a mild cerebro-vascular accident and one reported a previous history of a myocardial infarction. Means and confidence intervals for BP, anthropometrics, sleep and activity parameters are summarised in Table 2.

The mean 24h ABP value of the sample was above the American (AHA/ACC)[1] and New Zealand[2] diagnostic value for stage II hypertension (>140/90mmHg). The mean daytime sleepiness of the sample was below the cut-off value for excessive daytime sleepiness (ESS score >9)[13] in the group, suggesting a lower risk of daytime sleepiness. The objective measurements of sleep showed high mean sleep efficiency (>80%),[14] and the mean total sleep time was within the recommended range (7–9h) for an adult.[15] Twenty-three participants (92%) reported that they were regularly undertaking exercise or physical activities (mean 4.5±2.2 times per week) within the recommended duration (mean 4.5±2.6 hours per week). The mean moderate to vigorous physical activity (MVPA) duration per week was 12.9% of total time. MVPA per day and step count were above the recommended guidelines (150–300 minutes per week, and over 10,000 steps), although the group reported a higher total sedentary time

Table 1: Blood pressure, sleep and activity parameters of the group.

N=25 (Male: 17, Female: 8)	Mean ±SD	95% CI	
		Lower	Upper
Blood pressure (mmHg)			
Ambulatory BP systolic 24h (mmHg)	148.9±20.5	140.4	157.4
Ambulatory BP diastolic 24h (mmHg)	88.2±14.6	82.2	94.2
Ambulatory BP systolic day (mmHg)	152.4±20.1	144.1	160.6
Ambulatory BP diastolic day (mmHg)	91.2±14.1	85.4	97.0
Ambulatory BP systolic night (mmHg)	136.2±24.0	126.3	146.1
Ambulatory BP diastolic night (mmHg)	77.3±15.3	71.0	83.6
Office BP systolic (mmHg)	140.8±18.3	133.2	148.3
Office BP diastolic (mmHg)	83.5±12.1	78.5	88.5
Mean arterial pressure 24h (mmHg)	108.3±15.9	101.7	114.8
Mean arterial pressure day (mmHg)	111.4±15.3	105.1	117.7
Mean arterial pressure night (mmHg)	97.3±17.5	90.1	104.5
Pulse pressure 24h (mmHg)	60.9±12.5	55.7	66.0
Pulse pressure day (mmHg)	61.3±12.8	56.0	66.6
Pulse pressure night (mmHg)	59.8±13.6	54.2	65.5
Ambulatory HR 24h (bpm)	74.1±10.6	69.7	78.5
Ambulatory HR day (bpm)	76.7±11.4	72.0	81.4
Ambulatory HR night (bpm)	66.2±9.5	62.3	70.2
Anthropometrics			
Age (years)	51.8±8.9	-	-
Height (cm)	172.3±10.1	168.1	176.5
Body weight (kg)	98.3±18.8	90.6	106.1
BMI kg/m^2	33.2±6.2	30.6	35.7
Neck circumference (cm)	M:41.9±4.9, F:37.3±3.1	-	-
Waist circumferences (cm)	M:108.4±15.2, F:105.2±17.3	-	-
Waist to hip ratio	M:1.01±0.08, F:0.89±0.07	-	-
Sleep parameters			
Epworth Sleepiness Scale score	6.5±4.8	4.6	8.5
STOP-BANG score	5.2±1.9	4.4	6.0

Table 1: Blood pressure, sleep and activity parameters of the group (continued).

N=25 (Male: 17, Female: 8)	Mean ±SD	95% CI	
		Lower	Upper
Sleep efficiency (%)	92.9±8.6	89.4	96.5
Total sleep time (min)	471.1±91.1	433.5	508.7
Wake after sleep onset	31.5±38.2	15.7	47.2
Number of awakenings (per sleep)	2.8±4.3	1.08	4.60
Sleep Fragmentation Index	14.6±9.8	10.5	18.7
Activity parameters			
Freedson bouts/week	33.1±27.4	21.7	44.4
Total time in Freedson bouts/week (min)	442.3±386.1	282.9	601.7
Total sedentary bouts/week	125.1±24.7	114.9	135.3
Total time in sedentary bouts (min)/ week	3,226.2±994.9	2,815.5	3,636.9
Total MVPA (min)/week	1,295.3±451.5	1,108.9	1,481.6
Average MVPA per day	161.9±56.4	138.6	185.2
Steps counts total	78,257.8±23,387.3	68,604.0	87911.6

M: Male, F: Female, MVPA: Moderate to vigorous physical activity, MET: Metabolic equivalent, kcals: Kilo calories.

per week (Table 2). The mean value for Freedson (1998) activity bouts,[16] the MVPA with a minimum duration of 10 minutes, was 442.3±386.1 minutes per week, a relatively low value. In contrast, for sedentary bouts, the sedentary time comprising more than 10 minutes[16] was reported as 3,226.2±995.0 minutes per week, which is several times higher than Freedson bouts (Table 2).

Overall quality of life for the group was low (SF 36 score 66.7±19.8: 95% CI: 58.6 to 74.9). Particular components of the SF-36-role limitation due to physical health (68.0±40.5), energy/fatigue (53.0±25.4), health change (51.0±26.5) and general health (49.8±20.6) each contributed to the overall low quality of life score for the group.

Prevalence of individuals at high risk of tRHT

The mean office BP values for the group were above 130/80 mmHg, indicating that all the participants (n=25) could be categorised as aRHT.[1,2,17] The prevalence of high risk of tRHT among the group with RHT was 88% (95% CI: 68.8 to 97.5). The percentages for the categories of RHT based on the 24h ABP for the group are summarised in Table 2.

OSA risk in individuals at high risk of tRHT

Table 3 summarises the proportion at risk of OSA, based on sleep scores (STOP-BANG score>3 and ESS>9) in aRHT/tRHT, overall and for the gender-based categories. The percentage at risk of OSA was also high (86% with 95% CI: 65% to 97%) in participants at high risk of tRHT. Although the proportions at risk of OSA were high in the RHT groups, the association between tRHT and OSA risk was not statistically significant (Chi square=0.465, df=1, p=0.495). The risk estimation showed that the risk of having OSA in the group at high risk of tRHT was 1.158 (95% CI: 0.981 to 1.367).

Discussion

The primary aim of this study was to determine the prevalence of tRHT among a Dunedin-based group diagnosed with hypertension and being pharmacologically managed with three or more medications (ie, with aRHT). Secondary aims were to describe the characteristics of a Dunedin-based cohort under 60 years of age with aRHT and to explore the risk of OSA among the individuals at high risk of tRHT. The study results suggest a high prevalence of tRHT in the group with aRHT and the possibility of a close association with OSA risk.

Prevalence of tRHT in RHT

The prevalence of risk of tRHT was high (88%) in the group with aRHT, higher than recently estimated values described in the systematic review by Noubiap et al.[8] One of the reasons for higher prevalence in our study may be the use of the lower threshold (130/80mmHg).[2] for the diagnostic value. Diagnosis using the lower thresholds will encourage practitioners to start treatment early, potentially enhancing the reversibility of the condition.[4] However, previous studies have shown large variations in the prevalence of RHT.[18–20] Thus, further studies are needed to confirm the exact prevalence with the diagnosis of tRHT considering all the conditions in the definition provided by the American Heart Association (2018).[4]

Table 2: Approximate prevalence of resistant hypertension categories (diagnosed based on 24h ABP).

Hypertension category	Prevalence		
	Overall	Male	Female
nRHT	0 (0%) [95% CI: 0 to 14.2]	0 (0%)	0 (0%)
aRHT	25 (100%) [95% CI: 85.8 to 100]	17 (68%)	8 (32%)
tRHT	22 (88%) [95% CI: 68.8 to 97.5]	15 (60%)	7 (28%)
pRHT/wcRHT	3 (12%) [95% CI: 25 to 31.2]	2 (8%)	1 (4%)

nRHT: Non-resistant hypertension, aRHT: Apparent resistant hypertension, tRHT: True resistant hypertension, pRHT: Pseudo resistant hypertension, wcRHt: White coat resistant hypertension.

The association between RHT and OSA risk

Compared to other questionnaires, the STOP-BANG questionnaire score is a more valid and reliable measure to determine risk of OSA, especially in regard to specificity.[21] Our data indicated that the prevalence of risk of OSA was higher in both aRHT (88%) and high risk of tRHT (86%) groups in the study. Nearly half of the sample showed higher levels of daytime sleepiness (high ESS scores), and the energy and fatigue levels reported in the quality of life (SF-36) scores were low. Daytime sleepiness and fatigue are recognised as signs of OSA.[21] These findings may support the argument of there being a strong association between OSA and the condition RHT. Published studies using polysomnography have shown that the prevalence of OSA in RHT is more than 80%.[19,22] Although we did not use polysomnography to diagnose OSA, self-reported signs of fatigue and sleepiness in our cohort are strong indicators that OSA may have been present. A larger cohort study will be needed to confirm the prevalence of OSA in RHT.

The scatterplots of this study show no relationship between two variables (24h ABP and STOP-BANG score), which contrasts with previous studies that reported linear relationships and correlations between BP and sleep parameters (eg, the Apnoea Hypopnoea Index (AHI)).[9,19] Our small sample size may be the reason for not finding statistically significant results, though a large proportion of individuals at high risk of tRHT were also at high risk of OSA. Thus in-depth studies with large sample sizes are needed to determine such associations or to confirm whether there is a correlation between sleep scores and BP parameters in adults with RHT.

Sociodemographic and anthropometric characteristics

We specifically recruited participants who were 60 years and younger, leading to a relatively young mean age for the cohort (51.8±8.9 years). The mean number of years treated for hypertension (5.2±2.2 years) indicated that some participants may have been in their 40s when such medication was first prescribed. Thus, RHT can occur at a relatively young age without being caused by factors such as chronic kidney disease and without the known risks for hypertension associated with older age.[4] The relatively low number of self-reported comorbidities (such as diabetes) may be due to the young age range of the sample. Such low prevalence of diabetes in RHT groups is in agreement with the results of a previous study that included a large cohort of patients with RHT.[20] Thus, diabetes may not be highly prevalent in younger groups with RHT. Although Māori have a higher risk of hypertension and higher use of antihypertensive medication than New Zealand Europeans,[3] the study sample included only a small number of Māori (n= 2). The low Māori representation (8%) could be due to Māori comprising only 8.7% of the Otago population (according to 2018 census data).[23] The small number of Māori participants may be due to advertisements not being accessible or sufficiently engaging for them.

Table 3: Percentages of RHT categories for risk of OSA and daytime sleepiness.

Hypertension category	High OSA risk (SBQ)			High daytime sleepiness (ESS)		
	Overall	Male	Female	Overall	Male	Female
aRHT (n=25)	22 (88%)	16	6	13 (52%)	9	4
tRHT (n=22)	19 (86%)	14	5	12 (48%)	8	4
pRHT/wcRHT (n=3)	3 (12%)	2	1	1 (4%)	1	0

aRHT: Apparent resistant hypertension, wcRHT: White coat resistant hypertension, pRHT: Pseudo resistant hypertension; tRHT: True resistant hypertension, SBQ: STOP-BANG questionnaire, ESS: Epworth Sleepiness Scale questionnaire score.

Our future studies will seek consultation and input from Māori stakeholder groups to improve the relevance of the study and enhance strategies to recruit Māori participants specifically. Previous studies over the past decade have reported a low prevalence of smoking in cohorts with RHT. [18,20] Our study had similar findings. Alcohol intake and coffee consumption reported by our sample also did not exceed the recommended limits.[24]

The high BMI (>30kg/m^2) and increased neck (>40cm for male and >38cm for female) and waist (>94cm for male and >80cm for female)[25] circumferences indicate higher body fat and the presence of visceral and abdominal adiposity respectively in the group.[25] This is in agreement with previous studies with larger sample sizes and similar designs that have explored the anthropometrics of individuals with RHT.[19,20] The New Zealand Ministry of Health[25] has previously identified that increased BMI (>25kg/m^2) and waist circumference (>80cm for male and >94cm for female) are risk factors for high BP and poor cardiovascular health.[25] The sample in the present research reported markedly higher values compared to the values recommended by the New Zealand Ministry of Health.[25] Excess adipose tissue has the potential to activate the renin angiotensin aldosterone system, increase sympathetic activity, promote insulin and leptin resistance and increase endothelial dysfunction.[4]

Blood pressure characteristics

The BP values were similar to values reported in previous studies with similar cohorts in which the average BP was in the range 145–165/80–90mmHg.[19,20] The study group at risk of tRHT can be categorised under the uncontrolled RHT category as described in a recent guideline.[26] This situation could lead to prescribing more medications to manage BP and could result in refractory hypertension.[4] Also it is important to note that the mean office BP of the present study sample was lower than the reported 24h ABP value, indicating the importance of confirming BP over a 24h period.

Sleep and activity characteristics

Both self-reported and objectively measured physical activity levels in the study group were above the recommended values for gaining health benefits as defined by the Eating and Activity Guidelines of Ministry of Health and other prominent guidelines.[27] Despite this, the BP of the group was high, even though they were using three or more antihypertensive medications. This suggests that the presently recommended physical activity levels (150–300 min per week of moderate to vigorous physical activities[27,28]) may not be sufficient to benefit the population with RHT. Thus, further investigations are warranted to determine the BP response to physical activity in people with RHT.

The present study indicated that low quality of life was associated with the condition RHT. This is in line with the small amount of literature that has been published previously.[29,30]

Strengths

To our knowledge this was the first time a New Zealand population with aRHT was included in a comprehensive investigation. Thus this study has provided a valuable dataset. We used the most recent American (AHA/ACC)[1] and New Zealand updated[2] guidelines for diagnostic values for hypertension to determine the prevalence. The selected study sample was aged below 60 and this minimised the independent influence of ageing and associated predisposing factors for RHT. This comprehensive study design with appropriately calculated sample sizes will be an important model to use in future studies in the field.

Limitations

The sample size was adapted in several ways to ensure the study was feasible within the constraints of the PhD timeframe. We were unable to recruit the required sample size, and therefore the conclusions are limited to this cohort and need to be considered with some caution. To diagnose tRHT, the condition in the definition "maximum or maximally tolerated dose" was not used due to practical difficulties. Thus, the exact prevalence of tRHT may vary from the reported proportions. We determined the OSA risk according to the sleep scores, and we did not use overnight polysomnography, which is the measure recommended for diagnosing OSA. As the sample may not have been fully representative of the entire New

Zealand population, generalisability of our results cannot be assumed.

Recommendations

The prevalence of risk of OSA was high in this sample, confirming the need to screen for risk of OSA and assess sleep patterns in individuals diagnosed with, or at high risk of, tRHT. Lifestyle interventions, particularly exercise programmes and/or longer recommended periods of exercise than those for the general population, will be needed for this specific cohort at high risk of tRHT. Referring patients with RHT to health professionals, such as physiotherapists, for specific individualised exercise will also be beneficial upon confirmation of the positive outcomes of such interventions. To confirm the results of the present study, a country-based, large cohort study that addresses the reported limitations is highly recommended.

Conclusions

The prevalence of individuals at high risk of tRHT among aRHT was 88%, and the proportion at risk of OSA among the high-risk group for tRHT was 86%. The prevalence of tRHT may be high and OSA could be highly associated with RHT. The group was obese with higher neck and waist circumferences compared to recommended values, suggesting abdominal and visceral adiposity. Though the BP was high in the group, individuals were involved in levels of physical activity within the range recommended by the New Zealand Ministry of Health. However, the quality of life for this group was low, with the scores having been influenced by the reduced scores for the physical activity components of the questionnaire.

Competing interests:
Nil.

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Vitamin D deficiency, supplementation and testing: have we got it right in New Zealand?

Mark J Bolland, Alison Avenell, Andrew Grey

ABSTRACT

BACKGROUND: Severe prolonged vitamin D deficiency can cause rickets or osteomalacia. Both can be prevented by sunshine exposure or vitamin D supplementation. Although New Zealand guidance does not recommend vitamin D supplementation for the general population, it can be considered for individuals at risk of vitamin D deficiency. Routine measurement of 25-hydroxyvitamin D (25OHD) is also considered unnecessary.

METHODS: We investigated the rates of vitamin D supplementation, rickets and osteomalacia in New Zealand, and of 25OHD results in Auckland, over the last two decades.

RESULTS: Vitamin D prescriptions increased 14-fold, from 86,295/year to 1,215,507/year, between 2003 and 2019, with medication costs alone in 2019 being >$1 million. Despite these changes, the annual prevalence of hospital admissions for rickets, osteomalacia and unspecified vitamin D deficiency remained low and stable (10–20/year). 25OHD concentrations increased between 2002 and 2003 and between 2009 and 2019, and in the later time-period, 25OHD tests mainly identified individuals without vitamin D deficiency (40–50% >75nmol/L, 65–70% >50nmol/L and only 7–12.5% <25nmol/L).

CONCLUSIONS: Osteomalacia and rickets persist at low rates despite widespread, increasingly costly vitamin D supplementation and testing, which largely identifies individuals without vitamin D deficiency. These results suggest that vitamin D guidance and practice in New Zealand should change.

Severe prolonged vitamin D deficiency can cause rickets in children or osteomalacia in adults. Both are easily prevented by sunshine exposure and prevented or treated with vitamin D supplementation. Beyond these uncontroversial issues, vitamin D supplementation remains surprisingly topical. In the media, it is often portrayed enthusiastically as a cure for a wide range of illnesses,[1,2]whereas in scientific literature it is a subject of much debate.[3–6] For example, definitions of vitamin D deficiency range from 25-hydroxyvitamin D (25OHD) <25nmol/L to <100nmol/L,[7–10] even though the prevalence of biochemical osteomalacia is very low when 25OHD is <25nmol/L.[11]

New Zealand guidance on vitamin D supplementation and testing has been consistent for many years: supplementation is not recommended for the general population, but it can be considered for individuals from groups at risk of vitamin D deficiency.[12] At-risk groups are identified in this guidance: people with deeply pigmented skin, especially those who wear full-body coverage clothing; people who actively avoid sun exposure; people with low mobility who are frail or housebound; people in southern regions who spend a limited amount of time outdoors; and people with certain medical disorders (eg, kidney failure, malabsorption syndromes).[12] It is recognised that, because vitamin D testing costs considerably more (~$30 for gold standard LC-MS/MS assay costs alone) than vitamin D supplementation ($0.25/monthly tablet), supplementation for high-risk individuals should be undertaken without testing. Measurement of 25OHD, the accepted test for assessing vitamin D status, is only indicated for investigation of clinically suspected and symptomatic severe vitamin D deficiency, some biochemical

abnormalities (eg, hypocalcaemia and hypophosphataemia) and certain metabolic bone disorders.[12]

Despite the unchanged guidance, vitamin D supplementation has been rising. We sought to quantify changes in prescriptions for vitamin D (chemical ID: 1187, name: colecalciferol) in recent years, and whether there have been any corresponding changes in the prevalence of the consequences of severe vitamin D deficiency, rickets and osteomalacia or changes in testing for 25OHD. We have also compared 25OHD results from 2009–2019 with previously published results from 2002–2003. We then considered whether the temporal patterns identified have implications for current vitamin D guidance.

Methods

We obtained data on prescriptions for colecalciferol in New Zealand from between 2003 to 2019 and data on hospitalisations with ICD-10 discharge codes for osteomalacia (M83), rickets (E55.0) and vitamin D deficiency (E55) for 2000–2018 from Stats NZ. We obtained deidentified data from Testsafe, the Auckland regional biochemistry database that includes results from community and hospital patients, for all measurements of 25OHD between 1 January 2009 and 31 December 2019.[11] Several different 25OHD assays in different laboratories were used during this time-period, including the Diasorin radioimmunoassay, Diasorin Liaison and immunoassays on the Roche, Siemens and Abbot platforms. However, the overwhelming majority of tests during this period were done at one laboratory, Labplus, largely using the Roche assay. In 2012, Auckland District Health Board (ADHB) introduced restrictions on 25OHD requests at Labplus because of rising numbers of requests and costs.[13] These restrictions included requests being limited to certain specialists; to individuals from high risk groups for rickets/osteomalacia; for investigation of rickets/osteomalacia; for disorders of calcium and phosphate metabolism, osteoporosis or other metabolic bone disease; to patients with chronic renal failure and renal transplant recipients; and to children. Tests requested for other reasons were declined.

We compared the results from 2009–2019 with earlier results from Labplus between 1 January 2002 and 30 September 2003. At that time, Labplus was the only laboratory in the Auckland region measuring 25OHD, and all measurements during this period used the Diasorin radioimmunoassay.[14]

Descriptive data (eg, frequencies, proportions, means and standard deviations (SDs)) are presented. For the analyses presenting summary 25OHD data by the time of the year, sine curves were fitted to model the seasonal variation ($25OHD = a + b*\sin(2\Pi/365*\text{day of year}) + c*\cos(2\Pi/365*\text{day of year})$). All analyses were conducted with the R software package (R 3.5.1, 2019, R Foundation for Statistical Computing, Vienna, Austria).

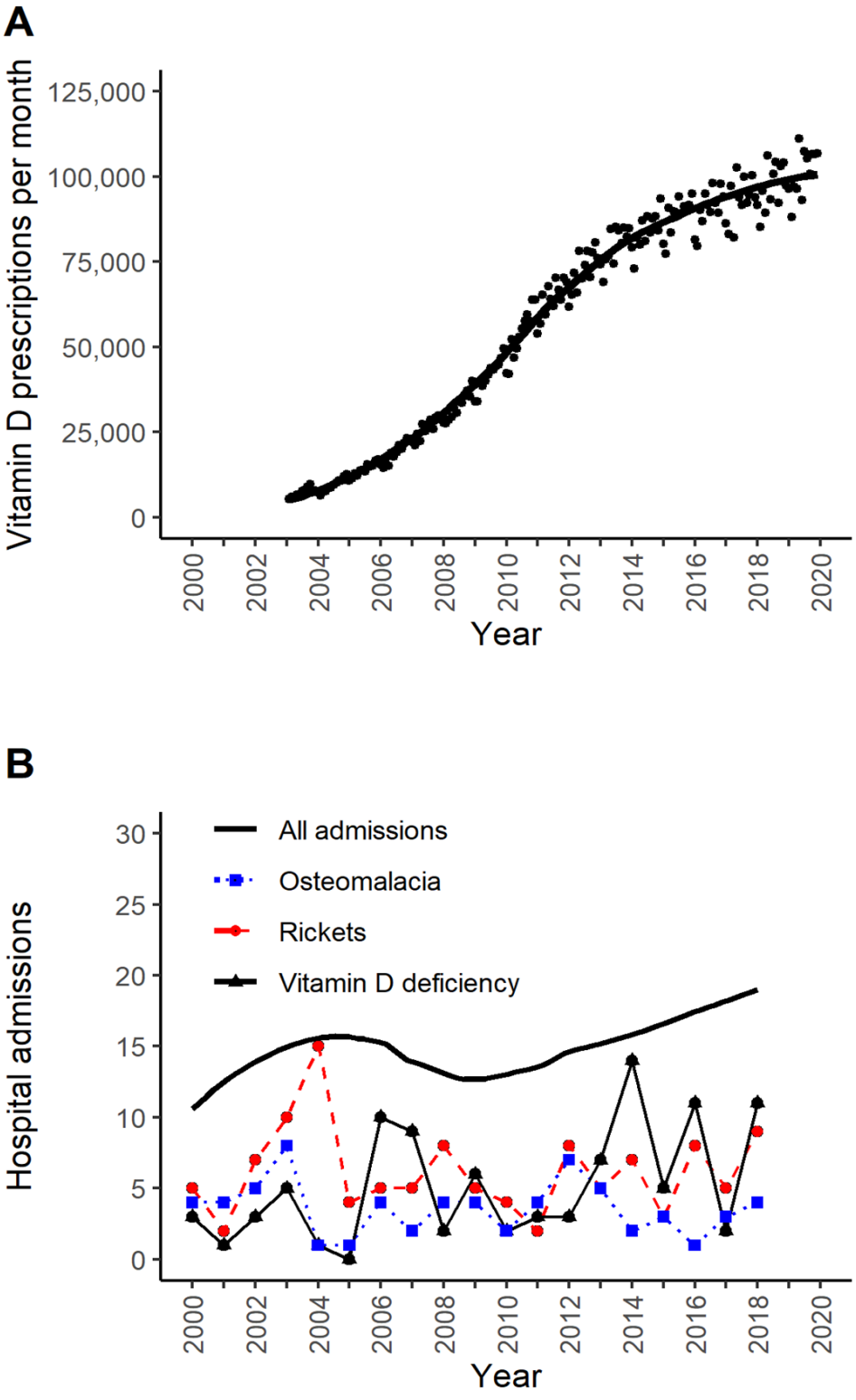
Results

Figure 1A shows that the number of colecalciferol prescriptions increased from about 6,000 per month in early 2003 to about 107,000 per month by late 2019. Translated to yearly values, there was a 14-fold increase in annual prescriptions, from 86,295 in 2003 to 1,215,507 in 2019. Assuming an average cost of $1 per prescription for colecalciferol, this equates to an increase in the cost of supplementation from <$100,000 per year to >$1.2 million per year, and this ignores the cost to the patient of any prescription charges (currently $5 per prescription for individuals >13 years without other exemptions) and costs from doctor and pharmacy visits to obtain the prescription.

Figure 1B shows the annual prevalence of hospital admissions in New Zealand for rickets, osteomalacia and unspecified vitamin D deficiency. The total number of admissions per year for these three conditions ranged between 10 and 20 with no obvious change in the number of admissions per year for any condition over time.

Figure 2 shows the rates of 25OHD measurements in the Auckland region between 2009 and 2019, along with the distribution of 25OHD results during this period. Two striking features in Figure 2 are the decrease in 25OHD concentrations in 2010 and the decrease in tests after 2012. In November 2009, there was a re-standardi-

Figure 1: (A) The number of prescriptions per month for vitamin D in New Zealand. (B) The number of hospital admissions per year for osteomalacia, rickets and unspecified vitamin D deficiency.



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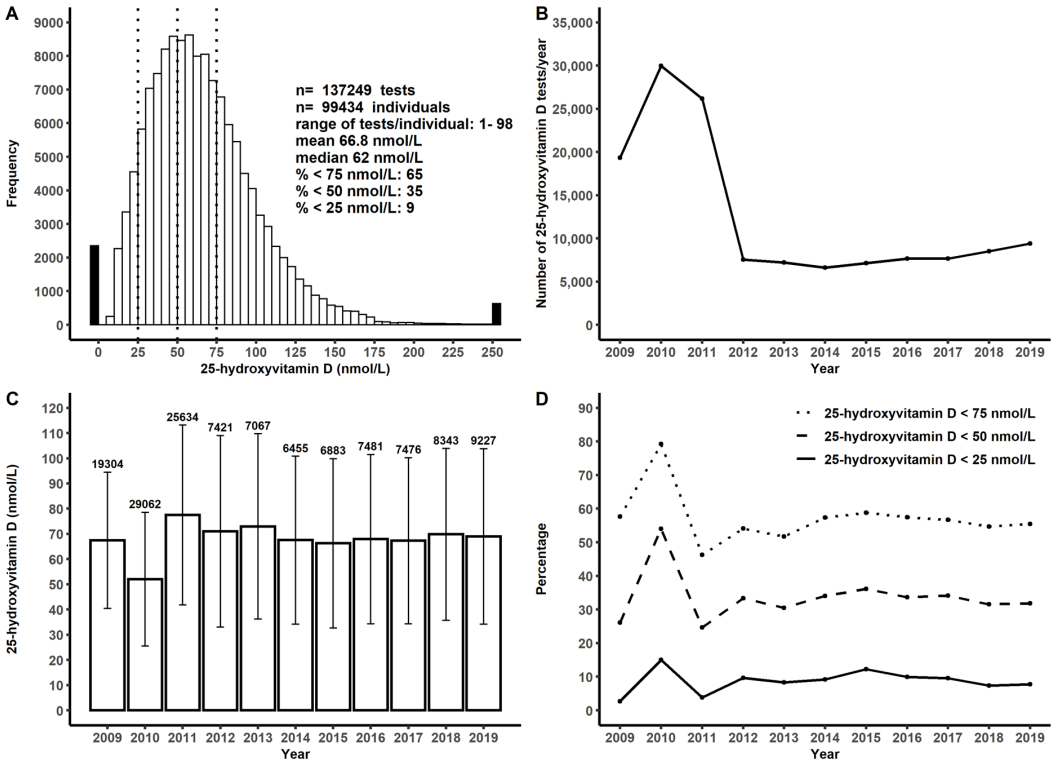
sation of the Roche assay used by Labplus, which led to results that were about 20% lower than previously. This explains the dramatic decrease in mean 25OHD in 2010. In 2012, ADHB introduced restrictions on 25OHD requests, which led to about a five-fold decrease in the number of tests per year. Despite the introduction of these restrictions, mean 25OHD remained stable after 2012, at approximately 70nmol/L each year (Figure 2C). Likewise, after 2012 the proportion of individuals with 25OHD <25nmol/L was low and stable (range 7.5%–12.5%); only approximately one third of individuals had 25OHD <50nmol/L (range 30%–35%); and 40%–50% had 25OHD >75nmol/L (Figure 2D).

The mean (55nmol/L) and median (53nmol/L) 25OHD were lower, and the proportions of individuals with 25OHD <50nmol/L and <75nmol/L were larger, in the earlier (2002–2003) compared to the later time-period (Figure 3). Similarly, the proportion with 25OHD <25nmol/L was higher in the earlier time-period. Figure 4 shows some loss of seasonal variation of 25OHD during the winter months in the later time-period. In 2002–2003, the mean 25OHD throughout the year closely followed a sine curve (Figure 4C), and, as expected, the proportions of 25OHD <25nmol/L and 25–50nmol/L were lower in summer and higher in winter, whereas the proportions of 25OHD 50–75nmol/L and >75nmol/L were higher in summer and lower in winter (Figure 4D). In contrast, in 2009–2019 there was little variation in mean 25OHD during the winter, spring and early summer months (Figure 4A): in weeks 1–4 (January) and 26–52 (end of June till December), the weekly mean 25OHD was between 57nmol/L and 65nmol/L. Reflecting the different seasonal variations during these weeks between the two time-periods, the variance of weekly mean 25OHD during these time-periods was smaller in 2009–2019 (4.4nmol/L) than in 2002–2003 (29nmol/L, P<0.001, F test). Likewise, there was less seasonal variation in the monthly proportions of individuals in each subgroup defined by 25OHD compared to the 2002–

Figure 2: (A) The distribution of 25-hydroxyvitamin D (25OHD) results between 2009 and 2019. The black bars indicate results that were below the lower limit or above the higher limit of detection. (B) The number of 25OHD tests by year. (C) The mean (SD) 25OHD by year. (D) The proportion of 25OHD <25, <50 or <75nmol/L by year.



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2003 period. In particular, there was very little variation in these proportions between July and January (Figure 4B).

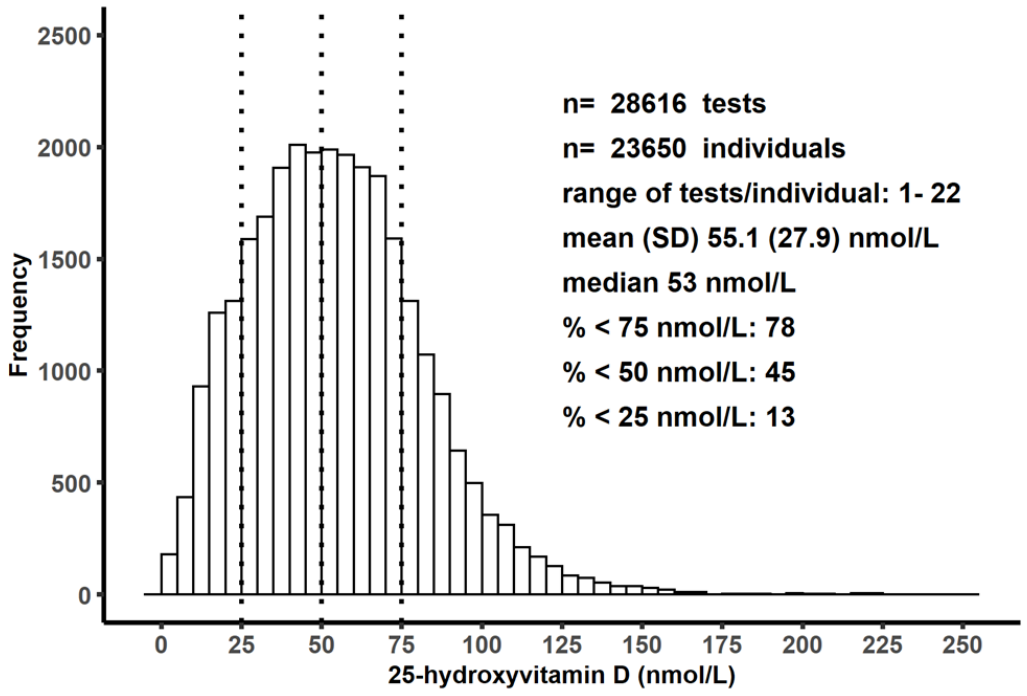
Discussion

Despite no change in guidance, vitamin D supplementation in New Zealand has increased dramatically over the last two decades and now exceeds 1.2 million prescriptions each year. Even with this very large increase, there is no evidence that the prevalence of the consequences of severe vitamin D deficiency, rickets and osteomalacia have changed over time. Fewer than 20 hospital admissions per year occur for these conditions or unspecified vitamin D deficiency. Between the two different time-periods (2002–2003 and 2009–2019), 25OHD concentrations increased; the proportions of measurements with 25OHD >50nmol/L and >75nmol/L grew and the proportions with 25OHD <25nmol/L shrank; and seasonal variation in 25OHD, particularly during the winter months, diminished. It seems most likely that the differences between the two time-periods are largely due to the increase in vitamin D supplementation from the first to second time-period. Since 2009, vitamin D measurements have mostly identified individuals without low vitamin D status: 40%–50% of 25OHD measurements were >75nmol/L, 65%–70% were >50nmol/L and only about 10% were <25nmol/L. Particularly noteworthy is that, even after restrictions for measuring 25OHD were introduced, the distribution of 25OHD results changed only a little, and there were no subsequent changes in proportions of results with 25OHD <25nmol/L.

Collectively, these findings suggest that the supplementation of vitamin D in New Zealand needs to change. Although vitamin D supplements are inexpensive to prescribe to an individual, their widespread use creates substantial costs for the health system and individual patients, and there is no clear clinical benefit from this expenditure. Adding to this concern is that, despite widespread supplementation, osteomalacia and rickets persist at a low prevalence, and vitamin D testing is still not targeting individuals at high risk of vitamin D deficiency.

Rickets and osteomalacia caused by vitamin D deficiency are both preventable. About two thirds of cases of osteomalacia in Auckland occur in the community setting,[11] suggesting that there may be still about 10 cases per year of osteomalacia in New Zealand, despite widespread supplementation. Two publications have

Figure 3: The distribution of 25-hydroxyvitamin D (25OHD) results between 2002 and 2003.



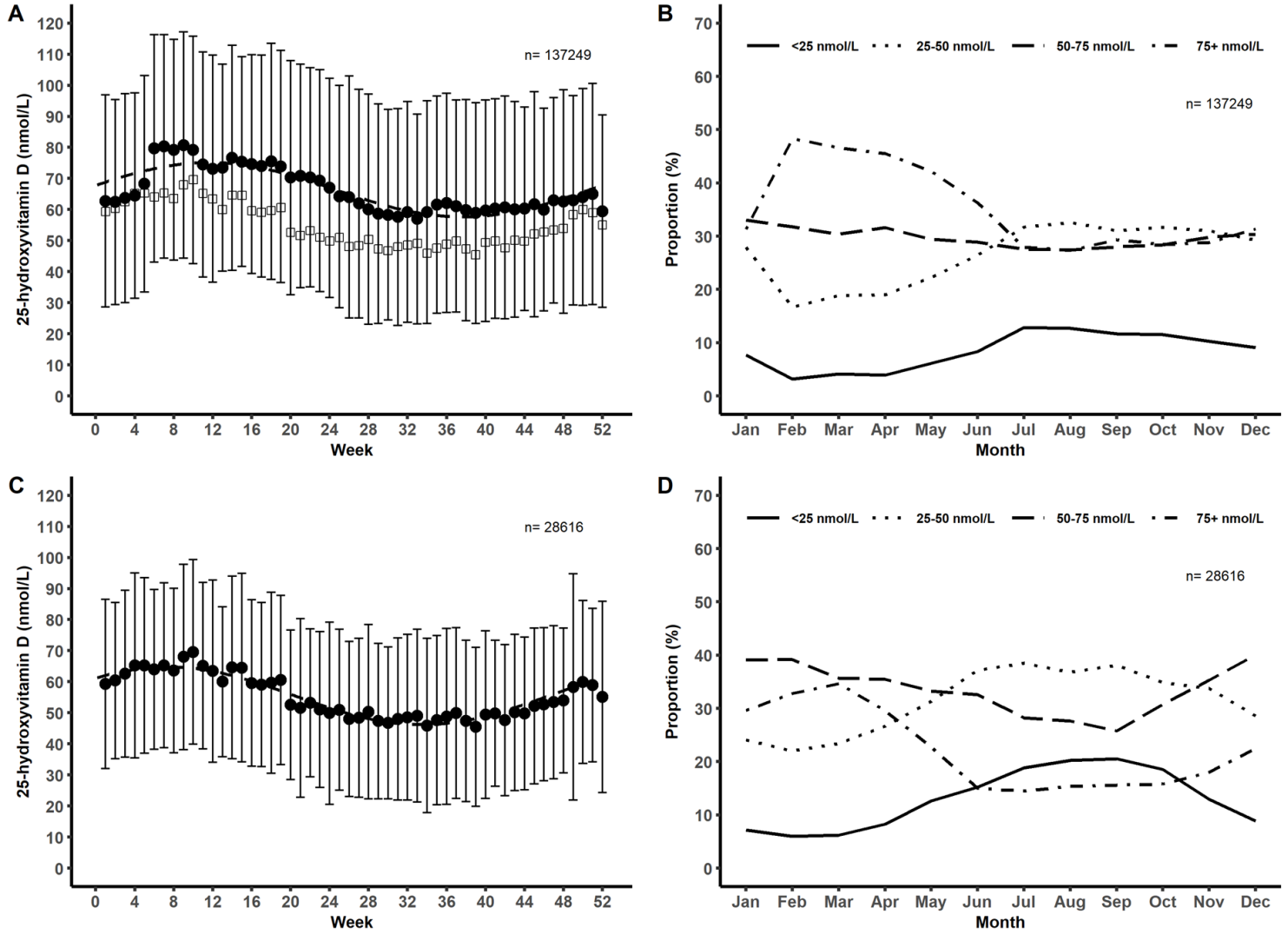
reported data on rickets due to vitamin D deficiency in New Zealand. In 1998, 18 children <5y with rickets due to vitamin D deficiency and 25OHD measurements <25nmol/L were identified in Auckland from hospital notes.[15] Although not explicitly stated, given the severity of their symptoms, all these cases likely had hospital care. A survey of New Zealand paediatricians between 2010 and 2013 identified 58 cases of rickets over 36 months in children <15 years.[16] Again, the number of hospitalisations was not reported, but based on the reported symptoms, it is likely the majority had hospital care. The approximate corresponding number of cases of rickets in this time-period, given the hospital discharge data, was 15, which suggests that the total number of cases of rickets in New Zealand is likely to be about four times the numbers generated from discharge coding. This suggests an ongoing rate of approximately 20 cases each year. The occurrence of 30 cases per year of these two preventable illnesses, despite annual vitamin D prescriptions increasing and exceeding 1.2 million in 2019, supports the view that different approaches to those currently being undertaken are required. Examples would include education programmes for high-risk groups, targeted supplementation programmes or food fortification.[17]

Vitamin D supplementation is widespread, even though the risk of rickets and osteomalacia is very low (and not being eradicated). So why are New Zealand practitioners increasingly prescribing vitamin D supplements? In the recent past, vitamin D has been promoted for the prevention of falls[18] and, in combination with calcium supplementation, for the prevention of fractures.[19] However, recent clinical trials have not found evidence that vitamin D (without calcium supplements) improves bone density[4,20] or prevents falls and fractures[4] or other extra-skeletal conditions[3,21–24] in populations with vitamin D insufficiency or sufficiency. Calcium supplementation is no longer recommended for fracture prevention because the risks outweigh the benefits.[25–28] This has led to changes in recommendations, such that vitamin D is no longer recommended for the prevention of falls or fractures.[28,29] If this guidance were followed and supplementation given only to individuals at high risk of osteomalacia or rickets or with specific medical indications,[12] it is likely that supplementation rates would decrease markedly without any harm arising, thereby producing a substantial saving to the health system.

There are several lines of evidence from randomised controlled clinical trials that allow the strong conclusion to be drawn that vitamin D supplementation of cohorts with baseline 25OHD >25nmol/L does not improve health outcomes. Firstly, meta-analyses of 81 trials show no effect from vitamin D on falls, total or hip fracture or bone density, and the majority of trials have been conducted in cohorts with baseline 25OHD between 25nmol/L and 50nmol/L (57%) or >50nmol/L (42%).[4] Secondly, in trials that report subgroup analyses by individual baseline 25OHD, vitamin D had no effect on falls, fractures or bone density in subgroups with lower baseline 25OHD, or no difference in effect from the subgroup with higher 25OHD.[4] Thirdly, when trials are grouped by their mean baseline 25OHD, there is no difference in effect from vitamin D between subgroups with lower and higher baseline 25OHD and/or no effect from vitamin D on falls, fractures or bone density in the subgroup with lower 25OHD.[4] Fourthly, there is no consistent evidence of non-musculoskeletal effects from vitamin D.[3,21–24] For the situation where cohorts have baseline 25OHD <25nmol/L, few trials have been carried out: before 2016, only 12 such trials had been reported with clinical endpoints, and eight of these had neutral outcomes.[30] Thus, for such populations there is insufficient evidence to draw conclusions regarding the effects of vitamin D supplementation, but individuals at high risk of osteomalacia or rickets should receive vitamin D supplements, as these conditions are readily preventable.

Vitamin D testing decreased by about 75% in Auckland following the introduction of specific restrictions by the testing laboratory. However, even with those restrictions, 25OHD tests still largely identify vitamin D sufficient individuals, with consistently only 8%–12% of test results being <25nmol/L. This suggests that further restrictions could be safely introduced to encourage appropriate testing of individuals at high risk of vitamin D deficiency. As vitamin D supplementation

Figure 4: (A) Mean (SD) 25-hydroxyvitamin D (25OHD) results by week of the year (January 1 = week 1) between 2009 and 2019 together with a sine curve line of best fit (dashed line). For comparison, the mean (SD) results from 2002–2003 (Figure 4C) are superimposed (open circles). (C) As for Figure 4A, but results from 2002–2003. (B) The proportions of measurements in each month for 2009–2019 grouped by 25OHD result (<25, 25–50, 50–75 or ≥75nmol/L). (D) The proportions of measurements in each month for 2002–2003 grouped by 25OHD result (<25, 25–50, 50–75 or ≥75nmol/L).



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is no longer routinely recommended in the management of osteoporosis, that criterion should be removed from testing indications.

A similar study undertaken in the United Kingdom also found increasing rates of vitamin D supplementation and testing, but still no decline in rates of hospital admissions for osteomalacia, rickets and undefined vitamin D deficiency.[17] To our knowledge, studies from other countries that address all these issues have not been reported.

An important limitation to these analyses is the change in population. The population of New Zealand increased in size by about 25% between 2003 and 2019. This change was not factored in any analyses. However, the size of the increase in prescriptions (14-fold) is much greater than the increase in population (1.25-fold), and the relatively few hospital admissions each year related to osteomalacia, rickets and unspecified vitamin D deficiency means that even random fluctuations of one or two cases a year are similar to or greater than the predicted effect of the increasing population size.

In summary, vitamin D supplementation is widespread and increasing steadily, but the conditions it is targeting, osteomalacia and rickets, persist at low rates. Likewise, vitamin D testing is frequently being undertaken in individuals at low risk of vitamin D deficiency. Taken together, this suggests that there is unnecessary testing and overtreatment and that vitamin D guidance and practice in New Zealand needs to change.

Competing interests:
None of the authors have any financial conflicts of interest, but all authors have co-authored randomised controlled trials and systematic reviews of the efficacy of vitamin D supplements and co-authored articles concluding that there is no role for routine vitamin D supplementation in community dwelling individuals.

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Workplace wellbeing in emergency departments in Aotearoa New Zealand 2020

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ABSTRACT

AIM: To quantify staff burnout and wellbeing in emergency departments (EDs) throughout New Zealand (NZ).

METHODS: A national cross sectional electronic survey of New Zealand clinical and non-clinical ED staff was conducted between 9 March and 3 April 2020. Burnout and wellbeing were assessed using the Copenhagen Burnout Inventory (CBI) and a variety of quantitative measures. Differences between measures were assessed by demography and work role using univariate analyses. Multivariate analyses assessed associations between burnout and wellbeing.

RESULTS: 1,372 staff responded from 22 EDs around New Zealand (response rate 43%). Most were female (n=678, 63%), NZ European (n=799, 59%), aged 20–39 years (n=743, 54%) and nurses (n=711, 52%). The overall prevalence of personal burnout was 60%, work-related burnout 55% and patient-related burnout 19%. There was a wide variation of burnout across all EDs. Females and nurses showed the highest degree of burnout by gender and role, respectively. Measures of wellbeing with significant negative correlations with burnout were work-related happiness, work-life balance, job satisfaction and perceived workplace excellence. Work stress had significant positive correlation with burnout.

CONCLUSION: New Zealand ED staff have a high degree of burnout. Safety, financial sustainability and quality of care are likely being adversely affected. Stakeholders can be informed by findings from this study to inspire meaningful interventions in EDs and throughout the New Zealand healthcare system.

Emergency department (ED) work involves high-pressure shift work, high patient volume, unsociable hours and critical decision-making with limited information. Patients and whānau are often physically and psychologically vulnerable in this environment and have rights to effective communication and services of an appropriate standard.[1] A culture of compassionate healthcare is critical to positive patient outcomes despite ED workplace challenges. The ED provides a perfect storm for staff burnout.[2]

Burnout is defined as "a state of vital exhaustion" in the International Classification of Diseases (ICD-11)[3] and is considered the most useful measure of barriers to professional wellbeing.[4] The importance of work to workers' health was illustrated by a 2018 New Zealand government inquiry into mental health, which identified that all workplaces have a critical role in promoting wellbeing.[5,6] This is enshrined in legislation that requires New Zealand employers to provide a mentally healthy workplace.[7]

Unlike for burnout, there is no universal definition of wellbeing or consistent way of measuring different constructs of wellbeing at work.[4] Te Whare Tapa Whā, a Māori vision of health, originally documented by Mason Durie in 1982, may be useful for ED staff in Aotearoa. This vision of wellbeing includes attention to taha tinana (the physical dimension), taha whānau (family health), taha hinengaro (mental health) and taha wairua (spiritual health).[8]

Current literature identifies that ED doctors have high levels of burnout compared to other specialties, up to 60% in some studies.[9] For example, a 2016 study of senior doctors in New Zealand (n=1,487) assessed burnout using the Copenhagen Burnout Inventory (CBI).[10] Along with psychiatrists, emergency physicians (n=102) had significantly higher mean work-related burnout scores than colleagues from other specialties.[10] A 2017 meta-analysis of international studies of ED nurses (n=1,588) estimated that 30% met at least one of the criteria for burnout as per the Maslach Burnout Inventory (MBI).[11] Other ED workgroups are less well studied: this was considered an important gap in the literature, and hence this study sought to include all staff groups within the ED.[12]

This work follows a 2018 pilot study (n=187) that measured burnout at Auckland City Hospital ED (AED).[13] Participants included doctors, nurses, clerical staff, orderlies and others. The proportion with high personal burnout was 42.1% (35.1%–49.3%, 95%CI), work-related burnout 35.0% (28.4%–42.1%, 95%CI) and patient-related burnout 27.9% (21.9%–34.8%, 95%CI). Of the doctors in this cohort (n=40), 30% met criteria for high personal burnout, and nurses (n=110) had the greatest proportion (50.9%) of personal burnout relative to other work groups. To the authors' knowledge, this remains the only peer-reviewed study involving all workgroups in a New Zealand ED.

The aim of this study was to assess burnout and wellbeing across New Zealand ED staff and identify subgroups with the greatest need of intervention. The design of the study allows repetition at future intervals to assess responses to wellbeing initiatives.

Methods

A national cross-sectional electronic survey of New Zealand ED staff, Workplace Wellbeing in Emergency Departments in Aotearoa New Zealand (WoWe@NZEDs 2020), was conducted between 9 March and 3 April 2020. The primary objective of the study was to quantify burnout in this national ED population. Secondary objectives were to measure ED staff wellbeing and identify at-risk subgroups.

A local site coordinator at each participating ED was recruited to promote the study, support and maximise participation and develop a sense of local ownership of the project. They were eligible for funding of up to NZ$1,500 per site. The survey was advertised three times in the Australasian College for Emergency Medicine (ACEM) bulletin, a weekly electronic newsletter sent to ACEM membership.

Participants were categorised into four work groups: nurse; doctor; other clinical (healthcare assistant, radiographer, phlebotomist, physiotherapist social worker); or non-clinical (cleaner, administration, orderly, security, others). EDs were categorised into ACEM training designation (major referral, regional referral, urban district, other) and patient census (based on annual presentation numbers, with ranges determined by the study authors).

The WoWe@NZEDs 2020 survey consisted of five sections: participant information and consent; demographic questions; burnout questions; other wellbeing questions; and a qualitative section constituted by six questions requiring open-ended responses (Supplement 1). This survey was based upon the survey instrument used in the 2018 pilot study in Auckland ED.[13] The qualitative results are reported separately.[14]

The CBI was used to assess three domains of burnout:

- Personal burnout: the degree of physical and psychological fatigue and exhaustion experienced by the person.
- Work-related burnout: the degree of physical and psychological fatigue and exhaustion that is perceived by the person as related to his/her work.
- Client-related burnout: the degree of physical and psychological fatigue and exhaustion that is perceived by the person as related to his/her work with clients.

Unlike other tools, the CBI enables participants to attribute the source of their exhaustion to work or other factors, including specifically to "clients" (patients) if relevant.[15] The CBI has previously been used in workforce studies in Australasia.[10,13] Participants were classified as having domain-related burnout if they scored 50 or more in that domain.

Wellbeing was measured against a variety of standards, including the Net Promoter Score (NPS). The NPS is based upon the question, "How likely are you to recommend this ED as a place to work?" A score of zero suggests respondents would warn people away from applying, and a score of 10 suggests that they would tell everyone they know to apply immediately. Scores of zero to six are designated as "detractors," seven and eight as "passives" and nine and ten are "promoters." Ultimately, NPS = (# of promoters – # of detractors) / total # of respondents.[16] Other measures of wellbeing were assessed using the questions shown in Supplement 1.

Burnout and wellbeing measures were compared between subgroups (demography, work group, ED ACEM designation and patient census) using Chi-squared or Fisher's exact tests for categorical variables and 1-way ANOVA or Wilcoxon summed rank tests for continuous variables. A two-tailed p-value <0.05 was taken to indicate statistical significance.

Ethics approval was granted by Auckland Health Research Ethics Committee (ref AH1164) and locality approvals were gained for each participating site. To ensure departmental anonymity, results were presented as percentages rather than absolute numbers. Departments were anonymised using sequential letters of the alphabet (letters A to V). The department with the highest prevalence of personal burnout was department A, and the department with the lowest prevalence department V (Figure 1).

The survey was accessed anonymously by participants using an electronic link emailed to local investigators for distribution electronically or in paper form. Survey data were stored on a REDCap (REDCap 9.4.1, 2020, Vanderbilt University, Nashville, Tennessee, USA) database, located on a secure server at the University of Auckland.

Results

A total of 1,372 participants from all staff groups responded from 22 EDs around New Zealand. The estimated response rate was 43% (see Supplement 2 for more details). Most participants were female (n=1,071, 78%), NZ European (n=799, 59%) and aged 20–39 years (n=743, 54%). Over half the cohort were nurses (n=711, 52%), and 7% were Māori (n=102). Demographic data for participants are shown in Table 1.

The overall prevalence of burnout was:

- Personal: 816/1,372, 59.5% (95%CI 56.9, 62.0)
- Work-related: 750/1,371, 54.7% (95%CI 52.1, 57.3)
- Patient-related: 265/1,366, 19.4% (95%CI 17.4, 21.6)

Mean burnout was:

- Personal: 51.5 (95%CI 50.5, 52.4)
- Work-related: 49.9 (95%CI 48.9, 50.9)
- Patient-related: 31.0 (95%CI 30.0, 32.0)

Table 2 shows the prevalence of burnout by demographic factors. Continuous data are provided in Supplement 4.

Annual census of patient presentations per annum and ACEM accreditation status of departments are reported in Supplement 3. Six EDs had an annual patient census over 50,000 (large), nine had 25,000–50,000 (medium) and the remaining seven had fewer than 25,000 (low). Although participants from large census departments had the highest prevalence of burnout in each domain, differences between departments, based upon annual census, were not statistically significant. Prevalence of burnout was similar in departments with medium and low annual patient census.

Staff working in major referral hospitals had the highest proportion of burnout in each domain and those in urban district departments had the lowest. These results were statistically significant for each burnout domain.

Burnout by gender showed statistically significant higher prevalence in females than males for personal and work-related burnout. The highest prevalence in all three burnout domains was in the "other" group (encompassing those identifying as transgender, non-binary, gender-diverse and those who preferred not to answer), although numbers in this group were small, which led to wide confidence intervals for burnout prevalence estimates. Participants with missing data for gender are not shown.

NZ Europeans had the highest proportion of participants with personal (63.0%) and work-related (57.9%) burnout. Māori

Table 1: Demographic data.

Participants		
Gender identity	**n**	**%**
Female	1,071	78.1
Male	287	20.9
Other	10	0.7
Missing	4	0.3
Total	1,372	100
Ethnicity		
NZ European	799	58.5
Other	322	23.6
Māori	102	7.5
Asian	101	7.4
Pasifika	41	3
Total	1,365	100
Age groups, years		
20–29	378	27.6
30–39	365	26.6
40–49	287	20.9
50–59	249	18.2
60 or above	87	6.3
Prefer not to answer	6	0.4
Total	1,372	100
Profession		
Nurse	711	51.8
Doctor	364	26.5
Clerical	158	11.5
Other	65	4.7
Healthcare assistant	41	3
Security	16	1.2
Orderly	12	0.9
Cleaner	3	0.2
Missing	2	0.2
Total	1,372	100

Table 1: Demographic data (continued).

Participants		
Doctor role		
Specialist	142	39.2
Registrar	102	28.2
House surgeon	89	24.6
MOSS*	19	5.2
Fellow	7	1.9
Other	3	0.8
Missing	2	0.6
Total	364	100
Medical specialty		
Emergency medicine	319	88.1
Other	32	8.8
Rural hospital generalist	11	3
Missing	2	0.6
Total	364	100
Nurse role		
Level 4	235	33.2
Level 3	158	22.3
Level 2	112	15.8
Senior nurse (eg, NUM)	103	14.6
Advanced nurse (eg, NP, CNS)	55	7.8
Other	24	3.4
New graduate	18	2.5
Enrolled nurse	2	0.3
Missing	4	0.6
Total	711	100

*MOSS = Medical Officer of Specialist Scale. NUM = Nurse unit manager. NP = Nurse practitioner. CNS = Clinical nurse specialist

Table 2: Prevalence of burnout.

	Personal n % (95%CI)	**Work-related n % (95%CI)**	**Patient-related n % (95%CI)**
Department census			
>50,000 (large)	445/698 63.8% (60.1, 67.3)	416/697 59.7% (55.9, 63.4)	154/695 22.2% (19.1, 25.4)
25,000–50,000 (medium)	286/505 56.6% (52.2, 61.0)	259/505 51.3% (46.8, 55.7)	79/503 15.7% (12.6, 19.2)
<25,000 (low)	85/169 50.3% (42.5, 58.1)	75/169 44.4% (36.8, 52.2)	32/168 19.0% (13.4, 25.8)
p=	p=0.19	p=0.08	p=0.07
ACEM designation			
Major referral	394/605 65.1% (62.2, 68.0)	371/604 61.4% (58.5, 64.3)	144/602 23.9% (21.3, 26.5)
Urban district	126/243 51.9% (45.8, 58.0)	100/243 41.2% (35.2, 47.2)	26/241 10.8% (7.0, 14.6)
Regional referral	222/383 58.0% (53.23, 62.8)	209/383 54.6% (49.8, 59.4)	65/383 17.0% (13.4, 20.6)
Other	74/141 52.5% (44.4, 60.6)	70/141 49.6% (41.5, 57.7)	30/140 21.4% (14.7, 28.1)
p=	p=0.001	p<0.001	p<0.001
Gender			
Male	128/287 44.6% (39.1, 50.2)	131/287 45.6% (40.0, 51.2)	56/286 19.6% (15.2, 24.0)
Female	678/1,071 63.3% (60.8, 65.8)	609/1,070 56.9% (54.3, 59.5)	202/1,066 18.9% (16.9, 20.9)
Other	7/10 70.0% (41.6, 98.4)	7/10 70.0% (41.6, 98.4)	5/10 50.0% (19.0, 81.0)
p=	p<0.001	p=0.002	p=0.046

Table 2: Prevalence of burnout (continued).

	Personal **n** **% (95%CI)**	**Work-related** **n** **% (95%CI)**	**Patient-related** **n** **% (95%CI)**
Ethnicity			
NZ European	503/799 63.0% (60.0, 66.1)	463/799 57.9% (54.8, 61.0)	152/796 19.1% (16.6, 21.6)
Māori	51/102 50.0% (40.4, 59.6)	49/101 48.5% (38.9, 58.1)	12/100 12.0% (5.8, 18.2)
Asian	52/101 51.5% (41.9, 61.2)	46/101 45.5% (35.9, 55.1)	16/101 15.8% (8.8, 22.8)
Pasifika	23/41 56.1% (41.0, 71.2)	23/41 56.1% (41.0, 71.2)	10/41 24.4% (11.3, 37.5)
Other	182/322 56.5% (51.3, 61.7)	163/322 50.6% (45.3, 55.9)	72/321 22.4% (18.0, 26.8)
p=	p=0.019	p=0.032	p=0.140
Age			
20–29	223/378 59.0% (54.2, 63.8)	204/377 54.1% (49.3, 58.9)	83/375 22.1% (18.1, 26.1)
30–39	231/365 63.3% (58.5, 68.1)	203/365 55.6% (50.7, 60.5)	74/364 20.3% (16.3, 24.3)
40–49	176/287 61.3% (55.8, 66.8)	159/287 55.4% (49.8, 61.0)	54/286 18.9% (14.5, 23.3)
50–59	141/249 56.6% (50.6, 62.6)	139/249 55.8% (50.0, 61.8)	41/249 16.5% (12.0, 21.0)
60+	41/87 47.1% (36.7, 57.5)	41/87 47.1% (36.7, 57.5)	12/86 14.0% (6.8, 21.2)
p=	p=0.061	p=0.668	p=0.283

Table 2: Prevalence of burnout (continued).

	Personal **n** **% (95%CI)**	**Work-related** **n** **% (95%CI)**	**Patient-related** **n** **% (95%CI)**
Role			
Nurse	489/711 68.8% (65.7, 72.0)	447/710 63.0% (59.7, 66.3)	183/709 25.8% (22.8, 28.8)
Doctor	184/364 50.5% (45.6, 55.5)	174/364 47.8% (42.9, 52.7)	49/362 13.5% (10.1, 16.9)
Non-clinical	92/192 47.9% (41.0, 54.8)	87/192 45.3% (38.4, 52.2)	25/190 13.2% (8.5, 17.9)
Other clinical	49/103 47.6% (38.1, 57.2)	40/103 38.8% (29.5, 48.1)	8/103 7.8% (2.7, 12.9)
p=	p<0.001	p<0.001	p<0.001

had the lowest proportion of participants with personal burnout (50.0%), and Asian participants had the lowest proportion of work-related burnout (45.5%). Pasifika participants had the highest proportion of patient-related burnout, although differences in patient-related burnout by ethnicity were not statistically significant.

Age-related prevalence of burnout was not statistically significant. Participants aged 60 years and over showed the lowest rates of burnout in all three domains.

Differences in the proportion of burnout between workgroups were statistically significant for all burnout domains. In each domain, nurses had the highest proportion of burnout (68.8% personal burnout, 63% work-related burnout, 25.8% patient-related burnout), followed by doctors and non-clinical staff, with other clinical staff having the lowest proportion.

Figure 1 shows the range of prevalence of burnout across individual departments. There was a wide range in the prevalence of personal burnout, from 39% (95%CI 22–59) in department V to 87% (95%CI 52–98) in department A.

As outlined in the methods section, the Net Promoter Score (NPS) is based upon the question, "How likely are you to recommend this ED as a place to work?" There were 472 (35.8%) detractors, 494 neutrals and 353 (26.8%) promoters, giving an NPS of -9.0% (26.8%–35.8%). Table 3 demonstrates that those with burnout ("yes") scored the NPS question lower than those without burnout ("no") in all domains of burnout.

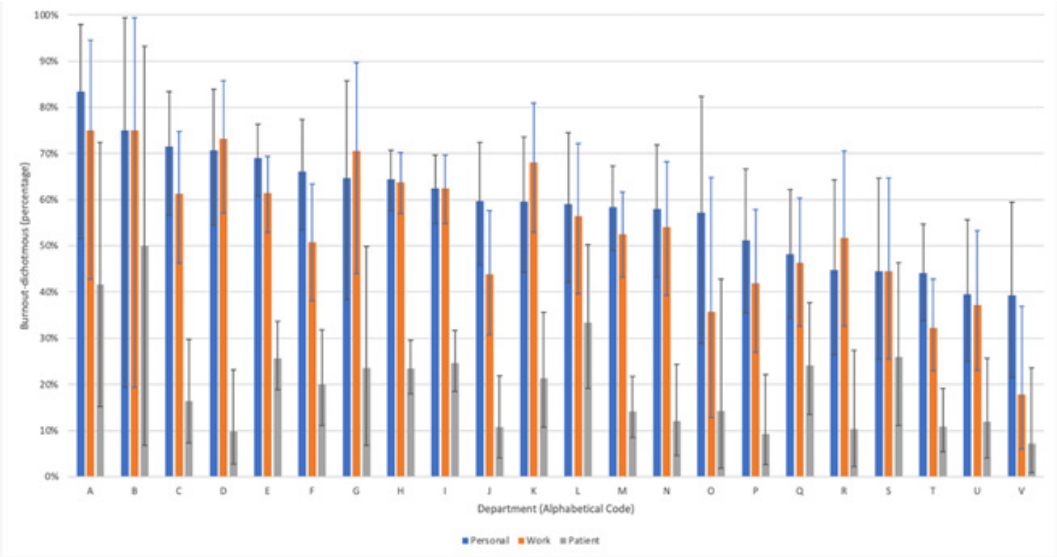
When compared to burnout, participant responses to the NPS question were inversely correlated with all domains of burnout (all p<0.001):

- Personal: n=1,319, r=-0.465
- Work-related: n=1,319, r=-0.538
- Patient-related: n=1,318, r=-0.373

That is, as mean burnout scores increased, scores on the NPS question decreased. The results of other wellbeing questions and their correlations with mean burnout are found in Supplement 5. Of these measures, the negative correlation between happiness and personal burnout showed the largest magnitude (Figure 2).

Measures of wellbeing with clinically and statistically significant negative correlations to work-related burnout were work-related happiness, work–life balance, job satisfaction and perceived workplace excellence, whereas work stress had a significant positive correlation (ie, as work stress scores increased, work-related burnout

Figure 1: Prevalence of burnout in each emergency department.



scores increased). Work motivation was significantly negatively correlated with patient-related burnout.

Discussion

Staff burnout is considered a risk to the provision of safe high-quality healthcare.[17] Although personal resilience factors must be optimal, system approaches are considered necessary for meaningfully and sustainably addressing burnout in healthcare.[17] This study demonstrates a high prevalence of burnout in New Zealand EDs. The highest rates of personal burnout were reported in nurses, NZ Europeans, those working in major referral centres or larger departments and respondents whose gender identity was female or other.

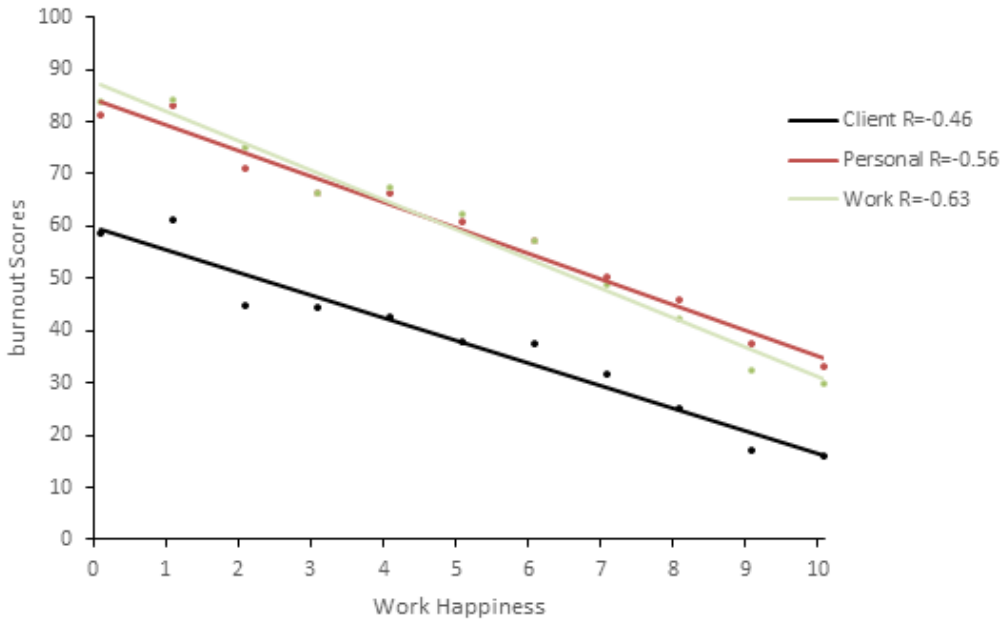
Burnout in this study (personal burnout 59.5%, work-related 54.7%, patient-related 19.4%) was higher than other recent studies using the CBI. The 2019 ACEM workforce survey (n=749) demonstrated a high prevalence of personal burnout (45%), work-related burnout (50%) and patient-related burnout (13%).[18] The 2015 Association of Salaried Medical Specialists (ASMS) survey (n=1,487) found burnout prevalence in each domain was 50%, 42% and 15% respectively.[10] And a single site NZ ED study (n=187) from 2018 demonstrated burnout prevalence was 42%, 35% and 28%.[13]

Of particular concern to the authors is the very high prevalence of work-related burnout (63.0% 95%CI 59.7, 66.3) in the nursing cohort (n=711). Given the relative size of this workforce (52%) in New Zealand EDs and the importance of excellent nursing in the provision of high-quality patient care, this must be of concern to all stakeholders. In addition to the clinical, moral and ethical

Table 3: Net Promoter Score and correlation with burnout.

	Type of burnout								
	Personal			**Work-related**			**Patient-related**		
	Yes	No	p	Yes	No	p	Yes	No	p
Mean (SD) score (0–10)	6.2 (2.5)	7.9 (2.0)	<0.001	5.9 (2.5)	8.0 (1.8)	<0.001	5.6 (2.4)	7.2 (2.4)	<0.001

Figure 2: Work happiness and burnout.



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concerns of the largest group in the New Zealand ED workplace demonstrating such a high prevalence of burnout, the financial burden of nurse turnover, although difficult to assess,[19] means the current state of burnout in the New Zealand ED workforce may be financially unsustainable. Investment that improves the wellbeing of New Zealand ED staff, particularly nurses, may make financial sense. As far as the authors are aware, the legal implications of district health boards providing what are arguably mentally unhealthy workplaces are untested. [5,7]

The authors are not aware of any similar multi-centre ED study on burnout with which to compare these results. This gap in the literature relating to the need to include all workgroups, as highlighted by Dyrbye,[12] was one of the inspirations for the study. A strength of this study is that all ED staff groups were eligible and encouraged to participate, unlike other studies, which have focused only on individual staff groups. Despite this, staff who were neither nurses nor doctors were under-represented in this survey, with only three cleaners and 16 orderlies having responded. These findings likely reflect a systematic problem with engaging some staff groups in the research, which should be addressed in future research efforts.

Those who identified as female or grouped as other reported significantly higher rates of burnout compared to their male colleagues. The gender distribution of the population from which the sample was taken was not collected in this study. Only 8% of nurses in New Zealand identified as male in the latest report from the New Zealand Nurses Organisation (NZNO).[20] That 52% of respondents in this survey were nurses (a numerically female dominated occupation) explains the high proportion of females (n=678, 63%) in this study.

Other studies have demonstrated that females are more at risk of work-related burnout compared to male colleagues.[21–23] Females are more likely to be dissatisfied with their work–life balance and experience anxiety and depression relating to work stressors.[22,23] Female physicians are more at risk of gender discrimination, sexual harassment, imposter syndrome (the inability to believe that one's skills, knowledge or success is deserved) and depression, all of which predispose them to burnout.[23] Furthermore, women are more likely to have partners in full-time employment, to perform domestic household tasks and to provide childcare, all of which increase time pressures and reduce self-care opportunities.[22]

An important limitation regarding gender differences and burnout in the available literature is the use of gender as a predominantly binary variable. This does not necessarily recognise the unique challenges of the ED workforce who are members of the LGBTQI+ community. Evidence shows these groups are at increased risk of discrimination and harassment[24] that likely increase risk of burnout; further research is needed in this area. Transgender, non-binary and gender-diverse staff with supportive supervisors have increased job satisfaction, highlighting the need to promote inclusive workplace cultures.[25]

The timing of this study is a noteworthy limitation to the generalisability of these results. The first nationwide COVID-19 pandemic lockdowns occurred during the study period. This likely had some effect on the results; however, it is debatable whether the lockdowns worsened or improved burnout. Regardless, the effects of the pandemic are still ongoing in New Zealand, and the authors suspect work conditions in New Zealand EDs are unlikely to have improved since the period of study. A repeat study, planned in 2022, may help clarify this.

Non-responder bias is an important limitation of this study, but neither the magnitude nor the direction of this bias is clear. Denominator data from the participating EDs were challenging to obtain and incomplete for 14 of the 22 participating EDs. At the eight sites where denominator information was available, the response rate was high (613/1,425, 43%) compared to similar studies.[10,13,18]

This first nationwide study of New Zealand ED staff found a high degree of burnout, particularly among nurses. Burnout is likely having a deleterious effect on the quality of care provided. Workplace wellbeing in healthcare must be of concern to staff themselves as well as to patients, whānau, employers, policymakers and government. Employers have a legal obligation to provide a healthy working environment.[7] At a

minimum, these results may provide some degree of objectivity to inform discussions among stakeholders about burnout and wellbeing in the health sector. Although an investigation of potential solutions is beyond the scope of this study, it is hoped that these findings may help inform and inspire much-needed meaningful interventions in New Zealand EDs and elsewhere throughout the New Zealand healthcare system. This is particularly timely given upcoming health system reforms.

Author contributions

MN conceived and designed the study and supervised data collection. This formed the basis of a dissertation for a Master of Health Sciences at the University of Auckland. CF performed all data analysis. SH drafted the manuscript, and all authors contributed to previous versions. All authors read and approved the final draft.

Supplementary material

- Supplements 1, 2 and 3: survey questions, response rate and departments
- Supplement 4: continuous data
- Supplement 5: burnout (mean) and wellbeing correlations

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Nil.

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Publicly reported health performance measures 2010–2020

Colin F Thompson

ABSTRACT

AIM: Performance measurement is central to healthcare management in many countries. The aim of this study was to determine whether performance measurement in a New Zealand healthcare organisation met a range of criteria supported by healthcare management literature.

METHOD: Performance expectations published in statements of intent and annual plans from an 11-year period were analysed for evidence of continuity, accuracy, effectiveness, patient centredness and clinical relevance.

RESULTS: 731 distinct performance measurements were identified. 48% were measured only once. Of those where comparison was possible, 21.9% met at least one expected target or range. In published reports there was limited reference to data verification methods, tests of significance, prospective linkage to actions, counterbalancing measures, application of benchmarks or standards, or patient measure prioritisation.

CONCLUSIONS: These findings suggest that healthcare organisations do not find performance measurement easy. This may be due to the wrong choice of measures, inappropriate targets, incomplete analyses or difficulty in linking measurement results to actions.

In the 1980s, many OECD countries reformed management of their publicly funded services with New Public Management.[1,2] New Public Management aimed to introduce best business practices from for-profit organisations into the non-profit sector. It was expected there would be improvements in performance and output through reductions in hierarchy, increased hands-on and entrepreneurial management, the application of private sector financial instruments, increased customer orientation, the introduction of managerial expertise, competition and the application of explicit standards and measures of performance.

Many features of New Public Management are incorporated in the organisation of New Zealand's 20 publicly funded district health boards (DHBs). A central component is the measurement of healthcare performance. The Crown Entities Act 2004 requires each DHB to provide statements of intent and annual reports on the performance of the hospital and its related services. Since July 2011 each DHB has also been required to provide an annual plan[3] that includes performance data.

But recently questions have been raised about DHB performance management. In 2016, for example, the New Zealand Ombudsman called for improved reporting of quality-of-care measures,[4] and yet there remains uncertainty about how performance management contributes to healthcare efficiency and effectiveness.[5] Suggestions have been made as to what is required for good measurement,[6] but there has been little research into the degree to which healthcare organisations follow these recommendations.

Using publicly reported performance measures, this audit assesses whether data from a single DHB demonstrate continuity, patient centredness, accuracy, effectiveness and clinical relevance.

Method

Statements of intent and annual plans for the DHB were viewed for the 11 financial years 2010/11 to 2020/21. In most years, the non-financial measures reported in the statements of intent were identical to those in the annual plans, but where there

was inconsistency, the measure recorded in the statement of intent was analysed. The four-year period 2014–2018 was represented by a single statement of intent. Therefore, all measures for those years were drawn from the annual plans. Measures published in the reports were usually accompanied by a short description, a baseline value then one or more expected annual targets or ranges.

Continuity was evaluated by the number of times a directly comparable measure was repeated in subsequent years. In some cases, one measure could be calculated from other measures, but this was not considered to be continuous reporting due to the reduced accessibility.

Patient-centredness was assessed by the balance of outcome to process measures. Process measures with a strong evidence-based connection to beneficial patient outcomes (eg, childhood immunisation percentages or cervical screening rates) and measures of patient experience or quality of life were re-classed as outcome measures. Projected service load figures were classed as process values. Any reference to patient involvement in measurement choice was classified as patient-centredness.

Accuracy, *effectiveness* and *clinical relevance* were assessed using content analysis software (QDA Miner 6.0, Provalis Research, Montreal) at a theme level of analysis. A deductive approach was used with predefined categories, codes and coding rules. Codes and search terms for each category are shown in Table 1. Accuracy of a measure was determined if there were any supporting references to validity, reliability or generalisability.[7] Effectiveness was determined by reference to a benchmark, standard, counterbalancing financial, time or opportunity measure, or alignment with a Ministry of Health (MoH)[8] or the Health Quality and Safety Commission (HQSC)[9] measure.

The presence of an action statement dependant on the result was deemed to support clinical relevance as targets had been described by the DHB as "expectations." Trends in the direction of the target were also classed as clinically relevant. These were assessed by transforming non-denominator measures repeated four or more times into percentages of the maximum achieved values. The averages of these percentages were then graphed. Separate graphs were prepared for measures with expected positive and negative trends, as these may have been susceptible to separate biases. Clinical relevance was also assessed by how often actual values agreed with the expected value or range for that year. Only expected values of two or more years in advance were included as often the one-year expected value had already become an actual value by the time of finalisation of the statement of intent or annual plan. The most recent actual values used in the 2020–2021 annual plan were from the 2018–19 reporting period.

Categorical variables were analysed using the Chi-squared test, and linear regression was used to assess significance of trends over time. A p-value of ≤0.05 was considered statistically significant.

Ethics committee approval was not sought.

Results

Between 2010/11 and 2020/21, the DHB published 731 distinct performance measures:

- Prevention services: 229
- Early detection and management: 208
- Intensive assessment and treatment: 160
- Rehabilitation and support: 134

Continuity

Three hundred and forty-nine measures (48%) were not repeated, 122 (17%) were repeated once and 102 (14%) repeated four or more times (Figure 1).

Patient-centredness

Five hundred and thirty-two of the 731 measures (72.7%) were assessed as processes and 199 (27.2%) as outcomes. Of the 160 measures where a target value or range was achieved, there were similar proportions of processes (73.1%) and outcomes (26.9%). Measures repeated four or more times were more likely to be outcomes than measures repeated less frequently (21.1% vs 12.7%, p<0.001). MoH and HQSC measures were more likely to be outcomes than non-MoH or non-HQSC measures (59.5% vs 11.7%, p<0.001).

Accuracy

Forty-three measures had one or more accompanying references supporting accuracy. Examples were a reference to a data source or a comment on capture methodology. There were no references to the application of statistical significance methods.

Effectiveness

Through content analysis, five measures referenced a standard, benchmark or national registry. Examples included a standard for screening the hearing of newborns and a MoH dataset. A further 172 corresponded (28 identically) with the MoH's 2020 performance measures and four with the HQSC inpatient experience survey. There were no references to specific counterbalancing costs, but aggregated financial costs were presented in the annual financial performance measures. There were 14 measures of counterbalancing non-financial costs of which 13 were readmission rates.

Clinical relevance

One or more target ranges or goals were achieved in 160 (21.9%) of the 731 measures. There were 1,025 data pairs where an actual value was available for comparison with an expected value or range. The expected value or range was achieved in 329 data pairs (32.1%). Among measures repeated four or more times, MoH and HQSC measures were not more likely to be achieved than non-MoH or non-HQSC measures (p=0.13). Outcome measures were also no more likely to be achieved than process measures. Fourteen of 42 outcome measures had 50% or more of expected values achieved compared with 29 of 60 process measures (p=0.13). Public health measures were less likely to be achieved than non-public health measures (21.7% vs 48.1%, p=0.024). There was a non-significant trend towards increasing values in measures that were expected to increase (p=0.19) (Figure 2) but a significant decrease in values in measures expected to decline (R^2=0.47, p=0.043) (Figure 3). No measures referenced a specific action being dependent on measurement result. Seventy-five measures referred to a general action such as a DHB smoking action plan or an equity programme.

Discussion

This survey of one healthcare organisation's publicly available performance measures showed that 48% were not followed-up over time and that, where comparison was possible, only 21.9% (32.1% of all data pairs) achieved the expected goal or range. There was little supporting reference to patient-centredness, accuracy, effectiveness or clinical relevance. Data verification methods and counterbalancing measures were infrequently reported; there was no reporting of tests of significance. Most performance measures were process measures without clear links to outcomes. Few measures had a benchmark, published standard or historical series for setting expected goals. However, the 172 measures

Figure 1: Numbers of measures repeated in subsequent years.

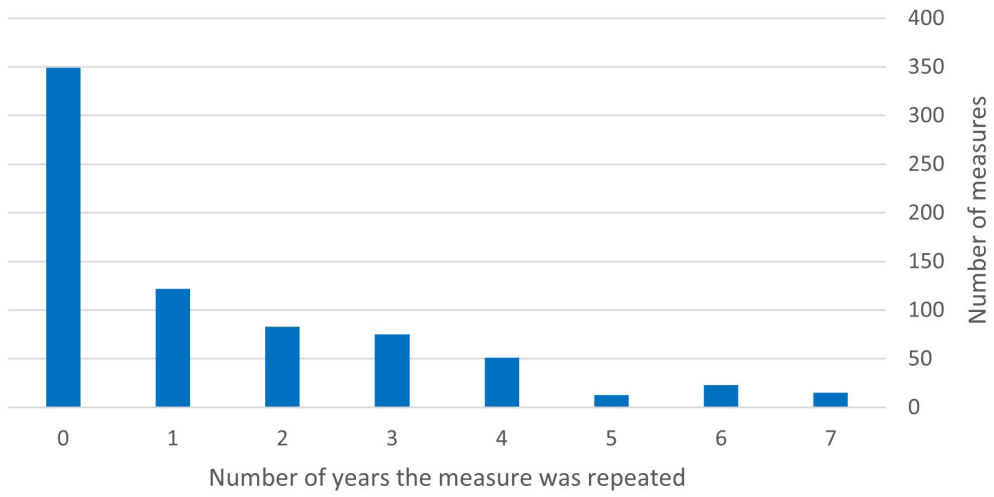


Figure 2: Time trend of measures expected to increase (by financial year).

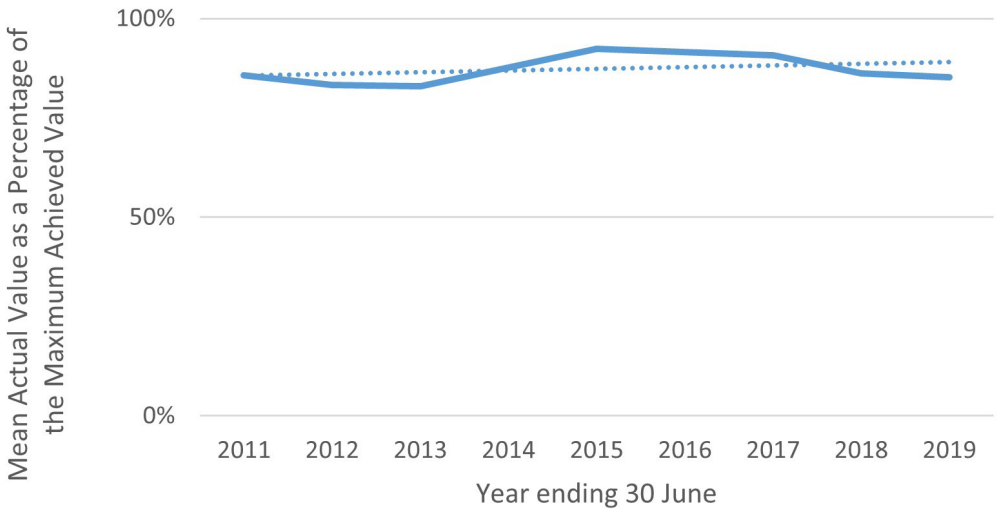
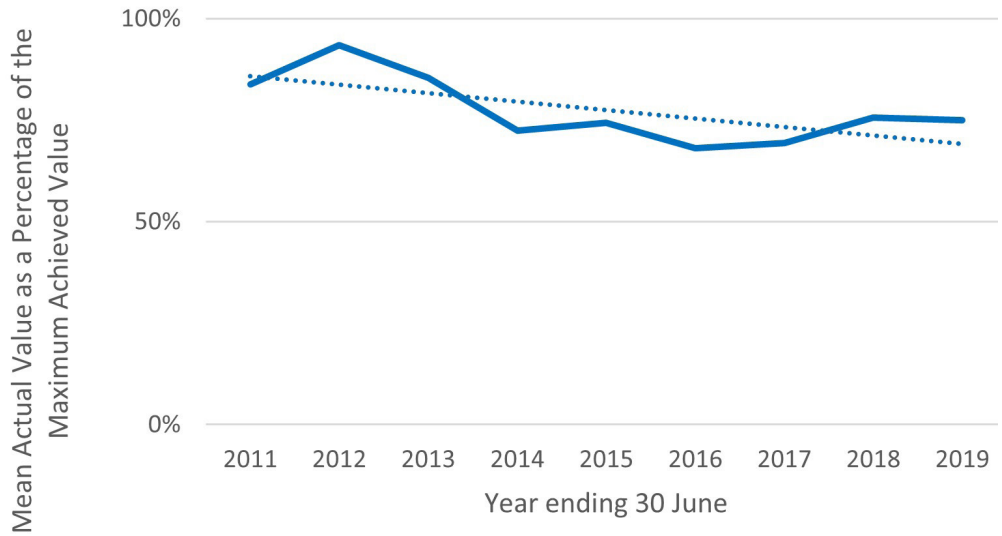


Figure 3: Time trend of measures expected to decrease (by financial year).



corresponding to MoH performance measures and the four HQSC patient experience measures allowed comparison with national data. During the 11 years that were reviewed, there was no significant increase in values expected to rise but a significant reduction in values expected to decrease.

There do not appear to be other similar audits of a single healthcare organisation in the literature. Targets and measures used by the UK's National Health Service (NHS) have been reported as improving some outcomes[10] but were not confirmed in a New Zealand setting.[11,12] Improved outcomes in other settings might be explained by clinician and patient co-designed indicators acting upon reputation.[13]

Multiple concerns have been raised about the use of performance measures in healthcare. In the NHS there are examples of fixation on the target rather than the underlying issue, as well as devaluation of unmeasured performance, short-term focus, difficulty dealing with rapidly changing environments, preference for quantitative evaluation over qualitative, inequity caused by over-rewarding and under-rewarding, oversimplification, acceptance of mediocrity, self-perpetuation of excellence by attraction of funding and staff, data misrepresentation, gaming, incorrect deductions, undermining of trust by patients and staff and the misuse of data by local and national healthcare governance bodies.[14–17]

Others have noted difficulties comparing data from different sources and in attributing differences.[18] Measurement oversight may be distributed, resulting in no clear line of responsibility. Time and money may be wasted if measures are not effective.[19] Confusion may occur from lack of agreement between measures,[6] and too much reliance may be put on process measures without enough on outcomes. Furthermore, clinical priorities may not even be suitable subjects for targets.[20]

Criteria have been suggested to improve performance measures. Measures should centre on the patient,[21,22] include quality-of-life measures and patient-reported outcomes, encompass a variety of care types,[23] be clinically relevant and clinically credible,[4] balance standardisation with variety[21] and address questions contributing to informed consent.[24] Measures should also address effective team working, the voice and influence of doctors, compassionate leadership,[25] allocative efficiency and aspects of service orientation such availability, affordability, approachability and acceptability.[26] There should be control groups, costs should be included,[23] the data accurate, appropriate tests of significance applied and measures publicly reported.[6] Results should be timely or even real-time,[27] be systematically analysed[21,28] and used to support local learning and continuous improvement.[11,15]

Table 1: Codes and search terms used in content analysis.

Category	Codes	Search terms	Number of measures
Accuracy	Validity, reliability, generalisability	Quality, data, accurate, consistent, reliable, dependable, statistic, credible	43
Effectiveness	Benchmark, standard, counterbalancing time measure, counterbalancing financial measure, counterbalancing opportunity measure, registry, dataset	Benchmark, standard, registry, dataset, cost, opportunity	5
Clinical Relevance	Accompanying pre-specified action	Action, dependant	0

A strength of this study is that it has been able to follow goals and repeated measures systematically over several years in a defined, consistent environment. Despite some changes in management over the study period, there were few infrastructure or care-delivery changes to confound the data. The organisation's planning teams had access to the data and also the means to apply the results to healthcare strategy.

A limitation to this study is that it only studied publicly available documents and so may have missed more robust data in documents only available to the DHB's strategic planning department or MoH. References to data accuracy, patient involvement, effectiveness or clinical relevance may have been omitted due to space constraints, although with documents being up to 175 pages in length, size may not have been an issue. Omission may have also been due to a desire to maintain public readability despite evidence that the public's response to performance measurements[6] may be less important than the effect on the organisation's reputation.[13] Although a conservative approach was taken in classification, and since validity might be expected to increase with the deductive approach, classification was still subjective and would be expected to be improved with independent coders. The study was of a single DHB so may not be generalisable to other DHBs.

These results suggest that healthcare organisations may have difficulty in applying what has been learnt about performance measurement. The difficulties in continually measuring data may be due to uncertainty about the value of the measures, the cost of repeated measurement or the scarcity of clinically oriented analytics staff. Healthcare is a complex adaptive system[21] requiring whole-of-healthcare measurement[29] and subject to competing interests from multiple stakeholders. The failure to achieve expected targets may be due to the wrong choice of measures (not patient focused, clinically relevant or proven to enhance patient outcomes) or due to failure to appropriately analyse and apply the findings to healthcare improvement processes. Improved performance measurement will be necessary in any strategy to improve healthcare productivity[30] and to move healthcare organisations from a product-dominant logic to a service-dominant system.[31]

Recommendations

Statements of intent and annual plans are important documents for public accountability. The vast range of services and transactions in a DHB cannot be fully captured, so accountability reporting should focus on headline patient-reported outcome measures prepared in partnership with clinicians and management. Because performance measures not only measure benefits and harms, they may cause harm themselves. They therefore need to be specific, measurable, relevant, time-bound and evidence-based, but also fully evaluated to demonstrate benefit against a rubric that includes trustworthiness, patient-centredness and effectiveness. They should be measured consistently until formal review indicates they are no longer useful. Results should be visibly linked to specific actions in the statements of intent and annual plans. There should be a balance of service, quality and cost measures. Healthcare systems are rich in data but poor in critical analysis. Therefore, until further evidence is gained on specific measures, consideration should be made of discontinuation of some measures to avoid harms related to information overload or incorrect conclusions. Specific performance measures using the same appropriateness criteria can be used for individual services or shared services.

Further research should look at barriers to involvement of patients and clinicians in the initiation, management and analysis of performance measures. There should be study on how to improve linkages between measures and actions and continued research into defining which measures directly improve outcomes.

Competing interests:
Dr Thompson reports they have been a party to discussions with management on improving DHB information quality.

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Barriers and solutions to trainee-led research collaboratives in New Zealand

STRATA Collaborative

ABSTRACT

This article seeks to describe our experience enabling large-scale collaborative studies within trainee-led surgical research networks, to highlight systemic barriers to the use of this methodology and to propose solutions that will facilitate trainee-led collaborative research in New Zealand.

The New Zealand Government's Health Research Strategy 2017–2027 aims to create a "vibrant research environment in the health sector" guided by the principles of research excellence, transparency, partnership with Māori and collaboration.[1] This strategy presents a valuable opportunity for us to determine the values and principles that guide collaborative clinical research in New Zealand.

Our experience enabling large-scale surgical studies within trainee-led networks has revealed several systemic barriers to research. What are these barriers and how do we get through them?

Trainee-led collaborative research networks

Trainee-led collaborative research networks are made up of teams of data-collectors, supported by supervisors, national leads and a steering committee. The collaborators range in clinical seniority from medical students to consultants. By working together, novice researchers can access expert mentorship and deliver high-quality research outputs while gaining research expertise, all within the time constraints of combining research with clinical work.[2]

The success of the networks is underpinned by their flat authorship model that encourages contribution from all collaborators and delivers equal recognition to each. This approach recognises that modern research is a team-based endeavour.

The specific trainee-led model of surgical research networks discussed in this article was first developed in the UK in 2007. Adoption of the model was rapid and widespread, such that 238/241 (99%) of the UK's gastrointestinal (GI) surgery centres had been involved in trainee-led collaborative studies by 2017.[3] As well as facilitating collaboration and patient participation, trainee-led collaborative networks in the UK have delivered high-quality, large-volume and practice-changing observational and interventional studies.[4,5]

To support the development and conduct of such collaborative trials and establish trainee-led networks in our region, the Royal Australasian College of Surgeons formed the Clinical Trials Network Australia and New Zealand (CTANZ).

In New Zealand, the Surgical Trainee Research Audit and Trials Aotearoa (STRATA) network successfully designed and enabled the Rural and Urban Risks of Appendicitis Complications (RURAL) study, a prospective multi-centre observational study of outcomes in paediatric appendicitis, and the Rib Fractures in Blunt Thoracic Trauma: New Zealand Management and Outcomes (RiBZ) study, a prospective multi-centre observational study of outcomes in isolated thoracic trauma. We are now designing the next nationwide cohort study to investigate outcomes after cholecystectomy.

New Zealand trainees have also made significant contributions to large international collaborative studies, such as REspiratory COmplications after abdomiNal surgery (RECON),[6] Ileus Management International (IMAGINE),[7] GlobalSurg-CovidSurg Week, and an audit of management of acute CHOLEcystitis during the COVID-19 pandemic (CHOLECOVID).

GlobalSurg-CovidSurg Week was a prospective cohort study that investigated the excess post-operative mortality and morbidity in patients with COVID-19. It is the largest prospective surgical study ever undertaken, with 14,000 collaborators including 99 New Zealanders and over 150,000 patients from 122 countries. The resulting papers have been published in high-impact journals and widely published in the local and international media.[8,9]

By collaborating in national and international cohort studies, New Zealand trainees gained valuable research skills and experience. During this early period of New Zealand's involvement in collaborative research, development of the governance and management structures that underpin the STRATA network has been ongoing and, like the UK networks, the ambition has been to develop and conduct home-grown national and international studies.

National barriers

Clinical studies in New Zealand require national ethical approval and locality approval from the individual district health boards (DHBs) they take place in. We are fortunate to have the New Zealand Health and Disability Ethics Committees (HDEC) that provide a national process ensuring proposed research meets established ethical standards.[10,11] Studies deemed ineligible for HDEC oversight, for example because they are classified as an audit activity, receive ethical review from regional committees. The National Ethics Advisory Board (NEAC) also offers several other pathways for ethical review, like the University of Otago Ethics Committee (Health), which reviews studies deemed "out of scope" by the HDEC.

But this multitude of non-centralised pathways that similar studies may go through, and the diverse national standards, may result in inconsistent reviews and conflicting requirements of study protocols.

This is exemplified by significant variations in the outcomes of the ethics review process. Some methodically similar observational studies that involve New Zealanders have been reviewed and approved by HDEC and others have been deemed out of scope by HDEC. This suggests there are potential inconsistencies in the application of a common ethical framework.

A consistent approach to the ethical assessment of observational studies would streamline study development, reduce the administrative burden for individual trials and increase skills-transfers (eg, in protocol development) between one generation of trainees and the next. We should be building-up New Zealand's national research capacity while still upholding the highest ethical standards.

We recognise the importance of consulting with the local Māori research committees at each DHB in which each study is conducted. Personally we have found this review process invaluable. But the processes and systems that facilitate this consultation vary widely across the country. Often they are under-resourced, and in some regions it is a barrier to effective consultation and implementation of locality-specific values. We believe that improving support, such as allocating more resources, for local iwi and the systems facilitating consultation would reduce this barrier to research participation in some regions.

Local barriers

We have found the application process for locality approval varies widely. Some DHBs use electronic pathways and others required paper forms. Similar variance exists in the user-friendliness of approval processes, with most systems being streamlined and transparent but others being opaque and difficult to navigate. Our concern is that this means some regions may be more likely to be included in projects than others, creating differential inclusion and representation of participants according to geography and funding. This may perpetuate inequity because those living in certain, particularly rural, districts may be less likely to participate in research or have a voice in the design of projects.

With the dissolution of DHBs due to occur in 2022, we have a unique opportunity to

develop a single system for the application and assessment of locality ethics approvals.

Targeting inequity

Research has traditionally been centred around academic institutions. In contrast, collaborative networks can breakdown historical barriers to research participation by including communities, clinicians and institutions nationwide. Importantly, research questions and study leadership could originate anywhere within a network unshackled from the traditional restraints of geography and hierarchy.

The New Zealand Health Research Strategy acknowledges the health inequity suffered by Māori and prioritises the Treaty of Waitangi's principles of partnership, participation and protection. Collaborative research networks represent a powerful mechanism through which Māori leadership in health research can emerge, like from among our medical student and trainee collaborators. Engagement with Māori health stakeholders is essential for identifying and answering pertinent research questions.

Research support

Large studies, particularly interventional studies, require support services including staff, facilities and equipment. The success of collaborative research networks in the UK was underpinned by stable funding for support services via the National Institute of Health Research (NIHR) Clinical Research Network.[12] This contrasts starkly against the episodic project-based funding currently available in New Zealand. It is critical that the funding review taking place as part of the New Zealand Health Research Strategy prioritises the establishment of stable research infrastructure. This may take shape in the form of distributed funding for research support staff, facilities and equipment.

Another way to support research is by funding Academic House Officer and Research Registrar positions similar to the Academic Foundation Positions in the UK. Ultimately, prioritising research at the local level can facilitate trainee-led collaborative networks, but sustained national funding would optimise the opportunity for New Zealand to drive the surgical research narrative through leadership of local, regional and global studies.

Trainee-led collaboratives are emerging in New Zealand, and there is an eager population of trainees with the willingness and capacity to deliver high-quality research. They offer a unique opportunity to build research capacity through the transfer of research skills and to begin addressing health inequities. New Zealand must be responsive to this changing research environment and leverage collaborative networks by supporting their development and facilitating their endeavours.

Conclusion

Here we present several challenges faced by collaborative networks in New Zealand. The key requirements include distributed research funding and development of consistent locality assessment processes. Research should be a core tenet of all DHBs, and engagement with Māori, rural and socioeconomically deprived communities must be prioritised.

Competing interests:
The authors CV and BE are members of the Surgical Trainee Research, Audit, and Trials Aotearoa (STRATA) Steering Group, and DW is a member of the STRATA Advisory Committee.

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Balloon aortic valvuloplasty for severe aortic stenosis: single-centre contemporary patterns and experience

Ammar Alsamarrai, Tom Kai Ming Wang

Aortic stenosis (AS) is the most common primary valvular heart disease in developed countries, and it is expected to become more prevalent with ageing populations.[1] Severe AS has high morbidity and mortality, and definitive treatment is by aortic valve replacement (AVR), either surgical AVR (SAVR) or transcatheter aortic valve implantation (TAVI).[2]

Balloon aortic valvuloplasty (BAV) was introduced in 1985 as a treatment option for patients with severe AS and prohibitive surgical risk. However, early studies showed only modest haemodynamic and symptomatic benefits, a negligible survival benefit and high complication rates, which led to diminished utilisation of this technique.[3] However, BAV has witnessed a resurgence in interest due to the role of valvuloplasty in TAVI and the use of BAV as a bridge to AVR.[4,5] Ben-dor et al (2010) reported outcomes for 262 patients that underwent BAV and noted that, when used as a bridge to AVR, BAV is safe and associated with a 50% reduction in mortality rate compared to stand-alone BAV. Also, in comparison to previous studies, Ben-dor et al reported lower vascular complications from BAV, which they attributed to smaller catheter sizes and the selection of safer vascular access.[6]

Auckland City Hospital introduced TAVI in 2011 and is the only centre in the region that performs both BAV and TAVI in the publicly funded healthcare setting. We evaluated our contemporary BAV experience over 14 years.

Methods

Adult patients who underwent BAV between 2005 and 2018 were retrospectively identified. Patients were considered for AVR on a case-by-case basis by a team of cardiologists, cardiac surgeons and anaesthetists. Patients were declined for AVR if they were of advanced age, had co-morbidities and/or were ineligible for publicly funded AVR. During the timeframe of this study, BAV was only performed as a palliative procedure for symptomatic relief, not as a bridge to subsequent TAVI or SAVR. However, some patients had made an improvement that allowed subsequent consideration of definitive AVR.

Clinical data were retrieved from electronic medical records. Results from the most recent echocardiogram before and after the procedure were recorded. Three patients required a general anaesthetic and the remainder required local anaesthesia. Femoral artery access was used in all cases. Follow-up was until 1 September 2020. Patients were not routinely followed-up after BAV. However, symptomatic improvement was documented in the medical records of some patients who had subsequent healthcare encounters for unrelated conditions. Continuous variables were reported as means with standard deviations. Categorical variables were reported in absolute values with percentages. A paired-samples t-test was used to compare echocardiographic and haemodynamic parameters before and after BAV. A Chi-square test was used to compare number of hospitalisations before and after BAV. A Kaplan-Meier curve was plotted to illustrate post-procedure survival in those who did not undergo subsequent AVR. This study received institutional approval by the Auckland District Health Board Research Office.

Results

Figure 1 outlines the total number of BAV procedures done per year over the study period, and Table 1 outlines the baseline characteristics of the cohort. Sixty-nine patients underwent 84 BAV procedures. The mean age was 84 (±8.4) years and 54% were male. There was a substantial prevalence of co-morbidities, including heart failure (71%), previous myocardial infarction (39%) and atrial fibrillation (33%). BAV was performed using the 10F Cristal (BALT, Montmorency, France) 20x45mm valvuloplasty balloon in the majority, and with the two-syringe technique for maximum inflation. Rapid ventricular pacing of the right ventricle during balloon inflation was utilised in most cases. Periprocedural heparin was administered for anticoagulation. Pressures in the ascending aorta and left ventricle were measured before and after balloon inflations. There was a significant improvement in aortic valve area (0.7 (±0.2) to 1.0 (±0.3) cm^2) and aortic valve mean gradient (52 (±17) to 36 (±13) mmHg) respectively after BAV ($p<0.01$ for both).

Serious complications included one in-hospital death due to severe aortic regurgitation and one case of pericardial tamponade requiring pericardiocentesis. During the procedure, two patients suffered from symptomatic cardiac ischaemia, one patient suffered a seizure, one patient had self-terminating atrial fibrillation and one patient experienced brief loss of consciousness. Two patients required a permanent pacemaker following BAV: one for tachycardia-bradycardia syndrome and the other for second-degree heart block. There were 12 post-procedure haematomas at the femoral access site; none required a blood transfusion or surgical intervention. One patient developed a pseudoaneurysm, which was treated conservatively. Although there were no cases of stroke immediately following BAV, one patient suffered a large occipital infarct five days after the procedure, but this was not directly attributable to the BAV.

During follow-up, 13 patients (19%) underwent 15 redo BAV procedures, seven patients (10%) underwent subsequent TAVI and one patient underwent subsequent SAVR. There was a significant reduction in cardiac-related hospitalisations (such as for heart failure, syncope, angina or myocardial infarction) six months after BAV compared to six months before BAV (23 vs 55, p=0.01). Excluding patients that underwent TAVI or SAVR, the proportion of patients alive

Figure 1: Number of balloon aortic valvuloplasty procedures done by year.

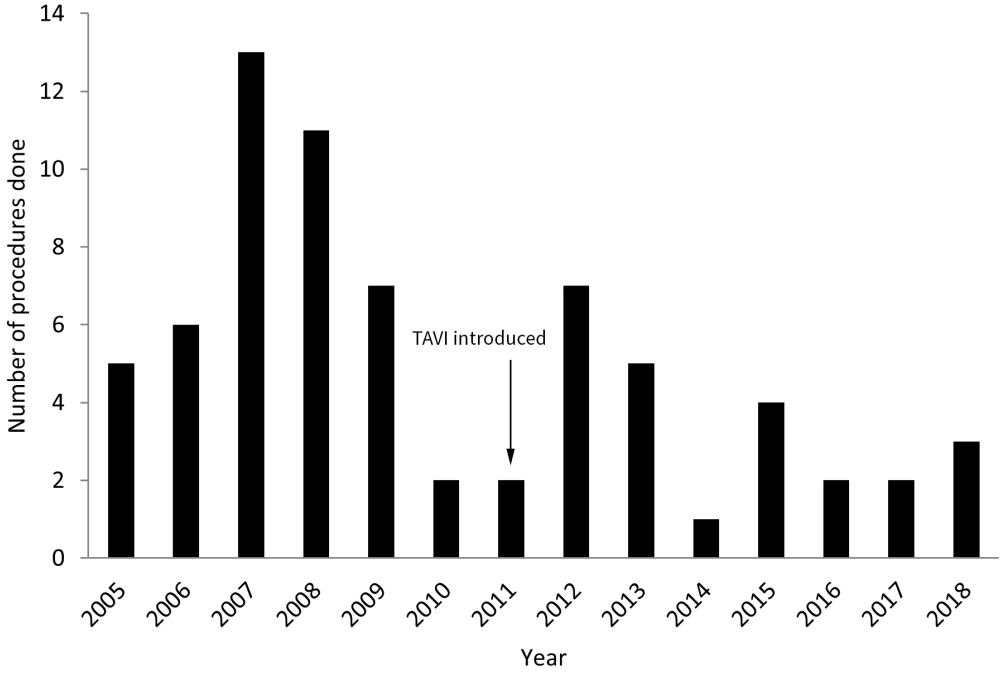

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Table 1: Baseline characteristics and outcomes.

Variable	Total (n=69)
Demographics	
Age (years)	84 (±8.4)
Male	37 (54%)
Ethnicity	
New Zealand European	53 (77%)
Māori	1 (1%)
Other	15 (22%)
Medical history	
Heart failure	42 (61%)
Hypertension	40 (58%)
Myocardial infarction	27 (39%)
Atrial fibrillation	23 (33%)
Chronic lung disease	19 (28%)
Diabetes	14 (20%)
Peripheral vascular disease	11 (16%)
Stroke or transient ischemic attack	10 (14%)
Pacemaker or implanted cardioverter-defibrillator	7 (10%)
Dialysis dependent	4 (6%)
Current smoker	3 (4%)
Presentation	
New York Heart Association III–IV symptoms	37 (54%)
Pulmonary oedema	17 (25%)
Syncope	17 (25%)
Angina at rest	6 (9%)
Ejection fraction ≥40% *	47 (68%)
Ejection fraction <40%	20 (29%)

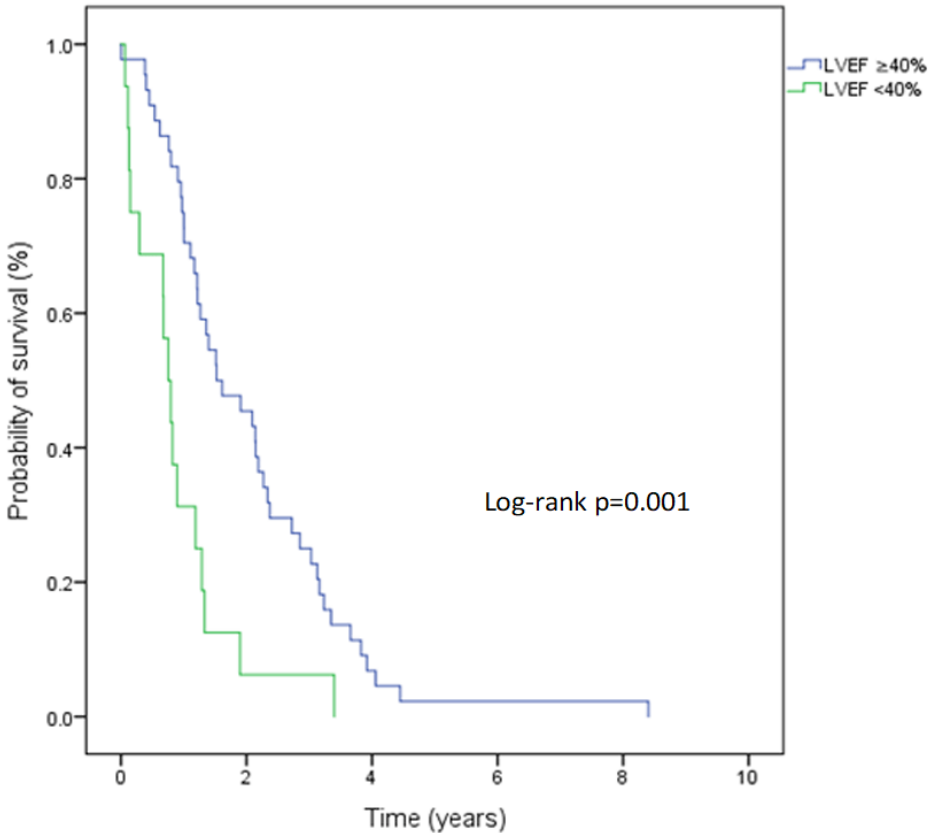
Table 1: Baseline characteristics and outcomes (continued).

Variable	Total (n=69)
Risk scores	
Logistic EuroSCORE	23% (±14)
EuroSCORE II	9.8% (±9.4)
Society of Thoracic Surgeons Score	7.8% (±4.0)
In-hospital events	
Access site haematoma	12 (17%)
Acute kidney injury	3 (4%)
Permanent pacemaker implantation	2 (3%)
Stroke	0
Death	1 (1%)
Outcomes at follow-up	
Length of symptomatic benefit (months) [#]	9.1 (±9.0)
Redo balloon aortic valvuloplasty	13 (19%)
Transcatheter aortic valve implantation	7 (10%)
Surgical aortic valve replacement	1 (1%)
Death	
30 days after balloon aortic valvuloplasty	2 (3%)
One year after balloon aortic valvuloplasty	23 (33%)
At follow-up	65 (94%)

[*] Data not available for all patients.

[#] Data were available in 31 patients.

Figure 2: Kaplan-Meier survival (excludes patients that underwent subsequent surgical aortic valve replacement or transcatheter aortic valve implantation) following index balloon aortic valvuloplasty, stratified by left ventricular ejection fraction (LVEF).



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one year after BAV was 67.1%, whereas the median survival was 1.73 years. Kaplan-Meier survival demonstrated a greater risk of mortality in patients with a baseline left ventricular ejection fraction <40% (Figure 2).

Discussion

Our study cohort represents high-risk patients, as evidenced by a poor median survival of 1.73 years after BAV, which is likely attributable to advanced age and comorbidities. Historically, the role of BAV has been as a palliative procedure for patients who cannot undergo SAVR due to prohibitive surgical risk. Internationally, since the introduction of TAVI at tertiary centres, there has been a general trend towards increasing the use of BAV.[7] Our study supports the role of BAV as a palliative procedure as there was symptomatic benefit of nine months on average in some patients and a reduction in cardiac related hospitalisations attributable to severe AS.

In our series, most patients had no or only minor complications after BAV, and there was only one in-hospital death. Outcomes following BAV have generally improved, with significant reductions in major complications in the contemporary era compared to what was observed when BAV was initially introduced.[8] Overall, the complication rates of BAV are similar to that of TAVI, which is an important consideration in deciding the goal of therapy when BAV is used as a palliative procedure.[9] BAV can provide unique information pertinent to TAVI and lead to potentially novel applications, including accurate sizing of the aortic annulus, assessing the efficacy of rapid ventricular pacing and anticipating complications of the valvuloplasty, which is common to both procedures.[10]

Redo-BAV has been reported by some studies (including patients in the PARTNER trial) to improve survival compared to medical therapy alone.[11,12] However, we did not find this to be the case in our cohort. Redo-BAV is often considered in patients who achieve favourable outcomes following the index procedure and when symptomatic benefit is maintained over a sufficient period of time, such as six months or more.

This study had some limitations. Firstly, its design was retrospective, observational and based on a single centre. Further, the sample size was relatively small. Third, TAVI was only introduced to Auckland City Hospital around 2011, so it was not available to all patients. Lastly, we did not record other pertinent outcome measures, such as functional capacity and quality of life, as patients were not routinely followed-up after BAV.

In conclusion, BAV is a safe procedure. The main indications are for symptomatic palliation of severe AS and, increasingly, as a bridge to definitive aortic valve intervention. Even after stand-alone BAV, overall survival is extremely poor. Redo-BAV is an option in some patients, but TAVI could be considered instead, given the similar adverse event rates between the two procedures.

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Crowned dens syndrome: a key differential for acute neck pain in the elderly

Sujatha Kamalaksha, Lucille Wilkinson, Sanjib Ghosh

Crowned dens syndrome (CDS) is an uncommon condition caused when calcium pyrophosphate dihydrate (CPPD) deposition occurs in cervical vertebral ligaments. Symptoms include acute neck pain with stiffness mimicking conditions like meningitis, epidural abscess, discitis and polymyalgia rheumatica or giant cell arteritis.[1] It should be considered as a differential diagnosis for acute neck pain in elderly populations who are not septic and have normal neurology. CDS has a good prognosis, and an early diagnosis is essential to avoid extensive invasive investigations and inadvertent treatment.

Case vignette

An 82-year-old man presented with a four-day history of acute atraumatic cervico-occipital pain and stiffness without infective symptoms or neurological deficits. Past medical history included minimally invasive parathyroidectomy for primary hyperparathyroidism, ischaemic heart disease, hypertension, epilepsy and solitary lung nodule. Medications included alendronic acid, sodium valproate, atorvastatin, aspirin, cilazapril and tamsulosin.

Examination was pertinent for severe limitation in neck movements in all directions, including rotation, flexion and extension. He was afebrile with normal neurological examination. Blood results showed persistently normal white cell count with significantly elevated C-reactive protein (CRP) at 252mg/L. Renal function and electrolytes were normal, apart from low serum phosphate of 0.51mmol/L.

Initial treatment consisted of empirical ceftriaxone and patient-controlled analgesia (PCA) pump for pain management. Peripheral blood cultures, urine analysis, cerebrospinal fluid analysis and chest radiograph were negative for sepsis. Cervical spine x-ray showed facet joint osteoarthritis. Concurrently performed computed tomography (CT) and magnetic resonance imaging (MRI) of cervical spine ruled out infection, abscess or malignancy. A close review of CT cervical spine revealed calcified transverse ligament around dens (Figures 1 and 2). Review of old plain radiographs of knee and hip joints confirmed chondrocalcinosis. A diagnosis of crowned dens syndrome was made in the context of clinical, laboratory and radiological findings.

Within a week of commencing colchicine and tapering dose of prednisone, symptoms resolved completely and the CRP normalised. Serum phosphate returned to normal without supplementation.

Discussion

Crowned dens syndrome was described first in 1985 by Bouvet et al.[2] It may be detected in up to 2% of patients over 70 years of age who present with acute neck pain.[3] Typical presentation is with acute severe neck pain associated with neck stiffness and a significant restriction of cervical movements and occasional fever, and the inflammatory markers are often elevated.[4] Neurological complications are rare; however, large cervical CPPD deposits may result in spinal stenosis or cervical myelopathy.[5] Ageing is a major risk factor, and others include haemochromatosis, primary hyperparathyroidism, hypophosphatemia, hypomagnesaemia, hereditary predisposition to CPPD and use of oral bisphosphonates.[6,7] The gold standard investigation for the diagnosis of CDS is CT scan because plain radiographs fail to detect the periodontoid calcifications.[8] CPPD depo-

sition may be located posterior only (50%), posterolateral (27.5%), circular (12.5%), lateral (5%) or anterior (5%) to the odontoid process, and findings may persist for about three months after symptom relief.[9] Integrated single photon emission tomography (SPECT) scan has been performed to evaluate target sites for facet joint injection which showed avidly increased uptake at the anterior border of the dens and calcification of the transverse ligament of the atlas.[10]

The majority of patients with CDS fully recover within a week of treatment with non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroid, colchicine or combination therapy.[3,11] There is some evidence of a role for colchicine in the prevention of both acute attacks of pseudogout and recurrent episodes of the other CPPD-related arthritides.[12] In rare cases, surgical decompression and stabilisation have been considered for central cord syndrome.[13]

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Figure 1: CT cervical spine in axial plane–transverse ligament calcification and crystal deposition.

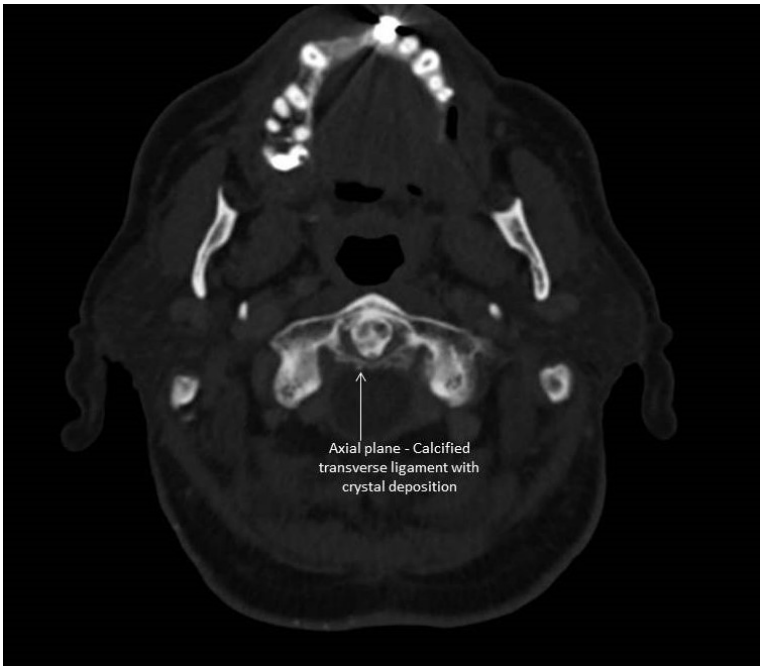
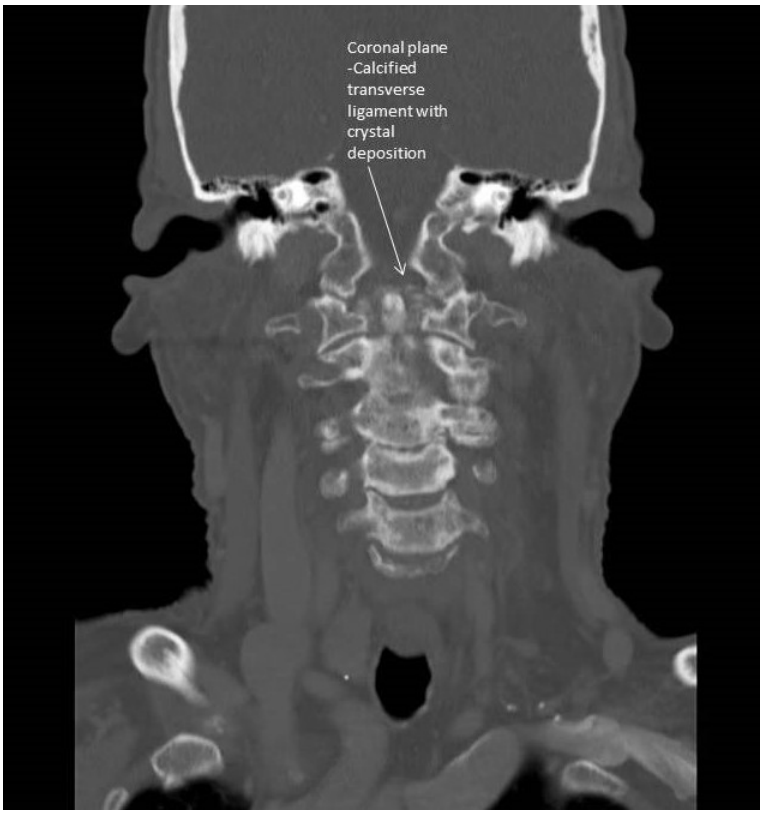


Figure 2: CT cervical spine in coronal plane–transverse ligament calcification and crystal deposition.



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The Spanish Flu pandemic and stable New Zealand suicide rates: historical lessons for COVID-19

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There were initial concerns that the COVID-19 pandemic might significantly increase worldwide suicide rates, due to the combined effects of economic recession, rising unemployment, job insecurity, income shock, social isolation, possible barriers to receiving mental health treatment, increased alcohol use, strained relationships, increased levels of national anxiety and distress.[1,2] Also, if the COVID-19 pandemic were to trigger another 1929–1930s "Great Depression" and raise unemployment by potentially 15–20%, suicide rates could increase by at least 15%, with working age men being the highest risk group.[1] Stuckler et al[3] reported that within European Union countries between 1970 and 2007, every 1% increase in unemployment rate was associated with a 0.79% increase in suicide rate for those aged under 65.

Pirkis et al[4] recently published the early impacts of the COVID-19 pandemic on suicide rates in mainly high-income and upper middle-income countries. They found that suicide rates were either stable or reduced compared with the pre-pandemic period. Pirkis et al also analysed New Zealand suicide rates during the COVID-19 pandemic and found that there was a statistically significant decrease in New Zealand suicide rates in both primary analysis between 1 April and 31 July 2020 (rate ratio: 0·79; 95% CI: 0·68–0·91) and sensitivity analysis between 1 April and 31 October 2020 (rate ratio: 0.81; 95% CI: 0.72–0.90), compared with the pre-pandemic period.[4]

In the context of the unexpected fall in New Zealand suicide rates during the COVID-19 pandemic, we have investigated whether the early phase of a previous pandemic—the "Spanish Flu" pandemic of 1918–1920—was associated with decreased New Zealand suicide rates. If so, we hypothesise that the longer-term effects of the Spanish Flu pandemic on New Zealand suicide rates might be indicative of the longer-term effects of the COVID-19 pandemic on future New Zealand suicide rates.

The Spanish Flu (1918–1920) killed 40 million people worldwide (ie, 2.1% of the world population), equivalent to 150 million deaths at current world population levels.[5] The significant estimated flu-generated worldwide gross domestic product (GDP) decline was c.6–8%.[5] The Spanish Flu was also New Zealand's most severe disaster event and is estimated to have killed 9,000 people.[6]

Methods

We obtained data from the World Health Organization[7] in relation to New Zealand crude suicide rates (total, males, females) between 1909 and 1929. Using descriptive epidemiology, we compared suicide rates during the Spanish Flu period (1918–1920) to both the pre-pandemic period (1909–1917) and the post-pandemic period (1921–1929). We also compared New Zealand GDP levels during the same time-periods.[8]

Results

During the Spanish Flu pandemic (1918–1920), New Zealand crude suicide rates (Table 1) averaged 11.2 per 100,000 population and were 6.4% lower than suicide

Table 1: New Zealand crude suicide rates, Spanish Flu mortality, World War I mortality and GDP between 1909 and 1929.

Year	Total crude suicide rates per 100,000 population	Male crude suicide rates per 100,000 population	Female crude suicide rates per 100,000 population	Spanish Flu deaths % of population	World War I deaths % of population	US$ GDP per capita
1909	12.1	18.6	4.8			6595
1910	10.1	16.4	3			7349
1911	12.2	19.1	4.6			7595
1912	11.9	19.8	3.2			7201
1913	13.8	20.7	6.3			7123
1914	12.6	20	4.4		0.04	7174
1915	10.3	18.2	1.9		0.14	7152
1916	13.4	21.6	5.1		0.33	7078
1917	11.3	17.5	5.2		0.43	6923
1918	10.2	18.2	2.7	0.57	0.32	6789
1919	12.2	18.5	5.8	0.03		7303
1920	11.2	18	3.6	0.09		7799
1921	12.8	20.3	5			7089
1922	13.1	20.4	5.5			6692
1923	10.4	16.9	3.7			7112
1924	12.3	19.2	5			7110
1925	13	20.4	5.4			7315
1926	11.3	18.1	4.2			6781
1927	14.5	24.4	4.2			6473
1928	14.5	21.7	7			7107
1929	15.7	24.2	7			7275

rates between 1909–1917 (12 per 100,000 population). Male and female suicide rates reduced by 4.5% and 5.8% respectively during this same comparison time-periods. When compared with the World War I period (1914–1918), suicide rates during the Spanish Flu period (1918–1920) were marginally lower, but there is an overlap in 1918. Notably, during the overlap year (1918), when disaster-related mortality due to a combination of the Spanish Flu (0.57% population mortality in 1918) and World War I (0.32% population mortality in 1918) was at its peak,[5] the suicide rate of 10.2 per 100,000 population was the second-lowest documented between 1909 and 1929 (lowest was 10.1 per 100,000 population in 1910). In the post-pandemic period (1921–1929), suicide rates increased by 16.7%, compared with the Spanish Flu period (1918–1920), with male and female suicide rates increasing by 13.1% and 29.5% respectively.

The 6.4% reduction in New Zealand suicide rates during the Spanish Flu pandemic (1918–1920) compared with 1909–1917 was associated with an incremental rise in New Zealand GDP levels,[8] which were 2% higher between 1918–1920 (average GDP US$7297) compared to 1909–1917 (average GDP US$7132). However, following the pandemic (1921–1929), the 16.7% increase in suicide rates compared to the Spanish Flu period was associated with a 4.1% decline in average GDP levels between 1921–1929 (average GDP US$6995).

Discussion

New Zealand suicide rates have appeared lower during the Spanish Flu pandemic and the early phase of the COVID-19 pandemic, a century later. Significantly, New Zealand suicide rates during the Spanish Flu pandemic have similarities with the reduced US suicide rates during the same pandemic.[9] There may be sociological and economic reasons for reduced suicide rates during pandemics, despite the impact of public health measures on travel, family life and personal freedoms. Within a collective experience of a disaster, social cohesion may increase with an emerging sense of shared identity and solidarity.[10] Such increased social cohesion and the relative stability of New Zealand GDP may explain the slight reduction in New Zealand suicide rates during the Spanish Flu. Durkheim first hypothesised great national crises, like wars, may protect against suicide because of an increased sense of patriotism and social connectedness leading to greater integration of society.[11] COVID-19 society-wide experiences and community pride in the successful public health measures might be inducing similar community-building sentiments in contemporary New Zealand.

Historical analysis of suicide rates during the Spanish Flu pandemic suggest that, because of the potential protective effect of social cohesion in the short-term, New Zealand's suicide rates may not be greatly affected by COVID-19. The evidence to date shows that shared adversity, community-wide solidarity and possibly increased altruism may partially mitigate the effects of relative economic hardship on the population risk of suicide during the early phase of the COVID-19 pandemic in New Zealand. Importantly, New Zealand has experienced the lowest COVID-19 cumulative death rate in the OECD (as of 26 June 2021) and also had the lowest level of "excess deaths" among OECD countries.[12] New Zealand has also performed better than other OECD countries in terms of GDP maintenance and lower unemployment rate increases, so there is a better economic baseline.[12] However, a higher suicide-risk might occur after COVID-19 pandemic resolution in New Zealand, particularly if the economy stagnates and social cohesion is reduced.

We note some limitations with respect to data accuracy of New Zealand suicide mortality data between the years 1909 and 1929. However, ongoing epidemiological and economic research is needed to ascertain the short-, medium- and longer-term impacts of the COVID-19 pandemic on New Zealand and global suicide rates. This will help to inform evidence-based economic and social policy responses.

Competing interests:
Nil.

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Colliery Medical Practice

1921

The conditions of medical practice under contract terms with the various Miners' Medical Associations of the West Coat of New Zealand have never been satisfactory. There is consequently almost a constant state of friction between the doctor and miners' committee, and no doctor stays very long, the position becoming impossible.

There is at present trouble at Denniston, where the conditions of service seem very unsatisfactory. In addition to an inadequate salary (which is the same as before the war), a bad climate, and limited social facilities, the present chief complaint is the condition of the house provided under the agreement, which in the words of the present occupant, "is in unspeakably bad repair, while the surgery and dispensary (so-called) are in such condition that no self-respecting medical man would consent to work in the for any length of time." The salary in £330, plus £200 as Hospital Medical Officer.

Th authorities should make the conditions of medical service more satisfactory and attractive in these districts, which are, at best, the least pleasing of practices from the doctor's point of view. Only thereby will good men be attracted and induced to stay, and miners want the best medical service obtainable, whether in case of accident to themselves or of illness of their wives and children.

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