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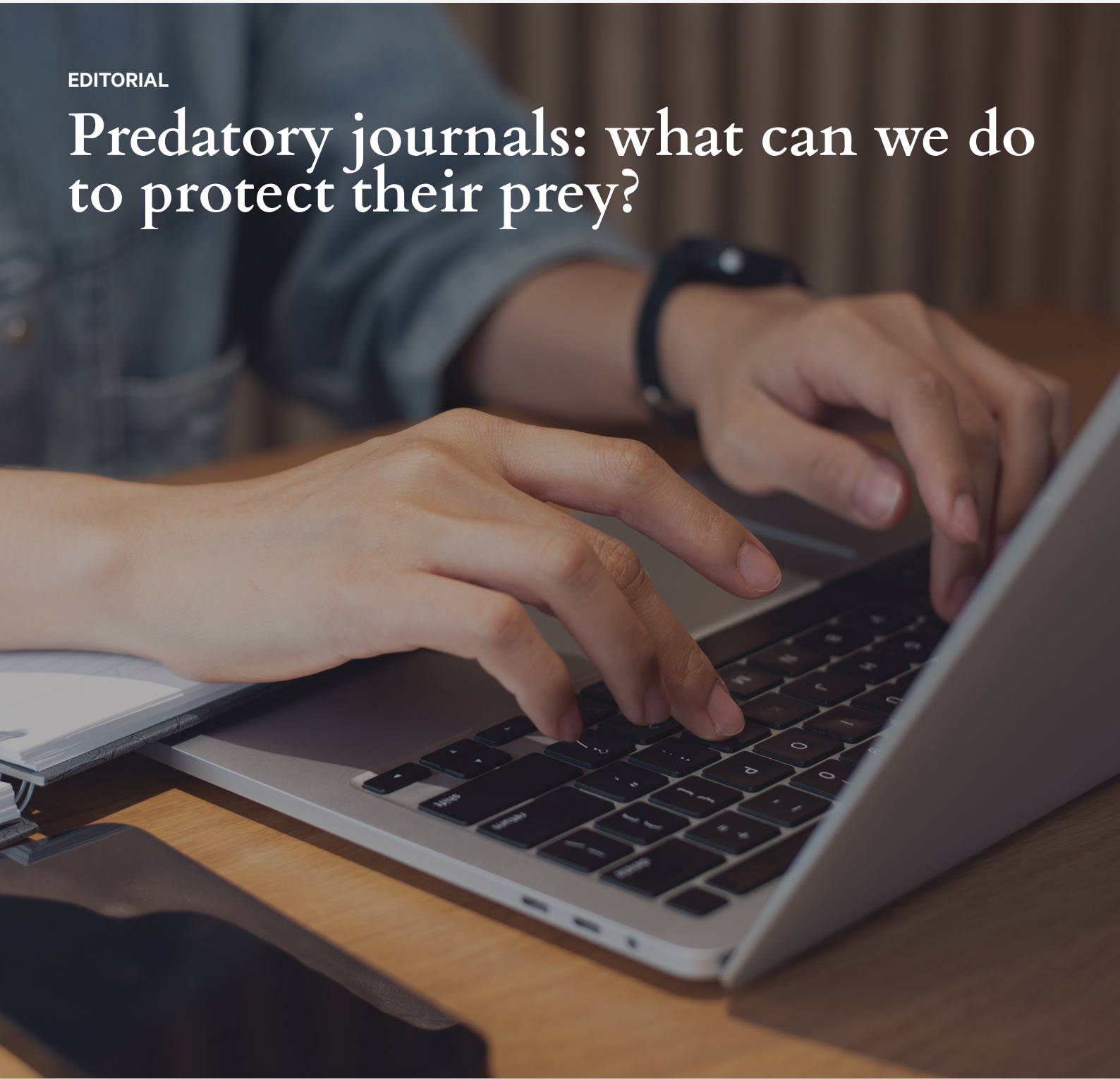

EDITORIAL

Predatory journals: what can we do to protect their prey?

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Predatory journals have developed strategies to profit by taking advantage of a climate that nurtures the growth of open access, author-pays publication models. Protecting the scientific community and the public from predatory journals requires action by all stakeholders.

The effect of an educational intervention on high school students' knowledge about vaping-related risks and expressed desire to quit vaping

Ben Wamamili, Philip Pattemore, John Pearson

We worked with high school students in Ōtautahi Christchurch to develop educational material about vaping and assessed whether the material increased students' knowledge about vaping-related health risks and encouraged who vaped to consider quitting. A total of 332 students from four high schools participated in our study between December 2022 and June 2023, and there was significant improvement in knowledge and desire to quit. Younger students (year 9 and 10) were particularly keen to quit vaping, suggesting that they may be a priority target for our intervention and similar interventions.

Does suicide in New Zealand follow a semi-lunar rhythm?

David Cumin, Nicholas Matzke, Rikki Solomon

For thousands of years the moon phases have been observed, and there has been speculation that human health and energy is altered across this cycle. However, there is a scientific debate over whether this link is real. We have investigated a possible link between the moon cycle and suicides in New Zealand in the hope that it might be possible to design more effective interventions and preventative programmes. We found no strong evidence of a difference in the rate of suicide during different phases of the moon.

How is the specialist–primary palliative care model functioning for cancer patients in the current New Zealand health system?

Jessica E Young, Richard Egan, Antonia C Lyons, Kevin Dew

Patient barriers to accessing hospice and palliative care have been well studied. Important, yet less investigated, is how cancer patients whose hospice referrals were not accepted are being cared for. This article aims to understand the referral process from palliative care providers' perspectives and the implications of the current hybrid specialist–primary palliative system for patients, families and health professionals. We interviewed 28 healthcare professionals via Zoom. Participants worked in specialist and primary palliative care settings, such as hospices and aged residential care, and were based in seven Aotearoa New Zealand regions. We thematically analysed the interview transcripts. We identified four themes: the state of the palliative care system; communication issues; unmet needs and inequities; and managing care within the current system. The limited funding for palliative care and other health services is resulting in a decrease in palliative care services. The specialist–primary model of end-of-life supportive care in New Zealand is undermined by under-funding. The implications for cancer patients, their families/whānau and their healthcare professionals are moves towards a more biomedical model of palliative care, a reduction in training and unsustainable work-arounds to manage care within the under-resourced system. Considering the ageing population, urgent action is needed.

Support for and likely impacts of endgame measures in the Smokefree Aotearoa Action Plan: findings from the 2020-2021 International Tobacco Control New Zealand (EASE) surveys

Janine Nip, James Stanley, Jane Zhang, Andrew Waa, Jude Ball, El-Shadan Tautolo, Ellie Johnson, Thomas K Agar, Anne CK Quah, Geoffrey T Fong, Richard Edwards

We conducted surveys between 2020 and 2021 of people who smoke or who recently quit smoking in Aotearoa New Zealand. Support among survey participants for the following policies was: 83% for a smokefree generation policy (banning the sale of tobacco to people born after a certain date), 75% for making only very low nicotine cigarettes available and 35% for a substantial reduction in tobacco retailers. Around half of the participants who smoked anticipated quitting completely, switching to vaping or cutting down the amount they smoke if very low nicotine cigarettes or substantial retailer reductions were introduced. These findings call in to question the Government's decision to repeal these policy measures in 2024.

The prevalence of aortic stenosis in Māori undergoing clinically indicated echocardiography compared to New Zealand Europeans

Matthew K Moore, Gregory T Jones, Gillian Whalley, Michael JA Williams, Ralph A Stewart, Sean Coffey

Aortic stenosis is a narrowing of the aortic valve that leads to higher pressure within the heart, and, if severe, can only be treated successfully with a procedure to implant a new valve. It is the most common cause of death due to heart valve disease in New Zealand. There has historically been little research into whether the burden of aortic stenosis differs between Māori and New Zealand Europeans, with the most recent suggesting that it was much less common in Māori. Our research shows that the amount of aortic stenosis is the same between Māori and New Zealand European people of the same age. So, while it is true that there is less aortic stenosis in Māori overall, this is due to the younger age in general of Māori compared to New Zealand Europeans.

Projected increases in the prevalence of diabetes mellitus in Aotearoa New Zealand, 2020–2044

Andrea Teng, James Stanley, Jeremy Krebs, Christopher GCA Jackson, Jonathan Koea, Nina Scott, Dianne Sika-Paotonu, Jeannine Stairmand, Chunhuan Lao, Ross Lawrenson, Jason Gurney

The diabetes epidemic, and the expansive breadth of services required for its management, elevate the need for high-quality evidence on the projected future burden. This study models existing diabetes trends by age, sex and birth cohort in Aotearoa New Zealand, to project out to 2040–2044. There was a 90% increase in number of people with diabetes from 268,000 in 2015–2019 to 502,000 by 2040–2044. The number of people with diabetes is projected to increase from 5.6% to 8.5% of the population. After adjusting for the effects of population growth and ageing, there remained a 30% increase in the underlying prevalence of diabetes. The biggest increases in diabetes prevalence were projected for Pacific peoples and Māori females. Projections support bold action on food environments and other evidence-based diabetes prevention tailored particularly for Māori, Pacific and (South) Asian groups.

Prevalence, impact and management strategies for dysmenorrhea in Aotearoa New Zealand: a scoping review

Melissa Black, Blake Perry, Michaela Walton, Alex Semprini, Mike Armour

Dysmenorrhea (period pain) affects the majority of young women worldwide, but geographical and cultural differences can influence the impact, symptom reporting and treatment. This scoping review assesses the current literature on the prevalence, impact and treatment of dysmenorrhea in Aotearoa New Zealand. Our findings show that the available data on dysmenorrhea in Aotearoa New Zealand is

limited and outdated, highlighting the need for up-to-date data, with a particular focus on Māori and Pacific peoples, and geographical diversity.

Principles for embedding learning and adaptation into New Zealand health system functioning: the example of the Viable System Model

Sharen Paine, Jeff Foote, Robin Gauld

If the New Zealand health system is to exist successfully over the long term it must develop the ability to learn and adapt. This is a non-trivial undertaking in such a large and complex system that exists in an ever-changing environment, so the use of a model that can support this work is necessary. The Viable System Model (VSM) is a good candidate, providing the basis for an operating model through which to clearly articulate all the requirements of a learning health system, and one that can persist over the long term. It also supports the realisation of the goals of financial sustainability, high performance, distributed decision making, clinical engagement and efficiency—or our understanding of why we are struggling to meet these goals.

Delayed presentation of severe cervical myelopathy two years post-motorcycle accident: a case report

Rohil Chauhan, Daniel Harvey, Anand Segar, Steven White

This case report describes a 43-year-old Māori male who developed worsening symptoms of spinal cord dysfunction, a condition called degenerative cervical myelopathy (DCM), 2 years after a motorcycle accident. Initially, magnetic resonance imaging (MRI) showed only mild spinal cord compression, but, over time, the patient experienced severe disabilities, including difficulty with balance, hand control and limb weakness. A repeat MRI revealed significant spinal cord damage, necessitating surgery to prevent further decline. This report emphasises the importance of regular follow-up for patients with spinal cord compression, educating patients about signs of DCM progression and equipping healthcare professionals to recognise and refer cases early. Timely diagnosis and intervention are critical to prevent the irreversible functional disabilities faced by patients with DCM.

Predatory journals: what can we do to protect their prey?

Christine Laine, Diane Babski, Vivienne C Bachelet, Till W Bärnighausen, Christopher Baethge, Kirsten Bibbins-Domingo, Frank Frizelle, Laragh Gollogy, Sabine Kleinert, Elizabeth Loder, João Monteiro, Eric J Rubin, Peush Sahni, Christina C Wee, Jin-Hong Yoo, Lilia Zakhama

A growing number of entities misrepresent themselves as scholarly journals for financial gain despite not meeting scholarly publishing standards.[1,2] As editors and members of the International Committee of Medical Journal Editors (ICMJE), we receive queries about these "predatory" or "pseudo" entities and are subject to their deception when they target our authors and reviewers. The number of predatory journals is difficult to accurately determine but was estimated at more than 15,000 in 2021.[3] While the ICMJE Recommendations include warnings about predatory publishing,[4] the Committee believes that the large number of increasingly bold predatory entities warrants shining a bright light on them and considering actions stakeholders can take to counter their deceptive efforts.

The practices that these entities employ include aggressive solicitation of manuscript submissions; the promise of extremely rapid turnaround times; and a lack of transparency about article submission, processing and even withdrawal charges. Predatory journals may claim that they follow legitimate editorial and publishing practices but do not actually conduct peer review or such functions as archiving journal content, managing potential conflicts of interest, enabling corrections and responding to author queries in a timely manner. In egregious cases, the "published" articles never appear despite authors having paid the requested fees.

Predatory journals often use journal names and branding features that mimic well-established journals. They may falsely state that they are members of or follow the recommendations of respected organisations such as the Committee on Publication Ethics, the Council of Science Editors, ICMJE and others. Predatory journals may fabricate indexing and citation metrics or may even have fallen through the cracks in the vetting process and be indexed.[5] To lend a veneer of credibility, these entities solicit individuals to serve on their editorial boards or as guest editors, sometimes listing persons in these roles without their consent. Predatory entities engage in these practices to purposefully deceive authors into submitting their work and paying associated fees.[6] Profits rise with the number of authors whom the predatory journal successfully captures.

These deceptive practices endanger authors, academic institutions, legitimate journals, legitimate publishers, the scholarly publishing process, science and the public.[6] Particularly vulnerable authors are those who are early in their careers, lack experience and adequate mentorship and face pressure to publish. Publication in a predatory journal may result in financial and professional consequences that interfere with the ability to publish work in legitimate journals. It is damaging to institutions' credibility when their faculty and grantees fall prey to these entities. Legitimate journals and publishers whom predatory entities mimic may receive unfounded accusations of improper behaviour. The existence of cunning predatory journals makes some academics and their institutions wary of legitimate open access, author-pays journals. Importantly, predatory journals can facilitate the dissemination of unvetted, weak or even fraudulent health information.[7]

What can authors do?

Authors must be aware that predatory journals exist and avoid submitting their work to them by evaluating the integrity of the journals they seek to publish in. Seeking the assistance of experienced mentors, colleagues and librarians may be helpful. Unfortunately, no current, comprehensive and accurate list of predatory journals is available. Creation of such a list is infeasible as new entities continuously appear and disappear. However, guidance from various organisations is available to help identify the characteristics of reputable peer-reviewed journals.

The World Association of Medical Editors offers practical recommendations that include a set of questions authors should ask when choosing a venue for publication.[2] The ThinkCheckSubmit.org site provides a checklist of features that can help authors identify trusted journals and publishers.[8] The site also includes a brief video about predatory publishing. In 2017, the US National Institutes of Health issued guidance to help their funded researchers distinguish reputable journals from predatory journals.[9] Authors should become familiar with these resources. When they have concerns about a particular journal's legitimacy, they should share those concerns with colleagues and their institutions.

Because predatory journals mimic legitimate entities, authors need to be vigilant when they receive a solicitation from a journal or publisher to submit their work or serve in an editorial role. They should carefully check the email address and URLs included in the communication to see if they match those of the legitimate entity. They may also contact the legitimate journal, forwarding the solicitation to inquire whether it actually came from that journal. Doing so not only protects the author from engaging with a predatory journal but also alerts the legitimate journal that it is being imitated.

What can institutions and funders do?

Academic institutions and funders should be invested in helping their constituents avoid predatory journals. They can achieve this by making the resources mentioned herein available via institutional channels such as training materials, especially to those early in their careers, and routinely reviewing where faculty and grantees publish. Institutional librarians are familiar with the journals that people at their institution read and seek to publish in and can play an important role in helping guide authors to legitimate journals. Like authors, librarians who become aware of concerns about a journal's legitimacy should share that information with their constituents as well as with librarians at other institutions. When librarians see a predatory journal that appears to be imitating a legitimate journal or publisher, they should alert their institutions and the mimicked journal.

In some situations, authors under pressure to publish may knowingly choose to publish in suspect journals to build a long list of publications to support academic promotion. This strategy would not be as effective if academic promotion committees weigh not only the quantity but also the quality of publications and the journals in which they appear.

What can journal editors and publishers do?

Journals should alert authors to the existence of predatory journals and the resources mentioned herein in their information for authors and in any "how to get published" programmes they offer. If editors and publishers become aware of a predatory entity that is imitating them, they should consider alerting their author community by posting a message on their website or sending an email communication to their authors, reviewers and editorial board members. Editors should recognise that authors may cite articles in predatory journals and should alert authors when they have concerns about the legitimacy of a citation.

Legal action against the predators is challenging because the predatory publishers are often ghost entities, contact persons can be difficult to identify and unresponsiveness to communication is common. However, publishers should still issue cease and desist letters because these actions can deter continued predatory behaviours even if no response is received.

Predatory journals have developed strategies to profit by taking advantage of a climate that nurtures the growth of open access, author-pays publication models. It is worrisome that despite the awareness of these entities for many years, academicians still fall prey to them. Protecting the scientific community and the public from predatory journals requires action by all stakeholders.

COMPETING INTERESTS

Dr Sahni's affiliation as representative and past president of the World Association of Medical Editors (WAME) does not imply endorsement by WAME member journals that are not part of the ICMJE.
CL reports employment by American College of Physicians and that her spouse has stock options in Targeted Diagnostics and Therapeutics.
TB reports grants from the National Institutes of Health (NIH), Alexander von Humboldt Foundation, German National Research Foundation, European Union, Germany Ministry of Education and Research, German Ministry of the Environment, Wellcome and KfW; serving on scientific advisory boards for NIH-funded research projects in Africa on climate change and health; and small stock ownership (EUR 5000) in CHEERS, an SME focussed on approaches to measure climate change and health in population cohorts.
KB reports employment by the American Medical Association and relationships with Resolve to Save Lives and with University of California, San Francisco.
EL reports employment by the British Medical Association.
JM reports employment by Springer Nature.
CW reports her role as Senior Deputy Editor of Annals Internal Medicine, employment by American College of Physicians and teaching activities at Beth Israel Deaconess Medical Center, Harvard University and Boston Medical Center for which she receives honoraria.

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The effect of an educational intervention on high school students' knowledge about vaping-related risks and expressed desire to quit vaping

Ben Wamamili, Philip Pattemore, John Pearson

ABSTRACT

AIM: Electronic cigarette use (vaping) has increased rapidly among adolescents globally. Most electronic cigarettes (e-cigarettes) contain nicotine, which is addictive and can cause behaviour problems and mood dysregulation. We sought to assess whether an educational intervention increased knowledge about vaping-related health risks and desire to quit among high school students. We assessed whether the effects differed between in-person or online intervention.

METHOD: The analysis included 332 students from four high schools in Ōtautahi Christchurch. Students were randomly assigned to an in-person or online group and completed pre- and post-intervention questionnaires. Risk factors for smoking and vaping were assessed with logistic regression. Schools' socio-economic status was imputed from their Equity Index rank. Intervention effects were assessed with and without demographic covariates using mixed-effect linear regression.

RESULTS: Students attending schools in lower socio-economic areas and those with Māori ethnicity were at greater risk of smoking and vaping. Risk of smoking increased with year level; however, risk of vaping did not.

There was significant improvement in responses to 3 out of 10 knowledge questions, and there was no evidence that post-intervention scores were affected by participant characteristics. The in-person group showed higher percentage improvements than the online group. Expressed desire to quit vaping increased from 61.7% to 68.8%; however, there was significantly greater desire to quit vaping in students from years 9 and 10 than years 11 and 12 (P=0.043).

CONCLUSION: Our educational intervention improved the knowledge of high school students on vaping-related health risks and increased expressed desire to quit vaping.

The use of electronic cigarettes or e-cigarettes, commonly known as vaping, has been rapidly increasing globally over the past decade, particularly among youth and young adults. In this paper, we define youth as people aged younger than 18 years old and young adults as people aged 18–24 years old. Youth vaping is an evolving public health concern in many countries, including Aotearoa New Zealand. Recent data show that in 2023, 16.4% of youth in Aotearoa New Zealand aged 14–15 years old used an e-cigarette in the past month (currently vaped).[1] In other countries in 2022, regular e-cigarette use was 11.8% among 14–17-year-olds in Australia,[2] 9.4% among 11–18-year-old students in the United States (US)[3] and 6.9% among 11–17-year-olds in the United Kingdom (UK).[4]

Although it is illegal in most countries to sell e-cigarettes (typically known as vapes) to people under the age of 18 years,[4,5] this has not stopped youth from vaping. Many youth vape out of curiosity, for fun/enjoyment of flavours and to vape with friends and peers.[4,6,7] The novelty and trendy looks of the thousands of vape devices that are constantly evolving have also made vapes popular among youth.[8]

Published results suggest family and friends are key sources of vape products for youth. In Aotearoa New Zealand, most youth get their vapes from friends/peers (53%) or other social contacts, including family members.[6,7,9] Friends are common sources in Australia (63–70%)[8,10] and the UK (46%).[4] Purchasing from a store is the predominant way of acquiring vapes among youth in the US (78%)[11] and the UK (48%).[4] Borrowing another person's vape is part of most vape users' social experience.[11]

Most vapes contain nicotine, which is highly addictive. Nicotine exposure in adolescence has a range of behavioural effects that can last into adulthood, including increased rewarding effects of abused drugs, deficits in cognitive function,

emotional dysregulation and sleep problems.[12,13] Further, serious lung injury has been reported from specific vaping ingredients, including bronchiolitis obliterans.[14,15] There is also evidence that vapes can deliver a range of potentially harmful chemicals and compounds (including heavy metals)[16] deep into the small airways.

Despite the known and the unknown long-term health risks, e-cigarette companies, many of which are owned or part-owned by tobacco companies,[17] have employed complex targeted marketing tactics to attract youth into vaping.[17,18] Legislation to reduce youth access to vaping products, close loopholes to marketing to youth and regulate the product flavours and nicotine content are key to managing this problem. Alongside these legislative measures, youth need to be adequately informed about vapes and vaping, with a goal to help reduce the misconception that e-cigarettes are harmless, desirable leisure products, and to inform youth about the involvement of the tobacco industry in manipulating the attractiveness of vaping to them. Effective interventions are needed to support students who have not started vaping not to start and students who wish to quit vaping do so. A possible approach is through targeted education; however, there is limited information about this in Aotearoa New Zealand. A 2020 US study (n=235) found a 14% increase in knowledge scores of students about vaping-related health risks after a 50-minute educational presentation.[19]

In this pilot multi-locality randomised interventional study with a pre- and post-intervention comparison group design we evaluated 1) whether a targeted educational intervention increased knowledge of high school students about vaping-related health risks and desire to quit vaping, and 2) whether the effects differed depending on delivery of the intervention (in-person vs online).

Data from the New Zealand Health Survey show persistently higher vaping rates in Māori and Pacific peoples;[20] hence, we sought to include a range of ethnicities and schools with diverse deprivation indices in the study and assessed how these demographics impacted our results.

Methods

Participants

This study was approved by the Human Ethics Committee (Health) of the University of Otago (H22/080) and all guidelines of the Māori Health Advancement programme were followed.[21] The study was conducted with students in years 9–12 (89% aged 13–15 years) at high schools in Ōtautahi Christchurch, Aotearoa New Zealand. The inclusion criteria included: current enrolment in a participating school, being physically present on the day of the intervention and providing a valid consent or assent to participate. Our target was to recruit 120–160 students in each group.

We contacted all 23 high schools in Ōtautahi Christchurch through the Canterbury West Coast Secondary Principals' Association (CWCSPA) to assess interest in the study. There was a very low response (one school expressed interest to participate), which continued despite a further follow-up through CWCSPA. We decided then to directly approach schools that we had connections with (through research or personal links) and that had a spread of decile levels and a mix of private/public and single sex/co-educational schools. Our final sample was a convenience sample of four high schools in Ōtautahi Christchurch. We engaged with each school to cause minimal disruption and tailor the student selection method to each school. The final decision on the number of students and classes or year levels that participated in the study was made by the individual schools. However, these were entire classes/year levels; for example, all students in year 9 (one or more streams) at school A.

Procedures

Block randomisation was used to assign students to one of two intervention groups. In schools where uneven numbers of classes/year levels of students were available, students were invited to sit in one classroom and class teacher(s) grouped them into two equal-sized groups that were randomly assigned to in-person or online intervention. In schools where an even number of classes participated, the research team randomly assigned whole classes to one of the two study groups.

Participants were assigned a participant number encoding the school, the year-level and the individual. Participants in the in-person group wrote the participant number on pre- and post-intervention questionnaires to allow for matching of responses, while participants in the online group used the numbers to access the study on Qualtrics.

In-person group

Participants were allowed 10–15 minutes to independently complete a pre-intervention survey, which was collected immediately before the intervention. The intervention included a 10–15-minute interactive discussion about vapes

and why youth vape, nicotine addiction, vape clouds (the aerosol or mist that is exhaled when vaping) and potential harms of vaping and the role of the tobacco industry in e-cigarettes. The discussions were facilitated by research assistants recruited from students at two local universities, a majority of whom were studying a health science course. Training was provided before research assistants visited schools.

During the intervention, students were encouraged to make informed decisions based on available evidence, and general quit vaping advice was provided. After the intervention, students were allowed 10 minutes to complete the post-intervention survey—less time was allocated for this task because demographic questions were removed.

Online group

Participants completed the entire study (pre- and post-intervention surveys and the intervention) online at a single sitting. Once participants opened the Qualtrics survey web page and consented to participate by ticking "Yes" in response to "Would you like to participate in this research?", they were prompted to enter their participant number before proceeding to complete a pre-intervention survey, watch a 5-minute educational video (intervention—included all information discussed in the in-person group) and complete a post-intervention survey. Participants were not allowed to go back and change their previous answers.

Measures

Demographic information included participant's age, gender and ethnicity using validated question items.[7] Street name and suburb were optional, and many students did not provide this information.

The questionnaires used validated items[22,23] to measure knowledge on the risks associated with vaping, and desire to quit vaping before and after the intervention. The questionnaires included items that assessed prevalence and patterns of vaping and smoking, reasons for vaping, perception of harmfulness of e-cigarettes compared with tobacco cigarettes and intentions to quit vaping. "Current vaping" was defined as vaping at least monthly, and "regular vaping" was defined as vaping at least weekly. We used "skip logic" to direct participants to relevant questions; for example, intention to quit was only asked of participants who vaped.

We assessed responses to 10 knowledge questions (six "true/false" and four "agree/disagree") and one additional "agree/disagree" question. The true/false questions included: "Some vapes are safe for youth"; "Most vapes contain nicotine"; "Nicotine is an addictive drug"; "Nicotine harms brain development"; "Vapes create a harmless water vapour" and "The tobacco industry is in the vape game".

The four agree/disagree knowledge questions included: "Vaping can cause lung damage"; "Vaping is addictive"; "Vaping will harm a person's health over time" and "Vaping can help people who smoke quit". The additional agree/disagree question was "Vaping makes one more socially acceptable to their friends".

Statistical analysis

Data have been aggregated across schools to ensure confidentiality of students and schools. Previously published[24,25] risk factors for smoking and vaping (male sex, Māori identification, year level and school Equity Index) were assessed with logistic regression. Schools' socio-economic status was imputed with the rank of their Equity Index.[26] Intervention effects were assessed with and without demographic covariates using mixed-effect linear regression of pre- and post-intervention scores with a random effect for participant.

There was no evidence that knowledge differed systematically between schools (maximum intra-class correlation coefficient [ICC] 0.041), so effects of schools as clusters were ignored. Multiple comparisons were accounted for by the Bonferroni method and differences in numbers of students planning to quit were tested with the mid-P exact test, and where 0 responses were recorded, the small sample correction was used. All analysis was performed using R version 4.2.1 (Vienna, Austria), with models fitted and assessed using the lme4, lmerTest and performance packages.

Results

The analysis included 332 students from four schools. About 89% of participants were aged 13–15 years; 82% identified as New Zealand European and 52% were female, **Table 1**. Slightly more students participated online (56%) than in person. Overall, more students reported ever vaping than ever smoking (42.5% vs 19.6%). Current and daily vaping (15.1% vs 6.6%) was higher than current and daily smoking (3.3% vs 6.6%). The rates of ever smoking in the four schools were 2.3%, 12.8%, 18.6% and 26.8% by increasing level of deprivation, indicating that on this gradient, the

Table 1: Demographic characteristics of study participants (n=332), ever smoking and vaping.

		Total		Ever smoked		Ever vaped	
		Row totals	% of Total N	n	% of Row total	n	% of Row total
Total	N	332	100.0	65	19.6	141	42.5
Year level	Year 9	132	39.8	20	15.2	52	39.4
	Year 10	115	34.6	21	18.3	48	41.7
	Year 11	64	19.3	15	23.4	28	43.8
	Year 12	21	6.3	9	42.9	13	61.9
Age *years*	13	83	25.0	9	10.8	28	33.7
	14	117	35.2	19	16.2	47	40.2
	15	96	28.9	26	27.1	47	49.0
	16+	36	10.8	11	30.6	19	52.8
Gender	Male	131	39.5	22	16.8	53	40.5
	Female	172	51.8	36	20.9	74	43.0
	Other/not stated	29	8.7	19	65.5	14	48.3
Ethnicity *prioritised*†	Māori	64	19.3	20	31.3	39	60.9
	Pacific peoples	14	4.2	8	57.1	11	78.6
	NZ European	272	81.9	55	20.2	118	43.4
Format	Online	186	56.0	43	23.1	84	45.2
	Paper	146	44.0	22	15.1	57	39.0
School	S1	43	13.0	1	2.3	10	23.3
	S2	39	11.7	5	12.8	13	33.3
	S3	153	46.1	41	26.8	68	44.4
	S4	97	29.2	18	18.6	50	51.5

†Multiple responses were allowed, hence percentages add up to more than 100%.

schools cover a broad socio-demographic range.

Regression models containing all predictors for ever smoking and ever vaping were significant (**Table 2**). The effect of student's year level was significant for ever smoking (p=0.0101), while school's Equity Index was significant for both ever smoking (p=0.0021) and ever vaping (p=0.0091). Māori had higher odds for ever smoking (p=0.0152) and ever vaping (p=0.0011) than non-Māori. Gender did not significantly predict ever smoking or ever vaping.

Overall, the baseline scores on the knowledge questions were high (over 75% on 8/10 questions). There was an improvement in responses for 7/10 knowledge questions after the intervention, of which 3 were statistically significant (**Table 3**) after adjusting for demographics. There was no evidence that socio-demographic variables (not

Table 2: Socio-demographic risk factors for ever smoking and ever vaping.

		Univariate			Multiple		
Ever smoking*		**OR**	**(95% CI)**	**P-value**	**OR**	**(95% CI)**	**P-value**
Male		0.74	(0.41, 1.30)	0.2984	0.60	(0.33, 1.08)	0.2984
Māori		2.25	(1.20, 4.15)	0.0122	1.87	(0.97, 3.56)	**0.0152**
Year level		1.48	(1.11, 1.98)	0.0072	1.33	(0.95, 1.90)	**0.0101**
Equity Index	S2	6.18	(0.94, 121.36)	0.0004	10.60	(1.52, 213.27)	**0.0021**
	S3	15.38	(3.18, 276.92)		15.32	(3.04, 279.47)	
	S4	9.57	(1.87, 175.14)		12.13	(2.28, 224.80)	
		Univariate			**Multiple**		
Ever vaping†		**OR**	**(95% CI)**	**P**	**OR**	**(95% CI)**	**P**
Male		0.87	(0.56, 1.36)	0.5490	0.76	(0.47, 1.23)	0.5490
Māori		2.54	(1.46, 4.49)	0.0009	2.16	(1.22, 3.88)	**0.0011**
Year level		1.21	(0.96, 1.54)	0.1140	1.32	(0.98, 1.80)	0.1610
Equity Index	S2	1.65	(0.63, 4.45)	0.0081	2.56	(0.90, 7.44)	**0.0091**
	S3	2.64	(1.25, 6.00)		2.43	(1.09, 5.76)	
	S4	3.51	(1.60, 8.24)		4.17	(1.79, 10.32)	

*****Odds ratios and 95% confidence intervals from logistic regression on ever smoked with P-values by ANOVA for individual risk factors (univariate) and a multiple regression model. Schools ranked by increasing level of need for support.
†Odds ratios and 95% confidence intervals from logistic regression on ever vaped with P-values by ANOVA for individual risk factors (univariate) and a multiple regression model. Schools ranked by increasing level of need for support.

shown) had a significant effect on the responses. More students agreed pre-intervention (42.77%) than post-intervention (37.65%) that vaping made one more socially acceptable, but the difference was not statistically significant (p=0.443).

More participants who vaped than participants who did not vape thought some vapes were safe for youth and that they created a harmless water vapour and could help smokers quit (**Table 4**).

The in-person (paper) mode of intervention (**Table 5**) showed higher percentage improvements for most questions, whereas a number of the items in the online delivery got worse (negative values for improvement).

Desire to quit vaping

Students who reported vaping regularly were asked whether they planned to quit vaping and there was a notable increase in the proportion of students who expressed a desire to quit from 61.7% pre-intervention to 68.8% post-intervention. Post-intervention, 26/33 year 9 and 10 students planned to quit compared to 7/15 year 11 and 12 students (OR=4.24, P=0.043). The numbers are small but there is a suggestion that students in early high school are more likely to express a desire to quit than older students.

Comparing knowledge between those with and without a desire to quit post-intervention, the only nominally significant difference post-intervention was that those with a desire to quit all agreed that "Vaping will harm a person's health over time." (OR=4.35, 95% CI: 0.539, 150.008; P=0.0343).

Discussion

Vaping has become a growing and serious problem for young people in Aotearoa New Zealand, at a time when smoking rates in high

Table 3: Responses to knowledge questions, before and after the intervention.

	Correct answer (true/agree responses), %			
	Before	**After**	**OR, 95% CI**	**P-value**
No vapes are safe for youth*	80.72	87.95	2.29 (1.33, 3.95)	**0.003**
Most vapes contain nicotine	93.67	92.17	0.73 (0.37, 1.47)	0.383
Nicotine is an addictive drug	95.78	93.67	0.57 (0.26, 1.28)	0.173
Nicotine harms brain development	90.06	91.57	1.30 (0.69, 2.45)	0.423
Vapes do not create a harmless water vapour*	72.59	79.52	1.89 (1.18, 3.05)	**0.009**
The tobacco industry is in the vape game	75.90	90.66	3.83 (2.27, 6.48)	**<0.001**
Vaping can cause lung damage	85.84	87.65	1.26 (0.73, 2.18)	0.453
Vaping is addictive	92.77	91.27	0.79 (0.43, 1.45)	0.699
Vaping will harm a person's health over time	88.25	89.46	1.18 (0.67, 2.08)	0.540
Vaping can help people who smoke quit	53.31	54.82	1.12 (0.74, 1.72)	0.294

*Statement re-written in negative form to match direction of other statements. Odds ratios (95% Confidence Interval) and P-value (ANOVA) for intervention (after) from mixed-effects regression adjusted for mode, gender, Māori ethnicity, school and year level. Bold P-values less than 0.05 after Bonferroni correction for multiple testing.

Table 4: Responses to knowledge questions by vaping status: before and after the intervention.

	Participants who vaped		Participants who did not vape	
	Response before (%)	**Response after (%)**	**Response before (%)**	**Response after (%)**
No vapes are safe for youth*	69.4	84.4	85.3	94.1
Most vapes contain nicotine	96.0	95.6	95.6	97.8
Nicotine is an addictive drug	98.0	100.0	97.4	98.5
Nicotine harms brain development	87.0	88.9	94.5	98.1
Vapes do not create a harmless water vapour*	61.2	73.3	76.8	86.5
The tobacco industry is in the vape game	87.5	93.2	77.9	97.0
Vaping can cause lung damage	86.0	88.9	87.6	96.2
Vaping is addictive	94.0	100.0	95.2	98.8
Vaping will harm a person's health over time	80.0	97.8	91.6	97.3
Vaping can help smokers quit	68.0	79.1	52.6	57.0

*Statement re-written in negative form to match direction of other statements.

Table 5: Responses to the knowledge questions submitted online and in-person (on paper).

	Percentage improvement in correct answer (%)			
	Online	**Paper**	**OR**	**P-value**
No vapes are safe for youth*	3.23	12.33	3.61 (1.15, 11.33)	0.028
Most vapes contain nicotine	-4.84	2.74	5.15 (1.09, 24.46)	0.039
Nicotine is an addictive drug	-6.99	4.11	35.07 (3.86, 319.00)	**0.002**
Nicotine harms brain development	-4.30	8.90	24.02 (3.89, 148.24)	**0.001**
Vapes do not create a harmless water vapour*	2.69	12.33	2.86 (1.06, 7.68)	0.037
The tobacco industry is in the vape game	9.68	21.23	6.00 (1.79, 20.06)	**0.004**
Vaping can cause lung damage	-0.54	4.79	2.13 (0.68, 6.66)	0.193
Vaping is addictive	-4.30	2.05	2.77 (0.78, 9.88)	0.116
Vaping will harm a person's health over time	-3.23	6.85	4.71 (1.34, 16.47)	0.015
Vaping can help people who smoke quit	-6.45	11.64	4.35 (1.75, 10.83)	**0.002**

*Statement re-written in negative form to match direction of other statements. Odds ratios (95% Confidence Interval) and P-value (ANOVA) for intervention (after) from mixed-effects regression adjusted for mode, gender, Māori ethnicity, school and year level. Bold P-values less than 0.05 after Bonferroni correction for multiple testing.

school students are very low. The current intervention resulted in an overall improvement in student knowledge in 7/10 knowledge questions (statistically significant in three questions) and increased expressed desire to quit vaping overall and within 30 days. The improvement was not affected by the student's socio-demographic characteristics. All nominally significant results were improved post-intervention and by the in-person mode. Further research is necessary to determine why this is and if a modified online intervention can be as effective as the in-person intervention. It is possible that the increased time spent on considering the issues in the in-person mode resulted in more change, or that the students perceived an in-person approach to be more authentic. The three questions that showed a significant improvement were all short "true or false" facts addressed by the intervention.

A striking feature of the data is the high level of knowledge of rangatahi (young people) before the intervention, with all questions except for "Vapes do not create a harmless water vapour" and "Vaping can help smokers quit" having over 75% correct response rates. However, there were some notable inconsistencies, in particular among rangatahi who vaped, where about 30% thought vaping was safe for youth, while 40% thought that vaping created a harmless water vapour. Such variation in knowledge suggests that there is indeed a place for ongoing interventions, particularly in trusted and safe environments.

The majority of the students (56%) who had been introduced to nicotine through nicotine-containing vapes had never smoked; thus, vapes were the first gateway to nicotine for over half of the participants. Consistent with previous studies in Aotearoa New Zealand[24,25] and beyond,[10] the rates of smoking and vaping increased with age and year level, with year 12 students at 2.8 times the risk of smoking compared to year 9 students, and 16-year-olds at 2.6 times the risk of smoking compared to 13-year-olds. Likewise, year 12 students were at 1.6 times the risk of vaping compared to year 9 students; however, this was not statistically significant. Our study found over twice the risk of vaping, similar to the increased risk of smoking, for Māori rangatahi, consistent with other sequelae of colonisation that impact health and are addressed by prioritising higher risk. Similarly, students reporting Pacific ethnicity were at even greater risk of vaping (OR 3.60, CI

1.06–16.47, P=0.005) after adjusting for gender, year level and deprivation, suggesting that prioritising this community would also be beneficial.

In this study, one in three students perceived vaping to make one more socially acceptable to their friends, which may illustrate the powerful influence peers can have on adolescents.[27,28] In a 2018 study, Wallace and Roche found students who reported having one or more friends who vaped perceived vaping as having a positive social impact.[28] We hypothesise that improved knowledge and support for vaping cessation could reduce pressure on students to vape. Our results suggest that incorporating formal vaping education into school curricula[29] using validated teaching tools could empower students to make better decisions.

Our study was met with a lot of interest by students, many of whom expressed a desire to quit vaping and asked for help. Our data suggests that the desire to quit is significantly stronger in years 9 and 10 than later years; thus, we recommend that interventions are timed early in the high school journey. While the evidence that greater knowledge in those desiring to quit did not survive correction for multiple comparisons, all those who wanted to quit agreed that vaping caused long term harm, significantly higher than those who did not want to quit. Currently in Aotearoa New Zealand there are few, if any, specific resources available to help students quit vaping, other than smoking cessation services based at general practices (GPs) and other specialist smoking cessation services. It is not known to what extent tobacco cessation services (including Quitline) will assist vaping cessation, but the common addictive ingredient of nicotine suggests that similar approaches might be helpful. However, what works for adults may not necessarily work for adolescents and young people, so targeting vaping cessation supports for young people is important. We hope that in addition to helping develop tools to educate youth about vaping, this study will stimulate debate about youth vaping and elicit support for young people wanting to quit vaping. This is vital to prevent a new epidemic of nicotine addiction.

Policy implications

There is no question that legislation of access, marketing and product use is of the first importance in reducing youth vaping. Alongside this, youth need to be informed of the misconception that vaping is a harmless, desirable behaviour. Vapes were first developed to help people who smoke quit, but instead of their availability being targeted to people who smoke, they have been made available to the general public and marketed as risk-free leisure products. Furthermore, using strategies well-known to the tobacco industry, flavours, colours and designs directed to attract youth have been introduced.[30]

Future studies could investigate if linking tobacco companies to vaping using statements such as “The tobacco industry wants you to vape” and using short fact-based statements, for example, “No vapes are safe for youth”, or “Vape clouds are harmful to health” might help students be wary of vapes. Secondly, policy and guidelines on the use of nicotine replacement therapy (NRT) should be updated to support youth wishing to use NRT to quit vaping. Thirdly, additional research is needed to assess the effectiveness of class-based educational interventions on reducing e-cigarette use among high school students.

Strengths and limitations

Strengths include the use of largely validated question items to assess the demographic characteristics of study participants[7] and measure knowledge about vaping and desire to quit vaping.[22,23] This gives us the confidence to compare our findings with studies that have used similar questions. Secondly, participants were drawn from schools that represented the broader socio-economic spectrum of schools in Ōtautahi Christchurch, making the results potentially generalisable to high school students in Ōtautahi Christchurch. Thirdly, the majority of participants were in year 9 or 10 and aged 15 years or younger, which is an important age group for uptake of vaping.

The main limitation of this study is that the findings in a convenience sample may not be fully generalisable to students in Ōtautahi Christchurch or Aotearoa New Zealand. Many schools did not participate or express an interest in participating when approached, and it is unclear what the reasons for non-participation were, but disruptions caused by COVID-19 cannot be ruled out. Secondly, the effects of the intervention were assessed immediately when knowledge retention would be expected to be high. We preferred a follow-up assessment, but this would have required additional time commitment from students at a time when they were already time constrained. Thirdly, while the study succeeded in engaging Māori and Pacific youth, numbers were limited and none of the authors have Māori whakapapa (ancestry). Any intervention targeting these communities would

benefit from culturally appropriate input at an early stage.

Conclusion

The intervention was successful in improving the knowledge of high school students on vaping-related health risks. Desire to quit was significantly more prevalent in year 9 and 10 students, suggesting these students are priority targets for interventions. Future studies should assess the effectiveness of this intervention in other settings and improve on it where necessary.

COMPETING INTERESTS
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Does suicide in New Zealand follow a semi-lunar rhythm?

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ABSTRACT

The hypothesis that lunar cycles influence human behaviour, particularly incidents recorded by police or coroners, has been a topic of public and media interest around the world for decades. While connections between lunar cycles and numerous cultural practices are well-documented, claims that lunar cycles influence crime or suicide statistics have not been consistently supported. There have been recent media claims that suicide rates in New Zealand follow a lunar cycle, correlating with the Māori Maramataka lunar calendar. Building on prior research, this study scrutinises the postulated association between lunar phases and suicide rates, for general and Māori populations.

Utilising 2 decades (2000–2022) of data from the National Coronial Information System (NCIS) and the New Zealand Ministry of Health – Manatū Hauora, the study employs Poisson regression models and cosine curve analyses. Results reveal no significant correlation between lunar phases and suicide rates for the overall population or the Māori sub-group. The absence of a lunar effect persists across univariate and multivariate analyses, incorporating annual, seasonal and day-of-the-week variations.

Contrary to claims linking lunar phases to Māori suicide rates, this study provides a robust analysis of comprehensive suicide data. While acknowledging potential limitations, such as the diversity among Maramataka systems and unaccounted external factors, this study emphasises the need for evidence-based practices in mental health interventions. Further research is warranted to explore potential lunar influences on less severe mental health indicators and to substantiate claims supporting traditional Māori Maramataka-based treatments.

The practice of keeping time by the moon possibly dates back as far as the Palaeolithic period.[1,2] Many cultural, ethnic and religious groups, including Jews, Chinese, Muslims and Hindus, still use a lunar calendar.[3] For almost as long as the lunar cycle has been observed there has been speculation that human health and energy is altered with different phases of the moon. The words "moon", "month" and "menses" all have the same etymological root, and a belief in a link between moon phases and menstrual cycling is common in many cultures. However, the scientific debate over whether this link is real, whether in industrialised or non-industrialised societies, remains unresolved, with many papers on both sides being published over decades.

In terms of mental health, the word "lunatic" is derived from *Luna*, the Roman goddess of the moon. This is not just ancient belief, as modern healthcare workers and the general public have said they believe in the influence of the moon on human behaviour.[4] However, various studies around the world have been unable to show any robust link between moon phases and mental health markers.[10] A notable exception is a study of elderly suicide in the Chinese community that showed a lower rate during the Chinese Lunar New Year, which occurs on the new moon that falls between 21 January and 20 February. The authors attributed a possible cause as family companionship, which is culturally appropriate at that time of year,[11] and might be similar to the finding that suicide rates can reduce during major holidays in Denmark.[12] However, without replication, this may be a false positive result, as was suggested had occurred with a Finnish study that showed a relationship between suicide and a lunar calendar.[13]

Like Chinese, Māori have traditionally noted the movements of the moon to mark time. The Maramataka is a lunar calendar and traditional Māori belief suggests that some days of the lunar cycle are better to do certain activities.[14] In a news article and national broadcast in New Zealand,[15] two Maramataka experts highlighted the well-documented disproportionate rate of suicide among Māori[16,17] and suggested that there is a link between the moon phases and suicide in New Zealand: they are quoted as stating that 35% of Māori suicides occurred on the new moon and 16% on the full moon, based on 10 years of coronial suicide data. They were invited to present the findings to the New Zealand Mental Health Foundation.[18] Another New Zealand researcher

has also claimed that suicides are greater at different lunar phases.[19] However, in both cases the data are unpublished, and the methodology is not well documented. Analysis may be complicated by the fact that different iwi use slightly different calendars, with their respective Ōhua or Huna (days of the full moon) occurring up to 5 days apart.[20,21,22]

If there is a connection between the lunar cycle and suicide, it might be possible to design more effective interventions and preventative programmes. Despite a lack of published evidence, the Maramataka has been suggested as a tool for improving mental health,[23] and the New Zealand Mental Health Foundation and Canterbury Health board support All Right?, which provides Maramataka calendars that they claim *"highlight the connection between the moon and our wellbeing."*

This study aims to test the hypothesis that there is an effect of lunar phase on rates of suicide in New Zealand generally and, specifically, among Māori.

Methods

This study utilised routinely collected health data to analyse the rates of suicide in New Zealand over the lunar cycle.

Data sources, extraction and processing

With ethics approval (AHREC #AH24778), we extracted date of death and prioritised ethnicity for confirmed suicides in New Zealand from two primary sources: the National Coronial Information System (NCIS) for suicides between 26 October 2006 and 18 September 2022, and the New Zealand Ministry of Health – Manatū Hauora[24] for suicides between 1 January 2000 and 26 December 2018.

The NCIS dataset provided detailed records, including incident and death start and end dates where there was uncertainty around the exact timing of incidents. However, due to only one suicide recorded in 2006, data starting from 29 October 2007, and under-reporting post-2019 caused by a lag in data processing, our analysis was confined to suicides reported from 29 October 2007 to 31 December 2019, inclusive. For consistency and accuracy, we calculated the date of death using the midpoint between the start and end dates of the incident.

Ethnicity data were categorised to closely align with those in the Ministry of Health dataset, following the Ethnicity code tables for the National Collections. Prioritised ethnicity and date of suicide were extracted from both datasets. We did not control for population size.

Moon phase was calculated for each day using the "lunar.phase" function in the "lunar" package for R (version 4.1.0), which outputs a value between 0 and 2π for the moon phase, given a date, where 0 represents a new moon and π refers to a full moon.

Statistical methods

We conducted Poisson regression analyses with suicide counts modelled against lunar phases. The lunar cycle was divided into 29 uniformly distributed bins to approximate daily intervals and was centred around the new moon. The full model included annual, seasonal, monthly and day-of-the-week effects as covariates. An offset of *log(Ndays)* was added to the model, where *Ndays* is the number of days in each lunar period, to account for differences in exposure and ensure the output of the model represented rate per day.[25] Model suitability was confirmed by testing for Pairwise comparisons between levels and was done using the "emmean" package in R.

Additionally, cosine curves with periods of a full- and semi-lunar rhythm were fitted to the data. This was done by fixing the mean and amplitude of the cosine model (with a fixed period of either a period of 29 days or 14.5 days) to be the mean and range of the data, respectively, while altering the phase of the cosine model until it maximised the correlation of the data (using the general-purpose optimisation function, "optim" in R). Furthermore, the moon phases were permuted and the calculations repeated 1,000 times. This allowed for a better estimation of how significantly the data fit a lunar or semi-lunar cycle.

The above analyses were repeated for only Māori deaths, under the hypothesis that they are more likely to be correlated with Maramataka classifications.

Results

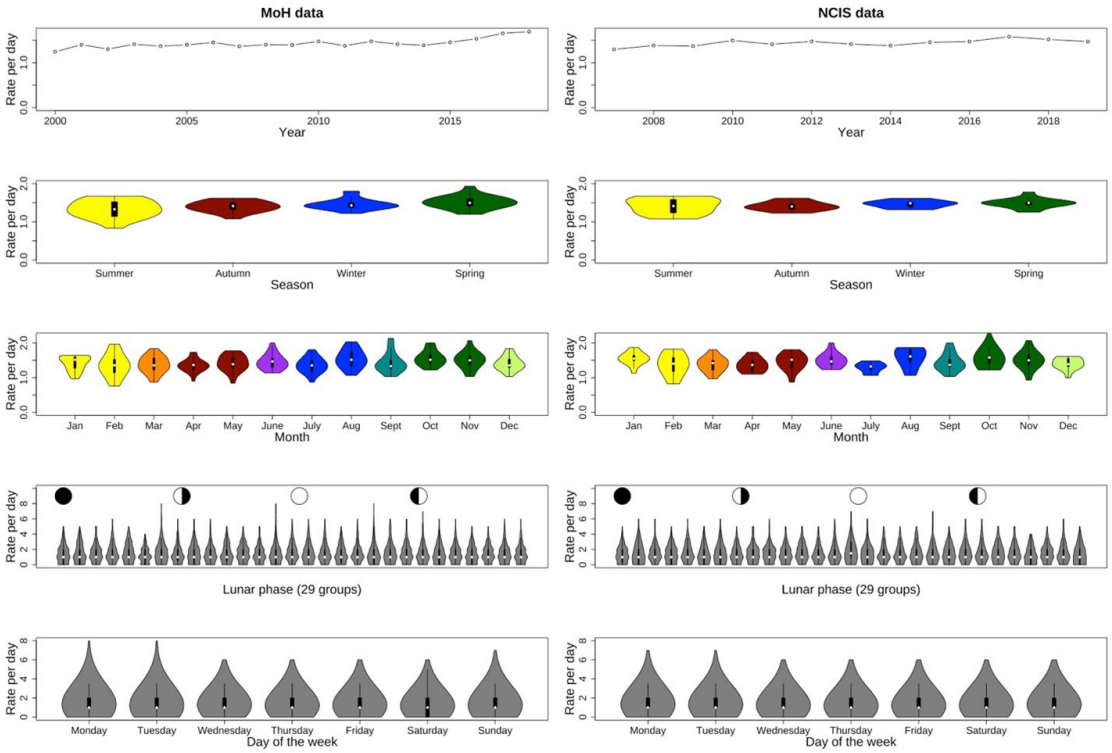
All data

There was a total of 9,929 suicides recorded by the Ministry of Health (overall rate of 1.43 suicides per day) and 6,447 recorded by NCIS (overall rate of 1.45 suicides per day). Notably, for the same overlapping time (29 October 2007 to 26 December 2018) there were 6,020 deaths recorded by the Ministry of Health and 5,903 recorded by NCIS (overall rates of 1.48 and 1.44 suicides per day, respectively). Māori were over-represented

Table 1: Summary of the ethnicity data from the two datasets.

	Ministry of Health data (N = 9,929)	**NCIS data (N = 6,447)**
Dates	1 Jan 2000–26 Dec 2018	29 Oct 2007–31 Dec 2019
Prioritised ethnicity N (%)		
Māori	1,980 (19.9%)	1,370 (21.3%)
Asian	433 (4.4%)	287 (4.5%)
Pacific	430 (4.3%)	331 (5.1%)
Other	7,086 (71.4%)	4,459 (69.2%)

Figure 1: Overview of the data from the Ministry of Health (left) and NCIS (right). The rate of suicide each year is plotted at the top. Below those are violin plots of the rates of suicide by season, year, lunar phase (divided into 29 equal parts, with inlayed lunar phase) and day of the week. Note that these represent the distribution of rates of suicide in each time "bin" over the whole dataset.



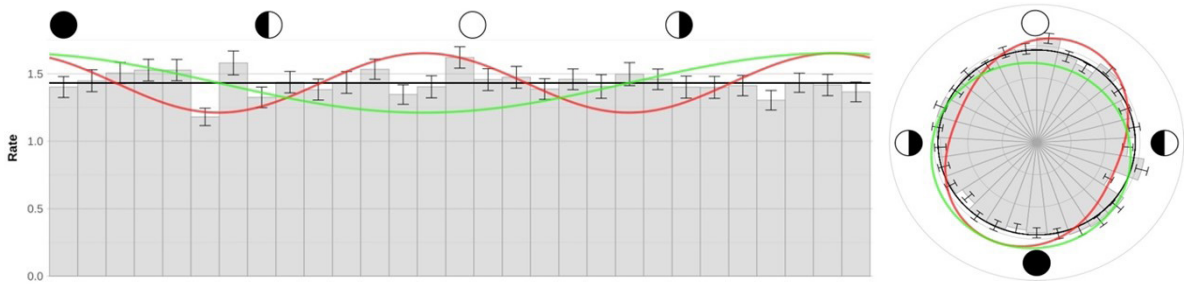
in both datasets (Table 1).

The rates of suicides per day in each year, season, month, lunar phase and day of the week are plotted in Figure 1 for the Ministry of Health (left) and NCIS (right) data.

Univariately, there was a significantly lower suicide rate in the lunar period centred at 1.08 (bin 6 of 29) compared with the period centred at 3.03 (bin 15 of 29; estimated [standard error] difference of 0.32 [0.08]) in the Ministry of Health dataset. There were no significant differences between any periods in the NCIS data.

There was also no significant difference in suicide rate by month in either dataset. However,

Figure 2: Rate of suicides by lunar phase with mean (black) and optimised cosine curves overlaid (red and green) in linear (left) and polar (right) coordinates for the 29 periods from the Ministry of Health data.



there was a significant, but moderate, difference in rate of suicide by season in the Ministry of Health dataset, with a higher suicide rate in spring and winter compared to summer (with estimated [standard error, p-value] differences of 0.11 [0.03, p<0.001] and 0.07 [0.03, p=0.05], respectively). There was also a significant difference in rate of suicide between days of the week in the Ministry of Health data (Monday being more likely than Saturday, with an estimated [standard error, p-value] difference of 0.12 [0.04, p=0.03]).

A multivariate Poisson model, with lunar phase (divided into 29 periods), year, month and day of the week as covariates confirms the higher rate of suicide at the phase centred at 3.03 and the lower rate at phase centred at 1.08 (respective estimated risk ratios [95% CI, p-value] are 1.16 [1.0–1.35, p=0.042]) and 0.85 (0.72–0.99, p=0.037 when compared with the rate centred at 0 [the new moon phase]) in the Ministry of Health data. There were no other statistically significant results in the lunar phases, and there are no significant differences in any lunar phase in the NCIS data. There was no over-dispersion in any of the models.

Considering the correlation with cosine functions, there was no significant correlation with either the lunar (green line in Figure 2) or semi-lunar (red line in Figure 2) cycle in either dataset. The level of correlation was also not significant after permutation testing. The Ministry of Health data are plotted in Figure 2 as a linear bar graph and in polar coordinates.

Sub-group analysis

We repeated the above analysis for only cases where the deceased was Māori. There was no significant difference in the rate of suicides by season. November had a significantly higher rate compared with March (effect size [standard error, p-value] of 0.42 [0.1], p=0.006) in the Ministry of Health dataset. In the NCIS dataset, Wednesday was associated with a lower rate of suicide compared with Saturday and Sunday (effect sizes of 0.32 [0.1, p=0.04] and 0.33 [0.1, p=0.03], respectively).

There were no significant differences in the rate of suicide between any of the moon phases. There were also no significant differences in the rate of suicide in a multivariate model. There was also no significant correlation to either lunar or semi-lunar cosine models.

Discussion

There is no strong evidence of a difference in the rate of suicide during different phases of the moon. This is true for the whole population and for the Māori population, in both univariate analysis and taking into account annual, seasonal and day-of-the-week variations.

The small effect size we saw in the Poisson models in the Ministry of Health dataset were marginally statistically significant and results were not adjusted for the multiple tests we performed (see below), so are most likely a false-positive,[13] especially as the result was not replicated with the NCIS data.

There was no evidence at all for a lunar rhythm in the rate of suicides in New Zealand. Our results are not unique; many other studies around the world have failed to replicate claims about lunar correlations with suicide (or other human behaviours).[10]

We did not do any sub-group analysis for age or gender or other demographic information, as there was no *a priori* reason to think that these covariates would be important. This was also the rationale for not controlling for population size, as we did not expect the population to change significantly over subsequent lunar cycles. Notably, there was a modest increase in national population over time and a relatively constant rate of suicides

over the years, indicating that suicide per capita is reducing.

Similarly, this work did not take any other factors into account, including neglecting possible global or local events that may have contributed to different rates of suicide, such as the COVID-19 pandemic, which occurred within the timeframe of our collected data. Also unaddressed were possible accidental correlations; for example, it is possible that any particular 15-year period might coincidentally have a particular moon phase fall on, or off, particular holidays or days of the week more than would be expected in a longer-term average. However, as the lunar year (12 lunar cycles) is 11 days shorter than the solar year, and thus strongly out of sync, we expect any effect to be small.

On the other hand, some holidays celebrated by substantial numbers of residents are timed with reference to a lunar calendar (e.g., Easter, Chinese New Year, and in 2022, Matariki, the Māori New Year, which became an official public holiday); celebrations or associated work/school holidays might conceivably induce detectable, although likely small, correlations with particular lunar phases. Thus, we did not test for holiday periods or other, more refined, timepoints.

We also recognise that different iwi have different Maramataka,[20] and there are differing interpretations as to which days might contribute to suggestions of "low energy". The data available do not allow the linkage of individuals to iwi or what their interpretation of Maramataka is. Furthermore, we recognise that a substantial proportion of Māori are urbanised and may have weaker linkages to traditional practices. Nevertheless, the distribution of suicides across the lunar cycle was approximately normal, so it is unlikely that accounting for urbanisation and iwi-based Maramataka would yield a different result.

This work involved numerous statistical comparisons, which increases the risk of a false positive. We did not correct for multiple testing across the models, and so our negative results are conservative.

We contacted the Ministry of Health and NCIS to try to understand why there are discrepancies between the recorded number of suicides. However, there is no clear reason that emerges. This is a phenomenon that should be considered in future work. Similarly, there is some uncertainty in the timing of some of the suicides in the NCIS data. We do not expect this to have significantly affected our results, given very comparable effects in the Ministry of Health dataset and our permutation tests.

We make no claims about the consideration of lunar or semi-lunar cycles during treatment for mental illness, and there is anecdotal evidence of efficacy for connecting patients to their environment. There may be other rationales for consideration of lunar, or other, cycles in the clinical treatment of particular patients. This deserves further study.

Only suicide was considered in this study. It may be the case that different results are found for less severe indicators of declining mental health, such as hospital admissions, patient self-reported status or medication use. More work is required to establish evidence in these areas to back up the New Zealand Mental Health Foundation and Canterbury Health board claims and provide a science-based rationale for supporting traditional Maramataka-based treatments.

COMPETING INTERESTS
Funding for this work came from an internal University of Auckland grant.

ACKNOWLEDGEMENTS
Suicide, particularly youth suicide, is a tragedy in every single case. We acknowledge that behind each of the numbers in our somewhat abstract statistical analysis are individuals, their family and wider circle of influence. We hope that our work adds to the knowledge base, however modestly, to help combat suicide in New Zealand.
DC and NM initiated discussions about testing the hypothesised linkage. DC obtained ethics approval and conducted the main statistical analysis in consultation with co-authors. RS provided information on maramataka and background on efforts to better understand and prevent suicide among Māori; he uses maramataka in his practice. There are no other possible conflicts of interest.
We would like to thank the excellent people at NCIS and the NZ Ministry of Health for their assistance exporting and understanding the data in their custody. We would also like to thank numerous colleagues who provided input into the analysis approach, framing of the paper, and encouragement of it.

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How is the specialist–primary palliative care model functioning for cancer patients in the current New Zealand health system?

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ABSTRACT

AIM: Patient barriers to accessing hospice and palliative care (PC) have been well studied. Important, yet less investigated, is how cancer patients whose hospice referrals were not accepted are being cared for. This article aims to understand the referral process from PC providers' perspectives and the implications of the current palliative system for patients, families and health professionals.

METHODS: We conducted interviews with 28 healthcare professionals via Zoom. Participants worked in specialist and primary PC settings, such as hospices and aged residential care, and were based in seven Aotearoa New Zealand regions. We thematically analysed the interview transcripts.

RESULTS: We identified four themes: the state of the PC system; communication issues; unmet needs and inequities; and managing care within the current system.

CONCLUSION: The limited funding for PC and other health services is resulting in a decrease in PC services. The specialist–primary model of end-of-life supportive care in New Zealand is undermined by under-funding. The implications for cancer patients, their families/whānau and their healthcare professionals are moves towards a more biomedical model of PC, a reduction in training and unsustainable work-arounds to manage care within the under-resourced system. Considering the ageing population, urgent action is needed.

As the population ages, the demand for palliative services will increase. However, hospice care is restricted to those with the highest needs.[1] Significant evidence supports the integration of holistic palliative care (PC) for patients with advanced cancer.[2] In Aotearoa New Zealand, community specialist PC (henceforth specialist PC) is provided by independent hospices to patients at home and in-patient units, and supports staff and their residents in aged residential care.[3] Several analyses have found wide variations in the provision of hospice and other specialist PC in New Zealand across localities and regions.[3–5]

Hospice is just one part of PC; primary or generalist PC can be provided by general practitioners (GPs), nurses (particularly district nurses), Māori health providers, oncologists, other specialists, social workers, occupational therapists, counsellors, chaplains and so on. New Zealand policy establishes a hybrid working model of PC that is provided by non-specialists and specialists, who differ by degree of training in PC.[6] The intention is a universal model of PC provision available to all, irrespective of setting or illness.[7] Factors that support good partnership between specialist and primary PC include: good communication between providers; clearly defined roles and responsibilities; opportunities to learn together; appropriate and timely access to specialist PC; and well-coordinated care.[8,9] Communication between providers, families and patients is a recognised factor in integrated care. All of the providers (and non-providers) caring for a particular person need to have a "shared vision of care" to ensure that their care is working towards the same person-centred goals.[10]

A lack of integration is a long-standing challenge for the specialist–primary PC model.[7,9] A systematic review called for research with healthcare professionals and patients about their perspectives on collaborative working in PC.[8] Integration was explored in a cross-country United Kingdom and New Zealand comparison early after the specialist–primary model was introduced in 2011.[9] In 2011, hospices cared for approximately 14,000 people (in an email from Hospice New Zealand, October 2024); in 2022/2023 they cared for 18,582 people, of whom 10,880 died.[11] Adjusting for the increase in deaths over this period (30,081 in

Table 1: Participants' healthcare sectors.

Sector	N
Community care and district nursing	10
Oncology	5
Hospice/specialist palliative care	4
Aged residential care	4
General practice	3
Hospital palliative care	2

2011 to 37,884 in 2023[12] and acknowledging that not all of the people the hospice cares for die in that reporting year), the percentage increase in the proportion of patients (and their whānau) cared for is 5.4% (in an email from Hospice New Zealand, October 2024).[12] More people in New Zealand die receiving primary PC. Close to 15 years on, another examination of how this hybrid model is operating in New Zealand is due, especially in light of funding and other challenges in the health system. We sought to understand the experiences of both specialist and primary PC providers within the current PC model of care, focussing on when a patient's referral is declined,[1] and to elicit their views on how the current system is functioning for cancer patients and their families/whānau. We focussed on cancer patients because their prognostic eligibility for hospice is clearer than other patient groups.

Methods

Critical realism underpinned this research.[13] We consulted with various healthcare organisations about the issues most salient to them regarding PC referrals and declines and designed the study to reflect this. Ethical approval was received from the Health and Disability Ethics Committee (2023 AM 11724).

Recruitment and data collection

Participants were recruited through healthcare organisations, including the Royal New Zealand College of General Practitioners and Hospice New Zealand, as well as through networking. One focus group with six community care coordinators and 22 individual interviews, mostly over Zoom, took place in 2022. We found it adequate to establish rapport over Zoom and discuss this subject. The medium appeared acceptable to participants. The interviews focussed on the factors contributing to hospice declining referrals, and questions included, "*Have you ever had a cancer patient's referral to hospice declined?*", "*What was that like for you, the patient and their family?*" and "*What do we know about people with cancer who don't access hospice, how are they being looked after?*" Transcripts were produced by a professional transcriber and offered to participants to check. Participants were given a $50 voucher in appreciation.

Participants

The 28 participants' healthcare sectors are described in Table 1. Several participants had worked in specialist PC and now work in primary PC. Participants worked in Dunedin, Wellington/Hutt Valley, Waikato, Christchurch, Auckland, Bay of Plenty and the Coromandel. Further demographic information was not requested, though participants represented a range of ethnicities and ages, and included five men.

Analysis

Thematic analysis was conducted on the interview transcripts using NVivo software (Lumivero, Version 14). JY intensively read and inductively coded each transcript line-by-line to capture how participants described the issues and implications of declined referrals.[14] JY created a codebook and memos of the developing categories and themes, and a research assistant applied the codebook to the remaining eight transcripts in discussion with JY's guidance. Through reflexive, iterative discussions, we developed four themes. We examined the transcripts for alignment and inconsistencies across themes and sectors.

Results

We report on four themes: the state of the PC system; communication issues; unmet needs and inequities in PC access; and managing care in the current system.

The state of the PC system

This theme described a model of PC that was changing out of necessity due to limited resourcing, because of a desire for people to have more community-based care and in response to more demand for their services. Participants described how the ageing population was increasing demand, and because oncology has adopted the promoted model of early/timely PC:[2] "*I'm a strong advocate, our whole department are strong advocates of early hospice referral*" (oncologist, regional hospital). The demand, combined with under-resourcing, required changes in the model of hospice care including referral/acceptance criteria, reduction of services and reduction or ceasing of educational programmes for primary PC. A hospice leader acknowledged the changing criteria and attributed it to resourcing issues. Instead of accepting previously eligible referrals, hospices were declining referrals for those who did not have immediate needs or needs that could be managed by another service.

> *So that's referral criteria, it's not the acceptance criteria. So, that can be a little bit different, and right now I know that some hospices are managing referrals based on their resource and what they can manage. (Leader, urban hospice)*

The gap between the referral and the acceptance criteria was frustrating for both primary and specialist PC providers. The impact on patients was noted.

> *It's really gotta be just symptom management or* [hospice] *don't seem to have a lot of support* [for] *someone at home … there's often been people that I've felt that the hospice should've really been involved in earlier time but they've been declined… It's just very frustrating. The oncology team had actually referred… the client was seen by hospice and then was told that he didn't really have any real symptoms or didn't really need the support 'cause he wasn't actively dying …* [and that he] *can get re-referred at a later date… I stayed on … supporting him at home until I've asked the GP again to do another re-referral to hospice … psychological support, all the other support that I thought he should've been getting, he is not getting. (Supportive nurse, urban community care)*

This one example demonstrates several routes of referral—oncology, GP, community nurses—illustrating the complexity of specialist–primary PC. One way of managing patients was to assess and decline and then suggest they are re-referred when the need changes. Re-referral was seen as an acceptable process by specialist PC providers but less so among primary PC providers.

Staffing shortages were contributing to the capacity of specialist PC. Constraints in capacity issues means hospice must focus on higher-needs patients, usually with physical symptoms. This undermines the holistic early approach hospice favours. The specialist–primary PC model goes some way to meeting the demand by hospice acting as a consultancy-based service, and primary PC providers remain the primary carers.

> *So we have quite a good relationship with* [local] *hospice out here. So we have a, we have a fortnightly meeting with them and then we just have phone contact. Like we have a lot of shared care patients because there's people under hospice, but also receiving treatment. So we liaise with them all the time. (Oncology nurse, urban hospital)*

For patients the siloed health system, including the specialist–primary PC model, contributed to patients feeling passed around or "dumped":

> *I think especially like oncology patients, they'd, sort of, feel this dumping, and so they'd kind of been through, you know, sometimes years of chemotherapy and perhaps even relationships with surgeons. And, then they, sort of, get to the point of you're too sick now there's nothing you can do we're going to pass you onto your GP, and then we're going to pass you onto hospice. And, you sort of feel that that's probably going to be the last sort*

of thing, and then you get passed off yet again [to aged residential care]. *(Nurse practitioner, rural aged residential care)*

Some participants identified that it relied on skilled primary PC providers to identify patients' palliative needs.

Communication issues

Changes to hospice services, such as the acceptance criteria, could have been better communicated across and within organisations.

We [put out communication about their criteria], *but what we do here is if we change something that's related to primary care, we will send an e-mail that will go to the practice managers of a practice. But that relies on the practice managers filtering it through, that relies on the practitioners reading it and understanding it. (Clinical nurse specialist, urban primary care and hospice)*

Participants described under-communication, where PC referrals did not contain the information required to triage the referral; slow communication, where the response was not considered to be timely enough to address the patient's needs; difficult communication, where they felt their requests and needs were not heard or dismissed; or no communication, where the communication was not responded to.

No-one had listened to my GP when they were requesting help from a consultant. The [hospice] *consultant had a preconceived idea, which was wrong, believed it was a family issue when that wasn't the case. And I think that's something that we struggle with is when our doctors actually need help, they actually genuinely need help, and that is sad I think that we can't get that input that we need for those really complex, because it falls back on us. (Clinical nurse manager, urban aged residential care)*

For those that it's a shared care model, I think the gap is around communication. That causes anxiety and confusion, for some, not all. That would be probably, and I know that from a agency, home and community support service agency I think this is certainly what's been raised recently is the vulnerability. That they are feeling when they are caring for a patient who is palliative and there's a lack of, or of disconnect around communication. (District nursing manager, urban hospital)

Other issues, related to trust, time/capacity and the clinical hierarchy influenced communication across PC providers. Clinicians being able to access notes from other sectors' patient management systems helped immensely and could reduce duplication, e.g., care plans.

Unmet needs and inequities in access to PC

The net result of the current PC system, combined with communication issues, were unmet needs and inequities in access for some patients. This affected particular groups more so than others: some ethnicities, rural dwelling patients and some illness groups (such as dementia and those with frail-dwelling community members) lacked access to the specialist PC they potentially needed.

The hospice is two and a half hours away so all their family and friends, it creates an immense distance really, it doesn't work, you know? Those people that want to, who are dying, prefer to be around family and friends in the process and in their own homes. (GP, rural primary care)

People with English as a second language, those living in a caravan park, non-residents and people of some faiths were also identified as having unique access issues. The stress on families to meet their family members' needs as they approached the end of life without specialist PC was noted by many. Other health system factors contributing to families' stress included the inability of many GPs to conduct home visits, as well as a lack of or minimal funding for home assistance in cases where the patient resided with family, despite family members working full-time. Another issue was that hospice services seemed to be unavailable to aged care residents, though support for staff was available from aged residential care hospice liaison nurses.

It's something that hospice do really well. But, they only tend to offer that to people in the community, they don't offer it in

residential age care … [some people] *come into care and they've got all these complex psychosocial issues. (Nurse practitioner, rural aged residential care)*

Unmet needs and access inequities were further compounded by the reduction in PC courses for primary providers. Both specialist PC and primary PC participants described that the PC expertise of non-specialists needed to increase, e.g., recognising delirium or dying.

Managing within an under-resourced PC system

The obvious solution to suboptimal PC is better funding to employ more staff so referrals can be accepted and staff have time to communicate, resulting in less stress and less need for gatekeeping.

There's international guidelines on when patients should be referred to palliative care … my sense is that the hospices generally aren't resourced for that. (Palliative medicine specialist, urban hospital)

In lieu of that, primary PC participants continued to support patients and families and came up with a range of workarounds to help overcome the above issues: being a "squeaky wheel" to get what the patient needed, providing culturally appropriate care, e.g., marae or church drop-in clinics, accepting that not every primary care interaction would generate income, working overtime, upskilling and educating families, drawing on community support, making other referrals, getting the GP more involved and, for rural GPs, always being on call.

Medicine often works this way, is knowing how to game the system. You happen to know to whom you should talk in a particular situation… But it shouldn't, it's often used as a means of getting out of the constraints of an under-resourced system or the inability to refer someone in the direction in which it would be appropriate to do so. (Medical oncologist, urban hospital)

In terms of communication, thorough handovers during transitions between PC settings, timely access to records and virtual consultations were helpful. We observed hospital PC acting as a bridge between hospices and primary PC. Different ways of clinicians working, such as individuals working concurrently in both specialist and primary PC, staff having flexibility in their roles, PC champions within organisations, more services provided by fewer providers and accessing the hospice consultancy service (e.g., aged residential care liaison nurses, 24/7 phone service where it existed) worked well.

These formal and informal strategies were described as how PC providers worked towards improving health outcomes for those typically disadvantaged and under-served by the health system. However, having clinicians wrangle care within a non-functional system is unsustainable and may have negative implications for the workforce, including burnout and retention issues.

Discussion

The effect of the hospice not being able to accept (or at least consult with) all referrals was frustrating for both specialists and primary PC participants, though it was noted by one hospice leader as the ideal. Patients are missing out on care that clinicians have identified there is a need for, resulting in additional stress for their families and healthcare providers.[15] There is also an inability to provide evidence-based care (early referrals of new cancers) due to current constraints.[16] This means the health system is not serving its purpose, and the discontinuities may cause staff to leave, resulting in even worse outcomes for patients. The need to reduce primary PC training by specialists is undermining the functionality of the specialist–primary model. This study sits within the context of a whole health system that is lacking funding and staff,[17–19] and also has integration and communication issues. Similar issues in the present study were identified in a survey of health professionals and service users by the National Palliative Care Work Programme.[20] Improvements could be made in communication between providers including regular case discussions. However, as an aged residential care manager articulated, you only get one chance with a dying person and their family. High-quality PC, whether primary or specialist, is important for the bereavement of living relatives; it also improves patients' quality of life and reduces secondary care use.[2,21] If the current PC system has room for improvement for cancer patients, then it is likely to be even worse for other patient groups because the hospice

model serves cancer patients most often.[11]

This transformation is important because the reality of the current PC system does not match the philosophy of early, or at least timely, PC for all people with serious and advanced diseases.[5] This philosophy may create expectations among patients and primary PC providers that people with advanced diseases receive early PC, but it is not possible to provide early (or timely for some) PC for all patients due to the shortage of specialist PC. Specialist PC may not be beneficial for all patients as some may not have complex PC needs and can be well cared for by primary PC. Given the scarcity of specialist PC resources, questions have shifted from whether to provide PC to when to provide it, to which patients, what to provide to whom and who should provide it.[22] The necessitated return to focus on symptoms (a biomedical model) over other support (a biopsychosocial-spiritual model) is at odds with the original intention of hospice and Te Whare Tapa Whā approach.[23,24]

Participants were concerned that any reduction in services meant people's needs would be overlooked and that it may disproportionately affect particular groups. Ethnicity is an essential and evidence-based marker of need.[25] Hospice appears to be providing access to services equitably for Māori, as in 2022/2023, Māori comprised 13% of hospice patients, a figure that closely aligns with their proportion of total deaths (12.5%).[11,12] Participants commented on some inequities among groups and situations. We need approaches to PC delivery that take into account intersecting inequities (e.g., racism, classism, ageism, ableism, sexism), groups that experience social disadvantages and PC access barriers (e.g., people experiencing mental distress, homelessness, poverty), and other social situations (e.g., rurality, English as a second language, mistrust in the health system).[26] Enhancing equity in PC access requires an inclusive, diverse, person-centred approach with community, structural, policy and system–level support with staff as diverse as the patients.

The specialist–primary PC model has many dimensions and includes providers and interactions with various models and indicators.[22] Work is underway to develop core service components in specialist PC in New Zealand.[5] Even though a model will need to be tailored to each region, while variation still remains, the unifying elements of such models are collaboration, coordination, communication and acknowledging the value of other providers.[27,28] Establishing shared care models and transition models between primary and specialist PC settings may help.[22,27,28] Articulating where on the spectrum of the "Consulting-Shared-Takeover Framework" specialist–primary providers are operating may help to describe, understand and assess how teams are working together, and their efficacy.[28] The five domains are: 1) what aspects of care (*scope*) are addressed by the specialist PC clinician? 2) who *prescribes* the treatments? 3) what *communication* occurs between the PC clinician and the patient's lead clinician? 4) who provides the *follow-up* visits and what is their frequency? and 5) who is the *most responsible practitioner*? Using the Consultation-Shared-Takeover Framework can support the sustainability of a service.[28] A more coordinated system with explicit modes of working together would mean that health professionals do not need to develop unsustainable makeshift strategies to circumvent the suboptimal PC system to ensure patients get the care they need. At a minimum, transparent acceptance (as opposed to referral) criteria and triaging systems should enhance the trust in, and effectiveness of, the specialist–primary PC model in New Zealand.

A strength of this research is the range of participants from different sectors, including both primary and specialist PC, to gain a fuller picture of the system and how it is working. However, we did not interview participants from all regions, so there may be further challenges and/or workarounds we have not identified due to the regional variation in PC services. Cancer deaths are easier to predict than other disease types, so findings may not apply to all patients at the end of life.

Conclusion

This research has identified that at times there is a lack of integration and communication between specialist and primary PC. Participants attributed the deterioration of this model to poor planning/under-funding, increased demand, lack of training for primary PC, siloed working, lack of effective communication channels and access to records, and workforce issues including the pandemic. The under-funding of PC is contributing to suboptimal PC provision, likely contributing to difficult experiences at the end of life for all involved. We echo calls for more funding for PC with equity built into it— for both primary and specialist—because at present, PC is not resourced for the philosophy of care espoused.[18,19] While the specialist–primary PC model is entrenched, the challenges need further

remediation to ensure workforce sustainability and patient- and family-centred care, especially considering the ageing population.[29] From this research we have developed a resource for primary palliative care providers to help them think about how they can continue to support patients and families who are dying without hospice.[30] Future research should seek patients' perspectives on the specialist–primary PC model and explore who health professionals see as being responsible for PC transformation (clinicians, managers, systems, policy, etc.).

COMPETING INTERESTS
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Support for and likely impacts of endgame measures in the Smokefree Aotearoa Action Plan: findings from the 2020–2021 International Tobacco Control New Zealand (EASE) surveys

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ABSTRACT

AIM: In February 2024, the Aotearoa New Zealand Government repealed legislation to mandate very low nicotine cigarettes (VLNCs), greatly reduce the number of tobacco retailers and disallow sale of tobacco products to people born after 2008 (smokefree generation). We investigated acceptability and likely impacts of these measures among people who smoke or who recently (≤2 years) quit smoking.

METHOD: We analysed data from 1,230 participants from Wave 3 (conducted in late 2020 and early 2021) and 615 participants from Wave 3.5 (conducted in June/July 2021) of the New Zealand arm of the International Tobacco Control (ITC) Policy Evaluation Project. Data were weighted to represent the national population of people who smoke and who recently quit smoking.

RESULTS: Support (excluding "Don't know" responses) was 82.7% (95% confidence interval 77.9, 86.6) for a smokefree generation, 75.0% (95% CI 71.4, 78.3) for mandated VLNCs and 35.2% (95% CI 31.7, 38.9) for retailer reduction. Support was mostly similar by ethnicity, gender, age and evidence of financial hardship, but was higher among people who had recently quit smoking.

Around half of the participants who smoked anticipated quitting completely, switching to vaping or cutting down the amount they smoke if mandated VLNCs or substantial retailer reductions were introduced. If VLNCs were mandated, 19% of people who smoked stated they would carry on smoking like they do now and find a way to get the cigarettes or tobacco they want to smoke.

CONCLUSION: Support for and anticipated actions in response to the smokefree legislation measures call into question the Government's decision to repeal them.

Despite public health efforts, an estimated 363,000 New Zealanders still smoke.[1] Smoking is the leading cause of preventable death in Aotearoa New Zealand. Its impact is substantially greater among certain population groups, including among those with socio-economic disadvantage, and among Māori.[2,3] In 2011, in response to a Māori Affairs Select Committee report, the New Zealand Government adopted a goal to reduce smoking prevalence and tobacco availability to minimal levels by 2025 (the Smokefree Aotearoa 2025 Goal).[4,5]

While a range of tobacco control interventions were introduced over the subsequent decade, these were largely "business-as-usual" approaches. In December 2021, the New Zealand Government introduced the Smokefree Aotearoa 2025 Action Plan (Smokefree Action Plan),[6] to reach a goal of <5% daily smoking prevalence for all groups of New Zealanders by 2025. The plan included three world-first "endgame" measures: 1) mandating very low nicotine cigarettes (VLNCs), 2) a substantial reduction in the number of retailers where tobacco can be sold, and 3) introduction of a "smokefree generation" by disallowing the sale of smoked tobacco products to people born on or after a certain date. Other supporting interventions included increased resources for mass media campaigns to promote smoking cessation and discourage smoking uptake in young people.[6]

In January 2023, smokefree legislation came into force that would implement the three world-first measures in the action plan (the *Smokefree Environments and Regulated Products [Smoked Tobacco] Amendment Act* [*SERPA Act*]). The reduction in retailers was due to be introduced in July 2024, mandated VLNCs in April 2025 and the smokefree generation in January 2027.[7] However, in February 2024, New Zealand's new

Government partially repealed the smokefree legislation, stopping the implementation of all three of these measures.

The International Tobacco Control (ITC) Policy Evaluation Project is an international cohort study, conducted in over 30 countries. It aims to measure the impacts of public health policies to reduce the adverse impacts of smoking.[8] The purpose of this study is to use data from the New Zealand arm of the study to understand 1) the degree of support for the Smokefree Action Plan measures among people who smoke or recently quit smoking, and 2) anticipated responses to the introduction of a retailer reduction and VLNCs among people who smoke. This information is important for establishing the degree of acceptability of the measures and estimating their likely impacts.

Methods

Study design, sampling and recruitment

Data were analysed from Waves 3 and 3.5 of the New Zealand arm of the ITC study (also known as EASE: Evidence for Achieving Smokefree 2025 Equitably). This is an ongoing prospective cohort and repeat cross-sectional study that surveys people who currently smoke or quit smoking within the last 2 years.[8] Survey waves are conducted every 12–18 months, and participants lost to follow-up are replenished by new participants.

Participants are eligible to take part if aged ≥18, living in Aotearoa New Zealand, and:

- currently smoke cigarettes or tobacco at least monthly, and have smoked at least 100 cigarettes in their lifetime, or
- previously smoked at least monthly, have smoked at least 100 cigarettes in their lifetime and quit smoking within the past 24 months.

Wave 3 was conducted online from 8 November to 24 December in 2020 and from 1 February to 27 February in 2021. It included participants from Wave 2 who agreed to participate in follow-up surveys and replenishment participants recruited through an online panel and social media. The sampling scheme was designed to ensure adequate statistical precision and explanatory power for priority population groups, aiming to recruit equal numbers of Māori, Pacific peoples and Non-Māori-Non-Pacific participants (i.e., 533 participants in each group), and 400 participants aged 18–24 years. We undertook active recruitment targeting these groups through posts on the University of Otago Pacific Islands Centre Facebook page, two local/community Facebook groups in areas with large Māori and Pacific populations (Porirua and South Auckland) and targeted paid social media advertisements.

Wave 3.5 was an interim online survey with a shorter questionnaire, conducted online from 8 June to 26 July in 2021. We only invited participants from Wave 3 for this survey, with no replenishment of participants.

Both surveys were implemented by research company Research New Zealand. Full details of the sampling and survey methods are available in the ITC Technical Report.[8]

Data collection and measures

Measures of ethnicity, age, gender, evidence of financial hardship and smoking status were collected. Ethnicity questions were based on the New Zealand Census questions. Smoking status was defined as a "person who smokes daily not intending to quit", "person who smokes daily intending to quit", "person who smokes less than daily but at least monthly" or "person who recently quit smoking". Wording of the survey questions relating to smoking status and financial hardship is shown in the Table 1 legend.

Wording of questions assessing support for policy measures and expected behaviours if policies are introduced are given in Textbox 1 and the results Tables. The question about support for a smokefree generation was included only in Wave 3.5; all other questions are reported from the Wave 3 survey.

Data analysis

Data analysis was conducted in R 4.1 (R Institute, Vienna, Austria), using the survey package[9] to conduct analyses on weighted data, accounting for complex survey design. Weighting was conducted using raked weight calculations drawing on ethnicity, gender, age group and region, with weights calibrated based on population estimates from the New Zealand Health Survey (for survey years 2018–2019 and 2019–2020, combined). These weights permitted estimates to be applicable to the Aotearoa New Zealand population of people who smoke or who have recently quit smoking.

We report prevalence of outcome measures for key demographic and smoking-related sub-groups as weighted percentages with 95% confidence intervals (95% CI). Missing and refused answers

Textbox 1: Survey questions and response options.

Support for Smokefree Action Plan measures:

Questions:

"If you could get nicotine in products other than tobacco products, would you support or oppose a law that reduces the amount of nicotine in cigarettes and tobacco, to make them less addictive?"

"Would you support or oppose a law that reduced the number of places in New Zealand that were allowed to sell tobacco from around 6,000 (the current number) to 300?"

"Would you support or oppose a law that prevents anyone who is currently 18 or younger from ever buying cigarettes or tobacco? This measure would eventually create a tobacco-free generation."

"Do you support or oppose increased government spending on media campaigns to discourage youth and young people from starting to smoke?"

"Do you support or oppose increased government spending on media campaigns to promote quitting smoking?"

"Do you support or oppose the Smokefree 2025 policy goal?" (Note that a description of the goal was given prior to asking this question, worded as follows: "We will now describe the government's Smokefree 2025 goal: the goal aims to reduce the availability of tobacco and the number of people smoking to minimal levels, thereby making New Zealand essentially a smokefree nation by 2025. ['Minimal numbers of people smoking' is often interpreted as: less than 5% of people in all population groups will smoke.]")

Response options:

"Strongly support", "Support", "Strongly oppose", "Oppose" and "Don't know".

Anticipated response to very low nicotine cigarettes:

Question:

"Which ONE of the following would you be MOST LIKELY to do if the amount of nicotine in cigarettes and tobacco was greatly reduced so they were no longer addictive?"

Response options:

"Carry on smoking like I do now, with the cigarettes or tobacco that were available", "Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke", "Reduce the amount I smoke", "Quit smoking entirely", "Switch to vaping/e-cigarettes" and "Don't know".

Anticipated response to a retailer reduction:

Question:

"Which ONE of the following would you be MOST LIKELY to do if the number of places in New Zealand that could sell tobacco was reduced from around 6,000 to 300?"

Response options:

"Carry on smoking like I do now", "Reduce the amount I smoke", "Quit smoking entirely", "Switch to vaping/e-cigarettes" and "Don't know".

were excluded. We estimated support for measures both excluding and including "Don't know" answers. In the results section we present support results with "Don't know" answers excluded, as this directly addresses the question of support from participants who expressed an opinion about support or opposition to the smokefree measures. The corresponding analyses of support measures including "Don't know" as a valid response option are presented in Figure 1 and the Appendices. Anticipated actions are presented with "Don't know" responses excluded.

To compare groups, we present marginally standardised percentages and absolute differences (with 95% CI) that adjust for potential confounding from the following covariates:[10] smoking status and quit intention, prioritised ethnicity, gender, age group and financial hardship. Marginal standardisation and differences for multinomial outcomes (more than two levels) were conducted in Stata 17 (Statacorp, College Station, TX).

Prioritised ethnicity was used for weighting (participants classified as: Māori [including people who also identified as Pacific peoples], Pacific peoples [excluding people who also identified as Māori] or Non-Māori-Non-Pacific). However, the results are reported using a modified total response ethnicity approach[11] to report estimates for Māori and Pacific peoples (relative to an exclusive non-Māori/non-Pacific category). This is to ensure appropriate representation of Māori and Pacific participants. For the analysis using modified total ethnicity, groups included Māori (including people who also identified as Pacific peoples), Pacific peoples (including people who also identified as Māori) or Non-Māori-Non-Pacific (people who do not identify as Māori or Pacific peoples). For reporting of patterning by ethnicity, two separate analyses were run to produce estimates for total Māori (relative to the mutually exclusive Non-Māori-Non-Pacific group) and for total Pacific peoples (relative to the mutually exclusive Non-Māori-Non-Pacific group).

Data for participants reporting "Other" for their gender were excluded from marginally adjusted estimates and differences, as there was an insufficient number to allow for inclusion as a category in the multivariable models (n=18 at W3, n=5 at W3.5).

Ethics

Ethical approval was obtained prior to participant recruitment from the University of Otago Human Ethics Committee (20/020) and University of Waterloo Research Ethics Board (REB #42549). All participants provided consent for participating in the surveys.

Results

Survey participants

Participant characteristics are shown in Table 1 (unweighted percentages to describe the participant profile). In Wave 3, there were 1,230 participants; 80.7% currently smoked and 19.3% had recently quit smoking. In Wave 3.5, there were 615 participants (50% retention from W3); 64.1% currently smoked and 35.9% had recently quit.

Support for the repealed measures

Support for each of the measures is summarised in Figure 1, including values for when "Don't know" answers were included.

Support for the mandated VLNC policy, among those who expressed support or opposition, was 75.0% (Figure 1, Table 2). Support for retailer reduction was 35.2% and support for a smokefree generation was 82.7% (Figure 1, Table 2). When "Don't know" answers were included, support was lower, particularly for VLNCs at 60.5% (Figure 1).

Analyses that excluded "Don't know" values are presented in Table 2. For analyses with "Don't know" answers included, please see Appendix Table 4.

As outlined in Table 2, all three measures had significantly greater support from people who recently quit smoking (compared to people who currently smoked) and from people who smoked less than daily (compared to people who smoked daily and intended to quit). There was lower support for VLNCs and retailer reduction among Māori compared with Non-Māori-Non-Pacific.

Support for mandated VLNCs and a smokefree generation was lower among people aged 18–24 compared to those aged ≥45; however, a substantial majority supported both these measures in all three age groups. People aged 25–44 were also less likely to support a smokefree generation compared to people aged ≥45. People aged 25–44 were more likely to support a retailer reduction compared with people aged ≥45.

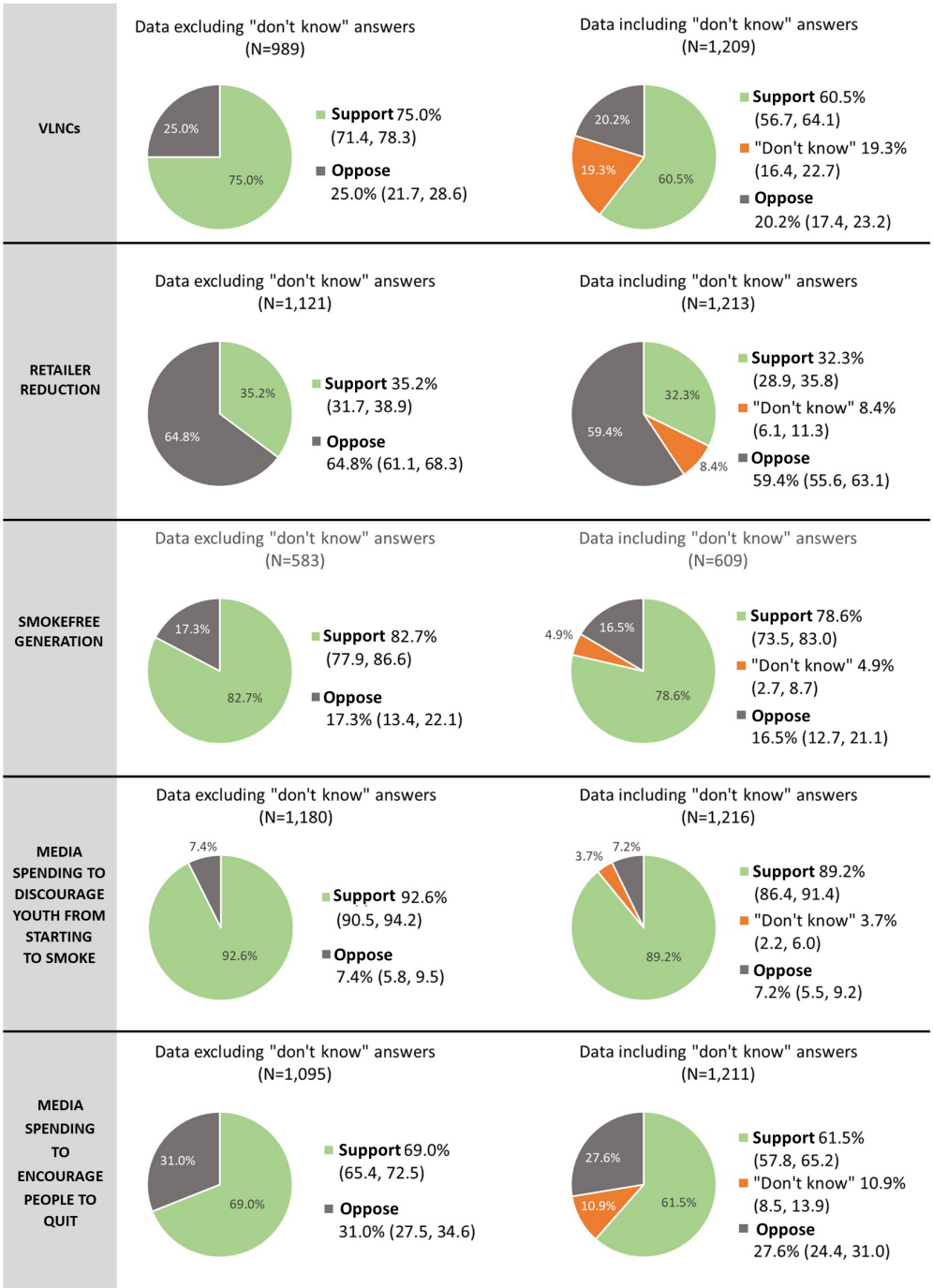
Support for a smokefree generation was higher in females compared to males (absolute marginal difference [aMD] 8.4%, Appendix Table 1). There was no clear evidence of any other differences in support for the three policy measures by ethnicity, age, gender or financial hardship. (Table 2 and Appendix Table 1).

Table 1: Participant characteristics.

Characteristic	Wave 3 N=1,230	Wave 3.5 N=615
	unweighted N (%) unless otherwise stated	
Age (years)*		
Mean (SD)	38.0 (14.8)	41.2 (15.2)
18–24	326 (26.5%)	111 (18.0%)
25–44	528 (42.9%)	267 (43.4%)
≥45	376 (30.6%)	237 (38.5%)
Gender		
Male	442 (35.9%)	206 (33.5%)
Female	770 (62.6%)	404 (65.7%)
Other	18 (1.5%)	5 (0.8%)
Ethnicity**		
Māori	492 (40.0%)	210 (34.1%)
Pacific peoples	238 (19.3%)	102 (16.6%)
Non-Māori-Non-Pacific	546 (44.4%)	319 (51.9%)
Smoking status^		
People who smoke daily	700 (56.9%)	295 (48.0%)
with no intent to quit	182 (14.8% of total)	89 (14.5% of total)
with intent to quit	474 (38.5% of total)	184 (29.9% of total)
no response to question on intent to quit#	44 (3.6% of total)	22 (3.6% of total)
People who smoke less than daily	292 (23.7%)	99 (16.1%)
People who have recently quit smoking	238 (19.3%)	221 (35.9%)
Evidence of financial hardship^^		
Yes	345 (28.0%)	141 (22.9%)
No	847 (68.9%)	450 (73.2%)
No response to question on financial hardship#	38 (3.1%)	24 (3.9%)

*Age for Wave 3.5 was calculated as age at date of W3 data collection to allow direct comparisons.
**Some participants identified as both Māori and Pacific peoples (n=46 [3.7%] from Wave 3 and n=16 [2.6%] from Wave 3.5) and are reported in both categories, resulting in percentages adding to over 100%.
^"Daily smoker, wanting to quit" is defined as a person who smoked daily and selected one of the following options when asked "Are you planning to quit smoking?": "within the next month", "between 1–6 months from now" or "sometime in the future, beyond 6 months".
^^Financial hardship is defined as answering "yes" to the following question: "In the last 30 days, because of a shortage of money, were you unable to pay any important bills on time, such as electricity, telephone or rent bills?".
#This includes participants who refused to answer, answered "Don't know", or had missing data for this question.

Figure 1: Support for the measures with "Don't know" responses included and excluded.



Percentages are weighted data. Support combines answers of "strongly support" or "support". Oppose combines answers of "strongly oppose" and "oppose". Data for support for a smokefree generation are from Wave 3.5; all other data are from Wave 3. Values in brackets are 95% confidence intervals.

For each measure we excluded participants who refused to answer. The number (%) excluded for Wave 3 were: mandated very low nicotine cigarettes: 21/1,230 (1.7%); retailer reduction: 17/1,230 (1.4%); media campaign spending to reduce youth uptake: 14/1,230 (1.1%); media campaign spending to encourage smoking cessation: 19/1,230 (1.5%). The number (%) excluded for Wave 3.5 were: smokefree generation: 6/615 (1.0%).

Very low nicotine cigarettes = VLNCs.

Table 2: Support for measures to mandate very low nicotine cigarettes, reduce retailer availability and introduce a smokefree generation ("Don't know" responses excluded).

	N support/N answered (%)	Weighted percentage (95% CI)	Marginally standardised percentage (95% CI)	Absolute marginal difference (95% CI)
"If you could get nicotine in products other than tobacco products, would you support or oppose a law that reduces the amount of nicotine in cigarettes and tobacco, to make them less addictive?"				
Total support	727/989	75.0 (71.4, 78.3)	N/A	N/A
Support by smoking status:				
- Smokes	574/793	72.1 (67.8, 76.0)	72.3 (67.4, 76.7)	Reference
- Recently quit	153/196	84.6 (77.7, 89.6)	84.7 (77.8, 89.7)	**12.4 (4.3, 20.5)**
Support by smoking status and intent to quit:				
- Smokes daily not intending to quit	69/130	51.3 (39.8, 62.6)	48.9 (37.9, 60.1)	Reference
- Smokes daily intending to quit	293/388	75.8 (70.1, 80.7)	76.0 (69.8, 81.2)	**27.0 (14.8, 39.3)**
- Smokes less than daily	196/250	78.6 (71.6, 84.3)	80.8 (74.1, 86.1)	**31.9 (19.1, 44.7)**
- Recently quit	153/196	84.6 (77.7, 89.6)	84.2 (77.3, 89.3)	**35.3 (21.8, 48.7)**
Support by total ethnicity:*				
- Māori	276/402	66.5 (60.6, 71.9)	68.7 (62.1, 74.7)	**-9.0 (-17.0, -1.0)**
- Pacific peoples	136/183	75.7 (67.5, 82.3)	77.3 (68.7, 84.1)	-0.4 (-9.5, 8.7)
- Non-Māori-Non-Pacific	341/441	78.6 (73.2, 83.1)	77.7 (72.6, 82.1)	Reference
Support by age group:				
- 18–24	180/264	65.0 (57.4, 72.0)	61.4 (53.2, 69.0)	**-18.3 (-27.5, -9.0)**
- 25–44	322/430	75.9 (70.4, 80.7)	76.4 (70.7, 81.3)	-3.2 (-10.5, 4.0)
- ≥45	225/295	78.5 (71.9, 83.9)	79.6 (74.1, 84.3)	Reference
"Would you support or oppose a law that reduced the number of places in New Zealand that were allowed to sell tobacco from around 6,000 (the current number) to 300?"				
Total support	402/1,121	35.2 (31.7, 38.9)	N/A	N/A
Support by smoking status:				
- Smokes	294/907	30.0 (26.4, 33.8)	28.7 (25.2, 32.6)	Reference
- Recently quit	108/214	53.2 (44.1, 62.2)	56.9 (47.5, 65.9)	**28.2 (18.0, 38.3)**
Support by smoking status and intent to quit:				
- Smokes daily not intending to quit	28/169	13.2 (8.5, 19.8)	13.1 (8.5, 19.5)	Reference
- Smokes daily intending to quit	135/426	29.1 (24.0, 34.7)	27.6 (22.7, 33.2)	**14.6 (7.0, 22.1)**
- Smokes less than daily	124/274	46.7 (39.5, 54.1)	44.5 (37.0, 52.3)	**31.5 (21.9, 41.0)**
- Recently quit	108/214	53.2 (44.1, 62.2)	57.2 (47.8, 66.1)	**44.2 (33.5, 54.8)**

Table 2 (continued): Support for measures to mandate very low nicotine cigarettes, reduce retailer availability and introduce a smokefree generation ("Don't know" responses excluded).

Support by total ethnicity:*				
- Māori	141/443	28.3 (23.6, 33.5)	29.3 (23.7, 35.5)	**-9.3 (-17.1, -1.6)**
- Pacific peoples	74/215	35.5 (27.9, 43.9)	31.3 (23.9, 39.9)	-7.3 (-16.9, 2.3)
- Non-Māori-Non-Pacific	197/505	37.5 (32.4, 42.9)	38.6 (33.6, 43.9)	Reference
Support by age group:				
- 18–24	98/299	37.0 (30.2, 44.4)	28.2 (22.2, 35.0)	-3.9 (-13.0, 5.2)
- 25–44	206/479	41.1 (35.5, 46.9)	42.1 (36.3, 48.0)	**10.0 (1.7, 18.3)**
- ≥45	98/343	28.5 (23.0, 34.6)	32.1 (26.4, 38.4)	Reference
"Would you support or oppose a law that prevents anyone who is currently 18 or younger from ever buying cigarettes or tobacco? This measure would eventually create a tobacco-free generation."				
Total support	498/583	82.7 (77.9, 86.6)	N/A	N/A
Support by smoking status:				
- Smokes	315/375	80.6 (74.8, 85.3)	80.4 (74.4, 85.3)	Reference
- Recently quit	183/208	89.9 (82.3, 94.5)	89.0 (81.2, 93.8)	**8.6 (0.3, 16.9)**
Support by smoking status and intent to quit:				
- Smokes daily not intending to quit	64/83	72.2 (58.6, 82.6)	70.0 (56.4, 80.8)	Reference
- Smokes daily intending to quit	157/197	81.4 (72.0, 88.1)	81.0 (71.6, 87.8)	11.0 (-3.4, 25.4)
- Smokes less than daily	76/93	83.3 (71.8, 90.7)	85.1 (74.7, 91.7)	**15.1 (0.2, 30.0)**
- Recently quit	183/208	89.9 (82.3, 94.5)	88.7 (80.9, 93.6)	**18.7 (4.9, 32.5)**
Support by total ethnicity:*				
- Māori	168/197	79.8 (69.7, 87.2)	80.9 (71.7, 87.7)	1.1 (-9.4, 11.5)
- Pacific peoples	83/96	85.0 (73.0, 92.2)	87.3 (77.9, 93.0)	7.3 (-2.5, 17.2)
- Non-Māori-Non-Pacific	258/305	82.5 (75.9, 87.5)	79.9 (72.5, 85.7)	Reference
Support by age group:				
- 18–24	77/103	71.9 (57.3, 82.9)	71.4 (55.9, 83.1)	**-17.7 (-32.6, -2.8)**
- 25–44	212/250	80.1 (71.7, 86.6)	77.9 (68.8, 85.0)	**-11.2 (-21.0, -1.4)**
- ≥45	209/230	89.3 (83.2, 93.3)	89.1 (82.7, 93.3)	Reference

When comparing groups, we present marginally standardised percentages and absolute differences (with 95% CI) that adjust for potential confounding from the following covariates: smoking status and quit intention, prioritised ethnicity, gender, age group and financial hardship.
Values in bold indicate statistically significant absolute marginal differences compared to the reference value.
Participants who refused to answer or answered "Don't know" were excluded. See Figure 1 for detail.
Support represents combined answers of "strongly support" or "support" (compared to "strongly oppose" and "oppose"). Data for all questions are from Wave 3, with the exception of support for a smokefree generation, which were from Wave 3.5.
*Total ethnicity data are presented for Māori and Pacific peoples. Some participants identified as both Māori and Pacific peoples (see Table 1); comparisons for these two groups are made to an exclusive non-Māori-non-Pacific group.

Support for increased media campaign spending and Aotearoa New Zealand's Smokefree goal

Support for increased media campaign spending to reduce youth uptake of cigarette smoking was 92.6% among those who expressed support or opposition (Figure 1). Support for media campaign spending to encourage smoking cessation was 69.0% (Figure 1). For detailed analyses by smoking status, ethnicity, age, gender or evidence of financial hardship see Appendix Tables 2, 3 and 5.

Overall support for the Smokefree Aotearoa goal of less than 5% daily smoking prevalence by 2025 was 56.7% (95% confidence interval 52.8, 60.5) when "Don't know" answers were excluded. When "Don't know" answers were included, support was 52.1% (95% confidence interval 48.3, 55.9, "Don't know" was 8.1%, oppose was 39.8%). For details, including support by smoking status, ethnicity, age, gender and evidence of financial hardship see Appendix Tables 2, 3 and 5.

Anticipated response to mandated VLNCs and retailer reduction

As outlined in Table 3, in response to the introduction of mandated VLNCs, 18.4% of people who smoke thought that they would reduce the amount they smoked, 13.0% thought they would quit smoking entirely and 14.3% thought they would switch to vaping.

In response to a reduction in retailer availability, 21.6% of people who currently smoke thought they would reduce the amount they smoked, 12.3% thought they would quit smoking entirely and 12.9% thought they would switch to vaping.

As demonstrated in Table 3, most of the responses varied by smoking status. For both measures, people who smoked daily and did not intend to quit smoking were more likely to report that they would "*carry on smoking like I do now*" than people who smoked daily and intended to quit and people who smoked less than daily.

In response to the introduction of VLNCs, men (compared to women) and people aged 18–24 years (compared to 45 and over) were more likely to report that they would "*carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke*." People aged 18–24 and people aged 25–44 were less likely to "*carry on smoking like I do now, with the cigarettes or tobacco that were available*" compared to people aged 45 and over. People aged 25–44 were also more likely to "*reduce the amount I smoke*" compared to people aged 45 and over. Values are available in Appendix Tables 6 and 7.

In response to a retailer reduction, people aged 18–24 and people aged 25–44 years were less likely to "*quit smoking entirely*" compared to people aged 45 and over. People aged 25–44 were more likely to "*reduce the amount I smoke*" compared to people aged 45 and over. People with evidence of financial hardship were less likely than those not in financial hardship to report that they would "*quit smoking entirely*." Values are available in Appendix Tables 8 and 9.

There were no major differences in anticipated responses by ethnicity (Appendix Tables 6 and 8).

Discussion

Among people who smoke or recently quit smoking there was strong support for mandated VLNCs (75%) and smokefree generation (83%) policies, as well as increased mass media expenditure. Support for a retailer reduction was the only measure with less than majority support (35%). People who smoked, particularly daily smokers without intent to quit, consistently demonstrated less support for the measures than people who had recently quit smoking. The findings were broadly in line with earlier findings from Wave 2 of the ITC NZ (EASE) Survey (conducted 2016–2017).[12]

The relatively low level of support for a retailer reduction aligns with other Aotearoa New Zealand-based studies.[12–15] A previous qualitative study among people who smoke found concern that a reduction in retailers could increase tobacco product prices, elevate stress due to changes in routine and reduce viability for local businesses.[14]

Around 50% of participants who smoked anticipated that they would reduce the amount they smoke, quit smoking completely or switch to vaping if either mandated VLNCs or substantial retailer reductions were introduced. The proportion anticipating these behaviour changes in response to mandated VLNCs (46%) was much greater than the proportion who stated they would try and obtain tobacco products they wanted to smoke (19%), presumably homegrown or illicit cigarettes or tobacco. These findings highlight that 1) many people who smoke anticipate the introduction of a retailer reduction or VLNCs would have helped them to reduce the amount they smoke or stop smoking, and 2) in contrast to arguments that these measures are likely to greatly increase the illicit market,[16] only a minority of participants reported they would consider taking steps to

Table 3: Anticipated responses to the introduction of very low nicotine cigarettes and a retailer reduction ("Don't know" responses excluded).

		n/N	Weighted percentage (95% CI)	Marginally standardised percentage (95% CI)	Absolute marginal difference (95% CI)
Anticipated response to the introduction of very low nicotine cigarettes: total					
	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	288/908	35.1 (31.2, 39.2)	N/A	N/A
	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	170/908	19.2 (16.0, 22.9)	N/A	N/A
	- Reduce the amount I smoke	184/908	18.4 (15.5, 21.7)	N/A	N/A
	- Quit smoking entirely	132/908	13.0 (10.6, 15.9)	N/A	N/A
	- Switch to vaping/ e-cigarettes	134/908	14.3 (11.6, 17.5)	N/A	N/A
Anticipated response to the introduction of very low nicotine cigarettes: by smoking status					
Smokes daily not intending to quit	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	91/172	55.2 (45.3, 64.7)	50.9 (42.3, 59.6)	Reference
	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	50/172	32.8 (23.7, 43.4)	35.6 (26.9, 44.2)	
	- Reduce the amount I smoke	23/172	9.7 (5.8, 16.0)	11.1 (5.7, 16.5)	
	- Quit smoking entirely	3/172	0.4 (0.1, 1.4)	0.4 (0.0, 0.9)	
	- Switch to vaping/ e-cigarettes	5/172	1.8 (0.7, 4.8)	2.0 (0.0, 3.9)	
Smokes daily intending to quit	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	124/428	30.9 (25.5, 36.8)	31.1 (25.2, 37.0)	**-19.8 (-30.2, -9.3)**

Table 3 (continued): Anticipated responses to the introduction of very low nicotine cigarettes and a retailer reduction ("Don't know" responses excluded).

Smokes daily intending to quit	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	81/428	17.8 (13.7, 22.6)	17.9 (13.3, 22.6)	**-17.6 (-27.3, -8.0)**
	- Reduce the amount I smoke	104/428	22.6 (18.1, 27.7)	21.1 (16.3, 25.9)	**10.0 (2.6, 17.3)**
	- Quit smoking entirely	69/428	15.0 (11.2, 19.8)	15.4 (10.8, 20.0)	**15.0 (10.4, 19.6)**
	- Switch to vaping/ e-cigarettes	50/428	13.8 (10.1, 18.5)	14.4 (9.9, 18.9)	**12.4 (7.4, 17.4)**
Smokes less than daily	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	57/274	24.5 (18.5, 31.7)	25.2 (18.1, 32.2)	**-25.8 (-37.2, -14.3)**
	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	34/274	10.0 (6.6, 14.9)	9.4 (5.2, 13.7)	**-26.2 (-36.2, -16.1)**
	- Reduce the amount I smoke	49/274	17.7 (12.6, 24.3)	17.9 (12.0, 23.9)	6.8 (-1.5, 15.1)
	- Quit smoking entirely	57/274	20.7 (15.4, 27.4)	21.7 (15.3, 28.2)	**21.3 (14.8, 27.8)**
	- Switch to vaping/ e-cigarettes	77/274	27.1 (20.6, 34.7)	25.8 (18.5, 33.1)	**23.8 (16.2, 31.5)**
Anticipated response to a retailer reduction: total					
	- Carry on smoking like I do now	466/939	53.2 (49.1, 57.2)	N/A	N/A
	- Reduce the amount I smoke	217/939	21.6 (18.6, 25.1)	N/A	N/A
	- Quit smoking entirely	121/939	12.3 (9.9, 15.1)	N/A	N/A
	- Switch to vaping/ e-cigarettes	135/939	12.9 (10.5, 15.7)	N/A	N/A
Anticipated response to a retailer reduction: by smoking status					
Smokes daily not intending to quit	- Carry on smoking like I do now	143/176	86.6 (80.0, 91.3)	85.0 (79.1, 90.8)	Reference
	- Reduce the amount I smoke	25/176	11.4 (7.0, 17.9)	13.0 (7.3, 18.6)	
	- Quit smoking entirely	4/176	1.0 (0.3, 3.6)	0.9 (0.0, 2.2)	
	- Switch to vaping/ e-cigarettes	4/176	1.0 (0.3, 3.2)	1.1 (0.0, 2.4)	

Table 3 (continued): Anticipated responses to the introduction of very low nicotine cigarettes and a retailer reduction ("Don't know" responses excluded).

Smokes daily intending to quit	- Carry on smoking like I do now	199/450	44.6 (38.9, 50.4)	45.3 (39.2, 51.3)	**-39.7 (-48.2, -31.1)**
	- Reduce the amount I smoke	127/450	28.0 (23.1, 33.4)	25.8 (20.8, 30.8)	**12.9 (5.2, 20.5)**
	- Quit smoking entirely	67/450	13.7 (10.4, 18.0)	14.6 (10.4, 18.8)	**13.7 (9.2, 18.2)**
	- Switch to vaping/ e-cigarettes	57/450	13.7 (10.2, 18.3)	14.3 (10.0, 18.6)	**13.2 (8.6, 17.7)**
Smokes less than daily	- Carry on smoking like I do now	100/273	37.4 (30.6, 44.7)	38.2 (30.5, 45.9)	**-46.8 (-56.7, -36.9)**
	- Reduce the amount I smoke	56/273	19.8 (14.5, 26.5)	18.8 (12.6, 24.9)	5.8 (-2.9, 14.5)
	- Quit smoking entirely	46/273	19.0 (13.7, 25.6)	21.1 (14.5, 27.7)	**20.1 (13.4, 26.9)**
	- Switch to vaping/ e-cigarettes	71/273	23.8 (18.2, 30.5)	22.0 (15.8, 28.2)	**20.8 (14.5, 27.2)**

Data are from Wave 3 participants. Values in bold are statistically significant absolute marginal differences compared to the reference value.
Wording of the questions is provided in Textbox 1.
For the overall number of participants in each group and the definition of financial hardship, see Table 1. Note that N answered values vary from the values in Table 1, as participants who refused to answer or answered "Don't know" were excluded.
For the total value for anticipated response to very low nicotine cigarettes, 7 out of 992 participants (0.7%) were excluded as they refused to answer or had no response, and 77 out of 992 participants (7.8%) were excluded as they answered "Don't know".
For the total value for anticipated response to a retailer reduction, 8 out of 992 participants (0.8%) were excluded as they refused to answer or had no response recorded, and 45 out of 992 participants (4.5%) were excluded as they answered "Don't know".
When comparing groups, we present marginally standardised percentages and absolute differences (with 95% CI) that adjust for potential confounding from the following covariates: smoking status and quit intention, prioritised ethnicity, gender, age group and financial hardship.
Electronic cigarettes = e-cigarettes.

obtain cigarettes with a higher nicotine content should VLNCs be introduced. However, the finding that some people who smoke would be likely to seek out illicit cigarettes or tobacco suggests that if a mandated VLNC policy is introduced additional actions to combat illicit trade should be introduced (such as increased resources for customs), as was planned in the Smokefree Aotearoa 2025 Action Plan.[6]

Importantly, there was no significant difference in anticipated responses to a retailer reduction or mandated VLNCs by ethnicity. Our findings are consistent with a recent study of anticipated responses to these measures in over 700 Māori who smoke.[17] They also align with modelling that suggests the interventions could significantly reduce smoking prevalence for Māori and Pacific peoples.[6,18,19]

A key strength of this study is that it provides results that are directly relevant to the three *SERPA Act* measures that were recently repealed, drawn from the people most affected by smoking. The sample is sufficiently large to provide robust indications of support and anticipated changes in response to the measures. It also allows us to evaluate differences in support by smoking status, intent to quit smoking and ethnicity.

Another strength is our presentation of data on support for the measures with and without "Don't know" answers. This allows results to be compared to other studies assessing support for smokefree measures, regardless of whether they opt to include or exclude "Don't know" answers.[12,20–25] Levels of support for the measures were largely similar, regardless of whether "Don't know" answers were included or excluded, as "Don't know" responses were rare. However, support for mandated VLNCs dropped substantially

when "Don't know" responses were included, reflecting the high percentage of "Don't know" responses (19%). The high level of "Don't know" responses for this policy likely reflects the unfamiliarity of VLNCs among people who smoke, as they have not been available in New Zealand. Of note, international studies have found at least 50% support for VLNC policies among participants in trials who had used VLNCs for several weeks.[20,21] Our findings emphasise the importance of assessing understanding of proposed policy measures and the need for public education.

One limitation of this study is that the recruitment target for Pacific participants was not reached, meaning that results for this group are less precise than for Māori or Non-Māori-Non-Pacific respondents.

Another limitation is that the study data were collected before the *SERPA Act* changes to include the three action plan measures were passed and subsequently repealed in early 2024. It is possible that responses to the survey questions may have changed in response to these events. At the time of writing, we are in the process of analysing data from Wave 4 (conducted in 2022) and recruiting for Wave 5 (September 2024), which will provide further insights. However, the results from Waves 3 and 3.5 align with findings from a population-based survey conducted in late 2023 in response to the news that the Government intended to repeal the three smokefree measures. Of those surveyed, support for retention of the three key measures was 68% for reduction in retailer numbers, 77% for mandated VLNCs and 65% for a smokefree generation.[26]

Our findings call into question the Government's decision to repeal the 2023 *SERPA Act* measures to reduce retailer numbers, mandate VLNCs and introduce a smokefree generation. The introduction of VLNCs and a smokefree generation were strongly supported by people who smoke or who have recently quit smoking, and retailer reductions by a majority of people who had recently quit. Anticipated responses to a reduction in retail numbers and VLNCs indicated that these measures had the potential to reduce smoking prevalence substantially and equitably.

COMPETING INTERESTS

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GTF has been an expert witness or consultant for governments defending their country's policies or regulations in litigation. Additional support to GTF is provided by a Senior Investigator Grant from the Ontario Institute for Cancer Research (IA-004).

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All other authors have no conflicts of interest to declare.

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Appendices

Appendix Table 1: Outcomes by gender and financial hardship: support for implementation of very low nicotine cigarettes and reduction in retailer availability, with "Don't know" responses excluded.

	N support/N answered	Weighted percentage (95% CI)	Marginally standardised percentage (95% CI)	Absolute marginal difference (95% CI)
"If you could get nicotine in products other than tobacco products, would you support or oppose a law that reduces the amount of nicotine in cigarettes and tobacco, to make them less addictive?"				
Total	727/989	75.0 (71.4, 78.3)	N/A	N/A
Gender:				
- Male	283/385	75.4 (69.7, 80.3)	74.8 (69.3, 79.7)	Reference
- Female	442/602	74.4 (70.1, 78.4)	75.6 (71.3, 79.6)	0.8 (-5.7, 7.3)
Evidence of financial hardship:				
- No	517/678	77.6 (73.2, 81.5)	76.8 (72.5, 80.6)	Reference
- Yes	188/278	68.2 (61.1, 74.5)	70.6 (63.8, 76.5)	-6.2 (-13.6, 1.1)
"Would you support or oppose a law that reduced the number of places in New Zealand that were allowed to sell tobacco from around 6,000 (the current number) to 300?"				
Total	402/1,121	35.2 (31.7, 38.9)	N/A	N/A
Gender:				
- Male	176/418	38.5 (33.0, 44.3)	37.8 (32.5, 43.4)	Reference
- Female	225/701	31.3 (27.3, 35.5)	32.6 (28.4, 37.0)	-5.2 (-12.0, 1.5)
Evidence of financial hardship:				
- No	262/775	34.7 (30.4, 39.2)	35.0 (31.0, 39.3)	Reference
- Yes	125/314	35.9 (29.6, 42.9)	36.8 (30.1, 43.9)	1.7 (-6.1, 9.5)
"Would you support or oppose a law that prevents anyone who is currently 18 or younger from ever buying cigarettes or tobacco? This measure would eventually create a tobacco-free generation."				
Total	498/583	82.7 (77.9, 86.6)	N/A	N/A
Gender:				
- Male	160/196	78.4 (70.4, 84.8)	77.9 (70.3, 84.1)	Reference
- Female	337/386	87.6 (82.8, 91.1)	86.4 (80.7, 90.5)	**8.4 (0.1, 16.7)**
Evidence of financial hardship:				
- No	370/428	84.2 (78.6, 88.5)	83.5 (77.9, 87.9)	Reference
- Yes	110/136	75.0 (63.4, 83.9)	75.1 (64.1, 83.7)	-8.3 (-19.0, 2.3)

Appendix Table 1 (continued): Outcomes by gender and financial hardship: support for implementation of very low nicotine cigarettes and reduction in retailer availability, with "Don't know" responses excluded.

Very low nicotine cigarette and retailer reduction data are from Wave 3 participants. Smokefree generation data are from Wave 3.5 participants.
Values in bold are statistically significant absolute marginal differences compared to the reference value.
Support is defined as answering "strongly support" or "support".
When comparing groups, we present marginally standardised percentages and absolute differences (with 95% CI) that adjust for potential confounding from the following covariates: smoking status and quit intention, prioritised ethnicity, gender, age group and financial hardship.
For the overall number of participants in each group and the definition of financial hardship, see Table 1 of the corresponding journal article. Note that N answered values vary from the values in Table 1, as participants who refused to answer or answered "Don't know" were excluded.
See Appendix Table 4 for these analyses including "Don't know" answers.

Appendix Table 2: Outcomes by smoking status, ethnicity and age: support for measures to increase media campaign spending and the Smokefree Aotearoa 2025 goal, with "Don't know" responses excluded.

	N support/N answered	Weighted percentage (95% CI)	Marginally standardised percentage (95% CI)	Absolute marginal difference (95% CI)
"Do you support or oppose increased government spending on media campaigns to discourage youth and young people from starting to smoke?"				
Total	1,087/1,180	92.6 (90.5, 94.2)	N/A	N/A
Support by smoking status:				
- Smokes	872/951	91.7 (89.2, 93.6)	92.0 (89.6, 93.9)	Reference
- Recently quit	215/229	95.5 (90.1, 98.0)	94.8 (89.6, 97.5)	2.8 (-1.2, 6.8)
Support by smoking status and intent to quit:				
- Smokes daily not intending to quit	143/169	82.7 (74.2, 88.8)	81.5 (73.4, 87.6)	Reference
- Smokes daily intending to quit	419/456	91.9 (88.3, 94.5)	92.4 (88.9, 94.9)	**10.9 (3.1, 18.7)**
- Smokes less than daily	272/285	97.3 (94.8, 98.6)	97.5 (95.3, 98.7)	**15.9 (8.6, 23.3)**
- Recently quit	215/229	95.5 (90.1, 98.0)	94.8 (89.5, 97.5)	**13.2 (5.0, 21.5)**
Support by total ethnicity:				
- Māori	426/467	90.3 (86.2, 93.3)	91.1 (86.7, 94.2)	-1.1 (-5.8, 3.6)
- Pacific	208/222	94.9 (90.9, 97.2)	95.3 (91.2, 97.5)	3.0 (-1.1, 7.1)
- Non-Māori-Non-Pacific	494/535	92.9 (89.7, 95.1)	92.3 (89.0, 94.6)	Reference
Support by age group:				
- 18–24	287/315	91.1 (86.7, 94.2)	89.3 (84.0, 93.0)	-3.5 (-9.1, 2.1)
- 25–44	467/510	93.1 (90.1, 95.2)	93.2 (90.3, 95.3)	0.4 (-3.6, 4.3)
- ≥45	333/355	92.7 (88.3, 95.5)	92.8 (88.7, 95.5)	Reference

Appendix Table 2 (continued): Outcomes by smoking status, ethnicity and age: support for measures to increase media campaign spending and the Smokefree Aotearoa 2025 goal, with "Don't know" responses excluded.

"Do you support or oppose increased government spending on media campaigns to promote quitting smoking?"				
Total	764/1,095	69.0 (65.4, 72.5)	N/A	N/A
Support by smoking status:				
- Smokes	602/882	66.4 (62.3, 70.4)	66.9 (62.4, 71.2)	Reference
- Recently quit	162/213	77.7 (69.7, 84.1)	77.9 (69.6, 84.4)	**10.9 (1.9, 20.0)**
Support by smoking status and intent to quit:				
- Smokes daily not intending to quit	71/158	46.6 (36.4, 57.0)	46.4 (36.5, 56.6)	Reference
- Smokes daily intending to quit	291/422	66.7 (60.7, 72.2)	68.2 (61.6, 74.1)	**21.8 (10.1, 33.4)**
- Smokes less than daily	219/272	81.6 (75.1, 86.6)	82.4 (75.7, 87.6)	**36.0 (23.9, 48.0)**
- Recently quit	162/213	77.7 (69.7, 84.1)	77.3 (69.0, 83.9)	**30.8 (17.6, 44.1)**
Support by total ethnicity:				
- Māori	291/440	63.5 (57.8, 68.8)	65.0 (58.8, 70.8)	-6.3 (-14.1, 1.6)
- Pacific	141/201	70.0 (61.6, 77.3)	69.4 (60.6, 77.0)	-1.9 (-11.4, 7.7)
- Non-Māori-Non-Pacific	358/496	70.8 (65.5, 75.6)	71.3 (66.1, 76.0)	Reference
Support by age group:				
- 18–24	210/289	74.1 (67.5, 79.7)	68.5 (60.7, 75.3)	0.0 (-10.0, 10.0)
- 25–44	339/482	69.9 (64.2, 75.0)	71.1 (65.5, 76.0)	2.6 (-5.6, 10.8)
- ≥45	215/324	65.9 (59.3, 71.9)	68.5 (61.9, 74.3)	Reference
"Do you support or oppose the Smokefree 2025 policy goal?" *				
Total	634/1,118	56.7 (52.8, 60.5)	N/A	N/A
Support by smoking status:				
- Smokes	475/904	49.8 (45.6, 54.0)	49.3 (44.9, 53.8)	Reference
- Recently quit	159/214	79.7 (72.1, 85.6)	80.4 (72.8, 86.3)	**31.1 (22.6, 39.5)**
Support by smoking status and intent to quit:				
- Smokes daily not intending to quit	36/168	17.1 (11.6, 24.5)	17.2 (11.7, 24.6)	Reference
- Smokes daily intending to quit	237/431	54.0 (48.0, 59.9)	54.1 (47.7, 60.5)	**36.9 (28.1, 45.8)**
- Smokes less than daily	189/268	70.0 (62.7, 76.4)	70.0 (62.2, 76.8)	**52.8 (43.0, 62.6)**
- Recently quit	159/214	79.7 (72.1, 85.6)	79.8 (72.2, 85.8)	**62.6 (53.0, 72.2)**
Support by total ethnicity:				
- Māori	238/453	49.8 (44.2, 55.4)	52.9 (46.8, 59.0)	-7.1 (-14.6, 0.5)

Appendix Table 2 (continued): Outcomes by smoking status, ethnicity and age: support for measures to increase media campaign spending and the Smokefree Aotearoa 2025 goal, with "Don't know" responses excluded.

- Pacific	114/207	56.6 (47.6, 65.2)	54.6 (46.5, 62.5)	-5.4 (-14.5, 3.8)
- Non-Māori-Non-Pacific	302/500	59.8 (54.2, 65.2)	60.0 (55.0, 64.8)	Reference
Support by age group:				
- 18–24	177/302	58.7 (51.5, 65.5)	50.8 (43.8, 57.8)	-1.5 (-10.9, 7.9)
- 25–44	294/483	63.7 (58.0, 69.1)	64.2 (58.8, 69.2)	**11.8 (4.0, 19.6)**
- ≥45	163/333	48.5 (41.9, 55.2)	52.3 (46.1, 58.4)	Reference

When comparing groups, we present marginally standardised percentages and absolute differences (with 95% CI) that adjust for potential confounding from the following covariates: smoking status and quit intention, prioritised ethnicity, gender, age group and financial hardship.
Values in bold are statistically significant absolute marginal differences compared to the reference value.
Participants who refused to answer or answered "Don't know" were excluded. 21/1,230 (1.7%) of participants refused to answer the question "Do you support or oppose the Smokefree 2025 policy goal?" 91/1,230 (7.4%) answered "Don't know". For refusal and "Don't know" values for other outcomes, see Figure 1.
Support represents combined answers of "strongly support" or "support" (compared to "strongly oppose" and "oppose"). Data for all questions are from Wave 3.
Total ethnicity data are presented for Māori and Pacific. Some participants identified as both Māori and Pacific (see Table 1); comparisons for these two groups are made to an exclusive non-Māori-non-Pacific group.
*A description of the goal was given prior to asking this question, worded as follows: "*We will now describe the Government's Smokefree 2025 goal: the goal aims to reduce the availability of tobacco and the number of people smoking to minimal levels, thereby making New Zealand essentially a smokefree nation by 2025. ('Minimal numbers of people smoking' is often interpreted as: less than 5% of people in all population groups will smoke.).*"

Appendix Table 3: Outcomes by gender and financial hardship: support for measures to increase media campaign spending and the Smokefree Aotearoa 2025 goal, with "Don't know" responses excluded.

	N support/N answered	**Weighted percentage (95% CI)**	**Marginally standardised percentage (95% CI)**	**Absolute difference (95% CI)**
"Do you support or oppose increased government spending on media campaigns to discourage youth and young people from starting to smoke?"				
Total	1,087/1,180	92.6 (90.5, 94.2)	N/A	N/A
Gender:				
- Male	389/430	91.8 (88.2, 94.3)	91.6 (87.9, 94.2)	Reference
- Female	697/749	93.5 (91.1, 95.3)	93.5 (90.9, 95.4)	1.9 (-2.0, 5.8)
Evidence of financial hardship:				
- No	756/813	93.3 (90.8, 95.2)	93.1 (90.6, 95.0)	Reference
- Yes	301/333	90.3 (85.4, 93.6)	90.7 (85.9, 94.0)	-2.4 (-6.9, 2.0)

Appendix Table 3 (continued): Outcomes by gender and financial hardship: support for measures to increase media campaign spending and the Smokefree Aotearoa 2025 goal, with "Don't know" responses excluded.

"Do you support or oppose increased government spending on media campaigns to promote quitting smoking?"				
Total	764/1,095	69.0 (65.4, 72.5)	N/A	N/A
Gender:				
- Male	288/403	70.8 (65.2, 75.9)	70.8 (65.1, 75.9)	Reference
- Female	475/691	67.0 (62.3, 71.4)	68.2 (63.5, 72.6)	-2.5 (-9.5, 4.4)
Evidence of financial hardship:				
- No	544/757	71.1 (66.7, 75.2)	71.1 (66.8, 75.0)	Reference
- Yes	203/307	64.5 (57.6, 70.8)	65.0 (57.9, 71.4)	-6.1 (-13.7, 1.4)
"Do you support or oppose the Smokefree 2025 policy goal?" *				
Total	634/1.118	56.7 (52.8, 60.5)	N/A	N/A
Gender:				
- Male	251/413	60.2 (54.3, 65.9)	59.3 (53.9, 64.6)	Reference
- Female	383/702	52.7 (48.0, 57.5)	54.7 (50.1, 59.2)	-4.6 (-11.1, 1.9)
Evidence of financial hardship:				
- No	442/767	58.6 (53.9, 63.1)	58.6 (54.2, 62.8)	Reference
- Yes	171/318	51.5 (44.2, 58.7)	53.4 (47.0, 59.7)	-5.2 (-12.3, 1.9)

Data are from Wave 3 participants. Values in bold are statistically significantly absolute marginal differences compared to the reference value.
Support is defined as answering "strongly support" or "support".
For the overall number of participants in each group and the definition of financial hardship, see Table 1 in the corresponding journal article.
When comparing groups, we present marginally standardised percentages and absolute differences (with 95% CI) that adjust for potential confounding from the following covariates: smoking status and quit intention, prioritised ethnicity, gender, age group and financial hardship.
Note that N answered values vary from the values in Table 1, as participants who refused to answer or answered "Don't know" were excluded.
See Appendix Table 5 for these analyses including "Don't know" answers.
*A description of the goal was given prior to asking this question, worded as follows: "*We will now describe the Government's Smokefree 2025 goal: the goal aims to reduce the availability of tobacco and the number of people smoking to minimal levels, thereby making New Zealand essentially a smokefree nation by 2025. ('Minimal numbers of people smoking' is often interpreted as: less than 5% of people in all population groups will smoke.).*"

Appendix Table 4: Support for implementation of very low nicotine cigarettes, reduction in retailer availability and introduction of a smokefree generation: analysis with "Don't know" responses included.

	N support/N answered	Weighted percentage (95% CI)	Marginally standardised percentage (95% CI)	Absolute marginal difference (95% CI)
"If you could get nicotine in products other than tobacco products, would you support or oppose a law that reduces the amount of nicotine in cigarettes and tobacco, to make them less addictive?"				
Total:				
- Support	727/1,209	60.5 (56.7, 64.1)	N/A	N/A
- Oppose	262/1,209	20.2 (17.4, 23.2)	N/A	N/A
- Don't know	220/1,209	19.3 (16.4, 22.7)	N/A	N/A
Support by smoking status:				
- Smokes	574/974	57.6 (53.5, 61.7)	57.8 (53.3, 62.3)	Reference
- Recently quit	153/235	70.2 (61.5, 77.7)	70.1 (61.3, 78.8)	**12.2 (2.0, 22.6)**
Oppose by smoking status:				
- Smokes	219/974	22.3 (19.1, 25.9)		
- Recently quit	43/235	12.8 (8.6, 18.6)		
Don't know by smoking status:				
- Smokes	181/974	20.0 (16.8, 23.7)		
- Recently quit	39/235	17.0 (10.8, 25.6)		
Support by smoking status and quit intent:				
- Smokes daily not intending to quit	69/174	36.4 (27.9, 45.9)	34.4 (25.5, 43.3)	Reference
- Smokes daily intending to quit	293/469	63.2 (57.6, 68.5)	64.3 (58.5, 70.0)	**29.9 (19.6, 40.2)**
- Smokes less than daily	196/288	66.5 (58.2, 73.9)	68.1 (59.9, 76.2)	**33.7 (21.4, 45.9)**
- Recently quit	153/235	70.2 (61.5, 77.7)	69.4 (60.7, 78.0)	**35.0 (22.2, 47.7)**
Oppose by smoking status and quit intent:				
- Smokes daily not intending to quit	61/174	34.6 (25.7, 44.8)		
- Smokes daily intending to quit	95/469	20.2 (16.0, 25.1)		
- Smokes less than daily	54/288	18.1 (13.2, 24.3)		
- Recently quit	43/235	12.8 (8.6, 18.6)		
Don't know by smoking status and quit intent:				
- Smokes daily not intending to quit	44/174	28.9 (20.9, 38.6)		
- Smokes daily intending to quit	81/469	16.6 (12.9, 21.1)		

Appendix Table 4 (continued): Support for implementation of very low nicotine cigarettes, reduction in retailer availability and introduction of a smokefree generation: analysis with "Don't know" responses included.

- Smokes less than daily	38/288	15.4 (9.4, 24.1)		
- Recently quit	39/235	17.0 (10.8, 25.6)		
Support by total ethnicity:				
- Māori	276/483	55.2 (49.7, 60.5)	57.2 (51.1, 63.5)	-6.3 (-14.4, 0.2)
- Pacific	136/232	59.0 (50.4, 67.1)	59.7 (50.5, 68.8)	-3.9 (-14.3, 6.5)
- Non-Māori-Non-Pacific	341/539	63.4 (57.9, 68.6)	63.6 (58.7, 68.6)	Reference
Oppose by total ethnicity:				
- Māori	126/483	27.8 (23.2, 32.9)		
- Pacific	47/232	19.0 (13.7, 25.7)		
- Non-Māori-Non-Pacific	100/539	17.3 (13.6, 21.8)		
Don't know by total ethnicity:				
- Māori	81/483	17.0 (13.3, 21.5)		
- Pacific	49/232	22.0 (15.2, 30.8)		
- Non-Māori-Non-Pacific	98/539	19.3 (15.2, 24.2)		
Support by age:				
- 18–24	180/320	53.4 (46.4, 60.3)	51.9 (44.6, 59.3)	**-13.8 (-23.5, -4.1)**
- 25–44	322/515	61.6 (55.7, 67.1)	60.6 (54.6, 66.6)	-5.1 (-13.4, 3.2)
- 45 and above	255/374	62.4 (56.0, 68.5)	65.7 (59.9, 71.6)	Reference
Oppose by age:				
- 18–24	84/320	28.8 (22.9, 35.4)		
- 25–44	108/515	19.6 (15.6, 24.3)		
- 45 and above	70/374	17.1 (12.7, 22.5)		
Don't know by age:				
- 18–24	56/320	17.8 (13.1, 23.8)		
- 25–44	85/515	18.8 (14.4, 24.3)		
- 45 and above	79/374	20.5 (15.7, 26.4)		
Support by gender:				
- Male	283/440	63.8 (57.9, 69.3)	63.0 (57.2, 68.8)	Reference
- Female	442/766	56.6 (52.1, 61.1)	59.2 (54.7, 63.6)	3.8 (-11.2, 3.6)

Appendix Table 4 (continued): Support for implementation of very low nicotine cigarettes, reduction in retailer availability and introduction of a smokefree generation: analysis with "Don't know" responses included.

Oppose by gender:				
- Male	102/440	20.8 (16.6, 25.8)		
- Female	160/766	19.4 (16.4, 22.9)		
Don't know by gender:				
- Male	55/440	15.4 (11.3, 20.6)		
- Female	164/766	23.9 (20.0, 28.3)		
Support by evidence of financial hardship:				
- No	517/838	62.4 (57.9, 66.7)	62.2 (58.1, 66.4)	Reference
- Yes	188/333	55.1 (47.9, 62.1)	58.3 (51.4, 65.3)	-3.9 (-11.8, 4.0)
Oppose by evidence of financial hardship:				
- No	161/838	18.0 (14.8, 21.7)		
- Yes	90/333	25.7 (20.4, 31.9)		
Don't know by evidence of financial hardship:				
- No	160/838	19.6 (16.1, 23.6)		
- Yes	55/333	19.2 (13.5, 26.4)		
"Would you support or oppose a law that reduced the number of places in New Zealand that were allowed to sell tobacco from around 6,000 (the current number) to 300?"				
Total:				
- Support	402/1,213	32.3 (28.9, 35.8)	N/A	N/A
- Oppose	719/1,213	59.4 (55.6, 63.1)	N/A	N/A
- Don't know	92/1,213	8.4 (6.1, 11.3)	N/A	N/A
Support by smoking status:				
- Smokes	294/980	27.6 (24.2, 31.2)	26.4 (23.0, 29.8)	Reference
- Recently quit	108/233	48.2 (39.4, 57.2)	52.4 (42.7, 62.0)	**26.0 (15.5, 36.5)**
Oppose by smoking status:				
- Smokes	613/980	64.4 (60.4, 68.2)		
- Recently quit	106/233	42.4 (33.8, 51.4)		
Don't know by smoking status:				
- Smokes	73/980	8.0 (5.7, 11.1)		
- Recently quit	19/233	9.4 (4.5, 18.6)		

Appendix Table 4 (continued): Support for implementation of very low nicotine cigarettes, reduction in retailer availability and introduction of a smokefree generation: analysis with "Don't know" responses included.

Support by smoking status and quit intent:				
- Smokes daily not intending to quit	28/180	12.5 (8.1, 18.8)	12.4 (7.3, 17.5)	Reference
- Smokes daily intending to quit	135/465	26.9 (22.2, 32.2)	25.5 (20.6, 30.4)	**13.1 (6.0, 20.3)**
- Smokes less than daily	124/292	41.9 (34.6, 49.5)	39.2 (31.6, 46.8)	**26.8 (17.5, 36.2)**
- Recently quit	108/233	48.2 (39.4, 57.2)	52.9 (43.3, 62.6)	**40.6 (29.6, 51.5)**
Oppose by smoking status and quit intent:				
- Smokes daily not intending to quit	141/180	82.2 (75.1, 87.6)		
- Smokes daily intending to quit	291/465	65.5 (60.0, 70.6)		
- Smokes less than daily	150/292	47.7 (40.1, 55.5)		
- Recently quit	106/233	42.4 (33.8, 51.4)		
Don't know by smoking status and quit intent:				
- Smokes daily not intending to quit	11/180	5.3 (2.7, 10.2)		
- Smokes daily intending to quit	39/465	7.6 (5.4, 10.6)		
- Smokes less than daily	18/292	10.4 (4.7, 21.4)		
- Recently quit	19/233	9.4 (4.5, 18.6)		
Support by total ethnicity:				
- Māori	141/487	25.9 (21.5, 30.8)	27.1 (21.7, 32.5)	**-8.7 (-16.0, -1.3)**
- Pacific	74/235	32.2 (25.1, 40.2)	27.9 (19.9, 35.8)	-7.9 (-17.3, 1.4)
- Non-Māori-Non-Pacific	197/537	34.5 (29.6, 39.7)	35.8 (31.0, 40.5)	Reference
Oppose by total ethnicity:				
- Māori	302/487	65.6 (60.4, 70.4)		
- Pacific	141/235	58.5 (49.9, 66.6)		
- Non-Māori-Non-Pacific	308/537	57.5 (52.0, 62.9)		
Don't know by total ethnicity:				
- Māori	44/487	8.5 (6.2, 11.7)		
- Pacific	20/235	9.3 (4.5, 18.1)		
- Non-Māori-Non-Pacific	32/537	7.9 (4.9, 12.6)		
Support by age:				
- 18–24	98/322	34.7 (28.2, 41.7)	26.7 (20.6, 32.8)	-3.3 (-12.1, 5.5)
- 25–44	206/521	36.9 (31.6, 42.6)	37.4 (31.7, 43.2)	7.4 (-0.7, 15.5)
- 45 and above	98/370	26.4 (21.2, 32.2)	30.0 (24.3, 35.8)	Reference

Appendix Table 4 (continued): Support for implementation of very low nicotine cigarettes, reduction in retailer availability and introduction of a smokefree generation: analysis with "Don't know" responses included.

Oppose by age:				
- 18–24	201/322	59.0 (52.0, 65.7)		
- 25–44	273/521	52.9 (47.1, 58.7)		
- 45 and above	245/370	66.2 (59.9, 72.1)		
Don't know by age:				
- 18–24	23/322	6.3 (3.9, 10.1)		
- 25–44	42/521	10.1 (6.4, 15.7)		
- 45 and above	27/370	7.4 (4.3, 12.4)		
Support by gender:				
- Male	176/443	35.5 (30.3, 41.2)	34.5 (29.1, 39.9)	Reference
- Female	225/767	28.4 (24.8, 32.4)	30.2 (26.2, 34.2)	-4.3 (-11.0, 2.4)
Oppose by gender:				
- Male	242/443	56.8 (50.9, 62.5)		
- Female	476/767	62.5 (58.1, 66.7)		
Don't know by gender:				
- Male	25/443	7.7 (4.5, 12.9)		
- Female	66/767	9.1 (6.6, 12.4)		
Support by evidence of financial hardship:				
- No	262/837	31.9 (27.9, 36.1)	32.2 (28.4, 36.1)	Reference
- Yes	125/340	32.7 (26.7, 39.3)	33.5 (26.6, 40.4)	1.3 (-6.5, 9.0)
Oppose by evidence of financial hardship:				
- No	513/837	60.0 (55.5, 64.4)		
- Yes	189/340	58.4 (51.3, 65.1)		
Don't know by evidence of financial hardship:				
- No	62/837	8.1 (5.5, 11.7)		
- Yes	26/340	8.9 (4.9, 15.5)		
"Would you support or oppose a law that prevents anyone who is currently 18 or younger from ever buying cigarettes or tobacco? This measure would eventually create a tobacco-free generation."				
Total:				
- Support	498/609	78.6 (73.5, 83.0)	N/A	N/A
- Oppose	85/609	16.5 (12.7, 21.1)	N/A	N/A

Appendix Table 4 (continued): Support for implementation of very low nicotine cigarettes, reduction in retailer availability and introduction of a smokefree generation: analysis with "Don't know" responses included.

- Don't know	26/609	4.9 (2.7, 8.7)	N/A	N/A
Support by smoking status:				
- Smokes	315/392	77.1 (71.2, 82.1)	76.8 (71.2, 82.4)	Reference
- Recently quit	183/217	83.8 (71.7, 91.4)	83.6 (75.9, 91.3)	6.8 (-2.8, 16.3)
Oppose by smoking status:				
- Smokes	60/392	18.6 (14.0, 24.2)		
- Recently quit	25/217	9.4 (5.1, 16.6)		
Don't know by smoking status:				
- Smokes	17/392	4.3 (2.4, 7.8)		
- Recently quit	9/217	6.7 (1.7, 23.0)		
Support by smoking status and quit intent:				
- Smokes daily not intending to quit	64/89	67.8 (54.8, 78.5)	63.5 (51.0, 76.1)	Reference
- Smokes daily intending to quit	157/183	78.6 (69.0, 85.8)	78.5 (70.4, 86.7)	**15.0 (0.2, 29.8)**
- Smokes less than daily	76/98	80.1 (68.8, 88.0)	82.0 (72.9, 91.1)	**18.5 (3.0, 33.9)**
- Recently quit	183/217	83.8 (71.7, 91.4)	83.0 (75.5, 90.6)	**19.5 (5.3, 33.7)**
Oppose by smoking status and quit intent:				
- Smokes daily not intending to quit	19/89	26.1 (16.3, 39.1)		
- Smokes daily intending to quit	22/183	18.0 (11.4, 27.2)		
- Smokes less than daily	17/98	16.1 (9.0, 27.2)		
- Recently quit	25/217	9.4 (5.1, 16.6)		
Don't know by smoking status and quit intent:				
- Smokes daily not intending to quit	6/89	6.1 (2.4, 14.5)		
- Smokes daily intending to quit	4/183	3.4 (1.0, 11.0)		
- Smokes less than daily	5/98	3.8 (1.4, 10.1)		
- Recently quit	9/217	6.7 (1.7, 23.0)		
Support by total ethnicity:				
- Māori	168/207	77.4 (67.6, 84.8)	78.9 (71.0, 86.7)	2.2 (-8.5, 12.9)
- Pacific	83/101	76.3 (60.4, 87.1)	78.5 (68.2, 88.8)	1.9 (-10.6, 14.3)
- Non-Māori-Non-Pacific	258/317	79.1 (72.4, 84.6)	76.6 (70.0, 83.3)	Reference

Appendix Table 4 (continued): Support for implementation of very low nicotine cigarettes, reduction in retailer availability and introduction of a smokefree generation: analysis with "Don't know" responses included.

Oppose by total ethnicity:				
- Māori	29/207	19.6 (12.4, 29.4)		
- Pacific	13/101	13.5 (6.9, 24.6)		
- Non-Māori-Non-Pacific	47/317	16.8 (11.9, 23.1)		
Don't know by total ethnicity:				
- Māori	10/207	3.1 (1.4, 6.8)		
- Pacific	5/101	10.3 (2.9, 30.4)		
- Non-Māori-Non-Pacific	12/317	4.1 (1.9, 8.5)		
Support by age:				
- 18–24	77/109	71.1 (56.8, 82.2)	71.1 (57.5, 84.7)	**-15.4 (-30.3, -0.4)**
- 25–44	212/264	73.6 (64.6, 81.0)	72.0 (63.7, 80.3)	**-14.5 (-24.6, -4.3)**
- 45 and above	209/236	86.8 (80.5, 91.2)	86.5 (80.8, 92.1)	Reference
Oppose by age:				
- 18–24	26/109	27.9 (16.9, 42.3)		
- 25–44	38/264	18.2 (12.3, 26.2)		
- 45 and above	21/236	10.4 (6.5, 16.4)		
Don't know by age:				
- 18–24	6/109	1.0 (0.4, 2.7)		
- 25–44	14/264	8.2 (3.9, 16.5)		
- 45 and above	6/236	2.8 (1.2, 6.6)		
Support by gender:				
- Male	160/205	74.2 (65.7, 81.2)	73.0 (65.6, 80.4)	Reference
- Female	337/403	83.7 (78.6, 87.8)	83.5 (78.4, 88.6)	**10.5 (1.5, 19.4)**
Oppose by gender:				
- Male	36/205	20.4 (14.4, 28.2)		
- Female	49/403	11.9 (8.5, 16.5)		
Don't know by gender:				
- Male	9/205	5.3 (2.1, 12.8)		
- Female	17/403	4.4 (2.4, 7.8)		
Support by evidence of financial hardship:				
- No	370/448	80.6 (74.9, 85.2)	79.7 (74.6, 84.7)	Reference

Appendix Table 4 (continued): Support for implementation of very low nicotine cigarettes, reduction in retailer availability and introduction of a smokefree generation: analysis with "Don't know" responses included.

- Yes	110/139	70.0 (56.8, 80.5)	71.0 (60.4, 81.5)	-8.7 (-20.1, 2.7)
Oppose by evidence of financial hardship:				
- No	58/448	15.2 (11.0, 20.5)		
- Yes	26/139	23.3 (14.8, 34.6)		
Don't know by evidence of financial hardship:				
- No	20/448	4.3 (2.3, 7.8)		
- Yes	3/139	6.8 (1.5, 25.6)		

Very low nicotine cigarette and retailer reduction data are from Wave 3 participants. Smokefree generation data are from Wave 3.5 participants.
Values in bold are statistically significant absolute marginal differences compared to the reference value.
Support is defined as answering "strongly support" or "support".
For the overall number of participants in each group and the definition of financial hardship, see Table 1 of the corresponding journal article.
When comparing groups, we present marginally standardised percentages and absolute differences (with 95% CI) that adjust for potential confounding from the following covariates: smoking status and quit intention, prioritised ethnicity, gender, age group and financial hardship.
In keeping with the aims of the study, sensitivity analyses were conducted only on support outcomes.
Total ethnicity data are presented for Māori and Pacific peoples. Some participants identified as both Māori and Pacific (see Table 1); comparisons for these two groups are made to an exclusive non-Māori-non-Pacific group.

Appendix Table 5: Support for measures to increase media campaign spending and the Smokefree Aotearoa 2025 goal: analysis with "Don't know" responses included.

	N support/N answered	**Weighted percentage (95% CI)**	**Marginally standardised percentage (95% CI)**	**Absolute difference (95% CI)**
"Do you support or oppose increased government spending on media campaigns to discourage youth and young people from starting to smoke?"				
Total:				
- Support	1,087/1,216	89.2 (86.4, 91.4)	N/A	N/A
- Oppose	93/1,216	7.2 (5.5, 9.2)	N/A	N/A
- Don't know	36/1,216	3.7 (2.2, 6.0)	N/A	N/A
Support by smoking status:				
- Smokes	872/980	87.7 (84.4, 90.4)	87.7 (84.3, 91.0)	Reference
- Recently quit	215/236	94.1 (88.9, 97.0)	93.9 (90.1, 97.7)	**6.3 (1.2, 11.3)**
Oppose by smoking status:				
- Smokes	79/980	7.9 (6.1, 10.3)		
- Recently quit	14/236	4.5 (2.0, 9.7)		

Appendix Table 5 (continued): Support for measures to increase media campaign spending and the Smokefree Aotearoa 2025 goal: analysis with "Don't know" responses included.

Don't know by smoking status:				
- Smokes	29/980	4.3 (2.5, 7.3)		
- Recently quit	7/236	1.4 (0.5, 3.8)		
Support by smoking status and quit intent:				
- Smokes daily not intending to quit	143/177	75.6 (64.8, 83.9)	75.2 (66.5, 83.8)	Reference
- Smokes daily intending to quit	419/470	89.3 (85.1, 92.3)	89.5 (85.8, 93.2)	**14.3 (5.0, 23.6)**
- Smokes less than daily	272/290	93.9 (88.9, 96.8)	93.8 (89.2, 98.4)	**18.6 (9.0, 28.2)**
- Recently quit	215/236	94.1 (88.9, 97.0)	93.9 (90.0, 97.7)	**18.7 (9.0, 28.4)**
Oppose by smoking status and quit intent:				
- Smokes daily not intending to quit	26/177	15.8 (10.2, 23.8)		
- Smokes daily intending to quit	37/470	7.9 (5.4, 11.4)		
- Smokes less than daily	13/290	2.6 (1.4, 5.0)		
- Recently quit	14/236	4.5 (2.0, 9.7)		
Don't know by smoking status and quit intent:				
- Smokes daily not intending to quit	8/177	8.6 (3.1, 21.5)		
- Smokes daily intending to quit	14/470	2.9 (1.4, 6.0)		
- Smokes less than daily	5/290	3.5 (1.3, 9.1)		
- Recently quit	7/236	1.4 (0.5, 3.8)		
Support by total ethnicity:				
- Māori	426/486	86.5 (82.0, 89.9)	85.3 (80.3, 90.4)	-5.0 (-10.9, 0.9)
- Pacific	208/231	89.9 (83.4, 94.0)	88.0 (81.3, 94.6)	-2.4 (-9.8, 5.0)
- Non-Māori-Non-Pacific	494/543	90.3 (86.2, 93.3)	90.4 (87.2, 93.5)	Reference
Oppose by total ethnicity:				
- Māori	41/486	9.3 (6.4, 13.2)		
- Pacific	14/231	4.8 (2.6, 8.6)		
- Non-Māori-Non-Pacific	41/543	6.9 (4.7, 10.0)		
Don't know by total ethnicity:				
- Māori	19/486	4.3 (2.5, 7.3)		
- Pacific	9/231	5.3 (2.3, 12.1)		
- Non-Māori-Non-Pacific	8/543	2.8 (1.1, 7.0)		

Appendix Table 5 (continued): Support for measures to increase media campaign spending and the Smokefree Aotearoa 2025 goal: analysis with "Don't know" responses included.

Support by age:				
- 18–24	287/324	88.4 (83.5, 92.0)	86.5 (81.3, 91.7)	-2.0 (-8.5, 4.5)
- 25–44	467/521	91.0 (87.6, 93.6)	91.0 (88.0, 94.1)	2.5 (-2.2, 7.2)
- 45 and above	333/371	87.6 (81.8, 91.7)	88.5 (84.6, 92.4)	Reference
Oppose by age:				
- 18–24	28/324	8.6 (5.6, 12.9)		
- 25–44	43/521	6.8 (4.7, 9.7)		
- 45 and above	22/371	6.9 (4.3, 11.1)		
Don't know by age:				
- 18–24	9/324	3.0 (1.4, 6.5)		
- 25–44	11/521	2.2 (1.0, 4.8)		
- 45 and above	16/371	5.5 (2.7, 11.0)		
Support by gender:				
- Male	389/442	88.0 (83.3, 91.5)	87.4 (83.4, 91.4)	Reference
- Female	697/772	90.6 (87.9, 92.8)	91.2 (88.7, 93.7)	3.8 (-0.9, 8.5)
Oppose by gender:				
- Male	41/442	7.9 (5.4, 11.3)		
- Female	52/772	6.3 (4.6, 8.6)		
Don't know by gender:				
- Male	12/442	4.2 (2.0, 8.6)		
- Female	23/772	3.1 (1.8, 5.0)		
Support by evidence of financial hardship:				
- No	756/839	89.9 (86.5, 92.5)	89.6 (86.9, 92.3)	Reference
- Yes	301/341	87.3 (81.7, 91.4)	88.2 (83.7, 92.6)	-1.4 (-6.5, 3.6)
Oppose by evidence of financial hardship:				
- No	57/839	6.4 (4.6, 8.8)		
- Yes	32/341	9.4 (6.2, 14.1)		
Don't know by evidence of financial hardship:				
- No	26/839	3.7 (2.0, 6.7)		
- Yes	8/341	3.3 (1.2, 8.3)		

Appendix Table 5 (continued): Support for measures to increase media campaign spending and the Smokefree Aotearoa 2025 goal: analysis with "Don't know" responses included.

"Do you support or oppose increased government spending on media campaigns to promote quitting smoking?"				
Total:				
- Support	764/1,211	61.5 (57.8, 65.2)	N/A	N/A
- Oppose	331/1,211	27.6 (24.4, 31.0)	N/A	N/A
- Don't know	116/1,211	10.9 (8.5, 13.9)	N/A	N/A
Support by smoking status:				
- Smokes	602/976	59.0 (54.9, 63.1)	59.3 (55.0, 63.7)	Reference
- Recently quit	162/235	69.9 (60.9, 77.5)	70.2 (61.8, 78.7)	**10.9 (1.0, 20.8)**
Oppose by smoking status:				
- Smokes	280/976	29.8 (26.2, 33.7)		
- Recently quit	51/235	20.0 (14.2, 27.5)		
Don't know by smoking status:				
- Smokes	94/976	11.1 (8.5, 14.4)		
- Recently quit	22/235	10.1 (5.1, 18.8)		
Support by smoking status and quit intent:				
- Smokes daily not intending to quit	71/175	42.2 (32.8, 52.3)	42.3 (32.6, 52.0)	Reference
- Smokes daily intending to quit	291/467	60.3 (54.5, 65.9)	61.8 (55.7, 68.0)	**19.5 (8.4, 30.7)**
- Smokes less than daily	219/291	71.7 (63.3, 78.9)	71.0 (62.8, 79.2)	**28.7 (15.8, 41.6)**
- Recently quit	162/235	69.9 (60.9, 77.5)	69.9 (61.5, 78.3)	**27.6 (14.2, 41.0)**
Oppose by smoking status and quit intent:				
- Smokes daily not intending to quit	87/175	48.4 (38.9, 58.1)		
- Smokes daily intending to quit	131/467	30.1 (25.1, 35.7)		
- Smokes less than daily	53/291	16.2 (11.6, 22.1)		
- Recently quit	51/235	20.0 (14.2, 27.5)		
Don't know by smoking status and quit intent:				
- Smokes daily not intending to quit	17/175	9.3 (5.3, 16.0)		
- Smokes daily intending to quit	45/467	9.5 (6.5, 13.7)		
- Smokes less than daily	19/291	12.1 (6.5, 21.4)		
- Recently quit	22/235	10.1 (5.1, 18.8)		

Appendix Table 5 (continued): Support for measures to increase media campaign spending and the Smokefree Aotearoa 2025 goal: analysis with "Don't know" responses included.

Support by total ethnicity:				
- Māori	291/488	55.9 (50.4, 61.2)	56.8 (50.6, 62.9)	**-9.9 (-17.9, -1.8)**
- Pacific	141/231	57.4 (48.6, 65.7)	54.8 (45.7, 63.9)	**-11.8 (-22.1, -1.5)**
- Non-Māori-Non-Pacific	358/537	65.2 (59.7, 70.3)	66.6 (61.6, 71.7)	Reference
Oppose by total ethnicity:				
- Māori	149/488	32.2 (27.3, 37.4)		
- Pacific	60/231	24.6 (18.3, 32.1)		
- Non-Māori-Non-Pacific	138/537	26.9 (22.4, 31.9)		
Don't know by total ethnicity:				
- Māori	48/488	12.0 (8.5, 16.5)		
- Pacific	30/231	18.0 (11.3, 27.5)		
- Non-Māori-Non-Pacific	41/537	7.9 (5.1, 12.2)		
Support by age:				
- 18–24	210/322	66.5 (59.8, 72.6)	63.5 (56.4, 70.6)	3.8 (-6.1, 13.7)
- 25–44	339/520	63.0 (57.2, 68.6)	64.4 (58.6, 70.2)	4.7 (-4.0, 13.4)
- 45 and above	215/369	57.7 (51.3, 64.0)	59.7 (53.3, 66.1)	Reference
Oppose by age:				
- 18–24	79/322	23.3 (18.2, 29.3)		
- 25–44	143/520	27.2 (22.5, 32.5)		
- 45 and above	109/369	29.8 (24.4, 35.9)		
Don't know by age:				
- 18–24	33/322	10.2 (6.6, 15.3)		
- 25–44	38/520	9.8 (6.2, 15.0)		
- 45 and above	45/369	12.4 (8.4, 17.9)		
Support by gender:				
- Male	288/440	62.5 (56.7, 68.0)	62.3 (56.4, 68.1)	Reference
- Female	475/768	60.4 (55.8, 64.8)	62.5 (57.9, 67.1)	0.2 (-7.2, 7.7)
Oppose by gender:				
- Male	115/440	25.8 (21.2, 30.9)		
- Female	216/768	29.7 (25.7, 34.1)		

Appendix Table 5 (continued): Support for measures to increase media campaign spending and the Smokefree Aotearoa 2025 goal: analysis with "Don't know" responses included.

Don't know by gender:				
- Male	37/440	11.7 (8.0, 16.9)		
- Female	77/768	9.9 (7.3, 13.1)		
Support by evidence of financial hardship:				
- No	544/838	63.6 (59.1, 67.9)	63.9 (59.7, 68.1)	Reference
- Yes	203/337	56.4 (49.2, 63.3)	58.0 (51.0, 64.9)	-6.0 (-13.7, 1.8)
Oppose by evidence of financial hardship:				
- No	213/838	25.8 (22.1, 29.9)		
- Yes	104/337	31.1 (25.3, 37.6)		
Don't know by evidence of financial hardship:				
- No	81/838	10.5 (7.9, 14.0)		
- Yes	30/337	12.5 (7.5, 20.2)		
"Do you support or oppose the Smokefree 2025 policy goal?" *				
Total:				
- Support	634/1,209	52.1 (48.3, 55.9)	N/A	N/A
- Oppose	484/1,209	39.8 (36.2, 43.5)	N/A	N/A
- Don't know	91/1,209	8.1 (6.1, 10.7)	N/A	N/A
Support by smoking status:				
- Smokes	475/977	45.4 (41.4, 49.5)	44.9 (40.8, 49.1)	Reference
- Recently quit	159/232	75.2 (67.5, 81.5)	75.5 (68.4, 82.6)	**30.5 (21.9, 39.1)**
Oppose by smoking status:				
- Smokes	429/977	45.8 (41.7, 49.9)		
- Recently quit	55/232	19.2 (13.6, 26.4)		
Don't know by smoking status:				
- Smokes	73/977	8.8 (6.4, 12.0)		
- Recently quit	18/232	5.6 (3.1, 10.0)		
Support by smoking status and quit intent:				
- Smokes daily not intending to quit	36/178	16.0 (10.9, 23.0)	16.2 (10.1, 22.2)	Reference
- Smokes daily intending to quit	237/468	49.6 (43.9, 55.4)	49.6 (43.3, 55.9)	**33.4 (24.9, 42.0)**
- Smokes less than daily	189/288	62.5 (54.2, 70.1)	62.2 (54.1, 70.2)	**46.0 (35.9, 56.1)**
- Recently quit	159/232	75.2 (67.5, 81.5)	75.2 (68.1, 82.2)	**59.0 (49.4, 68.6)**

Appendix Table 5 (continued): Support for measures to increase media campaign spending and the Smokefree Aotearoa 2025 goal: analysis with "Don't know" responses included.

Oppose by smoking status and quit intent:				
- Smokes daily not intending to quit	132/178	77.6 (69.6, 83.9)		
- Smokes daily intending to quit	194/468	42.2 (36.7, 48.0)		
- Smokes less than daily	79/288	26.8 (20.8, 33.8)		
- Recently quit	55/232	19.2 (13.6, 26.4)		
Don't know by smoking status and quit intent:				
- Smokes daily not intending to quit	10/178	6.4 (3.2, 12.4)		
- Smokes daily intending to quit	37/468	8.1 (5.3, 12.2)		
- Smokes less than daily	20/288	10.7 (5.4, 20.3)		
- Recently quit	18/232	5.6 (3.1, 10.0)		
Support by total ethnicity:				
- Māori	238/485	46.2 (40.8, 51.6)	49.2 (43.5, 54.9)	-6.0 (-13.5, 1.6)
- Pacific	114/230	50.7 (42.2, 59.2)	49.3 (41.6, 57.0)	-5.9 (-14.9, 3.2)
- Non-Māori-Non-Pacific	302/540	55.0 (49.5, 60.4)	55.2 (50.5, 59.8)	Reference
Oppose by total ethnicity:				
- Māori	215/485	46.6 (41.2, 52.0)		
- Pacific	93/230	38.9 (31.1, 47.3)		
- Non-Māori-Non-Pacific	198/540	37.0 (31.9, 42.3)		
Don't know by total ethnicity:				
- Māori	32/485	7.2 (4.8, 10.8)		
- Pacific	23/230	10.4 (6.2, 16.7)		
- Non-Māori-Non-Pacific	40/540	8.0 (5.2, 12.1)		
Support by age:				
- 18–24	177/325	55.1 (48.2, 61.9)	47.7 (41.0, 54.5)	-0.2 (-9.4, 9.0)
- 25–44	294/517	58.6 (52.8, 64.1)	58.7 (53.6, 63.8)	**10.7 (2.9, 18.6)**
- ≥45	163/367	44.1 (37.9, 50.6)	48.0 (42.1, 53.8)	Reference
Oppose by age:				
- 18–24	125/325	38.8 (32.4, 45.8)		
- 25–44	189/517	33.4 (28.4, 38.8)		
- ≥45	170/367	46.8 (40.5, 53.3)		

Appendix Table 5 (continued): Support for measures to increase media campaign spending and the Smokefree Aotearoa 2025 goal: analysis with "Don't know" responses included.

Don't know by age:				
- 18–24	23/325	6.0 (3.6, 10.0)		
- 25–44	34/517	8.1 (5.3, 12.2)		
- ≥45	34/367	9.1 (5.7, 14.2)		
Support by gender:				
- Male	251/441	55.2 (49.4, 61.0)	54.7 (49.5, 59.8)	Reference
- Female	383/765	48.6 (44.1, 53.1)	50.3 (46.2, 54.4)	-4.4 (-11.0, 2.3)
Oppose by gender:				
- Male	162/441	36.5 (31.1, 42.2)		
- Female	319/765	43.5 (39.1, 48.1)		
Don't know by gender:				
- Male	28/441	8.3 (5.3, 12.8)		
- Female	63/765	7.9 (5.9, 10.5)		
Support by evidence of financial hardship:				
- No	442/833	53.5 (48.9, 58.0)	53.6 (49.7, 57.5)	Reference
- Yes	171/341	47.9 (40.9, 54.9)	50.1 (44.0, 56.1)	-3.5 (-10.6, 3.5)
Oppose by evidence of financial hardship:				
- No	325/833	37.8 (33.6, 42.3)		
- Yes	147/341	45.1 (38.3, 52.2)		
Don't know by evidence of financial hardship:				
- No	66/833	8.7 (6.2, 12.0)		
- Yes	23/341	7.0 (4.2, 11.3)		

Data are from Wave 3 participants. Values in bold are statistically significant absolute marginal differences compared to the reference value.
Support is defined as answering "strongly support" or "support".
For the overall number of participants in each group and the definition of financial hardship, see Table 1 in the corresponding journal article.
When comparing groups, we present marginally standardised percentages and absolute differences (with 95% CI) that adjust for potential confounding from the following covariates: smoking status and quit intention, prioritised ethnicity, gender, age group and financial hardship.
In keeping with the aims of the study, sensitivity analyses were conducted only on "support" outcomes.
Total ethnicity data are presented for Māori and Pacific peoples. Some participants identified as both Māori and Pacific (see Table 1); comparisons for these two groups are made to an exclusive non-Māori-non-Pacific group.
* A description of the goal was given prior to asking this question, worded as follows: "*We will now describe the Government's Smokefree 2025 goal: the goal aims to reduce the availability of tobacco and the number of people smoking to minimal levels, thereby making New Zealand essentially a smokefree nation by 2025. ('Minimal numbers of people smoking' is often interpreted as: less than 5% of people in all population groups will smoke.)*."

Appendix Table 6: Outcomes by ethnicity and age: anticipated responses to the introduction of very low nicotine cigarettes, with "Don't know" responses excluded.

		n/N	Weighted percentage (95% CI)	Marginally standardised percentage (95% CI)	Absolute marginal difference (95% CI)
Total					
	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	288/908	35.1 (31.2, 39.2)	N/A	N/A
	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	170/908	19.2 (16.0, 22.9)	N/A	N/A
	- Reduce the amount I smoke	184/908	18.4 (15.5, 21.7)	N/A	N/A
	- Quit smoking entirely	132/908	13.0 (10.6, 15.9)	N/A	N/A
	- Switch to vaping/ e-cigarettes	134/908	14.3 (11.6, 17.5)	N/A	N/A
Total ethnicity					
Māori	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	117/368	34.8 (29.1, 40.9)	35.6 (29.0, 42.2)	0.8 (-7.8, 9.5)
	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	74/368	20.4 (15.9, 25.8)	20.0 (14.4, 25.6)	1.1 (-6.3, 8.5)
	- Reduce the amount I smoke	67/368	16.6 (12.7, 21.3)	13.8 (10.0, 17.6)	-5.2 (-11.2, 0.9)
	- Quit smoking entirely	59/368	14.9 (11.2, 19.5)	16.7 (12.0, 21.5)	5.3 (-0.4, 11.0)
	- Switch to vaping/ e-cigarettes	51/368	13.4 (9.9, 17.9)	13.8 (9.4, 18.3)	-2.0 (-8.3, 4.3)
Pacific peoples	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	45/183	27.5 (20.1, 36.4)	31.0 (22.1, 39.9)	-3.7 (-14.4, 6.9)
	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	40/183	22.6 (15.8, 31.2)	20.1 (12.2, 28.0)	1.1 (-8.1, 10.4)

Appendix Table 6 (continued): Outcomes by ethnicity and age: anticipated responses to the introduction of very low nicotine cigarettes, with "Don't know" responses excluded.

Pacific peoples	- Reduce the amount I smoke	42/183	23.6 (16.8, 32.0)	21.6 (14.1, 29.1)	2.7 (-6.2, 11.6)
	- Quit smoking entirely	25/183	13.0 (7.6, 21.3)	13.8 (6.7, 21.0)	2.4 (-5.3, 10.1)
	- Switch to vaping/ e-cigarettes	31/183	13.4 (8.8, 19.9)	13.4 (7.9, 18.9)	-2.5 (-9.5, 4.6)
Non-Māori-Non-Pacific	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	131/393	37.5 (31.6, 43.7)	34.7 (29.2, 40.3)	Reference
	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	68/393	18.1 (13.4, 24.0)	18.9 (14.2, 23.6)	
	- Reduce the amount I smoke	81/393	17.4 (13.4, 22.3)	19.0 (14.3, 23.6)	
	- Quit smoking entirely	54/393	11.9 (8.7, 16.1)	11.4 (8.2, 14.7)	
	- Switch to vaping/ e-cigarettes	59/393	15.1 (11.1, 20.2)	15.9 (11.5, 20.2)	
Age					
18–24	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	56/246	24.6 (18.5, 31.9)	26.6 (18.6, 34.6)	**-14.7 (-25.3, -4.1)**
	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	57/246	23.5 (17.5, 30.7)	30.1 (24.0, 36.2)	**16.1 (6.7, 25.7)**
	- Reduce the amount I smoke	39/246	12.8 (8.8, 18.4)	12.5 (7.6, 17.4)	-0.4 (-7.5, 6.7)
	- Quit smoking entirely	40/246	14.4 (10.0, 20.4)	11.3 (6.9, 15.6)	-6.6 (-14.1, 0.9)
	- Switch to vaping/ e-cigarettes	54/246	24.6 (18.3, 32.4)	19.5 (13.7, 25.4)	5.6 (-2.4, 13.6)
25–44	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	121/401	30.1 (24.6, 36.3)	30.0 (24.0, 36.2)	**-11.2 (-20.3, -2.1)**
	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	71/401	20.4 (15.6, 26.1)	21.1 (15.8, 26.5)	7.2 (0.0, 14.3)

Appendix Table 6 (continued): Outcomes by ethnicity and age: anticipated responses to the introduction of very low nicotine cigarettes, with "Don't know" responses excluded.

25–44	- Reduce the amount I smoke	104/401	24.8 (19.9, 30.5)	24.0 (18.7, 29.4)	**11.1 (3.9, 18.4)**
	- Quit smoking entirely	56/401	11.8 (8.5, 16.1)	11.3 (7.8, 14.9)	-6.5 (-13.2, 0.2)
	- Switch to vaping/ e-cigarettes	49/401	12.9 (9.0, 18.1)	13.4 (9.0, 19.2)	-0.5 (-7.6, 6.5)
≥45	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	111/261	45.5 (38.4, 52.8)	41.3 (34.6, 48.0)	Reference
	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	42/261	16.0 (10.7, 23.1)	14.0 (9.2, 18.8)	
	- Reduce the amount I smoke	41/261	13.4 (9.5, 18.5)	12.9 (8.2, 17.7)	
	- Quit smoking entirely	36/261	13.7 (9.6, 19.3)	17.8 (12.0, 23.6)	
	- Switch to vaping/ e-cigarettes	31/261	11.4 (7.8, 16.4)	13.9 (8.7, 19.2)	

Data are from Wave 3 participants. Values in bold are statistically significant absolute marginal differences compared to the reference value.
Wording of the question was "Which ONE of the following would you be MOST LIKELY to do if the amount of nicotine in cigarettes and tobacco was greatly reduced so they were no longer addictive?" Answer options were worded as per the text in the Table.
For the overall number of participants in each group and the definition of financial hardship, see Table 1. Note that N answered values vary from the values in Table 1, as participants who refused to answer or answered "Don't know" were excluded.
For the total value, 7 out of 992 participants (0.7%) were excluded, as they refused to answer or had no response, and 77 out of 992 participants (7.8%) were excluded, as they answered "Don't know".
When comparing groups, we present marginally standardised percentages and absolute differences (with 95% CI) that adjust for potential confounding from the following covariates: smoking status and quit intention, prioritised ethnicity, gender, age group and financial hardship.
Total ethnicity data are presented for Māori and Pacific peoples. Some participants identified as both Māori and Pacific (see Table 1); comparisons for these two groups are made to an exclusive non-Māori-non-Pacific group.
Electronic cigarettes = e-cigarettes.

Appendix Table 7: Outcomes by gender and financial hardship: anticipated responses to the introduction of very low nicotine cigarettes, with "Don't know" responses excluded.

		n/N	Weighted percentage (95% CI)	Marginally standardised percentage (95% CI)	Absolute difference (95% CI)
Total					
	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	288/908	35.1 (31.2, 39.2)	N/A	N/A
	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	170/908	19.2 (16.0, 22.9)	N/A	N/A
	- Reduce the amount I smoke	184/908	18.4 (15.5, 21.7)	N/A	N/A
	- Quit smoking entirely	132/908	13.0 (10.6, 15.9)	N/A	N/A
	- Switch to vaping/ e-cigarettes	134/908	14.3 (11.6, 17.5)	N/A	N/A
Gender					
Male	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	108/343	32.3 (26.6, 38.6)	31.4 (25.1, 37.7)	Reference
	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	76/343	23.0 (17.7, 29.2)	23.1 (17.9, 28.7)	
	- Reduce the amount I smoke	63/343	17.1 (12.9, 22.3)	16.5 (12.0, 21.0)	
	- Quit smoking entirely	50/343	13.5 (9.8, 18.3)	14.7 (10.2, 19.2)	
	- Switch to vaping/ e-cigarettes	46/343	14.1 (10.1, 19.3)	14.3 (9.9, 18.7)	
Female	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	180/564	38.3 (33.4, 43.6)	38.1 (33.3, 42.8)	6.7 (-1.3, 14.7)

Appendix Table 7 (continued): Outcomes by gender and financial hardship: anticipated responses to the introduction of very low nicotine cigarettes, with "Don't know" responses excluded.

Female	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	94/564	14.9 (11.8, 18.6)	14.7 (11.4, 18.0)	**-8.3 (-14.9, -1.8)**
	- Reduce the amount I smoke	120/564	19.9 (16.3, 24.0)	19.8 (15.9, 23.7)	3.3 (-2.6, 9.3)
	- Quit smoking entirely	82/564	12.4 (9.7, 15.7)	11.8 (8.9, 14.6)	-3.0 (-8.4, 2.5)
	- Switch to vaping/ e-cigarettes	88/564	14.5 (11.5, 18.3)	15.7 (12.2, 19.2)	1.4 (-4.3, 7.0)
Evidence of financial hardship					
No	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	202/606	36.9 (32.1, 42.1)	36.1 (31.4, 40.7)	Reference
	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	99/606	17.7 (13.8, 22.5)	17.7 (13.9, 21.4)	
	- Reduce the amount I smoke	127/606	18.3 (14.9, 22.4)	18.5 (14.9, 22.1)	
	- Quit smoking entirely	89/606	12.8 (10.0, 16.2)	13.1 (10.2, 16.1)	
	- Switch to vaping/ e-cigarettes	89/606	14.3 (11.1, 18.2)	14.6 (11.2, 18.0)	
Yes	- Carry on smoking like I do now, with the cigarettes or tobacco that were available	74/273	28.3 (22.1, 35.4)	30.2 (23.2, 37.1)	-5.9 (-14.1, 2.3)
	- Carry on smoking like I do now, but find a way to get the cigarettes or tobacco I want to smoke	66/273	23.8 (18.1, 30.6)	23.4 (16.8, 30.0)	5.7 (-1.7, 13.1)
	- Reduce the amount I smoke	52/273	18.5 (13.6, 24.6)	16.7 (11.6, 21.9)	-1.8 (-7.9, 4.4)
	- Quit smoking entirely	41/273	14.1 (9.5, 20.5)	13.7 (8.6, 18.9)	0.6 (-5.2, 6.4)
	- Switch to vaping/ e-cigarettes	40/273	15.4 (10.7, 21.5)	16.0 (10.3, 21.6)	1.4 (-5.2, 7.9)

Data are from Wave 3 participants. Values in bold are statistically significant absolute marginal differences compared to the reference value.

Appendix Table 7 (continued): Outcomes by gender and financial hardship: anticipated responses to the introduction of very low nicotine cigarettes, with "Don't know" responses excluded.

Wording of the question was "Which ONE of the following would you be MOST LIKELY to do if the amount of nicotine in cigarettes and tobacco was greatly reduced so they were no longer addictive?" Answer options were worded as per the text in the Table.
For the overall number of participants in each group and the definition of financial hardship, see Table 1 of the corresponding journal article. Note that N answered values vary from the values in Table 1, as participants who refused to answer or answered "Don't know" were excluded.
For the total value, 7 out of 992 participants (0.7%) were excluded, as they refused to answer or had no response, and 77 out of 992 participants (7.8%) were excluded, as they answered "Don't know".
When comparing groups, we present marginally standardised percentages and absolute differences (with 95% CI) that adjust for potential confounding from the following covariates: smoking status and quit intention, prioritised ethnicity, gender, age group and financial hardship.
Of note, some participants identified as both Māori and Pacific (please see Table 1 for detail).
Electronic cigarettes = e-cigarettes.

Appendix Table 8: Outcomes by ethnicity and age: anticipated responses to the introduction of a retailer reduction, with "Don't know" responses excluded.

		n/N	Weighted percentage (95% CI)	Marginally standardised percentage (95% CI)	Absolute marginal difference (95% CI)
Total					
	- Carry on smoking like I do now	466/939	53.2 (49.1, 57.2)	N/A	N/A
	- Reduce the amount I smoke	217/939	21.6 (18.6, 25.1)	N/A	N/A
	- Quit smoking entirely	121/939	12.3 (9.9, 15.1)	N/A	N/A
	- Switch to vaping/ e-cigarettes	135/939	12.9 (10.5, 15.7)	N/A	N/A
Total ethnicity					
Māori	- Carry on smoking like I do now	199/386	54.8 (49.0, 60.6)	55.4 (49.6, 61.2)	1.3 (-6.9, 9.5)
	- Reduce the amount I smoke	83/386	20.1 (15.9, 25.1)	18.4 (13.9, 22.9)	-2.9 (-9.6, 3.7)
	- Quit smoking entirely	52/386	12.9 (9.7, 17.1)	14.5 (10.3, 18.7)	4.1 (-1.0, 9.3)
	- Switch to vaping/ e-cigarettes	52/386	12.1 (8.9, 16.4)	11.6 (7.8, 15.4)	-2.4 (-8.1, 3.2)
Pacific peoples	- Carry on smoking like I do now	79/187	42.6 (33.9, 51.8)	46.2 (37.6, 54.8)	-7.9 (-18.3, 2.5)
	- Reduce the amount I smoke	48/187	29.3 (21.6, 38.5)	23.6 (16.0, 31.2)	2.3 (-6.7, 11.2)
	- Quit smoking entirely	27/187	12.9 (8.2, 19.8)	15.5 (8.9, 22.2)	5.1 (-2.2, 12.5)

Appendix Table 8 (continued): Outcomes by ethnicity and age: anticipated responses to the introduction of a retailer reduction, with "Don't know" responses excluded.

Pacific peoples	- Switch to vaping/ e-cigarettes	33/187	15.2 (9.9, 22.5)	14.6 (8.6, 20.7)	0.5 (-6.7, 7.8)
Non-Māori-Non-Pacific	- Carry on smoking like I do now	209/404	56.4 (50.4, 62.3)	54.2 (49.6, 61.2)	Reference
	- Reduce the amount I smoke	90/404	19.3 (15.2, 24.2)	21.4 (16.5, 26.2)	
	- Quit smoking entirely	46/404	11.6 (8.2, 16.1)	10.4 (7.2, 13.6)	
	- Switch to vaping/ e-cigarettes	59/404	12.7 (9.4, 17.0)	14.1 (8.2, 18.1)	
Age					
18–24	- Carry on smoking like I do now	118/253	48.3 (40.7, 56.0)	57.2 (50.3, 64.2)	1.7 (-8.1, 11.5)
	- Reduce the amount I smoke	46/253	16.3 (11.6, 22.3)	14.7 (9.5, 20.0)	0.3 (-7.2, 7.9)
	- Quit smoking entirely	31/253	12.2 (8.0, 18.1)	9.3 (5.3, 13.3)	**-7.8 (-14.9, -0.8)**
	- Switch to vaping/ e-cigarettes	58/253	23.2 (17.2, 30.6)	18.7 (13.0, 24.4)	5.8 (-2.0, 13.6)
25–44	- Carry on smoking like I do now	181/412	46.6 (40.5, 52.8)	49.1 (43.0, 55.1)	-6.5 (-15.5, 2.5)
	- Reduce the amount I smoke	128/412	30.3 (25.0, 36.2)	28.7 (23.0, 34.4)	**14.3 (6.6, 22.0)**
	- Quit smoking entirely	54/412	11.8 (8.5, 16.2)	10.6 (7.4, 13.8)	**-6.6 (-13.0, -0.1)**
	- Switch to vaping/ e-cigarettes	49/412	11.3 (8.1, 15.6)	11.6 (7.8, 15.3)	-1.3 (-7.5, 5.0)
≥45	- Carry on smoking like I do now	167/274	62.7 (55.8, 69.1)	55.6 (49.2, 61.9)	Reference
	- Reduce the amount I smoke	43/274	14.2 (10.2, 19.4)	14.4 (9.4, 19.4)	
	- Quit smoking entirely	36/274	12.8 (8.9, 18.2)	17.2 (11.6, 22.8)	
	- Switch to vaping/ e-cigarettes	28/274	10.2 (6.8, 15.1)	12.9 (7.8, 17.9)	

Data are from Wave 3 participants. Values in bold are statistically significant absolute marginal differences compared to the reference value.
Wording of the questions was "Which ONE of the following would you be MOST LIKELY to do if the number of places in New Zealand that could sell tobacco was reduced from around 6,000 to 300?" Answer options were worded as per the text in the Table. For the overall number of participants in each group and the definition of financial hardship, see Table 1. Note that N answered values vary from the values in Table 1, as participants who refused to answer or answered "Don't know" were excluded.

Appendix Table 8 (continued): Outcomes by ethnicity and age: anticipated responses to the introduction of a retailer reduction, with "Don't know" responses excluded.

For the total value, 8 out of 992 participants (0.8%) participants were excluded as they refused to answer or had no response recorded, and 45 out of 992 participants (4.5%) were excluded as they answered "Don't know".
When comparing groups, we present marginally standardised percentages and absolute differences (with 95% CI) that adjust for potential confounding from the following covariates: smoking status and quit intention, prioritised ethnicity, gender, age group and financial hardship.
Total ethnicity data are presented for Māori and Pacific peoples. Some participants identified as both Māori and Pacific (see Table 1); comparisons for these two groups are made to an exclusive non-Māori-non-Pacific group.

Appendix Table 9: Outcomes by gender and financial hardship: anticipated responses to the introduction of retailer reduction, with "Don't know" responses excluded.

		n/N	Weighted percentage (95% CI)	Marginally standardised percentage (95% CI)	Absolute difference (95% CI)
Total					
	- Carry on smoking like I do now	466/939	53.2 (49.1, 57.2)	N/A	N/A
	- Reduce the amount I smoke	217/939	21.6 (18.6, 25.1)	N/A	N/A
	- Quit smoking entirely	121/939	12.3 (9.9, 15.1)	N/A	N/A
	- Switch to vaping/ e-cigarettes	135/939	12.9 (10.5, 15.7)	N/A	N/A
Gender					
Male	- Carry on smoking like I do now	175/352	53.1 (46.8, 59.4)	52.6 (46.8, 58.3)	Reference
	- Reduce the amount I smoke	88/352	22.0 (17.4, 27.5)	22.2 (17.1, 27.2)	
	- Quit smoking entirely	45/352	13.1 (9.4, 17.9)	13.1 (9.2, 17.1)	
	- Switch to vaping/ e-cigarettes	44/352	11.8 (8.4, 16.3)	12.1 (8.3, 16.0)	
Female	- Carry on smoking like I do now	291/586	53.3 (48.3, 58.1)	53.3 (48.8, 57.7)	0.8 (-6.5, 8.1)
	- Reduce the amount I smoke	129/586	21.2 (17.6, 25.4)	20.0 (16.2, 23.8)	-2.3 (-8.6, 4.0)
	- Quit smoking entirely	76/586	11.4 (8.9, 14.6)	11.6 (8.7, 14.5)	-1.5 (-6.4, 3.4)
	- Switch to vaping/ e-cigarettes	90/586	14.1 (11.1, 17.8)	15.2 (11.7, 18.6)	3.0 (-2.1, 8.2)

Appendix Table 9 (continued): Outcomes by gender and financial hardship: anticipated responses to the introduction of retailer reduction, with "Don't know" responses excluded.

Evidence of financial hardship					
No	- Carry on smoking like I do now	314/631	54.5 (49.5, 59.3)	52.7 (48.2, 57.0)	Reference
	- Reduce the amount I smoke	135/631	19.1 (15.7, 23.1)	20.3 (16.6, 24.0)	
	- Quit smoking entirely	88/631	13.8 (10.7, 17.5)	13.8 (10.7, 16.9)	
	- Switch to vaping/ e-cigarettes	94/631	12.6 (9.9, 15.9)	13.3 (10.2, 16.3)	
Yes	- Carry on smoking like I do now	141/280	50.3 (43.0, 57.6)	53.6 (46.9, 60.3)	1.0 (-7.1, 9.0)
	- Reduce the amount I smoke	71/280	25.8 (19.8, 32.8)	23.2 (17.1, 29.2)	2.9 (-4.1, 9.9)
	- Quit smoking entirely	32/280	9.5 (6.4, 13.8)	9.0 (5.6, 12.4)	**-4.8 (-9.2, -0.3)**
	- Switch to vaping/ e-cigarettes	36/280	14.4 (9.8, 20.9)	14.2 (8.9, 19.5)	0.9 (-5.3, 7.1)

Data are from Wave 3 participants. Values in bold are statistically significant absolute marginal differences compared to the reference value.
Wording of the questions was "Which ONE of the following would you be MOST LIKELY to do if the number of places in New Zealand that could sell tobacco was reduced from around 6,000 to 300?" Answer options were worded as per the text in the Table.
For the overall number of participants in each group and the definition of financial hardship, see Table 1 of the corresponding journal article. Note that N answered values vary from the values in Table 1, as participants who refused to answer or answered "Don't know" were excluded.
For the total value, 8 out of 992 participants (0.8%) participants were excluded as they refused to answer or had no response recorded, and 45 out of 992 participants (4.5%) were excluded as they answered "Don't know".
When comparing groups, we present marginally standardised percentages and absolute differences (with 95% CI) that adjust for potential confounding from the following covariates: smoking status and quit intention, prioritised ethnicity, gender, age group and financial hardship.
Electronic cigarettes = e-cigarettes.

The prevalence of aortic stenosis in Māori undergoing clinically indicated echocardiography compared to New Zealand Europeans

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ABSTRACT

AIM: There are limited data on the prevalence of calcific aortic valve disease (CAVD) in Māori and known inequities in outcomes after aortic valve intervention. Our study aimed to investigate the prevalence of CAVD in Māori.

METHODS: Data from initial clinically indicated echocardiograms performed between 2010 to 2018 in patients aged ≥18 years were linked to nationally collected outcome data. Ethnicity was defined using protocols from the Ministry of Health.

RESULTS: Of the 23,635 patients, 1,312 (5.6%) identified as Māori, and 22,323 (94.4%) as European. Prevalence of aortic stenosis was 5.3% in Māori and 9.9% in Europeans. Age-specific prevalence did not differ between the two groups. Māori with CAVD were more than twice as likely to have advanced cardiac impairment (right ventricular dysfunction) than Europeans (10.1% vs 4.6, p<0.001).

CONCLUSIONS: Age-specific CAVD rates did not differ between Māori and Europeans, though Māori had a higher proportion of advanced cardiac impairment, which is likely unrelated to CAVD. Differences in population structure likely explain the difference in overall prevalence of CAVD. The improving life expectancy in Māori may lead to increasing incidence of CAVD, thus strategies to improve detection and medical management of CAVD should begin as soon as possible.

Calcific aortic valve disease (CAVD) consists of a spectrum of abnormalities, from thickening and calcification of the valve without haemodynamic significance (aortic sclerosis [ASc]) to calcification of the leaflets and reduction in valve opening (aortic stenosis [AS]) resulting in increased left ventricular afterload. AS affects over 9 million people world-wide, with age being a key risk factor for CAVD, alongside other markers of general cardiovascular risk including diabetes, dyslipidaemia and hypertension.[1–4] Variants in certain genes have also been associated with CAVD,[5,6] but while there has been significant progress in understanding the pathobiology of the disease and interventional treatment of severe disease, there have been no advances in medical therapies.[7–9]

The most recent data for the prevalence of CAVD in New Zealand came from the National Health Committee in 2014, which found that Māori had a lower age-standardised prevalence of severe CAVD compared to non-Māori.[10] There are currently no peer-reviewed publications examining the prevalence or incidence of CAVD in Māori. Recent work found markedly worse outcomes for Māori following treatment for severe CAVD, with Māori patients having significantly reduced survival following both transcatheter aortic valve implantation (TAVI) and surgical aortic valve replacement (SAVR) compared to Europeans, despite being significantly younger.[11,12]

Thus, we sought to investigate the prevalence and significance of CAVD in Māori undergoing clinically indicated echocardiography to provide information to researchers and clinicians.

Methods

Study cohort and approval

The study cohort for this retrospective study consisted of all patients over 18 years old who underwent clinically indicated echocardiography at Dunedin Hospital or Invercargill Hospital over a 9-year period between 1 January 2010 and 31 December 2018. Consultation with Māori was undertaken with the Ngāi Tahu Research Consultation Committee, and ethical approval was granted by the New Zealand Central Health

and Disability Ethics Committee (ref: 21/CEN/15). Locality approval was provided by Health New Zealand – Te Whatu Ora Southern.

Collection and cleaning of echocardiographic data

Data were stored in the syngo Dynamics echocardiographic picture archiving and communication system (PACS) (version VA20F, Siemens Healthineers, Erlangen, Germany), and extracted using the syngo Dynamics Data Miner. Subsequent studies on the same patient and any studies with missing CAVD status (n=1,323) were excluded, leading to an initial cohort size of 24,699. Of these, 23,635 identified as either Māori or European. Details of data extraction, cleaning, comprehensive variable definitions and non-ethnicity stratified outcomes are described in detail elsewhere.[13,14] Categorical variables, including CAVD status, were defined using tailored functions that analysed free-text fields for relevant phrases. CAVD classification was hence based on the reading cardiologist's clinical description in the echocardiography report. Mild-to-moderate and moderate-to-severe stenosis were coded as mild and moderate disease, respectively. Patients who had undergone previous SAVR or TAVI were described separately. When aggregating CAVD severity, those who had undergone aortic valve implantation (AVI) were included in the AS category.

Determination of extravalvular cardiac impairment

In order to further identify differences in CAVD phenotype, patients were categorised into CAVD stages using a previously developed staging system based on extravalvular cardiac impairment.[15] For clarity in this manuscript, "impairment" refers to this staging system, whereas "severity" refers to the common clinical understanding of mild, moderate and severe stenosis. While CAVD is not necessarily the cause of any identified extravalvular impairment, especially at lower levels of CAVD severity, higher stages of disease have been shown to be good predictors of prognosis in patients with CAVD.[16,17] Left ventricular (LV) mass was calculated using the Devereux formula. Body surface area was frequently not available in our dataset, so the upper limits of the normal range of absolute LV mass were used.[18] Similarly, E/e', a surrogate measure of mean left atrial pressure, is not measured in those with significant mitral valvular disease, mitral annular calcification, arrhythmia or other settings where E/e' is known to be inaccurate, and hence was assumed to be abnormal if it was not recorded.[19]

- Stage 0: No extravalvular cardiac impairment
- Stage 1: LV mass >224 (male) or >162 (female), E/e' >14 or not measured, or left ventricular ejection fraction <40%
- Stage 2: Moderately or worse dilated left atrium, atrial fibrillation, or moderate or worse mitral regurgitation
- Stage 3: Right ventricular systolic pressure >60mmHg, or moderate or worse tricuspid regurgitation
- Stage 4: Moderately or worse impaired right ventricular systolic function

Data validation

To investigate the accuracy of Data Miner output, 100 studies were randomly selected, with the dataset categorisation compared to the final echocardiography report. This revealed excellent agreement.[13]

Statistical analysis

All analysis was performed on a de-identified dataset with National Health Index numbers replaced by anonymous identifiers. Continuous data are expressed as mean (standard deviation) if normally distributed, and otherwise as median (interquartile range). Data were analysed using the Mann–Whitney U-test if continuous and non-normally distributed, and with ANOVA if normally distributed. Categorical variables were analysed using the Chi-squared test. All analyses, including data cleaning, were performed using RStudio with R version 3.6.3.[20–22] Age standardisation was performed using the RStudio package epitools.[23]

Results

Of the 23,635 people in the cohort, 1,312 (5.6%) identified as Māori, and 22,323 (94.4%) were European (Table 1). Māori were significantly younger than European patients (55.4 years vs 64.9 years, p<0.001), but the sex distribution was not significantly different between the two ethnicities (p=0.64). The proportion of bicuspid aortic valve disease appeared similar in both ethnicities (1.3% vs 1.6%).

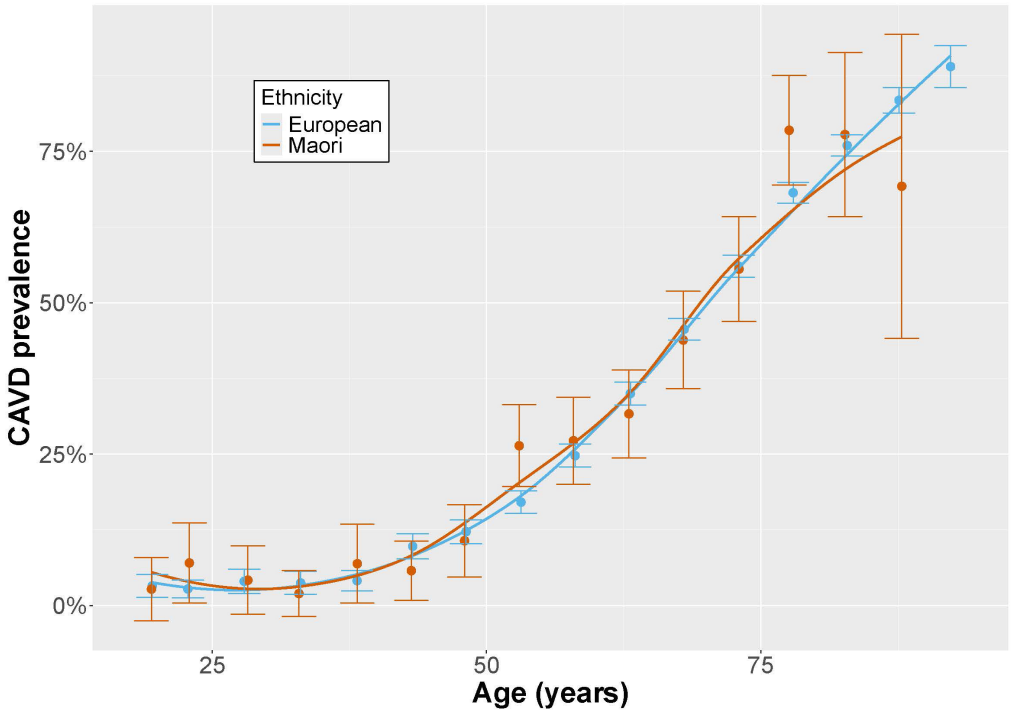
The proportion of any CAVD increased markedly with age. It was present in 50% of 70-year-olds

Table 1: Cohort characteristics.

	Overall (N=23,635)	**Māori (N=1,312)**	**European (N=22,323)**
Age (years)			
Mean (SD)	64.40 (16.70)	55.40 (16.70)	64.90 (16.60)
Sex			
Female	11,027 (46.7)	621 (47.3)	10,406 (46.6)
Male	12,608 (53.3)	691 (52.7)	11,917 (53.4)
Aortic valve maximum velocity (m/s)			
Mean (SD)	1.47 (0.87)	1.32 (0.69)	1.47 (0.88)
Not reported	2,374 (11.2)	134 (11.4)	2,240 (11.2)
CAVD severity			
No CAVD	13,464 (57.0)	915 (69.7)	12,549 (56.2)
Sclerosis	7,839 (33.2)	327 (24.9)	7,512 (33.7)
Mild	895 (3.8)	25 (1.9)	870 (3.9)
Moderate	522 (2.2)	16 (1.2)	506 (2.3)
Severe	370 (1.6)	8 (0.6)	362 (1.6)
AVI	545 (2.3)	21 (1.6)	524 (2.3)
Mitral annular calcification			
Yes	3,302 (14.0)	108 (8.2)	3,194 (14.3)
No	19,988 (84.6)	1,186 (90.4)	18,802 (84.2)
Not reported	345 (1.5)	18 (1.4)	327 (1.5)
Bicuspid aortic valve			
Yes	311 (1.3)	21 (1.6)	290 (1.3)
No	23,324 (98.7)	1,291 (98.4)	22,033 (98.7)

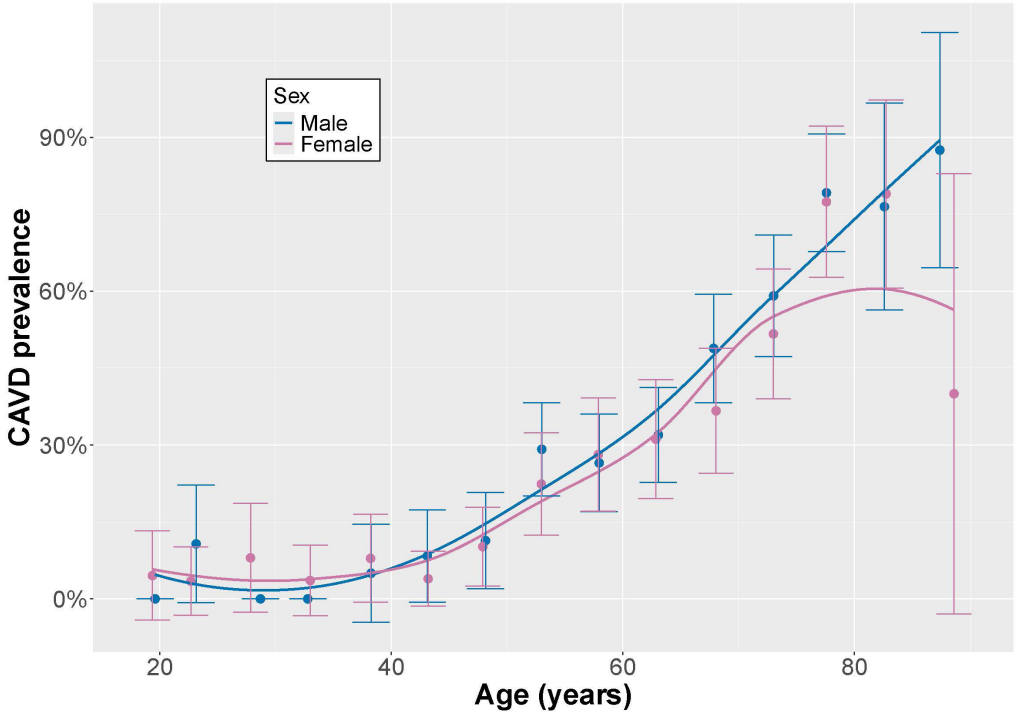
SD = standard deviation; CAVD = calcific aortic valve disease; AVI = aortic valve intervention.

Figure 1: Age-related prevalence of calcific aortic valve disease stratified by ethnicity in patients undergoing clinically indicated echocardiography.



Points are the proportion within each 5-year age band and the average age within each band. Error bars represent 95% confidence intervals. The plotted curve was fitted using locally weighed smoothing (LOESS regression function).

Figure 2: Age-related prevalence of calcific aortic valve disease in Māori, stratified by sex.



Points are the proportion within each 5-year age band and the average age within each band. Error bars represent 95% confidence intervals. The plotted curve was fitted using locally weighed smoothing (LOESS regression function).

Table 2: Proportion of Māori and Europeans with different severity of CAVD.

	Māori (n=1,313)	European (n=22,323)	Corrected p-value
Aortic sclerosis	327 (24.9)	7,512 (33.7)	<0.001
Aortic stenosis	70 (5.3)	2,262 (10.1)	<0.001
Any CAVD	397 (30.2)	9,774 (43.8)	<0.001

Cell values are expressed in n (%) and P determined using a two-sided Z-test (with Bonferroni correction for multiple testing).
CAVD = calcific aortic valve disease.

Table 3: Age-standardised rates per 100,000 of CAVD by ethnicity with 95% confidence intervals in patients undergoing clinically indicated echocardiography.

	Māori	European
Aortic sclerosis	9,100 (7,700–11,300)	7,900 (7,600–8,300)
Aortic stenosis	2,100 (1,500–3,600)	2,600 (2,400–3,000)
Any CAVD	11,200 (9,700–13,400)	10,600 (10,100–11,100)

CAVD = calcific aortic valve disease.

in the cohort (Figure 1). Across all age brackets, CAVD prevalence did not appear to differ between Māori and Europeans. Similarly, the prevalence of CAVD in Māori did not differ by sex (Figure 2). However, the overall prevalence of CAVD, AS and ASc were all significantly lower in Māori than in Europeans (Table 2).

In order to identify the effect of underlying age distributions, the prevalence of ASc, AS and any CAVD was age standardised using the World Health Organization standard population (Table 3). Rates of age-standardised CAVD were not different between the two ethnicities.

Rates of specific comorbid pathologies of the heart and surrounding structures in those with any CAVD are presented in Table 4. Using a previously developed staging system for extra-valvular cardiac impairment, patients were categorised into stages (Table 5). Notably, Māori had twice the proportion of stage 4 impairment compared with Europeans (10.1% vs 4.6%, p<0.001), and a slightly reduced proportion of stage 1 impairment (49.7% vs 55.7% in Europeans, p<0.01). Rates of stage 0, 2 and 3 impairment were similar between the two ethnicities.

Discussion

In this large descriptive study of over 20,000 patients undergoing clinically indicated echocardiography, including 1,313 Māori patients, overall rates of CAVD were lower in Māori than in Europeans (30.2% vs 40.3%). Age-unadjusted prevalence of AS in Europeans was almost double that in Māori (9.9% vs 5.3%). However, when age standardised, prevalence of CAVD was similar between the two groups (11.2 per 1,000 in Māori vs 10.6 per 1,000 in Europeans). There did not appear to be sex-related differences in CAVD in Māori.

Recent epidemiological data on the rate of CAVD in Māori are limited. The National Health Committee's review of AS in New Zealand, published in 2014, found that Māori had a lower age-standardised prevalence of severe AS than non-Māori.[10] This is concordant with our non-adjusted data, noting that low numbers prevented accurate age-standardisation for severe AS on its own. Comparisons with international data can be challenging. This is because routinely acquired data (such as hospital discharges) often only report clinically significant, usually severe, AS, and because the age groups studied and definitions of CAVD used can differ between reports. A 2013 meta-analysis found a pooled AS prevalence of 12.4% in those over 75 years old, which is similar to the overall rate in Europeans in our cohort, but over double that of Māori.[1] International evidence shows that CAVD is less

Table 4: Rate of comorbid pathologies of the heart and surrounding structures in those with any CAVD (sclerosis or aortic stenosis).

	Māori (N=397)	European (N=9,774)	Overall (N=10,171)
Left ventricular systolic dysfunction			
Normal	258 (65.0%)	6,725 (68.8%)	6,983 (68.7%)
Hyperdynamic	3 (0.8%)	150 (1.5%)	153 (1.5%)
Mild	37 (9.3%)	1,026 (10.5%)	1,063 (10.5%)
Moderate	21 (5.3%)	637 (6.5%)	658 (6.5%)
Severe	25 (6.3%)	424 (4.3%)	449 (4.4%)
Not reported	53 (13.4%)	812 (8.3%)	865 (8.5%)
Right ventricular systolic dysfunction			
Normal	268 (67.5%)	7,739 (79.2%)	8,007 (78.7%)
Hyperdynamic	0 (0%)	13 (0.1%)	13 (0.1%)
Mild	56 (14.1%)	767 (7.8%)	823 (8.1%)
Moderate	27 (6.8%)	328 (3.4%)	355 (3.5%)
Severe	15 (3.8%)	112 (1.1%)	127 (1.2%)
Not reported	31 (7.8%)	815 (8.3%)	846 (8.3%)
Right ventricular systolic pressure ≥25mmHg			
Yes	160 (40.3%)	4,032 (41.3%)	4,192 (41.2%)
No	93 (23.4%)	2,085 (21.3%)	2,178 (21.4%)
Not reported	144 (36.3%)	3,657 (37.4%)	3,801 (37.4%)
Mitral stenosis			
None	375 (94.5%)	9,361 (95.8%)	9,736 (95.7%)
Mild	0 (0%)	57 (0.6%)	57 (0.6%)
Moderate	0 (0%)	17 (0.2%)	17 (0.2%)
Severe	1 (0.3%)	5 (0.1%)	6 (0.1%)
MVR/repair	9 (2.3%)	69 (0.7%)	78 (0.8%)
Rheumatic valve	3 (0.8%)	9 (0.1%)	12 (0.1%)
Not reported	9 (2.3%)	256 (2.6%)	265 (2.6%)
Aortic regurgitation			
None	337 (84.9%)	8,445 (86.4%)	8,782 (86.3%)
Mild	51 (12.8%)	1,213 (12.4%)	1,264 (12.4%)

Table 4 (continued): Rate of comorbid pathologies of the heart and surrounding structures in those with any CAVD (sclerosis or aortic stenosis).

	Māori (N=397)	European (N=9,774)	Overall (N=10,171)
Moderate	8 (2.0%)	84 (0.9%)	92 (0.9%)
Severe	1 (0.3%)	32 (0.3%)	33 (0.3%)
Mitral regurgitation			
None	261 (65.7%)	6,394 (65.4%)	6,655 (65.4%)
Mild	78 (19.6%)	2,348 (24.0%)	2,426 (23.9%)
Moderate	16 (4.0%)	352 (3.6%)	368 (3.6%)
Severe	9 (2.3%)	73 (0.7%)	82 (0.8%)
Not reported	33 (8.3%)	607 (6.2%)	640 (6.3%)
Pulmonary regurgitation			
None	243 (61.2%)	5,111 (52.3%)	5,354 (52.6%)
Mild	18 (4.5%)	457 (4.7%)	475 (4.7%)
Moderate	0 (0%)	7 (0.1%)	7 (0.1%)
Severe	1 (0.3%)	2 (0.0%)	3 (0.0%)
Not reported	135 (34.0%)	4,197 (42.9%)	4,332 (42.6%)
Tricuspid regurgitation			
None	253 (63.7%)	6,343 (64.9%)	6,596 (64.9%)
Mild	82 (20.7%)	1,899 (19.4%)	1,981 (19.5%)
Moderate	22 (5.5%)	327 (3.3%)	349 (3.4%)
Severe	5 (1.3%)	40 (0.4%)	45 (0.4%)
Not reported	35 (8.8%)	1,165 (11.9%)	1,200 (11.8%)

CAVD = calcific aortic valve disease; MVR = mitral valve replacement.

Table 5: Stage of cardiac impairment in those with any CAVD, stratified by ethnicity.

	Māori (n=376)	European (n=9,250)
Stage 0	53 (14.1)	1,313 (14.2)
Stage 1	187 (49.7)	5,152 (55.7)
Stage 2	86 (22.9)	2,099 (22.7)
Stage 3	12 (3.2)	263 (2.8)
Stage 4	38 (10.1)	423 (4.6)

Cells are formatted as n (%). Chi-squared test: X-squared=25.578, df=4, p<0.001. CAVD = calcific aortic valve disease.

prevalent in certain ethnic groups, with this work primarily occurring in the United States of America (USA). There are limited data on the prevalence of CAVD in Indigenous populations; however, there is literature relating to non-European minority populations. Comparison with this work is useful, as inequities in health outcomes and access to care exist in those nations, and it is therefore important to note if similar or different findings have been made. Prior research has identified that African American patients have a lower prevalence of severe AS when compared to Caucasian patients (0.29% vs 0.91%).[24] This gap in prevalence existed across age bands, which was not observed in our study. A further study of Medicare beneficiaries in the USA found a similar result, with white patients having a higher overall prevalence of AS compared to Black, Hispanic or Asian/North American Native patients.[25] However, they also found that outcomes of all-cause hospitalisation, heart failure hospitalisation and 1-year mortality were significantly worse for Black patients than white patients. Unfortunately, a similar trend has been observed in New Zealand when examining outcomes following both TAVI and SAVR: Māori have significantly worse survival than Europeans (80.1% vs 93.9%), despite being over a decade younger at the time of TAVI (67.9 vs 80.6 years),[11] and worse survival even at 30 days post-SAVR.[12]

Certain key comorbidities were examined to determine if there were differences in cardiac impairment, outside the degree of stenosis. We applied a previously described staging criteria, based on the degree of cardiac impairment, to those with CAVD.[15] Strikingly, Māori were more than twice as likely to have stage 4 impairment compared with Europeans (10.1% vs 4.6, $p<0.001$). This finding suggests that although Māori have similar rates of CAVD to Europeans of the same age, their overall burden of cardiac impairment is significantly greater. The cardiac impairment is not likely to be directly related to CAVD in the majority of patients—there is no direct causal explanation for how ASc or mild AS, for example, would lead to right ventricular dysfunction. However, more advanced cardiac impairment is likely to impact on future mortality, as well as make subsequent valve intervention a higher-risk procedure. This may, for example, make less invasive approaches such as TAVI more appropriate in the setting of significant extravalvular cardiac impairment. In addition, earlier detection of extravalvular cardiac impairment will allow earlier management of this prior to any requirement for valvular intervention.

To our knowledge, this is the first large study to examine prevalence of CAVD in Māori undergoing clinically indicated echocardiography. A particular strength of our study is not just in its numbers, but in the availability of other echocardiographic information that allows us to further characterise the structural aspects of the heart. Several limitations to our study exist. For instance, we do not have information available on other cardiovascular risk factors, such as hypertension and diabetes, which are known to be associated with CAVD and are more prevalent in Māori.[2,26,27] Secondly, our study population might not be generalisable to all Māori in New Zealand, as the study locale was entirely in the lower South Island. It was also restricted to patients that were referred and received clinically indicated echocardiography and thus cannot explore the true population prevalence of CAVD. There may be a referral or access bias to echocardiography. Māori are more likely to live in remote and rural locations and may have limited access to healthcare overall,[28] so the numbers noted here may well be an under-estimate. Exploratory analyses revealed that there would be insufficient statistical power to draw valid inferences around outcomes following diagnosis of CAVD, and hence further longitudinal analysis was not performed.

In summary, there are similar age-specific rates of CAVD in Māori and Europeans, but with Māori having a higher proportion of more advanced cardiac impairment. The lower non-adjusted prevalence of CAVD in Māori is due to the different population structure, with lower life expectancy in Māori, rather than any apparent difference in prevalence at any specific point over the lifespan. As such, the lower non-adjusted prevalence is likely another representation of the health inequity faced by Māori—in short, we do not see as much CAVD in Māori because Māori do not live long enough to get it.

In the future, the improving life expectancy in Māori may well lead to increasing incidence of CAVD. The higher proportion of cardiac impairment means that attempts to improve detection through access to echocardiography, and, ideally, medical management of both the valve disease and associated cardiac impairment, should begin as soon as possible.

COMPETING INTERESTS
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Projected increases in the prevalence of diabetes mellitus in Aotearoa New Zealand, 2020–2044

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ABSTRACT

BACKGROUND: The prevalence of diabetes has been increasing in Aotearoa New Zealand by approximately 7% per year, and is three times higher among Māori and Pacific peoples than in Europeans. The depth of the diabetes epidemic, and the expansive breadth of services required for its management, elevate the need for high-quality evidence on the projected future burden of this complex disease.

METHODS: In this manuscript we have projected the prevalence of diabetes (type 1 and type 2 combined) out to 2040–2044 using age-period-cohort modelling. National-level data from central government on diabetes prevalence (Virtual Diabetes Register) were used to describe recent diabetes prevalence trends (2006–2019) by age group, calendar period and birth cohort, with these trends used to project diabetes prevalence out from 2020 to 2044.

RESULTS: Aotearoa New Zealand will experience a significant increase in the absolute volume of prevalent diabetes, rising by nearly 90% to more than 500,000 by 2044. The age-standardised prevalence of diabetes will increase from around 3.9% of the population (268,248) to 5.0% overall (502,358). The prevalence and volume of diabetes diagnoses will increase most drastically for Pacific peoples, most notably Pacific females for whom diabetes prevalence is projected to increase to 17% of the population by 2044.

CONCLUSIONS: The increases in the future burden of diabetes mellitus projected here will heighten pressure on health services. Immediate action is required to reduce new cases of diabetes and other obesity-related illnesses. Fiscal policies to prevent these diseases, coupled with population-level interventions to more effectively manage and control diabetes, are effective tools for reducing disease burden.

More than half a billion people (529 million) globally are currently estimated to be living with diabetes mellitus, with this prevalence projected to rise to 1.3 billion by 2050.[1] By far the most important driver of this global trend is obesity, with a recent large-scale review finding that up to 83% of all cases of diabetes are now attributable to obesity.[2] While it has been identified that biological factors (including genetics) have a role to play in risk of obesity, the simultaneous increases that have been observed in the prevalence of obesity across the world appear to be driven by the social determinants of obesity, including food environments.[3] The prevalence of diabetes has been increasing in Aotearoa New Zealand by approximately 7% per year, and is three times higher among Māori and Pacific peoples than in Europeans.[4] As such, the social determinants of the obesity epidemic are squarely implicated in both the overall volume of new diabetes diagnoses, as well as the significant disparities that exist in the burden of this disease within populations.[5]

The magnitude of this health issue, and the high likelihood that it will worsen over time, is difficult to fathom. In terms of healthcare delivery, diabetes is a multifaceted, multisystem disease that requires clinical input spanning all levels of our healthcare system.[6] Caring for a person with diabetes over time often involves a multidisciplinary team, which might include a general practitioner, endocrinologist, nurses, dietitians, pharmacists and other allied healthcare professionals.[7] The annual direct and indirect costs attributed to type 2 diabetes alone in Aotearoa New Zealand is estimated to be more than NZ$2 billion, projected to increase to approximately $3.5 billion in the next 20 years.[8]

The depth of the diabetes epidemic, and the expansive breadth of services required for its management, elevate the need for high-quality evidence on the projected future burden of this complex disease. Such evidence can be utilised to project future health service needs and can

provide a base for considering the cost effectiveness of public health interventions to reduce the future burden of diabetes.[9]

Numerous methods have been used to predict future prevalence rates of diabetes, including simple linear models,[8,10] dynamic Markov modelling[9] and Bayesian meta-regression modelling.[1] A 2020 report in Aotearoa New Zealand utilised a generalised linear model to estimate the prevalence of type 2 diabetes out to 2040 based on data from 2014 to 2018.[8] For the current study, we have projected the future prevalence of diabetes using age-period-cohort (APC) modelling.[11,12] This model allows for changes that occur over time in the age structure of a population (e.g., an ageing population), as well as cohort effects (such as increases over time in the obesogenic environment). In this way, APC modelling can be utilised as a proxy for underlying changes in risk factors (like obesity) among the population.[11]

In this manuscript we have projected the combined prevalence of type 1 and type 2 diabetes out to 2040–2044 using APC modelling. To do this we have used national-level data on diabetes prevalence to describe recent diabetes prevalence trends (2006–2019) by age group, calendar period and birth cohort, and then utilised these trends to project diabetes prevalence out from 2020 to 2044.

Methods

Numerator data

Diabetes prevalence for 2006–2019 was derived from the Virtual Diabetes Register (VDR). The VDR defines diabetes status based on routine healthcare data[13] and has been validated against primary care registers.[13,14] The VDR sets the diabetes status of each individual in Aotearoa New Zealand based on multiple data sources:[15]

- publicly funded hospital discharges with diabetes discharge code within the previous 10-year period;
- attendance at a diabetes education or diabetes screening appointment in an outpatient setting collection within the previous 3 years;
- publicly funded diabetes pharmaceuticals dispensed in community on two or more occasions within the previous 2 years, with some exclusions (e.g., insulin used by women between 5 months before and 2 weeks after giving birth);
- access to laboratory services, including four HbA_{1c} measurements and two albumin to creatinine ratio (ACR) measurements within the last 2 years, but excluding HbA_{1c} measurements within 9 months of birth.

A de-identified VDR dataset was extracted from National Collections data, provided by the data custodians Health New Zealand – Te Whatu Ora. Diabetes prevalence data were aggregated by 5-year age groups (0–85+ years old) over three historical time periods (2006–2009, 2010–2014, 2015–2019) for males and females. Because of concerns regarding poorer data coverage in the underlying VDR source datasets within the first time period (2006–2009), diabetes prevalence for this period was estimated by linear extrapolation from the 2010–2014 and 2015–2019 prevalences. Projections made using both this extrapolation method and the existing 2006–2009 data are shown in Appendix Table 2; the selected method made little (if any) difference to the projections. Ethnicity data were classified using the "total ethnicity" approach, wherein individuals can belong to more than one ethnic grouping (Māori, Pacific, Asian [South Asian and Other Asian] and European/Other). Sex was categorised as either female or male.

Denominator data

Denominator data were sourced from two places. Historical residential population data were requested from Stats NZ (custom extract) for 30 June 2001, 2006, 2013 and 2018, by 5-year age groups, sex and total ethnicity. Interpolation was used to estimate population numbers between data points, and linear extrapolation was used to give population numbers in 2019 to ensure that we had denominator data for the same period as the diabetes data. Person-time was then summed up for each of the five historical time periods.

Projected population estimates were extracted from a publicly available Stats NZ dataset, which covered the period 2020–2043.[16] We linearly extrapolated the 2042–2043 trend to calculate 2044 population numbers. Person-years (denominator) were summed for males and females by 5-year age groups in each of five projected 5-year time periods (2020–2024, 2025–2029, 2030–2034, 2035–2039, 2040–2044) in the total population and by total ethnicity.

Statistical analysis

Projected numbers of diabetes cases and

age-standardised prevalence rates (ASR; average per year per 100 population) were reported in the overall population and separately for males and females in the five projected time periods (2020–2044). The World Health Organization world population standard was used as the standard population. Sex-specific findings were also reported by ethnicity.

APC modelling was run using the Nordpred software package[17] in R (R Institute, Vienna, Austria). Default Nordpred settings were used for the modelled age groups, recent slope, the cut trend (which reduced the drift in subsequent projection periods) and the link function (link is g(x)=x^0.2, called power5).[18,19] The youngest age group that was modelled and projected was required to have at least 20 diabetes cases in every time period.

In addition to calculating projected diabetes cases and ASR, average annual percentage changes (AAPC) in diabetes cases and age-standardised prevalence were also calculated by comparing results in 2040–2044 with 2015–2019, assuming a constant change and adjusting for the years in between ((1+%change over 25 years)^(1/25)).

Results

Our total projected diabetes prevalence numbers and rates are presented in Table 1 and Figure 1. We project that the total number of people living with diabetes in Aotearoa New Zealand will rise from 268,248 in 2015–2019 (average annual prevalence in observed VDR data) to 502,358 by 2040–2044, a total increase of 87% and an average annual increase of 2.5%. The number of females with diabetes is projected to increase from 128,488 in 2015–2019 to 247,055 (92% increase), while the number of males with diabetes increases from 139,750 to 257,893 (85% increase). The number of total Māori living with diabetes will increase from 42,930 to 98,146 (129% increase), total Pacific from 38,215 to 106,485 (175% increase), total Asian from 42,933 to 136,084 (218% increase) and total European from 153,016 to 234,717 (53% increase).

In terms of ASR (Table 1/Figure 1), standardised to the World Health Organization World Population Standard, the prevalence rate of diabetes will continue to increase over time for both males and females, with females experiencing the most rapid increases (female ASR 3.6% in 2015–2019 to 5.0% in 2040–2044; male ASR 4.2% in 2015–2019 to 5.1% in 2040–2044). The largest absolute increases are projected to occur among Pacific females (13.1–17.3%) and males (ASR 12.4–14.2%), with smaller increases in prevalence rates among other ethnic groups (Table 1/Figure 2).

Discussion

Key findings

In this study, we have used APC models to project the prevalence of diabetes mellitus out from 2020–2044. Our projections suggest that over this time period:

- Aotearoa New Zealand will experience a significant increase in the absolute volume of prevalent diabetes, rising by nearly 90% to more than 500,000 by 2044;
- the age-standardised prevalence of diabetes mellitus will increase from approximately 3.9% of the population to 5.0% overall, an increase of around 30%;
- both the prevalence rate and volume of new prevalent diabetes diagnoses will increase most drastically for Pacific peoples, most notably Pacific females for whom diabetes prevalence is projected to increase to 17% of the population by 2044;
- by 2044, the combined number of Māori, Pacific and Asian peoples with diabetes (339,799) will exceed the number of Europeans with diabetes (234,717);
- the age-standardised prevalence rate of diabetes mellitus in females will increase faster than for males, with rates for these two groups conflating by 2044.

How do these projections compare to other regions?

The closest comparison data are from two recent reports: first, the Global Burden of Disease (GBD) study, which found that the number of people living with diabetes globally would increase from 529 million in 2021 to 1.31 billion by 2050, an increase of more than 148% globally, and approximately 48% in high-income countries.[1] Second, the International Diabetes Federation (IDF) Diabetes Atlas projects that the number of people living with diabetes globally will increase from 536 million in 2021 to 783 million by 2045, an increase of around 46% globally and approximately 13% in high-income countries.[20] While our own projections are not necessarily comparable due to methodological differences between studies, our observation of a near 90%

Table 1: Projected number of people with diabetes and age-standardised diabetes prevalence in 2040–2044 compared to 2015–2019, Aotearoa New Zealand.

		Historic				Projected				AAPC	
		2015–2019				2040–2044					
		Cases (n)	Pop. (n)	Crude (%)	ASR (%)	Cases (n)	Pop. (n)	Crude (%)	ASR (%)	People (%)	ASR (%)
Total	All	268,248	4,808,896	5.6	3.9	502,358	5,890,600	8.5	5.0	2.5	1.0
Males	All males	139,750	2,378,558	5.9	4.2	254,624	2,926,840	8.7	5.1	2.4	0.7
Total ethnicity	Māori	20,930	392,350	5.3	6.5	45,068	610,320	7.4	6.9	3.1	0.3
	Pacific	17,876	198,630	9.0	12.4	46,891	329,880	14.2	14.2	3.9	0.5
	Asian	22,236	356,764	6.2	7.2	67,332	705,120	9.5	6.8	4.5	−0.3
	European	81,349	1,681,504	4.8	3.0	121,778	1,907,560	6.4	3.4	1.6	0.5
Females	All females	128,488	2,430,338	5.3	3.6	247,055	2,963,760	8.3	5.0	2.6	1.2
Total ethnicity	Māori	22,000	399,296	5.5	6.1	53,078	611,960	8.7	7.6	3.6	0.9
	Pacific	20,339	196,384	10.4	13.1	58,381	324,600	18	17.3	4.3	1.1
	Asian	20,697	367,960	5.6	5.8	69,049	712,860	9.7	6.4	4.9	0.4
	European	71,667	1,734,308	4.1	2.5	112,939	1,954,980	5.8	3.2	1.8	1.0

AAPC = average annual percentage change; ASR = the age-standardised prevalence rate per 100 population (or percent).
Cases (n) are the average number of people with diabetes in each year of the time period.

Figure 1: Projected diabetes prevalent cases (left) and rates (right) in Aotearoa New Zealand, 2020–2044.

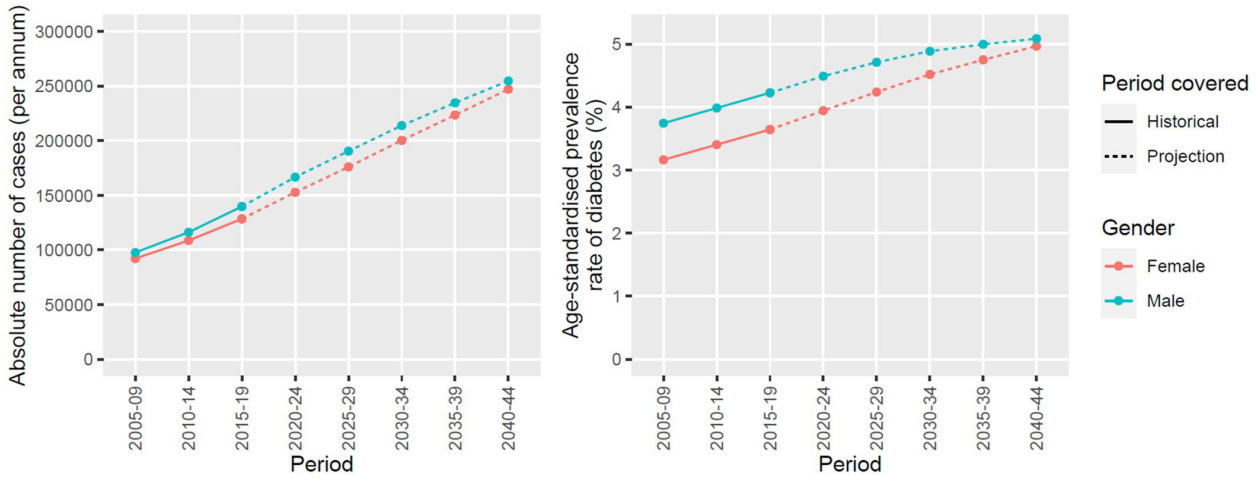
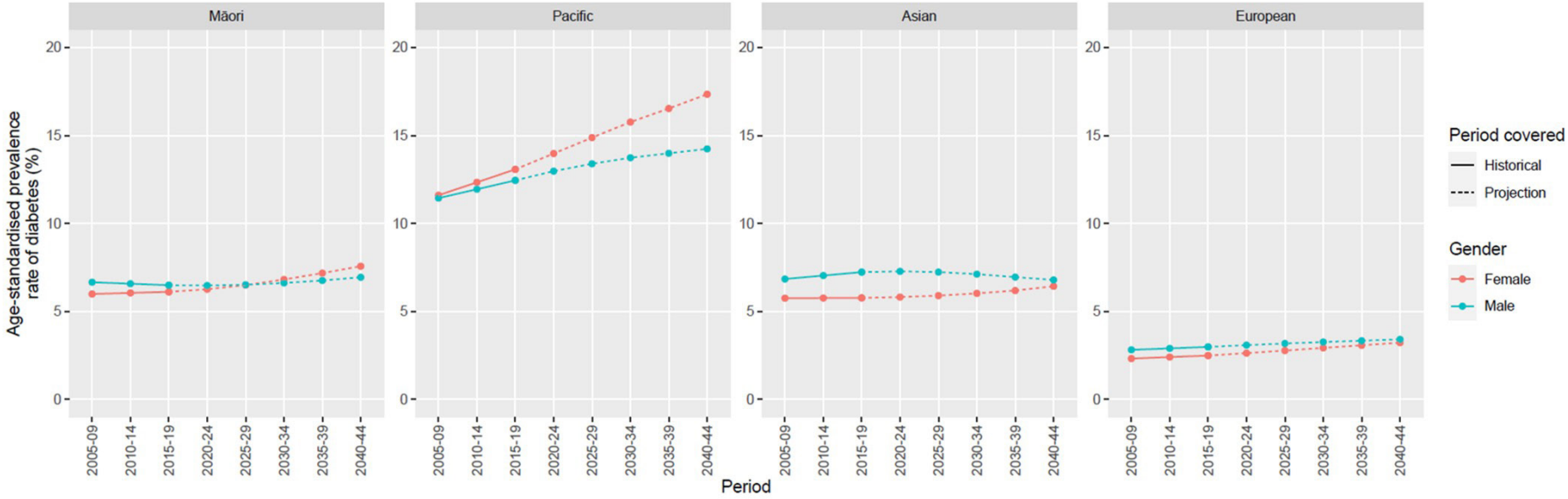


Figure 2: Projected diabetes prevalence rates by ethnicity in Aotearoa New Zealand, 2020–2044.



increase in diabetes prevalence is substantially higher than that projected for other high-income countries.

What is driving these increases?

The steep climb in the absolute number of New Zealanders with diabetes is driven by three factors: 1) population growth (more people living in Aotearoa New Zealand), 2) an ageing population (with a greater proportion of the population in age groups at higher risk of developing type 2 diabetes), and, perhaps most importantly, 3) actual increases in the risk of developing diabetes (increases in the proportion of the population diagnosed with diabetes within age groups, thus independent of age). The last factor is particularly important for Pacific peoples, for whom the projected increase in diabetes prevalence was most pronounced. This increasing prevalence will be almost entirely due to type 2 diabetes,[1] and it is likely that changing obesity profiles underpin the increase in prevalence. While biological factors such as genetics may contribute to changes in prevalence, these changes in obesity profiles are driven by disparities within our population in terms of access to the social and structural determinants of good health.[3,21] Socio-economic position (SEP) and the food environment, leading to excess weight, are likely to be major factors in the pronounced disparities in projected prevalence of diabetes for Pacific peoples. For example, progression of pre-diabetes to diabetes in Aotearoa New Zealand is associated with SEP and obesity.[22] High diabetes prevalence is concerning for Pacific peoples, who have been seen to have poorer diabetes control relative to other ethnic groups,[23] and who experience barriers to accessing healthcare.[24]

What do we need to do?

While population growth and an ageing population are difficult to change, it is within our control as a society to take meaningful action against the obesity epidemic—with a view to "plugging the dam" and reducing the number of people in Aotearoa New Zealand who will go on to develop type 2 diabetes. The recent report from Aotearoa New Zealand's Public Health Advisory Committee provides a number of recommendations regarding actions to improve our food environments, including fiscal policies such as sugary drinks taxation, restriction of unhealthy food marketing to children and community-based initiatives that improve access to nutritious, locally produced food.[25] Such actions will serve to reduce the rate of new cases of diabetes, while improvements in diabetes management (glycaemic control) will decrease the number of those who progress on to complications (vascular and neurological), as well as the severity of those complications. We also note that there is evidence of the effectiveness of population-level interventions to more effectively manage and control diabetes, and these interventions show promise.[26,27] As such, our diabetes crisis (both current and impending) provides an excellent opportunity for multiple agencies to work together to meaningfully reduce the population-level impact of a long-term condition.

Given the striking and inequitable patterning of our projections by ethnicity—where by 2044 we project that nearly one in seven Pacific males and one in six Pacific females will be living with diabetes, compared to one in 16 European males and one in 18 females (crude data)—actions taken to prevent diabetes and improve its clinical management must be designed and tailored to work best for Māori, Pacific and Asian populations. There is excellent work being undertaken and completed around the country to drive this vision forward; for example, the Government is developing a diabetes action plan; the independent Public Health Advisory Committee has completed a project on food environments; and multiple organisations are working within communities to address the drivers of our obesogenic environment and increase availability and accessibility of healthy food.[29] There is also a need for action in the management of pre-diabetes/early diabetes to reverse metabolic deficit, and we note that the DiRECT study in the United Kingdom has shown that weight management programmes can be delivered at scale nationally and achieve near 50% remission of diabetes symptoms.[28] The Green Prescription initiative, an exercise prescription programme, has shown some promise in improving activity levels,[30,31] and may benefit from further evaluation regarding what has worked and what has not. These and similar initiatives must continue to be resourced and supported as a matter of high priority if we are to avoid the unsustainable and potentially system-crippling future burden of diabetes that we have projected here.

Strengths and limitations

Like all projection models, APC models rely on the validity of available data for projecting trends into the future. For example, both population

count and diabetes prevalence projections are based on existing trends up to 2019, and do not account for any step-wise changes from major policy or health system setting changes after this date. If population changes into the future do not meet these assumptions, then the projections will be inaccurate. We considered presenting variation around our projected prevalence rates and volumes related to these analytical steps, but ultimately decided that the assumptions underpinning these variations could be misleading or inaccurate. As such, while we have done the best that we can to present robust projections, these are underpinned by methodological assumptions and should therefore be interpreted as indicative rather than precise.[11]

We have presented projections in diabetes prevalence for the total population, rather than focussing only on adults. We note that had we focussed solely on adults, the overall projected prevalence rate would have been higher than that reported here. However, because of the growing prevalence of both type 1 and type 2 diabetes among children and young adults,[32] we wanted to ensure that these groups were captured within our APC models, and thus included people of all ages within our analysis.

It is unclear whether changes in clinical practice and data collection have affected diabetes estimates over time. Indeed, the algorithm has been validated and is designed to avoid this, e.g., having strict criteria for the number of HbA_{1c} screening tests and excluding indicators of diabetes around the time of childbirth in women.[15] Some people in the VDR may have pre-diabetes rather than diabetes. The VDR accounts for 5.7% higher estimates of diabetes at the aggregate level when compared to laboratory records.[12] It is likely that we have under-counted the prevalence diabetes in Māori and possibly for Pacific peoples, given the under-count of Māori ethnicity in National Health Index data, which is used in the VDR algorithm.[33] Finally, we note that due to constraints with available data, this study projects diabetes prevalence (i.e., the total number of previously diagnosed cases within the population) rather than diabetes incidence (i.e., the number of new cases within the population diagnosed per year). Further methodological work is required to determine whether it is feasible to collect data on diabetes incidence at a national level.

Conclusions

Using APC modelling to project the prevalence of diabetes mellitus out to 2044, we found that Aotearoa New Zealand will experience a significant increase in the absolute volume of prevalent diabetes, rising by nearly 90% to more than 500,000 by 2044. We found that the age-standardised prevalence of diabetes will increase from around 3.9% of the population to 5.0% overall. We found that both the rate and volume of new prevalent diabetes diagnoses will increase most drastically for Pacific peoples—most notably Pacific females, for whom diabetes prevalence is projected to increase to 17% of the population by 2044. The projected increases in the future burden of diabetes mellitus in Aotearoa New Zealand are likely to stretch our health system to breaking point, if not beyond: and as such, immediate and bold action is required to stem the tide of diabetes and other obesity-related illnesses.

COMPETING INTERESTS
Nil.

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Appendix

Appendix Table 1: Virtual Diabetes Register inclusion criteria.

To be categorised as diabetes in any given year a person would have to meet one of these VDR criteria (2006–2019):	Coverage:
Publicly funded diabetes pharmaceuticals dispensed in the community on two or more occasions in the last 2 years. Excludes metformin in women 12–45 years, and insulin used between 5 months before and 2 weeks after giving birth.	Dataset quality has improved over time, e.g., in 2005 87% of dispensing had a unique identifier and this was 98% by 2010.
Laboratory records of four or more HbA_{1c} measurements and two ACR measurements within the last 2 years (excluding HbA_{1c} measurements within 9 months of giving birth).	Quality has improved over time, e.g., 88% of claims had an NHI in 2004 and this was 98% coverage by 2010.
Outpatient record of diabetes, education, management or screening in the last 3 years.	Records began in July 2006 (affecting 2006–2008 VDR).
Publicly funded hospital discharge with a diabetes discharge code in the last 10 years.	Records since 1988.

See source for further information.[15]
We used Output 2 VDR data—diabetes prevalence estimates on people who were alive and enrolled in a primary health organisation at some point during the calendar year of the VDR.[15]
VDR = Virtual Diabetes Register; ACR = albumin to creatinine ratio; NHI = National Health Index.

Appendix Table 2: The projected diabetes prevalence (2040–2044) found when using a linear extrapolation ("back-estimation") of 2010–2014 and 2015–2019 Virtual Diabetes Register (VDR) data to determine historical diabetes prevalence for the 2006–2009 period (top), compared to projections made using actual 2006–2009 VDR data. The projected number of cases is practically identical between the two methods; for example, using the existing 2006–2009 VDR data marginally increased the number of projected diabetes cases compared to the back-estimation method by 0.8% or 4,079 cases in total (out of 502,358 projected cases using the back-estimation method).

		Back-estimation of 2006–2009 data					
		Projected				**AAPC**	
		2040–2044					
		Cases (n)	**Pop. (n)**	**Crude (%)**	**ASR (%)**	**People (%)**	**ASR (%)**
Total	All	502,358	5,890,600	8.5	5.0	2.5	1.0
Males	All males	254,624	2,926,840	8.7	5.1	2.4	0.7
Total ethnicity	Māori	45,068	610,320	7.4	6.9	3.1	0.3
	Pacific	46,891	329,880	14.2	14.2	3.9	0.5
	Asian	67,332	705,120	9.5	6.8	4.5	−0.3
	European	121,778	1,907,560	6.4	3.4	1.6	0.5
Females	All females	247,055	2,963,760	8.3	5.0	2.6	1.2
Total ethnicity	Māori	53,078	611,960	8.7	7.6	3.6	0.9
	Pacific	58,381	324,600	18	17.3	4.3	1.1
	Asian	69,049	712,860	9.7	6.4	4.9	0.4
	European	112,939	1,954,980	5.8	3.2	1.8	1.0
		Using existing 2006–2009 data					
		Projected				**AAPC**	
		2040–2044					
		Cases (n)	**Pop. (n)**	**Crude (%)**	**ASR (%)**	**People (%)**	**ASR (%)**
Total	All	506,437	5,890,600	8.6	4.9	2.6	0.9
Males	All males	257,893	2,926,840	8.8	5.0	2.5	0.7
Total ethnicity	Māori	42,776	610,320	7	6.5	2.9	0.0
	Pacific	48,654	329,880	14.7	14.8	4.1	0.7
	Asian	72,798	705,120	10.3	7.3	4.9	0.0
	European	122,750	1,907,560	6.4	3.2	1.7	0.3

Appendix Table 2 (continued): The projected diabetes prevalence (2040–2044) found when using a linear extrapolation ("back-estimation") of 2010–2014 and 2015–2019 Virtual Diabetes Register (VDR) data to determine historical diabetes prevalence for the 2006–2009 period (top), compared to projections made using actual 2006–2009 VDR data. The projected number of cases is practically identical between the two methods; for example, using the existing 2006–2009 VDR data marginally increased the number of projected diabetes cases compared to the back-estimation method by 0.8% or 4,079 cases in total (out of 502,358 projected cases using the back-estimation method).

Females	All females	247,422	2,963,760	8.3	4.9	2.7	1.2
Total ethnicity	Māori	51,838	611,960	8.5	7.4	3.5	0.7
	Pacific	57,831	324,600	17.8	17.1	4.3	1.1
	Asian	69,286	712,860	9.7	6.3	5	0.4
	European	111,554	1,954,980	5.7	3.0	1.8	0.8

AAPC = average annual percentage changes; ASR = age-standardised prevalence rate.

Prevalence, impact and management strategies for dysmenorrhea in Aotearoa New Zealand: a scoping review

Melissa Black, Blake Perry, Michaela Walton, Alex Semprini, Mike Armour

ABSTRACT

BACKGROUND AND AIM: Dysmenorrhea affects the majority of young women worldwide, but geographical and cultural differences can influence the reporting, impact and management of symptoms. Aotearoa New Zealand is a culturally diverse country, with a high proportion of Māori and Pacific peoples. The aim of this scoping review was to assess the current literature on the prevalence, impact and management strategies for dysmenorrhea in Aotearoa New Zealand.

METHOD: The Joanna Briggs Institute (JBI) scoping review methodology was used to systematically map the evidence of prevalence, severity and symptoms, impact and management strategies for dysmenorrhea in Aotearoa New Zealand. Eight electronic databases were searched in August 2024.

RESULTS: Ten studies met the inclusion criteria. Our findings show that the current data for the prevalence, impact and management strategies for dysmenorrhea in Aotearoa New Zealand are both limited and outdated.

CONCLUSION: The results from this scoping review highlight the need for updated data on dysmenorrhea in Aotearoa New Zealand, with particular focus on Māori and Pacific peoples, and geographical diversity.

Dysmenorrhea affects the majority of women and those who menstruate under the age of 25 years, with prevalence estimated at 71% worldwide[1] and 92% in Australia.[2] Primary dysmenorrhea is the most common cause of dysmenorrhea, defined as painful uterine cramps of menstrual origin in the absence of underlying pelvic pathology.[3] Conversely, secondary dysmenorrhea is associated with an identifiable pelvic pathology, with endometriosis being the single most common cause.[4]

Dysmenorrhea has been shown to impact many aspects of an affected woman's life, including school/university/work absenteeism and reduction in participation in sporting or social activities, as well as overall physical and mental health.[1,2,5] Dysmenorrhea is often managed with analgesic drugs and/or the oral contraceptive pill (OCP). However, differences in management strategies have been observed between high-income and low-middle-income countries, with significantly higher OCP use in high-income countries.[6] Differences in dysmenorrhea management strategies may be influenced by geographical discrepancies in menstrual health education and literacy,[7] as well as access to, and quality of, healthcare services. Similarly, religious beliefs and/or cultural values can influence the reporting of menstrual symptoms, their impact on an affected person's life and the utilisation of treatment strategies.[6,8] Many factors may underpin these differences, including cultural taboos around menstruation, and knowledge and education on dysmenorrhea.[6]

Aotearoa New Zealand is a culturally diverse country with a high proportion of Māori (18% of total population) and Pacific peoples (8% of total population), who experience a higher burden of disease compared with their non-Māori and non-Pacific counterparts.[9] Specifically, Māori and Pacific peoples are at greater risk of metabolic, cardiovascular and reproductive disorders,[9] and have less engagement with healthcare services and higher rates of unmet needs.[10,11] The recently released *Women's Health Strategy*[12] by the New Zealand Ministry of Health underpins the importance of improving health equity and achieving equitable health outcomes for Māori and Pacific peoples, with disease services, pathways and treatments based on evidence from high-quality research. It is currently unclear as to how geographical and cultural differences in a New Zealand context may influence the prevalence,

impact and management of dysmenorrhea.

This scoping review aims to assess the literature on the prevalence, impact and management strategies for dysmenorrhea among New Zealand women and those who menstruate. This review of the available literature will identify research gaps and highlight the need for any future research to help inform appropriate education, management and treatment of dysmenorrhea in a New Zealand context.

Methods

Research question

The research question for this scoping review was "What evidence is available on the prevalence, impact and management strategies for dysmenorrhea in New Zealand women?". The researchers' original research question was focussed solely on primary dysmenorrhea; however, pilot testing of the search strategy returned a paucity of research. As such, the search strategy was amended and widened to include women with dysmenorrhea in New Zealand.

Study design

A scoping review was selected to answer the research question, and the Joanna Briggs Institute (JBI) scoping review methodology[13] was followed. The inclusion criteria consisted of women with dysmenorrhea in New Zealand, while papers that reported only secondary dysmenorrhea and/or chronic pelvic pain were excluded to remain aligned with the original research question. The key outcomes included prevalence of dysmenorrhea in New Zealand; severity and symptoms of dysmenorrhea; impact of dysmenorrhea; management/treatment strategies and their perceived effectiveness. It was expected that the results from this scoping review would elucidate the insufficient research in this area and highlight the need for further research.

Search strategy

A search strategy was designed, including key search terms (Table 1), which was adapted for each database. Eight electronic databases (PubMed, Web of Science, Cochrane Library, Scopus, EMBASE, CINAHL, PsycINFO, AMED) were systematically searched in February 2023 and again in August 2024 to ensure any recent research was included. The reference lists of included records were screened for additional studies.

We included all available literature published since 1980, including case reports, randomised controlled trials and reviews.

Research selection

All identified citations were uploaded into Mendeley Desktop 1.19.8 (Elsevier, Mendeley Ltd) and duplicates were manually removed. Two members of the research team independently screened the titles and abstracts of all citations, assessing them against the pre-specified inclusion and exclusion criteria. The full text of included citations were independently assessed by two members of the research team to identify research to be included in the scoping review. Any conflicts for inclusion/exclusion of citations during the title/abstract screening and full text review was discussed with the two researchers and one other member of the research team if a consensus was not achieved. The results of the search process are presented in a Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for Scoping Reviews (PRISMA-ScR) flow diagram[14] (Figure 1).

Data extraction

Data was extracted from the included papers independently by two of the research team and compared upon completion. Discrepancies were discussed and conflicts were resolved with a third member of the research team if required. Data on the study characteristics (design, location, participant description and demographics) and each of the following outcome measures was extracted from all papers, if available:

1. Prevalence of dysmenorrhea in New Zealand
2. Severity and symptoms of dysmenorrhea
3. Impact of dysmenorrhea
4. Management or treatment strategies
5. Perceived effectiveness of management or treatment strategies.

Results

Searches were performed on 16 August 2024 and the flow of studies through the selection process is illustrated in Figure 1. Ten papers met the inclusion and exclusion criteria and were included in the scoping review.

Study participants

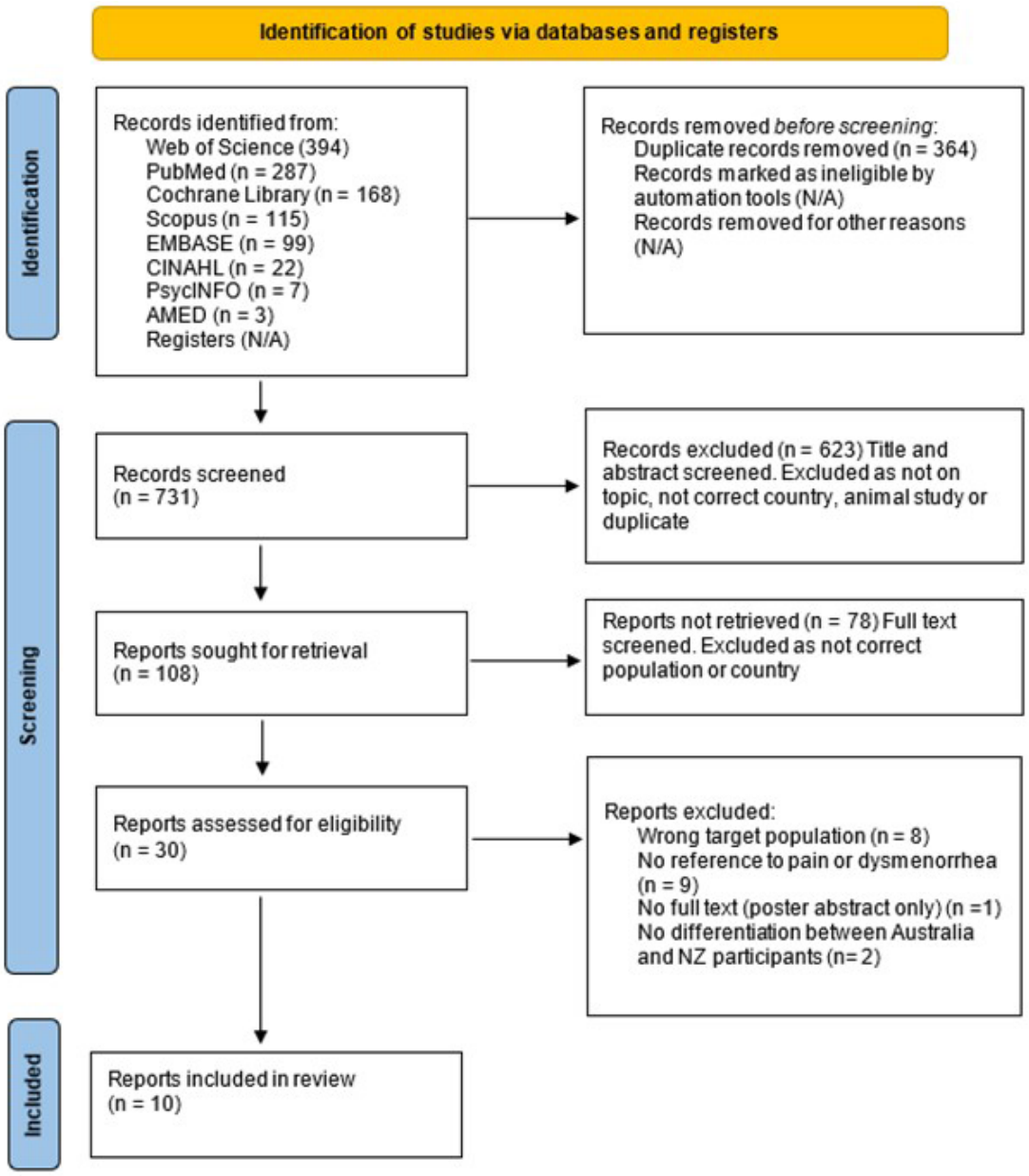
Table 2 gives an overview of the study participants in the included studies. Across the

Table 1: Search terms.

Dysmenorrhea in New Zealand				**Prevalence, impact and treatment**				
Dysmenorrh* “Menstrual pain” “Painful menst*” “Period pain” “Menstrual cycle”	AND	“New Zealand” NZ Aotearoa	AND	Prevalence	OR	Impact Symptom Affect Consequence Risk Well-being School Academic University Social Family Relationship Sleep Sport Exercise “Physical activity” Extracurricular Professional Employment Stress Anxiety “Mental health” “Quality of life”	OR	Treat* Manage* Self-care Hormonal “Oral contraceptive pill” “Non-steroidal anti-inflammatory drugs” “Electrical stimulation” Lifestyle Breathing Meditation Yoga Acupuncture Acupressure Massage Aromatherapy Mindfulness

*Truncation of root term in literature search.

Figure 1: PRISMA flow diagram of search screening results for a scoping review.



10 studies there are a total of 4,300 participants; however, some participant data were reported in multiple studies.[15,16,21,22] After deduplication, 3,277 individual participants were included. The participants ages' range from 13–54 years old, and include 3,123 women from the general population[15–19,23] and 154 participants with suspected or confirmed primary dysmenorrhea.[20–22,24] Four studies did not report ethnicity,[15,16,21,22] while two studies only reported the percentage of European participants and did not specify the ethnic categories for the remaining participants.[20,23] Of the remaining four studies, NZ European was the highest proportion of participants in all studies, followed by Māori (Table 2). Only two studies included (or reported on) Pacific peoples in their research.[19,24]

Study characteristics

The publication date of the included studies ranged from 1988 through to 2019 and consisted of a mixture of quantitative and qualitative study designs. No single study reported on all five outcomes.

Table 2: Study characteristic and reported outcomes from the studies (n = 10) included in this scoping review.

Study characteristics			**Participant characteristics**				**Outcomes**
	Study type	Study design	Number of participants	Participant age (years)	Participant description	Ethnicities reported	Outcomes reported on
Pullon et al. 1988[15] Reinken et al. 1990[16]	Quantitative	Cross-sectional Telephone questionnaire	1,456	16–54	Currently menstruating women recruited from a population of women who attended New Zealand general practice surgeries in Wellington in 1985	Not stated	1. Prevalence 2. Severity/symptoms 3. Impact
Grace, Zondervan 2004,[17] 2006[18]	Quantitative	Cross-sectional Random sample survey	1,160	18–50	Random sample of women from the electoral roll	European (83%) Māori (10%) Other (7%)	1. Prevalence 2. Severity/symptoms 3. Impact 4. Management/treatment
Farquhar et al. 2009[19]	Quantitative	Cross-sectional Pilot survey	78	16	School students from four secondary schools in Auckland	NZ European (19%) Māori (16%) Samoan (13%) Cook Island Māori (13%) Tongan (1%) Chinese (3%) Indian (1%) Other (8%) No data (26%)	1. Prevalence 2. Severity/symptoms 3. Impact 4. Management/treatment

Table 2 (continued): Study characteristic and reported outcomes from the studies (n = 10) included in this scoping review.

Kannan et al. 2015[20]	Quantitative	Feasibility for RCT (Aerobic exercise intervention)	10	21–44	Women with self-reported PD, and menstrual pain scoring at least 4 on 10cm VAS for at least 2 consecutive months	NZ European (50%) Not stated (50%)	2. Severity/symptoms 4. Management/treatment 5. Perceived effectiveness
Armour et al. 2017[21]	Quantitative	RCT (TCM acupuncture intervention)	74	18–45	Confirmed or suspected PD	Not stated	2. Severity/symptoms 4. Management/treatment 5. Perceived effectiveness
Armour et al. 2016[22]	Qualitative	Focus groups and semi-structured interviews	12	18–45	Small sample from Armour et al. 2017 RCT	Not stated	5. Perceived effectiveness
Righarts et al. 2018[23]	Quantitative	Longitudinal cohort study questionnaire	429	13–38	Women from the Dunedin Multidisciplinary Health and Development Study	NZ European (92%) Not stated (8%)	1. Prevalence 2. Severity/symptoms
Kannan et al. 2019[24]	Quantitative	RCT (Aerobic exercise intervention)	70	18–43	Women with confirmed PD	Reported in another publication:[25] NZ European (40%) Māori (1%) Pacific peoples (6%) Asian (49%) African (4%)	2. Severity/symptoms 4. Management/treatment 5. Perceived effectiveness

PD = primary dysmenorrhea; RCT = randomised controlled trial; TCM = traditional Chinese medicine.

Study outcomes

1. Prevalence of dysmenorrhea in New Zealand

Five of the included studies reported on prevalence of dysmenorrhea in New Zealand, incorporating four sets of unique participants. The reported dysmenorrhea prevalence observed in the cross-sectional studies was 53%,[15] with 33% reporting pain in their most recent menstrual cycle;[16] 55.2% and 66.5% reporting pain in the previous 3- or 12-months, respectively;[17] and 90% reporting sometimes or always having pain with their period.[19] Using a longitudinal cohort study, Righarts et al. 2018[23] reported that 57.6%, 68.9% and 46.3% of menstruating women at the ages of 13, 15 and 38 years, respectively, experienced dysmenorrhea in the previous 12-months. Among the 46.3% of women at the age of 38 years experiencing dysmenorrhea, this was divided into 28.1% primary and 18.1% secondary dysmenorrhea. Age-related differences were only compared in two studies,[15,17] with the highest rates of dysmenorrhea in the younger age groups (18–25 years), compared to >25 years. One study reported on ethnic differences for the prevalence of dysmenorrhea,[17] where NZ European women had a statistically significant higher rate (56.8%) of 3-month prevalence compared to Māori women (48.1%). However, after the authors adjusted for age, the difference between ethnic groups was no longer statistically significant.

2. Severity and symptoms of dysmenorrhea

Seven studies reported on severity and symptoms of dysmenorrhea. Studies involving an intervention reported average baseline dysmenorrhea pain scores as 7.7[20] using a 10cm Visual Analogue Scale (VAS), 2.7[21] and 6.5–6.8[24] on the 0–10 Numeric Rating Scale (NRS), with 0 being no pain and 10 being the worst pain imaginable. Peak pain or pain intensity was reported by two interventional studies at baseline, with a score of 5.1[21] on the 0–10 NRS, and 59.8 and 58.8[24] on the 0–100mm VAS for the intervention and control group, respectively. Across the observational studies, dysmenorrhea pain was described as moderate or severe for 51.4% using a verbal rating scale, and 40.3%[17] using a 10cm VAS; 32%[19] using a multidimensional scoring system; and 32.1%[23] (severity scale used not reported) of included women. One study[15] included the timing and duration of pain, with over half of women having pain both before and during menstruation, while 36% and 12% of women reporting pain that lasts 2, or 3 or more days, respectively.

3. Impact of dysmenorrhea

The impact of dysmenorrhea on New Zealand women was the outcome least frequently reported, with only three studies including dysmenorrhea impact details or data. From these studies, 12% of surveyed women have experienced dysmenorrhea discomfort severe enough to warrant time off work or school,[15] while 46% stated that their pain affected their everyday activities, with specific limitations in mobility and doing housework without having to use analgesics.[18] Farquhar et al. 2009[19] surveyed school-aged participants about the impact of their period pain on daily activities, with 45% reporting that their bleeding and period pain restricted their physical activities, while 17% reported limited school work and social activities, and 26% had missed school because of bleeding and/or pain. Half of all the high school-age study participants reported disturbed sleep during their menstrual cycle;[19] however, it is unclear if this is due to pain or other associated symptoms.

4. Management or treatment strategies

Two observational studies provided detail on the management or treatment of dysmenorrhea among their study participants: 10% of the 1,160 participants from the random sample survey had consulted with a general practitioner in the previous 12-months for their dysmenorrhea, and 2.9% had consulted with a specialist.[17] Of the 75 high school-aged participants, 41% had purchased over-the-counter medication for their dysmenorrhea in the previous 6-months, and 30% had consulted a healthcare professional (including the school nurse).[19]

Within the included texts, there were three studies in which the participants underwent an intervention aimed at reducing dysmenorrhea-related pain: aerobic treadmill exercise three times per week for 3–4 weeks, with an additional 4-weeks[20] or 6-months[24] of unsupervised training at home; and traditional Chinese medicine (TCM) acupuncture treatment over the course of three menstrual cycles.[21] Of the three interventional studies only one included a control group[24] for comparison against standard care.

5. Perceived effectiveness of management/ treatment strategies

All study interventions (aerobic exercise and TCM) resulted in a reduction in dysmenorrhea-related pain. Armour et al. 2017[21] observed a significant reduction in peak abdominal pain and a reduction in analgesic use in all four

acupuncture groups (a combination of high [HF] and low [LF] frequency, and manual [MA] and electro [EA] acupuncture). Peak pain was measured on a 0–10 NRS during the first 3 days of menses at the 12-month follow-up, with no difference observed between the groups; pre to post mean (95% CI) HF-MA: 4.4 (3.4–5.5) to 2.9 (1.8–4.0), HF-EA: 5.7 (4.7–6.8) to 4.2 (3.1–5.2), LF-MA: 5.5 (4.5–6.5) to 4.0 (3.0–4.9), LF-EA: 5.0 (3.9–6.0) to 4.2 (3.2–5.3). A subset of 12 participants from the acupuncture randomised controlled trial (RCT) took part in focus groups and semi-structured interviews to examine the impact of the TCM acupuncture treatment.[22] The subset of participants rated their perceived effectiveness of the treatment on a 0–10 NRS, with eight of twelve participants scoring >5/10 and were therefore classified as a responder. A key overarching theme that emerged from the focus groups and interviews was that the TCM acupuncture was "more than needles" and the participating women reported a benefit from the patient–practitioner relationship and the self-care advice delivered through the TCM framework. While a feasibility study investigating the 8-week exercise intervention (4-weeks in clinic and 4-weeks at home)[20] was not sufficiently powered to detect a statistically significant change in menstrual pain quality and intensity, the reductions in the dysmenorrhea pain intensity on a 0–100mm VAS from 71.7±16.4 (mean±SD) to 51.5±18.1 at 4-weeks and 35.8±19.3 at 8-weeks informed the development of the larger cohort RCT.[24] As such, the RCT demonstrated statistically significant benefits of exercise for reducing dysmenorrhea pain intensity on a 0–100mm VAS from 59.8±14.2 (mean±SD) at baseline to 54.1±11.8 at 1-month, 39.2±7.9 at 4-months and 38.1±6.8 at 7-months, as well as improving quality of life (mental and physical) at 4- and 7-months versus the control group.[24]

Discussion

Our scoping review found a paucity of contemporary evidence on the prevalence, impact and management of dysmenorrhea among women in New Zealand, and also reveals the lack of ethnic diversity within the cohorts, which do not accurately reflect the current demographic within New Zealand. Of the 3,277 study participants included in this review, <4% were reported as Māori and <1% as Pacific peoples—far below nationally representative levels; in addition, the actual number of Māori and Pacific participants remains unclear due to the majority of studies not reporting ethnic groups beyond NZ European. No studies included data on the geographical location of participants within New Zealand.

With the exception of the study by Farquhar et al. 2009,[19] who reported 90% prevalence of dysmenorrhea among their high school-age participants, the prevalence data described in this scoping review (33–69%) is lower compared to previously reported global (71%)[1] and Australian (92%)[2] dysmenorrhea prevalence. Variances in survey and interview question phrasing may contribute to differences in prevalence levels between studies. Moreover, the wide age range of participants included in this scoping review may contribute to the lower prevalence, with younger age often being associated with higher prevalence.[26] Grace and Zondervan 2004[17] were the only authors to compare ethnic differences for prevalence of dysmenorrhea, observing no difference after adjusting for age. The heterogeneity among the recall period for dysmenorrhea makes comparison between studies difficult, with some reporting pain in the most recent menstrual cycle,[16] while others reporting prevalence in the past 3-, 6-, or 12-months,[17,23] and some not stating the recall time.[15,19] Importantly, the studies with the largest sample size collected their data 39[15,16] and 23[17,18] years ago, respectively, and given the shift in prioritisation of women's health in New Zealand[12] the relevance of this data to present-day is unknown.

Dysmenorrhea symptoms and severity were reported in interventional and observational studies. As expected, the reported dysmenorrhea for those participants in the interventional studies is more severe than that reported in the observational studies, due to the specific target population and inclusion/exclusion criteria. The lack of data and the heterogeneity among the participants' age and the symptom severity tools/scales used in the observational studies make it difficult to draw any conclusions about the severity and symptoms of dysmenorrhea in New Zealand, and impossible to draw comparisons between ethnic groups. Of the small number of studies that have reported dysmenorrhea impact, it appears that the pain is sufficient to physically limit almost half of affected individuals and occasionally severe enough to cause time off work or school for between 12–26% of women,[15,19] similar to the 20.1% reporting absence from school or university due to dysmenorrhea in a previous systematic review.[1] Menstrual pain-related academic absentees

and physical, social and emotional impairments can have negative effects on an affected individuals' life course potential.[27] Greater understanding around dysmenorrhea and its impact on the different aspects of an affected person's life is required to further improve awareness and education in a New Zealand context to reduce the potential life burden.

The included observational studies yield little information regarding management or treatment of dysmenorrhea and their perceived effectiveness. Grace and Zondervan 2004[17] state that 10% of their sample had consulted with a general practitioner, and 2.9% with a specialist for their dysmenorrhea in the past 12-months, but do not detail the treatment strategies suggested or prescribed. Similarly, Farquhar et al. 2009[19] comment on over-the-counter medication use by students; however, the types of medication were not described, nor was their effectiveness at reducing dysmenorrhea. Previous research has found that self-care strategies such as analgesic use, exercise and heat application for managing dysmenorrhea are common, with the minority of affected individuals seeking medical intervention.[6] Given the current general practice workforce crisis in New Zealand,[28] in combination with higher costs of living, access to sexual and reproductive healthcare services is suboptimal.[29] It is unclear from previous research how ethnic and geographical differences observed in a New Zealand context may impact health literacy, access and willingness to visit healthcare services for dysmenorrhea. Additionally, the COVID-19 pandemic has also changed the landscape of healthcare within New Zealand, with longer wait times and a reduction in access to primary and secondary care.[30] Provided the aforementioned points, the relevance of previously collected dysmenorrhea impact and treatment data to present day is unknown; therefore, it is crucial to obtain more recent data on the unmet needs of those with dysmenorrhea in New Zealand.

The interventional studies included in this review are disparate in nature. While both interventions employed were effective for improving dysmenorrhea for New Zealand women, any comparisons between the studies are difficult due to the different interventions and lack of comparison to an appropriate control group.

Conclusions and future recommendations

The current available data on the prevalence, impact and management strategies for dysmenorrhea in New Zealand women is limited and out-of-date. This scoping review has highlighted the need for future research to update these data and encompass a range of ethnic groups, including Māori and Pacific peoples, as well as different geographical regions. This up-to-date data will quantify the current impact of dysmenorrhea among New Zealand women to inform appropriate development and implementation of treatment strategies.

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Principles for embedding learning and adaptation into New Zealand health system functioning: the example of the Viable System Model

Sharen Paine, Jeff Foote, Robin Gauld

ABSTRACT

This article makes the case for taking a model-based management approach, specifically using the Viable System Model (VSM), to embed learning and adaptation into the New Zealand health system so it can function as a learning health system. We draw on a case study of a specialist clinical service where the VSM was used to guide semi-structured interviews and workshops with clinicians and managers and to guide analysis of the findings. The VSM analysis revealed a lack of clarity of organisational functioning, and of the systems, processes and integrated IT infrastructure necessary to support the fundamental requirements of a learning health system. We conclude that model-based management, specifically using the VSM, has significant potential for embedding the requirements for a learning health system into core functioning, including identifying technology infrastructure requirements. In addition, the VSM holds promise for improving clinical engagement and enhancing the health system's ability to achieve financial sustainability, high performance, distributed decision making and efficiency.

The New Zealand health system is large, complex and subject to ongoing change.[1] To be viable over the long term, as for any system, our health system must take a consistent, continuous approach to learning.[2] Learning, defined here as how the system identifies, adopts and embeds organisational improvement and innovation, must sit alongside and enable other health system goals such as financial sustainability, high performance, distributed decision making, clinical engagement and efficiency.

In New Zealand, we are good at crafting health system strategies with ambitious goals, but we struggle with implementation and evaluation.[1] Further, we seldom recognise the interconnectedness between goals because we lack a deep understanding of the health system's functioning. Keeping up with the changes triggered by technological advancements, raising public expectations and the pressure to contain costs in such an interconnected system points to the need for organisations that can rapidly learn and adapt.[2]

Almost daily reports in the media remind us that our health system faces significant challenges. These include, but are not limited to, poor financial performance and an inability to clearly articulate the financial position; staffing shortages and low staff morale; old or insufficient infrastructure—both physical and technological; long waitlists, especially for surgery and mental health services; and emergency departments struggling to manage volumes. These issues are exacerbated by Health New Zealand – Te Whatu Ora's lack of a clearly articulated operating model for over 2 years since its establishment in mid-2022. The current (2024) drive for "efficiency" is centred on removing support staff, but this does not address underlying issues. It will reduce costs in the short term and increase pressure on staff. An effective, high-performing health system must be designed to enable efficiency without "sweating the asset"—that is, the staff.

There is demand for an approach to organising health system functioning to achieve its goals and establish it as a learning health system, or at least to enable us to understand why we cannot make sustained progress. An approach that has significant potential and is grounded in systems thinking is model-based management, specifically utilising the Viable System Model (VSM). The VSM is theoretically robust and has elsewhere[3] demostrated its usefulness in understanding the health system and service dysfunction.

What is a learning health system and why is it necessary?

A learning health system ensures people are supported by technology, and enables learning cycles for improvement through an underlying information infrastructure[4] (see Table 1). Such a system is "*Informed by evidence and actionable data in 'real-time' and creates the foundations of a system capable of meeting systems-wide, clinically oriented, and patient-relevant delivery targets.*"[4] Most importantly, it is a dynamic system that assesses, reviews and improves its performance.

A learning health system requires strong feedback loops.[5] Feedback loops provide information about system behaviour and performance and can prompt action. For example, current information indicates that our waiting lists have built up and wait times have extended.[6] What action must we take to address this and restore acceptable wait times over the long term? To fully leverage the lessons learnt from experience, we can no longer rely upon quick fixes that are project-based and *ad hoc*, and do not reflect the underlying causes of problems.[7] A learning organisation must have the systems and processes (including training) to enable lessons to be embedded in the system for the future, not simply to address the present,[8] and these must be supported by an underlying information infrastructure.[4] Therefore, the aim of being a learning organisation cannot be separated from operational management, including evidence-based, fit-for-purpose delivery models.[4] To embed our learning into the organisation's functioning, we must first understand that functioning. Comprehensive systems models are essential if we are to achieve this.[4] Further, model-based management would support our system to become resilient (to recover quickly from shocks) and preferably ultra-stable. Resilient systems stay the same after recovering from a shock; ultra-stable systems improve.[9]

The need for and benefits of a model

It is not possible for individual managers to maintain a full understanding of health system functioning, especially where each would likely have a different understanding based on their experiences, so a more formal, model-based approach is essential.[4] Model-based management is critical

Table 1: Key characteristics of a learning health system.

Clear standards of service delivery, both operational and clinical, to make sure we are managing patients/consumers through the process of healthcare service delivery effectively (where the patient/consumer is an active participant in their care and we are respectful of their time), as well as ensuring the clinical care provided is of the expected quality.
Timely assessment of non-adherence to standards (through feedback loops).
Communication processes that ensure prompt action can be taken in response to identified issues.
Clear operational management processes into which improvements can be embedded (resilience).
Training in new processes to support understanding and consistency of delivery.
Methods of monitoring known demand and changes in the environment that can alert us to issues (e.g., a disease outbreak) or opportunities arising (e.g., from research) so that we can prepare for them (ultra-stability).
Ad hoc monitoring processes to identify issues not captured by regular monitoring.
Processes for enabling issues or opportunities for improvement to be identified anywhere in the system at any time by anyone, and for potential solutions to be assessed/implemented.
Processes for the promulgation of lessons/innovations/improvements throughout the system.
Underlying information infrastructure designed to provide real- or near real-time data to support decision making. Data must be transformed into information that is accurate, timely, complete and relevant to the decisions that must be made, and presented in a digestible form to the receiver.

for enhancing a manager's understanding of the system they manage and making their efforts more effective.[10] Model-based management is where an organisation's management is supported by formal models, which are abstract representations of concrete systems, which must be of good quality, and are crucial for the management process to attain results.[10] In health, therefore, we need a model that is well-suited to large and complex organisations, and that is capable of learning and adaptation.

The VSM is a good candidate for this task and is well-tested and researched. The VSM has been used widely; for example, in sustainable business,[11] local government,[12] family violence prevention[13] and combatting transnational crime.[14] The VSM has increasingly been applied to health system settings to better understand and improve health system functioning, including to in-hospital residential treatment for stroke patients in Australia,[15] to assess Switzerland's pandemic response,[16] to establish an Austrian regional oncology service[17] and to find the source of systemic dysfunction in the orthopaedic department of a Norwegian hospital.[18]

The VSM

The VSM (see Table 2) describes the necessary and sufficient functions (sub-systems) and information flows required to set up the system for viability. Viability refers to the long-term survival of a system within its environment. The "system" refers to formal organisations as well as other forms of systems, such as bee colonies, and may be the whole health system, or any part of it. The model's structure is the same throughout the system/organisation. That is, it applies to the system/organisation as a whole, and to, say, a hospital, department or clinical service.

Table 2: Key characteristics of the Viable System Model (VSM).[19]

According to the VSM, a viable organisation must include five sub-systems. The VSM is recursive (where each level contains all the levels below it). Viability requires each sub-system to be present, of good quality and in balance, along with communication and control channels, at each level of the system/organisation. The recursive nature of the VSM enables the management of complexity. Each lower level manages a smaller scope but in greater detail. Each lower level has autonomy to manage its operations within agreed controls, enabling decisions to be made closer to their source. This reduces bureaucracy. The sub-systems represent functions, not positions, in an organisation chart. Some functions may be carried out by the same person or people. The sub-systems are:
System 5: Governance/purpose—establishes the organisation's purpose, identity, culture and values and ensures mechanisms are in place for the effective functioning of the entire organisation (i.e., for that level and its lower levels).
System 4: Planning/adaptation—considers the external environment for both known and unknown futures and includes links out to research. As the environment is ever-changing, this function is essential for the organisation to adapt.
System 3: Management control—manages the stability of the organisation, and brings together operational management, personnel, finance, IT and infrastructure to, for example, deliver to the current plan; and **3*:** Audit and monitoring—monitors the performance of the operational units (System 1s) against the targets System 3 has set, ensuring the rules and regulations promoted by System 2 are being followed.
System 2: Coordination—coordinates the necessary resources across System 1s to ensure that they function harmoniously and promote the rules and regulations set by System 3.
System 1: Operations—concerned with implementation, with doing what the organisation exists to do, so what happens here is what matters.
Absorbing lessons learnt and necessary change System 3 will absorb changes that can be made within the current resourcing. System 4 will consider more significant changes. Plans for significant change must consider the capacity and capabilities of the organisation and its ability to absorb the change. When Systems 3 and 4 cannot agree, System 5 will intervene to help resolve the issue.

This provides a common language for describing and understanding the organisation's functioning across the organisation. Once an organisation or service has a clear understanding of its purpose, it can be critiqued and designed using the VSM to achieve that purpose.

The VSM is a model for organisational structure and information flows, not content,[20] which must be determined by those managing the organisation. It is a model for both diagnosis and design.[21,22] A VSM diagnosis will identify where necessary system elements (sub-systems and communication channels) are absent or inadequate.[19] This then informs the design of the system as a learning system by indicating what must be included, but not the specific content. For example, the VSM indicates that managers at each level must have the information they need to make the decisions they are charged with (e.g., what mix of clinic types should we run), but it does not specify what that information is (e.g., what clinic types do we have and what is the demand for each given the clinical needs of our current patient population).

There is freedom to determine the specifics of organisation or service functioning within the model as long as all sub-systems and communication flows are present and functioning adequately. The VSM requires us to clearly articulate what the organisation does and how it does it. It focusses on delivering services to consumers and expressly caters to local differences within a common national strategy. The model requires us to define what services we deliver and to develop clarity and transparency about service provision (including standards of quality for consistency and equitable care delivery), demand, capacity, resource requirements, constraints, cost and value. We then have the detailed awareness and understanding of the system's functioning required to plan, fund, resource, manage, support, coordinate, deliver and track service delivery, as well as to learn/adapt over time.

The VSM not only identifies the sub-systems and communication channels required but also clarifies their relationship to each other and their environment. By applying the VSM, these aspects—necessary for a learning health system—can be *identified and integrated* into a functioning system. Of particular note is that System 2 (coordination) is a necessary function in its own right,[23] and is often absent.[19]

While focussing on service delivery, the model fully recognises the need for management and support services. The VSM drives the alignment of the efforts of support services (e.g., people and capability, information technology and finance) with each other, and, most importantly, with the operational delivery requirements. As the VSM drives a clearer, more accurate and complete understanding of service delivery mechanisms and support service needs, it supports a more precise definition of data and IT system requirements.

A key focus of the VSM is that it is a learning system. It is managed through feedback loops designed into the system to provide timely, accurate, complete and relevant information to support decision making. Firstly, through well-specified services, processes and standards, which are monitored both continuously from data capture and through regular and *ad hoc* audit processes, each level of the organisation would have the information it needs to identify where service delivery improvements can or must be made. The model embeds into the core system functioning the processes required for learning and adaptation. These are continuous processes that occur as part of everyday functioning and support improved efficiency, effectiveness, consistency and quality of service provision. Secondly, each level of the organisation would maintain awareness of, and adapt to, changes in its environment. For example, as treatments and technology advance there may be more services that can be provided in the community and/or by lower-skilled clinicians. With a clear understanding of its own functioning at any time, the organisation/service could adapt quickly. This differs from the common situation where the understanding of current functioning is vague. We note that before being implemented, any identified learning or adaptation opportunity must be assessed in relation to purpose and to whether it is ethical, leads to equitable outcomes, builds the resilience and sustainability of the system and does not marginalise or exclude stakeholders including Māori as Te Tiriti partners.[24]

A large complex organisation that relies on central control quickly becomes mired in bureaucracy and ceases to function effectively. The VSM addresses this problem by distributing the management of complexity and the decision making throughout the organisation in a nested structure of operational areas (e.g., a region, hospital, surgical service or clinical specialty such as ophthalmology). Every level of the system (organisation) contains all of the levels below it, and each level is responsible for setting up the conditions for all of its (nested) lower levels to be

successful. This means there is a collective responsibility for service delivery. Each lower level is responsible for, and understands, a smaller scope but in greater detail.

The VSM specifically facilitates local autonomy consistent with overall system coherence and cohesion. It achieves this through "communication and control" rather than "command and control". In other words, it allows for some decisions to be made centrally (e.g., do we need a new hospital), regionally (e.g., how do we organise our surgical services across the South Island) or locally (e.g., how can we best manage our specialist service delivery to meet local demand). Each part of the organisation, at each level, would have the information it needs to make the decisions that are relevant at that level and for the services it provides. Problems and system weaknesses could, therefore, be addressed closer to their source—providing a faster response, reducing bureaucracy and improving motivation and engagement throughout the system by activating systemic leadership of both clinicians and managers.

Key to the model's functioning are two-way information flows throughout the system. These information flows and their associated processes (e.g., resource/performance bargaining) address issues such as the *agreement* between organisation levels of both the resources required to deliver services and the performance measures that will track service delivery. Then, as necessary or as possible changes are identified, the resource/performance bargaining process would be undertaken again to allow understanding, agreement and adaptation to continue—to fulfil the purpose of the organisation/service. Without careful design and management, two-way information flows can take on various characteristics that may not necessarily support achievement of the purpose. The VSM's structure is such that interpenetration of the levels (i.e., where the managers of System 1s are members of the management team of the next level up) can support greater understanding of conflicting priorities and a more collaborative approach to achieving the overall system purpose. The VSM helps to surface issues but still relies on good managers to work these through to a resolution. System 3 (management control) can develop criteria for quality information (e.g., not leading to conflict or sub-optimisation), which are then put into practice by System 2 (coordination). Conflict resolution mechanisms can be established within System 4 (planning/adaptation, including intelligence), and may need to embody double loop learning to assess adaptive or less adaptive information flows. System 3* (audit/monitoring) will periodically audit the quality of information flows. We note that, while models are useful, they are not a panacea against all issues an organisation may face and will only be useful if utilised by well-trained managers.[17] Further, strong clinical leadership alongside competent managers at all levels of the organisation are essential for developing and implementing high-performing, quality healthcare services.[25] It is assumed, therefore, that at each level of the organisation, in each clinical service, there is a clinician/manager pair responsible for defining the service's purpose and setting it up to function to achieve that purpose in line with the aims of clinical governance.

Method

Our study adopted a case study methodology and was undertaken in 2020–2022 during the COVID-19 pandemic and the latest health system reforms.[26] The case study was of a high-volume clinical service and used insights from cybernetics and the VSM to address health system disconnects between governance, management and operations. The service was a specialist ophthalmology service within a large metropolitan public hospital (serving approximately 500,000 people) facing various governance, managerial and operational challenges.

The VSM was used to structure data collection and analysis through two rounds of inquiry to identify the organisational shortcomings facing the ophthalmology service, and their structural underpinnings. See Paine 2023[21] for how the analysis of organisational pathologies (functional deficiencies) was then used to develop a VSM-inspired management framework.

Eighteen participants were involved in the study, providing a variety of perspectives on health system functioning such as policy, management or data analytics, with most participants holding senior policy, clinical and managerial positions. The first round of inquiry involved interviews and workshops with fourteen participants about the challenges facing the specialist service (including interviews with six health reform leaders and one health system academic). The second round of inquiry involved interviews and workshops with five health reform leaders and nine specialist service managers and clinicians to refine a VSM diagnosis. Most participants were involved in both

rounds of inquiry. For both rounds, the interviews and workshop discussions were audio recorded and transcribed. Transcripts were imported into NVivo12®, a computer-assisted qualitative analysis programme. The data were analysed thematically using the constant comparative method to identify codes and develop themes.

Results

The results of the study are discussed below under four headings. While the study centred on one specialist service, the issues experienced were symptomatic of wider organisational failings.

Operational functioning, service specification and delivery

We found that there was an absence of a coherent operational management system within which to define service functioning and a lack of clarity of the parameters of service provision and of the consumer group being provided for. There was also insufficient support provided by the finance, people and capability, and technology support services. This was compounded by a plethora of disparate IT systems that required manual work to enter the outputs of one system as inputs to another. These factors hindered operational efficiency and service quality and limited true understanding of service cost and resource needs. It also made it difficult to capture any lessons learned, so there was much "reinventing of the wheel".

Monitoring service provision and managing change

We found that there was an absence of coherent, timely, complete, accurate and useable information with which to monitor and manage the service. While there was access to several *ad hoc* reports, very few of these supported the service to understand its functioning and service provision or to identify and respond to developing situations (e.g., waitlists building up). Furthermore, there was no scope in terms of available time or data to understand and consider external environment changes and their impacts.

Managing complexity—balancing centralisation and decentralisation

While the health system is largely set up in a nested structure of operational services as the VSM would suggest, *the functioning of and between these levels was inadequate*. That is, the necessary functions and communication channels that the VSM prescribes were either not present or not working at every level. Our study service had virtually no autonomy to make decisions and no input into its budget. The effect of both of these limitations was to increase the burden of bureaucracy on the organisation—wasting both time and money. As noted above, this severely hindered the ability of the service to learn and adapt by embedding that learning into its core functioning.

Communication—the importance of data

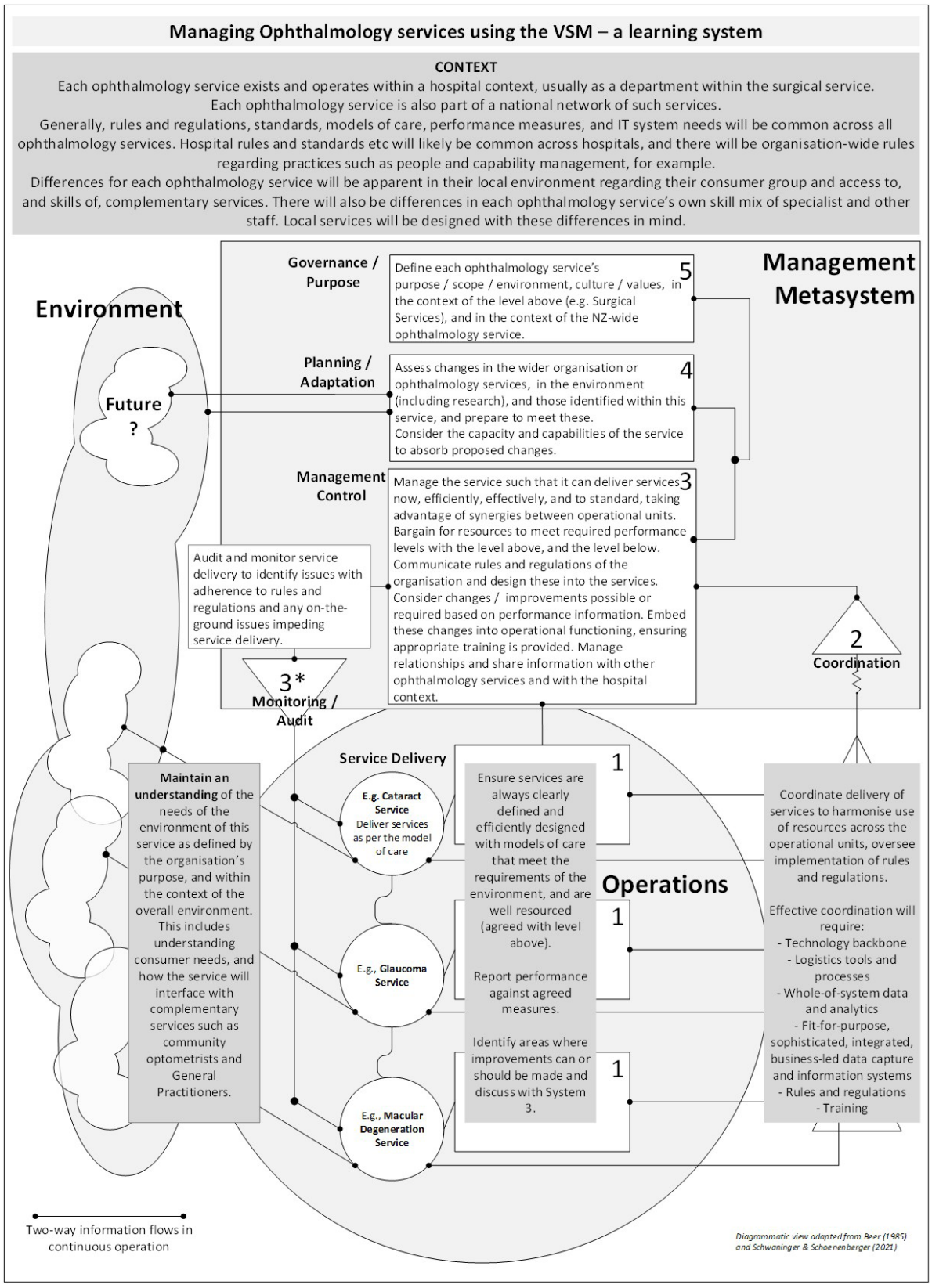
VSM functioning is highly dependent on the continuous two-way flows of accurate and relevant information based on quality data and facilitated through integrated, sophisticated IT systems. We found that the information flows were top-down rather than two-way. Further, the quality and timing of information available were well below what would be required to manage a high-volume clinical service with time-critical service delivery needs if it is to be a high-performing service ensuring quality and equity, and a learning health service.

Three key interrelated issues requiring attention were brought into clear focus as a result of the VSM diagnosis. Firstly, service delivery (System 1) is poorly defined. This impedes the ability of managers (System 3) to identify synergies between System 1s to improve efficiency and service to consumers, and impedes the ability to coordinate service delivery. Indeed, System 2 (coordination) is not recognised as a necessary, coherent function at all. The issues with Systems 1 and 2, combined with the lack of autonomy and inadequate support from adjunct services such as IT and finance, result in the service manager and clinical director (System 3) being drawn into the minutiae of day-to-day functioning.

Discussion

The VSM is designed as a learning system that adapts to and with its environment. Analysing a system using the VSM makes it is possible to identify whether or not the system under examination has the characteristics of, and is operating as, a learning system. Our study revealed that as New Zealand health services are set up and supported at present, they struggle to function, let alone operate as a learning system. The VSM provides the basis for an operating model through which to clearly articulate all the requirements of a learning health system, and one that can persist over the long term (see Figure 1).

Figure 1: Managing ophthalmology services using the Viable System Model—a learning system.



Leveraging the benefits of the VSM would not require services to "start from scratch". Rather, health system managers (with support from a facilitator) can realign and connect current efforts to build on existing strengths. A pilot project is suggested, perhaps working with Health New Zealand – Te Whatu Ora's Clinical Network for ophthalmology. The work would be undertaken with staff, including clinical directors and service managers. The pilot would utilise the detailed work (i.e., the development of a VSM-based Clinical Services Management Framework) undertaken through the research from which these views are drawn and act as a guide for other services.[21,23] The only external resource required is the facilitator. Internally, current resources such as the ophthalmology clinical network, decision support, production planning and IT services would be utilised.

The model structure described in this article could be used to identify gaps. For example: Are services clear about their purpose? Are the five basic functions in place and working? Are the support services aligned and supporting the purpose of the operational areas? Is there a balance of autonomy and control supported by appropriate performance reporting? Are services clearly articulated, including details of service provision? This work would lead to a prioritisation of improvement efforts and the development of solutions to address the identified gaps. A recent study in the National Health Service provides an excellent example of this,[3] as do these examples from Australia[15] and Norway. [18]

Outcome measures of a **diagnosis** phase might include:

1. **Service clarity:** detailed understanding of the service's demand/capacity and general situation (e.g., patient numbers, waitlists, equipment, staffing, funding, processes, IT systems) at any time.
2. **Service functioning:** understanding of the service's functioning *vis-à-vis* VSM subsystems and communication channels.
3. **Gap to being a learning health service:** prioritised list of actions/improvements required to achieve learning health service status.

Outcome measures of a **design** phase might include:

4. A fully populated version of the VSM-based Clinical Services Management Framework (including models of care, reporting, processes for resource/performance bargaining, etc.).
5. An understanding of the IT systems required to support processes and address information requirements.

Outcome measures following VSM **implementation** would include:

6. **Adaptive capacity**: improved ability to adapt to changes and unexpected challenges.
7. **System resilience**: enhanced resilience allowing the service to maintain functionality during disruptions.
8. **Process efficiency**: reduced wait times/no overdue follow-ups.
9. **Patient satisfaction**: improved patient experience and satisfaction.
10. **Clinical outcomes**: patients receiving care on time and therefore not deteriorating unnecessarily.
11. **Resource utilisation**: more efficient use of resources, including staff time and equipment.
12. **Staff satisfaction**: improved job satisfaction and reduced burnout among staff.
13. **A learning health system**: the service will have the processes and mechanisms in place to function as a learning health system and to be part of the wider organisational learning health system.

The pilot could be underpinned with research to better understand the impacts and challenges regarding leadership, culture, capability, data, IT systems, etc.—all of which are issues the system must grapple with.

Conclusion

Setting up a learning health system is a non-trivial but necessary undertaking. The New Zealand health system is complex and operates in a fast-changing environment. The VSM is not a short-term quick fix, nor is it an attempt at "simplification". Rather than pretend that the complexity and the need to adapt can be ignored, the VSM provides a way to manage effectively over the long term based on a theoretically sound systems approach. The dependence on data and, therefore, technology cannot be underestimated. By applying the VSM we can improve

our understanding of the data we need and use this understanding to drive technology requirements with greater accuracy and effectiveness. The VSM approach also supports the realisation of the goals of financial sustainability, high performance, distributed decision making, clinical engagement and efficiency—or our understanding of why we are struggling to meet these goals.

In implementing the VSM the messy practicalities of the real world must be considered. While good models are essential for good management, they support rather than replace good managers. Implementation of this approach leverages the knowledge of staff, and through participation in model development for their services the VSM can activate clinical leadership and help in the development of a deeper understanding of the approach such that it becomes part of the everyday way of thinking. Applying model-based management using the VSM will provide a level of understanding of our health system that we have never had before, but which is necessary if we are to have a health system that is sustainable over the long term and can become stronger by learning and adapting. We may find out that we are unable to afford all the services that we want to provide. Understanding this, however, will be better than the alternative, which is continual politically induced restructuring and inadequately planned implementation processes.

COMPETING INTERESTS
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Delayed presentation of severe cervical myelopathy two years post-motorcycle accident: a case report

Rohil Chauhan, Daniel Harvey, Anand Segar, Steven White

Myelopathy, defined as spinal cord dysfunction, can arise from a variety of aetiologies, with degenerative cervical myelopathy (DCM) being the most common.[1] DCM is a progressive neurodegenerative disorder caused by spinal cord compression resulting from degenerative or congenital factors. The global adult prevalence of DCM is 2.3%, rising to 5% in individuals over 40 years of age.[2] Māori and Pacific peoples in New Zealand are thought to be at elevated risk of developing DCM due to narrower cervical canal dimensions.[3]

The clinical progression of DCM is highly variable, characterised by stepwise neurological decline followed by periods of quiescence.[4] Given this unpredictability, early recognition of DCM-related signs and symptoms is critical to prevent irreversible neurological impairment.[1,4,5] We report a case of DCM diagnosed 2 years post-motorcycle accident, with a 1-year history of progressively worsening symptoms.

Case report

A 43-year-old Māori male presented to a secondary care orthopaedic spine centre with a 2-year history of persistent neck pain and bilateral C6 radicular arm pain. Over the past year, these symptoms had worsened, and the patient developed fine motor skill impairment, upper limb weakness, balance impairment and urinary incontinence, significantly affecting his ability to work and ambulate.

His medical history revealed a motorcycle accident 2 years prior, which resulted in a traumatic brain injury and skull and rib fractures. No cervical cord injury was diagnosed at that time. One-year post-accident, an MRI was arranged by a neurosurgeon for bilateral radicular arm pain, revealing multi-level neuroforaminal narrowing and mild C4/5 spinal cord compression (**Figure 2a)**. Surgery was not indicated at the time due to a lack of clinical DCM features, and epidural steroid injections were administered for radicular pain, providing only temporary relief.

Upon examination at the orthopaedic spine centre 1 year later, examination revealed a wide and unsteady gait, positive Romberg's sign, global hyperreflexia, bilateral Hoffman's and inverted supinator signs. Upper limb weakness was generalised but most marked for wrist extension, flexion, and finger abduction bilaterally. Repeat MRI (**Figure 2b**) demonstrated progressive C4/5 cord compression with myelomalacia and multi-level neuroforaminal compression. His modified Japanese Orthopaedic Association score was 11/18, indicating severe DCM, necessitating surgical decompression. The patient was scheduled for a C4/5 anterior cervical discectomy and fusion at the time of writing this report.

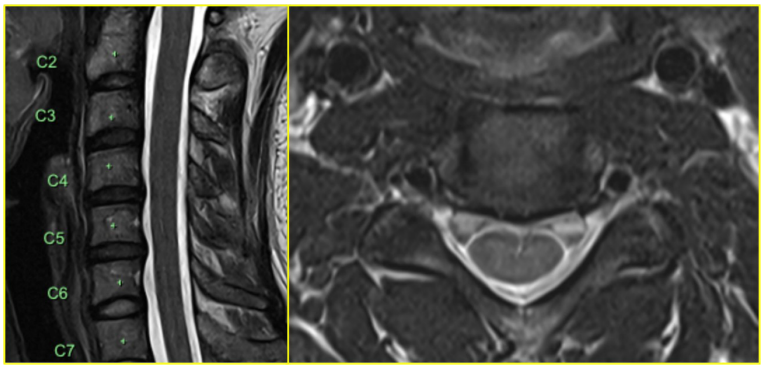
Discussion

DCM is a progressive condition that, if not diagnosed early, can lead to chronic disability,[5] unemployment and diminished quality of life.[6] Surgical decompression, indicated for moderate, severe or progressive cases, aims primarily to halt further deterioration rather than reverse existing deficits.[7] Early recognition and timely referral for evaluation are crucial to prevent irreversible impairment.[1,4,5]

Key DCM symptoms include hand numbness, paraesthesia, dexterity loss, clumsiness and balance disturbances,[8] with diagnostic signs such as hyper-reflexia and positive Babinski, Hoffman, clonus and inverted supinator reflexes.[9] Cervical spine MRI is necessary to correlate clinical findings with MRI evidence of cord compression.[1,7]

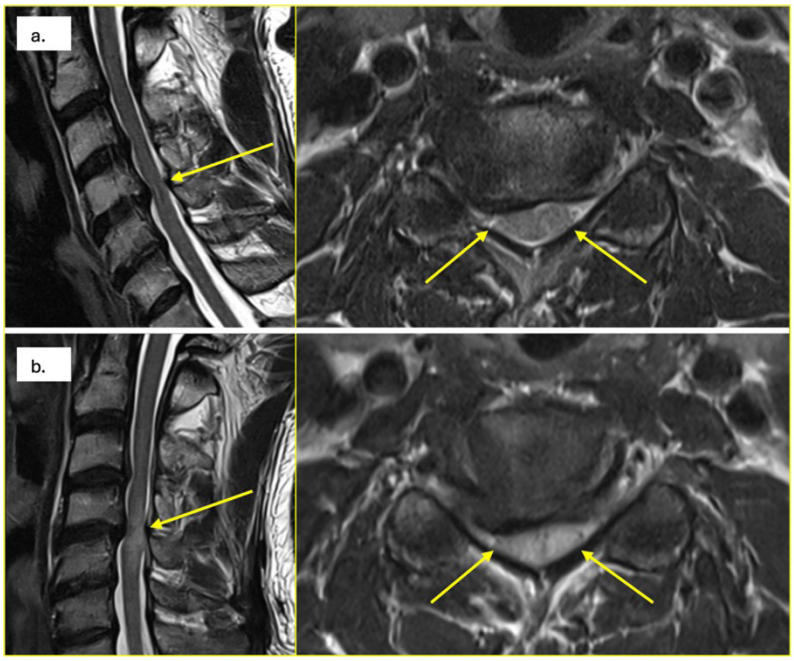
In this case, despite the absence of initial DCM features, symptoms worsened over the year, emphasising the importance of serial symptom monitoring and patient education when spinal cord compression is suspected or identified.[7]

Figure 1: Example of a normal cervical MRI sagittal and axial series, without cervical stenosis.



MRI = magnetic resonance imaging.

Figure 2a: Initial cervical MRI for the patient in the present case, showing mild cervical stenosis at C4/5 with possible myelomalacia (1-year post-accident), and **2b:** a repeat cervical MRI revealing severe C4/5 cervical stenosis with more marked myelomalacia (2-years post-accident).



MRI = magnetic resonance imaging.

Educating patients on symptoms necessitating urgent surgical reassessment facilitates timely intervention.[7] Understanding of DCM among New Zealand primary care clinicians is reportedly low.[10] Improving knowledge within primary care clinicians, in collaboration with surgical specialists, would facilitate patient education and monitoring, while maintaining a low referral threshold for surgical evaluation.

Conclusion

This case emphasises the importance of ongoing monitoring and patient education in individuals with suspected DCM or asymptomatic spinal cord compression. Early recognition of DCM should prompt referral for diagnostic and surgical evaluation. Future research should aim to develop clinical criteria to aid the timely recognition of DCM in primary care and community settings.

COMPETING INTERESTS
Nil.

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Notes on a Case of Gallstones

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The following notes on an unexpected death after a simple and uncomplicated case of gallstones may be of interest and service to other members of the profession, some of whom might be able to shed a further light on the condition, which will be of assistance in forestalling the occasionally sequalae of such operations.

The patient—Mrs. P., aged 52—was admitted to Napier Hospital on 14th November, 1923, with a history of attacks of sudden stabbing pain in the right hypochondriac region of three years' duration. The attacks lasted 6 to 18 hours and at first came on every two to three months. Latterly they were more severe and occurred every two to three weeks. During the attacks she sweated freely and could only obtain relief by injections of morphia, and during the last she vomited and became jaundiced. Between the attacks she suffered from a moderate degree of flatulent indigestion, but the appetite, bowels, and general health were good. Her past history revealed no serious illness, and she had always looked on herself as a strong and healthy woman. She had four children, of whom three are living and well. The youngest is 24 years.

Apart from the attacks of colic the only other complaints she had were occasional, slight, irregular hæhorrhages from the uterus occurring during the past eighteen months—her regular periods stopped five years ago.

Examination showed a well-nourished woman of good colour, whose lungs and heart appeared to be normal. There was moderate tenderness over the gall bladder region, but otherwise nothing of note in the abdomen. Urinary examination—negative.

Before operation on the 19th of November, 1923, she was somewhat restless during the night, but had four hours' continuous sleep and a pint of 10 per cent. glucose solution by mouth before going to the theatre. The anæsthetic was ether only throughout the operation, and the condition of the patient was good all the time—pulse strong and never above 100.

On opening the abdomen a small liver was exposed and pale thick-walled, and distended gall bladder, with a single large stone in the neck. A cholecystectomy was performed without any leakage of contents and little hæmorrhage. The appendix was removed and gauze drain and small rubber tube left in the gall bladder fossa. Fibroids were noted on the uterus.

On return to the ward patient recovered in a few hours from the anæsthetic, and was kept on saline and 5 per cent. glucose continuously, of which she retained several pints during the 24 hours.

Next day her condition was very satisfactory in the morning—moderate amount of pain and little vomiting; passed 8oz. urine. About mid-day pulse rate rose from a strong regular rate of 120-130 to 140, and became weak and running, and patient began to complain of feeling feverish. Abdomen moderately distended. Two-hourly injections of strophanthin (gr. 1/500) were given and gastric lavage with soda bicarbonate solution, from which the return was cloudy and bile-stained. Glucose and saline solution continued by mouth.

At 4 and 7 p.m. passed normal quantity of urine of specific gravity 1020, acid, and containing no albumen or acetone. Urea concentration was 2 per cent. Microscopically, many staphylococci were the only extraneous matters found. Patient still complained of the heat and general discomfort, and she was relieved by morphine and sponging. Colour was fair—did not sweat much. At 6 p.m. — Temperature, 98.4; pulse, 156; respiration, 34.

No signs of sepsis round wound, culture of swab from which showed a few staphylococci and gram negative bacilli. Abdomen softly distended and not tender.

At 10.30 p.m. patient was catheterised and 4oz. of normal urine obtained. Pulse became progressively worse and patient became unconscious at 3.30 a.m. and died at 5 a.m. Up to the onset of final state of unconsciousness patient had been quite clear and alert mentally.

At *post mortem* examination everything was in order at the site of operation. Liver—fatty and friable—weight 45oz. Kidneys—congested. Poor distinction between cortex and medulla. Uterus—several small subserous and submucous fibroids.

All the other organs appeared healthy.

Pathological reports were as follows:—Gall bladder— greatly thickened wall and loss of epithelium. No evidence of malignancy. Liver—fairly extensive fatty change and collections of inflammatory cells along portal tracts. Condition of moderate cholangitis. Kidney—toxic tubular nephritis.

The cause of death in this case does not seem to be satisfactorily covered by either—(1) Acute heart failure; (2) renal failure; (3) sepsis; (4) hæmorrhage; or (5) shock.

She had no history suggestive of even a minor degree of cardiac inefficiency, and at *post mortem* the heart muscle was of good healthy appearance and not dilated. That the kidney drainage was not fatal is indicated by the state of the urine, which is also against an acidosis. There was no sign of any sepsis either microscopically or macroscopically at *post mortem*.

Hæmorrhage was not more than a few ounces at operation, and none afterwards. Regarding shock, there was very little trauma or other cause for it at operation. The patient had a good strong pulse for 24 hours after operation, and normal or slightly raised temperature. When the pulse began to fail her appearance and elevation of temperature did not suggest a delayed shock.

The case more nearly seems to correspond with those described by *Heyd* (1) who stresses the constancy of more or less hepatic change in all cases of gallstones—a fact which does not appear to be recognised in the majority of textbooks; and which was arrived at by the examination of sections of liver tissue excised at operation from an extensive series of gall bladder cases. In all of these a varying degree of chronic hepatitis, surrounding the portal canals was found, and he concludes that the majority of infected gall bladders are secondary to a hepatitis, due to some chronic intestinal toxæmia—the infection reaching the gall bladder via the lymphatics. Many of these cases have ample reserve power of function in the liver—a few who can carry on the ordinary routine of life without symptoms, are nevertheless doing so with so little reserve that the added strain of operation determines a rapid and fatal failure of hepatic function which is manifested in three main types:—(1) Well for 24-36 hours after operation, then profound vaso-motor depression sets in. Patient has a cold, clammy skin and is clear mentally. No dilation of stomach and good kidney function. Generally occurs in cases with a secondary operation and excessive handling of pancreas. (2) Normal course to 5 days, after which patient becomes drowsy and rapidly comatose. Temperature rises to 103-4 deg. Kidney function remains good and abdomen negative. Generally occurs in cases with free drainage of bile. (3) After long history of chronic gall bladder trouble. Cholæmic symptoms with temperature of 104-5 deg. and delirium set in before patient recovers from the anæsthetic. The condition appears to be an alkalosis—CO combining power of the alveolar air being raised to 80 per cent."

I have quoted *Heyd's* article at some length because, in view of the above case, acute hepatic failure seems to be a factor which can easily go unforeseen in gall bladder operations, and may to some extent be obviated by a more thorough investigation of the hepatic condition by means of the lævulose tolerance test (2) or *Roche's* sodium salicylate test (3).

Some of the cases in *Heyd's* series, particularly those of type (1), he has treated successfully by means of massive doses of glucose (1000cc. of 10 per cent. solution intravenously., 4-6 hourly) and continuous rectal saline.

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