Cancer screening and better clinical diagnosis should not be in competition

Watching the watchers: assessing the nature and extent of children's screen time using wearable cameras

Who does not benefit from our national breast screening programme and who should have oversight?

The long-term impacts of COVID-19 on confirmed cases at least 12 months post-infection in Wellington, New Zealand: an observational, cross-sectional study

To subscribe to the *NZMJ*, email:

nzmj@pmagroup.co.nz

Subscribers to the *New Zealand Medical Journal* previously through the NZMA should now get in contact to subscribe via the above email if they wish to access the *Journal* for 2023.

Private subscription is available to institutions, to people who are not medical practitioners, and to medical practitioners who live outside New Zealand. Subscription rates are below.

All access to the *NZMJ* is by login and password, but IP access is available to some subscribers.

Read our conditions of access for subscribers for further information
journal.nzma.org.nz/legal/nzmj-conditions-of-access

If you are a member or a subscriber and have not yet received your login and password, or wish to receive email alerts, please email: nzmj@pmagroup.co.nz

Subscription rates for 2022

New Zealand subscription rates		Overseas subscription rates	
Individuals*	$360	Individual	$503
Institutions	$680	Institutions	$700
Individual article	$45	Individual article	$45

*NZ individual subscribers must not be doctors (access is via NZMA Membership)

New Zealand rates include GST. No GST is included in international rates.

Individual articles are available for purchase by emailing nzmj@pmagroup.co.nz.

Contents

Clinical correspondence

100 years ago in the *NZMJ*

Summaries

Watching the watchers: assessing the nature and extent of children's screen time using wearable cameras

Belinda M Lowe, Moira Smith, Richard Jaine, James Stanley, Ryan Gage, Louise Signal

Children's after-school screen use was analysed in the 2014/2015 New Zealand Kids'Cam study. Children aged 11–13 years wore an automatic camera that took photos of their surroundings every 7 seconds. Children spent a third of their after-school time on screens, including over half their time after 8 pm. Children were mostly watching programmes and gaming. There is urgent need for policy to protect children online.

Description and accuracy of antibiotic allergy labels at North Shore Hospital

Liam D Kelly, Tim Cutfield, Kerry Read

My paper shows that in North Shore Hospital the accuracy of recorded adverse reactions to the most commonly used class of antibiotics was only 66%. We showed that the utilisation of a focussed interview with patients can potentially remove this inaccurate label from a significant proportion of these patients, with either an interview alone, or with the use of a test dose of the medication. This interview can be conducted by the frontline staff that are already interviewing these patients as part of their initial assessment in the hospital. This would have great benefits for the patients and for the health service in New Zealand.

Ethnic group differences in patient satisfaction with GP services: findings from the New Zealand Attitudes and Values Study

Carol H J Lee, Chris G Sibley

This study found that lack of GP cultural respect is a key contributor to lower GP satisfaction levels among Māori, Pasifika and Asian peoples in New Zealand. Ratings of GP cultural respect were a more important determinant of GP satisfaction than patient demographic characteristics (e.g., age, gender, deprivation level of neighborhood). It is important to support GPs to provide more culturally respectful services for diverse groups, as high GP satisfaction is strongly linked with ratings of better healthcare access and health outcomes.

Incorporating faecal haemoglobin measurement using the faecal immunochemical test (FIT) in the referral, triage, and prioritisation pathway for patients with colorectal symptoms

James Falvey, Chris M A Frampton, Richard B Gearry, Ben Hudson, Lucinda Whiteley

Patients with bowel cancer (colorectal cancer [CRC]) often have few or no symptoms until the cancer is advanced. Meanwhile, although bowel symptoms are a common problem, most patients with bowel symptoms do not have a serious underlying cause such as CRC. Consequently, symptoms on their own are not a good decider of who should undergo bowel investigation. The current access criteria for bowel investigation in New Zealand are largely based on bowel symptoms, and this symptom basis likely contributes to high demand for investigation (usually by colonoscopy), even though few of these people have a serious cause detected. Detecting blood in the bowel motion using the faecal immunochemical test (FIT) is a powerful way of determining who is at risk of bowel cancer. This paper summarises the data that has been published internationally about the accuracy of FIT for CRC in patients with bowel symptoms (as opposed to those without bowel symptoms as per bowel screening). We hope that our paper

will promote discussion regarding the use of FIT in symptomatic cases, and hasten the introduction of FIT in the diagnostic process for New Zealanders with bowel symptoms.

The long-term impacts of COVID-19 on confirmed cases at least 12 months post-infection in Wellington, New Zealand: an observational, cross-sectional study

Nethmi Kearns, Neakiry Kivi, Emily Dickinson, Emma Mayo, Allie Eathorne, Augustus Anderson, Richard Beasley, Craig Thornley, Annette Nesdale

This study looked at the presence of ongoing symptoms and abnormalities in blood samples in confirmed cases of COVID-19 from the first wave within the Greater Wellington Region. The questionnaires and blood samples were done at an average of 1.7 years after first onset of COVID-19 symptoms. Just over half the participants felt that their current overall health was worse than it was prior to getting COVID-19. 90% of participants reported at least two ongoing symptoms since their first illness with COVID-19. There were minimal abnormalities in blood samples. This study shows that there is a wide variety of ongoing symptoms in participants, however a causal relationship between COVID-19 and these symptoms cannot be established.

A new national health system: the opportunity to address data quality issues in maternal immunisation coverage

Matthew Hobbs, Amber Young, Nikki Turner, Pauline Dawson, Esther Willing, Peter McIntyre, Christine G McIntosh

Obtaining accurate data on maternal immunisation is fraught with challenges. However, the recent New Zealand Health and Disability System Review focussed on the need for system-wide approaches to ensure the health system achieves better and equitable outcomes. The current environment of health reform presents a timely opportunity to address the challenge of low maternal immunisation coverage, which requires high quality data on immunisation coverage.

Towards a national equitable and sustainable clinical research infrastructure for Aotearoa New Zealand

Lisa K Stamp, Matire Harwood, Stuart Dalziel, Tom Love, David Moore, Kelvin Woock, Katrina Sharples, Frank Bloomfield

Clinical trials are a critical element of a modern, high-functioning, learning healthcare system. Clinical trials provide access to novel, as yet unfunded, treatments and deliver cutting-edge healthcare. Evidence from clinical trials ensures appropriateness of healthcare, allows disinvestment from practices that are found not to improve outcomes or be cost-effective and supports introduction of new approaches, all of which lead to improvement in health outcomes. Research must be recognised and promoted as a core activity for clinical staff at all levels of the healthcare system rather than something to be tolerated or even hindered. We report on a proposed National Clinical trials infrastructure for Aotearoa New Zealand.

The planning of cancer screening programmes

Brian Cox, Gil Barbezat, Murray Pfeifer, Alice Macklow, Dave MacKay, Melissa Vining, Phil Bagshaw

Cancer screening adds a considerable workload to oft over-stretched diagnostic services due to the large numbers of people who have positive screening tests. Specialists, and the resources to support them, tend to be in short-supply in many regions and specialist diagnostic services can become more difficult to access for patients with symptoms. The diagnostic services need to be included in all computer planning models of cancer screening so that the effect of screening on access to diagnostic services for people with symptoms can be predicted and the increase in staff, their training, and the facilities needed, can

be completed before cancer screening is undertaken. Insufficient planning for each of the national cancer screening programmes has occurred when they were established and this has also occurred in the national bowel screening programme.

Who does not benefit from our national breast screening programme and who should have oversight?

Ineke Meredith, Ross Lawrenson

The recent report on the delays for mammography encountered by women in the Wellington Region reminds us that the organisation of cancer screening is far from straightforward. Screening can reduce mortality from cancer, but it is costly and the benefits are only seen many years in the future. There is also the ability for cancer screening to cause harm and worsen inequity. Thus, ensuring the quality, safety and acceptability of our breast screening programme is important.

Cancer screening and better clinical diagnosis should not be in competition

Mark Elwood

In this volume of the *Journal*, we publish two articles that raise a challenging issue: how can we manage a screening programme and also protect or enhance the normal process of clinical diagnosis? Cox at al.[1] point to limitations in colposcopy services for cervical cancer and treatment services for breast cancer, and state that the limitations of clinical services—particularly for colonoscopy—necessitated a reduction in test sensitivity and a narrower age range for the bowel cancer screening programme when first introduced. Meredith and Lawrenson[2] argue that screening for breast cancer can impact the services for symptomatic patients and exacerbate existing inequities. They state that a screening programme should be part of an integrated service for the diagnosis and treatment of all patients. These papers come at a good time: recent major reviews of the breast and cervical screening services have called for major changes.[3–6]

In many ways, the screening programmes for cervical cancer, breast cancer and colorectal cancer have features that should be the ideal for all health services. The programmes have been designed based on high-quality international evidence, usually from large randomised trials, and follow international best practice. The programmes are nationally coordinated and designed to be consistent throughout the country, avoiding post-code lottery variations, although that depends on local service delivery issues. There are set performance criteria and requirements for evaluation. There has never been evaluation or quality control for other diagnostic routes on a national basis.

There is evidence that the inequities apparent in many aspects of New Zealand healthcare can be overcome, such as the demonstration that Māori and non-Māori women have similar outcomes following detection by screening, while inequities exist after clinical diagnosis.[7,8] The recent detailed review of the breast screening programme[3,4] concluded that it was consistent with the best international programmes in its design and performance; it was estimated that women who accepted regular screening had a 39% reduction in mortality.[9]

New Zealand has been cautious in its implementation of cancer screening, introducing programmes some years later than many other countries. Even so, resource limitations have produced restrictions on the screening programmes and unmet needs in diagnostic services. Ideally, setting up a screening programme should involve assessing and improving the various steps in the diagnostic process, and should lead to improvements in diagnostic and treatment services for all patients, not just those screened.

Much depends on how resources are managed. A new screening programme will require new, specific resources but will also put additional demands on services and staff who deal with the diagnosis and treatment of all patients. The demands of the screening programmes on gynaecologists, radiologists, surgeons, pathologists, nurses and other staff will be substantial. If the extra work is not adequately resourced, diagnostic and treatment services for other patients will be disadvantaged. Thus, the time from diagnosis to surgery in breast cancer for all patients has been increasing, with the proportion having surgery within 31 days dropping from 56% to 37% between 2004 and 2019, even before COVID-19.[8]

The clinical diagnosis route in New Zealand is far from satisfactory. One measure of poor quality of routine diagnostic processes is the proportion of patients presenting after an emergency admission: in a study of eight cancer types in 14 jurisdictions for 2012–2017, New Zealand ranked worst in this proportion overall and for seven of the eight cancer types assessed.[10] A higher proportion of emergency admissions was associated with a lower 1-year survival rate for most cancers.[10] In a study of primary care comparing 11 jurisdictions, access to diagnostic tests and specialist referrals for cancer by primary care

practitioners was more limited and took more time than in most other regions.[11]

A fundamental problem is that the cancer screening services are managed separately from the normal diagnostic services for the same disease, although the same staff may deal with the patients in both situations. The recent Wellington review noted that patients attending for screening who had symptoms could not be referred to diagnostic services, but were sent back to their general practitioner, causing more delay.[5] Further, the three cancer screening services are separate, using different invitation systems and promotion activities. A screening service for a disease should be planned and managed to improve the diagnostic services for all patients. As these two papers show, we have not done this well in New Zealand.

CORRESPONDING AUTHOR INFORMATION
Mark Elwood: Honorary Professor of Cancer Epidemiology, The University of Auckland; Honorary Professor, University of Waikato.
E: mark.elwood@auckland.ac.nz

REFERENCES
1. Cox B, Barbezat GO, Pfeifer MV, et al. The planning of cancer screening programmes. N Z Med J. 2023;136(1579):p-p.113-118.
2. Meredith I, Lawrenson R. Who does not benefit from national breast screening programme and who should have oversight? N Z Med J. 2023;136(1579):p-p.119-122.
3. National Screening Unit. Quality Improvement Review of Clinical Quality and Safety for Breast Screening Aotearoa [Internet]. Te Whatu Ora – Health New Zealand; 2022 [cited 2023 Jun 8]. Available from: https://www.nsu.govt.nz/publications/quality-improvement-review-clinical-quality-and-safety-breast-screening-aotearoa.
4. Elwood M. Epidemiological aspects of breast cancer screening relevant to Aotearoa: Report prepared for the quality improvement review of clinical safety and quality for BreastScreen Aotearoa [Internet]. Te Whatu Ora – Health New Zealand; 2022 [cited 2023 Jun 8]. Available from: https://www.nsu.govt.nz/system/files/resources/tewhatuora-bsa-qualityimprovementreview-epidemiological-report.pdf.
5. Te Whatu Ora – Health New Zealand. Te Whatu Ora – Health New Zealand Capital, Coast & Hutt Valley BreastScreen Central Review [Internet]. 2023 [cited Jun 8]. Available from: https://www.ccdhb.org.nz/news-publications/publications-and-consultation-documents/te-whatu-ora-health-new-zealand-capital-coast-hutt-valley-breastscreen-central-review.pdf.
6. Te Whatu Ora – Health New Zealand. Report of the Parliamentary Review Committee Regarding the National Cervical Screening Programme [Internet]. 2022 [cited 2023 Jun 8]. Available from: https://www.nsu.govt.nz/system/files/page/2021-prc-report-into-the-ncsp.pdf.
7. Lawrenson R, Lao C, Jacobson G, et al. Outcomes in different ethnic groups of New Zealand patients with screen-detected vs. non-screen-detected breast cancer. J Med Screen. 2019;26(4):197-203. doi: 10.1177/0969141319844801.
8. Gautier A, Harvey V, Kleinsman S, et al, editors. 30,000 voices: informing a better future for breast cancer for Aotearoa New Zealand [Internet]. Breast Cancer Foundation NZ: Auckland; 2022 [cited 2023 Jun 8]. https://www.breastcancerfoundation.org.nz/medical-professionals.
9. Morrell S, Taylor R, Roder D, et al. Mammography service screening and breast cancer mortality in New Zealand: a National Cohort Study 1999-2011. Br J Cancer. 2017;116(6):828-839. doi: 10.1038/bjc.2017.6.
10. McPhail S, Swann R, Johnson SA, et al. Risk factors and prognostic implications of diagnosis of cancer within 30 days after an emergency hospital admission (emergency presentation): an International Cancer Benchmarking Partnership (ICBP) population-based study. Lancet Oncol. 2022;23(5):587-600. doi: 10.1016/S1470-2045(22)00127-9.
11. Htun HW, Elwood JM, Ioannides SJ, et al. Investigations and referral for suspected cancer in primary care in New Zealand-A survey linked to the International Cancer Benchmarking Partnership. Eur J Cancer Care (Engl). 2017;26(3). doi: 10.1111/ecc.12634.

Watching the watchers: assessing the nature and extent of children's screen time using wearable cameras

Belinda M Lowe, Moira Smith, Richard Jaine, James Stanley, Ryan Gage, Louise Signal

ABSTRACT

AIM: Children's screen use has increased rapidly in recent years, yet little is known about this use in real-time due to reliance on self-report or proxy data sources. Screens provide benefits such as educational content and social connection, but also pose health risks including obesity, depression, poor sleep and poor cognitive performance. In this cross-sectional observational study, we aimed to determine the nature and extent of children's after-school screen time using wearable cameras.

METHOD: Children aged 11–13 years took part in the New Zealand Kids'Cam project in 2014/2015. Each child wore a camera that passively captured images of their surroundings every 7 seconds. Images from 108 children were manually coded.

RESULTS: Children spent over a third of their time on screens, including over half their time after 8pm. Television accounted for the highest proportion of screen time (42.4%), followed by computers (32.0%), mobile devices (13.0%) and tablets (12.6%). Approximately 10% of children's screen time involved multiple screen use.

CONCLUSION: Guidelines are needed to promote healthy screen time behaviour among children. Further research is also needed to monitor the impact of screens on children's wellbeing, including any socio-demographic differences, and to identify innovations to protect children from harm in the online space.

Children use a variety of screens in their daily lives, including mobile devices, computers, tablets and televisions. Such use may present both risks and benefits for their health and development.[1] Evidence from systematic reviews suggests that higher time spent on screens (all types combined) is associated with obesity, unhealthy diets, depressive symptoms, shorter and poorer quality sleep and poor cognitive performance.[2–6] More recently, the "fear of missing out" on things including social media access has emerged as a key driver of problematic screen use among adolescents, which (in turn) may have consequences for their mental health and wellbeing.[7–9] In addition, children's exposure to bullying on social media is of substantial concern.[10–12] Potential benefits of screen use may arise from opportunities to socialise and access to age-appropriate educational content,[13,14] although evidence of positive health impacts from systematic reviews has been inconsistent.[2] Screen use increased rapidly during the COVID-19 pandemic,[15] highlighting the need for contemporary methods to keep pace with technological developments and changing patterns of children's screen use.

Owing to the health risks associated with screen time, several countries and health organisations have issued guidelines on children's screen use. However, the contents of these guidelines vary. The World Health Organization (WHO) recommends screen time restrictions for children under age 5, but currently has no guidelines for older children and adolescents.[16] Some countries, including New Zealand, recommend that children and adolescents (outside school time) spend no more than 2 hours per day on screens.[17,18] Guidelines from other countries have offered more general advice rather than time limits, including recommendations to consider screen types and activities, and children's age and stage of development.[19–21]

To help inform policy to promote healthy screen use behaviour, researchers need reliable and accurate measures of screen activity. A weakness in the screen time literature has been a lack of data on non-television media (e.g., computers, smartphones and tablets)[2] and reliance on self-report methods or parent proxies to measure screen use. For example, Scharkow[22] found that, among 3,401 people aged 14–80 from individual United States households, self-report measures have poor accuracy for determining internet use compared with recorded logs of online activity. While Scharkow's study participants kept a log

record of their screen use, there are limitations associated with recorded logs, owing to high participant burden and the possibility that brief or reflexive uses are missed.[23] Multi-screen use—that is, the use of two or more media devices simultaneously, such as a TV and laptop or a handled device—is a growing phenomenon that may carry additional health risks than single-screen activity (e.g., poorer sleep quality),[24,25] yet few studies have evaluated multi-screen activity.

Wearable cameras offer a valuable opportunity to explore screen time behaviours. These devices capture images of the wearer's surroundings at fixed intervals (typically several images per minute). A pilot study of 15 adolescents from New Zealand aged 13–17 found that wearable cameras provide a feasible, acceptable method of measuring pre-bedtime screen behaviour, including multi-screen activity.[26] Given this background, we aimed to use wearable cameras to examine the extent (duration and frequency of use) and nature (types of screens, activities and when used) of children's screen time during the after-school period, using data collected in the 2014/2015 Kids'Cam project.[27] Kids'Cam was a cross-sectional observational study that recruited 168 randomly selected children, aged 11–13 years from 16 randomly selected schools in the Wellington Region of New Zealand.[27]

Methods

The Kids'Cam project

The study was conducted over a 12-month period (July 2014 to June 2015) to account for seasonal differences in the participants' environments and activities. Sampling was stratified by school decile and child ethnicity to enable equal explanatory power for socio-economic and ethnic subgroups. Each child was provided with a wearable camera (Autographer) and a GPS device (Qstarz BT-Q1300ST Sports Recorder). Children were instructed to wear the devices for 4 consecutive days (2 school and 2 weekend days) on lanyards around their necks. Children were asked to wear the devices for all waking hours, but to remove the camera in situations where privacy could be expected, if they felt uncomfortable, when swimming or playing vigorous sport, or if requested by others.[27] Ethical approval was obtained to study all aspects of children's lives relevant to public health from the University of Otago Human Ethics Committee (Health) (13/220). Further method-

ological details are published elsewhere.[27]

In this ancillary study of children's screen time, we included 108 Kids'Cam participants (64.3% of total sample) who captured at least 30 minutes of image data on Thursday afternoons after school. The after-school period was selected because it accounts for the largest proportion of children's weekday recreational time. Of the 2 weekdays on which data were collected—Thursday and Friday—Thursdays were chosen as being the most like usual weekdays; after-school behaviours often differ on Fridays, being the end of the school week.

Coding for screen time

A coding protocol was developed to guide the coding of children's screen time (Appendix 1). Screen time was defined as the duration of time spent engaged with a screen. The coding process differentiated between screen mediums (i.e., type of screen) and screen activities, as detailed below. Codes were "tagged" to each image using customised software. Prior to coding, a reliability test was conducted using a test dataset of five participants (n=4,279 outside school images), on which three coders (one of whom coded all the data) achieved 90% or more agreement.

Screen mediums included televisions, computers, tablets and mobile devices (full definitions are available in Appendix 1). Multiple screen use was defined as the use of any two or more screen mediums in an image, e.g., watching television while playing on a tablet. Screen activities included programmes, games, social activities (e.g., social media), internet, background, "other" and undetermined (Appendix 1). Background activity included situations where a screen was present in a child's vicinity, but the child did not appear to be fully engaged with it (e.g., they were facing away or doing something else). This generally applied to television, where children could still be influenced by the screen (e.g., through hearing advertising). "Other" was defined as any other type of screen-based activity, such as listening to music through a screen device or using productivity software such as Microsoft Word. Activities were coded as undetermined in situations where it was clear that the child was engaging with a screen, but the coder was unclear what was occurring on the screen; for example, due to obstruction of the screen in the image (e.g., food), interference of light or other image quality issues.

Statistical analysis

Statistical analyses were performed in Stata IC/16. Rates of screen time/hour (presented as means with 95% CIs) were calculated with negative binomial regression, using counts of screen time images as the numerator and total images captured as the denominator. Images were specified as contributing 7 seconds of recording time (this being the median interval between images). Analyses accounted for the stratified sampling design using Stata's svy command and associated weighting options, to better reflect the target population. Subgroup differences in screen time were examined with rate ratios (from the negative binomial models), mutually adjusting for: ethnicity, gender and socio-economic deprivation (New Zealand Individual Deprivation Index [NZiDep])[28] simplified to lower deprivation (NZiDep groups 1, 2 and 3 and higher deprivation (NZiDep groups 4 and 5) and body weight status according to Cole cut-offs: overweight/obese (BMI >25.0) and non-overweight (BMI <24.9).[29] Weight status was included given the evidence demonstrating an association between screen use and increased risk of unhealthy weight gain owing to greater sedentary behaviour/reduced physical activity, passive overconsumption and exposure to the marketing of unhealthy food.[30,31] Participants with unknown weight status (n=4) and socio-economic deprivation (n=3) (Table 1) were excluded from these comparisons.

Results

Sample characteristics

The characteristics of the 108 children are shown in Table 1. Just over half (56%) were female and 44% were overweight/obese children, which reflects the national statistics for children of this age at the time of the study. The ethnic distribution was 43% NZ European, 35% Māori and 22% Pacific (reflecting the stratified sampling design). There were more than twice as many children in the lower socio-economic deprivation group (70%) than the higher socio-economic deprivation group (28%).

Children captured a median of 2.0 hours' (interquartile range [IQR]: 1.4, 2.9) worth of images over the observation period, of which 95.8% were codable for screen activities. There was some variation in image capture across groups (Table 1), with children of higher socio-economic deprivation capturing fewer images than children of lower socio-economic deprivation.

Screen time

Children's mean rate of screen time was 23.1 minutes/hour, which included 2.3 mins/hour of multi-screen use (10.0% of total). Televisions accounted for the highest proportion of screen time (9.8 mins/hour; 42.4% of total), followed by computers (7.4 mins/hour; 32.0% of total), mobile devices (3.0 mins/hour; 13.0% of total) and tablets (2.9 mins/hour; 12.6% of total) (Table 2). Image examples of screen types and screen activities are shown in Figure 1.

Differences by key demographic groups are presented in Table 2. Females spent just over half as much time on screens (total screen time) (rate ratio [RR]=0.58, 95% CI 0.37–0.93) and a fifth of the time on computers (RR=0.19, 95% CI 0.04–0.85) than males. Total screen time was similar for Māori, NZ European and Pacific children (Table 2), though there were some differences by ethnicity in television viewing (relative to NZ European: RR for Pacific=2.10, 95% CI 1.14–3.87; RR for Māori=1.38, 95% CI 0.95–2.00). There were some patterns of screen time according to deprivation. Although total screen time was similar by deprivation, there was evidence that high deprivation children spent less screen time on computers (RR=0.17, 95% CI 0.05–0.54) and mobile devices (RR=0.33, 95% CI 0.14–0.75) relative to those of low deprivation. There was no strong evidence for patterning of screen time use according to overweight status (total screen time RR=0.76, 95% CI 0.46–1.23 for overweight/obese compared to not overweight group).

Screen activities

Of the screen activity categories (Appendix Table 1), watching programmes accounted for the highest proportion of total screen time (6.3 mins/hour; 27.0% of total), followed by games (5.6 mins/hour; 23.9% of total), other (3.3 mins/hour; 14.0% of total), background (3.0 mins/hour; 12.8% of total), social activities (1.8 mins/hour; 7.8% of total) and internet (1.6 mins/hour; 6.9% of total). On average, 1.3 minutes of screen activities were coded as "unknown" (7.7% of all screen time). 10 times lower rates of screen use for games were observed among girls (relative to boys) (RR=0.10, 95% CI 0.03–0.30) and games were used more than half as often by overweight children (relative to non-overweight children) (RR=0.31, 95% CI 0.10–1.00). Children of higher deprivation spent less time engaged in "other" screen activities than children of lower deprivation (RR=0.16, 95% CI 0.04–0.57).

Rates of screen use were highest in the late evening period (after 8 pm, mean of 37.7 mins/

Table 1: Participant characteristics of Kids'Cam Screen sample.

Characteristic	Frequency (unweighted %)	Median recording hours, unweighted (IQR)	Mean recording hours, weighted (95% CI)
Total sample	108 (100)	2.0 (1.4, 2.9)	2.2 (1.9, 2.5)
Gender			
Female	60 (56)	1.9 (1.1, 2.8)	2.4 (2.1, 2.6)
Male	48 (44)	2.3 (1.6, 3.0)	2.1 (1.6, 2.6)
Overweight status			
Not overweight	56 (54)	2.3 (1.5, 2.8)	2.3 (2.0, 2.7)
Overweight/obese	48 (46)	1.8 (1.2, 2.9)	2.0 (1.6, 2.5)
Ethnicity			
NZ European	46 (43)	2.6 (1.7, 2.9)	2.3 (2.0, 2.7)
Māori	38 (35)	1.7 (1.0, 2.7)	1.9 (1.4, 2.4)
Pacific	24 (22)	1.9 (1.7, 2.9)	2.0 (1.7, 2.4)
Socio-economic deprivation			
Low deprivation	75 (71)	2.5 (1.6, 3.0)	2.3 (2.0, 2.6)
High deprivation	30 (29)	1.7 (1.0, 2.5)	1.8 (1.5, 2.1)

Four missing age and three missing socio-economic deprivation.

hour) than in the early evening period (5:30 pm–8 pm, mean of 24.6 mins/hour) and early afternoon period (3 pm–5:30 pm, mean of 20.6 mins/hour) (Table 4). Higher rates of screen time closer to bedtime was predominantly explained by television use (26.3 mins/hour in the late evening; 69.7% of screen use), compared with 11.6 min/hour (46.9% of screen use) in the late evening and 6.6 mins/hour (32.1% of screen use) in the early afternoon (Table 4).

Discussion

Children in this study used screens, on average, for over one third of the after-school period, including over half the time after 8 pm. Television accounted for the highest proportion of screen time, which is consistent with previous studies,[32] although it is possible that screen use patterns have changed since this data was collected in 2014/2015. The high rate of screen activity raises health concerns as it likely displaced other activities

such as active play and sleep.[33] In addition, it is particularly problematic given the risk of exposure to cyberbullying.[10–12] The incidence of bullying on social media is particularly high among New Zealand children, with more than one in four parents reporting that their child had experienced cyberbullying.[10] High rates of screen time after 8 pm raised particular concerns for children's sleep hygiene; that is, practising behaviours that facilitate sleep and avoiding behaviours that interfere with sleep, given that national and international evidence demonstrate pre-bedtime screen use is associated with poor sleep outcomes.[5,6] Furthermore, the most popular screen activities (programmes and gaming) may have limited the opportunities for learning or development relative to other activities the children could have engaged in.

We found that children engaged in multi-screen activity 10% of the time while using screens, which is higher than 5% reported among a pilot study of adolescents aged 13–17.[26] Qualitative research suggests that children may use multiple

Table 2: Mean screen time in minutes per hour and mutually adjusted rate ratios for subgroup differences, by screen medium, including all screen mediums combined.

	All screens Mean (95% CI)	Rate ratio (95% CI)[a]	Television Mean (95% CI)	Rate ratio (95% CI)[a]	Computer Mean (95% CI)	Rate ratio (95% CI)[a]	Mobile device Mean (95% CI)	Rate ratio (95% CI)[a]	Tablet Mean (95%CI)	Rate ratio (95% CI)[a]
All participants	23.1 (100)	-	9.8 (42.4)	-	7.4 (32.0)	-	3.0 (13.0)	-	2.9 (12.6)	-
Gender										
Males	29.5 (100)	1 (Reference)	9.7 (33.0)	1 (Reference)	11.9 (40.3)	1 (Reference)	4.3 (14.6)	1 (Reference)	3.4 (11.5)	1 (Reference)
Females	16.5 (100)	0.58 (0.37–0.93)	9.9 (60.4)	1.02 (0.59–1.76)	2.3 (13.8)	0.19 (0.04–0.85)	1.6 (9.7)	0.37 (0.11–1.30)	2.3 (14.0)	0.68 (0.18–2.52)
Overweight status										
Not overweight	25.6 (100)	1 (Reference)	9.9 (38.7)	1 (Reference)	9.7 (37.9)	1 (Reference)	2.8 (11.0)	1 (Reference)	3.0 (11.6)	1 (Reference)
Overweight/obese	20.7 (100)	0.85 (0.53–1.36)	9.6 (46.5)	0.97 (0.71–1.34)	4.0 (19.2)	0.41 (0.15–1.14)	3.8 (18.3)	1.34 (0.42–4.31)	3.0 (14.4)	1.01 (0.26–3.82)
Ethnicity										
NZ European	22.9 (100)	1 (Reference)	8.3 (36.2)	1 (Reference)	8.1 (35.3)	1 (Reference)	3.2 (14.1)	1 (Reference)	3.1 (13.4)	1 (Reference)
Māori	24.3 (100)	1.11 (0.79–1.57)	11.5 (47.2)	1.38 (0.95–2.00)	6.9 (28.5)	0.85 (0.24–3.09)	3.4 (13.9)	1.05 (0.62–1.77)	2.4 (9.7)	0.77 (0.22–2.63)
Pacific	25.5 (100)	1.18 (0.72–1.94)	17.4 (68.3)	2.10 (1.14–3.87)	3.7 (14.5)	0.46 (0.11–1.97)	1.5 (5.8)	0.46 (0.16–1.31)	2.4 (9.4)	0.78 (0.32–1.87)
Deprivation										
Low	24.4 (100)	1 (Reference)	9.5 (39.0)	1 (Reference)	8.6 (35.4)	1 (Reference)	3.4 (14.1)	1 (Reference)	2.6 (10.8)	1 (Reference)
High	18.3 (100)	0.75 (0.46–1.23)	10.8 (59.2)	1.14 (0.69–1.86)	1.4 (7.9)	0.17 (0.05–0.54)	1.1 (6.2)	0.33 (0.14–0.75)	4.1 (22.7)	1.57 (0.74–3.34)

[a]Mutually adjusted for gender, overweight status, ethnicity and deprivation.

Table 3: Mean screen time in minutes per hour and mutually adjusted rate ratios for subgroup differences by screen activity.

	Pro-grammes Mean (%)	Rate ratio (95% CI)[a]	Games Mean (%)	Rate ratio (95% CI)[a]	Social Mean (%)	Rate ratio (95% CI)[a]	Internet Mean (%)	Rate ratio (95% CI)[a]	Back-ground Mean (%)	Rate ratio (95% CI)[a]	Other Mean (%)	Rate ratio (95% CI)[a]
All participants	6.3 (27.0)	-	5.6 (23.9)	-	1.8 (7.8)	-	1.6 (6.9)	-	3.0 (12.8)	-	3.3 (14.0)	-
Gender												
Males	5.2 (17.7)	1 (Reference)	9.7 (32.8)	1 (Reference)	2.6 (8.8)	1 (Reference)	2.1 (7.0)	1 (Reference)	4.0 (13.4)	1 (Reference)	4.0 (13.5)	1 (Reference)
Females	7.5 (45.8)	1.45 (0.79–2.65)	0.9 (5.6)	0.10 (0.03–0.30)	1.0 (5.8)	0.37 (0.03–4.32)	1.1 (6.9)	0.55 (0.13–2.39)	1.9 (11.5)	0.48 (0.17–1.35)	2.5 (15.0)	0.62 (0.15–2.59)
Overweight status												
Not overweight	6.3 (24.6)	1 (Reference)	7.4 (29.0)	1 (Reference)	0.8 (3.2)	1 (Reference)	1.9 (7.6)	1 (Reference)	3.0 (11.9)	1 (Reference)	4.0 (15.5)	1 (Reference)
Overweight/obese	5.9 (28.6)	0.94 (0.63–1.40)	2.8 (13.5)	0.38 (0.20–0.71)	3.9 (18.7)	4.67 (0.91–23.94)	1.2 (5.6)	0.60 (0.16–2.29)	3.1 (14.9)	1.01 (0.30–3.44)	2.3 (11.3)	0.59 (0.23–1.52)
Ethnicity												
NZ European	5.3 (23.1)	1 (Reference)	6.0 (26.2)	1 (Reference)	1.9 (8.5)	1 (Reference)	1.6 (7.1)	1 (Reference)	2.6 (11.4)	1 (Reference)	3.8 (16.5)	1 (Reference)
Māori	9.0 (37.1)	1.71 (0.94–3.09)	5.2 (21.5)	0.87 (0.24–3.16)	2.1 (8.6)	1.07 (0.23– 4.95)	1.8 (7.5)	1.11 (0.31–3.96)	2.0 (8.4)	0.78 (0.21–2.87)	2.1 (8.5)	0.55 (0.12–2.51)
Pacific	9.3 (36.4)	1.76 (0.80–3.84)	3.5 (13.6)	0.58 (0.20–1.69)	0.8 (3.0)	0.39 (0.07–2.37)	1.3 (5.2)	0.81 (0.11–6.25)	6.5 (25.6)	2.50 (0.66–9.40)	1.5 (6.1)	0.41 (0.04–4.16)
Deprivation												
Low	5.8 (23.6)	1 (Reference)	6.3 (25.9)	1 (Reference)	1.7 (7.0)	1 (Reference)	1.8 (7.3)	1 (Reference)	3.1 (12.7)	1 (Reference)	3.8 (15.7)	1 (Reference)
High	8.5 (46.6)	1.48 (0.74, 2.96)	2.0 (10.8)	0.31 (0.10–1.00)	2.6 (14.1)	1.51 (0.57–4.03)	0.8 (4.1)	0.42 (0.08–2.24)	2.3 (12.9)	0.76 (0.21–2.71)	0.6 (3.3)	0.16 (0.04–0.57)

[a]Mutually adjusted for gender, overweight status, ethnicity and deprivation.

Table 4: Mean minutes per hour of screen use in the early afternoon, early evening and late evening (with % of screen time)

Screen use	Early afternoon (3 pm–5:30 pm)	Early evening (5:30 pm–8 pm)	Late evening (after 8 pm)
All screens	20.6 (100.0)	24.6 (100.0)	37.7 (100.0)
Television	6.6 (32.1)	11.6 (46.9)	26.3 (69.7)
Computer	7.0 (33.9)	8.4 (34.2)	7.2 (19.0)
Mobile	3.7 (17.8)	2.4 (9.8)	1.7 (4.4)
Tablet	3.3 (16.2)	2.2 (9.1)	2.6 (6.9)

Figure 1: (Top left) programme on television; (top right) gaming on computer; (bottom left) social activity on mobile device; (bottom right) multi-screen activity with unknown activity on mobile device and programme on television.

screens for several reasons, including tempering impatience while a device is loading, filtering out unwanted advertising and because it is enjoyable.[24] A recent review found limited research on multiple screen use in the literature,[2] although there is some evidence that multiple screen use is associated with poorer sleep quality than single screen use.[25]

While we found no associations by bodyweight, we found several patterns in screen use by other socio-demographic characteristics, which are largely consistent with previous studies. These include: higher rates of total, computer and gaming screen time among boys than girls;[35] lower computer use among children of higher deprivation, consistent with their lower access to computers;[36] and higher rates of television use among Pacific[6] and Māori children than NZ European children.[37] The differences by ethnicity and socio-economic deprivation add to previous concerns about "digital divides", characterised by differences in the nature of digital screen access by deprivation.[38] A surprising finding was more screen time on tablets among children of high deprivation than those of low deprivation, which may be explained by the lower cost of these devices compared to computers.

Our study identifies some strengths of wearable cameras for assessing screen time, which echo some of Smith et al.'s pilot study findings.[26] The method enabled the recording of children's screen use as they went about their day, potentially making this one of the first studies to do so. Differentiating between screen activities is important given evidence that the type of activity affects health outcomes.[1] The passive method of data collection also minimizes participant burden. This is particularly important for capturing mobile device use, which often occurs for brief periods of time and is likely under-reported in previous research. It also enables the study of any screen device that is in front of the child. However, cameras cannot determine where children are directing their attention. This presents a challenge for identifying children's engagement with "background" screens (e.g., televisions). Correctly identifying these activities may therefore require wearable cameras to be used alongside other methods, e.g., self-report or activity logs. The coding of images is also time intensive. While automated image recognition could expedite coding of some visual elements, this is less feasible for the variable nature of screen activities.

As well as the strengths of wearable cameras identified above, a key strength of this study was the high rate of image capture. Cameras worn in the Kids'Cam project captured images of children's surroundings approximately every 7 seconds, which was more than twice as frequent as previous research.[26] This likely yields a more accurate measure of brief bouts of screen activity (e.g., mobile phone use). Further, the sample size of 108 was considerably larger than previous research,[26] helping to identify the utility of this methodology on a larger scale.

The study has some limitations. It is possible that the 2014/2015 dataset may not accurately reflect current trends in screen type usage and screen activities, particularly since the COVID-19 pandemic. Our sample was limited to children of Māori, Pacific or NZ European ethnicity. To gather more comprehensive information, future studies should be designed to include New Zealand's other ethnic groups. As the cameras captured a median of 2 hours after school, we only recorded approximately a quarter of children's after-school time. Also, because we excluded 60 children with fewer than 30 minutes of image data, we do not know their use. Nevertheless, for the majority of children in the study, it is possible to see the nature of their screen use and determine that screens play a dominant role in the children's lives.

Conclusions

In this study, wearable cameras were used to explore the nature and extent of children's screen time. The approach enabled an objective and reliable assessment of screen activity across all types of screens, including multi-screen activity. Children in the study spent over one third of their after-school time using screens, with higher rates of screen time in the late evening period (after 8 pm). Most screen use involved watching programmes and gaming. The high rate of recreational screen time, including pre-bedtime, reinforces the need for consistent guidelines to promote healthy screen time behaviour among children. Further research is needed to monitor the impact of screens on children's wellbeing, including any socio-demographic differences, and for innovation in protecting children from harm in the online space.

AUTHOR INFORMATION
Belinda M Lowe: Department of Public Health, University of Otago Wellington.
Moira Smith: Department of Public Health, University of Otago Wellington.
Richard Jaine: Department of Public Health, University of Otago Wellington.
James Stanley: Department of Public Health, University of Otago Wellington.
Ryan Gage: Department of Public Health, University of Otago Wellington.
Louise Signal: Department of Public Health, University of Otago Wellington.

CORRESPONDING AUTHOR
Louise Signal: Public Health, University of Otago Wellington, 23a Mein St, Newtown, Wellington.
 E: louise.signal@otago.ac.nz

REFERENCES
1. Sanders T, Parker PD, Del Pozo-Cruz B, et al. Type of screen time moderates effects on outcomes in 4013 children: evidence from the Longitudinal Study of Australian Children. Int J Behav Nutr Phys Act. 2019;16(1):117. doi: 10.1186/s12966-019-0881-7.

2. Stiglic N, Viner RM. Effects of screentime on the health and well-being of children and adolescents: a systematic review of reviews. BMJ Open. 2019;9(1):e023191. doi: 10.1136/bmjopen-2018-023191.

3. Hale L, Guan S. Screen time and sleep among school-aged children and adolescents: a systematic literature review. Sleep Med Rev. 2015;21:50-58. doi: 10.1016/j.smrv.2014.07.007.

4. Walsh JJ, Barnes JD, Cameron JD, et al. Associations between 24 hour movement behaviours and global cognition in US children: a cross-sectional observational study. Lancet Child Adolesc Health. 2018;2(11):783-91. doi: 10.1016/S2352-4642(18)30278-5.

5. Hale L, Kirschen GW, LeBourgeois MK, et al. Youth Screen Media Habits and Sleep: Sleep-Friendly Screen Behavior Recommendations for Clinicians, Educators, and Parents. Child Adolesc Psychiatr Clin N Am. 2018;27(2):229-45. doi: 10.1016/j.chc.2017.11.014.

6. Galland BC, de Wilde T, Taylor RW, et al. Sleep and pre-bedtime activities in New Zealand adolescents: differences by ethnicity. Sleep Health. 2020;6(1):23-31. doi: 10.1016/j.sleh.2019.09.002.

7. Amran MS, Jamaluddin KA. Adolescent Screen Time Associated with Risk Factor of Fear of Missing Out During Pandemic COVID-19. Cyberpsychol Behav Soc Netw. 2022;25(6):398-403. doi: 10.1089/cyber.2021.0308.

8. Song HY, Kim JH. Smartphone Use Type, Fear of Missing Out, Social Support, and Smartphone Screen Time Among Adolescents in Korea: Interactive Effects. Front Public Health. 2022;10:822741. doi: 10.3389/fpubh.2022.822741.

9. Gupta M, Sharma A. Fear of missing out: A brief overview of origin, theoretical underpinnings and relationship with mental health. World J Clin Cases. 2021;9(19):4881-89. doi: 10.12998/wjcc.v9.i19.4881.

10. Newall M. Cyberbullying: A Global Advisor Survey [Internet]. USA: Ipsos Public Affairs; 2018 [cited 2023 Jun 23]. Available from: https://www.ipsos.com/sites/default/files/ct/news/documents/2018-06/cyberbullying_june2018.pdf.

11. Cataldo I, Lepri B, Neoh MJY, et al. Social Media Usage and Development of Psychiatric Disorders in Childhood and Adolescence: A Review. Front Psychiatry. 2020;11:508595. doi: 10.3389/fpsyt.2020.508595.

12. Wilkinson C, Low F, Gluckman P. Screen Time: The effects on children's emotional, social and cognitive development [Internet]. The University of Auckland – Koi Tū: The Centre for Informed Futures; 2021 [cited 2023 Jun 15]. Available from: https://informedfutures.org/wp-content/uploads/Screen-time-The-effects-on-childrens-emotional-social-cognitive-development.pdf.

13. Odgers C. Smartphones are bad for some teens, not all. Nature. 2018;554(7693):432-34. doi: 10.1038/d41586-018-02109-8.

14. Canadian Paediatric Society, Digital Health Task Force, Ottawa, Ontario. Screen time and young children: Promoting health and development in a digital world. Paediatr Child Health. 2017;22(8):461-77. doi: 10.1093/pch/pxx123.

15. Sultana A, Tasnim S, Hossain M, et al. Digital screen time during the COVID-19 pandemic: a public health concern. F1000Research. 2021;10(81) doi: 10.12688/f1000research.50880.1.

16. World Health Organization. Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age [Internet]. Geneva: World Health Organization; 2019 [cited 2023 Jun 15]. Available from: https://apps.who.int/iris/bitstream/handle/10665/311664/9789241550536-eng.pdf.

17. Te Whatu Ora – Health New Zealand. Physical Activity [Internet]. Manatū Hauora – Ministry of Health: 2017 [cited 2021 Feb 21]. Available from: https://www.health.govt.nz/our-work/preventative-health-wellness/

physical-activity#kids.

18. Queensland Government. Screen time guidelines [Internet]. 2019 [cited 2020 Oct 2]. Available from: https://growinggoodhabits.hw.qld.gov.au/need-to-know/screen-time-guidelines/.

19. Shifrin D, Brown A, Hill D, et al. Growing up digital: media research symposium. 2015 [cited 2023 Jun 15]. Available from: https://www.semanticscholar.org/paper/Growing-Up-Digital%3A-Media-Research-Symposium-Shifrin-Hill/fa7630faa9f2c16e0fc59534573b2346d39b1bb9.

20. Netsafe. Screen time advice for parents [Internet]. 2019 [cited 2020 Oct 2]. Available from: https://www.netsafe.org.nz/screen-time/.

21. COUNCIL ON COMMUNICATIONS AND MEDIA. Media Use in School-Aged Children and Adolescents. Pediatrics. 2016;138(5):e20162592. doi: 10.1542/peds.2016-2592.

22. Scharkow M. The accuracy of self-reported internet use-a validation study using client log data. Commun Methods Meas. 2016;10(1):13-27. doi: 10.1080/19312458.2015.1118446.

23. Orben A, Przybylski AK. Screens, Teens, and Psychological Well-Being: Evidence From Three Time-Use-Diary Studies. Psychol Sci. 2019;30(5):682-96. doi: 10.1177/0956797619830329.

24. Jago R, Sebire SJ, Gorely T, et al. "I'm on it 24/7 at the moment": a qualitative examination of multi-screen viewing behaviours among UK 10-11 year olds. Int J Behav Nutr Phys Act. 2011;8:85. doi: 10.1186/1479-5868-8-85.

25. van der Schuur WA, Baumgartner SE, Sumter SR, et al. Media multitasking and sleep problems: a longitudinal study among adolescents. Comput Hum Behav. 2018;81:316-24. doi: https://doi.org/10.1016/j.chb.2017.12.024.

26. Smith C, Galland BC, de Bruin WE, et al. Feasibility of Automated Cameras to Measure Screen Use in Adolescents. Am J Prev Med. 2019;57(3):417-24. doi: 10.1016/j.amepre.2019.04.012.

27. Signal LN, Smith MB, Barr M, et al. Kids' Cam: an objective methodology to study the world in which children live. Am J Prev Med. 2017;53(3):e89-e95. Signal LN, Smith MB, Barr M, et al. Kids' Cam: an objective methodology to study the world in which children live. Am J Prev Med. 2017;53(3):e89-e95.

28. Salmond C, Crampton P, King P, et al. NZiDep: a New Zealand index of socioeconomic deprivation for individuals. Soc Sci Med. 2006;62(6):1474-85. doi: 10.1016/j.socscimed.2005.08.008.

29. Cole TJ, Lobstein T. Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. Pediatr Obes. 2012;7(4):284-94. doi: 10.1111/j.2047-6310.2012.00064.x.

30. Robinson TN, Banda JA, Hale L, et al. Screen Media Exposure and Obesity in Children and Adolescents. Pediatrics. 2017;140(Suppl 2):S97-s101. doi: 10.1542/peds.2016-1758K.

31. Haghjoo P, Siri G, Soleimani E, et al. Screen time increases overweight and obesity risk among adolescents: a systematic review and dose-response meta-analysis. BMC Prim Care. 2022;23(1):161. doi: 10.1186/s12875-022-01761-4.

32. Brunton C, NZ On Air, BSA. Children's media use study [Internet]. 2015 [cited 2020 Aug 13]. Available from: https://www.bsa.govt.nz/oldsite/assets/Research/Childrens_Media_Report_2015_FINAL_for_publishing_2.pdf.

33. Harbard E, Allen NB, Trinder J, et al. What's Keeping Teenagers Up? Prebedtime Behaviors and Actigraphy-Assessed Sleep Over School and Vacation J Adolesc Health. 2016;58(4):426-32. doi: 10.1016/j.jadohealth.2015.12.011.

34. Riedel BW. Sleep Hygiene. In: Treatment of late-life insomnia. Thousand Oaks, CA, USA: Sage Publications; 2000.

35. Anderson SE, Economos CD, Must A. Active play and screen time in US children aged 4 to 11 years in relation to sociodemographic and weight status characteristics: a nationally representative cross-sectional analysis. BMC Public Health. 2008;8(1):366. doi: 10.1186/1471-2458-8-366.

36. Common Sense Media. The common sense census: media use by tweens and teens, 2019 [Internet]. 2019 [cited 2021 Feb 22]. Available from: https://www.commonsensemedia.org/research/the-common-sense-census-media-use-by-tweens-and-teens-2021.

37. Manatū Hauora – Ministry of Health. New Zealand Health survey - annual data explorer. 2019 [cited 2020 Apr 2], Available from: https://minhealthnz.shinyapps.io/nz-health-survey-2018-19-annual-data-explorer/_w_ab5b87da/#!/home.

38. Harris C, Straker L, Pollock C. A socioeconomic related 'digital divide' exists in how, not if, young people use computers. PLoS ONE. 2017;12(3):e0175011. doi: 10.1371/journal.pone.0175011.

Appendix 1: Kids'Cam Screens Annotation Manual—Image data

Research questions:

- What is the nature and extent of children's screen time during the after-school period on a typical weekday?
- What is the association between children's after school screen time, type and activity, and children's body weight, gender, ethnicity and socio-economic deprivation?

Annotation overview

The development of the annotation schedule for Kids'Cam Screens was based on observations made during scoping research. It was further informed by the annotation protocols the Kids'Cam food marketing project (hereafter Kids'Cam), and other projects that used wearable cameras (Barr et al., 2015; Doherty et al., 2012; Gemming et al., 2013). The bespoke software developed by Dublin City University for Kids'Cam was adapted for use in Kids'Cam Screens. It required a three-tiered, "tree" > "branch" > "leaf" annotation scheme. An example of the software is shown in Figure 1. The left panel shows the three-tier annotation panel, while images for each hour are shown on the right. A calendar can be seen in the top left corner to navigate day and date of the images shown. Images captured during the designated time period from every eligible participant totalled 120,780. Every image was reviewed for the instance of a screen, the screen type and activity carried out, and annotated accordingly. For Kids'Cam Screen Time the three-tiered annotation scheme of "setting" > "screen type" > "activity" was used.

Figure 1: Example of annotation software interface.
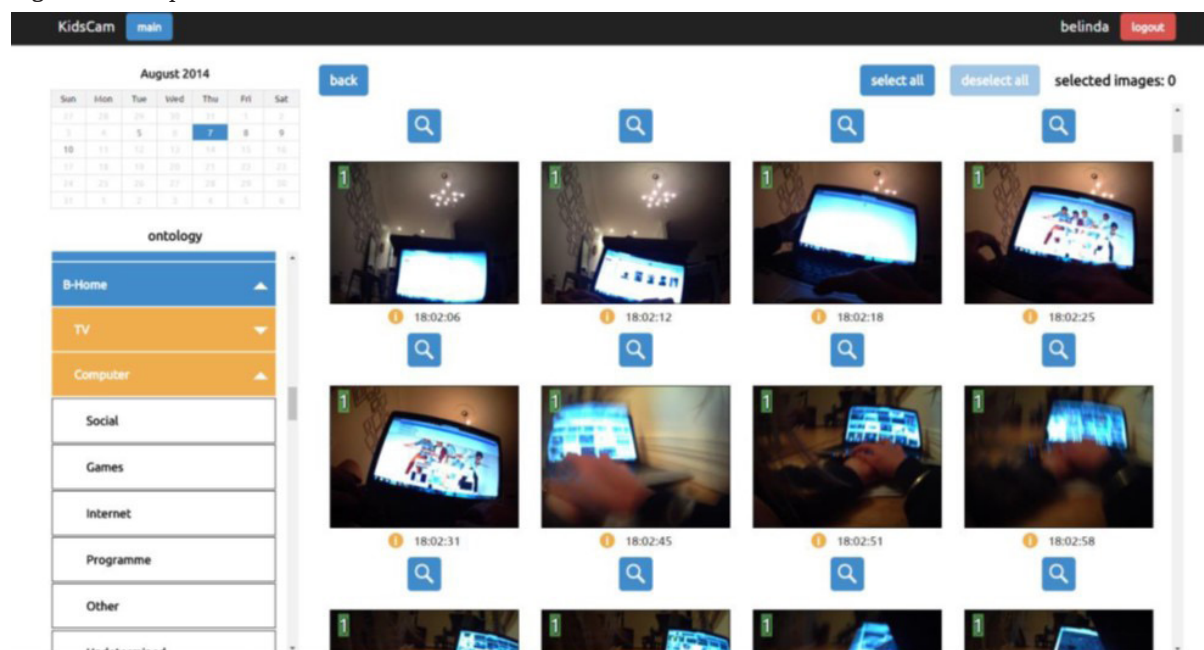
Study definitions

Table 1: Kids'Cam Screens setting annotations and corresponding definitions.

Setting	Definition
Home	Includes all spaces within the home gates and boundaries i.e., indoor and outdoor spaces; or someone else's home
Community venue	Library Recreation centre/community hall— a public space where meetings are held Marae—includes the meeting house, dining hall, education and associated facilities and residential accommodation associated with the marae Church
Street	On the street, outside private property or a community venue or retail store
Food retail	A retail store that sells food. Includes supermarkets, cafes, bakeries, etc.
Other retail	General product retailers whose primary purpose is something other than food retail
Outdoor recreation space	Parks—characterised by the presence of large, open, grassed spaces, possibly with some equipment such as climbing frames or playgrounds (not primarily used for organised sport) Walking track—characterised by in-bush or off-road areas such as the town belt Beach River
Private transport	Inside a car, van or truck
Public transport—facility	Associated with public transport facilities—e.g., bus shelters, train stations, airports etc.
Public transport—vehicle	Inside a bus, train, airplane, ferry

Table 2: Screen categories and corresponding definitions.

Medium	Definition
Television (TV)	Generally an electronic screen that could stand alone, or mounted to the wall
Computer	Includes desktop computer and laptops
Tablet	An electronic screen that does not require a keyboard or mouse, most commonly used for surfing the internet and running applications: e.g., iPads or Samsung Galaxy tablets
Mobile device	A handheld device, most commonly used for surfing the internet and running applications. Includes smart phones and iPods

Table 3: Screen-based "activity" annotations and corresponding definitions for Kids'Cam Screen Time.

Activity	Definition
Programme	Watching any form of programme or movie; this activity was most common on a television screen
Games	Content of the screen appeared to present some goal or objective, with rules and restrictions around obtaining it
Social	Activities that involved interacting with others. Encompassed activities such as Facebook, Instagram, Snapchat, text-messaging, etc., and were most often carried out on mobile devices, tablets and computers
Internet	Using websites other than those used for social or gaming activity; included online shopping and watching videos on YouTube
Background	When a screen was present in the child's immediate vicinity; however, the child did not appear to be fully engaged with it, but could still be influenced by it
Other	During the scoping study it was determined that an "Other" annotation would be required to describe any screen-based activity other than those described above, such as listening to music on iTunes, or running offline programmes such as Microsoft Word and Microsoft PowerPoint
Undetermined	Images where it was clear the child was engaging with a screen (see page 80), but the annotator was uncertain what was occurring on the screen: this situation most commonly occurred due to an interference of light

Logging in as User

1) Type in the Kids'Cam URL (http://139.80.145.170) into the web browser (*Google Chrome)* of a computer connected to the University of Otago Server.
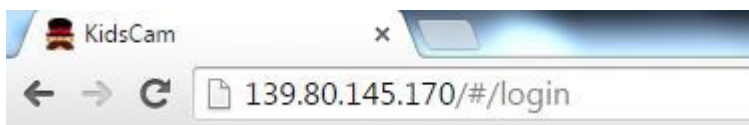
2) Type in your username and password to access the photos you have been personally assigned.

Accessing photos

1) Once logged in, your assignments will appear. In order to access a participant's photos click on the annotate button.

2) Next click on the date you are interested in using the calendar function and then select the time by clicking on the appropriate hour.

Annotating an image

1) Annotations must be made after having magnified the image by clicking the magnify function. Further magnification is permitted if necessary by clicking on the image once. The image will appear in a new tab fully magnified.
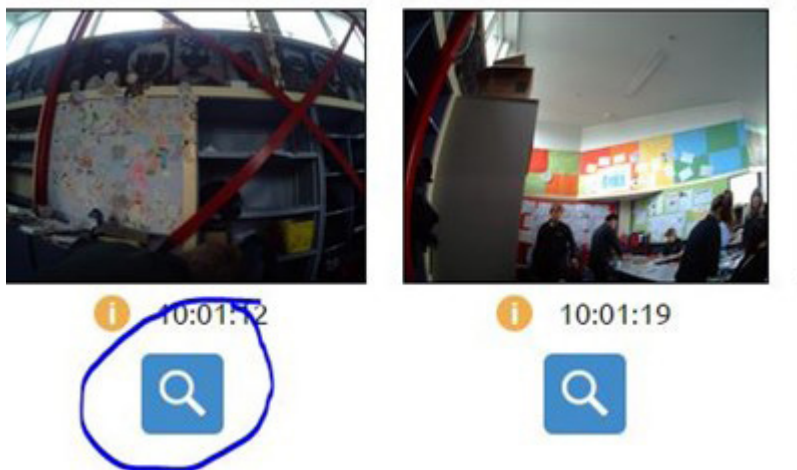
2) Alternatively, you can zoom in 300%; then the thumbnails become the same size as a magnified image and magnification is not required in order to code.
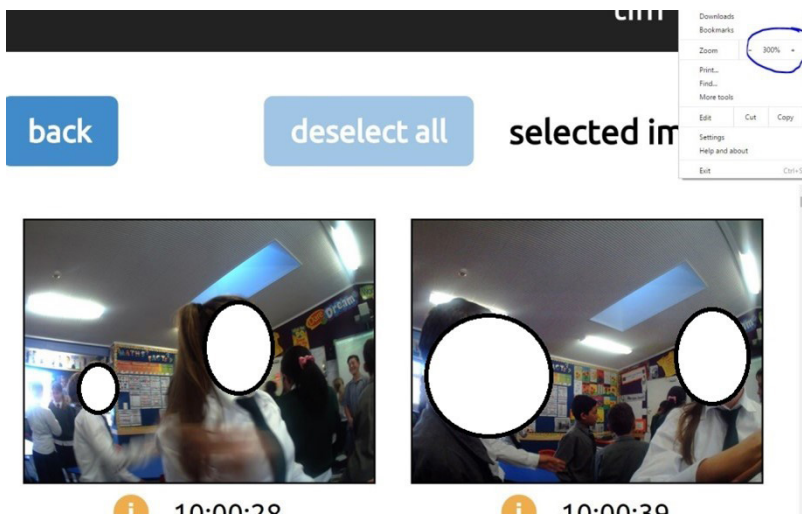
3) In order to annotate an image you **must click out of the magnified image** and click on the image you wish to annotate. Selection is symbolised by the blue border.
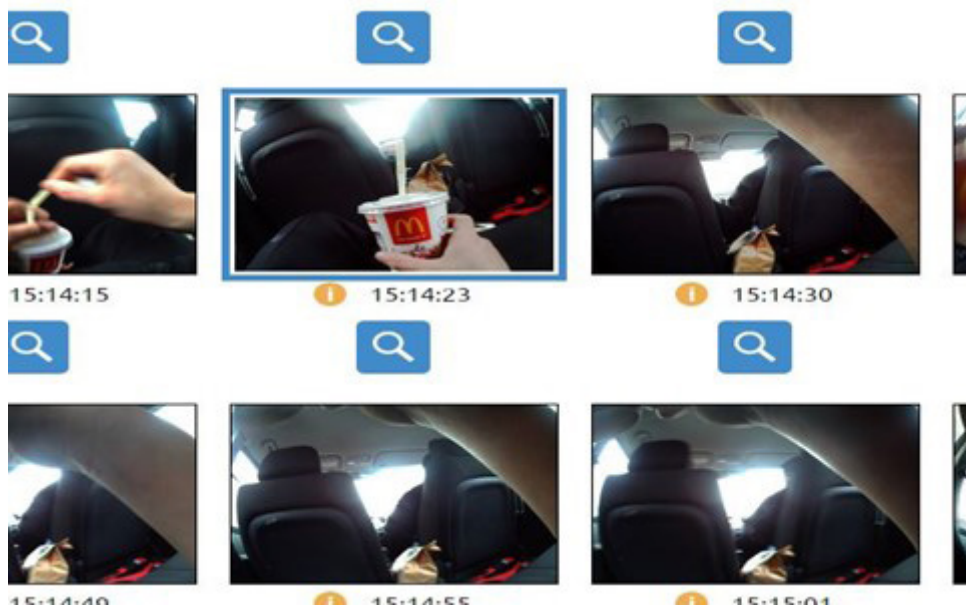
4) Annotators are to code images in the following sequence:
 Setting > Screen type > Screen activity
5) First the image must be coded for setting (see setting definitions) using the annotation ontology bar to the left of your screen.
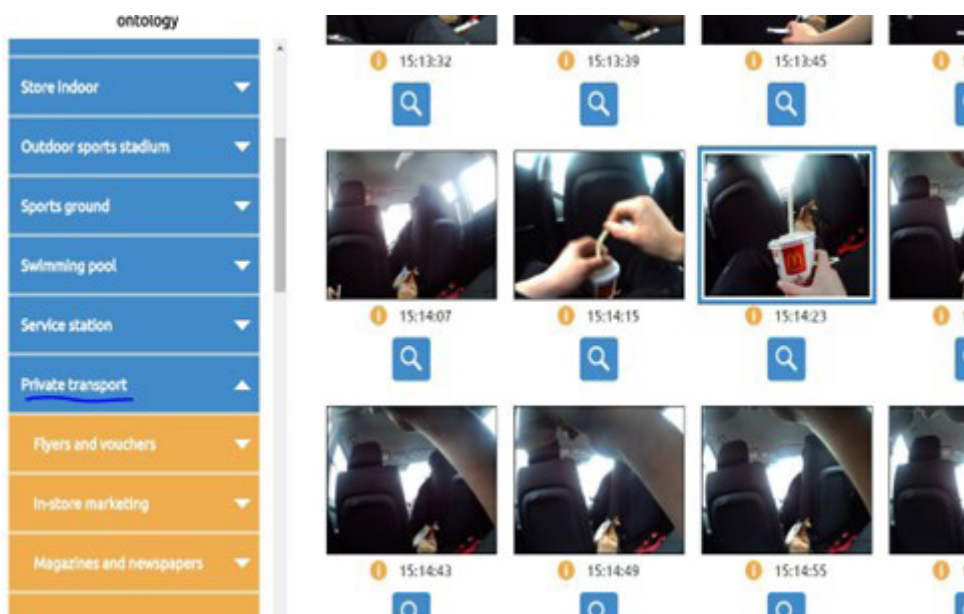
6) Once setting is selected, the ontology will open up a selection of screen types. Once determined (see definitions) select the appropriate screen type.
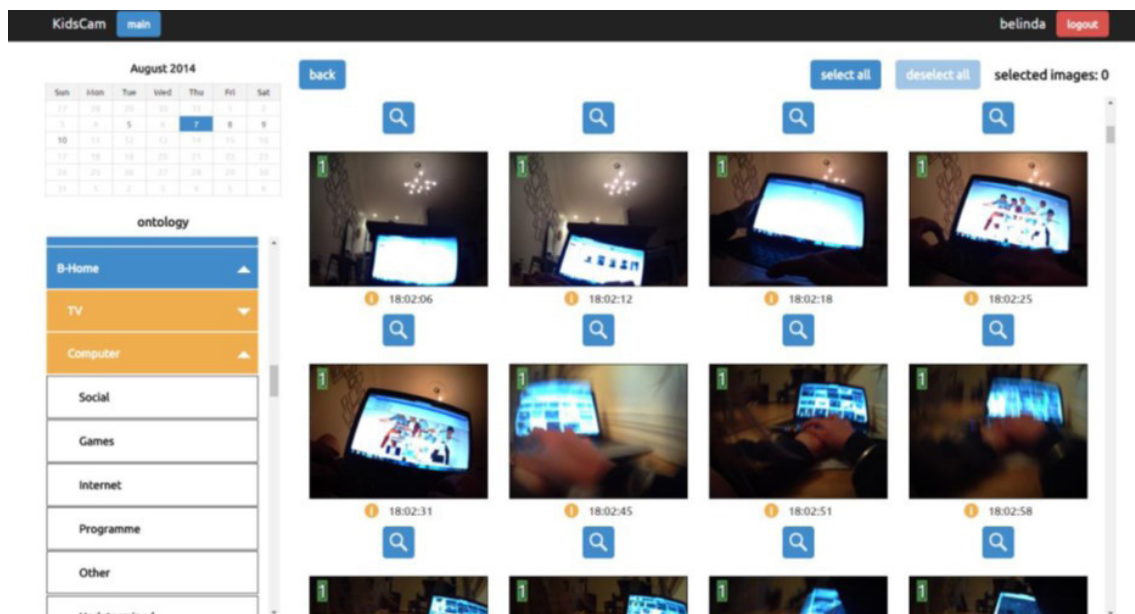
7) Once the screen type is selected a range of screen activities will appear. Once determined (see definitions) select the appropriate activity and the photo will be annotated. A green marker will appear to inform you the image has been annotated.

8) Make sure you deselect the images before making another annotation by hitting the "deselect" button.
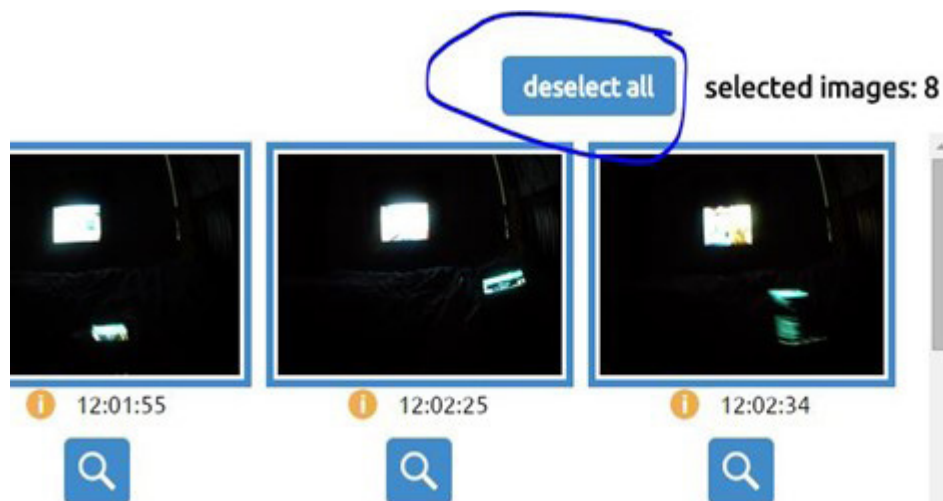
9) To delete an annotation, select the photos you want to remove the annotations from. Then pull curser over highlighted ontology level and a red X will appear. Click the X.

Multiple screen use

Multiple screen use is defined as the use of any two or more screen mediums in an image, e.g., watching television while playing on a tablet. Figure 2 shows an example of a child using two screen types simultaneously.

Figure 2: Example of an image that would be annotated as "Home" > "Television" > "Programme" and "Home" > "Mobile Device" > "Unknown".
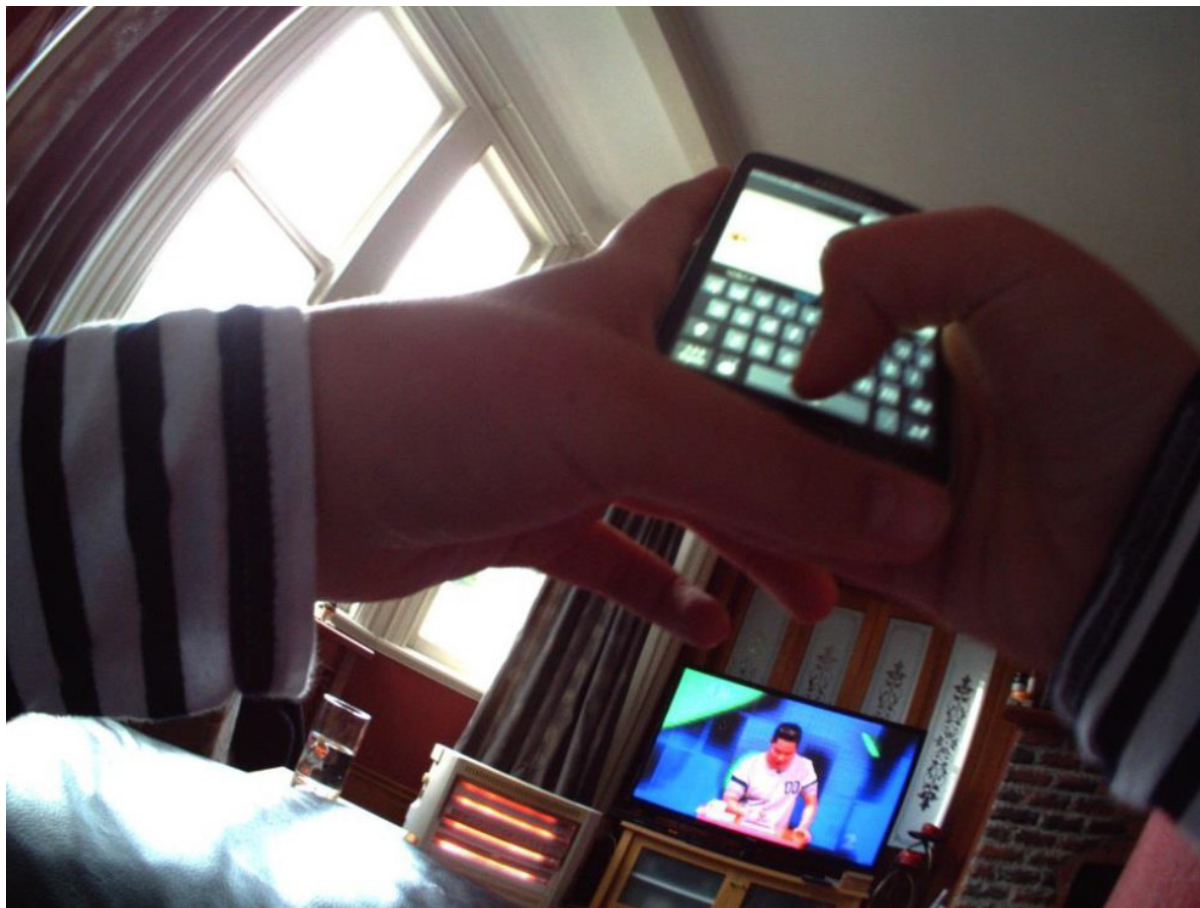
Blurry and blocked images

During the scoping study, it was observed that within a sequence of images containing a screen, some images were completely blocked. Such instances occurred when, for example, the participant was watching television, the camera flipped and images were taken while the camera was lying flat against the child's torso, or the camera fell behind a blanket or sweatshirt. In the event of a completely blocked image, the 18-image rule was devised to ensure consistency throughout the analysis process.

The 18-image rule states that a series of fully blocked images can be counted as screen time if the images before and after the blocked image show a screen, and that no more than 18 images (approximately 2–3 minutes) occur in between. If more than 18 blocked images occur between two images with screens, the blocked images cannot be included as screen time; they are also removed from total time. The rule, and the choice of 18 images, was based on previous wearable camera research. The SenseCam Coding Manual produced by The University of California, San Diego, USA, used a 10-image rule (the equivalent of 3 minutes, given reduced image-taking frequency of the cameras used in the study) when coding for physical activity and environment. The authors thought 3 minutes was justified, as a change in context or environment is unlikely in that time period (Doherty et al., 2012).

The images in Figure 3 illustrate how the 18-image rule was implemented for fully blocked images in Kids'Cam Screen Time. The first image shows that the child is watching television. In the two following images, the camera has fallen behind a blanket, and thus the annotator cannot be certain that the child is still watching the television. However, the subsequent images show the television in plain sight again. In this instance, all four images would be annotated as "Home" > "Television" > "Programme". If, however, 19 or more images elapsed between the images in which the television is seen, the blocked images would be annotated as "Uncodable", and also excluded from total time. The argument for the 18-image rule is that even if the television was obstructed for up to 18 images (2–3 minutes), if an image showing the screen on appears subsequently, it is unlikely the screen was switched off.

Figure 3: Series of 6 images that would all be annotated 'Home' > 'Television' > 'Programme'.
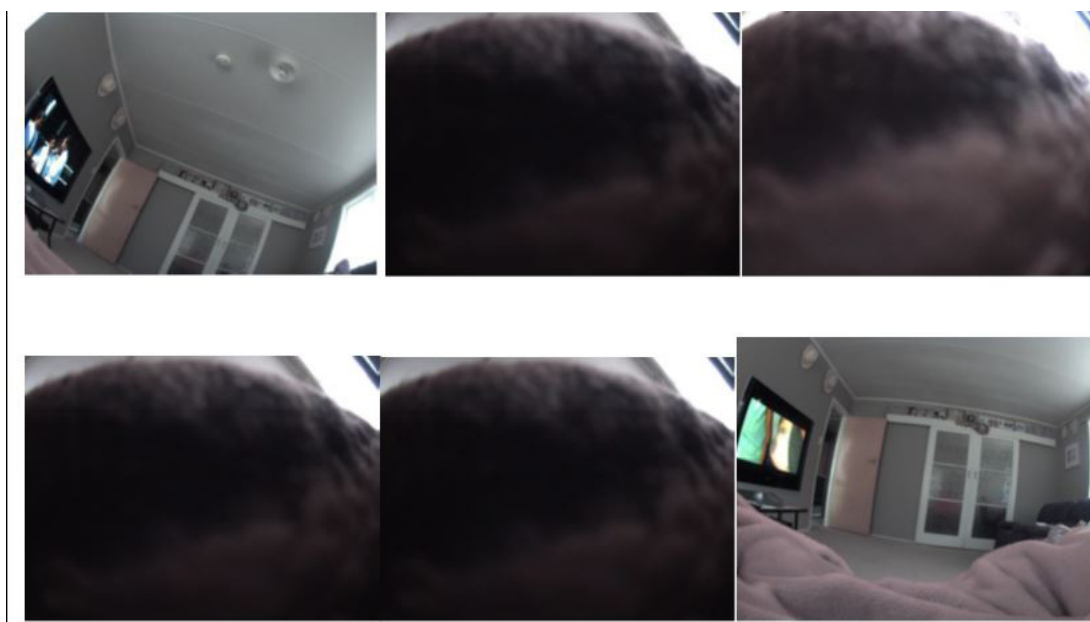
Computers

1) Images are only to be coded using an external computer screen no larger or smaller than 22'. Do not code using a laptop screen or the Kids'Cam server screen.

2) **Always** use the *Google Chrome* internet browser to access and analyse the images, as the annotation framework has been optimised for this platform.

Data analysis rules

For images that are separated by less than 1 second, the first image will be counted towards the data analysis. Any subsequent images within the 1-second time lapse will be removed from the analysis.

Ethics

1. Keep the identifiable features of the data **confidential;** these features of the data should not be discussed with anyone outside the research team.

2. Do not leave data or equipment containing unsecured data unattended. If you leave your computer for any amount of time you must **log out.**

3. The University of Otago possesses ownership of all image data. Applicants cannot copy data without the written approval of the Principal Investigator or retain copies of the data after completion of work. Any data copied or released must be stored on a password-protected device and must have gone through the appropriate anonymised procedure.

4. Protect the anonymity of all participants, third parties and their environments. To protect the privacy of those who may be inadvertently captured in the images, all images used in disseminated material will have identifiable people, street names, places, retail outlets, businesses and school names blurred. The demographic information collected will only be viewed by the core Kids'Cam team.

References

Barr, M., Signal, L., Jenkin, G., & Smith, M. (2015). Capturing exposures: using automated cameras to document environmental determinants of obesity. Health Promotion International, 30(1), 56-63.

Doherty, A. R., Kelly, P., Kerr, J., Marshall, S., Oliver, M., Badland, H., & Foster, C. (2012). Use of wearable cameras to assess population physical activity behaviours: an observational study. The Lancet, 380, S35.

Gemming, L., Doherty, A., Kelly, P., Utter, J., & Mhurchu, C. N. (2013). Feasibility of a SenseCam-assisted 24-h recall to reduce under-reporting of energy intake. European journal of clinical nutrition, 67(10), 1095-1099.

Description and accuracy of antibiotic allergy labels at North Shore Hospital

Liam D Kelly, Tim Cutfield, Kerry Read

ABSTRACT

AIMS: Antibiotic allergy labels are common and associated with adverse care. Most people with an antibiotic allergy label are found to be non-allergic on investigation. The aims of this study were to evaluate the burden and accuracy of antibiotic allergy labels at North Shore Hospital and to identify and assess beta-lactam specific allergies, and the potential impact of an inpatient antibiotic allergy service.

METHODS: An evaluation of documented inpatient adverse drug reaction (ADR) labels. Structured assessment of beta-lactam allergies was undertaken using the Austin Health tool.

RESULTS: Three hundred and seven patients were reviewed; 78 patients had an antibiotic allergy label, with 102 individual labels. Fifty-five of these 78 patients underwent structured assessment. Forty-four patients had a beta-lactam-specific antibiotic allergy label. Using the Austin Health tool, 9/44 (20%) of beta-lactam-specific allergy labels could have been removed following a history alone and a further 16/44 (36%) would have been appropriate for direct oral challenge. Antibiotic allergy label accuracy was 64% for beta-lactam antibiotics, and 69% for non-beta-lactams.

CONCLUSIONS: The prevalence of antibiotic specific allergies in our centre was similar to New Zealand and Australian statistics.[1,2] Our study showed that a significant proportion of inpatients with a beta-lactam-specific allergy could be de-labelled on history or with a single dose challenge.

Antibiotic allergies are a very frequently reported adverse drug reaction (ADR) subset in the general population, with an estimated 10% of the general adult population reporting having a penicillin allergy. However, less than 1% of people are confirmed as having an immunoglobulin E (IgE) medicated penicillin allergy when formally tested. Unfortunately, there is both a lack of availability of and awareness of antibiotic allergy testing services in Australia and New Zealand.[3] In hospitals, approximately 25% of patients who require antimicrobial therapy report an allergy to at least one antimicrobial agent.[4] Having an antibiotic allergy "label" is associated with an increased use of less tolerable, more costly alternative "second line" antibiotics, longer hospitalisations, higher total healthcare costs, increased *Clostridioides difficile* infections, increased resistant organism colonisation and increased mortality.[5,6–9]

North Shore Hospital is a 663-bed tertiary care academic centre in Auckland, New Zealand. Each year 46,000 people present to the emergency department, with another 15,000 seen in the Assessment and Diagnostics Unit.[10,11] The use of MedChart Electronic Medication Management version 8.3.1 provided by Dedalus (MedChart)

allows for the identification of patients who report having an adverse reaction to any medication once a history has been taken from them by their admitting doctor and pharmacist. Although remote specialist allergy advice is available from another hospital in the Auckland Region, at North Shore Hospital there is currently no mechanism for routine inpatient evaluation and validation of antibiotic allergy labels. The benefit of such a service has already been demonstrated in Auckland: 80% of patients in Middlemore Hospital with a label of "penicillin allergy" safely had their penicillin label removed, including 64% removed by a structured allergy history alone.[12] This study echoes the growing body of international evidence that similarly supports the removal of antibiotic allergy labels by both non-specialist and allergy-specialised services using verified antibiotic assessment tools.[13–16] An adverse drug reaction encompasses all adverse events related to a medication and its administration, while an allergy is restricted specifically to an IgE-mediated reaction. We wanted to identify the accuracy of documented antibiotic allergies and ADRs in inpatients at our institute, and to assess the potential impact of an antibiotic allergy evaluation service on antibiotic allergy labels.

Methods

Medical and surgical staff admitting patients to North Shore Hospital are required to ask about patients' allergies and adverse drug reactions, which are then recorded in the patient's MedChart record. In addition, medication reconciliation is performed for all admitted patients, with the patient's usual medications and any pre-existing allergies and ADRs confirmed and documented by a clinical pharmacist. This information is then uploaded onto the MedChart system. ADRs are uploaded as either an allergy or an intolerance. We documented all antibiotic-specific ADRs and all beta-lactam-specific allergies.

With reference to the *Ethical Guidelines for Observational Studies: Observational research, audits and related activities* (NEAC 2012), this study did not meet the threshold of requiring review by a Health & Disability Ethics Committee. The study was granted Waitematā District Health Board Locality Authorisation (ref: RM14304)

We conducted a study of adult medical and surgical inpatients in North Shore Hospital between October and September 2019. Prior to the study, the interviewing investigator received training in antibiotic allergy assessment by experienced clinicians. The beta-lactam antibiotic allergy assessment tool (AAAT) developed at Austin Health, Melbourne, Australia was utilised for this project. This is a validated tool developed to aid non-allergists in the assessment and management of all patients with reported beta-lactam allergies. Using patient-reported signs and symptoms, the tool phenotypes the reaction according to what system is affected, when and for how long, and what the reaction was. An appropriate management strategy is then recommended. After training, the interviewing investigator was assessed for their ability to correctly determine an antibiotic allergy phenotype and make a recommendation on the appropriate management strategy for the identified phenotype using a series of published clinical scenarios specifically designed for this purpose. In choosing to utilise the Austin Health AAAT, we focussed our investigation on beta-lactam specific allergies. This AAAT was selected as it is a point-of-care tool that can be easily used by a spectrum of non-allergist healthcare professionals.[15]

The interviewing investigator alternated between medical and surgical wards throughout the study. Every week, using MedChart, the ADR histories of all patients on the chosen ward were reviewed. Patients' age, gender and ethnicity data were collected. The total number of medication allergies and ADRs were recorded, with specific recording of culprit antibiotics (by antibiotic class). Patients without an ADR history were excluded. Patients with a documented antibiotic specific allergy were approached for a detailed allergy interview, during which they were asked to describe the documented allergy and to quantify when the reaction had occurred. The Austin Health tool enabled us to phenotype each reported reaction to beta-lactam antibiotics.[15] This allowed us to identify which patients could have their label removed by history alone (direct de-labelling), those who were appropriate for a supervised oral penicillin challenge, those who were suitable for skin testing followed by oral rechallenging and those who required further specialist assessment. The accuracy of pre-existing antibiotics ADRs and allergies was assessed by comparing the medication and information documented in MedChart with the history given by the patients.

Inclusion criteria were adults aged 18 years and above who were admitted under the general medical, orthopaedic or general surgical services, and who had at least one ADR label recorded on MedChart. Patients were not approached for a detailed allergy history if they were physiologically unstable at the time of interview, declined an interview or were unable to provide an accurate history, including those with significant cognitive impairment where no collateral could be obtained, or if there was a language barrier where no interpreter was available to accurately interview the patient.

Interpretation and statistical analysis

The outcomes of interest were the proportion of inpatients with antibiotic ADR labels, the amount of beta-lactam-specific antibiotic allergy labels, the accuracy of these beta-lactam antibiotic allergy labels and the proportion of patients with beta-lactam antibiotic allergy labels that might be appropriate for "direct de-labelling" or direct oral antibiotic challenge. Descriptive and comparative statistical analyses were performed using IBM SPSS version 25 (IBM Corporation, Armonk, NY). Inter-group differences between patients with "any ADR label", patients with antibiotic ADR labels who were interviewed and patients with antibiotic ADR labels who were not interviewed were analysed using ANOVA (age) and Fisher's exact tests (sex, ethnicity).

Results

A total of 307 patients were reviewed. One hundred and sixty-nine out of 307 (55%) of these patients had a recorded ADR. Seventy-eight out of 169 (25%) had an antibiotic-specific allergy. Of these 78 patients, 55/78 (71%) did not meet any of the exclusion criteria so were interviewed (Figure 1).

There were 102 antibiotic allergy labels in total recorded for the 78 inpatients. Penicillins were the most frequently recorded antibiotic allergy class with 54/102 (53%), followed by macrolides with 11/102 (11%), sulphonamides with 10/102 (10%), and cephalosporins with 6/102 (6%). There were 21/102 (20%) antibiotic-specific allergies from other classes.

Beta-lactam phenotypes and recommended management

In the interviewed cohort of 55 patients, we identified and phenotyped 47 beta-lactam-specific antibiotic allergies (41 penicillin and 6 cephalosporin) in 44 patients. The most described beta-lactam allergy phenotypes were dermatological (n=27, 57%) (Table 2). There were four (9%) respiratory or systemic reactions, two (4%) were haematological, eight (17%) were gastrointestinal and six (13%) were unknown. There were two patients (4%) with beta-lactam-specific allergies that were not covered by the Austin Health Tool: one had a report of bradycardia associated with amoxicillin-clavulanate, and one reported myalgia associated with penicillin use. Neither of these reactions were assessed as likely to be mediated by drug allergy, and therefore would also be appropriate for supervised direct oral challenge.

After phenotyping the 44 patients with beta-lactam-specific allergies, the Austin Health Tool recommended the following management: nine patients (20%) were appropriate for direct de-labelling, 16 patients (36%) were appropriate for a supervised direct oral challenge, 14 patients (32%) were appropriate for inpatient skin testing before oral challenge and three patients (7%) were deemed appropriate for outpatient specialist antibiotic allergy assessment and/or testing.

Figure 1: Patient selection process.
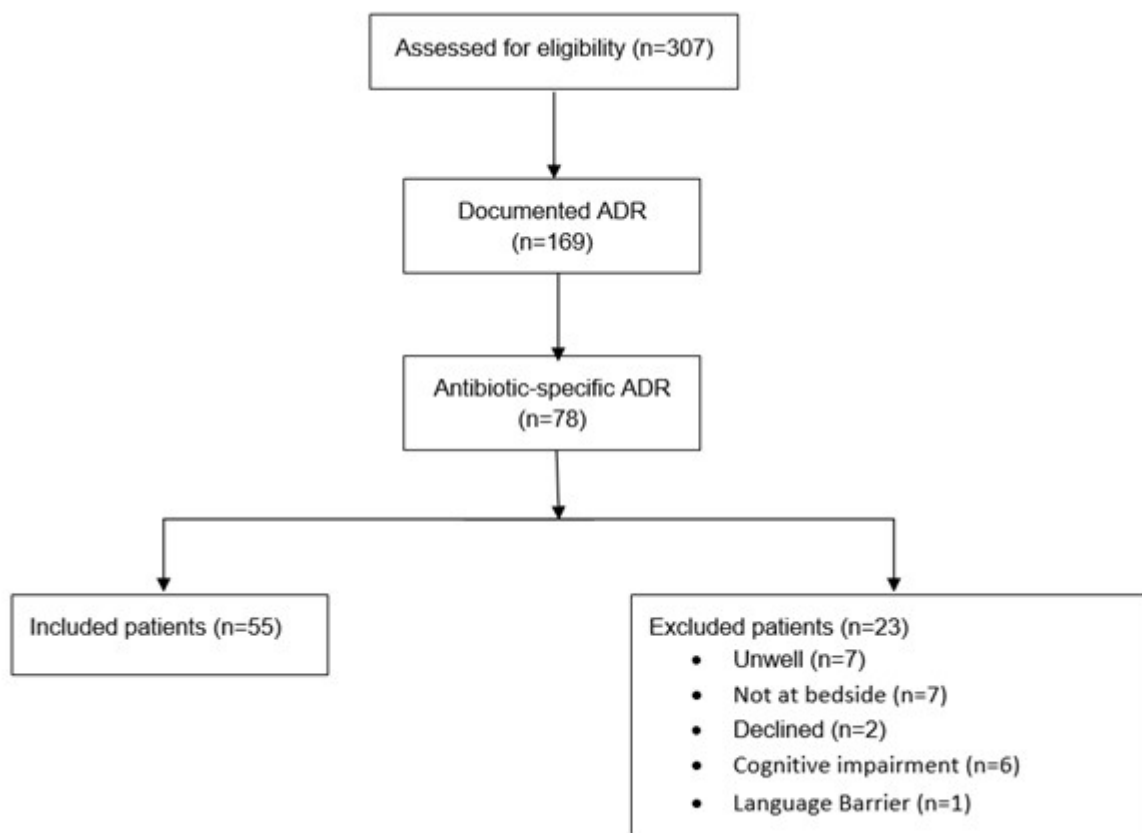
Table 1: Comparative demographics between patients with any adverse drug reaction label and both interviewed and non-interviewed patients with antibiotic-allergy labels.

Demographics	Any ADR label (n=169)	Antibiotic specific allergy interviewed (n=55)	P-value
Median age, years (IQR)	76 (64–86)	77 (63–88)	0.22
Female	100 (60%)	35 (64%)	0.89
Ethnicity			
NZ European	117 (69%)	38 (69%)	0.97
Other European	31 (18%)	11 (20%)	
Pacific Islands	9 (5%)	2 (4%)	
Māori	6 (4%)	2 (4%)	
Asian	6 (4%)	2 (4%)	

Table 2: Austin Health Tool dermatological phenotypes in patients with beta-lactam adverse drug reactions.

Clinical manifestations		Number (%) of patients (n=27)
Childhood exanthem[&]		1 (4)
Immediate diffuse rash [%]		1 (4)
Diffuse rash or localised rash with no other symptoms [#]	Within the last 10 years	2 (8)
	Over 10 years ago	12 (48)
Rash and mucosal ulceration		1 (4)
Pustular, blistering or desquamating rash		2 (8)
Angioedema		8 (32)

[&] Details of rash timing with antibiotic course unknown, with no severe features or hospitalisation.

[%] Immediate considered to be within 2 hours of first dose.

[#] Onset after first 24 hours of beginning the antibiotic course.

Accuracy of recorded antibiotic labels

From the interviewed cohort of 55 patients, we compared all antibiotic specific allergies (n=73) recorded on MedChart against the allergy description obtained by structured allergy history. The accuracy of beta-lactam-specific allergies was 30/47 (64%), the accuracy of non-beta-lactam antibiotic allergy labels was 18/26 (69%). Overall, the accuracy of antibiotic allergy labels was 48/73 (66%).

Discussion

Our study shows that antibiotic-specific allergy labels are common in the adult inpatient population at North Shore Hospital, with 25% of the overall inpatients having one or more antibiotic allergy MedChart label. This compares similarly with other international centres, with the National Antimicrobial Prescribing Survey in Australia finding a rate of 25% in their population.[2] Consistent with other literature, we found that

beta-lactams (penicillins 53%, cephalosporins 6%) were the class of antibiotic most commonly associated with antibiotic allergy labels.[4] Following a structured allergy assessment, a third of these beta-lactam allergies were found to be inaccurate.

While specialist allergist services are critical for the formal evaluation of complex patients or potentially life-threatening allergic reactions, there is increasing evidence to support the role of appropriately trained non-allergists in the identification, assessment and evaluation of patients with antibiotic allergies.[17] Such services have demonstrated that select, low-risk patients can safely undergo an oral beta-lactam challenge without prior skin testing and have found that over 90% of challenged patients tolerate penicillins.[18] In our study, we found that 39 (71%) beta-lactam-specific allergies would have been appropriate for assessment by a trained non-allergist: nine reactions could be de-labelled by history alone, and a further 30 reactions would have been suitable for either an oral antibiotic challenge or a skin test in order to be de-labelled. Incorporating a validated, reproducible tool such as the Austin Health tool in the routine evaluation and potential removal of allergy labels could be associated with benefits for patients (reduced morbidity and mortality), for the hospital (reduced cost and duration of inpatient stays) and for wider society (by avoidance of unnecessarily broad-spectrum antibiotic use).[13–16,19]

Together, these findings support the introduction of a service to undertake routine evaluation of beta-lactam allergy labels at North Shore Hospital. The training of front-line staff who undertake the initial medication history and medication reconciliation (medical, surgical, and pharmacy staff) in the routine use of an AAAT would be beneficial in terms of antibiotic stewardship and patient outcomes. Inequalities exist nationwide with regards to access to specialist allergy services. Routine use of an AAAT would aid to reduce the amount of people who are referred to these over-subscribed services. Looking more broadly, our study, as well as the Middlemore study, show that the regular use of an AAAT in hospitalised patients in New Zealand hospitals by non-allergy specialists is beneficial.[12] A national guideline outlining their role and use across New Zealand is lacking. The authors hope that studies such as ours will aid to change this.

This study is limited by its relatively small size from one hospital, which may skew our findings. North Shore Hospital has a lower proportion of Māori, Pacific Island and Asian ethnic groups than the general New Zealand population.[20] Our small sample size and differing ethnic breakdown could be factors that led to the discrepancy between the proportion of Middlemore patients who can be de-labelled by interview alone (64%) and of North Shore patients (20%). Recall bias of our participants must also be assumed in the description of ADRs, especially those from more than 10 years ago; however, this is not unique to our study, and other challenge studies have shown that such historic reactions can frequently be challenged safely.

Conclusion

We have shown that at our centre, recorded antibiotic allergies are very common, and frequently inaccurate. The introduction of a service for the routine evaluation of antibiotic allergies would be expected to significantly improve the delivery of best practice medicine to our clients. Importantly, the bulk of this service could be offered by staff that are already present and seeing these patients without the need for specialist intervention or referrals.

AUTHOR INFORMATION

Liam D Kelly: Respiratory Registrar, Mater Misericordiae University Hospital, Dublin, Ireland.

Tim Cutfield: Infectious Diseases and General Medicine Physician, Counties Manukau District Health Board, Auckland, New Zealand.

Kerry Read: Department of Medicine and Infectious Disease, Waitematā District Health Board, Auckland, New Zealand.

CORRESPONDING AUTHOR

Liam D Kelly: Respiratory Registrar, Mater Misericordiae University Hospital, Dublin, Ireland.
E: lk92lk92@gmail.com

REFERENCES

1. Cantrill JA, Cottrell WN. Accuracy of drug allergy documentation. Am J Health Syst Pharm. 1997 Jul 15;54(14):1627-9. doi: 10.1093/ajhp/54.14.1627.

2. Trubiano JA, Cairns KA, Evans JA, et al. The prevalence and impact of antimicrobial allergies and adverse drug reactions at an Australian tertiary centre. BMC Infect Dis. 2015 Dec 16;15:572. doi: 10.1186/s12879-015-1303-3.

3. Trubiano JA, Worth LJ, Urbancic K, et al. Return to sender: the need to re-address patient antibiotic allergy labels in Australia and New Zealand. Intern Med J. 2016 Nov;46(11):1311-1317. doi: 10.1111/imj.13221.

4. Lee CE, Zembower TR, Fotis MA, et al. The incidence of antimicrobial allergies in hospitalized patients: implications regarding prescribing patterns and emerging bacterial resistance. Arch Intern Med. 2000;160(18):2819-22. doi: 10.1001/archinte.160.18.2819.

5. Lin ,L Nagtegaal JE, Buijtels PCAM, Jong E. Antimicrobial stewardship intervention: optimizing antibiotic treatment in hospitalized patients with reported antibiotic allergy. J Hosp Infect. 2020;104(2):137-143. doi: 10.1016/j.jhin.2019.10.007.

6. Macy E, Contreras R. Health care use and serious infection prevalence associated with penicillin "allergy" in hospitalized patients: A cohort study. J Allergy Clin Immunol. 2014;133(3):790-6. doi: 10.1016/j.jaci.2013.09.021.

7. Blumenthal KG, Lu N, Zhang Y, et al. Recorded Penicillin Allergy and Risk of Mortality: a Population-Based Matched Cohort Study. J Gen Intern Med. 2019;34(9):1685-1687. doi: 10.1007/s11606-019-04991-y.

8. Huang KG, Cluzet V, Hamilton K, Fadugba O. The Impact of Reported Beta-Lactam Allergy in Hospitalized Patients With Hematologic Malignancies Requiring Antibiotics. Clin Infect Dis. 2018;67(1):27-33. doi: 10.1093/cid/ciy037.

9. Moran R, Devchand M, Smibert O, Trubiano JA. Antibiotic allergy labels in hospitalized and critically ill adults: A review of current impacts of inaccurate labelling. Br J Clin Pharmacol. 2019;85(3):492-500. doi: 10.1111/bcp.13830.

10. Manatū Hauora –Ministry of Health. North Shore Hospital [Internet]. [cited 2021 Dec 18]. Available from: https://www.health.govt.nz/your-health/certified-providers/public-hospital/north-shore-hospital.

11. Te Whatu Ora –Waitemata. Emergency Department (ED) - North Shore Hospital [Intenet. [cited 2021 Dec 18]. Available from: https://www.waitematadhb.govt.nz/hospitals-clinics/clinics-services/emergency-department-ed-north-shore-hospital/.

12. du Plessis T, Walls G, Jordan A, Holland DJ. Implementation of a pharmacist-led penicillin allergy de-labelling service in a public hospital. J Antimicrob Chemother. 2019 May 1;74(5):1438-1446. doi: 10.1093/jac/dky575.

13. Staicu ML, Vyles D, Shenoy ES, et al. Penicillin Allergy Delabeling: A Multidisciplinary Opportunity. J Allergy Clin Immunol Pract. 2020;8(9):2858-2868. e16. doi: 10.1016/j.jaip.2020.04.059.

14. Morjaria S, Inumerables F, Patel D, et al. Penicillin Allergy Testing: An Outpatient Nurse-Driven Program for Patients With Cancer. Clin J Oncol Nurs. 2021 Apr 1;25(2):143-150. doi: 10.1188/21.CJON.143-150.

15. Devchand M, Urbancic KF, Khumra S, et al. Pathways to improved antibiotic allergy and antimicrobial stewardship practice - the validation of a beta-lactam antibiotic allergy assessment tool. J Allergy Clin Immunol Pract. 2019;7(3):1063-1065. e5. doi: 10.1016/j.jaip.2018.07.048.

16. Sigona NS, Steele JM, Miller CD. Impact of a pharmacist-driven beta-lactam allergy interview on inpatient antimicrobial therapy: A pilot project.

J Am Pharm Assoc (2003). 2016;56(6):665-669. doi: 10.1016/j.japh.2016.05.005.

17. Ramsey A, Mustafa SS, Holly AM, et al. Direct Challenges to Penicillin-Based Antibiotics in the Inpatient Setting. J Allergy Clin Immunol Pract. 2020;8(7):2294-2301. doi: 10.1016/j.jaip.2020.02.033.

18. Blumenthal KG, Peter JG, Trubiano JA, Phillips EJ. Antibiotic allergy. Lancet. 2019 Jan 12;393(10167):183-198. doi: 10.1016/

S0140-6736(18)32218-9.

19. Hills T, Arroll N, Duffy E, et al. Penicillin Allergy De-labeling Results in Significant Changes in Outpatient Antibiotic Prescribing Patterns. Front Allergy. 2020 Dec 16;1:586301. doi: 10.3389/falgy.2020.586301.

20. Te Whatu Ora –Waitemata. Our Community [Internet]. [cited 2021 Dec 18]. Available from: https://www.waitematadhb.govt.nz/about-us/our-community/.

Ethnic group differences in patient satisfaction with GP services: findings from the New Zealand Attitudes and Values Study

Carol H J Lee, Chris G Sibley

ABSTRACT

AIM: To identify key predictors of general practitioner (GP) satisfaction and increase insight into the mechanisms behind ethnic health inequities in New Zealand.

METHOD: Regression analyses were conducted using data from the 2019 New Zealand Attitudes and Values Study (n=38,465).

RESULTS: Initially, Māori and Asian peoples showed lower, and Pasifika people showed no significant difference in GP satisfaction level relative to New Zealand (NZ) Europeans. However, after accounting for differences in patient-perceived GP cultural respect and GP ethnic similarity, Māori and Pasifika people showed higher and Asian peoples showed no difference in GP satisfaction level relative to NZ Europeans. These effects continued to hold when adjusting for a range of demographic factors. Subsequent regression analyses were conducted to investigate the impact of GP perceptions, GP satisfaction and demographic factors on healthcare access satisfaction and health status across ethnic groups. For all ethnic groups, GP satisfaction was the strongest predictor of satisfaction with access to healthcare. Higher GP satisfaction was also a significant predictor of higher self-rated health and lower psychological distress.

CONCLUSION: Lack of GP cultural respect is a key contributor to lower GP satisfaction among ethnic minorities, which can further exacerbate inequities in healthcare access and health outcomes. Interventions to enhance GPs' provision of culturally respectful and safe healthcare services may help reduce ethnic health inequities and improve population health.

In July 2022, a new national New Zealand health system was launched with the aim of delivering more "equitable", "accessible", "cohesive", and "people-centred" healthcare services.[1] The health system had previously failed to fulfil Te Tiriti o Waitangi obligations and long under-served Māori (the Indigenous population) and other minority groups.[2,3] Past studies indicate that ethnic minorities are less likely to have ethnic-concordant general practitioners (GPs), and often encounter cultural misunderstandings or racism in the primary healthcare setting.[4–8] Relative to New Zealand (NZ) Europeans (67.8% and 74.1%), ratings of high GP satisfaction and perceived cultural respect are lower among Māori (60.7% and 62.5%), Pasifika peoples (64.8% and 65.2%) and Asian peoples (59% and 60.8%).[8] (Note: The proportion of "high GP satisfaction" and "high GP cultural respect" are reported respectively for each ethnic group. All differences in proportions between NZ Europeans and ethnic minority groups were statistically significant, except for GP satisfaction between NZ European and Pasifika peoples).

As GPs are generally the first health professional one encounters in the health system, it is essential that they provide satisfactory and culturally respectful services to all patients. Lack of GP cultural awareness and respect can make it difficult for ethnic minorities to build rapport and comfortably discuss health concerns.[5,6] Perceived racism can further lead to higher unmet healthcare needs, and negative mental and physical health outcomes.[4,9–11] Enhancing GP cultural respect may thus be an important mechanism that helps increase GP satisfaction among ethnic minorities and reduce ethnic health inequities.

In addition to ethnic minority status, lower education and socio-economic status, and younger age have been linked to reduced access to and/or lower quality healthcare services.[10,12–15] However, studies have yet to examine the extent to which patient perceptions of GPs (i.e., degree of ethnic similarity and cultural respect) contribute to ethnic differences in GP satisfaction relative to demographic factors. Moreover, little is known about whether GP-related or demographic factors are stronger predictors of healthcare access

and health outcomes for distinct ethnic groups. As cultural values, health beliefs and healthcare experiences differ across ethnic groups,[16–19] there may be ethnic disparities in key predictors of good health and satisfactory healthcare access.

The present study assesses whether GP cultural respect is a key driver of lower GP satisfaction among ethnic minorities, independent of demographic factors. Data for this study were derived from the 2019 New Zealand Attitudes and Values study, before the 2022 health reform. A nested regression with three blocks is conducted to investigate how the relationship between: 1) ethnic groups (NZ Europeans, Māori, Pasifika, Asian) and GP satisfaction changes when we 2) include GP perception variables in our model, and 3) further control for a range of patient demographic factors. Subsequently, we examine the distinct influence that GP satisfaction, GP perceptions and demographic variables have on patient satisfaction with healthcare access, level of psychological distress and self-rated health for each ethnic group. Identifying ethnicity-specific predictors of positive health outcomes will inform improvements to the delivery of culturally respectful and equitable health services.

Method

Sampling procedure

The New Zealand Attitudes and Values Study (NZAVS) is an annual longitudinal study of a probability sample of New Zealanders. It is reviewed by a Human Participants Ethics Committee every 3 years. Time 1 (2009) NZAVS participants were randomly sampled from the New Zealand electoral roll (response rate: 16.6%). This study uses Time 11 data (2019, n=42,684; see technical document).[20]

Participants

Time 11 participants had a mean age of 52 years (standard deviation [SD]=13.87), mean deprivation score of 4.75 (1 = low deprivation, 10 = high deprivation), and median household income of $100,000 NZD (SD=125,544.83). Around 63.8% of participants were female (35.8% male), 92.6% were NZ European, 10.1% were Māori, 2.7% were Pasifika, and 4.5% were Asian (ethnic categories not mutually exclusive). Roughly 78% were born in New Zealand and 90.1% had a regular family doctor/GP.

Statistical analyses

All regressions were conducted on Mplus version 8 and only included those with a regular GP. Block one of the nested regressions predicting GP satisfaction included Māori, Pasifika and Asian ethnicities (reference group: NZ Europeans). Block two included GP ethnic similarity and GP cultural respect. Block three included a wide range of demographic variables.

Multiple regressions predicting satisfaction with healthcare access, psychological distress and self-rated health were conducted for NZ Europeans, Māori, Pasifika peoples and Asian peoples separately. Predictors included GP satisfaction, GP ethnic similarity, GP cultural respect and demographic factors. Missing data for exogenous variables were estimated using Rubin's multiple imputation procedure (10,000 imputed datasets, thinned every 200th iteration).

Measures
GP perception variables

Participants were asked, "*Do you have a regular family doctor/GP?*" (yes/no answer). If "yes", participants were asked to rate on a scale of 1 to 7 to what extent:

1. "*Are you satisfied with the service and care you receive from your family doctor/GP?*" (1 = not satisfied, 7 = very satisfied)
2. "*Do you think your doctor/GP shares a similar cultural background to you?*" (1 = definitely no, 7 = definitely yes)
3. "*Does your doctor/GP respect your cultural background when you are discussing health issues with them?*" (1 = definitely no, 7 = definitely yes)

Demographic variables

Ethnicity was measured using the standard New Zealand Census item, whereby participants indicated which ethnic group(s) they belonged to. This item was used to create a prioritised ethnicity variable (order of prioritisation: Māori, Pasifika, Asian, NZ European). Education was coded into an 11-level ordinal variable (0 = no qualification, 1 = Level 1 Certificate [basic knowledge/skills for work] to 10 = doctoral degree) based on the 10 tertiary qualification levels in New Zealand. Deprivation level was measured using the 2018 New Zealand Deprivation Index (1 = least deprived to 10 = most deprived).[21]

Healthcare access and health status

Participants rated their level of satisfaction with their "*access to healthcare when you need it (e.g., doctor, GP)*", on a scale of 0 (completely dissatisfied) to 10 (completely satisfied). Self-rated health was measured using the average of three items from the Short-form Subjective Health Scale.[22] Psychological distress was measured using the average score of the 6 items on the Kessler-6 Scale.[23]

Results

GP cultural respect is referred to as "GP respect" and GP ethnic similarity is referred to as "GP similarity" in the Results section for ease of readability. These concepts were assessed as two separate variables and included in model 2 and 3 of the nested regressions predicting GP satisfaction.

As shown in Table 1, NZ Europeans showed the highest percentage of "high GP satisfaction" (64.9%) followed by Pasifika peoples (58.9%), Māori (58%), and Asian peoples (54.3%). Fifty-two percent of NZ Europeans reported "high GP similarity" compared to only 23% of Māori and Pasifika peoples, and 27.7% of Asian peoples. Seventy-five percent of NZ Europeans reported "high GP respect" whereas 62.5% of Māori, 67.3% of Pasifika peoples and 63.8% of Asian peoples reported the equivalent. "Low GP respect" was lowest among NZ Europeans (1%), followed by Pasifika peoples (2.3%) and Asian peoples (2.4%), and Māori (3.6%).

Predicting GP satisfaction
Model 1: ethnicity

As seen in Table 2, model 1 only assessed ethnic differences in GP satisfaction. Māori (Beta [B]=-.192, standard error [SE]=.026, p<.001) and Asian (B=-.239, SE=.035, p<.001) peoples showed lower satisfaction compared to NZ Europeans, while Pasifika peoples showed no significant difference.

Model 2: inclusion of GP respect and GP similarity

After including GP respect and GP similarity, Māori (B=.078, SE=.023, p<.001) and Pasifika peoples (B=.168, SE=.041, p<.001) showed higher GP satisfaction compared to NZ Europeans. Asian ethnicity was no longer significant. GP respect (B=.473, SE=.007, p<.001) and GP similarity (B=.100, SE=.004, p<.001) were associated with higher GP satisfaction. Both GP variables had a standardised beta (β) above .1 (β=.409 and .136 respectively).

Model 3: inclusion of demographic variables

After including demographic variables, Māori (B=.104, SE=.023, p<.001) and Pasifika peoples (B=.180, SE=.021, p<.001) continued to show higher GP satisfaction compared to NZ Europeans. The strength of association between GP satisfaction and these two ethnic groups slightly increased compared to Model 2. Asian ethnicity remained non-significant. GP respect (B=.471, SE=.007, p<.001) and GP similarity (B=.093, SE=.004, p<.001) continued to show the strongest association with greater GP satisfaction (β=.408 and .127 respectively).

Men (B=.093, SE=.003, p<.001), older (B=.007, SE=.001, p<.001) and religious people (B=.047, SE=.013, p<.001), and those living in urban areas (B=.095, SE=.017, p<.001) showed higher GP satisfaction. In contrast, higher deprivation (B=-.011, SE=.002, p<.001) and being employed (B=-.047, SE=.016, p=.003) were linked with lower GP satisfaction. Education level, parental and partner status and born in New Zealand were non-significant.

Predicting healthcare access satisfaction, psychological distress and self-rated health

Tables reporting regression results for each ethnic group can be found in the Appendix. Only GP variables and key demographic variables are reported in-text.

NZ Europeans
Healthcare access satisfaction

Higher GP satisfaction (B=.646, SE=.011, p<.001), GP respect (B=.089, SE=.049, p<.001), and GP similarity (B=.028, SE=.006, p<.001) were associated with higher healthcare access satisfaction. All variables except "born in New Zealand" were significant. Having a partner (B=.458, SE=.027, p<.001) and lower deprivation (B=-.048, SE=.004, p<.001) were the strongest demographic predictors. Overall, GP satisfaction showed the strongest effect (β=.412).

Psychological distress

Higher GP satisfaction (B=-.054, SE=.003, p<.001), GP respect (B=-.012, SE=.003, p<.001) and GP similarity (B=-.008, SE=.002, p<.001) were associated with lower psychological distress. All demographic variables except religion were significant. Age (B=-.015, SE=.000, p<.001) and having a partner (B=-.160, SE=.009, p<.001) showed particularly strong

Table 1: Percentage of low, moderate and high ratings of GP satisfaction, GP respect and GP similarity across prioritised ethnic groups.

	GP satisfaction (N=38,411 for total sample)			GP cultural similarity (N=38,205 for total sample)			GP cultural respect (N=38,022 for total sample)		
	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
NZ European	3.9% (978)	31.1% (7,761)	64.9% (16,190)	12.2% (3,018)	35.8% (8,880)	52.1% (12,919)	1% (249)	23.6% (5,815)	75.4% (18,623)
Māori	6.3% (322)	35.7% (1,840)	58% (2,989)	31.2% (1,595)	45.8% (2,342)	23% (1,174)	3.6% (181)	33.9% (1,716)	62.5% (3,165)
Pasifika	4.3% (82)	36.8% (698)	58.9% (1,116)	30.0% (565)	47.3% (888)	22.7% (427)	2.3% (43)	30.5% (576)	67.3% (1,272)
Asian	4.8% (273)	40.9% (2,339)	54.3% (3,104)	31.3% (1,780)	41% (2,335)	27.7% (1,574)	2.4% (134)	33.9% (1,923)	63.8% (3,619)
Total sample	4.5% (1,715)	33.6% (12,903	61.9% (23,793)	18.6% (7,110)	38.7% (14,776)	42.7% (16,319)	1.6% (618)	27.0% (10,277)	71.3% (27,127)

Notes: Items were rated on a Likert scale of 1 (not satisfied/definitely no) to 7 (very satisfied/definitely yes). Ratings were categorised into three groups: low (1–2), moderate (3–5) and high (6–7). Only respondents who indicated having a GP were included in analyses. Ethnic categories were mutually exclusive and prioritised in the following order: Māori, Pasifika, Asian, NZ European. Standard NZAVS weighting procedure on gender, ethnicity and region of residence applied.

Table 2: Regression predicting GP satisfaction.

	Model 1: ethnicity				Model 2: GP respect and similarity				Model 3: demographic factors			
	B	SE	STD beta	P-value	B	SE	STD beta	P-value	B	SE	STD beta	P-value
Māori	-.192	.026	-.041	.000**	.078	.023	.017	.000**	.104	.023	.022	.000**
Pasifika	.014	.048	.002	.773	.168	.041	.019	.000**	.180	.040	.021	.000**
Asian	-.239	.035	-.035	.000**	.001	.031	.000	.984	.013	.033	.002	.694
GP respect					.473	.007	.409	.000**	.471	.007	.408	.000**
GP similarity					.100	.004	.136	000**	.093	.004	.127	.000**
Gender									.093	.013	.032	.000**
Age									.007	.001	.071	.000**
Education									-.002	.002	-.004	.344
Deprivation									-.011	.002	-.022	.000**
Religion									.047	.013	.016	.000**
Parent									-.032	.017	-.010	.059
Partner									-.012	.016	-.004	.465
Employment									-.047	.016	-.014	.003**
Urban									.095	.017	.026	.000**
Born in New Zealand									-.027	.016	-.008	.089

Note: *p<.05
**p<.01.
NZ Europeans were the reference group for ethnicity. STD beta refers to standardised beta (STD beta >.1 bolded). Sample limited to those who indicated having a GP. Analyses conducted with data imputation for missing values. Average number of observations = 38,465. R-squared = .003, .217, .225 respectively.

effects. Overall, age (β=-.296) and GP satisfaction (β=-.112) showed the strongest effects.

Self-rated health

Higher GP satisfaction (B=.104, SE=.005, p<.001), GP respect (B=.025, SE=.006, p<.001), and GP similarity (B=.020, SE=.004, p<.001) were associated with higher self-rated health. Most demographic variables were significant. Overall, employment (B=.362, β=-.132, SE=.016, p<.001) and GP satisfaction (β=-.123) showed the strongest effects.

Māori
Healthcare access satisfaction

Higher GP satisfaction (B=.746, SE=.034, p<.001) was associated with higher healthcare access satisfaction. GP respect and GP similarity were non-significant. Having a partner (B=.380, SE=.081, p<.001) and lower deprivation (B=-.062, SE=.012, p<.001) were strongest demographic predictors. Overall, GP satisfaction showed the strongest effect (β=.459).

Psychological distress

Higher GP satisfaction (B=-.059, SE=.009, p<.001) was associated with lower psychological distress, but GP respect and GP similarity were non-significant. Of the demographic variables, age (B=-.018, SE=.001, p<.001) and employment (B=-.281, SE=.030, p<.001) showed the strongest effects. These variables showed stronger effects than GP satisfaction (β=-.119 vs β=-.326 and β=-.161 respectively).

Self-rated health

Higher GP satisfaction (B=.102, SE=.016, p<.001) and GP similarity (B=.027, SE=.010, p=.008) were associated with higher self-rated health. GP respect was non-significant. Employment (B=.479, SE=.050, p<.001) and having a partner (B=.217, SE=.046, p<.001) were the two strongest demographic predictors. Overall, employment (β=.168) and GP satisfaction (β=-.126) showed the strongest effects.

Pasifika peoples
Healthcare access satisfaction

Higher GP satisfaction (B=.572, SE=.067, p<.001) and GP similarity (B=.160, SE=.064, p=.012), older age (B=.012, SE=.005, p=.024) and having a partner (B=.525, SE=.152, p=.001) were associated with higher healthcare access satisfaction. All other

variables were non-significant. GP satisfaction (β=.337) showed the strongest effect, followed by partner status (β=.110) and GP respect (β=.100).

Psychological distress

Older age (B=-.014, SE=.002, p<.001), higher education (B=-.032, SE=.009, p<.001), being a parent (B=-.136, SE=.061, p=.027) and employed (B=-.253, SE=.063, p<.001) were associated with lower psychological distress. GP satisfaction (B=-.036, SE=.019, p=.059) showed a marginally significant effect, and all other variables were non-significant.

Self-rated health

Higher GP satisfaction (B=.108, SE=.033, p=.001), being religious (B=.164, SE=.080, p=.041), employed (B=.298, SE=.100, p=.003) and having a partner (B=.237, SE=.091, p=.009) were associated with higher self-rated health. GP satisfaction (β=.127) and employment (β=.102) showed particularly strong effects. All other variables were non-significant.

Asian peoples
Healthcare access satisfaction

Higher GP satisfaction (B=.632, SE=.051, p<.001) and GP respect (B=.104, SE=.050, p=.037), having a partner (B=.403, SE=.128, p=.002) and being born in New Zealand (B=.384, SE=.109, p<.001) were associated with higher satisfaction. GP satisfaction showed the strongest effect (β=.408). All other variables were non-significant.

Psychological distress

Higher GP satisfaction (B=-.054, SE=.105, p<.001), older age (B=-.014, SE=.002, p<.001) and having a partner (B=-.176, SE=.045, p<.001), being employed (B=-.164, SE=.047, p=.001) and lower deprivation (B=.015, SE=.007, p=.023) were associated with lower psychological distress. Age (β=-.272) showed the strongest effect, followed by having a partner (β=-.105) and GP satisfaction (β=-.103). All other variables were non-significant.

Self-rated health

Higher GP satisfaction (B=.093, SE=.026, p<.001) and GP respect (B=.061, SE=.028, p=.027), and being born overseas (B=-.246, SE=.066, p<.001) was associated with higher self-rated health. GP satisfaction (β=.109) showed the strongest effect. All other variables were non-significant.

Discussion

Predictors of GP satisfaction

GP cultural respect was identified as a key driver of ethnic disparities in GP satisfaction. When only assessing ethnic differences, Māori and Asian peoples showed lower, and Pasifika peoples showed no significant difference in GP satisfaction compared to NZ Europeans. However, these effects substantially changed after accounting for differences in patient-perceived GP cultural respect and ethnic similarity. Māori and Pasifika peoples now showed higher, and Asian peoples showed no difference in GP satisfaction, relative to NZ Europeans. These changed effects remained significant after a wide range of demographic factors were further controlled for.

Men, older, religious people, unemployed individuals and those living in urban and more affluent areas showed higher GP satisfaction. Financial and physical barriers to healthcare are likely to drive lower satisfaction among those living in rural or more deprived areas.[12,24] Conversely, women and young people are less likely to report that their healthcare professionals listened to them and involved them in treatment decisions.[15] A notable finding from our study was that GP perceptions, especially GP cultural respect, showed a much stronger relationship with GP satisfaction than demographic factors. Controlling for demographic factors alone did not alter initial ethnic differences in GP satisfaction (see Appendix). Hence, low GP cultural respect appears to be the most central factor driving low GP satisfaction among ethnic minorities.

Māori and other ethnic minorities persistently report greater feelings of discrimination and culturally incongruent healthcare.[5–7,12,25] Our findings suggest that interventions focussed on patient-perceived cultural respect would be a key method to increase GP satisfaction among these groups. As cultural barriers and racism are strongly linked to low healthcare access and poor health outcomes,[4,9,10] supporting GPs to be more culturally respectful may help increase ethnic minorities' healthcare utilisation and reduce health inequities.[5–7,12,25] Given the lower proportion of ethnic minority doctors in New Zealand,[26] it is encouraging to find that GP cultural respect is a stronger predictor of GP satisfaction than GP ethnic similarity. Even if one does not have an ethnic-concordant GP, their GP satisfaction may still be substantially improved if GPs can provide culturally respectful healthcare services.

To better address health inequities, GPs should aim to deliver "culturally safe" healthcare; a more comprehensive concept that encompasses and goes beyond cultural respect.[27] Cultural safety requires doctors to be critically conscious of their own attitudes and prejudices that may impact interactions with patients and reduce bias that contributes to health inequity.[27] Yet, the demands of clinical competencies often leave doctors with limited time and energy to dedicate to cultural training and the provision of culturally safe services to diverse groups.[16] The significance of cultural respect and safety,[27] including its contribution to clinical outcomes and reducing health inequities, may require greater recognition in the healthcare system. Beyond the inclusion of cultural safety in policies and frameworks, our results indicate the importance of evaluating how well cultural safety is being translated into actual clinical practice.

Predictors of healthcare access satisfaction, psychological distress and self-rated health

GP satisfaction was associated with higher healthcare access satisfaction and better health status for all ethnic groups. These associations were comparable to or stronger than that identified between demographic factors and health outcomes. Despite controlling for a wide range of factors (including GP satisfaction), GP cultural respect showed significant associations with higher healthcare access satisfaction among Pasifika peoples and Asian peoples, and higher self-rated health among Asian peoples. These findings further emphasise the overarching impact of GP cultural respect, illustrating its promising role in contributing to improved healthcare access and health status for ethnic minorities.

GP cultural respect and ethnic similarity showed significant relationships with all three outcome variables only among NZ Europeans. Higher GP ethnic similarity was associated with higher Māori self-rated health but was not significant for Pasifika peoples and Asian peoples. While increasing GP satisfaction may be an effective way to improve self-rated health for all ethnic groups, having an ethnic-concordant GP appears to have further unique health benefits for Māori.

Generally, older age, having a partner and higher education, and being employed were associated with better healthcare access and/or positive health across ethnic groups. Younger age was a particularly strong risk factor for higher psychological

distress. Greater deprivation consistently predicted negative health and reduced healthcare access for NZ Europeans and Māori, but only predicted increased distress for Asian peoples and was not significant for Pasifika peoples. Among Asian peoples, those born in New Zealand reported better access to healthcare but lower self-rated health. Hence, second-generation Asian immigrants may encounter fewer language or cultural barriers to healthcare access, but this does not necessarily indicate better health status.

Across all ethnic groups, GP satisfaction was by far the strongest predictor of healthcare access satisfaction. Māori and Pasifika peoples frequently report financial barriers to healthcare,[12] but our results suggest that GP satisfaction is a more crucial determinant of perceived access to healthcare than deprivation. Increasing GP satisfaction through greater cultural respect should be better recognised as a priority area of intervention to improve healthcare access among ethnic minorities. Moreover, it is essential to note that there may be ethnic group differences in the way one judges GP cultural respect, and each ethnic group has unique characteristics that impact their pattern of healthcare utilisation and health outcomes (e.g., Māori experience of colonisation, younger Pasifika population).[17,28] Healthcare professionals should be aware of such differences, and recognise that patients and the community themselves may know best what cultural safety looks like for them.[27]

Caveats and future research

Our sample had a higher proportion of women, NZ Europeans and those with higher education and income, and only people with a regular GP were included in analyses (the proportion of women was 63.8% and NZ Europeans was 92.6%. Participants could identify with more than one ethnicity. Mean education level was 5.7 (1 = lowest, 10 = highest) and median household income was $100,000). Thus, our findings cannot be generalised to all groups in New Zealand. Further research is warranted on ethnic minorities with lower income and educational qualifications, and limited English abilities, as these groups are most likely to experience culturally incongruent GP services. There would also be great value in continuously tracking changes in GP satisfaction and health outcomes across ethnic groups throughout and beyond the health reform. This would allow us to assess the extent to which aspired improvements in health equity are being achieved over time.

Conclusion

Patient-perceived GP cultural respect was identified as a key driver of ethnic disparities in GP satisfaction. Initially, Māori and Asian peoples showed lower, and Pasifika peoples showed no significant difference in GP satisfaction level, relative to NZ Europeans. After accounting for differences in GP cultural respect and ethnic similarity, Māori and Pasifika peoples showed higher and Asian peoples showed no difference in satisfaction level compared to NZ Europeans. Higher GP satisfaction showed strong associations with better healthcare access and health outcomes for all ethnic groups. Increasing GP satisfaction through the provision of culturally respectful and safe healthcare services may be an essential step to reducing ethnic health inequities and improving population health.

AUTHOR INFORMATION

Carol H J Lee: PhD Graduate, School of Psychology, The University of Auckland, New Zealand; Health Promoter, Auckland Regional Public Health Service, New Zealand.

Chris G Sibley: Professor, School of Psychology, The University of Auckland, New Zealand.

CORRESPONDING AUTHOR

Carol H J Lee: Auckland Regional Public Health Service, Greenlane Clinical Centre, Auckland.
E: carollee@adhb.govt.nz

REFERENCES

1. Future of Health | Te Anamata O Te Oranga. The future of Health [Internet]. Health Reform Transition Unit; 2022 [cited 2022 Nov 1]. Available from: https://www.futureofhealth.govt.nz/.

2. Came H, Cornes R, McCreanor T. Treaty of Waitangi in New Zealand public health strategies and plans 2006-2016. N Z Med J. 2018;131(1469):32-7.

3. Sheridan NF, Kenealy TW, Connolly MJ, et al. Health equity in the New Zealand health care system: a national survey. Int J Equity Health. 2011 Oct 20;10:45. doi: 10.1186/1475-9276-10-45.

4. Harris RB, Cormack DM, Stanley J. Experience of racism and associations with unmet need and healthcare satisfaction: the 2011/12 adult New Zealand Health Survey. Aust N Z J Public Health. 2019 Feb;43(1):75-80. doi: 10.1111/1753-6405.12835.

5. Graham R, Masters-Awatere B. Experiences of Māori of Aotearoa New Zealand's public health system: a systematic review of two decades of published qualitative research. Aust N Z J Public Health. 2020;44(3):193-200.

6. Ludeke M, Puni R, Cook L, et al. Access to general practice for Pacific peoples: a place for cultural competency. J Prim Health Care. 2012 Jun 1;4(2):123-30.

7. Mehta S. Health needs assessment of Asian people living in the Auckland region [Internet]. Auckland: Northern DHB Support Agency; 2012 [cited 2022 Nov 1]. Available from: https://www.countiesmanukau.health.nz/assets/About-CMH/Performance-and-planning/health-status/79875e5978/2012-health-needs-of-asian-people.pdf.

8. Lee CHJ, Sibley CG. Ethnic disparities in vaccine safety attitudes and perceptions of family doctors/general practitioners. Vaccine. 2020;38(45):7024–32. doi: 10.1016/j.vaccine.2020.09.030.

9. Paradies Y, Ben J, Denson N, et al. Racism as a Determinant of Health: A Systematic Review and Meta-Analysis. PLoS One. 2015;10(9):e0138511. doi: 10.1371/journal.pone.0138511.

10. Talamaivao N, Harris R, Cormack D, et al. Racism and health in Aotearoa New Zealand: a systematic review of quantitative studies. N Z Med J. 2020;133(1521):55-68.

11. Ben J, Cormack D, Harris R, Paradies Y. Racism and health service utilisation: a systematic review and meta-analysis. PLoS One. 2017;12(12):e0189900.

12. Manatū Hauora – Ministry of Health. Annual Update of Key Results 2020/21: New Zealand Health Survey [Internet]. 2022 [cited 2022 Aug 8]. Available from: https://www.health.govt.nz/publication/annual-update-key-results-2020-21-new-zealand-health-survey.

13. Lee CH, Sibley CG. Demographic and psychological correlates of satisfaction with healthcare access in New Zealand. N Z Med J. 2017;130(1459):11-24.

14. Kripalani S, Jacobson TA, Mugalla IC, et al. Health literacy and the quality of physician-patient communication during hospitalization. J Hosp Med. 2010;5(5):269-75. doi: 10.1002/jhm.667.

15. Te Tāhū Hauora Health Quality & Safety Commission. Ngā hua o te tiro whānui – Survey results. 2022 [cited 2022 Aug 19]. Available from: https://www.hqsc.govt.nz/our-data/patient-experience/survey-results/.

16. Simmonds S, Carter M, Preval N, Wilson R. Cultural Safety Baseline Data Report Release and Recommendations [Internet]. Medical Council of New Zealand and Te Ohu Rata o Aotearoa: Wellington; 2020 [cited 2022 Nov 1]. Available from: https://www.mcnz.org.nz/assets/Publications/Reports/f5c692d6b0/Cultural-Safety-Baseline-Data-Report-FINAL-September-2020.pdf.

17. Mauri Ora Associates, SAEJ Consultancy, Panapa Ehau. Best health outcomes for Pacific Peoples: Practice Implications. Medical Council of New Zealand: 2010.

18. Schouten BC, Meeuwesen L. Cultural differences in medical communication: a review of the literature. Patient Educ Couns. 2006;64(1-3):21-34. doi: 10.1016/j.pec.2005.11.014.

19. Wong A. Challenges for Asian health and Asian health promotion in New Zealand [Internet]. Health Promotion Forum of New Zealand; 2015 [cited 2022 Nov 1]. Available from: https://www.ecald.com/assets/Resources/Assets/Challenges-for-Asian-health.pdf.

20. Sibley CG. Sampling procedure and sample details for the New Zealand Attitudes and Values Study. PsyArXiv. 2021. https://doi.org/10.31234/osf.io/wgqvy

21. Atkinson J, Salmond C, Crampton P. NZDep2013 Index of Deprivation [Internet]. Department of Public Health, University of Otago: Wellington; 2014 [cited 2022 Nov 1]. Available from: https://www.otago.ac.nz/wellington/otago069936.pdf.

22. Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (Sf-36). I. conceptual framework and item selection. Med Care. 1992;30(6):473–83.

23. Kessler RC, Green JG, Gruber MJ, et al Screening for serious mental illness in the general population with the K6 screening scale: results from the WHO World Mental Health (WMH) survey initiative. Int J Methods Psychiatr Res. 2010;19:4–22.

24. Brabyn L, Barnett R. Population need and geographical access to general practitioners in rural New Zealand. N Z Med J. 2004;117(1199):U996.

25. Harris R, Cormack D, Tobias M, et al. Self-reported experience of racial discrimination and health care use in New Zealand: results from the 2006/07 New Zealand Health Survey. Am J Public Health. 2012;102(5):1012-9. doi: 10.2105/AJPH.2011.300626.

26. Kaunihera Rata o Aotearoa I Medical Council of New Zealand. The New Zealand Medical Workforce in 2021 [Internet]. 2021 [cited 2022 Nov 1]. Available from: https://www.mcnz.org.nz/assets/Publications/Workforce-Survey/d9d2757aad/Workforce-Survey-Report-2021.pdf.

27. Curtis E, Jones R, Tipene-Leach D, et al. Why cultural safety rather than cultural competency is required to achieve health equity: a literature review and recommended definition. Int J Equity Health. 2019;18(1):174. doi: 10.1186/s12939-019-1082-3.

28. Jansen P, Bacal K, Crengle S. He Ritenga Whakaaro: Māori experiences of health services. Mauri Ora Associates: Auckland; 2008 [cited 2022 Nov 1].

Appendix

Table A1: Socio-demographic characteristics of sample for each ethnic group and total sample.

	Gender		Mean age (Age range, SD)	Proportion of people born in New Zealand	Proportion of employed people	Mean education level (SD)	Mean deprivation level (SD)
	Female	Male					
NZ European (n=35,701)	65.29%	34.71%	52.94 (18–99, 13.57)	80.16%	75.73%	5.69 (2.66)	4.63 (2.69)
Māori (n=3,794)	68.2%	31.8%	50.85 (18–92, 13.38)	96.86%	75.08%	5.08 (2.74)	5.84 (2.89)
Pasifika peoples (n=1,012)	66.47%	33.53%	48.89 (19–92, 13.66)	75.27%	75.74%	5.30 (2.70)	6.00 (3.01)
Asian peoples (n=1,670)	64.80%	35.2%	46.03 (18–83, 14.09)	29.42%	78.70%	6.82 (2.19)	4.94 (2.69)
Total sample (n=38,265)	64.95%	35.05%	52.70 (18–99, 13.58)	78.08%	75.73%	5.70 (2.66)	4.71 (2.72)

Note: Data imputation for missing values was used for all regressions. Sample descriptives were obtained from Mplus regression analysis results. "Total sample" was used for the nested regressions predicting GP satisfaction.

Table A2: Regression predicting healthcare access satisfaction, psychological distress and self-reported health among *NZ Europeans*.

	Healthcare access satisfaction				Psychological distress (K6)				Self-rated health			
	B	SE	STD beta	P-value	B	SE	STD beta	P-value	B	SE	STD beta	P-value
GP satisfaction	.646	.011	**.412**	.000**	-.054	.003	**-.112**	.000**	.104	.005	**.123**	.000**
GP respect	.089	.011	.049	.000**	-.012	.003	-.021	.000**	.025	.006	.025	.000**
GP similarity	.028	.006	.023	.000**	-.008	.002	-.021	.000**	.020	.004	.031	.000**
Gender	.062	.021	.014	.004**	-.026	.007	-.018	.000**	-.077	.013	-.031	.000**
Age	.006	.001	.035	.000**	-.015	.000	**-.296**	.000**	.004	.001	.041	.000**
Education	.038	.004	.047	.000**	-.011	.001	-.045	.000**	.011	.002	.024	.000**
Deprivation	-.048	.004	-.060	.000**	.013	.001	.051	.000**	-.023	.002	-.052	.000**
Religion	-.047	.022	-.010	.033*	.008	.007	.006	.239	-.003	.013	-.001	.842
Parent	-.120	.027	-.024	.000**	-.082	.009	-.052	.000**	.123	.016	.045	.000**
Partner	.458	.027	.090	.000**	-.160	.009	**-.102**	.000**	.163	.016	.059	.000**
Employment	.118	.026	.023	.000**	-.167	.009	-.106	.000**	.362	.016	**.132**	.000**
Urban	.204	.028	.037	.000**	.047	.008	.027	.000**	-.080	.015	-.027	.000**
Born in New Zealand	-.026	.025	-.005	.309	-.039	.008	-.023	.000**	-.006	.015	-.002	.675

Note: *p<.05
**p<.01
Sample limited to those who indicated having a GP and identified as being NZ European. STD beta refers to standardised beta (STD >.1 bolded). Analyses conducted with data imputation for missing values.
Average number of observations = 35,701. R-squared = .224, .148, .057, respectively.

Table A3: Regression predicting healthcare access satisfaction, psychological distress and self-reported health among *Māori*.

	Healthcare access satisfaction				Psychological distress (K6)				Self-rated health			
	B	SE	STD beta	P-value	B	SE	STD beta	P-value	B	SE	STD beta	P-value
GP satisfaction	.746	.034	**.459**	.000**	-.059	.009	**-.119**	.000**	.102	.016	**.126**	.000**
GP respect	.041	.035	.024	.240	-.008	.010	-.014	.450	.016	.017	.019	.350
GP similarity	.006	.018	.005	.754	.007	.006	.018	.242	.027	.010	.045	.008**
Gender	.098	.073	.019	.180	.000	.024	.000	.996	-.138	.041	-.052	.001**
Age	.014	.003	.074	.000**	-.018	.001	**-.326**	.000**	.007	.002	.077	.000**
Education	.029	.014	.032	.033*	-.012	.004	-.042	.008**	.005	.008	.010	.553
Deprivation	-.062	.012	-.072	.000**	.011	.004	.040	.009**	-.030	.007	-.071	.000**
Religion	-.121	.074	-.024	.105	.024	.024	.015	.328	-.025	.041	-.010	.538
Parent	-.274	.090	-.047	.002**	-.079	.030	-.044	.010*	.041	.050	.014	.416
Partner	.380	.081	.072	.000**	-.154	.027	-.096	.000**	.217	.046	.083	.000**
Employment	.226	.090	.040	.012*	-.281	.030	**-.161**	.000**	.479	.050	**.168**	.000**
Urban	.327	.097	.052	.001**	.073	.028	.038	.008**	-.054	.049	-.017	.267
Born in New Zealand	-.174	.167	-.012	.297	-.089	.064	-.021	.164	.126	.103	.018	.223

Note: *p<.05
**p<.01
Sample limited to those who indicated having a GP and identified as being Māori. STD beta refers to standardised beta (STD >.1 bolded). Analyses conducted with data imputation for missing values. Average number of observations = 3,794. R-squared = .256, .167, .078, respectively.

Table A4: Regression predicting healthcare access satisfaction, psychological distress, and self-reported health among *Pasifika peoples.*

	Healthcare access satisfaction				Psychological distress (K6)				Self-rated health			
	B	SE	STD beta	P-value	B	SE	STD beta	P-value	B	SE	STD beta	P-value
GP satisfaction	.572	.067	**.377**	.000**	-.036	.019	-.069	.059	.108	.033	**.127**	.001**
GP respect	.160	.064	**.100**	.012*	-.023	.020	-.042	.235	.005	.034	.006	.885
GP similarity	-.033	.032	-.031	.299	.009	.012	.024	.467	.037	.020	.063	.061
Gender	.113	.131	.024	.387	-.074	.049	-.045	.129	-.129	.082	-.048	.116
Age	.012	.005	.073	.024*	-.014	.002	**-.244**	.000**	.004	.003	.046	.188
Education	.032	.025	.038	.207	-.032	.009	**-.109**	.001**	.013	.016	.028	.407
Deprivation	-.014	.023	-.018	.547	.003	.009	.012	.713	-.012	.014	-.029	.385
Religion	-.184	.129	-.041	.153	.011	.049	.007	.829	-.164	.080	-.065	.041*
Parent	-.277	.167	-.055	.098	-.136	.061	-.078	.027*	-.002	.096	-.001	.980
Partner	.525	.152	**.110**	.001**	-.091	.056	-.055	.105	.237	.091	.089	.009**
Employment	.192	.162	.037	.235	-.253	.063	**-.139**	.000**	.298	.100	**.102**	.003**
Urban	.192	.193	.026	.320	.102	.078	.040	.190	.037	.134	.009	.781
Born in New Zealand	-.116	.156	-.022	.458	-.128	.060	-.071	.031	-.133	.095	-.046	.160

Note: *p<.05
**p < .01
Sample limited to those who indicated having a GP and identified as being of Pacific ethnicity. STD beta refers to standardised beta (STD >.1 bolded). Analyses conducted with data imputation for missing values. Average number of observations = 1,012. R-squared = .213, .127, .059, respectively.

Table A5: Regression predicting healthcare access satisfaction, psychological distress, and self-reported health among *Asian peoples.*

	Healthcare access satisfaction				Psychological distress (K6)				Self-rated health			
	B	SE	STD beta	P-value	B	SE	STD beta	P-value	B	SE	STD beta	P-value
GP satisfaction	.632	.051	**.408**	.000**	-.054	.015	**-.103**	.000**	.093	.026	**.109**	.000**
GP respect	.104	.050	.061	.037*	-.021	.016	-.036	.192	.061	.028	.066	.027*
GP similarity	.001	.025	.001	.955	.000	.009	.000	.990	-.012	.015	-.020	.436
Gender	.124	.098	.027	.206	-.013	.037	-.008	.728	.009	.061	.004	.878
Age	.007	.004	.042	.105	-.014	.002	**-.272**	.000**	.001	.002	.013	.645
Education	.026	.022	.026	.238	-.023	.009	-.067	.007**	.021	.015	.038	.150
Deprivation	-.020	.018	-.025	.263	.015	.007	.054	.023*	-.020	.011	-.045	.078
Religion	.041	.100	.009	.685	-.008	.036	-.006	.815	.055	.059	.023	.353
Parent	-.134	.127	-.030	.289	-.044	.045	-.028	.335	.125	.077	.050	.103
Partner	.403	.128	.082	.002**	-.176	.045	**-.105**	.000**	.059	.074	.022	.425
Employment	.172	.128	.032	.180	-.164	.047	-.089	.001**	.142	.081	.048	.080
Urban	-.014	.228	-.001	.951	-.069	.094	-.020	.460	-.220	.147	-.040	.135
Born in New Zealand	.384	.109	.080	.000**	-.043	.040	-.026	.275	-.246	.066	-.093	.000**

Note: *p<.05
**p<.01
Sample limited to those who indicated having a GP and identified as being of Asian ethnicity. STD beta refers to standardised beta (STD >.1 bolded). Analyses conducted with data imputation for missing values. Average number of observations = 1,670. R-squared = .213, .138, .050, respectively.

Table A6: Regression predicting GP satisfaction (without GP respect and GP similarity).

	Step 1: ethnicity				Step 2: demographic factors			
	B	SE	STD beta	P-value	B	SE	STD beta	P-value
Māori	-.192	.026	-.041	.000**	-.133	.026	-.028	.000**
Pasifika	.013	.048	.002	.780	.055	.047	.006	.243
Asian	-.237	.035	-.035	.000**	-.194	.037	-.028	.000**
Gender					.030	.015	.010	.039
Age					.011	.001	.106	.000**
Education					.009	.003	.017	.001**
Deprivation					-.026	.003	-.050	.000**
Religion					.078	.015	.027	.000**
Parent					-.034	.019	-.011	.072
Partner					.004	.018	.001	.839
Employment					-.075	.018	-.023	.000**
Urban					.145	.019	.040	.000**
Born in New Zealand					.007	.018	.002	.707

Note: *p<.05
**p <.01. Sample limited to those who indicated having a GP. STD beta refers to standardised beta (STD >.1 bolded). Analyses conducted with data imputation for missing values. Average number of observations = 38,465. R-squared = .003, .02, respectively.

Incorporating faecal haemoglobin measurement using the faecal immunochemical test (FIT) in the referral, triage, and prioritisation pathway for patients with colorectal symptoms

James Falvey, Chris M A Frampton, Richard B Gearry, Ben Hudson, Lucinda Whiteley

ABSTRACT

Incorporating faecal haemoglobin (FHb) measurement using the faecal immunochemical test (FIT) in the investigation pathway for patients with colorectal symptoms may improve access to colonoscopy for those at greatest risk of significant disease.

AIM: To derive a colorectal symptom pathway incorporating standard clinical and FIT data to guide referral, triage, and prioritisation of cases in New Zealand.

METHOD: Diagnostic accuracy of FIT to rule out colorectal cancer (CRC) was determined by meta-analysis. Thereafter, the risk of CRC after FIT was estimated for common clinical presentations by Bayesian methodology, using a specifically collated retrospective cohort of symptomatic cases. A symptom/FIT pathway was developed iteratively following multi-disciplinary engagement.

RESULTS: Eighteen studies were included in meta-analysis. The sensitivity and specificity for CRC were 89.0% (95%CI 87.0–90.9%) and 80.1% (95%CI 77.7–82.4%) respectively, at a FHb threshold of >10mcg haemoglobin per gram stool, and 95.7% (95%CI 93.2–97.7%) and 60.5% (95%CI 53.8–67.0%) respectively, at the limit of detection. The final pathway was 97% sensitive for CRC, compared with 90% for the current direct access criteria, and requires 47% fewer colonoscopies. Estimated prevalence of CRC among those declined investigation was 0.23%.

CONCLUSION: Incorporating FIT in the new patient symptomatic pathway as presented appears feasible, safe, and allows for resources to be targeted to those at greatest risk of disease. Further work is needed to ensure equity for Māori if this pathway were introduced nationally.

Waiting times for colonoscopies are long and risk harm due to the delayed diagnosis of serious gastro-intestinal diseases, including colorectal cancer (CRC). We have reported that the New Zealand Ministry of Health, now Manatū Hauora, referral criteria for direct access outpatient colonoscopy or computed tomography colonography (CTC),[1] hereafter the direct access criteria, have a low specificity for CRC.[2] This low specificity, together with high colorectal symptom burden in the general population contributes to high referral rates and low yield from investigation. Improving access to colorectal investigations for New Zealanders who have significant bowel disease is an immediate priority for gastroenterology and surgical services and should be undertaken to increase the detection of significant diseases, reduce time to diagnosis, and reduce the number of investigations performed with no significant finding.

Data indicates that incorporating faecal haemoglobin (FHb) measurement by using the faecal immunochemical test (FIT) into the new patient investigation pathway may help to satisfy these goals.[3,4] FIT has been extensively investigated in symptomatic populations and has been successfully incorporated into new patient symptomatic pathways,[5] and used to re-prioritise cases waiting for colonoscopy following pandemic related delays.[6] Indeed, the British Society of Gastroenterology (BSG) and the Association of Coloproctology of Great Britain and Ireland (ACPGBI) recommend the implementation of FIT as a diagnostic tool for all patients with symptoms or signs of a suspected CRC diagnosis, other than those with an anal or rectal mass or anal ulceration.[7] Identifying

combined FIT/symptom thresholds to direct referral and investigation of cases requires both a reliable estimate of the prior risk of disease for common clinical presentations, and knowledge of the diagnostic accuracy of FIT at the proposed FHb thresholds, neither of which is known absolutely.

We aimed to derive a colorectal symptom pathway incorporating standard referral (direct access criteria), and FIT data, to guide referral, triage, and prioritisation of cases.

Methods

An overview of the study design is shown in Figure 1.

Diagnostic accuracy of a single rule out FIT for colorectal cancer

Search strategy and exclusions are summarised in Figure 2. Studies were included if they reported the diagnostic accuracy of a single rule out FIT (at threshold >10mcg/g or at a threshold of >4mcg/g or lower) for colorectal cancer in a cohort of patients with unexplained colorectal symptoms. Studies reported as full papers, with a complete, patient level dataset (sufficient to allow sensitivity and specificity to be calculated), were considered for inclusion, including those reporting outcomes based on either clinical follow-up (>6 months) or colonic investigation. A quality assessment tool for diagnostic accuracy studies (QUADAS-2) was used to facilitate the assessment of study quality. Studies from the same population were allowed when referral dates did not overlap. Studies were excluded if they did not meet inclusion criteria and furthermore if they included surveillance cases, or where the mode of investigation or follow-up period was deemed insufficient to diagnose incident colorectal cancer. Database search, literature review, quality assessment, decision to include or exclude, and data extraction was made by one author (James Falvey). Patient level data was manually extracted from each included study and grouped according to FIT threshold for meta-analysis. FHb thresholds for analysis were at >10mcg haemoglobin per gram of stool (mcg/g), and at the limit of detection of the test (LoD) (any threshold <4mcg/g). Meta analyses were undertaken using a random effects model due to heterogeneity in study design, and performed using MedCalc for Windows, version 19.4 (MedCalc Software, Ostend, Belgium). The pragmatic approach to the LoD was taken to avoid overestimating sensitivity for CRC, reflect

variation in assay sensitivity, and to remain consistent with prior methodology.[8]

The prior risk of CRC according to the direct access criteria has been reported previously (2018 dataset).[2] Briefly, a retrospective cohort study was performed which collected referral, demographic and outcome data for all first primary care referrals for direct access colorectal investigations made to Canterbury district health board (now Te Whatu Ora – Waitaha Canterbury) using a dedicated electronic referral form (eform) in the year 2018. The eform includes a free text section for clinical history and tick boxes that allow the case history to be summarised with respect to the direct access criteria. General practitioners have access to additional guidance regarding the investigation and referral of cases through an online resource (Community HealthPathways). Faecal occult blood (FOB) testing is not included in the direct access criteria or included as a required field in the eform. Cases were followed for a median of 33 months. One hundred and twenty-eight CRC cases were detected among 3,200 referrals. For the purposes of this study, referrals for patients with suspected Inflammatory bowel disease (IBD) were not included (2 CRC among 214 referrals for suspected IBD [0.9%]).

Likelihood ratios (LR) derived from summary accuracy data were used to calculate disease prevalence for clinical groups following FIT and were unadjusted. Simple proportions were converted to odds (and vice versa) as required and are presented as percentages or number needed to investigate (NNI) or decline (NND) to detect or miss one CRC. Detection of high-risk adenoma is estimated based on the prevalence of advanced polyps in the 2018 dataset, and using LRs derived from published data for advanced adenomas.[9] FIT positivity rates at each threshold were calculated as follows: $n = ([C - c_b P]/[c_a - c_b])/P$, where n is the proportion of cases with a test result at or above the threshold, C is the total number of cases of CRC in a population (P), and c_a and c_b are the prevalence of CRC for cases with test results above and below the threshold, respectively. To determine the investigative resource requirements of the pathway, the secondary care decision aid has been followed with additional assumptions for categories requiring triagers' discretion as follows:

- iron deficiency anaemia (IDA) 80% colonoscopy and 20% CTC.

- rectal bleeding (RB) 40–49 years/detectable FHb <10mcg/g, 50% colonoscopy and 50% CTC.
- RB <39 years/FHb >10mcg/g, 100% colonoscopy.
- altered bowel habit (ABH) >50 years/detectable FHb <10mcg/g, 50% colonoscopy and 50% CTC.
- other presentations FHb >10mcg/g, 100% colonoscopy, detectable FHb <10mcg/g, 50% CTC and 50% decline.

Modelling does not make allowance for any change in primary care referral practice, or the effect of expanding access criteria in the proposed pathway (to younger patients with rectal bleeding, or due to lowering age thresholds for Māori and Pacific people). The proportion of cases meeting criteria for colonoscopy, but who in usual clinical practice would be offered an alternative mode of investigation due to age-related frailty or the presence of significant comorbidity has not been estimated for either the current proposal or the direct access criteria, or the ACPGBI/BSG guideline for urgent colonoscopy. Outcome estimates of sensitivity, specificity, NNI, and NND were determined for each of these criteria. The upper 95% CI of negative likelihood ratios (NLR) derived from summary data were used to determine the worst-case missed cancer rates for rule out thresholds. Ninety-five percent CI were calculated by the binomial exact method.

CRC incidence by novel symptom criteria was determined from the 2018 dataset by mapping the direct access criteria to the novel criteria. Symptom thresholds for referral are unchanged from the direct access criteria (e.g., altered bowel habit [ABH] refers to looser and/or more frequent stools, and unexplained rectal bleeding [RB] refers to cases where benign anal causes have been treated or excluded).

Results

Meta-analysis

Eighteen studies were included in meta-analysis. The study characteristics, quality assessment, and diagnostic accuracy of included studies are shown in Table 1. One study was excluded as it did not report FIT accuracy data at a threshold consistent with our analysis.[25] Of those studies excluded on methodological or other grounds despite apparently meeting inclusion criteria, one provided insufficient information regarding the reference standard and had too short a period of clinical follow-up,[26] one was deemed at high risk of bias in both case selection and case follow-up,[27] four had incomplete investigation or follow-up of cases (usually FIT negative),[28–31] one did not contain patient level data,[32] and one was excluded due to multiple samples counted as a single positive if any gave an above threshold result.[33] Forrest plots for the primary analyses are shown in Figure 3. Summary sensitivity and specificity of FIT at FHb threshold >10mcg/g were 89.0% (95%CI 87.0–90.9%)(I^2 33.14%) and 80.1% (95%CI 77.7–82.4%)(I^2 98.2%) respectively, and at the LoD were 95.7% (95%CI 93.2–97.7%)(I^2 58.84%) and 60.5% (95%CI 53.8–67.0%)(I^2 99.4%), respectively. Correspondingly, the NLR of FIT for CRC at thresholds of >10mcg/g and at LoD were 0.14 (95%CI 0.12–0.16) and 0.07 (95%CI 0.04–0.11), respectively. There was significant heterogeneity between studies. The source of this was investigated by subgroup analysis according to the following study characteristics: cohort date (pre vs not pre-2017), retrospective vs prospective data collection, recruitment location (primary or secondary care), analyser (HM-jack arc, OC-sensor, other/unknown), colorectal cancer prevalence (>3% vs <3%), and reference standard (colonoscopy only,[9,10,12,15,16] any colonic investigation,[3,11,14,17,19,24] follow-up[4,13,18,20–23]) (see Table 1 for study characteristics). Significant heterogeneity was still identified within the subgroups for both sensitivity and specificity, and the estimates between subgroups did not differ significantly; however, the limited sample size limits the robustness with which these effects can be explored. Outliers were sought with respect to study design, prevalence, sensitivity, and specificity; however, exclusion of individual studies did not significantly influence results.

Canterbury colorectal symptom pathway

The proposed pathway is summarised in Figure 4. For Symptom/FHb categories where the risk of CRC is low, triggers will use discretion in determining the most appropriate outcome (e.g., CTC, flexible sigmoidoscopy, outpatient review, or a further period of observation in primary care) based on age, case presentation, co-morbidity, and local resource availability. The outcome in the secondary care decision aid (Figure 4b) for such categories is denoted 'triggers discretion', and for simplicity in modelling, it is assumed that all cases will undergo either colonoscopy or

CTC (see methods). Estimated CRC prevalence by clinical category, age, and FHb threshold are shown in Table 2. Pathway sensitivity and specificity are shown in Table 3, along with those for the direct access criteria, and those of the ACPGBI/BSG guidance for urgent colonoscopy. Within the limits of the analysis, the sensitivity for advanced polyps is estimated to fall from 84.2% for the direct access criteria to 70.4% for the Canterbury pathway.

Discussion

Our study demonstrates how incorporating FIT in the investigation, referral, and prioritisation of patients with colorectal symptoms may both improve sensitivity for colorectal cancer, while simultaneously reducing the number of investigations performed. Indeed, including FHb measurement to guide patient care was previously an established strategy in New Zealand. In Canterbury, between 2010–2017, a qualitative FIT was incorporated in the colorectal symptom assessment and referral pathway and provided the strongest single predictor for colorectal cancer diagnosis, above anaemia and rectal bleeding.[34] Thereafter, while Canterbury moved away from FHb and adopted the direct access criteria (based on the 2005 NICE guideline, CG27), the United Kingdom sought to increase sensitivity for CRC (NICE NG12) by incorporating a rule-in guaiac based FOB (gFOB) for primary care patients with low risk symptoms (CRC risk of <3%).[35] In the UK the low specificity of gFOB led to increased demand for colorectal investigation and a higher NNI to detect one cancer,[36] and this was addressed by replacing gFOB with FIT >10mcg/g (NICE DG30) in 2017.[33] The discriminatory value of a quantitative FIT for CRC, and its validity beyond population screening and low risk symptoms to high risk scenarios such as rectal bleeding have subsequently been confirmed.[11,12,37,38] This reflects a broader concept, that the discriminating power of FIT for CRC is determinate (notwithstanding variation in tumour size, location, biology, and stool sampling method), while its clinical utility varies by FHb threshold and the pre-test probability of disease.

A major strength of this study is that our conclusions are based on actual cancer rates in our referral population, and a current estimate of FIT accuracy. Furthermore, because we are primarily concerned with optimising the clinical pathway sensitivity and understanding the risk of declining investigation, we have estimated the worst-case scenario miss rates for each clinical presentation using the upper 95th CI of the NLR calculated from our summary sensitivity and specificity, which encompass the least favourable estimate of the diagnostic accuracy of rule out FIT found in contemporary meta-analysis.[8,39,40] Table 4 shows that this is important because there was significant heterogeneity between studies included in meta-analysis, and this impacts on the accuracy with which the diagnostic accuracy of FIT can be estimated.

We estimate the missed cancer rate for the Canterbury pathway to be 2.9%, compared with 9.5% for the direct access criteria (Table 3). In our proposal, cases meeting symptom threshold who have FHb >10mcg/g undergo investigation with colonoscopy. However, because almost 10% of CRC are missed at this threshold, we further recommend that all cases with detectable FHb <10mcg/g be referred and investigated appropriately given case characteristics and resource availability. Although the CRC rate of those with detectable FHb<10mcg/g is just 1.47%, we see benefit in a pathway that provides definitive care at the first contact, reducing the risk of frequent repeat testing (and associated false positive tests) and the inequity that is likely to result from such an approach. A higher rule out threshold of >10mcg/g would reduce colonoscopy volumes further; however, the pathway as it stands has the potential to lower demand for colonoscopy by 47%. More restrictive criteria may not only delay diagnosis for some cases of colorectal cancer, but also reduce sensitivity of the pathway for other significant colorectal disease.[9,41–43]

Simplifying the clinical categories when compared with the direct access criteria is justified on several grounds. Foremost, the distinction between urgent and non-urgent categories in the direct access criteria appears arbitrary with some non-urgent categories having greater risk of CRC than others afforded urgent investigation.[2] Thereafter, as New Zealand data have repeatedly shown that CRC risk falls in the order IDA>RB>ABH,[2,34,44] and because FIT discriminates CRC risk with greater power than any of these,[12] it follows that all cases be stratified by FIT, and usability of the resulting criteria is enhanced by simplifying the clinical component.

We see benefit in amending the access criteria in several other ways. Lowering age thresholds for investigating Māori and Pacific people by 10
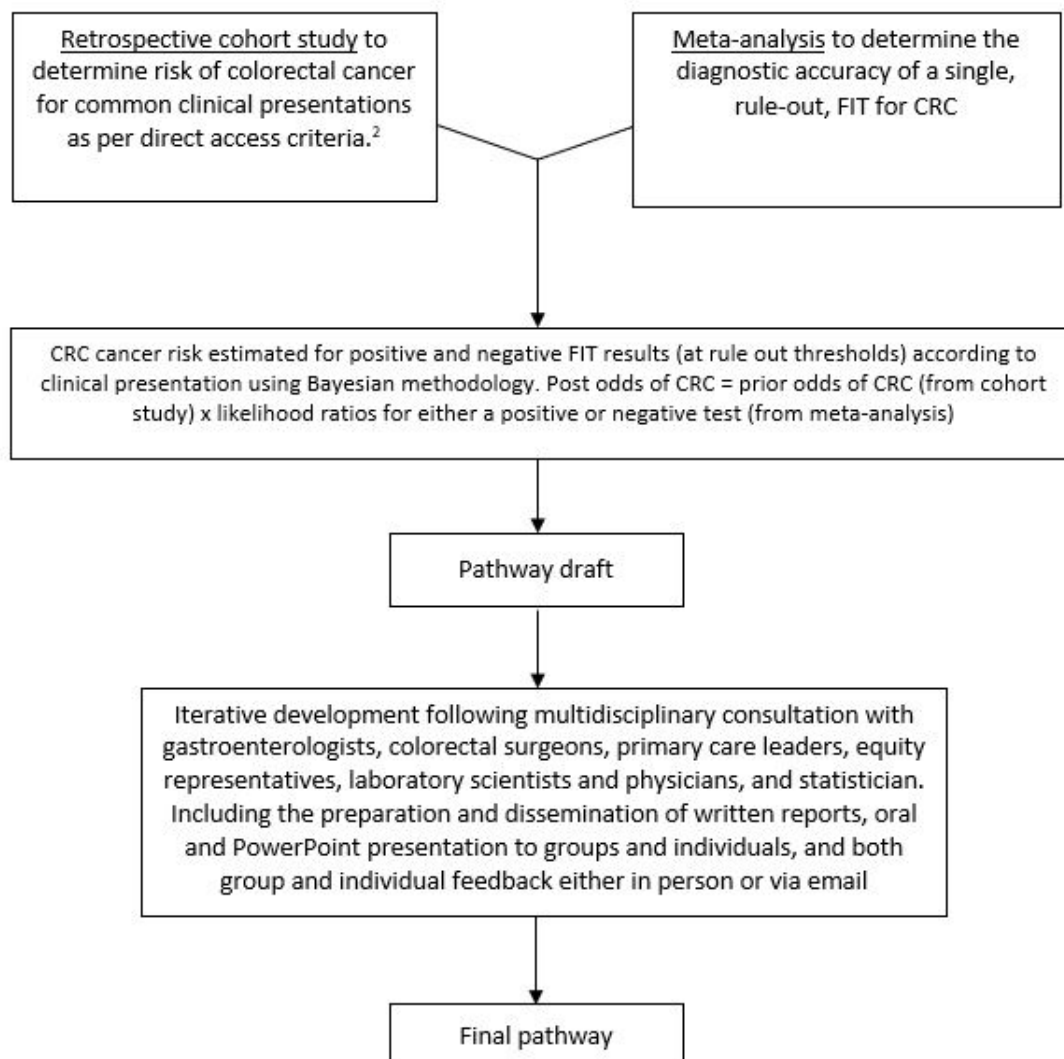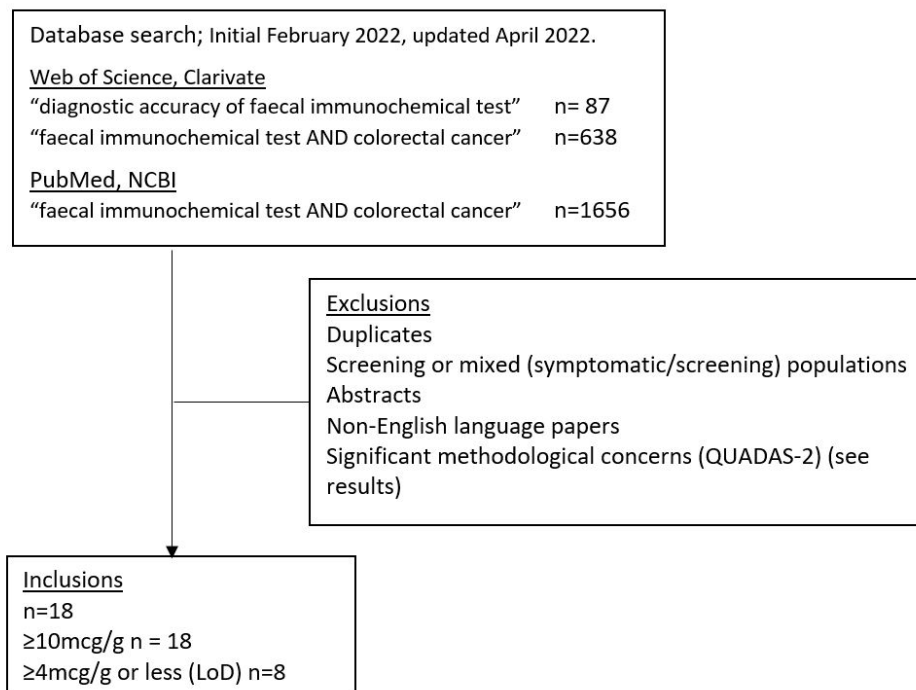
Figure 1: Overview of study design.

Figure 2: Meta-analysis search strategy and review process.

Database search; Initial February 2022, updated April 2022.

Web of Science, Clarivate
"diagnostic accuracy of faecal immunochemical test"   n= 87
"faecal immunochemical test AND colorectal cancer"   n=638

PubMed, NCBI
"faecal immunochemical test AND colorectal cancer"   n=1656

Exclusions
Duplicates
Screening or mixed (symptomatic/screening) populations
Abstracts
Non-English language papers
Significant methodological concerns (QUADAS-2) (see results)

Inclusions
n=18
≥10mcg/g n = 18
≥4mcg/g or less (LoD) n=8

Table 1: Studies included in meta-analysis.

Study	Description *(Including retrospective vs prospective design, primary or secondary care recruitment, cohort date, laboratory analyser, and location)*	n	CRC prevalence %	FU interval months	QUADAS-2						Flow and timing	Threshold mcg/g	Sensitivity	Specificity
					Risk of bias			Applicability concerns						
					Selection	Index test	Reference standard	Selection	Index test	Reference standard				
McDonald et al.[3]	Consecutive referrals from primary care for investigation of lower GI tract completing FIT and endoscopy. Secondary care prospective cohort. 2010–2012. OC-Sensor. Tayside, Scotland.	280	2.14	NA	Low	Un-clear	Low	Low	Low	Low	Low	10	1.00	0.94
Rodriguez-Alonso et al.[10]	Symptomatic outpatients referred for and completing diagnostic colonoscopy. Secondary care prospective cohort. 2011–2012. OC-Sensor. Barcelona, Spain.	1003	2.99	NA	Low	Low	Low	Low	Low	Low	Low	0	1.00	0.43
												10	0.97	0.80
Mowat et al. 2016[11]	All adults referred for investigation of bowel symptoms. 2013–2014. Secondary care prospective cohort study. OC-Sensor. Tayside, Scotland	750	3.73	NA	Low	Un-clear	Low	Low	Low	Low	High	2	1.00	0.43
												10	0.89	0.79

Table 1 (continued): Studies included in meta-analysis.

Study	Description (Including retrospective vs prospective design, primary or secondary care recruitment, cohort date, laboratory analyser, and location)	n	CRC prevalence %	FU interval months	QUADAS-2							Threshold mcg/g	Sensitivity	Specificity
					Risk of bias			Applicability concerns			Flow and timing			
					Selection	Index test	Reference standard	Selection	Index test	Reference standard				
Herrero et al.[12]	Consecutive symptomatic patients referred for colonoscopy. Prospective secondary care cross-sectional study. 2012–2013. OC-Sensor. Ourense, Spain.	1572	13.6	NA	Low	Low	Low	Low	Low	Low	Low	10	0.93	0.63
Mowat et al. 2019[13]	New onset symptomatic patients in primary care as per NICE NG12. Primary care prospective cohort. 2015–2018. HM-JACKarc. Tay-side, Scotland	5372	1.82	24-36	Low	Low	Low	Low	Low	Low	Low	10	0.88	0.79
Khan et al.[14]	Patients with bowel symptoms referred under 2 week wait colorectal cancer pathway, and completing investigations. Secondary care prospective. 2017–2018. HM-JACKarc. East Sussex, England.	928	5.06	NA	Unclear	Un-clear	Low	Low	Low	Low	Low	10	0.85	0.84

Table 1 (continued): Studies included in meta-analysis.

| Study	Description (Including retrospective vs prospective design, primary or secondary care recruitment, cohort date, laboratory analyser, and location)	n	CRC prevalence %	FU interval months	QUADAS-2						Flow and timing	Threshold mcg/g	Sensitivity	Specificity
					Risk of bias			Applicability concerns						
					Selection	Index test	Reference standard	Selection	Index test	Reference standard				
Navarro et al.[15]	Secondary care prospective observational study of patients referred with symptoms and accepted for colonoscopy. 2016–2018. SENTiFIT. Zaragoza, Spain.	727	4.95	NA	Low	Low	Low	Low	Low	Low	Low	10	0.94	0.75
Tsapournas et al.[16]	Patients referred for colonoscopy with colorectal symptoms. Secondary care prospective cohort. 2013–2017. QuikRead go. Sweden.	242	5.37	NA	Unclear	Low	Low	Low	Low	Low	Low	10	0.92	0.77
d'Souza et al.[9]	Patients referred and accepted for investigation by colonoscopy under the NICE NG12 2-week wait rules. Prospective multi-centre secondary care cohort. 2017–2019. HM-JACKarc. England.	9822	3.35	NA	Unclear	Low	Unclear	Low	Low	Low	Low	2	0.97	0.65
												10	0.91	0.84

Table 1 (continued): Studies included in meta-analysis.

Study	Description (Including retrospective vs prospective design, primary or secondary care recruitment, cohort date, laboratory analyser, and location)	n	CRC prevalence %	FU interval months	QUADAS-2 Risk of bias Selection	Index test	Reference standard	Applicability concerns Selection	Index test	Reference standard	Flow and timing	Threshold mcg/g	Sensitivity	Specificity
Mowat et al. 2021[4]	FIT requested in primary care to guide referral for any colorectal symptom. Retrospective, primary care, cohort. 2015–2016. HM-JACK-arc. Tayside, Scotland.	5381	1.95	24–36	Low	Low	Unclear	Low	Low	Unclear	Low	2	0.97	0.49
												10	0.87	0.79
Turvill et al. [17]	Patients referred according to NICE NG12 2-week wait. Multicentre. Prospective, secondary care cohort. HM-JACKarc. 2018–2019. Yorkshire/Humber, England.	5040	3.00	NA	High	Un-clear	Low	Low	Low	Low	Low	2	0.93	0.61
												10	0.87	0.81
J Bailey et al. 2021[18]	Patients referred for investigation of colorectal symptoms; excluding rectal bleeding and rectal mass. Result incorporated into referral pathway. Retrospective audit. Primary care. 2017–2019. OC-sensor. Nottingham, England.	13032	1.77	2–25	Low	Low	Low	Low	Low	Low	High	4	0.97	0.70
												10	0.92	0.82

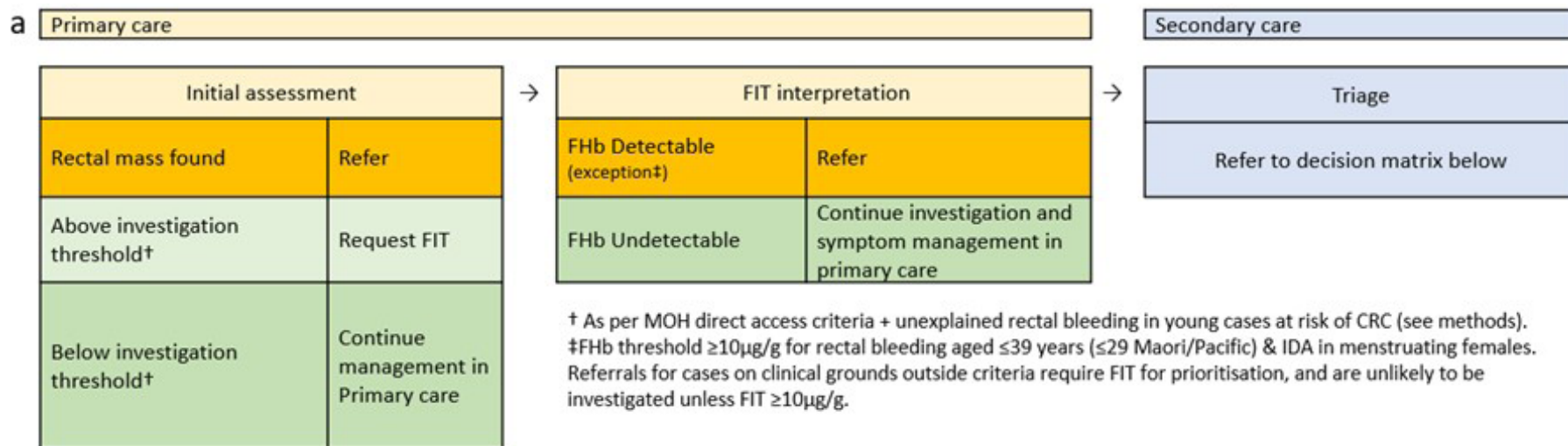**Table 1 (continued):** Studies included in meta-analysis.

Study	Description *(Including retrospective vs prospective design, primary or secondary care recruitment, cohort date, laboratory analyser, and location)*	n	CRC prevalence %	FU interval months	QUADAS-2							Threshold mcg/g	Sensitivity	Specificity
					Risk of bias			Applicability concerns			Flow and timing			
					Selection	Index test	Reference standard	Selection	Index test	Reference standard				
Laszlo et al.[19]	Prospective, secondary care, multicentre observational study. All patients referred with abdominal symptoms for suspected CRC and those meeting NG12. 2017–2019. OC-Sensor. England.	3589	2.51	NA	Unclear	Un-clear	Low	Low	Low	Low	Low	4	0.88	0.73
												10	0.83	0.80
Johnstone et al.[20]	Retrospective observational study of all patients with FIT submitted from primary care. 2018–2019. Greater Glasgow and Clyde, Scotland.	4737	1.22	22–28	Low	Low	Low	Low	Low	Low	Low	10	0.91	0.80
MacDonald et al.[21]	Prospective, observational. Consecutive referrals of symptomatic colorectal patients from primary care. 2016–2019. HM-JACKarc. Lanarkshire, Scotland.	5250	2.88	24	Low	Low	Low	Low	Low	Low	Low	10	0.87	0.67

Table 1 (continued): Studies included in meta-analysis.

Study	Description (Including retrospective vs prospective design, primary or secondary care recruitment, cohort date, laboratory analyser, and location)	n	CRC prevalence %	FU interval months	QUADAS-2							Threshold mcg/g	Sensitivity	Specificity
					Risk of bias			Applicability concerns			Flow and timing			
					Selection	Index test	Reference standard	Selection	Index test	Reference standard				
Pin-Vieito et al.[22]	Population based retrospective cohort of patients with lower GI symptoms referred from primary care. San Sebastian cohort only. 2012–2016. OC-Sensor. Spain.	4543	1.61	24	Unclear	Low	Low	Unclear	Unclear	Low	Low	10	0.81	0.83
S Bailey et al.[23]	Patients with low-risk symptoms meeting NICE NG12/DG30. Retrospective, observational study of primary care based FIT. 2018. HM-JACKarc. Southwest England.	3890	1.31	12	Low	Low	Low	Low	Low	Low	Low	10	0.84	0.85
Maclean et al.[24]	Symptomatic patients referred under NICE NG12 completing investigation. Prospective, secondary care-based cohort. 2019–2020. SENTiFIT. Surrey, England.	553	2.53	NA	Unclear	Unclear	Low	Unclear	Low	Low	Low	3	1.00	0.77
												10	1.00	0.85

Figure 3: Forrest plots of studies reporting the diagnostic accuracy of a single rule out FIT for CRC.
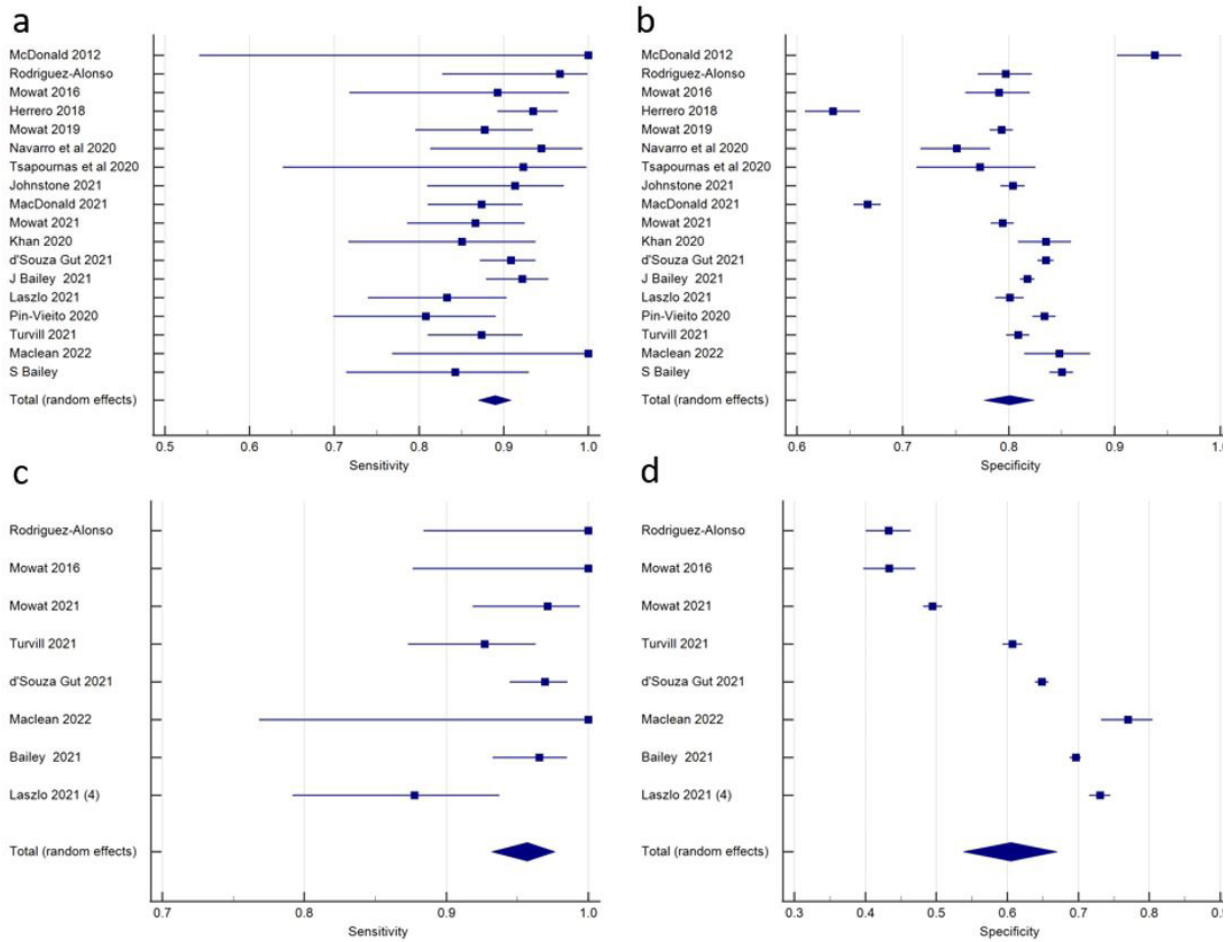
a and b: sensitivity and specificity at >10mcg/g respectively.
c and d: sensitivity and specificity at LoD respectively.

Figure 4: Canterbury colorectal symptom pathway. a: Patient flow diagram. b: Secondary care decision aid.

Table 2: Colorectal cancer prevalence, and number needed to investigate or decline according to symptom and FHb threshold.

| Category | 2018 Canterbury dataset* | | Calculated case number by FHb threshold or range | | | | | | | | | |
| | | | >150 mcg/g | | 10–150 mcg/g | | <10 mcg/g | | <LoD | | LoD–10 mcg/g | |
	n (% of total)	CRC (%)	n	CRC (%) NNI	n	CRC (%) NNI	n	CRC (%) NNI (WC)	n	CRC (%) NNI (WC)	n	CRC (%) NNI
IDA + RB	389 (13.4)	36 (9.25)	44.55	25.49 (57.21) 1.75	57.52	6.47 (11.25) 9	286.93	4.04 (1.41) 71 (62)	214.82	1.52 (0.71) 141 (90)	72.10	2.52 (3.49) 29
RB + ABH >50years	684 (23.6)	39 (5.70)	62.44	27.61 (44.22) 2.26	100.29	7.01(6.99) 14	521.27	4.38 (0.84) 119 (104)	391.39	1.65 (0.42) 237 (151)	129.88	2.73 (2.10) 48
RB + ABH 40–49 years	66 (2.3)	2 (3.03)	4.87	1.42 (29.06) 3.44	9.61	0.36 (3.74) 27	51.51	0.22 (0.44) 230 (201)	38.76	0.08 (0.22) 458 (292)	12.76	0.14 (1.10) 91
RB + ABH <39 years	144 (5.0)	1 (0.69)	8.43	0.71 (8.40) 11.91	20.86	0.18 (0.86) 116	114.71	0.11 (0.10) 1022 (895)	86.45	0.04 (0.05) 2044 (1301)	28.26	0.07 (0.25) 404
ABH >50 years	1061 (36.6)	28 (2.64)	75.61	19.82 (26.22) 3.81	154.42	5.03 (3.26) 31	830.97	3.14 (0.38) 265 (232)	625.38	1.18 (0.19) 528 (336)	205.59	1.96 (0.95) 105
Other criteria	554 (19.1)	11 (1.99)	37.11	7.79 (20.99) 4.77	80.50	1.98 (2.46) 41	436.39	1.23 (0.28) 354 (310)	328.58	0.47 (0.14) 706 (450)	107.81	0.77 (0.71) 140
All*	2898 (100)	117 (4.04)	233.01	82.84 (35.55) 2.81	423.21	21.04 (4.97) 20	2241.78	13.13 (0.59) 171 (150)	1685.38	4.95 (0.29) 341 (217)	556.40	8.18 (1.47) 68

*excluding 88 cases (9 CRC) referred with a rectal mass, and 214 cases (2 CRC) referred for concern regarding inflammatory bowel disease.
IDA: iron deficiency anaemia
RB: rectal bleeding
ABH: altered bowel habit
CRC: colorectal cancer
NNI: number needed to investigate to detect one cancer
WC: NND at upper 95% CI of the NLR (worst case scenario)

Table 3: Overall sensitivity, specificity, and resource implications of proposed pathway.

Criteria	Colonoscopy per 1,000 referrals	Expected CTC per 1,000 referrals	Sensitivity for CRC (95% CI)	Specificity for CRC (95% CI)	NNI	NND
MOH direct access criteria	775		90.5 (84.0–95.0)	24.0 (22.4–25.6)	21	56
Urgent referral for colonoscopy ACPG-BI/BSG 2022[7]	250		89.6 (82.1–93.8)	77.9 (76.4–79.4)	7	171
Canterbury pathway	407*	81	97.1 (92.1–99.1)	54.2 (52.3–56.0)	12	426

*includes 10% conversion from CTC to colonoscopy.
NNI: number needed to investigate.
NND: number needed to decline.
CTC: computed tomography colonography.
CRC: colorectal cancer.
ACPGBI/BSG: Association of coloproctology of Great Britain and Ireland/British Society of Gastroenterology.

Table 4: Negative likelihood ratios for rule out thresholds of FIT calculated from contemporary meta-analyses.

	Current study (95% CI)	Saw et al. 2022[39] *>2mcg/g	Booth et al. 2022[40]	Pin-Vieito et al. 2022[8]
>10mcg/g	0.14 (0.12–0.16)	0.14	0.12	0.15
LoD	0.07 (0.04–0.11)	*0.05	0.08	0.09

years reflects disease risk and survival outcomes for these peoples,[45,46] and aims to align the rate of investigation of these peoples with the higher rate of investigation of NZ Europeans found in the 2018 dataset.[2] The change also aligns the colorectal pathway with the Canterbury upper gastrointestinal pathway, which has lower age thresholds for at risk populations, and is consistent with the recent extension of age criteria for Māori and Pacific people in the National Bowel Screening Program (NBSP). Meanwhile, recommending FHb measurement for patients below the age of 50 years who have unexplained RB addresses concern regarding the increasing incidence of CRC in the young,[47] and brings order to the current *ad hoc* approach for this patient group, the higher rule out threshold (>10mcg/g) being justified by the low prior risk.

Primary sector engagement indicates a strong preference for FHb testing in primary care supported by comprehensive education and online resources (in Canterbury via Community Health-Pathways) for both test interpretation and to guide primary care-based management of colorectal symptoms. FIT request and interpretation in primary care has several benefits: promoting decision making by a single physician aware of the entire patient history, optimising sample return through explanation of the investigative process and the immediate provision of standardised collection device and requisition form for all faecal tests, and allowing follow-up in primary care for cases not returning samples using community-based staff. Furthermore, FHb testing in primary care avoids unnecessary case referral, saving time in primary and secondary care, and facilitating rapid clinical decision making.

There are few data regarding accuracy of FIT for most non-malignant colorectal conditions other than IBD and high-risk adenomas. FIT has good diagnostic accuracy for colonic IBD,[42] and is likely to have utility in the diagnosis of other bleeding pathologies such as drug induced, ischaemic, or diverticular colitis, colonic angiodysplastic bleeding and ulcerative conditions such as stercoral ulceration or rectal ulcer syndrome. However, there is no expectation that FIT would be useful in the diagnosis of microscopic colitis or other non-bleeding pathologies, and FIT is unreliable in the diagnosis of proximal gastrointestinal bleeding and small bowel Crohn's disease.[48,49] To ensure that a FIT based colorectal investigation pathway does not compromise the diagnosis of either malignant, or non-malignant colorectal

disease, we have started with the lowest rule out threshold and propose to develop the pathway iteratively in response to prospective data.

FIT is currently being used in Canterbury to re-prioritise cases awaiting non-urgent new patient colonoscopy, and outcome data from the project will be reported in due course. Subsequently, the safe implementation of a pathway for new patients is dependent on robust primary sector engagement, education, and strong governance. Several future scenarios are conceivable. Future data may show that FIT has greater accuracy than estimated in the present study. In that situation, it would be appropriate to adopt a higher rule out threshold, retaining excellent sensitivity for CRC with lower rates of investigation. The current modelling assumes no change in GP referral practice; however, it is likely that GPs will have a lower threshold for investigating with FIT than they currently have for referring for invasive investigation. To maintain a high yield from invasive investigation in this situation, it may be necessary to increase the FIT threshold at which cases are accepted. Effort should be made to avoid this scenario, and the extreme case of surrogate screening, by emphasising the importance of symptom threshold for testing, as the higher the rule out FIT threshold is set, the less reassurance an individual symptomatic patient will receive from a 'negative' test. Reassuringly, where data are available, FIT testing rates have been shown to stabilise over time, suggesting that surrogate screening is unlikely to be widespread.[13,33]

Comparison of the current proposal with the new UK guideline is pertinent. Neither pathway recommends FIT in cases with anorectal lesions, and both recommend FIT in primary care. Thereafter, the pathways diverge with the ACPGBI/BSG recommending urgent referral for symptomatic cases with FHb >10mcg/g, while the Canterbury pathway follows a graduated approach, both to urgency and mode of investigation dependent on FHb concentration and case presentation. The ACPGBI/BSG delegates decisions regarding referral of cases with FHb<10mcg to the discretion of the referring doctor, while the Canterbury pathway anticipates accepting cases for non-urgent investigation when the FHb is detectable above the LoD. Referral of cases below this threshold, made due to enduring concern, would be judged on their merit. To

derive future iterations of the pathway, and ultimately a national solution for FIT in symptomatic cases, the merits of resource distribution between various facets of colonoscopy activity must be considered, including for symptomatic, screening, and surveillance cases. According to our dataset, the number needed to investigate to detect one CRC in the current direct access criteria is 21 (90.5% sensitive), compared with 12 for the current proposal (97% sensitive), 14 in the NBSP (assuming 7% CRC detection at colonoscopy), and 6 in the latest UK guideline (sensitivity 90%). Further discussion on this point is important but beyond the current work.

Much is beyond the scope of this study. We have neither performed economic analysis, nor detailed the complex processes required to ensure patient engagement and equity of outcome for population groups. Neither have we sought to resolve all clinical scenarios. For example, given the increasing risk of CRC with age, is there an upper age threshold beyond which all cases should be investigated irrespective of FHb result? How long should a persistently symptomatic patient be observed and managed in primary care before repeat FHb testing, and how should a repeat FIT result be interpreted? Neither have we fully addressed the investigation of colorectal symptoms in younger cases where IBD is the more common diagnosis, nor how to approach a case at risk of both CRC and IBD.

Improving access to colonoscopy for patients at risk of serious disease is an immediate concern for New Zealand. Formally incorporating FHb measurement into the assessment, referral, and prioritisation of colorectal symptoms appears achievable and should enable a high sensitivity for colorectal cancer, while also reducing the number of colonoscopies performed with no significant finding. This will expedite the investigation of those at higher risk, as colonoscopies can be undertaken more rapidly in this group. Robust primary and secondary sector education, community collaboration, development of strategies to ensure equity, research, prospective data gathering, analysis and feedback, are all essential for the initial and future success of the pathway.

AUTHOR INFORMATION
James Falvey: Gastroenterologist, Department of Gastroenterology, Christchurch Hospital, Te Whatu Ora Waitaha, Christchurch.
Christopher M A Frampton: Professor of Biostatistics, Department of Medicine, University of Otago, Christchurch Campus, Christchurch.
Richard B Gearry: Professor of Medicine and Head of Department of Medicine, University of Otago, Christchurch Campus; Gastroenterologist, Department of Gastroenterology, Christchurch Hospital, Te Whatu Ora Waitaha, Christchurch.
Ben Hudson: Head of Department and Senior Lecturer, Department of General Practice, University of Otago, Christchurch Campus; General Practitioner.
Lucinda Whiteley: General Practitioner, Clinical Leader Canterbury Initiative, Te Whatu Ora Waitaha, Christchurch.

CORRESPONDING AUTHOR
James Falvey: Gastroenterologist, Department of Gastroenterology, Christchurch Hospital, Te Whatu Ora Waitaha, Christchurch. Ph: 03 364 0640. E: james.falvey@cdhb.health.nz

REFERENCES
1. Manatū Hauora – Ministry of Health [Internet]. Referral Criteria for Direct Access Outpatient Colonoscopy or Computed Tomography Colonography; 2019 [cited 2022 Sep 1]. Available from: https://www.health.govt.nz/publication/referral-criteria-direct-access-outpatient-colonoscopy-or-computed-tomography-colonography.
2. John RA, Wang H, Sylevych V, Falvey JD. Improving early detection of colorectal cancer in Aotearoa New Zealand: how do the direct access criteria perform? N Z Med J. 2022 Oct 28;135(1564):31-40.
3. McDonald PJ, Digby J, Innes C, Strachan JA, Carey FA, Steele RJ et al. Low faecal haemoglobin concentration potentially rules out significant colorectal disease. Colorectal Dis. 2013 Mar;15(3):e151-9. doi: 10.1111/codi.12087.
4. Mowat C, Digby J, Strachan JA, McCann RK, Carey FA, Fraser CG et al. Faecal haemoglobin concentration thresholds for reassurance and urgent investigation for colorectal cancer based on a faecal immunochemical test in symptomatic patients in primary care. Ann Clin Biochem. 2021 May;58(3):211-219. doi: 10.1177/0004563220985547.
5. NICE National Institute for Health and Care Excellence [Internet]. Quantitative faecal immunochemical tests to guide referral for colorectal cancer in primary care.; 2017 July 26 [cited 2022 Sep 1]. Available from: https://www.nice.org.uk/guidance/dg30
6. Maclean W, Limb C, Mackenzie P, Whyte MB, Benton SC, Rockall T et al. Adoption of faecal immunochemical testing for 2-week-wait colorectal patients during the COVID-19 pandemic: an observational cohort study reporting a new service at a regional centre. Colorectal Dis. 2021 Jul;23(7):1622-1629. doi: 10.1111/codi.15408.
7. Monahan KJ, Davies MM, Abulafi M, Banerjea A, Nicholson B, Arasaradnam R et al. Faecal immunochemical testing (FIT) in patients with signs or symptoms of suspected colorectal cancer (CRC): a joint guideline from the Association of Coloproctology of Great Britain and Ireland (ACPGBI) and the British Society of Gastroenterology (BSG). Gut. 2022;71(10):1939–62.
8. Pin-Vieito N, Tejido-Sandoval C, De Vicente-Bielza N, et al. Faecal immunochemical tests safely enhance rational use of resources during the assessment of suspected symptomatic colorectal cancer in primary care: Systematic review and meta-analysis. Gut. 2022;71(5):1939-1962.
9. D'souza N, Georgiou Delisle T, Chen M, Benton S, Abulafi M; NICE FIT Steering Group. Faecal immunochemical test is superior to symptoms in predicting pathology in patients with suspected colorectal cancer symptoms referred on a 2WW pathway: a diagnostic accuracy study. Gut. 2021 Jun;70(6):1130-1138. doi: 10.1136/gutjnl-2020-321956.
10. Rodríguez-Alonso L, Rodríguez-Moranta F, Ruiz-Cerulla A, Lobatón T, Arajol C, Binefa G et al. An urgent referral strategy for symptomatic patients with suspected colorectal cancer based on a quantitative immunochemical faecal occult blood test. Dig Liver Dis. 2015 Sep;47(9):797-804. doi:

10.1016/j.dld.2015.05.004.

11. Mowat C, Digby J, Strachan JA, Wilson R, Carey FA, Fraser CG et al. Faecal haemoglobin and faecal calprotectin as indicators of bowel disease in patients presenting to primary care with bowel symptoms. Gut. 2016 Sep;65(9):1463-9. doi: 10.1136/gutjnl-2015-309579.

12. Herrero JM, Vega P, Salve M, Bujanda L, Cubiella J. Symptom or faecal immunochemical test based referral criteria for colorectal cancer detection in symptomatic patients: a diagnostic tests study. BMC Gastroenterol. 2018 Oct 25;18(1):155. doi: 10.1186/s12876-018-0887-7.

13. Mowat C, Digby J, Strachan JA, McCann R, Hall C, Heather D et al. Impact of introducing a faecal immunochemical test (FIT) for haemoglobin into primary care on the outcome of patients with new bowel symptoms: a prospective cohort study. BMJ Open Gastroenterol. 2019 May 4;6(1):e000293. doi: 10.1136/bmjgast-2019-000293.

14. Khan AA, Klimovskij M, Harshen R. Accuracy of faecal immunochemical testing in patients with symptomatic colorectal cancer. BJS Open. 2020 Sep 18;4(6):1180-8. doi: 10.1002/bjs5.50346.

15. Navarro M, Hijos G, Sostres C, Lué A, Puente-Lanzarote JJ, Carrera-Lasfuentes P et al. Reducing the Cut-Off Value of the Fecal Immunochemical Test for Symptomatic Patients Does Not Improve Diagnostic Performance. Front Med (Lausanne). 2020 Sep 2;7:410 doi: 10.3389/fmed.2020.00410.

16. Tsapournas G, Hellström PM, Cao Y, Olsson LI. Diagnostic accuracy of a quantitative faecal immunochemical test vs. symptoms suspected for colorectal cancer in patients referred for colonoscopy. Scand J Gastroenterol. 2020 Feb;55(2):184-192. doi: 10.1080/00365521.2019.1708965.

17. Turvill JL, Turnock D, Cottingham D, Haritakis M, Jeffery L, Girdwood A et al. The Fast Track FIT study: diagnostic accuracy of faecal immunochemical test for haemoglobin in patients with suspected colorectal cancer. Br J Gen Pract. 2021 Jul 29;71(709):e643-e651. doi: 10.3399/BJGP.2020.1098.

18. Bailey JA, Weller J, Chapman CJ, Ford A, Hardy K, Oliver S et al. Faecal immunochemical testing and blood tests for prioritization of urgent colorectal cancer referrals in symptomatic patients: a 2-year evaluation. BJS Open. 2021 Mar 5;5(2):zraa056. doi: 10.1093/bjsopen/zraa056.

19. Laszlo HE, Seward E, Ayling RM, Lake J, Malhi A, Stephens C et al. Faecal immunochemical test for patients with 'high-risk' bowel symptoms: a large prospective cohort study and updated literature review. Br J Cancer. 2022 Mar;126(5):736-743. doi:

20. Johnstone MS, Burton P, Kourounis G, Winter J, Crighton E, Mansouri D et al. Combining the quantitative faecal immunochemical test and full blood count reliably rules out colorectal cancer in a symptomatic patient referral pathway. Int J Colorectal Dis. 2022 Feb;37(2):457-466. doi: 10.1007/s00384-021-04079-2.

21. MacDonald S, MacDonald L, Godwin J, Macdonald A, Thornton M et al. The diagnostic accuracy of the faecal immunohistochemical test in identifying significant bowel disease in a symptomatic population. Colorectal Dis. 2022 Mar;24(3):257-263. doi: 10.1111/codi.15994.

22. Pin-Vieito N, García Nimo L, Bujanda L, Román Alonso B, Gutierrez-Stampa MÁ, Aguilar-Gama V et al. Optimal diagnostic accuracy of quantitative faecal immunochemical test positivity thresholds for colorectal cancer detection in primary health care: A community-based cohort study. United European Gastroenterol J. 2021 Mar;9(2):256-267. doi: 10.1177/2050640620949714.

23. Bailey SER, Abel GA, Atkins A, Byford R, Davies SJ, Mays J et al. Diagnostic performance of a faecal immunochemical test for patients with low-risk symptoms of colorectal cancer in primary care: an evaluation in the South West of England. Br J Cancer. 2021 Mar;124(7):1231-1236. doi: 10.1038/s41416-020-01221-9.

24. MacLean W, Zahoor Z, O'Driscoll S, Piggott C, Whyte MB, Rockall T et al. Comparison of the QuikRead go®point-of-care faecal immunochemical test for haemoglobin with the FOB Gold Wide® laboratory analyser to diagnose colorectal cancer in symptomatic patients. Clin Chem Lab Med. 2021 Oct 25;60(1):101-108. doi: 10.1515/cclm-2021-0655.

25. Widlak MM, Thomas CL, Thomas MG, Tomkins C, Smith S, O'Connell N et al. Diagnostic accuracy of faecal biomarkers in detecting colorectal cancer and adenoma in symptomatic patients. Aliment Pharmacol Ther. 2017 Jan;45(2):354-363. doi: 10.1111/apt.13865.

26. Chapman C, Bunce J, Oliver S, Ng O, Tangri A, Rogers R et al. Service evaluation of faecal immunochemical testing and anaemia for risk stratification in the 2-week-wait pathway for colorectal cancer. BJS open. 2019 Jan 28;3(3):395-402. doi: 10.1002/bjs5.50131.

27. Farrugia A, Widlak M, Evans C, Smith SC, Arasaradnam R et al. Faecal immunochemical testing (FIT) in symptomatic patients: what are we missing? Frontline Gastroenterol. 2020 Jan;11(1):28-33. doi: 10.1136/flgastro-2018-101174.

28. Juul JS, Hornung N, Andersen B, Laurberg S,

Olesen F, Vedsted P et al. The value of using the faecal immunochemical test in general practice on patients presenting with non-alarm symptoms of colorectal cancer. Br J Cancer. 2018 Aug;119(4):471-479. doi: 10.1038/s41416-018-0178-7.

29. Ayling RM, Machesney M. Service evaluation of faecal immunochemical testing introduced for use in North East London for patients at low risk of colorectal cancer. J Clin Pathol. 2021 Mar;74(3):163-166. doi: 10.1136/jclinpath-2020-206632.

30. Clackett W, Barclay ST, Stanley AJ, Cahill A. The Value of Quantitative Faecal Immunochemical Testing as a Prioritisation Tool for the Endoscopic Investigation of Patients With Iron Deficiency. Front Med (Lausanne). 2021 Jul 22;8:700753. doi: 10.3389/fmed.2021.700753.

31. Turvill J, Mellen S, Jeffery L, Bevan S, Keding A, Turnock D et al. Diagnostic accuracy of one or two faecal haemoglobin and calprotectin measurements in patients with suspected colorectal cancer. Scand J Gastroenterol. 2018 Dec;53(12):1526-1534. doi: 10.1080/00365521.2018.1539761.

32. D'Souza N, Hicks G, Benton SC, Abulafi M. The diagnostic accuracy of the faecal immunochemical test for colorectal cancer in risk-stratified symptomatic patients. Ann R Coll Surg Engl. 2020 Mar;102(3):174-179. doi: 10.1308/rcsann.2019.0144.

33. Nicholson BD, James T, East JE, Grimshaw D, Paddon M, Justice S et al. Experience of adopting faecal immunochemical testing to meet the NICE colorectal cancer referral criteria for low-risk symptomatic primary care patients in Oxfordshire, UK. Frontline Gastroenterol. 2019 Oct;10(4):347-355. doi: 10.1136/flgastro-2018-101052.

34. Sanders AD, Stevenson C, Pearson J, Burt M, McGeoch G, Hudson B et al. A novel pathway for investigation of colorectal symptoms with colonoscopy or computed tomography colonography. N Z Med J. 2013 Sep 13;126(1382):45-57.

35. NICE National Institute for Health and Care Excellence [Internet]. NICE guideline; 2015 June 23 [cited 2022 Sep 1]. Suspected cancer: recognition and referral Available from: https://www.nice.org.uk/guidance/ng12.

36. Christopher J, Flint TR, Ahmed H, Dhir N, Li R, Macfarland K et al. Straight-to-test for the two-week-wait colorectal cancer pathway under the updated NICE guidelines reduces time to cancer diagnosis and treatment. Ann R Coll Surg Engl. 2019 May;101(5):333-339. doi: 10.1308/rcsann.2019.0022.

37. Digby J, Strachan JA, McCann R, Steele RJ, Fraser CG, Mowat C et al. Measurement of faecal haemoglobin with a faecal immunochemical test can assist in defining which patients attending primary care with rectal bleeding require urgent referral. Ann Clin Biochem. 2020 Jul;57(4):325-327. doi: 10.1177/0004563220935622.

38. Högberg C, Gunnarsson U, Cronberg O, Thulesius H, Lilja M, Jansson S et al. Qualitative faecal immunochemical tests (FITs) for diagnosing colorectal cancer in patients with histories of rectal bleeding in primary care: a cohort study. Int J Colorectal Dis. 2020 Nov;35(11):2035-2040. doi: 10.1007/s00384-020-03672-1.

39. Saw KS, Liu C, Xu W, Varghese C, Parry S, Bissett I. Faecal immunochemical test to triage patients with possible colorectal cancer symptoms: meta-analysis. Br J Surg. 2022 Feb 1;109(2):182-190.

40. Booth R, Carten R, D'Souza N, Westwood M, Kleijnen J, Abulafi M. Role of the faecal immunochemical test in patients with risk-stratified suspected colorectal cancer symptoms: A systematic review and meta-analysis to inform the ACPGBI/BSG guidelines. Lancet Reg Health Eur. 2022 Oct 3;23:100518. doi: 10.1016/j.lanepe.2022.100518.

41. Takashima S, Kato J, Hiraoka S, Nakarai A, Takei D, Inokuchi T et al. Evaluation of Mucosal Healing in Ulcerative Colitis by Fecal Calprotectin Vs. Fecal Immunochemical Test. Am J Gastroenterol. 2015 Jun;110(6):873-80. doi: 10.1038/ajg.2015.66.

42. Mooiweer E, Fidder HH, Siersema PD, Laheij RJ, Oldenburg B. Fecal hemoglobin and calprotectin are equally effective in identifying patients with inflammatory bowel disease with active endoscopic inflammation. Inflamm Bowel Dis. 2014 Feb;20(2):307-14. doi: 10.1097/01.MIB.0000438428.30800.a6.

43. Mowat C, Digby J, Cleary S, Gray L, Datt P, Goudie DR et al. Faecal haemoglobin concentration in adenoma, before and after polypectomy, approaches the ideal tumour marker. Ann Clin Biochem. 2022 Jul;59(4):272-276. doi: 10.1177/00045632221080897.

44. Hirsz M, Hunt L, Mayo M, Chepulis L. Symptoms associated with colorectal cancer in patients referred to secondary care. N Z Med J. 2022 May 6;135(1554):137-139.

45. McLeod M, Harris R, Paine SJ, Crengle S, Cormack D, Scott N et al. Bowel cancer screening age range extension for Māori: what is all the fuss about? N Z Med J. 2021 May 21;134(1535):71-77.

46. Sharples KJ, Firth MJ, Hinder VA, Hill AG, Jeffery M, Sarfati D et al. The New Zealand PIPER Project: colorectal cancer survival according to rurality, ethnicity and socioeconomic depreivation-results from a retrospective cohort study. N Z Med J. 2018 Jun 8;131(1476):24-39.

47. Akimoto N, Ugai T, Zhong R, Hamada T, Fujiyoshi K et al. Rising incidence of early-onset colorectal cancer - a call to action. Nat Rev Clin Oncol. 2021 Apr;18(4):230-243. doi: 10.1038/s41571-020-00445-1.

48. Inokuchi T, Kato J, Hiraoka S, Takashima S, Nakarai A, Takei D et al. Fecal Immunochemical Test Versus Fecal Calprotectin for Prediction of Mucosal Healing in Crohn's Disease. Inflamm Bowel Dis. 2016 May;22(5):1078-85. doi: 10.1097/MIB.0000000000000728.

49. Pin-Vieito N, Iglesias MJ, Remedios D, Rodríguez-Alonso L, Rodriguez-Moranta F, Álvarez-Sánchez V et al. Retrospective cohort study: Risk of gastrointestinal cancer in a symptomatic cohort after a complete colonoscopy: Role of faecal immunochemical test. World J Gastroenterol. 2020 Jan 7;26(1):70-85. doi: 10.3748/wjg.v26.i1.70.

The long-term impacts of COVID-19 on confirmed cases at least 12 months post-infection in Wellington, New Zealand: an observational, cross-sectional study

Nethmi Kearns, Neakiry Kivi, Emily Dickinson, Emma Mayo, Allie Eathorne, Augustus Anderson, Richard Beasley, Craig Thornley, Annette Nesdale

ABSTRACT

AIM: To explore the prevalence of ongoing symptoms and laboratory abnormalities in confirmed cases of COVID-19 from the first wave within the Greater Wellington Region, after at least 12 months post infection.

METHOD: COVID-19 cases were obtained from EpiSurv. Eligible participants electronically completed questionnaires (Overall Health Survey, Patient Health Questionnaire-9 [PHQ-9], Generalised Anxiety Disorder-7 [GAD-7], Pittsburgh Sleep Quality Index, EuroQol 5 Dimension 5 Level [EQ-5D-5L], Fatigue Severity Scale [FSS], WHO Symptom Questionnaire, Modified Medical Research Council Dyspnoea Scale [mMRC Dyspnoea Scale]). Blood samples were analysed for cardiac, endocrine, haematological, liver, antibody, and inflammatory markers.

RESULTS: Forty-two of 88 eligible cases undertook the study. Participants were enrolled at a median 628.5 days from symptom onset. Fifty-two point four percent felt that their current overall health was worse than it was prior to contracting COVID-19. Ninety percent of participants reported at least two ongoing symptoms since their acute illness. Between 45–72% of participants reported each of anxiety, depression, dyspnoea, pain/discomfort, and sleep difficulties, assessed using the GAD-7, PHQ-9, mMRC Dyspnoea Scale, EQ-5D-5L and FSS questionnaires respectively. There were minimal laboratory abnormalities.

CONCLUSION: There is a high prevalence of ongoing symptoms following the first wave of COVID-19 infection in Aotearoa New Zealand. At a median of 1.7 years post infection, there is a wide spectrum of symptoms and symptom severity, although as an observational, cross-sectional study a causal relationship between symptoms or their severity and COVID-19 infection cannot be firmly established.

"Long COVID", "post COVID-19 syndrome", "long haulers", "post-COVID conditions", "post-acute sequelae of SARS CoV-2 infection" and "chronic COVID" are terms used to categorise and describe persisting health impairments following an acute COVID-19 infection.[1,2] There is no internationally agreed definition of long COVID, with various institutions such as the World Health Organization[3] (WHO) and Centers for Disease Control and Prevention[2] (CDC) having different definitions, albeit with fundamental similarities. The joint guideline created by the National Institute for Health and Care Excellence (NICE), the Scottish Intercollegiate Guidelines Network (SIGN) and the Royal College of General Practitioners (RCGP)[4] define "Acute COVID-19" as signs and symptoms for up to 4 weeks, "Ongoing symptomatic COVID-19" as signs and symptoms of COVID-19 from 4 weeks up to 12 weeks, and "Post-COVID-19 syndrome" as signs and symptoms that develop during or after an infection consistent with COVID-19, continue for more than 12 weeks and are not explained by an alternative diagnosis. Aotearoa New Zealand guidelines follow the same definition, with the exception that "Post-COVID-19 syndrome" is named long COVID.

There is a large variation in international prevalence estimates of long COVID. Variation in estimated prevalence is likely due to multiple factors including differences between hospitalised and non-hospitalised patients, lack of a consistent definition of "long COVID", differences in follow-up periods, inclusion or exclusion of symptomatic patients with negative tests, and response and non-response biases. In those admitted to hospital, 50–89%

report experiencing at least one symptom after two months,[5] and 76% report at least one symptom at six months.[6] In a study examining a largely non-hospitalised population (96.6% of cases were non-hospitalised), 33.8% of COVID-19 positive cases had at least one ongoing symptom at 60 days and 24.1% at 90 days.[7] At a 1 year follow-up, fatigue (28%), dyspnoea (18%) and arthromyalgia (26%) were the most prevalent symptoms.[8] However, over 60 physical and psychological signs and symptoms with wide prevalence estimates are reported in the literature.[9]

To further understand the long-term characteristics and burden of long COVID, we undertook an observational study to explore the prevalence of ongoing symptoms and persisting laboratory test abnormalities in confirmed cases of COVID-19 from the first wave within the Greater Wellington Region, after at least 12 months post-infection.

Methods

Study design and participants

This was an observational, cross-sectional study conducted remotely by the Medical Research Institute of New Zealand (MRINZ) in partnership with Regional Public Health (RPH), now known as the National Public Health Service, Capital, Coast, Hutt Valley, and Wairarapa. This study was run in accordance with the declaration of Helsinki and was approved by the Southern Health and Disability Ethics Committee (21/STH/111) and registered with the Australian and New Zealand Clinical Trials Registry (ACTRN 12621000524897p). The decision to run the study remotely was taken due to the active community cases of COVID-19 at the time of the study and to mitigate the risks to the study, participants, and staff.

Participants were considered eligible if they were aged 18 years and above, had laboratory PCR confirmed SARS-CoV2 infection during the first wave (28 February 2020 to 1 August 2020) and at least 12 months had elapsed since the first onset of COVID-19 symptoms. Participants were excluded if during the two weeks prior they had symptoms of an acute infection, had been asked to self-isolate, quarantine or stay at home by Public Health officials, or had any other condition which, at the investigator's discretion, was believed to present a risk or impact the feasibility of the study or the study results.

Study procedures

Confirmed COVID-19 cases were identified from Aotearoa New Zealand's national notifiable disease surveillance database, EpiSurv. All eligible cases were contacted by RPH and provided with a participant information sheet. Cases who expressed interest in taking part in the study were referred to the MRINZ. Investigators from the MRINZ contacted potential participants to further explain the study and obtain informed consent. Consent was obtained remotely in all participants via RED-Cap, a secure, United States Health Insurance Portability and Accountability Act 1996 (HIPAA) compliant web-based application hosted and supported by the MRINZ.[10] Participant-reported data relating to demographics and medical history were entered into REDCap directly by the investigator. Participants were then sent a link to the questionnaires (Table 1) via REDCap. Participants were also asked whether "Apart from getting COVID-19, has anything significant happened in your life that could affect the above responses?" following the PHQ-9, GAD-7, PSQI and FSS questionnaires. Laboratory blood test request forms were mailed to participants, and they were able to provide a blood specimen in a participating blood collection centre across Aotearoa New Zealand.

The primary outcome was patient-perceived overall health status, determined using a study specific Overall health questionnaire (Table 1). Secondary outcome measures included patient-reported symptom questionnaires on mental health, quality of life, dyspnoea, fatigue, sleep quality, ongoing symptoms, and laboratory tests.

Statistical methods

Continuous data are summarised by mean and standard deviation (SD), median and inter-quartile range (IQR), and minimum to maximum. Categorical data are summarised by counts and proportions expressed as percentages. SAS version 9.4 was used.

Results

There were 96 confirmed COVID-19 cases of whom 88 were eligible for the study. Forty-four participants consented to the study and 37 completed both the questionnaires and gave a blood sample. Five participants only completed either the questionnaires or blood sampling (Figure 1) and 42 participants were included in the analysis. The median time from onset of COVID-19 symptoms to enrolment was 628.5 days (IQR 599 to 687).

Baseline characteristics

The mean (SD) age of cases was 45.5 (15.5), 54.5% were male and the majority were recorded as being of European ethnicity (90.9%) (Table 2). Eighty-nine percent of cases had received at least two doses of a COVID-19 vaccine at time of enrolment.

Patient reported outcomes

Overall health rating

For the primary outcome, the majority of participants (52.4%, N=22) felt that their current overall health was worse than it was prior to contracting COVID-19 (Table 3). Thirty-eight percent (N=16) of participants reported that their health status was the same as it was before.

Mental health

The majority of participants (54.8%, N=23) scored 5 or above in the PHQ-9, indicating some level of depression. Of those who had a positive screen for symptoms of depression, approximately one third (N=14) had symptoms of mild depression. Thirteen of the participants with symptoms of depression (31% of all respondents) did not identify a significant event in their life (apart from COVID-19) that could have affected their responses. The GAD-7 questionnaire identified 45.2% (N=19) of participants as showing symptoms of anxiety with scores greater than or equal to 5. Eleven of the participants with symptoms of anxiety (26.2% of all respondents) did not identify a significant event in their life (apart from COVID-19) that could have affected their responses. Figure 2 illustrates the number of participants in each severity group for anxiety and depression.

Quality of life

The median (IQR) EQ-5D-5L VAS was 75.5 (56 to 85). The dimension of quality of life most commonly affected was pain/discomfort (54.8%, N=23) and anxiety/depression (54.8%, N=23). One participant reported having issues with self-care, while 33.3% (N=14) and 16.7% (N=7) participants reported having issues with conducting usual activities and mobility, respectively (Figure 2). A breakdown of participants reporting each level of severity within the five dimensions of EQ-5D-5L is shown in Appendix Table 2.

Dyspnoea

The majority of participants (57.1%, N=24) reported having some degree of breathlessness. Eighteen participants (42.9%) indicated Grade 0 on the scale, i.e., no abnormal dyspnoea (only feeling breathless with strenuous exercise). Figure 2 illustrates the number of participants within each grade.

Fatigue

The median (IQR) FSS score was 3.9 (2.7 to 4.8). Half of the participants reported a score >4.0 and were classified as being fatigued. Fourteen of the participants with symptoms of fatigue (33.3% of all respondents) did not identify a significant event in their life (apart from COVID-19) that could have affected their responses.

Sleep quality

The median (IQR) PSQI score was 6.5 (6 to 8). Scores greater than 5 are associated with poor sleep quality and were seen in 76.2% (N=32) of participants. Twenty-five of the participants with symptoms of fatigue (59.5% of all respondents) did not identify a significant event in their life (apart from COVID-19) that could have affected their responses.

Ongoing symptoms

Almost all participants (92.9%, N=39) reported having at least one ongoing symptom while 90.5% (N=38) reported having two or more ongoing symptoms. The most common symptoms were persistent fatigue (64.3%, N=27), followed by dizziness/light-headedness, forgetfulness, post-exercise malaise, and trouble in concentrating, reported by 23 (54.8%) of participants for each symptom. Appendix Table 3 details the frequency of all symptoms.

Laboratory tests

Table 4 summarises the results from blood tests conducted. None of the participants had abnormalities in cardiac markers. One participant had lymphopaenia and three participants had raised ferritin. There were no abnormalities in estimated glomerular filtration rate, and one participant had hyponatraemia. Sixteen point two percent (N=6) participants had abnormal thyroid function tests, while 13.5% (N=5) participants had abnormal liver function enzymes. One participant had very mildly raised CRP (9mg/L). All participants were reactive to SARS-CoV-2 IgG Spike Ab test, while 70% were reactive to the SARS-CoV-2 IgG+IgM (N protein) test. Two unvaccinated participants were reactive to both antibody tests, while the third had no reactivity to SARS-CoV-2 IgG+IgM (N protein) test.

Table 1: Description of symptom questionnaires.

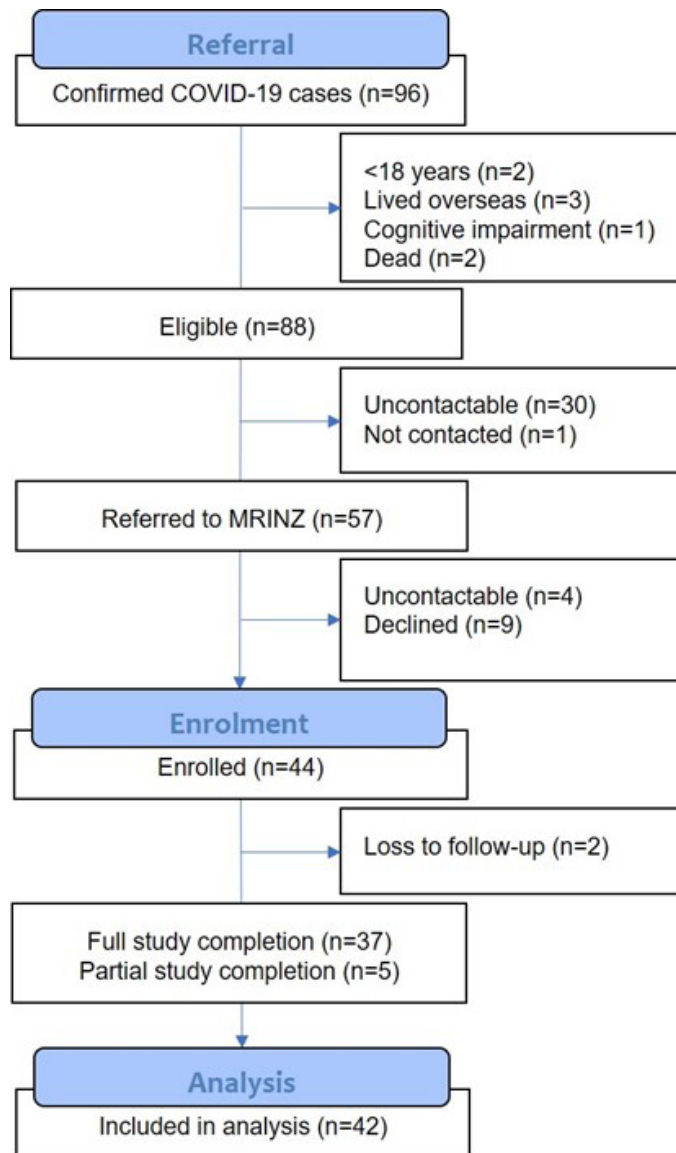| Patient-reported symptom questionnaires	
Overall health questionnaire	Compares overall health prior to getting COVID-19 with current overall health using the following question and response options: *compared to your overall health before getting COVID-19, how would you rate your overall health now?* • My overall health is much better than it was before getting COVID-19. • My overall health is a little better than it was before getting COVID-19. • My overall health is the same as it was before getting COVID-19. • My overall health is a little worse than it was before getting COVID-19. • My overall health is much worse than it was before getting COVID-19.
Modified Medical Research Council Dyspnoea Scale (mMRC Dyspnoea Scale)[11]	Consists of five statements about perceived breathlessness from Grade 0, "I only get breathless with strenuous exercise" to Grade 4, "I am too breathless to leave the house, or I am breathless when dressing or undressing".
Patient Health Questionnaire-9 (PHQ9)[12]	Nine item instrument for detection of depression. Participants are asked how often they were bothered by 9 problems over the preceding 2 weeks and required to select one of "not at all", "several days," "more than half the days," and "nearly every day".
Generalised Anxiety Disorder-7 (GAD7)[13]	Seven item instrument that uses some of the DSM-V criteria for GAD to identify probable cases of GAD along with measuring anxiety symptom severity. Participants are asked how often they were bothered by 7 problems over the preceding 2 weeks and are required to select one of "not at all," "several days," "more than half the days," and "nearly every day".
Pittsburgh Sleep Quality Index (PSQI)[14]	Self-rated questionnaire which assesses sleep quality and disturbances over a 1-month time interval.
EQ-5D-5L[15]	Patient reported questionnaire comprising of five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension has 5 levels: no problems, slight problems, moderate problems, severe problems, and extreme problems.
EQ-5D-5L VAS[15]	The EQ-5D-5L Visual Analogue Scale is a patient reported questionnaire recording the patient's self-rated health "today".
Fatigue Severity Scale (FSS)[16]	Nine item instrument on fatigue, its severity and how it affects certain activities. The items are scored on a 7-point scale with 1=strongly disagree and 7=strongly agree.
WHO Symptom Questionnaire[17]	Section 2.6 of the WHO's Global COVID-19 Clinical Platform Case Report Form for Post COVID condition (Post COVID-19 CRF).

Figure 1: Flow diagram of participants.

Table 2: Baseline characteristics of participants.

Characteristic	N=44
Age; mean years (SD)	45.5 (15.4)
Sex (%)	
Female	19 (45.2)
Ethnicity[a] (%)	
Māori	3 (7.1)
Asian	1 (2.4)
European	38 (90.5)
Smoking (%)	
Never	31 (73.8)
Ex-smoker	8 (19.1)
Current	3 (7.1)
Chronic disease[b] (%)	
Yes	26 (61.9)
COVID-19 vaccination status[e]	
Unvaccinated	3 (6.8)
Partially vaccinated	1 (2.4)
Fully vaccinated[c]	38 (90.5)
Hospital admission[d]	
Yes	2 (4.5)
[a]Prioritised ethnicity using Level 1 codes[18]	
[b]See Appendix Table 1 for list of included chronic diseases	
[c]Defined as having received two doses of a COVID-19 vaccine at time of enrolment	
[d]Defined as hospitalisation for at least four hours	
[e]The participants were a vaccine-naïve population during infection in 2020 and were vaccinated once the roll-out commenced in 2021.	

Table 3: Results for primary outcome.

Overall health rating	N/42 (%)
Much better	2 (4.8)
A little better	2 (4.8)
The same	16 (38.1)
A little worse	20 (47.6)
Much worse	2 (4.8)

Figure 2: Patient reported outcomes: Modified Borg Dyspnoea Scale score, PHQ-9-Patient Health Questionnaire-9, GAD-7- Generalised Anxiety Disorder-7, EQ-5D-5L-Quality of Life questionnaire.
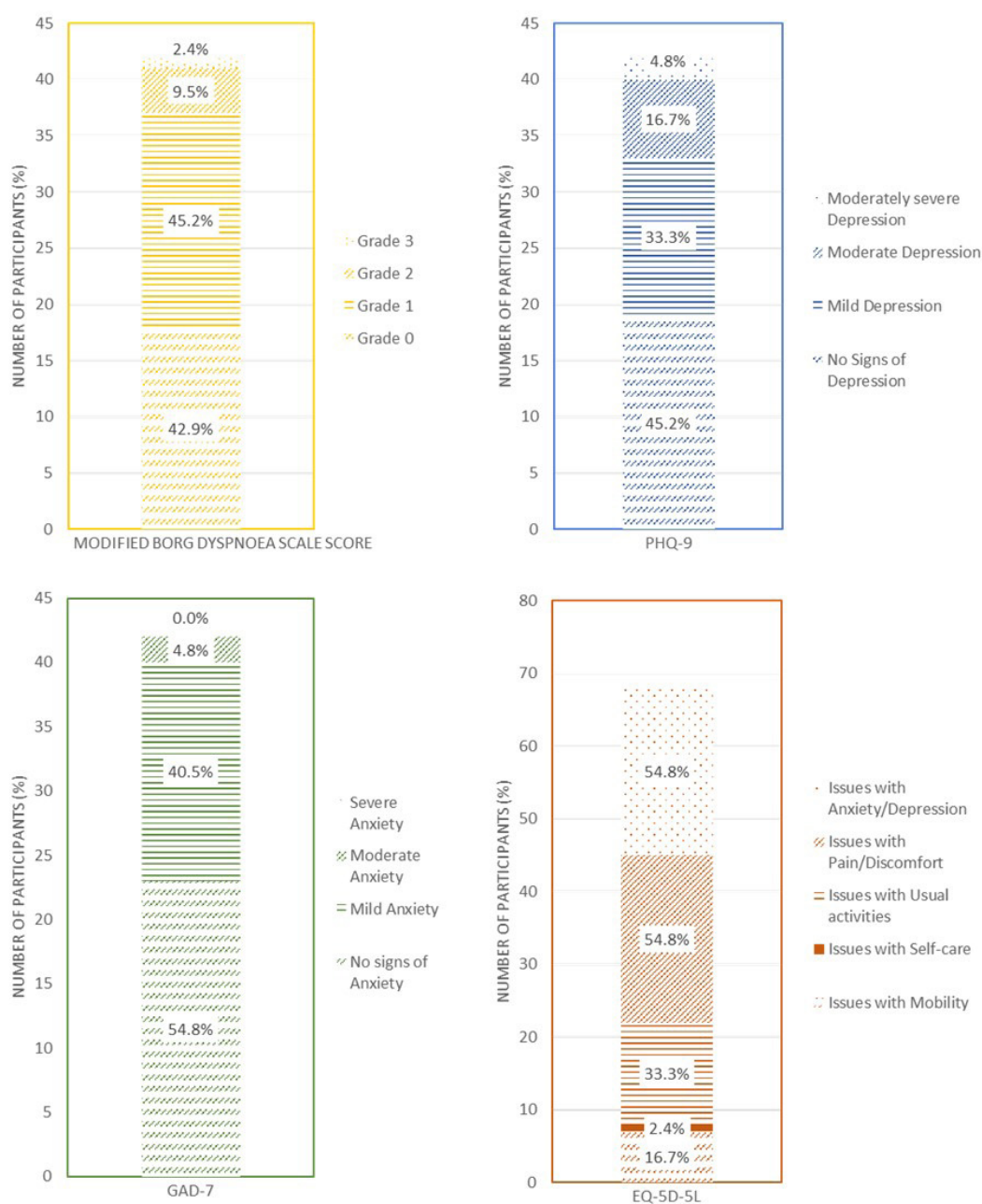
Table 4: Results of laboratory tests.

Laboratory test	N/37ᵃ (%)
Anaemia	0 (0)
Lymphopaenia	1 (2.7)
Serum Sodium out of range	1 (2.7)
Serum Potassium out of range	0 (0)
eGFR <60 mL/min per 1·73 m²	0 (0) N=35
HbA1c> 41 mmol/mol	0 (0)
Hs-Troponin T 14ng/L	0 (0)
NT ProBNP>35 pmol/L	0 (0)
Free T3 out of range	2 (5.4)
Free T4 out of range	2 (5.4)
TSH out of range	3 (8.1)
AST > upper limit of normal reference range	1 (2.8) N=36
ALT > upper limit of normal reference range	1 (2.7)
GGT > upper limit of normal reference range	3 (8.1)
Bilirubin > upper limit of normal reference range	2 (5.4)
CRP>6 mg/L	1 (2.7)
ESR>30 mm/hr	0 (0) N=36
Ferritin >500 ug/L	3 (8.3) N=36
SARS-CoV-2 IgG+IgM (N protein)	
Reactive	26 (70.3)
Non-reactive	11 (29.7)
SARS-CoV-2 IgG Spike Ab	
Reactive	37 (100)
Non-reactive	0 (0)
ᵃUnless otherwise specified	

Discussion

In this study we explored the prevalence of ongoing symptoms at a median 1.7 years (628.5 days) following the first onset of COVID-19 symptoms in cases from the first alpha/beta wave in a vaccine-naïve population in the Greater Wellington Region. COVID-19 vaccines were first available in December 2020, so none of the study participants were vaccinated prior to their COVID-19 illness. Over half of the participants felt that their current overall health was worse than it was prior to contracting COVID-19. A vast majority (90%) of participants reported at least two ongoing symptoms since their first acute COVID-19 illness. Between 45–72% of participants reported each of anxiety, depression, dyspnoea, pain/discomfort, and sleep difficulties assessed using the GAD-7, PHQ-9, mMRC Dyspnoea Scale, EQ-5D-5L, and FSS questionnaires, respectively.

There are important limitations to our study. This study is an observational, cross-sectional study with a very small sample size intended for a descriptive analysis, so a causal relationship between symptoms and COVID-19 infection cannot be established. It is challenging to distinguish long COVID symptoms from symptoms that participants may have had prior to infection with COVID-19 or symptoms that occur post-infection but for a different reason. The lack of a baseline (pre-COVID-19) assessment, or a control group for comparison, also mean that any symptoms or laboratory abnormality observed in our study group cannot be definitively attributed to COVID-19. We asked participants to identify whether their answers to anxiety, depression, fatigue, and sleep quality questionnaires could have been affected by something other than COVID-19, to only consider symptoms experienced after the acute episode of COVID-19 in the WHO Symptom Questionnaire, and to compare overall health to before getting COVID-19. However, the responses depended on accurate recall, which could have introduced a degree of measurement error.

There may be a non-response bias where the outcomes in those that declined participation or were uncontactable differ from those that did take part. As our study included eight questionnaires, misclassification bias due to respondent fatigue is also a possibility, as participants may not have provided consistent responses to reduce the burden of answering questions. Participants were, however, able to leave and return to the online questionnaires at a later time, which was a feature designed to mitigate survey fatigue. Given the lack of a confirmatory test or syndromic definition for the diagnosis of long COVID, surveys were chosen based on a review of the international literature available at the time of study design. As long COVID encompasses a wide range of symptoms, it is likely that the surveys do not capture all the potential features of long COVID.

It is also possible that participant reported outcomes were affected by poor recall, particularly in questionnaires where participants had to reflect on their health status prior to getting COVID-19 (Overall Health Questionnaire and WHO Symptom Questionnaire). This is, however, unlikely to be an issue with the FSS, GAD-7/PHQ-9 and PSQI, as they ascertain symptoms related to the previous 1, 2, and 4 weeks, respectively. Additionally, the findings of this study have limited generalisability to all individuals with COVID-19 infections, given the occurrence of newer variants since the initial alpha/beta variants in our study population.

A systematic review and meta-analysis[8] published in November 2021 synthesised evidence from 18 papers on post-COVID symptoms persisting for at least 12 months in both hospitalised and non-hospitalised populations. It identified a pooled prevalence of 18% (95% CI: 13–24) at 1-year follow-up for dyspnoea. A New Zealand case control study[19] that included largely non-hospitalised cases who tested positive in March–June 2020 showed that dyspnoea persisted in 27% of cases compared to 6% in controls (p<0.001), at a mean of 306 days post COVID-19 testing. Another New Zealand cross-sectional study[20] surveyed 990 participants who had tested positive for COVID-19 or were a probable case between 2020 and 30 Nov 2021 (which includes the Delta wave and participants who were only 7 months post positive test/probable case). Of the 405 participants who answered the survey on long COVID, they found that over 50% of tāngata whenua and tāngata Tiriti experienced shortness of breath, which is in keeping with our findings where 57.1% reported having some degree of breathlessness using the mMRC Dyspnoea Scale and 50% using the WHO Symptom Questionnaire.

Similarly, our study had a higher prevalence of sleep difficulties, which were seen in 59.5% of participants compared to the pooled prevalence of 12% (95% CI: 7–17) in the meta-analysis.[8]

The screening questionnaires for mental health symptoms identified symptoms of depression in 31% and anxiety in 26.2% of participants that were not subjectively attributed to another cause. This is similar to the pooled prevalence found at least at 12 months of 23% (95% CI: 12–34) for depression and 26.2% (95% CI: 15–29) for anxiety,[8] and the prevalence of approximately one third for symptoms of anxiety and depression in the New Zealand cross-sectional study.[20] One third of our participants also reported experiencing fatigue, which is similar to the pooled prevalence of 28% (95% CI: 18–39) at least at 12 months,[8] but less than the prevalence of 60–77% seen in the New Zealand studies.[19,20]

The reported prevalence for depression and fatigue using the WHO Symptom Questionnaire was higher than that of the PHQ-9 and FSS, respectively. We believe the prevalence identified through the latter two questionnaires are likely to be closer to the true estimate, as these questionnaires are screening questionnaires designed to explore different presentations of the same problem. For example, the PHQ-9 asks nine questions on symptoms related to depression such as trouble in concentrating, feeling low or having little energy to elicit, whether the respondent is showing signs of depression. An average score with pre-determined cut-offs is then calculated for none, mild, moderate, and severe depression. The WHO Symptom Questionnaire, on the other hand, only has one question related to each of anxiety, depression, and fatigue, which can be answered "yes" by participants if they subjectively think they suffer from the condition. The high prevalence of anxiety and depression was also seen in the EQ-5D-5L, where 54.8% of respondents reported feeling slightly/moderately anxious or depressed when directly asked to identify the degree of anxiety or depression they felt.

A high proportion (>90%) of our participants reported having at least one ongoing symptom, as well as experiencing two or more symptoms. This is higher than the prevalence identified in a non-hospitalised study population of 304 in Italy, where only 53.0% of patients reported at least one symptoms at 12 months after onset of illness.[21] The study, however, used the Acute Respiratory Tract Infection Questionnaire to ascertain symptoms, which is less comprehensive than the WHO Symptom Questionnaire. A Faroese study[22] of a largely non-hospitalised sample of 180 participants also showed that only 53.2% had at least one ongoing symptom. However, the mean follow-up period for this study was only 125 days and the symptoms questionnaire that was used largely focused on acute symptoms. The New Zealand case control study[19] had a prevalence of 75.6% in cases experiencing any symptoms, although a modified community-acquired pneumonia questionnaire was used to assess the persistence of only five symptoms.

The impact of these symptoms on quality of life was measured using the EQ-5D-5L. The dimension of quality of life most commonly affected was pain/discomfort (54.8%, N=23) and anxiety/depression (54.8%, N=23) in our study. The higher degree of impact seen on pain/discomfort and anxiety/depression domains compared to the other domains is similar to that seen in an English study of non-hospitalised cases at 6 months.[23] In our study, moderate to severe symptoms were only seen in six (14.3%) participants in the usual activities, pain/discomfort, and anxiety/depression domains. This contrasts with the much higher prevalence of moderate, severe, and extreme symptoms seen in the walking, self-care, usual activities, and pain/discomfort domains of the New Zealand cross-sectional study.[20] They showed that between 3–42% of tāngata whenua and 5–48% of tāngata Tiriti experienced moderate to extreme symptoms in these domains, with impact on usual activities being the most affected area, irrespective of ethnicity. The authors acknowledge, however, that there may be a selection bias in these estimates depending on whether those who did not answer the long COVID survey had symptoms or not.

There were minimal laboratory abnormalities in our study sample, despite extensive screening for cardiac, endocrine, haematological, liver, antibody, and inflammatory markers. This is unsurprising, as in a study of hospitalised COVID-19 patients, blood test results had returned to normal after a median of 54 days, despite significant abnormalities at discharge.[24] In another cohort study of non-hospitalised participants, there was no difference in blood test results between COVID-19 patients and controls at a 6 months follow up.[25]

Comparison of our study with other studies of long COVID is challenging given the variety of methods used, the heterogeneity in questionnaires, differences in patient populations and infected variants, description of symptoms, and disparities in follow-up lengths. Since infection

with alpha and beta variants in our study population, bigger waves of transmission with Delta and Omicron variants have occurred in Aotearoa New Zealand, with evidence pointing to a possibly lower risk of long COVID with the Omicron variant compared to the Delta variant.[26] This variability in available evidence illustrates why the diagnosis of long COVID can be challenging. This is compounded by the lack of distinct laboratory or radiological features to aid diagnosis. The clinical spectrum of patients with long COVID means that patients may need input from a variety of healthcare providers with individualised assessment, management, and treatment goals, a further

addition to already stretched health systems.[27]

This study found that over half of the study participants (who had COVID during the first wave of infection) reported their current overall health as being worse compared to pre-COVID, with 90% reporting at least two ongoing symptoms 1.7 years later. With 37% of New Zealand's population (as of 22 November 2022) now having had COVID, long COVID presents a real issue to the health of New Zealanders and its impacts on the health system. This will, however, require further careful investigation, particularly of a large number of people who have had infection with the Delta and Omicron variants.

AUTHOR INFORMATION

Nethmi Kearns: Medical Research Institute of New Zealand, Wellington, New Zealand.

Neakiry Kivi: Medical Research Institute of New Zealand, Wellington, New Zealand.

Emily Dickinson: Medical Research Institute of New Zealand, Wellington, New Zealand.

Emma Mayo: National Public Health Service, Capital, Coast, Hutt Valley and Wairarapa, New Zealand.

Allie Eathorne: Medical Research Institute of New Zealand, Wellington, New Zealand.

Augustus Anderson: Medical Research Institute of New Zealand, Wellington, New Zealand.

Richard Beasley: Medical Research Institute of New Zealand, Wellington, New Zealand.

Craig Thornley: National Public Health Service, Capital, Coast, Hutt Valley and Wairarapa, New Zealand.

Annette Nesdale: National Public Health Service, Capital, Coast, Hutt Valley and Wairarapa, New Zealand.

CORRESPONDING AUTHOR

Dr Nethmi Kearns: Medical Research Institute of New Zealand, Wellington 6242, New Zealand. E: nethmi.kearns@mrinz.ac.nz

REFERENCES

1. Marshall M. The lasting misery of coronavirus long-haulers. Nature. 2020 Sep;585(7825):339-341. doi: 10.1038/d41586-020-02598-6.

2. Centers for Disease Control and Prevention [Internet]. Long COVID or Post-COVID Conditions; c2022 [cited 2022 Oct 18]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/long-term-effects/.

3. World Health Organization [Internet]. A clinical case definition of post COVID-19 condition by a Delphi consensus [Internet]; c2021 [cited 2022 Oct 18]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-Post_COVID-19_condition-Clinical_case_definition-2021.1.

4. Te Whatu Ora Health New Zealand [Internet]. Long COVID for health professionals. Manatū Hauora Ministry of Health; c2022 [cited 2023 Jan 17]. Available from: https://www.health.govt.nz/covid-19-novel-coronavirus/covid-19-information-health-professionals/long-covid-health-professionals.

5. NIHR National Institute for Health and Care Research [Internet]. Living with Covid19 – Second review. National Institute for Health Research; c2021 Mar [cited 2022 Oct 11]. Available from: https://evidence.nihr.ac.uk/themedreview/living-with-covid19-second-review/.

6. Huang C, Huang L, Wang Y, Li X, Ren L, Gu X et al. 6-month consequences of COVID-19 in patients discharged from hospital: a cohort study. Lancet. 2021 Jan 16;397(10270):220-232. doi: 10.1016/S0140-6736(20)32656-8.

7. Cirulli ET, Schiabor Barrett KM, Riffle S, Bolze A, Neveux I, Dabe S et al. Long-term COVID-19 symptoms in a large unselected population. medRxiv [Internet]. 2020 Oct [cited 2022 Oct 18]. Available from: https://www.medrxiv.org/content/10.1101/2020.10.07.20208702v3.

8. Han Q, Zheng B, Daines L, Sheikh A. Long-Term Sequelae of COVID-19: A Systematic Review and Meta-Analysis of One-Year Follow-Up Studies on Post-COVID Symptoms. Pathogens. 2022 Feb 19;11(2):269. doi: 10.3390/pathogens11020269.

9. Michelen M, Manoharan L, Elkheir N, Cheng V, Dagens A, Hastie C et al. Characterising long COVID: a living systematic review. BMJ Glob Health. 2021 Sep;6(9):e005427. doi: 10.1136/bmjgh-2021-005427.

10. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)--a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform. 2009 Apr;42(2):377-81. doi: 10.1016/j.jbi.2008.08.010.

11. Fletcher C, Clifton M, Fairburn A, et al. Standardized Questionaries on Respiratory Symptoms. Br Med J. 1960 Dec 3;2(5213):1665.

12. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med. 2001 Sep;16(9):606-13. doi: 10.1046/j.1525-1497.2001.016009606.x.

13. Spitzer RL, Kroenke K, Williams JB, Löwe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. Arch Intern Med.

2006 May 22;166(10):1092-7. doi: 10.1001/archinte.166.10.1092.

14. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989 May;28(2):193-213. doi: 10.1016/0165-1781(89)90047-4.

15. EQ-5D [Internet]. EQ-5D-5L | About; c2021 [cited 2022 Aug 16]. Available from: https://euroqol.org/eq-5d-instruments/eq-5d-5l-about/.

16. Krupp LB, LaRocca NG, Muir-Nash J, Steinberg AD. The fatigue severity scale: application to patients with multiple sclerosis and systemic lupus erythematosus. Arch Neurol. 1989 Oct;46(10):1121-3. doi: 10.1001/archneur.1989.00520460115022.

17. World Health Organization [Internet]. Global COVID-19 Clinical Platform Case Report Form (CRF) for Post COVID condition (Post COVID-19 CRF); c2021 [cited 2021 Mar 2]. Available from: https://www.who.int/publications/i/item/global-covid-19-clinical-platform-case-report-form-(crf)-for-post-covid-conditions-(post-covid-19-crf-)

18. Manatū Hauora Ministry of Health [Internet]. HISO 10001:2017 Ethnicity Data Protocols; c2017 [cited 2022 Aug 16]. Available from: www.moh.govt.nz/notebook/nbbooks.sf/0/569DDB6A56F7E726CC2581FC00665BEB/$file/hiso-10001-2017-ethnicity-data-protocols.pdf

19. Cheung J, Nordmeier K, Kelland S, Harrington M, Williman J, Storer M et al. Symptom persistence and recovery among COVID-19 survivors during a limited outbreak in Canterbury, New Zealand: a prospective cohort study. Intern Med J. 2023 Jan;53(1):37-45. doi: 10.1111/imj.15930.

20. Russell L, Jeffreys M, Cumming J, Churchward M, Ashby W, Asiasiga L et al. Ngā Kawekawe o Mate Korona | Impacts of COVID-19 in Aotearoa. Te Hikuwai Rangahau Hauora | Health Services Research Centre [Internet]. 2023 Jan [cited 2023 Feb 7]. Available from: https://covidaotearoa.com/wp-content/uploads/2023/01/Nga-Kawekawe-o-Mate-Korona-Full-Report-2023-01-24.pdf.

21. Boscolo-Rizzo P, Guida F, Polesel J, Marcuzzo AV, Capriotti V, D'Alessandro A et al. Sequelae in adults at 12 months after mild-to-moderate coronavirus disease 2019 (COVID-19). Int Forum Allergy Rhinol. 2021 Dec;11(12):1685-1688. doi: 10.1002/alr.22832.

22. Petersen MS, Kristiansen MF, Hanusson KD, Danielsen ME, Á Steig B, Gaini S et al. Long COVID in the Faroe Islands: A Longitudinal Study Among Nonhospitalized Patients. Clin Infect Dis. 2021 Dec 6;73(11):e4058-4063. doi: 10.1093/cid/ciaa1792.

23. Sandmann FG, Tessier E, Lacy J, Kall M, Van Leeuwen E, Charlett A et al. Long-Term Health-Related Quality of Life in Non-Hospitalized Coronavirus Disease 2019 (COVID-19) Cases With Confirmed Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Infection in England: Longitudinal Analysis and Cross-Sectional Comparison With Controls. Clin Infect Dis. 2022 Aug 24;75(1):e962-973. doi: 10.1093/cid/ciac151.

24. Mandal S, Barnett J, Brill SE, Brown JS, Denneny EK, Hare SS et al. 'Long-COVID': a cross-sectional study of persisting symptoms, biomarker and imaging abnormalities following hospitalisation for COVID-19. Thorax. 2021 Apr;76(4):396-398. doi: 10.1136/thoraxjnl-2020-215818.

25. Wyller V, Selvakumar J, Havdal L, Drevvatne M, Brodwall E, Berven L et al. Prevalence and predictors of long COVID among non-hospitalised adolescents and young adults: a prospective controlled cohort study. Research Square [Internet]; 2022 Sep [cited 2023 Feb 14]. Available from: https://www.researchsquare.com/article/rs-2021203/v1

26. Antonelli M, Pujol JC, Spector TD, Ourselin S, Steves CJ. Risk of long COVID associated with delta versus omicron variants of SARS-CoV-2. Lancet. 2022 Jun 18;399(10343):2263-2264. doi: 10.1016/S0140-6736(22)00941-2.

27. Beasley R, Kearns N, Hills T. Charting a course for the management of long COVID. Lancet Respir Med. 2021 Dec;9(12):1358-1360. doi: 10.1016/S2213-2600(21)00314-3.

Appendices

Appendix Table 1: Frequency of self-reported chronic disorders by system.

Disorder	N
Psychiatric disorders	6
Allergy	7
Blood and lymphatic system disorders	1
Malignancy	3
Cardiovascular disorders	9
Ear and labyrinth disorders	4
Endocrine disorders	3
Eye disorders	1
Gastrointestinal disorders	5
Chronic infection	1
Metabolic disorder	2
Musculoskeletal and connective tissue disorders	6
Nervous system disorders	5
Reproductive system and breast disorders	2
Respiratory disorders	7

Individual disorders are not published due to disorders with counts less than 1 being potentially identifiable. Some participants reported multiple disorders.

Appendix Table 2: Frequency of responses in each domain of EQ-5D-5L.

Variable	N/42 (%)
Mobility	
I have no problems in walking about	35 (83.3)
I have slight problems in walking about	4 (9.5)
I have moderate problems in walking about	3 (7.1)
I have severe problems in walking about	0 (0)
I am unable to walk about	0 (0)
Self-care	
I have no problems washing or dressing myself	41 (97.6)
I have slight problems washing or dressing myself	1 (2.4)
I have moderate problems washing or dressing myself	0 (0)
I have severe problems washing or dressing myself	0 (0)
I am unable to wash or dress myself	0 (0)
Usual activities	
I have no problems doing my usual activities	28 (66.7)
I have slight problems doing my usual activities	8 (19.0)
I have moderate problems doing my usual activities	6 (14.3)
I have severe problems doing my usual activities	0 (0)
I am unable to do my usual activities	0 (0)
Pain/discomfort	
I have no pain or discomfort	19 (45.2)
I have slight pain or discomfort	17 (40.5)
I have moderate pain or discomfort	5 (11.9)
I have severe pain or discomfort	1 (2.4)
I have extreme pain or discomfort	0 (0)
Anxiety/depression	
I am not anxious or depressed	19 (45.2)
I am slightly anxious or depressed	17 (40.5)
I am moderately anxious or depressed	6 (14.3)
I am severely anxious or depressed	0 (0)
I am extremely anxious or depressed	0 (0)

Appendix Table 3: Frequency of ongoing symptoms.

Symptom	N/42(%)
Anxiety	17 (40.5)
Behaviour change	16 (38.1)
Can't move and/or feel one side of body or face	3 (7.1)
Chest pain	14 (33.3)
Constipation	7 (16.7)
Depressed mood	21 (50.0)
Diarrhoea	11 (26.2)
Dysmenorrhoea	7 (33.3)*
Dizziness/light headedness	23 (54.8)
Fainting/blackouts	4 (9.5)
Fever	5 (11.9)
Forgetfulness	23 (54.8)
Jerking of limbs	12 (28.6)
Joint pain/swelling	16 (38.1)
Loss of appetite	16 (38.1)
Loss of interest/pleasure	22 (52.4)
Lumpy lesions	0 (0)
Nausea/vomiting	8 (19.0)
Numbness or tingling	14 (33.3)
Pain on breathing	12 (28.6)
Palpitations	16 (38.1)
Persistent dry cough	12 (28.6)
Persistent fatigue	27 (64.3)
Problems hearing	12 (28.6)
Persistent headache	19 (45.2)
Persistent muscle pain	16 (38.1)
Post-exercise malaise	23 (54.8)
Problems passing urine	3 (7.1)
Problems seeing	14 (33.3)

Appendix Table 3 (continued): Frequency of ongoing symptoms.

Symptom	N/42(%)
Problems swallowing	2 (4.8)
Problems with balance	10 (23.8)
Problems with gait/falls	3 (7.1)
Reduced smell	17 (40.5)
Reduced taste	13 (31.0)
Ringing in ears	11 (26.2)
Seizures	1 (2.4)
Shortness of breath	21 (50.0)
Skin rash	3 (7.1)
Slowness of movement	6 (14.3)
Sleeping less	18 (42.9)
Sleeping more	17 (40.5)
Stiffness of muscles	18 (42.9)
Stomach pain	9 (21.4)
Swollen ankles	3 (7.1)
Tremors	5 (11.9)
Trouble in concentrating	23 (54.8)
Weakness in limbs	12 (28.6)
Weight loss	8 (19.0)
Erectile dysfunction	5 (20.8)[$]
Hallucinations	1 (2.4)
[*]Female sex N=20, [$]Male sex N=24	

A new national health system: the opportunity to address data quality issues in maternal immunisation coverage

Matthew Hobbs, Amber Young, Nikki Turner, Pauline Dawson, Esther Willing, Peter McIntyre, Christine G McIntosh

ABSTRACT

AIM: Maternal immunisation coverage is suboptimal in Aotearoa New Zealand. Our objective was to highlight discrepancies resulting from how maternal immunisation coverage for pertussis and influenza is measured in Aotearoa New Zealand.

METHOD: A retrospective cohort study of pregnant people was undertaken using administrative datasets. Maternity and immunisation data from three sources (National Immunisation Register [NIR], general practice [GP], and pharmaceutical claims) were linked to determine the proportion of immunisation records not recorded in the NIR but captured in claims data, and to compare this with coverage data available from Te Whatu Ora – Health New Zealand.

RESULTS: We found that while increasing numbers of maternal immunisations are being captured in the NIR, around 10% remain unrecorded on the NIR, but within claims datasets.

CONCLUSION: Accurate maternal immunisation coverage data is important for public health action. Implementation of the whole-of-life Aotearoa Immunisation Register (AIR) is an important opportunity to improve completeness and consistency of maternal immunisation coverage reporting.

Maternal immunisation against pertussis and influenza is critical to prevent hospitalisation and potentially fatal outcomes during pregnancy and in early infancy.[1] While maternal immunisation for both pertussis and influenza in Aotearoa New Zealand has increased since 2013, it remains suboptimal and inequitable,[1,2] and obtaining accurate data on maternal immunisation is fraught with challenges. The recent New Zealand Health and Disability System Review[3] focused on the need for system-wide approaches to ensure the health system achieves better and equitable outcomes. The current environment of health reform presents a timely opportunity to address the challenge of low maternal immunisation coverage, which requires high quality data on immunisation coverage.[4,5]

In Aotearoa New Zealand, vaccination in pregnancy has been government funded through general practice (GP) and hospitals nationwide since 2010 for influenza, and 2013 for pertussis. Delivery through pharmacies has been funded since March 2017 for influenza and September 2022 for pertussis. There is an annual drive to immunise the population against influenza which includes extensive advertising and media coverage, as well as a concerted government-funded effort to vaccinate high-risk patients, including those who are pregnant. There has been less attention to pertussis vaccination in pregnancy. In previous work examining maternal coverage in Aotearoa New Zealand, seasonal variation in coverage for influenza was identified,[2] with a peak at the start of the influenza season, declining later in the year.

Capturing clear maternal immunisation coverage in Aotearoa New Zealand is not straightforward due to the number of providers, the funding arrangements, and how they both claim and record vaccination events. Even determining pregnancy status at the time of vaccination can be problematic due to the status being unknown or not discussed by the provider.

In Aotearoa New Zealand, an immunisation event can be captured using multiple data sources: the National Immunisation Register (NIR), Proclaims, and the Pharmaceutical Collection. The NIR began as a register for the Meningococcal B (MeNZB)

vaccination campaign and, from 2006, evolved into a register for all childhood immunisation enrolments and events, as per the New Zealand National Immunisation Schedule. From 2013, the NIR increasingly captured selected adult scheduled immunisations, including those given during pregnancy (pertussis and influenza). The Proclaims and Pharmaceutical Collection datasets contain data on the fee-for-service payments made to GPs or community pharmacies, respectively, for providing government-funded immunisations. Workplace influenza vaccinations have not been well captured by either system; it is recommended to notify GPs of an influenza vaccine receipt, but this relies on both the vaccinee informing the workplace service of the correct GP and that completed vaccinations are communicated accurately to the practice and uploaded onto the NIR. It is unknown how effective this is, but it is certainly not complete.

The objective of this study was to quantify discrepancies in maternal immunisation coverage using the Te Whatu Ora – Health New Zealand QLIK data platform and a range of data sources, including NIR, Proclaims, or Pharmaceutical collection.

Methods

Consistent with previous publications,[1,2] we determined maternal coverage for influenza and pertussis using the Aotearoa New Zealand administrative health data sources in the following way: the study population (denominator) consisted of all pregnant people with a delivery between 1 January 2013 and 30 June 2021 in the Maternity collection dataset. People were excluded (n=32,063) if the gestational age at delivery was less than 20 weeks or greater than 45 weeks, if either the date of last menstrual period or gestational age at delivery was missing, if maternal age at delivery was less than 12 or greater than 50 years of age, and if flagged as a non-resident. The numerator was receipt of an influenza or pertussis vaccine during pregnancy, determined by a valid entry for a pertussis and/or influenza vaccine in available data sources (NIR, Proclaims, or Pharmaceutical collection) during their eligible pregnancy within the cohort. Available sources of immunisation information were prioritised in the following order: NIR, Proclaims, then Pharmaceutical Collection and an immunisation was considered valid if it occurred between the last menstrual period

and delivery date, as recorded in the Maternity collection. Immunisation data was linked to the Maternity collection via an encrypted National Health Index identifier. We determined the proportion of immunisation records captured outside the NIR in claims data (Proclaims or Pharmaceutical collection) and, additionally, compared our study data to the coverage data provided by Te Whatu Ora – Health New Zealand via their QLIK platform. All statistical analyses were undertaken using SAS Enterprise Guide (9.4) statistical software (SAS Institute Inc., Cary, NC, USA). This study was approved by The University of Auckland Human Participants Ethics Committee (Ref. 022536).

Results

Our findings show that since 2014, the number of maternal influenza immunisations identified by the NIR data has grown from less than 55% of all immunisations to just over 90% (see Figure 1, Panel 1A). However, in 2021, almost 10% of maternal influenza immunisations were only identified by using the GP claims or pharmaceutical claims databases, with similar findings for maternal pertussis immunisations (see Figure 1, Panel 2A). Pertussis did not become funded in pharmacies until 2022, so there was not any pharmaceutical claims information until after this date. A large discrepancy was identified between our study data coverage to that provided by Te Whatu Ora – Health New Zealand (see Figure 1, Panel 1C). The pertussis data provided by Te Whatu Ora is similar to our datasets, with a slightly higher coverage in QLIK data from 2019 onwards. There were large differences between the influenza datasets, showing that there is a large underestimate in the Te Whatu Ora data in maternal influenza immunisations. It is important to note that the significant drop in 2021 influenza study data is due to incomplete data.

Discussion

Our study aimed to quantify discrepancies in maternal immunisation coverage using the Te Whatu Ora – Health New Zealand QLIK data platform and a range of data sources, including NIR, Proclaims, or Pharmaceutical collection. Our findings clearly demonstrate that while an increasing number of maternal immunisations are being captured in the NIR, there remains a

Figure 1: The proportion contribution of each immunisation dataset to the numerator for influenza (Panel 1A) and pertussis (Panel 1B) immunisation in pregnancy and a comparison in our study data coverage to that provided by Te Whatu Ora – Health New Zealand (Panel 1C).

Figure 1A: The proportion contribution of each immunisation dataset to the numerator for influenza immunisation.
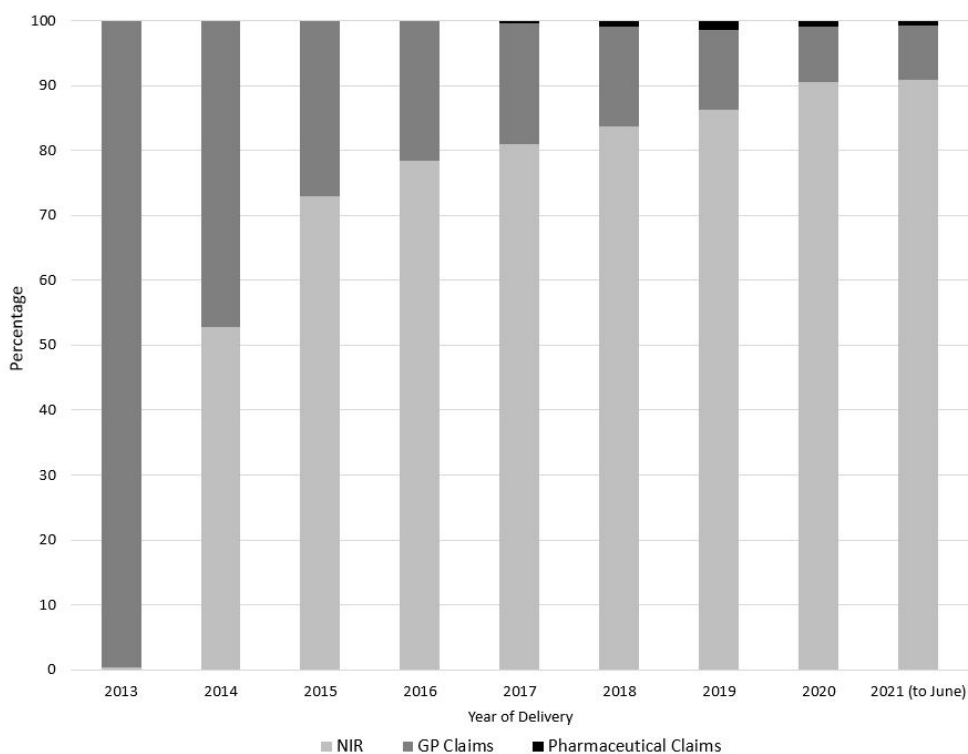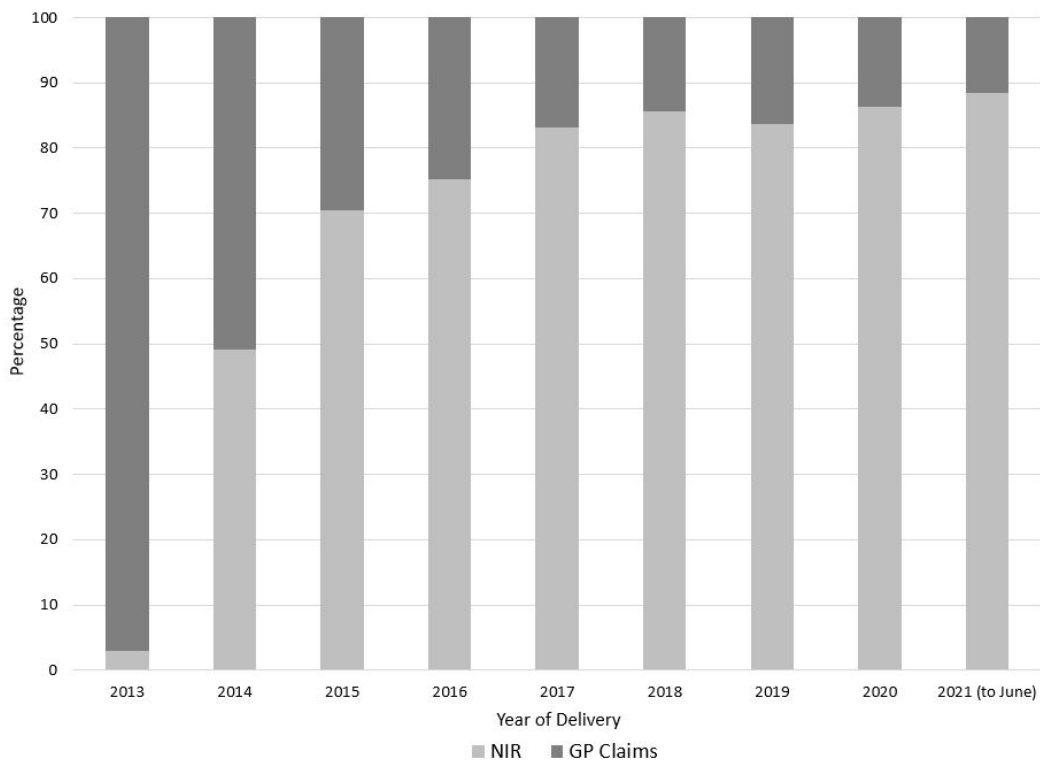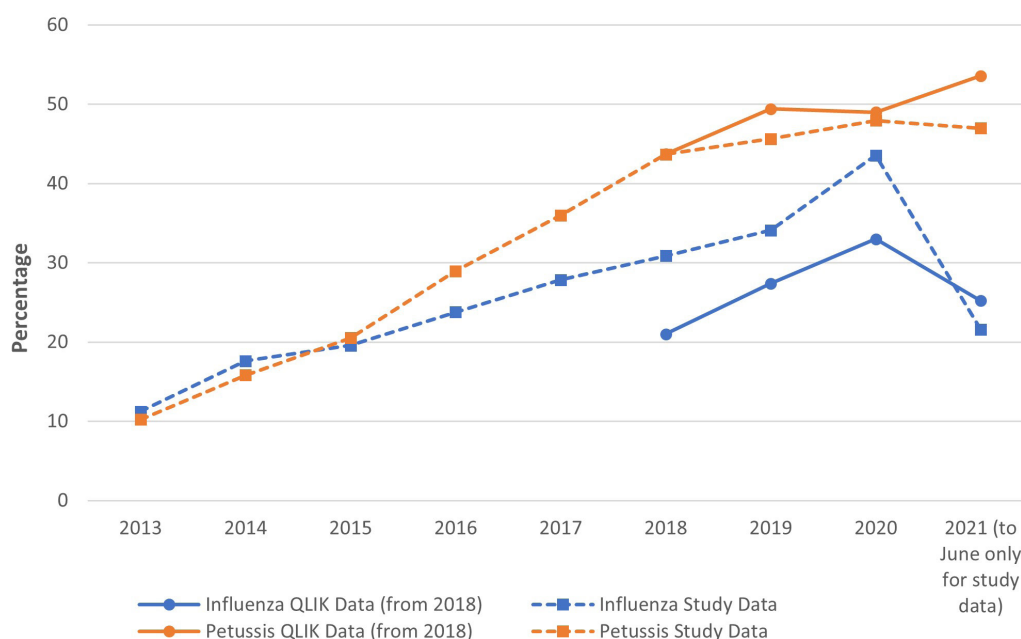

Figure 1B: The proportion contribution of each immunisation dataset to the numerator for pertussis immunisation.

Figure 1C: Immunisation in pregnancy and a comparison in our study data coverage to that provided by Te Whatu Ora – Health New Zealand.

data discrepancy of up to 10% between QLIK reporting and the combined NIR and claims datasets. There is currently no gold-standard dataset for reporting immunisation coverage in Aotearoa New Zealand; however, if researchers or policymakers are aiming to determine maternal immunisation coverage they should utilise as many of these different sources as possible, as has been the case for recent publications.[1,2] Understanding why immunisation events are not being captured is critical if we are to improve the way in which data is collected and then utilised. For instance, it is unclear why coverage is higher in QLIK data than our study data for pertussis, but lower for influenza. This could be due to events not being entered into the NIR or data entry into the NIR not being coded for pregnancy. There are several plausible systems reasons for these errors. Considering where these gaps are occurring will be important as the new AIR is being designed.

Te Whatu Ora – Health New Zealand provides NIR data via their QLIK platform to their approved users to better support service delivery and to improve immunisation coverage, including summary statistics and trends on maternal influenza and pertussis coverage.[6] The same trend is seen between the QLIK

NIR and our study coverage data. However, QLIK estimates similar coverage for pertussis and much lower coverage for influenza compared to our study data, which utilised multiple data sources. This is despite, in theory, using the same source data for the denominator (the maternity collection). The degree of data cleaning and exclusion and inclusion criteria Te Whatu Ora – Health New Zealand is using to determine the denominator and how they determine administration of a vaccine during pregnancy from the NIR is unclear, and not well defined for replication or allowing for understanding of bias in the numerator or denominator. It is also worth noting that the claims based administrative datasets (GP and pharmaceutical claims, and the maternity collection) have a lag of up to 12 months, reducing the ability of timely analysis and reporting of maternal coverage. To some degree Te Whatu Ora – Health New Zealand gets around this limitation in their QLIK data by only using the NIR as the numerator (lags 1–3 months) and using provisional or previous year maternity data (denominator), but at the expense of accuracy.

Maternal immunisation, the first vaccine event in the life-course immunisation programme for a child, remains important to prevent influenza and pertussis-related adverse outcomes,

as well as an important opportunity to engage with whānau around immunisation. Capturing maternal immunisation coverage in Aotearoa New Zealand is currently problematic and several data publications, including Te Whatu Ora – Health New Zealand, are likely to be underestimating coverage. We have shown that relying on the NIR as a single data source is not a reliable option, and neither is relying solely on funding claims. To be entitled to free maternal immunisations, individuals must disclose their pregnancy, which enables the correct coding of pregnancy with the vaccination event into the NIR. However, there are many reasons pregnancy may not be disclosed, e.g., for some, the cost of the vaccine is not a large barrier compared to convenience and discretion (if wanted in early pregnancy), so there is no obligation to disclose pregnancy to receive a vaccine. It has been shown that administrative health data that relies on accuracy from claiming for funding is notoriously inaccurate and surveillance systems that capture immunisation coverage accurately assists with increasing coverage.[7,8] With no gold-standard, it is unclear how inaccurate the NIR may be; however, some estimates suggest it could be up to 10% from true immunisation coverage.[9] In addition, the NIR is known to be inaccurate for children's coverage when compared to data from GP practice management systems or the Well Child book.[9,10] Therefore, it is unlikely that we are going to get a reliable full coding of "pregnancy"

status in the immunisation register going forward without both changes to incentives to improve a focus on pregnancy, alongside greater attention to how data is entered at the vaccinator level to minimise the risk of missing pregnancy as a code. Ultimately, reliance on the NIR alone under-reports vaccination coverage in pregnancy. The change to Aotearoa New Zealand's health system presents an opportunity for a nationally coherent strategy around collection and presentation of important health statistics, especially if health targets are ever considered again. These health system changes also allow for important conversations around delivery, incentives, equity, and governance of immunisation, as well as data sovereignty and the use of overseas data storage.[11] Users of Aotearoa New Zealand administration health data and statistics require confidence in their determination and thus interpretation.

Conclusion

Increasing numbers of maternal influenza and pertussis-containing immunisations are being captured in the NIR. However, around 10% continue to remain outside the NIR, leading to inaccuracies in reporting. While there is currently no gold standard, the improved capture of maternal immunisation data is needed to ensure accurate reporting and monitoring of immunisation coverage.

COMPETING INTERESTS

Nil.

AUTHOR INFORMATION

Matthew Hobbs: Faculty of Health | Te Kaupeka Oranga, University of Canterbury | Te Whare Wānanga o Waitaha, Christchurch | Otautahi, New Zealand; GeoHealth Laboratory | Te Taiwhenua o te Hauora, Geospatial Research Institute Toi Hangarau, University of Canterbury | Te Whare Wānanga o Waitaha, Christchurch | Otautahi, New Zealand.

Amber Young: School of Pharmacy | He Rau Kawakawa, University of Otago | Te Whare Wānanga o Ōtākou, Dunedin | Ōtepoti, New Zealand.

Nikki Turner: Department of General Practice and Primary Health Care | School of Population Health | Faculty of Medical and Health Sciences | The University of Auckland, Auckland | Tāmaki Makaurau, New Zealand.

Pauline Dawson: Department of Women's and Children's Health, Dunedin School of Medicine | Te Kura Whaiora o Ōtepoti, University of Otago | Te Whare Wānanga o Ōtākou, Dunedin | Ōtepoti, New Zealand.

Esther Willing: Kōhatu Centre for Hauora Māori I Division of Health Sciences | Te Whare Wānanga o Ōtākou, University of Otago | Dunedin, New Zealand.

Peter McIntyre: Department of Women's and Children's Health, Dunedin School of Medicine | Te Kura Whaiora o Ōtepoti, University of Otago | Te Whare Wānanga o Ōtākou, Dunedin | Ōtepoti, New Zealand.

Christine G McIntosh: Department of Paediatrics: Child and Youth Health | School of Medicine | Faculty of Medical and Health Sciences | The University of Auckland, Auckland | Tāmaki Makaurau, New Zealand.

CORRESPONDING AUTHOR

Dr Matthew Hobbs: University of Canterbury, New Zealand. E: matt.hobbs@canterbury.ac.nz

REFERENCES

1. Pointon L, Howe AS, Hobbs M, Paynter J, Gauld N, Turner N et al. Evidence of suboptimal maternal vaccination coverage in pregnant New Zealand women and increasing inequity over time: A nationwide retrospective cohort study. Vaccine. 2022 Mar 25;40(14):2150-2160. doi: 10.1016/j.vaccine.2022.02.079.

2. Howe AS, Pointon L, Gauld N, Paynter J, Willing E, Turner N. Pertussis and influenza immunisation coverage of pregnant women in New Zealand. Vaccine. 2020 Oct 7;38(43):6766-6776. doi: 10.1016/j.vaccine.2020.08.030.

3. Manatū Hauora – Ministry of Health [Internet]. Health and Disability System Review – Final Report. Wellington: Manatū Hauora – Ministry of Health; c2020 [cited 2022 Nov 21]. Available from: https://www.health.govt.nz/publication/health-and-disability-system-review-final-report.

4. Marek L, Hobbs M, Wiki J, McCarthy J, Tomintz M, Campbell M et al. Spatial-temporal patterns of childhood immunization in New Zealand (2006-2017): an improving pattern but not for all? Eur J Public Health. 2021 Jul 13;31(3):561-566. doi: 10.1093/eurpub/ckaa225.

5. Marek L, Hobbs M, McCarthy J, Wiki J, Tomintz M, Cambpell M et al. Investigating spatial variation and change (2006-2017) in childhood immunisation coverage in New Zealand. Soc Sci Med. 2020 Nov;264: 113292. doi: 10.1016/j.socscimed.2020.113292.

6. Manatū Hauora – Ministry of Health [Internet]. National Immunisation Register publications. Wellington: Manatū Hauora – Ministry of Health; c2022 [cited 2023 May 1]. Available from: https://www.health.govt.nz/our-work/preventative-health-wellness/immunisation/national-immunisation-register/national-immunisation-register-publications.

7. Choi H. Adjusting for linkage errors to analyse coverage of the administrative population. Statistical J IAOS. 2019;35:253-259. doi: 10.3233/SJI-180483.

8. Turner NB, Baker M, Carr J, Mansoor O. Improving immunisation coverage: what needs to be done? NZ Pub Health Report. 2000;7(3):11-14.

9. Reynolds G, Timo M, Dev A, Poole T, Turner N. Effective general practice: audit and feedback for the primary series of immunisations. J Prim Health Care. 2014 Mar 1;6(1):40-8.

10. Howe AS, Chisholm H, Paynter J, Willing E, Turner N. Does the National Immunisation Register stack up? Quantifying accuracy when compared to parent-held health record books. N Z Med J. 2021 Sep 3;134(1541):22-32.

11. Hobbs M, Ahuriri-Driscoll A, Marek L, Campbell M, Tomintz M, Kingham S. Reducing health inequity for Māori people in New Zealand. Lancet. 2019;394(10209):1613-1614. doi: 10.1016/S0140-6736(19)30044-3.

Towards a national equitable and sustainable clinical research infrastructure for Aotearoa New Zealand

Lisa K Stamp, Matire Harwood, Stuart Dalziel, Tom Love, David Moore, Kelvin Woock, Katrina Sharples, Frank Bloomfield

ABSTRACT

Clinical trials are a critical element of a modern, high-functioning, learning healthcare system. Clinical trials provide access to novel, as yet unfunded treatments, and deliver cutting-edge healthcare. Evidence from clinical trials ensures appropriateness of healthcare, allows disinvestment from practices that are found not to improve outcomes or be cost-effective, and supports the introduction of new approaches, all of which leads to improvement in health outcomes. In 2020, Manatū Hauora – Ministry of Health and The Health Research Council of New Zealand funded a project to understand the current state of clinical trial activity in Aotearoa New Zealand and to propose the infrastructure required to support equitable clinical trial activity, in order to ensure that trials benefiting from publicly funded infrastructure are responsive to the needs of New Zealanders and ultimately enable equitable delivery of the best healthcare we can achieve to all New Zealanders. This viewpoint reports the process that was undertaken to develop the final proposed infrastructure and the rationale for the approach. The restructuring of the Aotearoa New Zealand health system into Te Whatu Ora – Health New Zealand and Te Aka Whai Ora – Māori Health Authority that will both operate hospital services and commission primary and community healthcare at a national level provides the ideal opportunity to integrate and embed research into Aotearoa New Zealand's healthcare system. Integration of clinical trials and research more broadly into the public healthcare system will require a significant shift in the culture within our healthcare system. Research must be recognised and promoted as a core activity for clinical staff at all levels of the healthcare system, rather than something to be tolerated or even hindered. Strong leadership will be required from the top of Te Whatu Ora – Health New Zealand down to ensure the required cultural shift to recognise the value of clinical trials to all aspects of the healthcare system, and to grow capability and capacity of the health research workforce. The investment required by the Government to implement the proposed clinical trial infrastructure will be substantial, but now is the ideal time for investment in clinical trials infrastructure in Aotearoa New Zealand. We urge the Government to be bold and invest now to ensure the benefits can be reaped for all New Zealanders in years to come.

Clinical trials are a core element of a modern, high-functioning, learning healthcare system. Clinical trials can provide access to novel, as yet unfunded treatments, and deliver cutting-edge healthcare. The evidence generated by clinical trials is ultimately used to improve our health services, from public health and prevention interventions, through to specialised medicines and novel devices, to delivery of care by increasing the efficacy and efficiency of care, thereby bettering the health of New Zealanders.

Aotearoa New Zealand does not invest as effectively as it could, and should, in clinical trial research, nor in health research generally when compared to Australia, the United Kingdom and the United States.[1,2] Thus, we do not realise the significant potential benefits of clinical trial research for the people of Aotearoa New Zealand. Current clinical trial benefits are distributed inequitably because of the health system's fragmentation and rigidity, a lack of understanding of the benefits of clinical trials, and because clinical research is not embedded as part of a learning healthcare system. To respect Te Tiriti o Waitangi and meet the Crown's obligations as a treaty partner, it is critical that we have reliable clinical evidence of the efficacy and safety of healthcare interventions for Aotearoa New Zealand's population, especially Māori. Realising the potential of clinical trials research in Aotearoa New Zealand is aligned with the New Zealand Health Research Strategy 2017–2027 (https://www.health.govt.nz/publication/new-zealand-health-research-strategy-2017-2027)

and the New Zealand Health Research Prioritisation Framework (https://www.hrc.govt.nz/resources/new-zealand-health-research-prioritisation-framework).

In 2020, Manatū Hauora – Ministry of Health (MoH) and The Health Research Council of New Zealand (HRC) funded a project to understand the current state of clinical trial activity in Aotearoa New Zealand and to propose the infrastructure required to support equitable clinical trial activity, in order to ensure that trials benefiting from publicly funded infrastructure (including commercial trials) are responsive to the needs of New Zealanders and ultimately enable the equitable delivery of the best healthcare we can achieve to all New Zealanders. Herein, we outline the process undertaken to determine the broad infrastructure required for clinical trials in Aotearoa New Zealand and our proposal for the way forward.

Methodology

The scope of the project was defined by the HRC and MoH as outlined in the Request for Proposals (RfP) (Table 1). This project was independent research led by the authors and involved a diverse group of clinical researchers from a range of backgrounds and disciplines. It involved a specific Rōpū Māori, a Pacific advisory group, and a consumer group. The programme leads consulted a group of international researchers and reported to an expert steering group appointed by the MoH and HRC. There were two clearly defined areas for focus outlined in the RfP, namely systems and data (Table 1). Activity within the project was divided into five workstreams: clinical trial activity, infrastructure and networks, data systems and curation, equity and consumer engagement, prioritisation, knowledge translation and implementation, and workforce capability.

Within the two focus areas, systems and data, the research first sought to provide an assessment of the current state of clinical trial activity in Aotearoa New Zealand. We collected information from the Australian New Zealand Clinical Trials Registry (ANZCTR), conducted a survey of researchers, carried out 58 individual and group interviews, and consulted with the Rōpū Māori, Pacific advisory group, and consumer group. Two pieces of work—a synthesis of international best practice and Kaupapa Māori analysis—were also undertaken. The current state findings were reviewed by stakeholders in an

all-day "world café", facilitated and attended virtually due to COVID-19 restrictions. The 72 attendees included consumer representatives, primary care (including rural general practitioners), community trialists, pharmaceutical and medical device companies, Māori, Pacific, and hospital-based clinical trial researchers, to name a few. The workshop provided deep insights into what the ideal clinical trials infrastructure for Aotearoa New Zealand would look like, and if implemented, what benefit should come from this unique opportunity in the health sector.

The findings from the world café workshop, alongside previously gathered current-state material, were used to refine and develop the clinical trial infrastructure options by the project team. A Delphi survey was undertaken to test the criticality of the options and whether stakeholders considered they were necessary or critical for inclusion in any proposed infrastructure. The 347 participants included the study investigators, Māori, Pacific, consumers, and industry and healthcare stakeholders. A key modification of the Delphi method for the purposes of this project was that investigators reserved their right to include infrastructure options even if not deemed critical by the stakeholders, which is particularly important for areas of the infrastructure that should be a "given," such as Māori data sovereignty mechanisms, embeddedness of Te Tiriti within the clinical trial system, and Māori co-governance and input into operational matters and priority.

Conducting the Delphi survey helped capture the viewpoints of the diverse and varied stakeholder groups. Being an iterative process, it assessed the level of agreement and provided a mechanism for resolving disagreement to build consensus around the proposed options. During the first round, participants were able to submit options that might have been missed; the group voted on the additional options in the two remaining rounds. In each round, stakeholders were given a list of potential infrastructure options and asked to rank them on a scale of 0 (not important) to 9 (critical) in terms of how critical the option was for inclusion in the proposed infrastructure (i.e., how necessary it is for this option to be included for the system to be successful). After each round, the aggregate results were presented back to the stakeholders. There was the opportunity for stakeholders to provide feedback to enable any necessary clarification of the

options within the next round and to express interest in attending a consensus meeting to finalise the results of the Delphi. At the end of the three rounds, conducted between October 2021 and February 2022, it became clearer where there was consensus for critical inclusion of infrastructure options and where there was not. Consensus for inclusion was determined when >70% of respondents had voted a score of 7 out of 9 or higher **and** <15% of respondents voted a score of 3 out of 9 or lower. For consensus for exclusion, the criteria were reversed. A further consensus meeting was held after the third round by video-conference as a final test of consensus for critical inclusion of infrastructure options, and to discuss and finalise a decision on the options that did not reach a consensus.

The findings of the Delphi survey were categorised by respondent group (Māori, consumer, and general, where general refers to all other stakeholders) to compare the perceptions of criticality between groups. This categorisation was of particular importance for understanding Māori respondents' perceptions and whether they differed from the perceptions of the rest of the stakeholders.

Based on the Delphi survey results and data from the previous phases, the project team outlined a high-level roadmap of the steps required to transform the current state to the desired future state. Critical factors considered the needs to best support a sustainable and nationally coordinated clinical trials enterprise in Aotearoa New Zealand and contribute to improved and more equitable health outcomes for New Zealanders.

Key findings from the current state analysis

Aotearoa New Zealand's healthcare system does not generally have a strong research culture, notwithstanding individual examples of excellence. Research is not embedded within everyday practice nor within the organisational structure which often does not facilitate research activity; indeed, in many cases, the system is a barrier to the conduct of research. The clinical research workforces lack support. Investigators within the healthcare system rarely have time spent on clinical research acknowledged or accommodated and often are not supported by a functioning health research ecosystem within their place of work. The Māori and Pacific clinical research workforces are particularly thinly stretched, with barriers to development and support for those wishing to pursue a research career.

Despite the challenges, clinical trials are being conducted in Aotearoa New Zealand in a wide range of settings, with a wide range of goals, in a variety of ways, at all phases of medicine development and evaluation (discovery and development of medicine, preclinical research, clinical research) as well as in public health, functional foods, biotechnology development, devices, and trials to improve standards of routine care. In some cases, clinical trials are undertaken principally to provide access to medication, rather than primarily for a research goal. Clinical trials being undertaken in Aotearoa New Zealand range from small (<50 participants) to very large (>1,000). There are examples of good access to key infrastructure, such as statistical expertise, or experienced research nurse support, but that access is very patchy. The lack of infrastructure is an important barrier to undertaking research, to development of a sustainable research workforce and to equitable access to linical trials for patients across the motu. Existing clinical trial networks provide critical support for researchers, enabling high-quality success, but they are fragile and not resourced sustainably. Accurately costing and adequately funding clinical trials and clinical trial development is difficult, and the ability to conduct a long-term clinical trial (>3 years) within existing funding caps is problematic. The variable nature of research capability, capacity, and infrastructure across Aotearoa New Zealand, together with the requirement for multiple approvals at different sites, means it can be challenging, time-consuming and expensive to recruit multiple sites to clinical trials. These factors often lead to recruitment that lags behind overly ambitious targets and the need for multiple applications for funding to support a single trial.

Of particular importance, there is a gap in partnership with Māori, both in the design and conduct of individual trials, and in the wider infrastructure of trial activity, including in the management of data and tissue samples with appropriate tikanga. Information needs are changing, data governance processes are diverse and often not systematic, and there is little guidance on data sovereignty. There is a need for clinical trial methodologies and conduct to be more responsive to Māori needs, and more culturally safe.

Table 1: Areas of focus of the project from the RfP.

Areas of focus
Systems
Community/organisational/regional/national and international systems and networks that improve **coordination of, and collaboration for, Aotearoa New Zealand clinical trials**, and subsequent knowledge transfer.
Description
• Pathways/models for identifying research that reflects clinical **priorities** of the health sector and public/ patients.   • The reach and capability of clinical trials **networks**, both Aotearoa New Zealand-only networks and Aotearoa New Zealand arms of multi-national networks, particularly with respect to reach across disciplines, geographical regions/unit, levels of the health system, and current and potential future capabilities and sustainability.   • Clinical trial **site and coordinating centre** structures, functions, and facilities for public-good and commercial clinical trials (conducted in the public healthcare system).   • **Workforce** capabilities that are specific to the conduct of public-good and/or commercial clinical trials (conducted in the public healthcare system), above normal service delivery personnel, to include identifying roles or capabilities that would be better centralised or viewed as shared services.   • Systems for a national equitable approach to patient/participant **recruitment** for public-good and commercial trials (conducted in the public healthcare system).   • **Culturally appropriate involvement** of consumers (including Māori) in the trial process, including in trial design, monitoring, and as participants.   • Processes for **knowledge translation**, including audience-specific pathways for patients, service providers, and decision makers (managerial or policy), including implementation (as appropriate) of trial results (from Aotearoa New Zealand and international research).
Data
Clinical quality registries, electronic medical records, administrative datasets, research databases and research-supportive IT systems.
Description
• Identify and address data silos and/or optimise **interoperability** in a clinical trial setting.   • Availability and adequacy of **routinely collected data** for public-good and commercial clinical trials throughout the trial lifecycle, and associated issues, such as ethical aspects related to use of routine data.   • Types of and standards for clinical research **databases** including Australasian and international.   • Management and availability of data outputs from public-good research for **further use**, with specific consideration of cultural and ethical aspects of data use.   • The use of **clinical trial management systems** to aid efficiency and effectiveness.

Table 2: Overarching recommendations.

Overarching recommendations
National level essentials
• National leadership at the executive level within HNZ and the Māori Health Authority.
• Strategies to increase Māori and Pacific clinical trials workforce.
• National approach to developing relationships with Māori to ensure co-design and partnership.
• National approach to data governance, curation, sharing, and Māori data sovereignty.
• National resource of people and information to support clinical trial activity.
• National approach to consumer partnership, including education and training of consumer research partners.
• National support for clinical trials networks and infrastructure.
Regional level essentials
• Consumer engagement support.
• Support with Māori community engagement and Māori health advancement.
• Local/regional activity that identifies clinical trial activity of specific importance to local communities, including Māori.
• Provision of support in the following areas: statistics, health economics, ethics and regulatory approvals, finance and budgeting clinical trials, database design provision and maintenance, and a 24-hour randomisation service, including unblinding.
Recommendations
• The national clinical trials infrastructure must be underpinned by principles of Te Tiriti and developed in co-governance with Māori.
• The responsibility for ensuring high-quality research activity must be woven into the job descriptions of all senior clinical leaders in Health NZ and the Māori Health Authority. There must also be targeted measures of accountability for these senior clinical leaders.
• There must be an adequately resourced National Research Office for Te Whatu Ora – Health New Zealand, co-governed with the Māori Health Authority, with research leadership at the executive level of the organisations. While this function exists within the context of health research policy leadership from Manatū Hauora – Ministry of Health, in order to envisage possible gains it is essential for Te Whatu Ora – Health New Zealand to have research leadership at the operational level.
• There should be a National Clinical Trial Infrastructure Centre with expertise from across the country that will provide leadership, governance, expertise, and overall, high-level national support and coordination of trial activity, including the support of clinical trial networks in Aotearoa New Zealand.
• There should be Regional Clinical Trial Coordinating Centres around the country that, between them, provide the necessary expertise to support clinical trials. Each of these centres will support trial development and conduct across regional nodes to ensure equity of access for both researchers and participants, and will collaborate with other centres to support local, regional, national, and international trials.

Table 2 (continued): Overarching recommendations.

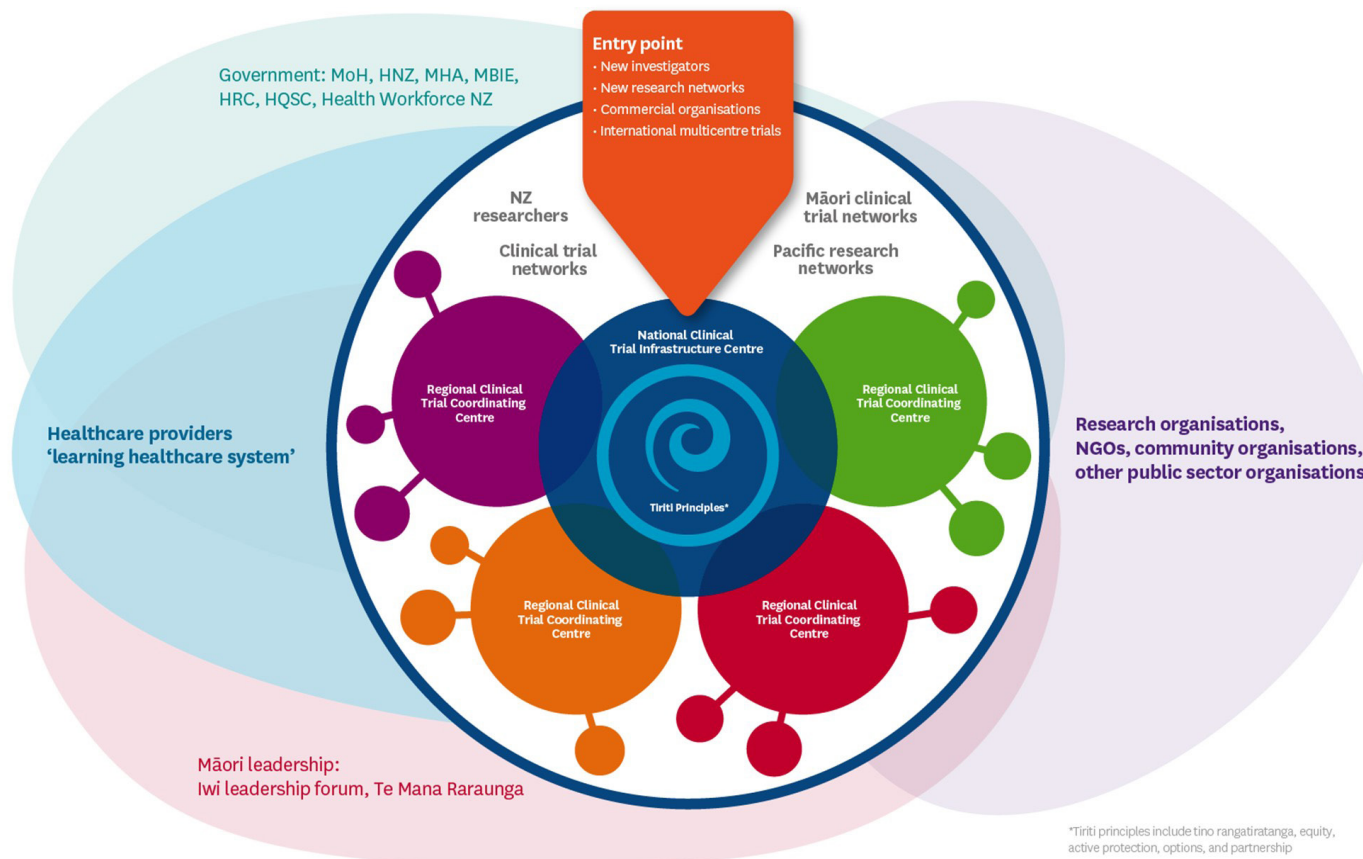| Overarching recommendations |
| --- |
| **Recommendations** |
| • There should be sustainable and systematic networks for Māori and Pacific researchers to support Māori and Pacific research communities in a regular and coordinated way, in accordance with the recommendations and priorities identified above, along with active development and support for the Māori health research workforce to meet commitments to Te Tiriti and to reduce inequities in health. |
| • Partnership with Māori and local Māori communities at every level, including trial implementation and national infrastructure. |
| • Supporting Te Ao Māori methods/priorities and engagement with researchers and communities. |
| • Embedding Māori data sovereignty and tikanga about data in the clinical trials system. |
| • Ensure knowledge translation has a positive impact for Māori and reduces inequities in health outcomes. |
| • When funding mechanisms are developed, ensure they are responsive to Māori community needs and researcher obligations. |
| • Support and train tauiwi workforce to engage with Te Ao Māori. |
| • Active development and support for the Pacific health research workforce. |
| • All publicly funded clinical trials should include consumer research partners. |
| • There should be a national federated health data system with Māori data governance at the core that allows the embedding of research in routine clinical care and provides culturally appropriate long-term curation of research data. |
| • A clear responsibility for research knowledge translation and implementation must be established within Aotearoa New Zealand's new healthcare system that is well integrated with change management, clinical governance functions, and the health system's role and responsibilities as an effective Te Tiriti partner for Māori. |

Figure 1: Proposed structure.
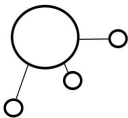
Table 3: Legend for the diagram of the proposed model.

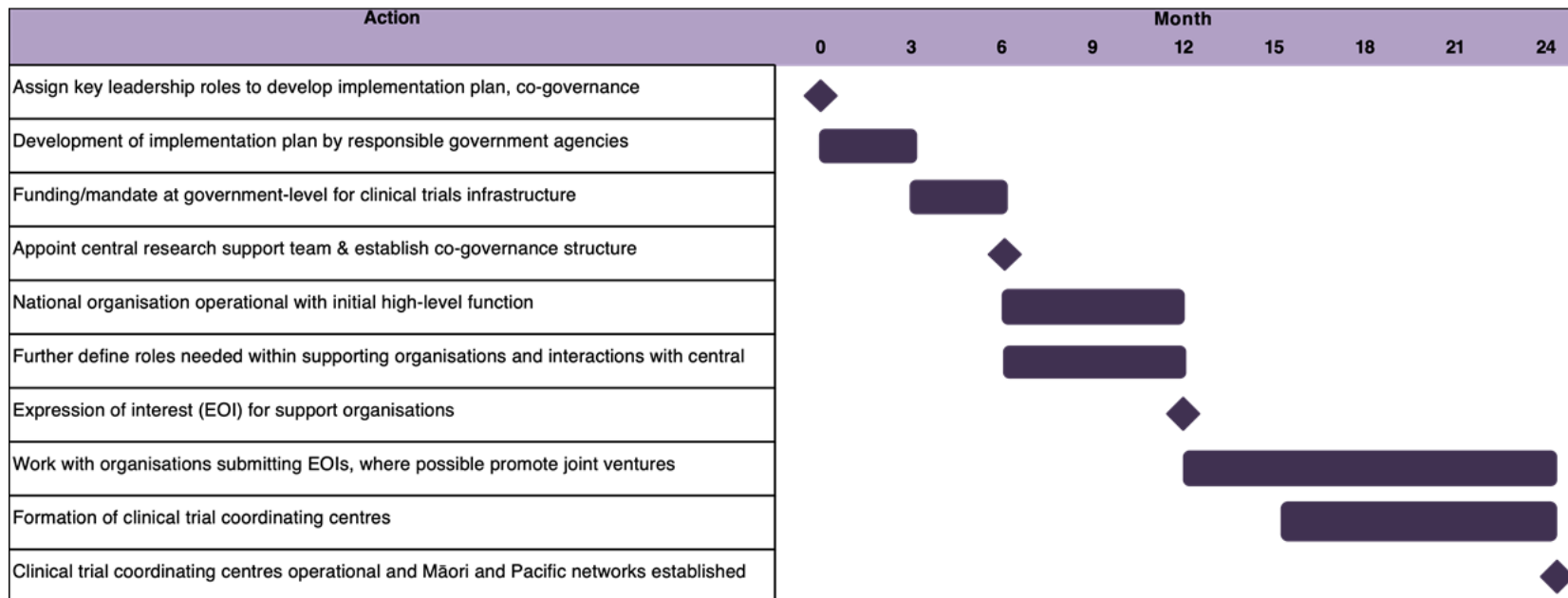| Legend	Description of component
●	**National Clinical Trial Infrastructure Centre** (section 6.3.1) *Collaboration of expertise and key stakeholders from across the country to provide leadership and national support for clinical trial activity*: • Governance and advice • Administration and data systems • Signpost, information collation, connections, and marketing • Education and methodology.
(node diagram)	**Regional Clinical Trial Coordinating Centre(s)** (section 6.3.2) *Region-specific collaborations between academia, healthcare providers, Kaupapa Māori services, Iwi Māori Partnership Boards, and other research organisations to support the development and conduct of investigator-led trials using a system of regional nodes*: • Partnership and engagement • Prioritisation of local research need and resource use • Expertise and support.
▼	**Entry point** *New researchers, new research networks, commercial organisations, and international trials will access the infrastructure through the National Clinical Trials Organisation.*
Government	*The leadership of the national clinical trials infrastructure should include representation from government departments and agencies to ensure research is embedded and resourced*: • Manatū Hauora – Ministry of Health • Te Whatu Ora – Health New Zealand • Te Aka Whai Ora – Māori Health Authority • Ministry of Business, Innovation and Employment • Health Research Council of New Zealand • Health Quality & Safety Commission • Health Workforce New Zealand.
Healthcare providers "learning healthcare system"	*Functional relationships between the clinical trials infrastructure and healthcare providers are essential for embedding research in healthcare and moving towards a learning healthcare system.*
Māori leadership	*Māori leadership would be embedded within the national clinical trials infrastructure; functional relationships with national Māori organisations, including the Iwi Leadership Forum and Te Mana Raraunga, are also critical.*
Allied organisations	*The leadership of the national clinical trials infrastructure should include representation from research organisations (including universities), NGOs, community organisations such as consumer groups, and other relevant public sector organisations.*

Table 4: Proposed timeline.

Action	Month								
	0	3	6	9	12	15	18	21	24
Assign key leadership roles to develop implementation plan, co-governance	◆								
Development of implementation plan by responsible government agencies	▬▬								
Funding/mandate at government-level for clinical trials infrastructure		▬▬							
Appoint central research support team & establish co-governance structure			◆						
National organisation operational with initial high-level function			▬▬▬						
Further define roles needed within supporting organisations and interactions with central			▬▬▬						
Expression of interest (EOI) for support organisations					◆				
Work with organisations submitting EOIs, where possible promote joint ventures						▬▬▬▬▬			
Formation of clinical trial coordinating centres							▬▬▬▬		
Clinical trial coordinating centres operational and Māori and Pacific networks established									◆

Consumers have important and rapidly growing roles in clinical trials and in making sure research is relevant and meaningful. Through the consultation process we have heard there is a need to create more opportunities for consumers to be research partners at all stages of the clinical trials process.

There is relatively little focus on translation of research results into practice. Translation is a particular issue for Māori given the extractive nature of research, the need to tailor results for Māori providers, and a need to demonstrate positive benefits for Māori to participate in trials. From the healthcare system perspective, translation is important to ensure the knowledge obtained from clinical trials improves clinical practice.

Thus, it is clear that any new infrastructure established must provide an opportunity for partnership with Māori, embed Te Tiriti o Waitangi, and allow for Māori to have greater leadership and governance to ensure Māori responsiveness (see full analysis at https://cdn.auckland.ac.nz/assets/liggins/docs/Appendix%20A-M%c4%81ori%20Relevant%20Themes%20in%20the%20Enhancing%20Clinical%20Trials%20Project.pdf).

Proposed infrastructure

The proposed essential elements of the infrastructure are outlined in Tables 2, 3 and Figure 1. Our proposal consists of two main components: 1) a National Clinical Trial Infrastructure Centre that provides and manages some of the functions and activities that have been agreed to be critical through the Delphi survey process (such as the website, facilitation of access to resource, coordination of key stakeholder groups such as consumers, Rōpū Māori and Pacific Advisory Group), and 2) a number of Regional Clinical Trial Coordinating Centres, procured by the National Clinical Trial Infrastructure Centre, that provide and manage operational functions and activities either at local level, across specific communities or more widely where there is specific expertise, on behalf of the Infrastructure Centre. Supporting organisations may be consortia or could contract other organisations as suppliers for necessary resources. Further details can be found in the full report (https://cdn.auckland.ac.nz/assets/liggins/docs/HP8537%20-%20LIG_Clinical%20Trials_FINAL_v6.pdf). Importantly, such an infrastructure will benefit all health research, not just clinical trials being undertaken within the public healthcare system.

Table 3 explains the components of the diagram of the proposed model.

Why now?

In April 2021, the Minister of Health announced a restructuring of the Aotearoa New Zealand health system, consolidating the 20 district health boards into Te Whatu Ora – Health New Zealand and Te Aka Whai Ora – Māori Health Authority, which will both operate hospital services and commission primary and community healthcare. This national approach provides the ideal opportunity to integrate and embed research into Aotearoa New Zealand's healthcare system.

We recognise that the integration of clinical trials and research more broadly into the public healthcare system will require a significant shift in the culture within our healthcare system. The significant structural changes underway with Te Whatu Ora – Health New Zealand and Te Aka Whai Ora – Māori Health Authority mean that now is the ideal time to enact such change. The required cultural change will need to be led from the top down with appropriate key performance indicators with respect to research for managers. Research must be recognised and promoted as a core activity for clinical staff at all levels of the healthcare system, rather than something to be tolerated or even hindered.

Kaupapa Māori health research is a vital mechanism for Māori to gain tino rangatiratanga (self-determination) within research and maintain control and autonomy over the knowledge considered relevant and legitimate to Māori.[3] Kaupapa Māori research, in the broadest sense, embeds the principles of being Māori and Te Ao Māori worldview within research by acknowledging the "Māori way of doing things".[4] To realise the currently unmet potential benefits of clinical trials, and particularly to ensure equity of access to participation in and realisation of the benefits from clinical trials will require both the system culture change and considerable building of capacity and capability in the Māori, and also Pacific, health research workforce.

Investment required

The investment required by the Government to implement the proposed clinical trial infrastructure will be substantial. In the first instance, at least 10 years' funding will be required in order to see a complete clinical trial cycle from

study design to funding, trial completion and reporting. It is therefore vital that the decision makers understand the financial benefits to the healthcare system of clinical trials. A study of the spill-over effects of public investment in health research in the UK found that every additional £1 GBP of public spend was associated with an eventual additional £0.99 GBP of private research and development spend in the UK.[5] Combined with other estimates of rate of return on investment, the findings suggested investment into public medical research in the UK retrieves a return between 15 and 18% per annum. This return was also thought to potentially be additive to other estimates, extending the estimated rate of return to a conservative 25% per annum.[6,7] Studies looking at the return on Australian health research and development investment produced benefit-cost ratio (BCR) estimates between 2.2:1 and 5:1.[8–10] This means that, at the time, for every $1 AUD of costs, there were between $2.17 and $5 AUD of benefits. A further study focusing only on the Australian National Health and Medical Research Council (NHMRC) expenditure estimated a BCR ratio of 3.2:1 from $10 billion AUD of R&D funding, highlighting benefits of (in AUD): $7.7 billion reduction in burden of disease, $1.3 billion direct health system expenditure savings, $1.9 billion reduction in productivity loss, $0.6 billion reduction in other financial costs, $0.3 billion reduction in deadweight loss, and $2.6 billion value of commercialisation.[11] A scoping review of 288 clinical trials concluded there are spill-over benefits for healthcare systems, including better health outcomes, enhanced research capacity, and drug cost avoidance.[12] Thus, the value of investing in clinical trials is net positive for funders through improved health outcomes, cost avoidance, and spill-over effects that encourage wider private spending. It is in health providers'/funders' best interests to ensure and support clinical trial activity. A proposed timeline for implementation is seen in Table 4. There exists substantial expertise in clinical trials across the Aotearoa New Zealand health system, and we note the importance of preserving and enhancing this in the development of the national clinical trials infrastructure.

We recognise that we are in a time of significant financial pressure within the health system and more generally within the economy. However, as noted above, there are financial savings to a public healthcare system engaged in research. Furthermore, it is critical that the development of clinical trials and other research infrastructure is considered and coordinated as part of the reorganisation of the health system at community, primary, and secondary levels. For example, coordination of the development of research infrastructure with the development of national health data systems is essential for enabling the embedding of research in clinical care and progress towards a learning healthcare system. In this regard, it is pleasing to see that Te Whatu Ora – Health New Zealand has appointed a Director of Evidence, Research and Clinical Trials, who will be responsible for the oversight of developing a plan to implement the Enhancing Aotearoa New Zealand Clinical Trials recommendations in collaboration with Manatū Hauora – Ministry of Health and Te Aka Whai Ora – Māori Health Authority, as well as providing strategic direction and leadership over embedding research as a priority within Te Whatu Ora – Health New Zealand.[13]

Summary

Now is the ideal time for investment in clinical trials infrastructure in Aotearoa New Zealand. Engagement with a broad range and large number of stakeholders demonstrated enormous enthusiasm and broad consensus for the approach outlined herein. Strong leadership will be required to ensure the required cultural shift to recognise the value of clinical trials to all aspects of the healthcare system, and to grow the capability and capacity of the health research workforce. We urge the Government to be bold and invest now to ensure the benefits can be reaped for all New Zealanders in years to come.

AUTHOR INFORMATION

Lisa K Stamp: Rheumatologist, Department of Medicine, University of Otago, Christchurch, Christchurch, New Zealand.

Matire Harwood: General Practitioner, Papakura Marae Health Clinic, and Department of General Practice and Primary Healthcare, Auckland, New Zealand.

Stuart Dalziel: Paediatrician, Cure Kids Chair, Department of Paediatrics, Child and Youth Health, The University of Auckland, Auckland, New Zealand.

Tom Love: Director Sapere Research Group, Wellington, New Zealand.

David Moore: Managing Director, Sapere Research Group, Wellington, New Zealand.

Kelvin Woock: Senior Consultant, Sapere Research Group, Wellington, New Zealand.

Katrina Sharples: Biostatistician, Department of Mathematics and Statistics, University of Otago, Dunedin, New Zealand.

Frank Bloomfield: Paediatrician, The University of Auckland; Liggins Institute, Auckland, New Zealand.

CORRESPONDING AUTHOR

Professor Lisa K Stamp: Department of Medicine, University of Otago, Christchurch, Christchurch 8014, New Zealand. E: lisa.stamp@cdhb.health.nz

REFERENCES

1. Reid IR, Joyce P, Fraser J, Crampton P. Government funding of health research in New Zealand. N Z Med J. 2014 Feb 14;127(1389):25-30.

2. Joyce P, Reid IR. Health research funding: international comparisons with New Zealand. N Z

Med J. 2008 Sep;121(1208):7.

3. Mikahere-Hall A. Constructing research from an indigenous Kaupapa Māori perspective: An example of decolonising research. Psychother Politics Int. 2017 Oct;15(2):e1428. doi: 10.1002/ppi.1428.

4. Curtis E. Indigenous Positioning in Health Research: The importance of Kaupapa Māori theory-informed practice. AlterNative: An International Journal of Indigenous Peoples. 2016 Dec;12(4):396-410. doi: 10.20507/AlterNative.2016.12.4.5

5. Sussex J, Feng Y, Mestre-Ferrandiz J, Pistollato M, Hafner M, Burridge P, et al. Quantifying the economic impact of government and charity funding of medical research on private research and development funding in the United Kingdom. BMC Med. 2016 Feb 24;14:32. doi: 10.1186/s12916-016-0564-z.

6. Grant J, Buxton MJ. Economic returns to medical research funding. BMJ Open. 2018 Sep 10;8(9):e022131. doi: 10.1136/bmjopen-2018-022131.

7. Health Economics Research Group, Office of Health Economics, RAND Europe [Internet]. Medical Research: What's it worth? Estimating the economic benefits from medical research in the UK. London: UK Evaluation Forum; 2008 Nov [cited 2022 Aug 12]. Available from: https://www.ukri.org/wp-content/uploads/2022/02/MRC-030222-medical-research-whats-it-worth.pdf.

8. Access Economics [Internet]. Exceptional Returns: The value of Investing in Health R&D in Australia. Australia: Australian Society for Medical Research; 2003 Sep [cited 2022 Aug 12]. Available from: https://asmr.org.au/wp-content/uploads/library/Except.pdf.

9. Access Economics [Internet]. Exceptional Returns: The value of Investing in Health R&D in Australia II. Australia: Australian Society for Medical Research; 2008 Jun [cited 2022 Aug 12]. Available from: https://asmr.org.au/wp-content/uploads/library/ExceptII08.pdf.

10. Latera Economics [Internet]. The Economic Value of Australia's Investment in Health and Medical Research: Reinforcing the Evidence for Exceptional Returns. Australia: Research Australia; 2010 Oct [cited 2022 Aug 12]. Available from: https://lateraleconomics.com.au/wp-content/uploads/2014/02/The-Ec-Value-of-Austs-Invmt-in-Med-Research.pdf.

11. Deloitte Access Economics [Internet]. Extrapolated returns from investment in medical research future fund (MRFF). Australia: Australian Society for Medical Research; 2014 Oct [cited 2022 Aug 12]. Available from: https://asmr.org.au/wp-content/uploads/library/ASMR%20Deloittee%20Report_MRFF.pdf.

12. Bentley C, Cressman S, van der Hoek K, Arts K, Dancey J, Peacock S. Conducting clinical trials-costs, impacts, and the value of clinical trials networks: A scoping review. Clin Trials. 2019 Apr;16(2):183-93. doi: 10.1177/1740774518820060.

13. Te Whatu Ora – Health New Zealand [Internet]. Service Improvement and Innovation Consultation Document. Wellington: Te Whatu Ora – Health New Zealand; 2023 Mar [cited 2022 Aug 12]. Available from: https://www.nzdoctor.co.nz/sites/default/files/2023-04/Consultation%20Pack%20-%20Service%20Improvement%20and%20Innovation%20consultation%20document.pdf.

The planning of cancer screening programmes

Brian Cox, Gil Barbezat, Murray Pfeifer, Alice Macklow, Dave MacKay, Melissa Vining, Phil Bagshaw

Abstract

Positive screening tests require investigation, usually by specialists. Specialist services are known to be limited. The planning of screening programmes must first include a model of existing diagnostic and follow-up services of symptomatic patients so that the added impact of the extra referrals required for screening can be estimated. This is fundamental to the planning of screening programmes; inevitable diagnostic delay, impeded access to services for symptomatic patients, and resulting harm or increased mortality from disease can thus be avoided.

For a cancer screening programme to be a major advance in the control of cancer in the population, it must be properly organised and resourced. New Zealand has three important national cancer screening programmes, but unfortunately each has had troubled beginnings.

The cervical screening programme arose from the recommendation of a national inquiry into the inappropriate management of detected abnormalities.[1] This was followed by an inquiry into the under-reporting of significant pre-invasive disease detected by screening.[2] Colposcopy services, vital for the timely assessment of positive screening programme tests, have also experienced intermittent difficulties meeting their requirements.[3] The initial years of the breast screening programme included sending several hundred women to Australia for treatment,[4] as the services in New Zealand could not cope with the amount of breast cancer detected by the screening programme. In 2011, it was considered that delayed breast screening may have harmed some women.[5,6] More recently, major concerns have been raised about the capacity of colonoscopy services to manage both symptomatic and screen-detected colorectal disease.[7,8] The potential harm to women of unwarranted delays in breast screening has also been raised again.[9]

The principles for screening programmes were established over 50 years ago.[10] The magnitude of the additional demands on health services created by screening are clearly predictable. Unless additional trained staff and physical resources are provided, they get diverted from the management of symptomatic patients.

Screening protocols, including the age range of those to be invited to screening and the frequency and type of test to be used, can be usefully assessed by computer simulation models.[11–16] These can be used to predict the potential impact and additional service demands of a cancer screening programme. However, among several well described problems,[17] they have the fundamental limitation of assuming that unlimited resources can be brought in, or purchased, to cope with the increased demand. This is not the acceptable situation for any health service operating with restrictions of staff and resources, as found in New Zealand. Modelling the impact of cancer screening programmes requires preemptive modelling of the current services, especially the diagnosis, treatment, and follow-up resources available.[18] Then, the effect of the predictable increased demand on the health service can be estimated. When introduced to a system with effectively fixed resources, particularly essential clinical staff, facilities, and laboratory processing capacity, the increased demand will inevitably result in some shifting of work from symptomatic patients to the assessment of people who have a positive screening test.

Simulation models, or fully funded pilot programmes, used to plan the introduction of screening programmes that do not include existing services for symptomatic patients are not models of the future needs of a screening service. They are therefore very limited in their use for planning screening programmes.[18] The required simulation models of the available services for symptomatic patients also need to be regionally specific when considerable regional variations in

the health service exist. The current commonly used models of screening policy are inadequate for this purpose. In addition, any monitoring or evaluation of screening programmes needs to assess services for symptomatic patients and the impact of screening services on them. This should be an ethical requirement of the public health medicine practice of screening and is an example of how public health often relies on the support of clinical services. The National Screening Unit is responsible for the safety, effectiveness, and quality of organised screening programmes, and has recently been incorporated into the Population Health and Prevention directorate within Te Whatu Ora – Health New Zealand. How that may alter the effectiveness of the screening programmes is yet to be determined.

In New Zealand, the failure to appropriately include the existing treatment resources in planning models for screening has repeatedly resulted in the inadequate planning of the introduction of screening programmes. This is currently evident in the introduction of the country-wide national bowel screening programme, rolled out since 2017. For 2018, national gastroenterology services were declining 21.9% of all referrals.[19] It is unlikely that this was due to inappropriate referrals from general practitioners or surgeons. It was more likely due to an incapacity to meet the requirements for the assessment of symptomatic patients. It is also likely that this effect varied considerably between regions.

It was clear from preliminary assessments and the pilot study of the New Zealand bowel screening programme[20] that considerably more colonoscopy staff and facilities would be needed.[21–24] However, the political imperative for Manatū Hauora – Ministry of Health to produce a bowel screening programme, with the support of several cancer organisations, appeared to become paramount. Any resulting shift of staff and resources away from symptomatic patients and their follow-up can be expected to have produced delays in diagnosis and the declining of necessary fundamental investigations, particularly colonoscopy, for symptomatic patients. Whether a subsequent increase in mortality is greater or less than the possible reduction in bowel cancer mortality achieved by the screening programme is yet to be ascertained. If it occurred, it would raise a number of ethical issues and be an avoidable failure of the practice of public health medicine.

When the extent of the increase in clinical load became evident after the pilot study,[25] the concentration of haemoglobin in faeces used to trigger a colonoscopy was increased and the eligible age range was restricted to 60–74 years for the national programme.[23,26] This was a clear recognition that the years between the planning of the pilot study and the start of the national bowel screening programme were not judiciously used to ensure that the programme had the necessary staff and resources to maintain appropriate services for symptomatic patients. Requests to expand training programmes for colonoscopists were ignored in 2013 and subsequently. The desire for nurses to perform colonoscopy was determined in 2017,[27] but by September 2021, there were only seven nurse endoscopists,[28] suggesting inadequate resourcing for the training of nurse endoscopists. The suggested efficacy of the screening programme by the pilot study has been reduced significantly.

During the period of reduced gastroenterology services in response to the COVID-19 pandemic in 2020, the Cancer Control Agency requested that people with positive bowel screening tests should have priority for colonoscopy over many symptomatic patients.[29] This was the result of an inaccurate estimate of the risk of bowel cancer in symptomatic patients because the age of patients was not considered.[30]

While the private sector may be keen to be paid to cover any shortfall in resources, this can be expected to increase the cost of the programme. Because of the relatively fixed and low numbers of gastroenterologists in New Zealand[24] and the time commitments of surgeon colonoscopists in public hospitals, this potentially results in a transfer of staff from the public to the private sector, further reducing the capacity of the already overloaded public endoscopy services.

The effect on the services for symptomatic patients is not mere speculation. Three independent inquiries in the Southern region have shown that many patients have been seriously disadvantaged by being declined a colonoscopy.[8,31–35] The adequate provision of assessment services for people who test positive at screening is a fundamental requirement of a screening programme. However, this must not be met by preventing symptomatic patients from receiving timely and adequate investigation.

Physicians, other health professionals, and the public may not fully appreciate the appropriate assessment of a successful screening

programme.[36] Therefore, as was ascertained for the breast screening programme,[37] further ongoing independent monitoring of screening programmes has been shown to be essential to safeguard against serious failures of such programmes and their associated health services. However, an organisation with the capacity and authority to ensure appropriate and lasting action is undertaken where necessary is also essential. With among the highest risk of developing bowel cancer in the world, New Zealand certainly merits an adequately funded, high quality, and carefully monitored screening programme, as well as expert care for symptomatic patients.

COMPETING INTERESTS

Nil.

AUTHOR INFORMATION

Res Ass Prof Brian Cox: Hugh Adam Cancer Epidemiology Unit, Department of Preventive and Social Medicine, Dunedin School of Medicine, New Zealand.

Prof Gilbert Olivier Barbezat: Medicine, Dunedin School of Medicine, New Zealand.

Mr Murray V Pfeifer: General Surgeon – Retired, New Zealand.

Ms Alice Nancy Macklow: Independent Research, Independent Research Agency, New Zealand.

Dr Dave McKay: General Practitioner and Palliative Care doctor, Helensburgh Medical Centre and Otago Community Hospice, New Zealand.

Mrs Melissa Vining: Cancer Care Advocate, New Zealand.

Mr Philip Bagshaw: General Surgery, Canterbury Charity Hospital Trust, New Zealand.

CORRESPONDING AUTHOR

Dr Brian Cox: Hugh Adam Cancer Epidemiology Unit, Department of Preventive and Social Medicine, Dunedin School of Medicine, New Zealand.
E: brian.cox@otago.ac.nz

REFERENCES

1. Committee of Inquiry into Allegations Concerning the Treatment of Cervical Cancer at National Women's Hospital and into Other Related Matters. The Report of the Committee of Inquiry into Allegations Concerning the Treatment of Cervical Cancer at National Women's Hospital and into Other Related Matters. New Zealand: Government Printing Office;1988. 288 p.

2. Duffy AP, Barrett DK, Duggan MA. Report of the Ministerial Inquiry into the Under-Reporting of Cervical Smear Abnormalities in the Gisborne Region. New Zealand: Government Printing Office; 2001. 275 p.

3. Johnston M. Cervical cancer checks ordered after hospital failures exposed. NZ Herald [Internet]. 2006 May 3 [cited 2022 Dec 14]. Available from: www.nzherald.co.nz/nz/cervical-cancer-checks-ordered-after-hospital-failures-exposed/BF4SSCOJSWNIRHN33WDCK4TTAA/.

4. Taylor K. More cancer patients fly to Australia. NZ Herald [Internet]. 2000 Nov 9 [cited 2022 Dec 14]. Available from: www.nzherald.co.nz/nz/more-cancer-patients-fly-to-australia/NWGR3HERA4RYZZIWEZ7VWHWNNI/.

5. Muller J. Review of the BreastScreen Aotearoa Program: Future Directions for the National Screening Unit Working in Partnership with Lead Providers for a Sustainable Quality Program. Wellington: Ministry of Health; 2011 Aug.

6. McLean E. NZ breast-screening slated. Otago Daily Times [Internet]. 2012 Jan 8 [cited 2023 May 19]. Available from: https://www.odt.co.nz/news/national/nz-breast-screening-slated.

7. Bagshaw P, Goodman P, Cox B. Official Information Act investigation of the Ministry of Health's process to assess the Southern District Health Board's readiness to join the National Bowel Screening Programme in 2018. N Z Med J 2021;134(1534):99-113.

8. Bissett I, Broome K. Colonoscopy Patient Review. Southern DHB Board Meeting [Internet]. Dunedin: Wakari Hospital Campus; 2020 Oct 6 [cited 2022 Dec 14]. Available from: https://www.southernhealth.nz/sites/default/files/2020-10/2020-10-06%20SDHB%20Board%20Agenda_public.pdf.

9. Te Whatu Ora – Health New Zealand. Te Whatu Ora – Health New Zealand Capital, Coast & Hutt Valley BreastScreen Central Review. Wellington: Te Whatu Ora – Health New Zealand; 2023 [cited 2022 Nov 3]. Available from: https://www.ccdhb.org.nz/news-publications/publications-and-consultation-documents/te-whatu-ora-health-new-zealand-capital-coast-hutt-valley-breastscreen-central-review.pdf.

10. Wilson JMG, Jungner G. Principles and practice of screening for disease. Public Health Paper No. 34. Geneva: World Health Organization; 1968.

11. Parkin DM. A computer simulation model for the practical planning of cervical cancer screening programmes. Br J Cancer. 1985 Apr;51(4):551-68. doi: 10.1038/bjc.1985.78.

12. Habbema JD, van Oortmarssen GJ, Lubbe JT, van der Mass PJ. The MISCAN simulation program for the evaluation of screening for disease. Comput Methods Programs Biomed. 1985 May;20(1):79-93. doi: 10.1016/0169-2607(85)90048-3.

13. Mandelblatt J, Schechter CB, Lawrence W, Yi B, Cullen J. The SPECTRUM population model of the impact of screening and treatment on U.S. breast cancer trends from 1975 to 2000: principles and practice of the model methods. J Natl Cancer Inst Monogr. 2006;(36):47-55. doi: 10.1093/jncimonographs/lgj008.

14. Bespalov A, Barchuk A, Auvinen A, Nevalainen J. Cancer screening simulation models: a state of the art review. BMC Med Inform Decis Mak. 2021 Dec 20;21(1):359. doi: 10.1186/s12911-021-01713-5.

15. Smith H, Varshoei P, Boushey R, Kuziemsky C. Simulation modeling validity and utility in colorectal cancer screening delivery: A systematic review. J Am Med Inform Assoc. 2020 Jun

1;27(6):908-916. doi: 10.1093/jamia/ocaa022.

16. van Ballegooijen M, Boer R, Zauber AG. Simulation of colorectal cancer screening: what we do and do not know and does it matter. Best Pract Res Clin Gastroenterol. 2010 Aug;24(4):427-37. doi: 10.1016/j.bpg.2010.07.001.

17. Salt JD. The seven habits of highly defective simulation projects. J Simul. 2008 Nov;2(3):155-161. doi: 10.1057/jos.2008.7.

18. Campbell LA, Blake JT, Kephart G, Grunfeld E, MacIntosh D. Understanding the effects of competition for constrained colonoscopy services with the introduction of population-level colorectal cancer screening. Med Decis Making. 2017 Feb;37(2):253-263. doi: 10.1177/0272989X16670638.

19. Manatū Hauora – Ministry of Health. National Patient Flow: Prioritisation outcome of referrals for first specialist assessment tables (developmental) [Internet]. Wellington: Manatū Hauora – Ministry of Health; 2019 Nov [cited 2022 Dec 14]. Available from: www.health.govt.nz/publication/national-patient-flow-prioritisation-outcome-referrals-first-specialist-assessment-tables.

20. Manatū Hauora – Ministry of Health. Final Evaluation Report of the Bowel Screening Pilot: Screening Rounds One and Two. Wellington: Centre for Public Health Research, Massey University; 2017 Feb [cited 2022 Dec 14]. Available from: https://www.health.govt.nz/publication/final-evaluation-report-bowel-screening-pilot-screening-rounds-one-and-two.

21. Members of the National Health Committee Working Party on Population Screening for Colorectal Cancer. Recommendations on population screening for colorectal cancer in New Zealand. N Z Med J 1999;112:4-6.

22. Cox B. Cancer screening in New Zealand. New Ethicals. 2003 Nov. p15-26.

23. Green T, Richardson A, Parry S. Colonoscopy requirements of population screening for colorectal cancer in New Zealand. N Z Med J. 2012 Jun 8;125(1356):85-95.

24. Caspritz T, Arnold M, White C, Schultz M. A Critical Analysis of the Gastroenterology Specialist Workforce in New Zealand: Challenges & Solutions. NZ Soc Gastroenterol. 2018 Nov.

25. National Screening Unit. International comparisons with New Zealand's bowel screening programme [Internet]. Wellingon: Manatū Hauora – Ministry of Health; 2017 Jul [cited 2022 Dec 9]. Available from: www.nsu.govt.nz/health-professionals/national-bowel-screening-programme/international-comparisons-new-zealand's.

26. National Screening Unit. Time to screen. About bowel screening [Internet]. Wellington: National Screening Unit; 2022 [cited 2022 Dec 9]. Available from: www.timetoscreen.nz/bowel-screening/about-the-national-bowel-screening-programme/.

27. Tucker D, Scrymgeour G, Marshall B. Toward Developing a Nurse Endoscopist Role in New Zealand. Gastroenterol Nurs. 2017 Mar/Apr;40(2):128-133. doi: 10.1097/SGA.0000000000000146.

28. National Screening Unit. Karen Kempin's story - nurse endoscopist [Internet]. Wellington: National Screening Unit; 2021 Sep [cited 2022 Dec 13]. Available from: www.nsu.govt.nz/news/karen-kempins-story-nurse-endoscopist.

29. Manatū Hauora – Ministry of Health, Te Aho o Te Kahu Cancer Control Agency. Covid-19 Gastrointestinal Endoscopy Guidance [Internet]. Wellington: Te Aho o Te Kahu Cancer Control Agency, Manatū Hauora – Ministry of Health; 2020 Aug 13 [cited 2020 Sep 9]. Available from: https://www.nzno.org.nz/Portals/0/Files/Documents/Groups/Cancer%20Nurses/Newsletters/2020-08-25%20COVID%20Endoscopy%20Guidance%20V2_0.pdf.

30. Bagshaw P, Cox B. Adequacy of publicly funded colonoscopy services in New Zealand. N Z Med J. 2020 Dec 4;133 (1526):7-11.

31. Bagshaw P, Ding S. Assessment of Diagnostic & Treatment Times for Endoscopy Cases [Internet]. Dunedin: Te Whatu Ora Southern; 2019 Jul [cited 2022 Dec 14]. Available from: https://www.southernhealth.nz/sites/default/files/2019-07/SDHB%20Endoscopy%20Cases%20Report%20Final%20-%20redacted.pdf.

32. Connolly A. Final Report: Recommendations to address various matters in relation to Colonoscopy Services at Southern DHB. Dunedin: Te Whatu Ora Southern; 2020 Jan.

33. Mckenzie-Maclean J. Battling bowel cancer - the frustration, the tears, the gratitude. Stuff [Internet]. 2021 Jul 17 [cited 2022 Dec 14]. Available from: www.stuff.co.nz/national/health/125629526/battling-bowel-cancer--the-frustration-the-tears-the-gratitude?

34. McLean E. SDHB's reaction indicates colonoscopy saga not over. Otago Daily Times [Internet]. 2022 Jan 26 [cited 2022 Dec 14]. Available from: https://www.odt.co.nz/opinion/sdhb%E2%80%99s-reaction-indicates-colonoscopy-saga-not-over.

35. Steyl L. Report finds SDHB doctors struggling to get colonoscopy approvals. Stuff [Internet]. 2020 Feb 5 [cited 2020 Sep 9]. Available from: https://www.stuff.co.nz/national/119254268/report-finds-sdhb-doctors-struggling-to-get-colonoscopy-approvals.

36. Wegwarth O, Schwartz LM, Woloshin S, Gaissmaier W, Gigerenzer G. Do physicians understand cancer screening statistics? A national survey of primary care physicians in the United States. Ann Intern Med. 2012 Mar 6;156(5):340-9. doi: 10.7326/0003-4819-156-5-201203060-00005.

37. Chamberlain J. BreastScreen Aotearoa: An independent review [Internet]. Manatū Hauora – Ministry of Health; 2002 May [cited 2022 Dec 14]. Available from: https://www.moh.govt.nz/notebook/nbbooks.nsf/ea5ef2c0e4ab8ac485256caa0065e3eb/b23455b11360122ecc256f5b006ac00f/$FILE/ChamberlainReview.pdf.

Who does not benefit from our national breast screening programme and who should have oversight?

Ineke Meredith, Ross Lawrenson

ABSTRACT

The recent report on the delays for mammography encountered by women in the Wellington Region reminds us that the organisation of cancer screening is far from straightforward, and we highlight these complexities in our viewpoint article. Screening can reduce mortality from cancer, but it is costly, and the benefits are many years in the future. Cancer screening can result in some individuals being over-diagnosed and over-treated, can impact on the services for symptomatic patients and can exacerbate inequities. Reviewing the quality, safety and acceptability of our breast screening programme is important but there is a need to acknowledge the role of the resulting clinical services, including the opportunity cost to symptomatic patients who seek healthcare in the same system.

The recent report on the delays for mammography encountered by women in the Wellington Region reminds us that the organisation of cancer screening is far from straightforward. Screening can reduce mortality from cancer, but it is costly, and the benefits are many years in the future. Cancer screening can result in some individuals being over-diagnosed and over-treated, can impact on the services for symptomatic patients and can exacerbate inequities. It is therefore essential that the decision makers (Ministers, Crown Agencies and their executives) are informed using the best scientific advice available. In New Zealand this advice is provided by the National Screening Advisory Committee (NSAC) and is based on consideration of the criteria outlined by the National Health Committee in 2003.[1] We thus have a national screening unit that is responsible for the organisation of population screening, while the general health services are responsible for the diagnosis, treatment and follow-up of those found to be at high risk from screening. The provision of screening and follow-up has been devolved to various screening units, radiology suppliers and hospitals sometimes resulting in variations in the delivery of care. Reviewing the quality, safety and acceptability of our breast screening programme is important but there is a need to acknowledge the role of the resulting clinical services, including the opportunity cost to symptomatic patients who seek healthcare in the same system.

Breast Screening Aotearoa (hereafter called BSA) was established in New Zealand in December 1998, and at that time provided screening to asymptomatic women aged 50–64 years. In 2004, the eligible age range was extended to include all women aged 45–69 years. The programme before that moment covered 356,000 New Zealand women, and the extension translated into an extra 238,000 women in the two new age categories.[2] Now, there is discussion to increase the upper end of the screening age to 74 years—which means that 42,000 additional mammograms would be performed each year, generating the need for 1,600 extra appointments to follow-up mammographic findings.[3] This does not take into account the additional perioperative work to address increasing age-related comorbidity. In the context of delays to screening over 2020–2021, these resource demands become increasingly significant. It is estimated that 28,500 breast screens were missed during this time and although it is expected to be cleared by the end of June 2023, it impacted Māori and Pasifika women disproportionately, which highlights the necessity to achieve equity for these groups.[4] Only 45% of all breast cancers are diagnosed through the screening programme,[5] reinforcing the work required to optimise coverage for women in the current age range. There is already an increasing gap between workforce demand and supply with specialist workforce shortages across each step of the screening pathway, from diagnostics to treatment. The age increase would require additional radiologists, radiographers, BSA-accredited surgeons, BSA-accredited pathologists

and support staff. All service providers would require new sites or site extensions and new equipment. In many places in New Zealand, BSA and symptomatic breast clinics share equipment and resource. Screening services do not operate in a vacuum and therefore these extra demands on a health system will have unintended negative consequences if resources are shifted away from any symptomatic patient accessing a symptomatic breast service in New Zealand, as well as women who are identified as being high risk requiring more intensive surveillance. Breast radiology—which incorporates mammography, ultrasound, and biopsy—is central to the "modern breast clinic" and aims to address women presenting with symptoms and signs of breast disease. Due to increased awareness of breast disease as a result of public campaigning and media, there is an increased volume of breast referrals allowing detection of breast cancer at an earlier stage, but this is accompanied by a much larger number of women with benign conditions with high expectation for rapid diagnosis. Moreover, as experience with breast imaging and knowledge of risk evolves, radiologists and surgeons are faced with a demand for more imaging, and new technologies, even in the setting of screening. In 2019, it became mandatory in many places throughout the United States of America for "mammography providers" to report breast density to all women undergoing mammography because it is a marker of increased risk of breast cancer.[6] It followed that for these women a complementary ultrasound of both breasts should be recommended. Due to the increase in labour required to ultrasound both breasts (40–45 minutes), in New Zealand, it would not be feasible to institute such an adjunct in all women with a breast density over 50% presenting to screening nor to a public breast clinic.

Over-treatment remains a significant concern in breast screening programmes world-wide, with estimates of over-treatment that lie anywhere between 10–22% in randomised controlled trials.[7] Ductal carcinoma *in situ* (DCIS) was rarely diagnosed prior to breast screening, but makes up 20–25% of all screen-detected "breast cancers" world-wide.[8] In New Zealand, it constitutes 16.5% of all breast cancers, with 47.6% being high grade.[5] It is often referred to as Stage 0 breast cancer, yet DCIS is a non-invasive non-obligate precursor of breast cancer, the management of which includes breast-conserving surgery or mastectomy, adjuvant radiotherapy and in some countries endocrine therapy. In 2012, Sir Michael

Marmot identified that women with DCIS, labelled as "cancer patients" live with the negative impact of anxiety and sequelae of treatment despite the fact that most DCIS lesions will never progress to invasive disease.[9] This has led to several large-scale international trials that are investigating the natural history of low-grade DCIS in an attempt to de-escalate treatment for tens of thousands of women world-wide.[10,11] Overall, approximately 70% of all women diagnosed with DCIS in New Zealand undergo breast-conserving surgery (the remainder undergo mastectomy) and approximately 75% of all women will be referred for radiotherapy. Although this is rather simplistic because DCIS exists in a spectrum of severity from low grade to high grade, most specialists acknowledge that high-grade DCIS is the most likely to undergo transformation, although again that risk is not well defined due to a lack of evidence.

One unforeseen consequence of the age extension in 2004 was a reduction in the coverage of Māori women in the 50–64 years age group in New Zealand.[2] BSA is a voluntary programme. The colorectal cancer screening programme, which was developed without oversight from NSAC, is based on a national register and to which eligible members of the population are invited and can opt off, while BSA is an opt-on programme. That is, women must first be informed about the programme, and then call in or enrol online once they reach the eligible screening age. There exists significant inequity both in terms of screening coverage and outcomes between Māori women and non-Māori non-Pasifika women in New Zealand. Māori women consistently have significantly lower rates of screening coverage than both Pasifika and non-Māori, non-Pasifika women, yet they have a 39% higher incidence of breast cancer than their non-Māori, non-Pasifika counterparts.[5] Both Māori and Pasifika women are more likely to present with non-BSA (symptomatic) cancers than non-Māori non-Pasifika, and thus more likely to die from their disease. Notwithstanding this, Māori women participating in BSA experience a significant survival benefit with a 56% lower breast cancer mortality if they have a screen-detected breast cancer.[5] Māori and Pasifika women remain priority groups for BSA, yet despite a recommendation for a national register in 2011 to improve coverage, this is yet to take effect. Those instituting screening programmes must consider that just by the nature of people likely to present to screening, existing disparities will be widened, and there exists an obligation under Te Tiriti o Waitangi to eradicate these.

Breast cancer is the most common cancer to affect women in New Zealand and the second most common cause of death. Our national mammographic screening programme reduces breast cancer mortality by an estimated 30% in regularly screened women.[12] While outcomes for Māori and Pasifika women identified through screening are the same as for others, there are substantial inequities in the diagnosis, treatment and outcomes for the 55% of women who are diagnosed symptomatically.[13] However, while the BSA Quality Improvement Review is valuable it does not address the fact that our national screening programmes are running within a health system under pressure from workforce shortages and other competing demands. The clinicians and organisations responsible for the diagnosis treatment and outcomes of women identified through screening do not seem to play a critical role in the review's recommendations. One criticism by the Epidemiological Review was that there appears to be little effective linkage between the BSA records and clinical records for all women diagnosed with breast cancer. Currently the governance of our cancer screening programmes is confusing. Te Manatū Hauora – Ministry of Health is the Government's primary advisor on health, priority setting, policy and system performance and would appear to be the logical home for NSAC so that expert advice could be directly available to the Director-General and the Minister on screening policy. Cancer screening is managed by a division within the new Public Health Unit also responsible for immunisation. Following the concerns over delays in offering mammograms to women in the Wellington Region, the review recently released[14] looked at the performance of its sister division within Te Whatu Ora – Health New Zealand. Te Whatu Ora and Te Aka Whai Ora – Māori Health Authority are now developing an Action Plan in response to the recommendations with a Pae Whakatere to oversee implementation. A breast screening program is more than just a delivery of mammograms to find potential early breast cancers—rather, it must be part of an integrated service providing early diagnosis and treatment to all women with breast cancer. It is essential that those clinical experts in the field are therefore included in the design and delivery. This is happening with the National Breast Cancer Quality Performance Indicators being developed by Te Aho o Te Kahu, the Cancer Control Agency. The principle Simplify to Unify[15] is supposed to be driving the reforms, but when we come to improving breast cancer outcome it seems we are tending to complicate and divide.

AUTHOR INFORMATION
Dr Ineke Meredith: Breast & General Surgeon, Paris Breast Centre, France.
Professor Ross Lawrenson: Medical Research Centre, The University of Waikato, Hamilton, New Zealand; Strategy and Funding, Waikato Hospital, Hamilton, New Zealand.

CORRESPONDING AUTHOR
Dr Ineke Meredith: Breast & General Surgeon, Paris Breast Centre, France. E: inekemeredith@gmail.com

REFERENCES
1. National Health Committee. Screening to Improve Health in New Zealand: Criteria to assess screening programmes [Internet]. Wellington, New Zealand; 2023 Apr [cited 2023 Jun 10]. Available from: https://www.nsu.govt.nz/system/files/resources/screening_to_improve_health.pdf.
2. New Zealand Government. BreastScreen Aotearoa programme extended 24 February 2004 [Internet]. 2004 Feb 24 [cited 2023 May 1]. Available from: www.beehive.govt.nz/release/breastscreen-aotearoa-programme-extended.
3. Te Manatū Hauora – Ministry of Health. Impact analysis: Extending BreastScreen Aotearoa to include women aged 70-74 years. Wellington, New Zealand; 2019 [cited 2023 May 1]. Available from: www.nsu.govt.nz/system/files/resources/impact-analysis-extending-age-range-breastscreen-aotearoa-may19.pdf.
4. Te Whatu Ora – Health New Zealand. BSA Quality and Safety Review Report [Internet]. 2023 May 10 [cited 2023 Jun 10]. Available from: https://www.tewhatuora.govt.nz/publications/bsa-quality-and-safety-review-report/.
5. Gautier A, Harvey V, Kleinsman S, et al, editors. 30,000 voices: informing a better future for breast cancer for Aotearoa New Zealand [Internet]. Breast Cancer Foundation NZ: Auckland; 2022 [cited 2023 Jun 8]. https://www.breastcancerfoundation.org.nz/medical-professionals.
6. Henderson LM, Marsh MW, Earnhardt K, et al. Understanding the response of mammography facilities to breast density notification. Cancer. 2020; 126(24):5230-5238. doi: 10.1002/cncr.33198.
7. Carter JL, Coletti RJ, Harris RP. Quantifying and monitoring overdiagnosis in cancer screening: a systematic review of methods. BMJ. 2015:350:g7773. doi: 10.1136/bmj.g7773.
8. van Seijen M, Lips EH, Thompson AM, et al. Ductal carcinoma in situ: to treat or not to treat, that is the question. Br J Cancer. 2019 Aug;121(4):285-292. doi: 10.1038/s41416-019-0478-6.
9. Independent UK Panel on Breast Cancer Screening. The benefits and harms of breast cancer screening: an independent review. Lancet. 2012;380:P1778-1786. https://doi.org/10.1016/S0140-6736(12)61611-0.
10. Hwang ES, Hyslop T, Lynch T, et al. The COMET (Comparison of Operative versus Monitoring and Endocrine Therapy) trial: a phase III randomized controlled trial for low-risk ductal carcinoma in situ (DCIS). BMJ Open. 2019;9(3):e026797. doi: 10.1136/bmjopen-2018-026797.
11. Pilewskie M, Olcese C, Patil S, Van Zee KJ. Women with Low-Risk DCIS Eligible for the LORIS Trial After Complete Surgical Excision: How Low is Their Risk After Standard Therapy? Ann Surg Oncol. 2016;23(13):4253-4261. doi: 10.1245/s10434-016-5595-3.
12. Morrell S, Taylor R, Roder D, et al. Mammography service screening and breast cancer mortality in New Zealand: a National Cohort Study 1999-2011. Br J Cancer. 2017;116(6):828-839. doi: 10.1038/bjc.2017.6.
13. Seneviratne S, Campbell I, Scott N, et al. Impact of mammographic screening on ethnic and socioeconomic inequities in breast cancer stage at diagnosis and survival in New Zealand: a cohort study. BMC Public Health. 2015 Jan 31;15:46. doi: 10.1186/s12889-015-1383-4.
14. Te Whatu Ora – Health New Zealand. Quality Improvement Review of Clinical Quality and Safety for Breast Screen Aotearoa New Zealand [Internet]. 2022 Nov [cited 2023 Jun 10]. Available from: https://www.nsu.govt.nz/system/files/resources/tewhatuora-bsa-qualityimprovementreview.pdf.
15. 15) Te Whatu Ora – Health New Zealand. Simplify to unify: Te Whatu Ora Organisation Consultation [Internet]. [cited 2023 Jun 10]. Available from: https://www.tewhatuora.govt.nz/whats-happening/consultations/simplify-to-unify-te-whatu-ora-organisation-change-overview/.

Unintended consequences of the End of Life Choice Act

Adam Sims, Gary Cheung

The *End of Life Choice Act* (the *Act*) was implemented in New Zealand in November 2021. The Act provides a medico-legal framework for terminally ill people experiencing unbearable suffering to access assisted dying. In the first year, there were 661 applications and 257 assisted deaths.[1] However, 91 people were assessed as ineligible by attending medical practitioners who reviewed eligibility against the criteria as outlined in the *Act* and the clinical outcomes of these ineligible cases are unknown.[1] We report the case of a 96-year-old man (Mr B) and 95-year-old woman (Mrs D) who attempted suicide after they were deemed ineligible for assisted dying. Both cases were admitted to a tertiary hospital in New Zealand following their suicide attempt. The first author worked as a liaison psychiatrist in the hospital and assessed both cases as part of his clinical work during the first year of assisted dying being available in New Zealand. Both cases provided informed consent to share their stories in the hope that their experiences could improve future patient care.

Case reports

Mr B's wife died 18 months prior to his presentation to hospital, and he reported feeling "lonely and desperate" since her death. As a result, he moved into residential care from independent living. He suffered from insomnia and worsening mood in the weeks leading up to his residential care placement and was prescribed melatonin and escitalopram. He requested assisted dying through his general practitioner, but this was declined because he did not suffer from a terminal illness that was likely to end his life within 6 months. He then contacted family members saying goodbye, stating he was suicidal. He was later found on the floor of his room with a call bell tied around his neck. He was transferred to hospital via ambulance for further assessment. While in hospital, he had another self-strangulation attempt using his hands. His antidepressant was switched to sertraline and his mood gradually improved. He became more animated and less hopeless in his disposition. On reflection in hospital, he reported feeling increasingly demoralised when told he was ineligible for assisted dying and this promoted his suicidal thinking. He denied past history of depression, suicide attempt or other mental health problems. He had chosen strangulation because of its "availability". He said he had not contemplated suicide before being told he was ineligible for assisted dying. Of note, his older sister suffered from depression and died by suicide in her 20s.

Mrs D lives in an independent flat with a package of care to support her needs and close oversight from family members. She has death wishes for 5 years. She approached her general practitioner about assisted dying but was deemed ineligible because she did not have a terminal illness that was likely to end her life within 6 months. She then acted to take her life by overdose after stockpiling medication. On admission to hospital, she was confused but recovered well and was discharged back home a few days later. She has been an active member of EXIT and strong advocate for end-of-life choice. She has previously considered flying to Switzerland to end her life. Of note, her brother died by suicide in his 20s. She maintained an active wish to die after discharge but made no further plans to harm herself.

Discussion

Neither of these cases were referred to the Ministry of Health's Assisted Dying Service due to their ineligible status. Both individuals were in their 90s and acted to take their life after being told they were ineligible by their general practitioner. Interestingly, they both had siblings who died by suicide in their 20s. These two cases reflect the possible unintended consequences of the *Act*. Since the *Act* is likely to have a significant societal change as assisted dying becomes "normalised" in New Zealand, it may have been a contributing factor to their openness in expressing their death wishes to their general practitioner and requesting an assisted death. There is very limited international literature on suicide attempt in the context of ineligibility for an assisted death.

In 2020, Isenberg-Grzeda et al. reported the first ever case series of three older adults in their 80s who attempted suicide after they were deemed ineligible for an assisted death in Canada.[2] All three cases had a history of depression and mild cognitive impairment, while two cases had a history of suicide attempts. The authors highlighted the time following an ineligible assisted-death assessment represents a heightened at-risk period.[2] There has also been a case report of an older Canadian man with pancreatic adenocarcinoma who requested assisted dying after a suicide attempt.[3] Our first case had a diagnosis of depression, and we can conceptualise his wish to die as part of his depressive syndrome. Our second case had chronic death wishes but no clear diagnosis of depression. She might have a subsyndromal depressive illness, but death wishes in the very old are not uncommon and could be part of an existential crisis, rather than an underlying psychiatric disorder. The limited international literature and our two cases suggest a comprehensive suicide risk assessment should routinely form part of an assisted-death assessment. The Ministry of Health has developed a care pathway for practitioners providing assisted dying services, including ensuring an ineligible person is supported to have access to primary or end-of-life care.[4] However, there is no guidance on suicide risk assessment. The management of those who are not eligible for assisted dying requires careful follow-up and treatment.

AUTHOR INFORMATION

Adam Sims: Consultant Psychiatrist, Mental Health for Older Persons Service, Te Whatu Ora, Wellington.

Gary Cheung: Consultant Psychiatrist and Associate Professor, The University of Auckland.

CORRESPONDING AUTHOR

Adam Sims: Consultant Psychiatrist, Mental Health for Older Persons Service, Te Whatu Ora, Wellington. E: adam.sims@mhaids.health.nz

REFERENCES

1. Manatū Hauora – Ministry of Health. Assisted Dying Service Data and Reporting: Assisted Dying Service yearly report 2021/2022 [Internet]. [cited 2023 Apr]. Available from: https://www.health.govt.nz/system/files/documents/pages/assisted-dying-1-year-report-2023-26apr23.pdf.

2. Isenberg-Grzeda E, Bean S, Cohen C, Selby D. Suicide Attempt After Determination of Ineligibility For Assisted Death: A Case Series. J Pain Symptom Manage. 2020 Jul;60(1):158-163. doi: 10.1016/j.jpainsymman.2020.02.016.

3. Nayyar D, Kawaguchi S, Mah B. Request for medical assistance in dying after a suicide attempt in a 75-year-old man with pancreatic adenocarcinoma. CMAJ. 2019 Jul 29;191(30):E838-40. doi: 10.1503/cmaj.190175.

4. Manatū Hauora – Ministry of Health. Assisted dying care pathways for health practitioners: Supporting information guide [Internet]. 2021 Sep [cited 2021 Sep]. Available from: https://www.health.govt.nz/system/files/documents/pages/3-assisted-dying-care-pathways-sep21_0.pdf.

Cancer of the Breast
I. Operative Treatment

NZMJ, 1923

In this paper I propose to deal briefly with the operative treatment of cancer of the breast. I am taking it for granted that in the present state of our knowledge and experience the radical operation gives the victims of cancer of the breast the best chance of permanent cure, that is, in what may be called operable cases. The paper will also include the procedure to be adopted in doubtful cases, as well as palliative operations and the treatment of recurrence.

I do not propose to enter into any details of surgical anatomy beyond dwelling for a short time on the lymphatic circulation. *Handley's* permeation theory is largely responsible for the details of the modern operation and it will not be waste of time to recapitulate it.

The lymphatics of the breast run for the most part into the plexus on the deep fascia over the pectoralis major. This plexus, in the words of *Handley*, "is really a conventional subdivision of the deep fascial lymphatic plexus whose network of inter-communication channels invests the entire body. This great plexus is divisible by the median plane of the body, and by two horizontal planes, passing through the clavicles, and through the umbilicus respectively, into six catchment areas, three on either side, draining, as the case may be, into the cervical, the axillary, or the inguinal glands. Within each area a set of special trunk lymphatics arises from the plexus and converges on the corresponding set of glands. The line, or rather zone, separating any two adjacent areas may be called the lymphatics water-parting, and is anatomically a zone of narrow tortuous channels nowhere traversed by trunk lymphatics, a region consequently where the lymphs stream is at its feeblest and where even very fine particles are liable to be arrested.

"The general idea, then, which we have obtained of the parietal lymphatic system is that of a vast horizontal network of the channels co-extensive with the surface of the body and receiving above, numberless fine vertical tributaries which convey to it must include the breast. On its deep aspect the plexus receives tributaries from the subjacent tissues. From this great plexus, which lies in the subcutaneous fat upon the deep fascia, the lymph is conveyed by six set of lymphatic trunks each draining a definite area to the cervical, axillary, or the inguinal glands."

The lymphatics of the breast, then, run mainly via the pectoral fascia into the axillary glands, but the anastomosis we have been describing brings them into close communication with the lymphatics of the opposite breast and the opposite pectoral fascia, and by that means with the opposite axilla.

In all probability some lymphatics run direct to the supraclavicular glands, others, following the main blood supply of the breast, run with the perforating branches of the internal mammary artery to the anterior mediastinum, joining the few glands situated there. Of much more importance is the close connection which occurs between the superficial lymphatics on the one hand and those of the thorax and abdomen on the other, which occurs in the neighbourhood of the umbilicus and epigastric notch.

So much for the lymphatic circulation. *Handley* summarises his conclusions about the spread of cancer as follows:—"Dissemination is usually accomplished by the actual growth of cancer cells along the finer vessels of the lymphatic plexuses—permeation. Embolic invasion of the regional lymphatic glands, though it almost invariably occurs, only leads to the invasion of the blood stream after a long delay, and the work of M. B. Schmidt shows that cancer cells which reach the blood usually disappear without giving rise to metastases. Permeation takes place almost as readily against the lymph stream as with it. It spreads through the lymphatic vessels around the primary neoplasm in much the same way as would a thick injection fluid introduced into the tissues by a syringe.

"The disappearance of permeated lymphatics in the area which intervenes between the annular microscopic growing edge and the primary neoplasm is due to the destruction after a time of the cancerous permeated lymphatics by the defensive process of 'perilymphatic fibrosis.' The recognition of this process at once removes the difficulty

that permeated lymphatics are absent in the region immediately surrounding the naked eye primary growth. Cancer thus spreads in the parietal tissues by permeating the lymphatic system like an annular ringworm. The growing edge extends like a ripple in a wider and wider circle within whose circumference healing processes take place so that the area of permeation at any one time is not a disc but a ring. The spread of cancer in the parietal tissues is in fact as truly a serpiginous process as the most typical tertiary syphilide. But in the case of cancer the spreading edge is invisible; and, moreover, the advancing growing microscopic edge of a cancer, owing to the failure at isolated points of the defensive process of perilymphatic fibrosis, may leave in its track here and there isolated secondary foci which give rise to macroscopic metastases. Such nodules, in spite of their apparent isolation, arise in continuity with the primary growth, but perilymphatic fibrosis has destroyed the permeated lymphatics which formed the lines of communication."

Hence the necessity for the wide removal of the deep fascia. Whether or not the invasion of the axillary glands is the starting point for further spread is a debateable point. *Sistrunk* has shown in a careful analysis of the results of 218 operations for cancer of the breast at the *Mayo Clinic* during the years 1911-12-13, that 80 per cent. of those showing local recurrences has been proved to have invasion of the axillary glands at the time of original operation. It may well be that the involvement of the axillary glands is only another indication of the widespread dissemination which has already occurred along the peripheral lymphatic plexus. The prognosis in these cases is bad. *Sistrunk* shows that the large majority of them are dead within five years.

Diagnosis is not included in my contribution to this discussion, but I should like to enter a plea for the necessity of at once coming to a decision. It cannot be too often or too emphatically stated that no palpable tumour of the breast should be watched. If the diagnosis is uncertain, the sooner it is made certain the better, and at present the only way to do that is to operate on it. The mortality from cancer of the breast is still too high, even though there has been a slight improvement of late years. The ignorance of the public is partly responsible. Many cases of cancer are painless until a late stage. We shall have to keep on educating the public until at least it will not be the patient's fault if she does not have her operation done at the earliest possible moment.

I am afraid we are sometimes to blame for the delay ourselves. We make mistakes in diagnosis. These mistakes do not matter if the treatment is to be exploratory, but if, being uncertain, our advice is to wait and see, we incur a very grave responsibility. We may bitterly repent giving that advice later on. At the same time accurate diagnosis is difficult. *McCarty*, in an analysis of 1373 cases of cancer and mastitis, found that mastitis was correctly diagnosed in 37 per cent. In 63 per cent. the diagnosis depended on the microscope. Similarly there was a clinical diagnosis of involvement of the axillary glands in 325 cases. Of these only 37 per cent. proved to be actually carcinomatous.

There are some factors which are beyond our control in this cancer business. Amongst them is the question of virulence. We must have all met with cases which seemed early, in which the most careful and thorough operation was performed, and yet which quickly recurred and led to the early death of the victim. On the other hand details of many cases have been published which have been regarded as almost inoperable, but yet palliative or incomplete operations have been done with the result that the patients have been given many years of comparative health.

In the treatment of doubtful cases there is need for the close association of the surgeon and surgical pathologist. I do not know how often in our large centres fresh tissue is examined microscopically during the operation. I have noted the want of it in Timaru on more than one occasion. We cannot help lessening the patient's chances if we remove a piece of growth and send it away to a distance for a pathologist's report. No matter what you do, cauterize the wound with a red hot poker, sew the edges ever so carefully, there must be a flush of blood to the damaged area which carries with it an increased lymph flow. The problem in the large centres is not so difficult as it is for the smaller ones. There was hope that in Timaru we should have organised our hospital service so as to include a pathologist. Instead, the South Canterbury Hospital Board has seen fit to dispense with the services of its honorary staff and to carry on the hospital as a one-man show. Other hospital boards may follow suit.

It ought not to be difficult, if we could only combine a little more and limit the number of private hospitals and concentrate on one good one in each town which would have facilities for elementary pathological work and radiological

treatment if necessary. There would probably not be room for a resident pathologist, but it would be quite possible for one or two of the practitioners to acquire sufficient skill in cutting frozen sections and in coming to a sufficiently accurate idea as to the diagnosis.

McCarty, from the standpoint of the surgical pathologist, as one who is well acquainted with the activities of both surgeon and surgical pathologist, advises the following procedure:—

1. The condition in the breast which is associated with classical signs of carcinoma should be treated radically.
2. In doubtful cases, in women *near* or *over* 35, the entire mammary gland should be removed for immediate examination. If the primary or secondary hyperplasia be present nothing more should be done. If tertiary hyperplasia be present, a radical operation should be performed.
3. In doubtful cases *near* or *under* 35 years of age, a wide sector of the mammary gland, including the pathological conditions, should be removed for examination. If primary hyperplasia be present nothing more should be done. If secondary hyperplasia be present the rest of the mammary gland should be removed, and if tertiary hyperplasia be present the radical operation should be accomplished.

In not a few tumours of the breast the lump turns out to be a cyst. True the cyst often contains a papilloma and such papillomata are often malignant. Cyst formation is a fortunate occurrence. Some of the earliest cases of cancer observed have been associated with cyst formation. In any doubtful case I see no reason why a hypodermic needle should not be used *at the operation* to determine whether fluid is present or not. If the fluid is serous you will probably be safe in removing a wide sector of the breast and submitting it to microscopic examination. If it is hæmorrhagic, and you have no pathologist present to advise you, it will be better to do the radical operation.

Cheatle removes the doubtful breast through a transverse convex incision below the nipple. The incision is extended into the axilla and the principal glands are removed, but a complete clearance is not done unless the microscope shows malignancy. He leaves the nipple for sentimental reasons, a step of doubtful utility.

The skin is dissected up above and below, the nipple being carefully dissected out. The breast is then removed, together with the pectoral fascia and the main glands of the axilla. If the nipple is not conserved two elliptical incisions enclosing the nipple will give the best access. There will be no difficulty in getting the flaps together.

Another method, described in an article by *Fitzwilliams* in the *British Medical Journal* for the 20th Jan., 1923, attacks the tumour from the deep aspect of the breast. An incision is made along the circumference of the breast on the lower and outer sides, extending about half-way round and going at once down to the muscles. The breast is then lifted up and the deep surface exposed. The whole of it can be removed in this way or a sector large enough to contain the part to be examined.

Into all the questions which centre round the radical operation for the removal of a malignant growth it will be impossible to for me to enter in the short time at my disposal. I shall content myself with indicating certain principles and describe the procedure which has seemed to me to promise the best results. I can speak of it from my own experience.

The popular idea of cancer with its roots going deeply into the surrounding tissues has much to justify it. We have to endeavour to remove that growth in a bag, and in doing so we have to close the neck of the bag first and then carefully turn up the edges all round, realising that the bag is to be a big one and is never to be opened anywhere so that not a single particle of the contents escapes. Unfortunately for us and our victims the roots are invisible. We can only do our best.

Handley's ideal skin to removed must be the minimum. A circular area centred on the growth, not on the nipple, with a diameter of four to five inches. No consideration of difficulty in closing the wound to be allowed to interfere. Very much more important still is the area of deep fascia to be removed. This can scarcely be too wide. If *Handley* is right, and it is difficult to disprove his idea, this is where the growing edge is. We must get outside of it at all costs if we want to overtake the disease and arrest it before it causes fatal metastases.

There are numerous incisions described. The essentials are the circular area to be removed, a linear incision from its lower edge down to the mid-line or across it in the epigastric region, and an upward incision, which should not run along the anterior axilla fold but which may mark out a

flap to give access to the axilla. Whatever incision is chosen should be lightly marked out as this is the first step of the operation.

Next, the upper part of the incision is deepened, reflecting the skin with a thin layer of fat until the clavicle is reached above and internally, and the latissimus dorsi is well exposed behind.

A little dissection soon exposes the tendon of the pectoralis major, which is divided close to its insertion. Its upper edge is then cleared, taking care not to damage the cephalic vein, and its clavicular attachment divided, after which the muscle is turned downwards and inwards. I believe it is better to take away the whole of the pectoralis major. Access to the axilla is much improved and the functional results are quite good as those in which the clavicular fibres have been left.

The fascia over the coraco-brachialis is next incised up to the coracoid process, and the tendon of the pectoralis minor divided after hooking the finger under it. By attaching catch forceps to the divided fascia and tendon of the pectoralis minor it is possible to clear the axillary vessels and brachial plexus with very little trouble. Gentle traction on the forceps helps considerably, and by working behind the fascia with a pair of *Mayo's* scissors one is keeping outside the bag in which the tumour lies. The same principle is followed in separating the fascia over the latissimus dorsi from its dorsal to its ventral surface, and this is succeeded by that over the subscapularis muscle, and finally that over the upper part of the serratus magnus. It is important to save the long subscapular and long thoracic nerves, and when they are exposed they are dissected out and the fascia passed under them. The axilla is by this time completely cleared. Only the two nerves saved and the axillary vessels and brachial plexus remain as the contents of the space. A gauze pack is put into the axilla whilst the axillary fat and glands are wrapped in another to prevent soiling of the wound.

Turning now to the breast, the previously marked out incisions are deepened, the knife lateralized and the skin reflected with a thin layer of fat until the opposite border of the sternum is reached internally and well beyond the epigastric triangle below. The skin flaps are everywhere wrapped in warm cloths to protect their vitality.

The deep fascia is now incised along the opposite margin of the sternum, and, putting the breast and axillary tissues gently on the stretch, the fascia is raised, taking with it the origins of the pectoralis major and minor muscles working from above down and out. Perforating branches of the arteries are caught before being cut if possible. The rectus sheath on both sides is incised and raised, followed by the fascia over the external oblique muscle. Finally the fascia over the rest of the serratus magnus remains to be separated and the tumour is free. Time is of less importance than loss of blood, and it is worth while to stop as much bleeding as possible.

As a rule the skin edges come together without much difficulty. It is better to have a sinuous or triradiate scar than a linear one. Drainage is provided by a stab puncture through the lowest angle of the wound. The arm is fixed to the side. A large gauze dressing is placed in the axilla and another pad under the clavicle. It is important to obliterate the dead space there and prevent accumulation of serum, and to get the flaps to adhere at once to the underlying chest wall. This is secured by adequate dressing, gentle pressure by bandage, and above all by preventing all movement of the arm for some days. No advantage is gained by putting the arm up in the abducted position.

Such is the radical operation. Burying radium tubes at the danger points, as described by *Handley*, is beyond the range of most of us. Unless there are palpable supra-clavicle glands it would seem that it is unnecessary to interfere with them at this time. As soon as possible after the operation X-ray treatment should be begun. In the ideal private hospitals I have visualised the X-ray plant will be on the spot. At present we have to wait in many cases until the patient is convalescent.

I have been much troubled with sloughing of the edges of the flaps. Perhaps some one can tell us how it is to be avoided. It causes an unfortunate delay in convalescence and may lead to some adhesion of the skin to the chest wall, thereby hampering movements.*

(*Of the many descriptions of the operation that by *Lyle* in *Johnson's Operative Therapeusis* is, I think, the best.)