Making the next steps the right ones: progress towards the Smokefree Aotearoa 2025 Goal

Pregnant women lack accurate knowledge of their BMI and recommended weight gain during pregnancy

Smoking prevalence in New Zealand from 1996–2015: a critical review of national data sources to inform progress toward the Smokefree 2025 goal
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Smoking prevalence in New Zealand from 1996–2015: a critical review of national data sources to inform progress toward the Smokefree 2025 goal

Jude Ball, James Stanley, Nick Wilson, Tony Blakely, Richard Edwards

The New Zealand Government has committed to a goal of becoming a smokefree nation by 2025. This study analysed findings from the Census, the New Zealand Health Survey and the Health and Lifestyles Survey to assess progress towards the smokefree goal. The findings show that recent declines in smoking are modest, and are clearly inadequate for achieving the Smokefree 2025 and interim 2018 goals, particularly for Māori and Pacific peoples. Māori and Pacific smoking rates remain unacceptably high, and urgent action is needed to reduce the health burden of tobacco on these communities.

The All New Zealand Acute Coronary Syndrome Quality Improvement Programme: Implementation, Methodology and Cohorts (ANZACS-QI 9)

AJ Kerr, MJA Williams, S Harding, H White, RN Doughty, C Nunn, G Devlin, C Grey, M Lee, CF Flynn, MR Rhodes, K Sutherland, S Wells, RT Jackson, RAH Stewart, on behalf of the ANZACS-QI investigators

There is a formidable evidence base supporting the use of a range of lifestyle, pharmaceutical and interventional treatments to improve outcomes in patients with heart attacks. However, in practice, there is often a substantial gap between ideal treatment based on clinical trials and what is achieved in practice. The identification of these evidence-practice gaps, and the implementation of programmes to close them, represent an important opportunity to improve the outcomes of patients with CVD in New Zealand. The All New Zealand Acute Coronary Syndrome Quality Improvement programme (ANZACS-QI) has recently been implemented in 41 NZ public hospitals to support appropriate, evidence based management of ACS and subsequently of other cardiac patients regardless of age, sex, ethnicity, socioeconomic status, or rural or city dwelling. In this report we describe the development and national implementation of ANZACS-QI, its governance, the data collection processes and the current ANZACS-QI cohorts and available results.

Pregnant women lack accurate knowledge of their BMI and recommended gestational weight gain

Emma Jeffs, Jillian J Haszard, Benjamin Sharp, Joanna Gullam, Helen Paterson

This study indicates that New Zealand women, particularly those who are overweight and obese, are unaware of their own body size, and this may lead to an under or over-estimation of the right amount of weight they should gain in their pregnancy, which may in turn lead to increased risk of poor health outcomes for both mother and baby. Public Health campaigns, related to healthy weight gain in pregnancy, similar to those aimed at giving up smoking in pregnancy, are urgently required.

Smoking in cars: knowledge, behaviours and support for smokefree cars legislation among New Zealand smokers and recent quitters

Judy Li, Sarah Nelson, Rhiannon Newcombe, Darren Walton

This study fills the information gap around smoking in cars, by providing a more complete picture of the attitudes and behaviours of smokers and recent quitters. The findings noted that smoking in cars is still a problem in New Zealand. This problem could possibly be addressed through new health promotion messages to improve understanding of the health risks caused by smoking in cars, or through legislation. In fact, a large majority of respondents in this study supported banning smoking in cars while children are in them.
Improved scores for observed teamwork in the clinical environment following a multidisciplinary operating room simulation intervention

Jennifer Weller, David Cumin, Ian Civil, Jane Torrie, Alexander Garden, Andrew MacCormick, Nishanthi Gurusinghe, Matthew Boyd, Christopher Frampton, Ludvig Selander, Martina Cokorilo, Magnus Tranvik, Lisa Carlsson, Tracey Lee, Wai Leap Ng, Michael Crossan, Alan Merry

Failures in teamwork and communication are a contributing factor in the majority of unintended events causing patient harm. To address this, we provided team training for 20 complete general surgical teams from two large metropolitan hospitals in the Multidisciplinary Operating Room Simulation (MORSim) course. To evaluate if this team training was effective, we observed operating room teams in over 200 cases before and after the training, and scored teamwork performance. We found a significant improvement in teamwork scores following MORSim. Previous research suggests this would translate to a clinically important reduction in patient harm for surgical patients. On the basis of these findings, ACC has provided funding for the national roll out of MORSim in every public hospital in New Zealand.

Key design features of a new smokefree law to help achieve the Smokefree Aotearoa New Zealand 2025 goal

Louise Delany, George Thomson, Nick Wilson, Richard Edwards

University of Otago researchers propose a comprehensive new law to help New Zealand reach the government's Smokefree 2025 goal. The law would require all those dealing with tobacco to be licensed, and the makeup of tobacco products (for instance, flavours and sugar) would be controlled. If smoking prevalence targets relevant to the 2025 goal are not reached, tobacco sales would be moved to non-commercial agencies.

‘Poorly defined’: unknown unknowns in New Zealand Rural Health

David Fearnley, Ross Lawrenson, Garry Nixon

Ensuring equity of access to health services and outcomes for rural people in NZ is compromised by the Statistics NZ definition of rurality which is not suitable for the purposes of health research. The geographic definition does not take available health services into account and so the population defined as “rural” differs from that which actually receives rural health care. Around 40% of the people who actually access rural health services are currently classified as “urban”, and 20% of those defined as “rural” actually receive urban health care. The extent of this mismatch masks any inequality in health care access or outcomes that may exist and hampers all current and future research. Rural versus urban disparities in both access to health services and in health outcomes are well recognised in other similar countries. It is quite likely these same disparities exist in NZ but we don't have the tools to uncover and describe them. Until we can identify these disparities we won't see rural healthcare policy to address them. We are proposing a “fit for purpose” definition of rurality for rural research, and to use this definition to analyse current health data to better understand rural health in NZ. Rural healthcare research in NZ is a very undeveloped field.
Making the next steps the right ones: progress towards the Smokefree Aotearoa 2025 Goal

Judith McCool, Chris Bullen

It was certainly an exciting challenge: reducing tobacco prevalence to 5% or less within our population by 2025. The prospect of New Zealand, once again, leading the way internationally on tobacco control reinvigorated local advocacy efforts and brought a new focus to tobacco control research (Ministry of Health, 2011). The challenge was generally accepted to be optimistic, but with the right measures implemented in a timely way, entirely feasible.

However, 5 years after setting the 2015 goal, tobacco smoking remains sharply delineated along lines of ethnicity and socioeconomic position.1 How this came to be is another story. Reflecting on the tobacco control articles in this issue of the New Zealand Medical Journal, a number of facts are clear: tobacco use is not declining among the populations who smoke the most (Māori, Pacific, people on low incomes, people with mental health conditions); despite public information campaigns about the hazards of smoking in cars, it is still occurring; robust legislation remains a vital tool for leveraging meaningful actions for reducing tobacco use.

With a fast approaching Smokefree Aotearoa 2015 deadline, the next steps will be critical.

Novel and innovative approaches will be needed to address the discrepancies in these declining rates. Robust evaluation will provide evidence at the appropriate level.

Evidence-based interventions should be central to what happens next. However, as Ball and colleagues point out, we lack specificity of evidence to on the cultural antecedents to tobacco use and quitting. As a result, some tobacco control interventions designed to reduce tobacco use are more equal than others. Most starkly, expected declines in tobacco use for Māori and Pacific people have not been achieved as projected, nor will they be unless a different approach is undertaken. In essence, just when we need to get down to specifics, our tools are found to be too blunt or simply not fit for purpose.

Better tracking systems are needed. Repeated cross sectional surveys are a pragmatic, constructive approach to establish consistent measures, over time, of a population in a state of change.5 An example of this approach, applied with some success, is the UK Smoking Toolkit Study (STS), a monthly survey of smokers in the UK. The STS provides data, over time, on smoking prevalence and behaviour. The benefit of this approach is that it is regular, methodologically consistent, and can track group changes in response to shifts in policy and other interventions. Ball and colleague’s analyses alert us to the risks of relying on omnibus or periodic surveys with significant or unpredictable time lapses between measures.

In this issue, we see further evidence of the feasibility of introducing a ban on smoking in cars as a means of protecting children from second-hand smoke. There is no doubt better protection for New Zealand children is a priority, and there is merit in enforcing smokefree environments. Yet, in respect to making real gains in reducing tobacco use, could efforts to eliminate smoking in cars be missing the real issue? Radically reducing tobacco use will lower the amount and frequency of smoking in cars, regardless of who is
present in the vehicle. Overall reduction in prevalence will be the result of a combination of efforts. Real, sustained achievements in promoting quitting and halting uptake will result from identifying, trialing and scaling up those initiatives that redefine being smokefree.

The idea of a Tobacco Control Act with a Tobacco and Nicotine Authority dedicated to the enforcement of the legislation has been advanced as a mechanism to achieve the 2025 goal. Although high level political support and dedicated taxes are essential for a successful tobacco control programme, is a completely new Act necessary and feasible? In other jurisdictions, dedicated tobacco taskforces or authorities have been proposed, but raise concerns about the risk of excess cost and bureaucracy. In the spirit of ensuring equitable and effective use of resources, why not make the best of the legislation at hand, while at the same time identifying and investing in initiatives that better engage those groups that need the most support to become ex-smokers? Thomson-Evans’ innovative trial of Tauhere Ringaringa (hand ties) as a means of connecting Māori with the traditional ritual of quitting tobacco is a good example.4 Ad hoc, bespoke initiatives alone are insufficient, but investing in the scale-up of innovative strategies for engaging Māori, Pacific and other risk groups is likely to be a worthwhile investment. With evidence, tracked via sharper monitoring tools, we will be in a better position to recognise and nurture the emergence of social changes that will lead to smoking becoming a thing of the past for all New Zealanders.

**REFERENCES:**


Pregnant women lack accurate knowledge of their BMI and recommended weight gain during pregnancy

Karaponi Okesene-Gafa, Lesley McCowan

In the survey by Jeffs et al in this issue of the New Zealand Medical Journal, of 644 pregnant women in the South Island of New Zealand, 66% accurately reported, 31% underestimated and 3% overestimated their body mass index (BMI)—defined as weight/height. Of concern is that overweight and obese women in this study were more likely to underestimate their BMI, a finding that is commonly reported in the literature. Participants in this study were predominantly of New Zealand European ethnicity and the majority were also highly educated. Hence, the generalisability of these findings to multi-ethnic settings in New Zealand is uncertain. Pregnant women in areas of low health literacy and high deprivation may have lower rates of correctly self-reporting their BMI. A survey we had carried out in South Auckland region of 422 multi-ethnic women in pregnancy showed that overweight and obese women tended to perceive themselves to be lighter on the figure rating scale. It is also of concern that high BMI may be considered “normal” by some groups in New Zealand, where extreme obesity is common, and by some ethnic groups, especially Pacific. For example, it is frequently verbalised by clinicians at Middlemore Hospital in South Auckland that a woman with a BMI of 30–35 kg/m² admitted in labour is considered to have a “normal” BMI, because this BMI is the average in this community.

BMI should be calculated from a measured maternal weight (in early pregnancy, preferably in the first trimester) and measured height. BMI calculated from self-reported weight or height is often inaccurate, with women tending to underestimate weight and overestimate height resulting in a lower BMI which has implications for clinical practice.

Only 31% of women surveyed in this study were able to correctly report their recommended weight gain in pregnancy. The Institute of Medicine (IOM) have recommended optimum pregnancy weight gain throughout the whole of pregnancy according to maternal BMI. Recommended weight gains are: underweight (BMI <18.5 kg/m²), normal weight (BMI 18.5–24.9 kg/m²), overweight (BMI 25–29.9 kg/m²), obese (BMI≥30) were 12.5–18 kg, 11.5–16 kg, 7–11.5 kg, and 5–9 kg, respectively.

Excessive weight gain in pregnancy greater than that recommended by the IOM is associated with increased risks of adverse pregnancy outcomes, namely gestational diabetes, preeclampsia, delivering large for gestational age babies, and caesarean in labour independent of maternal BMI. New Zealand data are limited, but excessive weight gain in pregnancy was reported in approximately 70% of women in their first pregnancy participating in the Screening for Pregnancy Endpoints (SCOPE) study. In this study, overweight and obese women were more likely to gain excessive weight during pregnancy when compared to normal weight women.

The low number of women surveyed by Jeffs et al who correctly estimated their optimum gestational weight gain according to their BMI, suggests that there is a general lack of knowledge in women about...
recommended weight gain during pregnancy. The authors are probably correct in extrapolating their study findings to New Zealand as a whole, and suggesting that many pregnant women in New Zealand do not know their BMI and also do not know the amount of weight they should gain during pregnancy.

Furthermore, women with excessive gestational weight gain are at risk of retaining the excess weight postnatally. They are less likely to lose weight between pregnancies, and may enter further pregnancies more overweight or obese. This further compounds the associations between maternal obesity and offspring metabolic dysfunction. The offspring of mothers with excessive gestational weight gain have increased BMI, blood pressure and abnormal metabolic profile in early adult life.7

The findings from this study support the need to strengthen health messages for pregnant women in New Zealand about the importance of optimal weight gain during pregnancy. Achieving weight gain within the IOM guidelines can improve health outcomes for both mothers and babies. A recent Cochrane review8 showed that diet, exercise, or both reduced excessive gestational weight gain by 20%. There was also a 15% reduction in risk of foetal macrosomia in obese pregnant women. Other beneficial outcomes included a reduction in maternal hypertension, caesarean births, and neonatal respiratory distress syndrome. By weighing women early in pregnancy, weight gain can be monitored by weighing at antenatal visits and plotting the weight gain on the chart developed by the New Zealand Ministry of Health “Guidance for Healthy Weight Gain in Pregnancy”.9

The implementation of gestational weight gain guidelines in practice, however, is challenging. Plotting weight may assist women to keep track of their weight and to modify their dietary intake and physical activity. A recent feasibility randomised trial has demonstrated that regular weighing, plotting weight on a chart, and providing feedback about weight gain is acceptable to pregnant women.10 There was a trend to reduced excessive weight gain in women who were randomised to regular weighing and plotting weight, and a large trial is now planned.

As obese women are more likely to gain an excessive amount of weight during pregnancy than non-obese women, there is a need for effective and reproducible interventions in these women.11 With this in mind, a group of New Zealand researchers are trialling dietary education (provided by community health workers) along with probiotics/placebo in obese pregnant women in South Auckland. The aim is to reduce excessive pregnancy weight gain and optimise weight of the baby—see the HUMBA (Healthy Mums and Babies) randomised controlled trial, www.humba.ac.nz. It is also planned to follow these women and children long-term to monitor the later health effects of the dietary education and probiotic treatments. If health benefits are demonstrated, these interventions have been designed to be applicable to clinical practice.

The lead maternity carer system in New Zealand means that the majority of pregnant women receive their antenatal care provided by a self-employed midwife. A smaller proportion receive their antenatal care provided by the hospital/District Health Board, a private obstetrician, or through sole or shared care with a general practitioner. The onus is therefore on all health care professionals providing care to women in pregnancy to have adequate knowledge about healthy nutrition and healthy weight gain in pregnancy, and to be able to counsel pregnant women in their care. The Liggins institute (Gravida) offer free courses and on-line education for health professionals on “healthy conversations”.12 These tools have been developed to assist women to set achievable goals around healthy eating, and aim to stay within recommended weight gain in pregnancy. The New Zealand National Heart Foundation also provide Certificate in Nutrition courses,13 which include healthy nutrition during pregnancy for health professionals, community health workers, or community members interested in helping their communities to eat healthy. These multipronged approaches may help to improve nutrition literacy and support New Zealand women to eat healthy and keep to recommended weight gain in pregnancy.
REFERENCES:


Smoking prevalence in New Zealand from 1996–2015: a critical review of national data sources to inform progress toward the Smokefree 2025 goal

Jude Ball, James Stanley, Nick Wilson, Tony Blakely, Richard Edwards

ABSTRACT

AIM: The New Zealand Government has committed to a goal of becoming a smokefree nation by 2025. This study analysed recent smoking trends using three national data sets to: i) assess progress towards the smokefree goal; and ii) critically evaluate New Zealand’s main national-level data sources on smoking prevalence for measuring progress towards the Smokefree 2025 goal.

METHODS: Trends in adult (age 15+) daily smoking prevalence from 1996 to 2015 were compiled from three data sources: the New Zealand Census, the New Zealand Health Survey (NZHS), and the Health and Lifestyles Survey (HLS). We compared key features of the surveys (eg, sample size, ethnicity classification), examined composite trends across surveys, and analysed differences between and within surveys over time.

RESULTS: Both the Census and the NZHS show a decline in adult (age 15+) daily smoking over the past 18 years, from 23–25% in 1996/97, to around 15% in 2014/15, with broadly consistent findings from the HLS since it began in 2008. However, recent NZHS findings do not suggest substantive reductions in daily smoking prevalence, particularly for Māori and Pacific populations, with 2014/15 rates of 35.5% and 22.4% in these populations respectively, and no statistically significant change since 2006/07. NZHS has advantages over the New Zealand Census and the HLS for the purposes of monitoring annual progress towards the Smokefree 2025 goal.

CONCLUSION: These data collectively suggest that recent declines in smoking prevalence are modest and clearly inadequate for achieving the Smokefree 2025 and interim 2018 goals, particularly for Māori and Pacific peoples. Continuation and improvement of tobacco-related surveillance is crucial for monitoring progress toward the 2025 goal.

Smoking is the single biggest preventable risk factor for premature death and morbidity in New Zealand, with Māori and Pacific peoples disproportionately affected.1 In March 2011, in response to the recommendations of the Māori Affairs Select Committee,2 the New Zealand Government committed to becoming an essentially smokefree nation with minimal smoking levels and tobacco availability by 2025.3 This was seen as a major victory for public health, and temporarily put New Zealand at the forefront of tobacco control globally.

The Government subsequently set interim goals to be achieved by 2018: i) daily smoking prevalence must fall to 10% overall, and ii) the Māori and Pacific rates should have halved from their 2011 levels, ie, to no more than 19% for Māori and 12% for Pacific peoples.4

Given this background, this paper reviews trends in smoking prevalence from 1996 to 2015, based on three national data sets. We aimed to answer the following questions:

1. Do the various surveys present a consistent picture about smoking
trends in the adult population and by ethnicity?

2. What are the strengths and weaknesses of current national data sources for monitoring progress towards the Smokefree 2025 goal?

3. What do the figures tell us about progress towards the Smokefree 2025 goal, and 2018 interim goals?

Method

The current study reviewed time trends in tobacco use among adult (age 15+) New Zealanders, using repeated cross-sectional survey data from the public domain. The key data sources for the 1996–2015 period were the New Zealand Census (Census) conducted by Statistics New Zealand, which included questions on tobacco use in 1996, 2006, and 2013; the Ministry of Health’s New Zealand Health Survey (NZHS) which was conducted in 1996/7, 2002/3, 2006/7 and as a rolling study since 2011/12 (reporting annually); and the Health and Lifestyles Survey (HLS) conducted by the Health Promotion Agency (HPA) every 2 years since 2008.

All three surveys measure smoking behaviour in adults aged 15+, using approximately comparable questions and definitions for daily smoking (see Table 1). Daily smoking is the primary prevalence measure used in the current paper because it is the only measure comparable across all three data sources.

We sourced Census and HLS data from the Health Promotion Agency’s online tobacco control data repository, and NZHS data from the Ministry of Health website. Overall, adult daily smoking prevalence (unadjusted) for the 1996–2015 period was plotted, and the findings from the three surveys compared. We also plotted prevalence by ethnicity (Māori, Pacific, Asian and European/Other), where this was available in the public domain. In Figures 1 and 3 (overall and by ethnicity), a smoothed trend in smoking rates over time has also been plotted (indicated with dashed lines) to give a composite trend based on all of the reported data sources. These trends were calculated using restricted quadratic spline fits, with the fitting of the lines weighted by the inverse variance of the estimates (i.e., the more statistically precise data sources have a higher weighting in determining the shape of the line). The variances were derived from the reported confidence intervals for each data source. For the 1996/97 and 2001/02 NZHS data (for which no confidence intervals are reported in public domain documents) the inverse variance weight for the total was set to 5 (based on weightings for subsequent iterations of the NZHS); for the Census (which has no sampling variability, by definition), an arbitrary inverse weight was set at 10 for the overall trends (taken as double the weight of the NZHS estimates, as the most statistically precise survey tool here).

For the ethnicity-specific trend estimates (Figure 3), the weight for the Census estimates was set separately for each ethnic group (again, as double the weight for the most precise NZHS estimate for that ethnic group.) In all figures, the x-axis (time) position of data points is positioned as follows: for the Census at 1 March (since Census dates across this period were in early March); for the NZHS, at 1 January as the midpoint of the data collection period (e.g., for the 2006/2007 NZHS, the midpoint is January 1, 2007); and for the HLS, at 1 July (field dates generally from May to August).

Results: appraisal of data sources

Definition of ‘smoking’

The survey questions used to derive smoking prevalence for each survey are provided in Table 1. The Census includes manufactured cigarettes and loose tobacco (‘rollies’) in its definition, and excludes cigars and pipes, marijuana and other smoked non-tobacco products in questions about current smoking. Use of non-smoked tobacco products (e.g., chewing tobacco) and passive smoking are also specifically excluded in the Census definition.

The NZHS definition of smoking changed between 2002/03 and 2006/07. Up until 2006/07, the survey asked “Do you smoke one or more tobacco cigarettes a day?” and was therefore in line with the Census definition. From 2006/7, the first question in the tobacco section has been “Have you ever smoked cigarettes or tobacco at all, even just a few puffs? Please include...
pipes and cigars.” Presumably the prevalence question that follows (“How often do you now smoke?”) also includes pipes and cigars, although this is not explicitly stated in the interview schedule. Given the NZHS seems to include daily pipe and cigar smokers and the Census does not, the NZHS prevalence estimate in 2006/07 and subsequent years is likely to be inflated compared with the Census. However, findings from the NZHS suggest that the prevalence of pipe or cigar smoking is low, at less than 2% in 2012/13. Therefore, the systematic difference between the NZHS and Census since 2006/07 is likely to be negligible.

Other key aspects of survey design for the Census, NZHS and HLS are shown in and discussed below.

### Table 1: Smoking prevalence questions in major New Zealand based surveys.

<table>
<thead>
<tr>
<th>Survey</th>
<th>Question wording</th>
<th>Response categories</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>NZ Census</td>
<td>Do you smoke cigarettes regularly (that is, one or more a day)?</td>
<td>Yes, No</td>
<td>Same wording in 1996, 2007, 2013.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Census definition of ‘regular’ smoking is equivalent to ‘daily smoking’ in the NZHS and HLS surveys.</td>
</tr>
<tr>
<td>NZHS</td>
<td>How often do you now smoke?</td>
<td>You don’t smoke now, At least once a day, At least once a week, At least once a month, Less often than once a month</td>
<td>The answer options are provided on a showcard, and read out by the interviewer.</td>
</tr>
<tr>
<td></td>
<td>(2006/7, 2011/12, 2012/13, 2013/14, 2014/15)</td>
<td></td>
<td>This question is only asked of those who have smoked 100+ cigarettes in their life.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Different question phrasing and answer profile in 1996/97 and 2002/03: “Do you smoke one or more tobacco cigarettes in a day?”</td>
</tr>
<tr>
<td>HLS</td>
<td>Looking at Showcard [Tx], which best describes how often you smoke tobacco now?</td>
<td>At least once a day, At least once a week, At least once a month, Less often than once a month, I do not smoke now</td>
<td>Unlike the NZHS, the HLS does not include the 100+ minimum requirement in the definition of daily smoking.</td>
</tr>
</tbody>
</table>

### Mode of survey administration

The NZHS and HLS surveys are administered face-to-face by a trained interviewer, whereas the Census is a self-completion questionnaire. These administration modes have different methodological strengths, with face-to-face surveys typically yielding the highest response rates, for example, and self-completion questionnaires minimizing social desirability bias in surveys of sensitive topics. Few studies have examined differences in the reporting of smoking behaviour by mode of survey administration, and findings are mixed. A major Danish survey of the general population found a significant mode effect, with higher reporting of daily smoking in face-to-face interviews compared with self-completion questionnaires. A smaller US study found no significant mode difference in reported smoking status or number of cigarettes smoked per day in a survey of Latina and African American women aged 12–21. These findings suggest that social desirability bias does not necessarily lead to...
under-reporting of smoking in face-to-face surveys, and in fact, under-reporting may be more likely in self-administered modes.

**Classification of ethnicity**

Both the Census and NZHS use ‘total response’ for categorising ethnicity. This means people who reported more than one ethnic group are counted once in each group reported, and the total number of responses for all ethnic groups is greater than the total number of people who responded.

The HLS uses a ‘prioritisation’ method, where each person is allocated to a single ethnic group based on the ethnicities they have identified. In 2008, ethnicity was classified using prioritisation in the order of Pacific peoples, Māori, Asian and European/Other (ie, a person identifying as both Māori and Pacific would be counted as ‘Pacific’). In 2010 and subsequent years, the order of prioritisation was changed to Māori, Pacific peoples, Asian, and European/Other (ie, a person identifying as both Māori and Pacific would be counted as ‘Māori’). As a result, the HLS findings by ethnicity have limited comparability between 2008 and subsequent years.

Research comparing prioritised and total response ethnicity suggests these different methods of categorisation produce little difference in results for health behaviours. However, prioritisation with Māori as the prioritised group results in understatement of group size for non-Māori groups, in particular Pacific peoples. Statistics New Zealand argue that valid analysis of a group depends on the consideration of all its members, and prioritisation “is no longer considered viable in reflecting the changing face of ethnic diversity in New Zealand”.

**New Zealand Census**

For the purposes of monitoring daily smoking prevalence, the Census has the advantage of reaching 93–95% of the New Zealand adult population (aged 15+), and, as it is a census of the total population, it is not subject to sampling error. However, post-enumeration surveys show that there is likely to be systematic undercounting of smokers, since smokers are over-represented in the groups most likely to be missed by the Census. For example in 2013, younger adults aged 15–29 years had a higher relative undercount (est. 4.8%) than other age groups, and the estimated under-

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**Table 2: Key features of national data sets on tobacco use in New Zealand.**

<table>
<thead>
<tr>
<th>Data source</th>
<th>Mode of survey administration</th>
<th>Sample size (approximate)</th>
<th>Sample methods</th>
<th>Survey response rate</th>
<th>Non-response to smoking question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Census</td>
<td>Self-completed written survey</td>
<td>N/A</td>
<td>N/A</td>
<td>(Estimated)</td>
<td>Not stated + response unidentifiable</td>
</tr>
<tr>
<td></td>
<td>Online option available from 2006: 7% completed online in 2006, and 34% in 2013)</td>
<td></td>
<td></td>
<td>2013: 93.8% 2006: 94.5% 1996: 95.3%</td>
<td></td>
</tr>
<tr>
<td>NZHS</td>
<td>Face-to-face interview, using showcards.</td>
<td>2002/3 and subsequent: approx. 13,000 1996/97: approx. 8,000</td>
<td>Multi-stage, stratified, probability-proportional-to-size (PPS) sampling design. Since 2011/12 dual frame: area (meshblock) and electoral roll.</td>
<td>Adult weighted response rate: 2014/15: 79% 2013/14: 80% 2012/13: 80% 2011/12: 79% 2006/07: 68%</td>
<td>Overall, less than 1% missing data due to “don’t know” responses and refusals.</td>
</tr>
</tbody>
</table>
count was also higher for Māori (6.1%) and Pacific peoples (4.8%) compared to Asian (3.0%) and European (1.9%). The estimated undercount for Māori and Pacific was substantially higher in 2013 than previous years (for example, it was about 3% for Māori in both 2006 and 1996).17

Census data quality is also affected by the relatively high question non-response rate, with 4–5% of respondents not answering the smoking question as directed, or at all.18 For the purposes of this paper, question non-response includes individuals who filled in the Census form, but did not respond to the smoking question (“not stated”), and responses that could not be classified or did not provide the type of information asked for (“response unidentifiable”). It is plausible that smokers are also over-represented in this group, however analysis of non-response by ethnicity, age, and other sociodemographic variables is not possible with public domain data. Another factor that may affect data quality is the household nature of data collection, which may result in under-reporting in people who wish to hide their smoking from other family members. For example, teenagers may not admit to daily smoking if their parents are collating the household’s individual Census forms.

A disadvantage of the Census for monitoring progress towards the Smokefree 2025 goal is the long time period between data collection points, with only three data points in the last 20 years. This is in part due to the pattern (at least to date) of the tobacco question not being included in every Census. As a result, the Census is less useful for identifying recent trends in smoking prevalence than the more frequent NZHS. However, the upcoming 2018 Census (which will include the smoking question) will be well timed to measure progress against the Smokefree 2025 interim goals.

The only significant change in the way Census data were collected, defined, and classified between 1996, 2006 and 2013 was the introduction of an online survey option in 2006, when 7% of respondents completed their survey forms online. This increased to 34% in 2013.19 The online version has built-in editing functionality, for example allowing only one response to be selected for each of the smoking questions, whereas multiple responses to these questions are possible when forms are completed on paper. This reduces the risk of invalid responses to individual questions, and as a result, data from online forms may be of higher quality than data from paper forms. According to Statistics New Zealand, 2013 data “is fully comparable with data from the 2006 Census” and “highly comparable with the 1996 Census data”.18

New Zealand Health Survey

Strengths of the NZHS are its large sample size, continuous sampling design, and the high response rates achieved since 2011. The NZHS is administered face-to-face, and this mode has the advantage of high item response, and places the least cognitive demand on respondents.10 As previously noted, social desirability bias can affect face-to-face surveys on sensitive topics, but there is no evidence that this is the case for questions about tobacco use.11-12

The NZHS has a survey response rate of between 68% and 80%. Of note is that the survey response rate increased between 2006/7 (68%) and 2011/12 (79%), which is likely due to a change in fieldwork provider that occurred at that time. It is plausible that smokers are over-represented amongst NZHS non-responders, however calibrated weights used in calculating population-level estimates in the NZHS include adjustment for non-response (both for non-participation by individuals, and also non-response to individual items) with this adjustment based on population stratified by age, ethnicity, and socioeconomic position.20 Furthermore, the relatively high response rate in the last three waves reduces the risk and/or potential impact of such a bias compared with earlier waves. If the level of non-response remains approximately constant, then any bias in recent and future estimates should be consistent, and the observed trends are likely to be fairly reliable.

The NZHS uses sampling methods to select interviewees, and hence is subject to sampling error, illustrated by the error bars in Figures 1 and 2 (representing 95% confidence intervals [CI] of the estimates).

A disadvantage of the NZHS for examining trends over time is questionable
comparability between pre- and post-2011 NZHS iterations, due to a number of significant methodological changes. Prior to 2011, the NZHS was conducted every 4–6 years, and from July 2011 it became a continuous survey, with question sets and reporting periods retaining a July to June timetable. Another change was the introduction of a dual sample frame using electoral roll-based identification of high-Māori mesh blocks. Prior to 2011, the NZHS only included people living in private accommodation; since then the target population has broadened to the New Zealand usually resident population, including those living in non-private accommodation (such as aged care facilities and student accommodation). The NZHS 2012 methodology report notes, “To make the current and past surveys more comparable, the weights from the earlier surveys have been re-benchmarked, using benchmarks that reflect the target of the current survey".21

The weightings for 2011/12 and subsequent years were adjusted again in 2014/15 to correct minor errors in how the weights were initially calculated and to further refine population weightings based on the 2013 Census.20 The prevalence figures for 2011/12, 2012/13 and 2013/14 presented in the current paper are those issued by the Ministry of Health in 2015 and differ slightly from the Ministry’s previously published data.

In summary, the relative weaknesses of the NZHS for monitoring smoking prevalence over time are limited comparability pre- and post-2011, and the inherent imprecision in the prevalence estimation process arising from a sampling-based design.

Health and Lifestyles Survey
The HLS collects information on attitudes and behaviour relating to HPA’s programme areas of alcohol, tobacco control, sun safety, minimising gambling harm, nutrition and physical activity, mental health, and immunisation. The frequency of the HLS is a strength of this survey compared with the Census. However, the HLS does not have any clear advantages over the NZHS for the purpose of monitoring smoking prevalence over time. It has a similar survey response rate, but is less frequent (every 2 years) and has a substantially smaller sample size, which results in poor precision for subgroup analyses. This is illustrated in Figure 2, with the error bars (95% CI) indicating a high margin of error in the HLS when considering specific ethnic groups. Furthermore, ethnicity classification was changed after 2008 (as described above), meaning that comparability between 2008 and subsequent years is limited for analysis by ethnicity.

It is plausible that smokers are over-represented among those who cannot be contacted or refuse participation in the survey, however the HLS methodology report notes, “each selection weight was adjusted using the response rate of the meshblock the respondent was selected from...to compensate for any non-response bias that may have arisen from people refusing to participate in the survey”.22 A sharp improvement in response rate occurred between 2010 (56.7%) and 2012 (83.1%), probably due to a change in fieldwork supplier. As a result, non-response bias, if it occurs, has likely reduced in the most recent two waves of the HLS. However, as noted for the NZHS, non-response should not affect the validity of trends observed after 2012 if non-response remains consistent over time.

Results: prevalence estimates and trends
Adult daily smoking prevalence
Both the Census and the NZHS show a steady decline in adult (age 15+) daily smoking over the past 18 years, from 23–25% in 1996/97, to 18–21% in 2006/07, and then to around 15% in the 2013 to 2015 period, as shown in Figure 1. The HLS, since it began in 2008, shows broadly consistent findings. The dashed line in Figure 1 represents the weighted estimate of smoking prevalence in New Zealand based on all three data sources, and shows a decreasing prevalence of smoking over the study period.

Daily smoking prevalence by ethnicity
Daily smoking prevalence trends for the main ethnic groupings are discussed below. Note that ethnic breakdowns of
Census and NZHS data are not available in the public domain for years prior to 2006, so the analysis below focuses on the 2006–2015 period. Figure 2 presents the prevalence data for all three data sources, separated into panels by data source, with 95% confidence intervals included. Figure 3 presents trends in smoking prevalence by ethnic group (demarcated by colour) for the Census, NZHS and HLS (demarcated by the shape of the data points). The dashed lines give an indicative trend in smoking rates over time for each ethnic group (weighted by the precision of the data sources: these weights were highest for the Census, followed by the NZHS, and then the HLS, as can be seen by the widths of the confidence intervals in Figure 2). A version of this figure including confidence intervals for individual survey estimates is available from the authors. The confidence intervals are the same as those included in Figure 2.

New Zealand European is the largest ethnic group in the country, and in all three data sets the analysis is combined with ‘Other’ ethnicity (ie, this aggregate group covers those people not identifying as Māori, Pacific or Asian). The daily smoking prevalence for this group tracked steadily down from 2006 until 2013 (Figure 3), when the figures from the NZHS and Census converged at 13–14%. However, the most recent findings from the NZHS show no further decline since 2012/13.

The daily smoking rate for Māori adults was generally around twice that of the general population in all the surveys and at all time points (Figure 3). However, the recent trends in Māori and Pacific tobacco use are not clear, since the different data sources (considered individually) give different messages (Figure 2). Census data indicate that daily smoking among Māori fell from 42.2% in 2006 to 32.7% in 2013—a dramatic drop in just 7 years. However, the NZHS presents a less promising picture: according to the unadjusted data, daily smoking amongst Māori decreased only modestly in 8 years, from 39.2% in 2006/07 to 35.5% in 2014/15, a change well within the NZHS survey’s margin of error for this ethnic group.

Pacific smoking was also consistently higher than for European/Other (Figure 3). Estimates of the Pacific daily smoking rate in 2006–07 were 29.2% in the Census and 24.8% in the NZHS. As seen for Māori, the Census figures present a more positive picture of recent trends than the NZHS, showing a drop of 7% in Pacific daily
smoking in 7 years (2006–2013) to 22%. In contrast, the NZHS shows a modest 2.4% drop from 24.8% in 2006/07 to 22.4% in 2014/15. Again this change is within the margin of error of the NZHS.

Asian peoples have the lowest rate of daily smoking of the main ethnic groupings (Figure 2). The NZHS shows a steady decline in daily smoking amongst Asian peoples from 9.2% in 2007 to 5.9% in 2014/15, and this is echoed by the Census figures (Figure 3).

According to Ministry of Health analysis, Asian peoples were the only ethnic grouping to show a statistically significant decline in smoking (after age-adjustment) since 2011/12, when the 2025 goal was set.

**Discussion**

This study is the first critical review of New Zealand’s national data sources on smoking prevalence. Its scope was limited to data available in the public domain.

**Consistency of findings between data sources**

The Census, NZHS and HLS present a relatively consistent picture about overall trends in daily smoking prevalence over the past 18 years, but there are important
discrepancies in findings by ethnicity in the period since 2006. The Census presents more encouraging results for smoking decline among Māori and Pacific than the NZHS, with the latter indicating there has been no statistically significant reduction in daily smoking prevalence in these groups since 2006/07 (after adjustment for differences in the population age structure over time). It is not clear why the Census and NZHS findings are inconsistent for prevalence trends by ethnicity. An increase in non-response/non-inclusion of Māori and Pacific in the 2013 Census compared to previous years may partly account for this finding, resulting in a higher number of ‘missing’ Māori and Pacific smokers in the 2013 Census compared with 2006. This could be investigated by a more in-depth study and appropriate sensitivity analyses.

Figure 3: Ethnic-specific trends in New Zealand adult (age 15+) daily smoking prevalence 2006–2014/15.*

* The size of the points in Figure 3 is proportional to the weight of each data source for determining the smoothed trend for that ethnic group.
Strengths and weaknesses of current data sources

Of the three data sources currently available, we believe the NZHS is the most useful single source for monitoring progress in reducing smoking prevalence towards Smokefree 2025 goals. The Census is too infrequent to detect year on year changes, and the sample for the HLS is too small to provide reliable estimates of prevalence by ethnicity—both of which are crucial for assessing progress towards the 2018 interim targets. The NZHS has a large enough sample size to provide reasonably precise prevalence estimates by ethnicity, and the reporting of annual data allows timely monitoring of trends. Furthermore, the NZHS annual reports also include information on whether observed changes in smoking rates are statistically significant once changes in the population age structure have been considered.

However, the Census and HLS also contribute to monitoring progress towards the Smokefree 2025 goals. The NZHS sample size is inadequate to monitor trends in smaller groups that are key to reaching the Smokefree 2025 goal—for example, smoking trends in 15–19 and 20–24-year-olds stratified by ethnicity. The Census enables this more finely grained analysis by age/gender/ethnicity on a periodic basis, and provides valuable complementary data, for example on smoking by occupation and by socioeconomic status.

The HLS also has a niche function in the overall surveillance system, as it provides a regular more comprehensive dataset on smoking-related attitudes, beliefs and behaviours and the impact of tobacco control measures. For example, it provides data on attitudes to current and future tobacco control measures, as well as data on factors that influence smoking uptake and quitting. For this reason, the HLS may be the most useful regular survey for monitoring a broader range of tobacco-related attitudes and behaviours. There is a periodic tobacco module for the NZHS which also provides more in-depth information (currently in field for the 2015/16 NZHS period); however, questions on tobacco-related attitudes are limited in scope, and the timing and frequency of its inclusion in the NZHS is irregular, making it less useful for the purpose of monitoring emerging trends.

Progress towards the Smokefree 2025 goal

All three data sources suggest there has been a modest decline in overall daily smoking prevalence over the last 7–8 years, from 18–21% in 2006–08 to a 2013/15 level of 15%. Age-adjusted NZHS findings indicate that this is a real change, and is not simply driven by underlying changes in the age structure of the population.

However, two recent modelling studies based on Census findings have suggested that with business-as-usual trends, the 2025 goal (of achieving a smoking prevalence under 5%) is unlikely to be achieved for any ethnic group in New Zealand. Another modelling study has suggested that this goal will not be achieved even with high annual tobacco tax increases through to 2025 (superimposed on baseline trends).

Recent trends in Māori and Pacific daily smoking prevalence are not clear, given the discrepancy in findings between the Census and the NZHS. However, both data sources suggest that the 2018 interim targets—smoking prevalence of no more than 19% for Māori and 12% for Pacific peoples—will be missed by a substantial margin. The apparent lack of progress indicated by the NZHS findings is extremely concerning, and points to an urgent need for enhanced tobacco control measures, including targeted interventions for Māori and Pacific groups and an emphasis on population measures that will have a strong impact on smoking prevalence in these populations.

Implications for surveillance system design and policy

Notwithstanding the discrepancies noted above, the current surveillance system is fairly robust for monitoring smoking prevalence, though it is important that all three data sources are maintained and the methods remain robust and consistent. For example, inclusion of the smoking question in the 2018 Census (and beyond to 2025) is very important, since this will enable fine-grained analysis on a periodic basis, and will provide a cross-check on use of the NZHS data as the preferred data source.

Current trends, along with recent modelling studies, suggest that the
interim 2018 goal and the Smokefree 2025 goal will not be met, and will be missed by a substantial margin for Māori and Pacific peoples. Bold and urgent action is needed to accelerate smoking decline, particularly interventions that make a difference for high-need groups, for example Māori, Pacific, and pregnant women. Policy measures identified as high priority by the tobacco control sector and recommended by the Māori Affairs Select Committee include introduction of plain packaging, reduction in availability and supply of tobacco, mass media campaigns targeted at Māori and pregnant women, and continued tax increases.\textsuperscript{32}

\section*{Competing interests:}
Nil.

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The All New Zealand Acute Coronary Syndrome Quality Improvement Programme: Implementation, Methodology and Cohorts (ANZACS-QI 9)

AJ Kerr, MJA Williams, S Harding, H White, RN Doughty, C Nunn, G Devlin, C Grey, M Lee, C Flynn, M Rhodes, K Sutherland, S Wells, RT Jackson, RAH Stewart, on behalf of the ANZACS-QI investigators

ABSTRACT

The All New Zealand Acute Coronary Syndrome Quality Improvement programme (ANZACS-QI) uses a web-based system to create a clinical registry of patients with acute coronary syndrome (ACS) and other cardiac problems admitted to hospitals across New Zealand. This detailed clinical registry is complemented by parallel analyses of, and individual linkage to, New Zealand’s multiple routine health information datasets. The programme is primarily designed to support secondary care clinicians to implement evidence based guidelines and to meet national performance targets for New Zealand cardiac patients. ANZACS-QI simultaneously generates a large-scale research database and provides an electronic data infrastructure for clinical registry studies. ANZACS-QI has been successfully implemented in all the 41 public hospitals across New Zealand where acute cardiac patients are admitted. By June 2015 25,273 patients with suspected ACS and 30,696 referred for coronary angiography were registered in ANZACS-QI.

In this report we describe the development and national implementation of ANZACS-QI, its governance, the data collection processes and the current ANZACS-QI cohorts and available outputs.

Since the late 1960s, the age-standardised mortality rate for ischaemic heart disease in New Zealand has decreased from 253 to 66 per 100,000.¹ This improvement across many Western countries, including New Zealand, has been attributed to a combination of improved lifestyle (smoking cessation, diet) and utilisation of evidence-based therapies (primary and secondary prevention medications, coronary revascularisation).²⁻⁵ Despite this, cardiovascular disease (CVD), and in particular coronary heart disease (CHD), remains the most common cause of death worldwide.⁶ In New Zealand, age-standardised mortality rates for vascular disease are still higher than those in many other Western countries (www.mortality-trends.org) and, of concern, important disparities exist in the burden of CVD mortality borne by some ethnic groups and by those living in areas of greater deprivation.⁷⁻⁹ In 2010, the age-standardised rate of ischaemic heart disease mortality was 55% higher among New Zealand Māori men compared with the rate for non-Māori men, while the rate for Māori women was nearly twice as high (99%) as that for non-Māori women.¹⁰ Those living in greater deprivation also have disproportionately higher CVD event rates.

There is a formidable evidence base supporting the use of a range of lifestyle, pharmaceutical, and interventional treatments to improve outcomes in patients with acute CVD events. For example, national and international guidelines recommend timely coronary angiography and revascularisation as appropriate for patients with acute coronary syndrome (ACS).¹¹⁻¹⁵ There is robust evidence to support the use of antiplatelet/anticoagulant,¹⁶⁻¹⁷ BP-lowering¹⁸⁻²⁰ and statin²¹⁻²³ medications, to improve outcomes in patients with established atherosclerotic CVD. This evidence base is constantly developing, with new treatments and technologies becoming available every year.
However, in practice, there is often a substantial gap between ideal treatment based on clinical trials and what is achieved in practice—the evidence-practice gap—with suboptimal initiation and longer-term maintenance of evidence-based therapy across the spectrum of CVD. Prior studies have reported that revascularisation rates in non-Māori, non-Pacific New Zealanders are significantly higher when compared with Māori and Pacific people and in non-Māori compared with Māori. A series of three audits of ACS patient management in New Zealand over the last 10 years have demonstrated suboptimal provision of cardiac investigation in ACS patients. Marked variation in both the use of coronary intervention procedures and delay in treatment have also been documented. Gaps in the utilisation of secondary prevention therapy in New Zealand have been well documented. The identification of these evidence-practice gaps, and the implementation of programmes to close them, represent an important opportunity to improve the outcomes of patients with CVD in New Zealand.

Figure 1: ANZACS-QI programme cohorts, data flow and outputs. The interactions with the associated ANZACS-QI registry trials are shown.

ANZACS-QI Programme

ACS Routine Information cohort (Ministry of Health)

ACS-CathPCI Registry cohort (ANZACS-QI platform)

Registry Trials

Per study - enrolment, ethics, consent

Additional data sets within ANZACS-QI ± other dataset

NHI encryption (ANZACS-QI and VIEW governance, National ethics approval.)

Linked Routine and ANZACS-QI data

Linked dataset per study

Quality Improvement ↔ Research

Registry Trials Research

Why was ANZACS-QI established?

The primary aim of the All New Zealand Acute Coronary Syndrome Quality Improvement programme (ANZACS-QI) is to support appropriate, evidence-based management of ACS and subsequently of other cardiac patients regardless of age, sex, ethnicity, socioeconomic status, or rural or city dwelling. The ANZACS-QI programme supports this aim through its two arms—a quality improvement arm and a research arm.

ANZACS-QI programme cohorts and processes

The ANZACS-QI programme utilises two complementary data sources to generate two overlapping cohorts:

1. The ACS-CathPCI Registry cohort, generated using web-based software that enables secondary care clinicians to systematically collect data on ACS patients, coronary angiography and
percutaneous coronary intervention (PCI) procedures in all New Zealand hospitals.

2. The ACS Routine Information cohort, derived directly from national health datasets.

While the ACS Routine Information cohort includes all New Zealand ACS patients, it is relatively limited in content. In contrast, the ACS-CathPCI Registry cohort captures more in-depth data on every ACS patient who has a coronary angiogram in New Zealand, all other patients having coronary angiography procedures and on some other ACS patients. The two overlapping data sources can be linked using the National Health Index (NHI) number, as discussed further below.


Patients with a suspected diagnosis of ACS in New Zealand are admitted to one of 41 public hospitals and cared for by a mixture of cardiology and general medical teams. From mid-2012, the national goal, supported by a New Zealand Ministry of Health (MOH) indicator and directive to DHBs, was to achieve complete CathPCI registration in all patients undergoing coronary angiography regardless of indication, and a complete Cath-PCI and ACS dataset in all patients suspected by clinicians to have ACS at admission, who are referred for coronary angiography. Therefore, the goal was the registration of all New Zealand patients with a final diagnosis of ACS who had undergone coronary angiography (note: coronary angiography is indicated after ACS in most high-risk ACS patients in national and international guidelines).11-15 Centres were also encouraged to continue including other ACS patients in the Registry, but this was not mandatory and the comprehensiveness of capture varies by centre. The Registry was also implemented in all six private hospitals that provide coronary angiography, for predominantly non-ACS indications.

Development, funding and implementation

The Registry cohort was established in mid-2007, when a web-based ACS registry was introduced into Middlemore Hospital in Auckland, New Zealand. In 2010, a ‘CathPCI’ registry for use in the cardiac catheterisation laboratory was added to capture data for patients undergoing coronary angiography and PCI. Electronic linkage of common data fields between the ACS and CathPCI forms allows data items to be entered in the location where it is most appropriate and therefore most accurate—coronary angiography and PCI data in the cardiac catheterisation laboratory, risk factor and in-hospital outcomes in the cardiology ward.

In late 2011, the New Zealand National Cardiac Network proposed the establishment of a national combined ACS-CathPCI Registry to be governed under the auspices of the New Zealand branch of the Cardiac Society of Australia and New Zealand (CSANZ). This initiative was supported by the then Minister of Health, Tony Ryall, and funded by the MOH, and after a competitive tender process, a partnership between Enigma Solutions (software developers) and the National Institute for Health Innovation (NIHI, University of Auckland) was contracted to implement the national roll out of the ANZACS-QI Registry.

By November 2013, the Registry was implemented in all 20 publically funded District Health Boards (DHBs) and their 41 hospitals which admit ACS patients. In New Zealand, virtually all ACS patients are admitted and managed in a public hospital.

Connected Health Network Integration

The ANZACS-QI web platform uses the Connected Health Network (CHN), a standards-based, commercial model for the secure delivery of universal connectivity across the New Zealand health sector. The CHN is a “network of networks” delivered by multiple telecommunication service providers on a competitive basis, using industry standard, commodity capability. It is overseen by the MOH. Connected Health aims to improve reliability, safety, and security of transferring health information, as only products or services certified against approved network connectivity standards, such as ANZACS-QI, will be allowed to connect to the network. All authorised users
have individual usernames and passwords allocated by a system administrator.

Who enters data?

On arrival at the Coronary Care Unit or catheterisation laboratory, patients are registered by clerical or clinical staff using an ANZACS-QI web form. The MOH Health Identity Programme (http://www.health.govt.nz/our-work/health-identity/health-identity-programme) provides the ability within the ANZACS-QI Registry for users to perform a search to find the demographic data for their patients. The data are automatically populated into the registration section of the web form. Clinical staff—medical, nursing and radiology—enter individual patient data into mandatory fields on the web form. At discharge, all fields are checked for completeness and missing data entered as required. The Cardiac Network and MOH set minimum requirements for form completion, which is assessed by monthly DHB completion reports, and provider-initiated ANZACS-QI system reports.

Data quality

This is facilitated by having a mandatory dataset, in-form definition statements, in-form automatic validation rules, automatic data capture from source datasets on demographics and laboratory results, as well as standardised user training and regular auditing. Each participating hospital is audited annually by a visiting audit nurse, with 20 randomly-selected CathPCI and ACS forms assessed, covering all data used for key performance indicator reporting. To date, the national data accuracy is 95% with a range of 83% to 99% across hospitals.

Data linkage

Audit and research activity is augmented by anonymised linkage of the Registry dataset to the national Routine Information dataset. Over 98% of New Zealanders have a unique health identifier (the National Health Index number, or NHI) which identifies individuals in multiple national and regional health system databases. With provider permission, patient registry data are anonymised by encrypting the NHI and then transferred from ANZACS-QI servers to the University of Auckland. The ever-growing Registry dataset can be regularly linked to national Routine Information dataset, via similarly encrypted NHIs, to measure processes (drug dispensing, subsequent cardiac procedures and laboratory monitoring) and outcomes (CVD hospitalisations and deaths).

What is measured?

A complete list of the data items in the ACS and CathPCI forms with definition statements and variable histories are available in the ANZACS-QI data dictionaries available at: https://www.fmhs.auckland.ac.nz/en/soph/about/our-departments/epidemiology-and-biostatistics/research/view-study/research.html

ACS form

This form collects demographic, risk factor, investigation, management, and in-hospital outcome data for all patients admitted with a suspected ACS.

CathPCI form

The original 2010 CathPCI form was designed to collect a basic dataset on all patients undergoing coronary angiography including demographics, procedure indication, arterial access route, extent of coronary artery disease, performance of PCI and in-hospital outcomes. In September 2014 (see Figure 2), an expanded form was introduced nationally which retained the core dataset, but also captured risk factors and coronary lesion level recording of both lesion characteristics and interventional treatment in PCI patients.

The current ANZACS-QI registry cohort

The national roll-out of the ANZACS-QI Registry across the DHBs was staggered over 6 months. The growth of the separate CathPCI and ACS admission cohorts are shown in Figure 3.

ACS registration

A total of 27,936 public hospital admissions with suspected ACS have been registered between 1 August 2007, and 20 June 2015. Complete data is available for 24,555 (87.9%) admissions, with a final confirmed diagnosis of ACS in 19,488 (79.4%) of admissions. The confirmed ACS diagnosis recorded is the clinician determined diagnosis at discharge according to standard definitions.
Sub-cohort 1 (Table 1)
All patients with a confirmed ACS diagnosis and complete registry dataset. Data from each participating hospital is included in this sub-cohort from the first month when each hospital achieved at least 90% completion of their registered ACS forms. This cohort excludes admissions before 2012 to reflect contemporary practice.

Sub-cohort 2 (Table 2)
All coronary angiograms (all episodes) in New Zealand public hospitals from November 2013 (when CathPCI registration completion rates approached 100% in all New Zealand public hospital cardiac catheterisation laboratories).

The ANZACS-QI national Routine Information (ACS) cohort
This cohort is used to describe and investigate national trends in ACS incidence, investigation, management and outcomes and can also be linked to the ANZACS-QI registries for these purposes.

The Routine Information cohort comprises anonymously linked baseline and longitudinal secondary data sourced directly from routinely collected New Zealand health datasets obtained from the New Zealand MOH (see Table 3). All New Zealand residents aged 20 years or over who are admitted to hospital with a primary or secondary International Classification of Disease 10 (ICD10) code consistent with ACS (I20.0, I21x, I22x) are included in the cohort.

All source data were subject to quality checks by the MOH prior to delivery to the University of Auckland and again by the research team following integration. These data are updated annually.

Baseline characteristics of the 100,579 subjects admitted with ACS from 1 January 2006 to 31 December 2013 with complete demographic data (144,279 ACS hospitalisations) are shown in Table 4.

Ethics approval and governance
Governance of the ANZACS-QI registry data is by the ANZACS-QI governance group on behalf of the New Zealand branch of the Cardiac Society of Australia and New Zealand (CSANZ). The governance group includes the clinical leaders of the Cardiac

CathPCI registration
A total of 33,538 referrals for coronary angiography in 30,696 people have been registered since 1 November 2010. Of these referrals, complete data are available in 33,049 (98.5%).

Using the ANZACS-QI combined ACS-CathPCI Registry cohort, various sub-cohorts can be defined. In Tables 2 and 3 we show two illustrative sub-cohorts.
Figure 3: ANZACS-QI ACS-CathPCI registry cohort growth. Admissions with completed datasets are shown.

Table 1: ANZACS-QI ACS sub-cohort from 1 July 2012 to 30 June 2015.

<table>
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<tr>
<th>Demographics</th>
<th>Overall (N=14,190)</th>
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<th>50–&lt;60y (n=2,819)</th>
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<th>70–&lt;80y (n=3,666)</th>
<th>≥80y (n=2,410)</th>
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<tr>
<td>Gender, n (%)</td>
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<td>Male</td>
<td>9,426 (66.4)</td>
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<td>2,123 (75.3)</td>
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<td>2,279 (62.2)</td>
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<td>4,764 (33.6)</td>
<td>346 (24.7)</td>
<td>696 (24.7)</td>
<td>1,171 (30.1)</td>
<td>1,387 (37.8)</td>
<td>1,164 (48.3)</td>
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<td>Ethnicity, n (%)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>1,579 (11.1)</td>
<td>273 (19.5)</td>
<td>501 (17.8)</td>
<td>476 (12.2)</td>
<td>262 (7.1)</td>
<td>67 (2.8)</td>
<td></td>
</tr>
<tr>
<td>Pacific</td>
<td>803 (5.7)</td>
<td>187 (13.4)</td>
<td>252 (8.9)</td>
<td>221 (5.7)</td>
<td>125 (3.4)</td>
<td>18 (0.7)</td>
<td></td>
</tr>
<tr>
<td>Indian</td>
<td>633 (4.5)</td>
<td>113 (8.1)</td>
<td>185 (6.6)</td>
<td>171 (4.4)</td>
<td>119 (3.2)</td>
<td>45 (1.9)</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>357 (2.5)</td>
<td>52 (3.7)</td>
<td>95 (3.4)</td>
<td>108 (2.8)</td>
<td>75 (2.0)</td>
<td>27 (1.1)</td>
<td></td>
</tr>
<tr>
<td>New Zealand European/Other</td>
<td>10,818 (76.2)</td>
<td>775 (55.4)</td>
<td>1,786 (63.4)</td>
<td>2,919 (74.9)</td>
<td>3,085 (84.2)</td>
<td>2,253 (93.5)</td>
<td></td>
</tr>
</tbody>
</table>
Table 2: ANZACS-QI CathPCI sub-cohort (coronary angiography) from 1 November 2013 to 30 June 2015.

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Overall (N=22,445)</th>
<th>Age Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt;50y (n=2,356)</td>
</tr>
<tr>
<td>Gender, n (%), Male/Female</td>
<td>14,969 (66.7)/7,476 (33.3)</td>
<td>1,721 (73.1)/635 (27.0)</td>
</tr>
<tr>
<td>Ethnicity, n (%), Māori/Pacific/Indian/Asian/New Zealand European/Other</td>
<td>2,303 (10.3)/1,068 (4.8)/899 (4.0)/719 (3.2)/17,456 (77.8)</td>
<td>479 (20.3)/267 (11.3)/155 (6.6)/98 (4.2)/1,357 (57.6)</td>
</tr>
<tr>
<td>Indication</td>
<td></td>
<td>Suspected ACS, n (%)</td>
</tr>
<tr>
<td></td>
<td>12,214 (54.4)/2,165 (9.6)/10,049 (44.8)</td>
<td>1,501 (63.7)/373 (15.8)/1,128 (47.9)</td>
</tr>
<tr>
<td></td>
<td>10,231 (45.6)/6,577 (29.3)/3,654 (16.3)</td>
<td>855 (36.3)/453 (19.2)/402 (17.1)</td>
</tr>
</tbody>
</table>

Table 3: Variables available in the ANZACS-QI Routine Information Cohort.

<table>
<thead>
<tr>
<th>Name of dataset and data contained</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Minimum Dataset41 (publicly funded hospitalisations)</td>
<td>Admission-related data: date of admission, date of discharge, ICD-coded discharge diagnoses, ICD-coded procedural diagnoses (including angiography, PCI, CABG), DHB of domicile. Demographic data: age at admission, sex, ethnicity, deprivation quintile, domicile, rurality of residence. Previous hospitalisations: previous ACS and ischaemic heart disease admissions; Charlson comorbidities (MI, peripheral vascular disease, heart failure, chronic obstructive pulmonary disease, connective tissue disease, ulcers, dementia, cerebrovascular disease, hemiplegia, diabetes, liver disease, renal disease, neoplasms, AIDS); total Charlson comorbidity score.</td>
</tr>
<tr>
<td>Pharmaceutical Collection42</td>
<td>Government-subsidised medication dispensing claims from community pharmacies.</td>
</tr>
<tr>
<td>Mortality Collection43</td>
<td>Date of death and ICD-coded underlying and contributing causes of death.</td>
</tr>
</tbody>
</table>

CABG, coronary artery bypass grafting; AIDS, acquired immune deficiency syndrome
### Table 4: Baseline characteristics of National ACS cohort (2006–2013), by age group.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Overall (N=100,579)</th>
<th>Age Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt;50y (n=8,005)</td>
</tr>
<tr>
<td>Gender, n (%)</td>
<td></td>
<td>58,885 (58.5)</td>
</tr>
<tr>
<td>Male</td>
<td>41,694 (41.5)</td>
<td>2,036 (25.4)</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td>17,191 (17.0)</td>
</tr>
<tr>
<td>Ethnicity, n (%)</td>
<td></td>
<td>8,981 (8.9)</td>
</tr>
<tr>
<td>Māori</td>
<td>5,265 (5.2)</td>
<td>1,086 (7.5)</td>
</tr>
<tr>
<td>Pacific</td>
<td>83,593 (83.1)</td>
<td>4,876 (60.9)</td>
</tr>
<tr>
<td>Asian</td>
<td>3,737 (3.7)</td>
<td>384 (10.4)</td>
</tr>
<tr>
<td>New Zealand European/Other</td>
<td></td>
<td>24,284 (24.1)</td>
</tr>
<tr>
<td>ACS type, n (%)</td>
<td></td>
<td>16,645 (16.6)</td>
</tr>
<tr>
<td>STEMI</td>
<td>54,311 (54.2)</td>
<td>3,725 (46.5)</td>
</tr>
<tr>
<td>NSTEMI</td>
<td>5,119 (5.1)</td>
<td>226 (2.8)</td>
</tr>
<tr>
<td>MI unspecified</td>
<td>24,284 (24.1)</td>
<td>1,830 (22.9)</td>
</tr>
<tr>
<td>Unstable angina</td>
<td></td>
<td>13,178 (13.3)</td>
</tr>
<tr>
<td>Deprivation Quintile</td>
<td></td>
<td>15,595 (15.8)</td>
</tr>
<tr>
<td>2</td>
<td>20,249 (20.5)</td>
<td>1,364 (17.4)</td>
</tr>
<tr>
<td>4</td>
<td>26,125 (26.5)</td>
<td>1,955 (25.0)</td>
</tr>
<tr>
<td>5</td>
<td>23,638 (23.9)</td>
<td>2,518 (32.2)</td>
</tr>
<tr>
<td>Charlson comorbidity score, n (%)</td>
<td></td>
<td>57,407 (57.1)</td>
</tr>
<tr>
<td>0 (no comorbidity)</td>
<td></td>
<td>25,225 (25.1)</td>
</tr>
<tr>
<td>1-2 (moderate)</td>
<td>17,947 (17.9)</td>
<td>514 (6.4)</td>
</tr>
<tr>
<td>≥3 (severe)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Clinical Networks for the four New Zealand regions, the Chairs of the New Zealand interventional working group, and CSANZ, Heart Rhythm New Zealand, nursing, consumer, MOH and the national Health Information Technology Board representatives. Written protocols and processes have been established to ensure appropriate data access and use through the ANZACS-QI Governance group. The ANZACS-QI Privacy Framework (available on request) has been approved by the New Zealand Privacy Commission and the ANZACS-QI governance group. Information about the ANZACS-QI Registry is available at all hospital sites, and patients may opt out of having their data being included in the cohort on request.

ANZACS-QI is also part of the wider Health Research Council (HRC) and National Heart Foundation (NHF) funded Vascular Informatics using Epidemiology and the Web (VIEW) research programme based at the University of Auckland. The VIEW research team oversee the use and governance of any audit or research use of the national routine information datasets. As all ANZACS-QI Registry data and national Routine data is anonymised before being sent to the VIEW researchers, individual patient consent is not required by ethics committees. The VIEW study was approved by the Northern Region Ethics Committee Y in 2003 (AKY/03/12/314), with subsequent amendments to include the ANZACS-QI registries, and with annual approvals by the National Multi-Region Ethics Committee since 2007 (MEOC0/7/EXP).
and discharge medications, and outcome measures, including 28-day and 1-year rate of recurrent myocardial infarction MI and death. These reports allow comparison of DHBs and national averages.

Publications and process improvement

The ANZACS-QI Registry and Routine Information datasets have been used to better understand the pattern of modifiable risk in the ACS cohort, describe the distribution of ACS risk and its relationship with appropriate investigation, management, late outcomes, and investigate the accuracy of the internationally recommended GRACE ACS risk score for the New Zealand ACS population. The initial cohort was used to develop the national indicators for appropriate timing of catheterisation for STEMI and non-ST elevation ACS patients, optimum vascular access for coronary angiography, and to define the temporal components of pre-hospital delayed presentation in patients with ACS. Implementation of ANZACS-QI has been associated with important reductions in waiting times for ACS patients to receive coronary angiography and their consequent length of hospital stay, and improved rates of radial access for coronary angiography (Vascular access for invasive coronary angiography in New Zealand 2013–15 report for DHBs). We aim to develop New Zealand-specific ACS and bleeding risk equations for ACS patients which will be incorporated within the ANZACS-QI platform.

The national Routine Information datasets have been used to track the dispensing of statin medications up to 3 years post-ACS discharge, investigate the 1-year outcomes after ACS presentation and their demographic determinants, and to define the pre-hospital case fatality for ischaemic heart disease and explore contributing factors. The Routine Information ACS cohort has been used to produce a national ACS report regarding New Zealand and DHB trends since 2006 in ACS incidence, coronary angiography and revascularisation rates and 28-day and 1-year outcomes. It is planned that a summary of this data will be made publicly available through the New Zealand Health Quality and Safety Commission Atlas of Health Care Variation website.

ANZACS-QI strengths and weaknesses

The ANZACS-QI Registry aimed to achieve comprehensive capture and data completion in all New Zealand patients undergoing coronary angiography and all those with ACS referred for coronary angiography. By early 2014, this goal had been achieved for these “core” cohorts. One limitation is that other ACS patients are not systematically captured as the cohort definition in each DHB is defined by their own local quality improvement goal. Some DHBs (including the five Midland DHBs and the Waitemata DHB) aim to comprehensively capture all ACS patients, others aim to capture only ACS patients admitted under the cardiology service (eg, Auckland and Counties Manukau DBHs), while other DHBs capture only the ACS patients referred for coronary angiography. Using the national routine dataset as the reference, in 2013 71% (4,472/6,305) of all New Zealand patients under 70 years admitted with ACS had a coronary angiogram and 48% (7,316/15,202) for all age groups.

The ANZACS-QI software has predominately mandatory data fields. This has facilitated nearly complete (99%) risk factor data collection for key variables, the addition of built-in ranges, and validity checks at the point of data entry have reduced transcription errors. While these are important strengths of the cohort, and the dataset is much richer than that available through the national datasets, it represents a compromise between an ideal ‘research’ dataset and the requirements dictated by the need for comprehensive patient capture and associated data entry staff knowledge/workload. There are also a small number of non-mandatory fields (eg body mass index and HbA\textsubscript{1c}) where it was judged that requiring completion might be too burdensome.

We electronically link the ANZACS-QI baseline data, via each person’s unique NHI, to national health datasets. This ensures almost complete ascertainment of deaths and CVD events. More than 95% of patients with an acute CVD event in New Zealand are managed by public health services. However, participants who die, or have other CVD outcome events outside New
Zealand, will be missed unless these events are subsequently documented in primary or secondary care records. Participants who emigrate are also lost to follow-up.

The national ethnicity prioritisation protocol enables us to generate a single ethnicity classification across multiple databases. For example, if a patient self-identifies as Māori in any of the linked databases, they will be classified as Māori. Unfortunately, the national ethnicity coding system only allows accurate identification of Indian patients and not other South Asian ethnicities at high-CVD risk (e.g., Pakistani, Bangladeshi, Sri Lankan). Other study limitations relate to the accuracy and reliability of routine information national data. IHD hospitalisations were identified using ICD-10 codes extracted from routinely collected hospitalisation data. Studies from several European countries have reported high sensitivity and positive predictive values for ICD-coded IHD events in national datasets.55-57

Future directions

The ANZACS-QI Registry Trials Group (RTG) utilises the core ANZACS-QI electronic platform, datasets, and outcomes linkage to cost efficiently run clinical trials in ACS patients (see Figure 1). These studies have their own separate ethics approvals. Study-dependent additional datasets are presented within the ANZACS-QI web platform with randomisation modules as appropriate. The ANZACS-QI RTG has its own coordination group to govern the development and implementation of these studies. There are currently two multi-centre clinical registry studies which are recruiting patients.

The entering of Registry data by clinicians is time consuming, and requires ongoing efforts to maintain training and data accuracy. Several parallel solutions are being used to ameliorate these issues. For example, some centres are integrating ANZACS-QI with local systems to auto-populate laboratory data onto the forms. In the longer-term, it may be possible for data to be exchanged between the Registry and the electronic discharge summaries to minimise double entry. There is now regular linkage of the Registry and the national Routine Information datasets, so that where data is available in the national datasets it is not necessary for this to be entered into the registries.

Additional linked ANZACS-QI registries

Since the national implementation of the ACS and CathPCI datasets, several other modules have been added onto the ANZACS-QI platform. The first is the Device registry, which captures information on pacemakers, implantable cardiac defibrillators, and cardiac resynchronisation therapy, the Congestive Cardiac Failure (CCF) registry (building on the existing New Zealand Heart Failure Registry) and a Cardiac CT and MRI reporting tool and registry which is in the final stages of development. In the Northern region (Northland, Waitemata, Auckland, and Counties-Manukau DHBs), which admit approximately one-third of all New Zealand ACS cases, regional laboratory data is available for linkage to ANZACS-QI through the VIEW programme.

In a parallel development, the MOH funded a national Cardiac Surgical registry in 2012. Permissions have been obtained to link this registry with ANZACS-QI datasets to facilitate national reporting of cardiac surgical outcomes.

Conclusion

The ANZACS-QI programme is primarily designed to support secondary care clinicians to implement evidence-based guidelines, and to meet national performance targets for New Zealand cardiac patients. ANZACS-QI has been successfully implemented in all the 41 public hospitals across New Zealand where acute cardiac patients are admitted.
Dr Kerr reports grants from HRC during the conduct of the study. Dr. White reports grants from Sanofi Aventis, grants from Eli Lilly and Company, grants from National Institute of Health, grants from Merck Sharpe & Dohm, grants and personal fees from AstraZeneca, grants from GlaxoSmithKline, grants from Omthera Pharmaceuticals, grants from Pfizer New Zealand, grants from Intarcia Therapeutics Inc, grants from Elsi1 Inc., grants from DalGen Products and Services, grants from Daiichi Sankyo Pharma Development, outside the submitted work. Dr. Grey reports grants from Health Research Council, grants from National Heart Foundation, during the conduct of the study.

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URL:
REFERENCES:

36. Thorley S, Marshall R, Chan WC, et al. Four out of ten patients are not taking statins regularly during the 12 months after an acute coronary event. European Journal
Pregnant women lack accurate knowledge of their BMI and recommended gestational weight gain

Emma Jeffs, Jillian J Haszard, Benjamin Sharp, Joanna Gullam, Helen Paterson

ABSTRACT

AIM: To investigate pregnant women’s knowledge of their body mass index (BMI) and their knowledge of gestational weight gain guidelines.

METHODS: Participants were recruited when attending their nuchal translucency scan at between 11 and 13 weeks, 6 days gestation in Dunedin or Christchurch, New Zealand. Recruitment staff measured participants’ weight and height. By way of a self-administered, paper-based survey, participants were asked to identify their body size (including: underweight (BMI <18.5 kg/m$^2$); normal weight (18.5–24.9); overweight (25–29.9); and obese (≥30)), and recommended gestational weight gain (including the 2009 Institute of Medicine guidelines for healthy weight gain in pregnancy, along with the options: “I should not gain any weight in my pregnancy”; plus “It does not matter how much weight I gain”). Participant-measured BMI was compared to responses for perceived BMI and recommended gestational weight gain to assess accuracy. Demographic predictors of accuracy were also investigated.

RESULTS: In total, 644 women were included. Sixty-six percent of these correctly identified their BMI category, however only 31% identified their correct gestational weight gain recommendation. Overweight and obese women were much more likely to underestimate their BMI than normal weight women (p<0.001 for both). Overweight and obese women were also more likely to overestimate their weight gain recommendation (OR=4, p<0.001; OR=18, p<0.001, respectively) while normal weight women were more likely to underestimate their weight gain recommendation (p<0.001). Independent of BMI, women of New Zealand European ethnicity were less likely to underestimate their recommended gestational weight gain compared to other women of non-Māori/non-Pacific Island ethnicity (p=0.001), whereas younger women (p=0.012) were more likely to underestimate recommended gestational weight gain.

CONCLUSION: The present study indicates that New Zealand women, particularly those who are overweight and obese, lack accurate knowledge of their own body size, and this may lead to an under- or over-estimation of appropriate gestational weight gain, which may in turn lead to increased risk of poor health outcomes in pregnancy. Education strategies related to healthy weight gain in pregnancy are urgently required.

Obesity is a global health concern. Pregnancy has now been recognised as a critical time to affect the potential for life-long obesity risk in mother and child. The New Zealand Ministry of Health (MoH) has released the “Childhood Obesity Plan”. This document outlines 22 initiatives to support a reduction in obesity in children and young people up to 18 years of age in an endeavour to reduce the number of individuals who are obese when they enter adulthood, and are therefore more likely to carry this through life. Initiative number five of this document states that increased support should be offered regarding “guidance for healthy weight gain in pregnancy”. This recommendation is derived from evidence that women who gain excess weight in pregnancy are more likely to have overweight and obese children, irrespective of the environment in which they are raised, and that appropriate gestational weight gain can mitigate the impact of maternal overweight and obesity.
The “Childhood Obesity Plan” references the 2014 MoH Guidance for Healthy Weight Gain in Pregnancy3 as the guiding document for initiative number five. The overarching guidelines held within this document recommend that women be advised and supported by their Lead Maternity Carer (LMC)—who are primarily midwives—to gain weight according to the 2009 Institute of Medicine (IoM) Guidelines for Healthy Weight Gain in Pregnancy (Table One).1 The IoM guidelines recommend weight gain based on pre-pregnancy, or early pregnancy BMI, and therefore rely on accurate knowledge of BMI, the absence of which may result in under- or over-estimation of recommended weight gain, and consequently, increased pregnancy risk.1

Overweight and obese individuals today are more likely to consider themselves to be of normal weight than overweight and obese individuals 20 years ago,4 and individuals of all BMI groups are more likely to identify increased body size as normal,5 indicating an upward shift in the social norms of body habitus. Women of childbearing age are particularly susceptible to misperception of their own body weight, with estimates suggesting nearly 25% of overweight women underestimate their own weight.6 Further, there is evidence to suggest that women are not having their weight and height routinely and accurately measured in pregnancy,7 and there are discrepancies in the knowledge and practices of LMCs related to weight gain in pregnancy.8

The aim of this study was to investigate pregnant women’s knowledge of their BMI and gestational weight gain guidelines.

### Methods

Participants were taking part in two larger studies. The first (the Christchurch cohort) aimed to describe women’s knowledge and perceptions of the risks of excess weight in pregnancy, and the second, factors related to intuitive eating in pregnancy (the Dunedin cohort). Both studies collected identical data related to perceived BMI and weight gain recommendations and measured the height and weight of all participants who consented. All women participating in the Dunedin and the Christchurch studies were included.

Recruitment was undertaken at four community radiology centres in Christchurch (in 2011), and one in Dunedin (in 2013–2015). Participants were recruited when attending their nuchal translucency (NT) scan at between 11 weeks and 13 weeks, 6-days gestation. Inclusion criterion included: the ability to read and write in English; consent to having height and weight measured; and additionally, for the Christchurch Cohort only, presenting with a completed Maternal Serum Screening in the First Trimester (MSS-1) form. Once recruited, participants were weighed on calibrated SECA 813 electronic scales, and had their height measured using SECA 206 or SECA 217 stadiometers. Instruction on the correct use of both the scales and stadiometers was provided by research staff according to instructions given in the 2008/09 Adult Nutrition Survey (Accessed at: www.health.govt.nz/publication/methodology-report-2008-09-nz-adult-nutrition-survey, page 28). Weight and height measurements were taken once and measurements were recorded to two decimal places. BMI was calculated as: weight (kg)/height² (m²).

To assess knowledge of appropriate weight gain for pregnancy, six options were posed by way of a paper-based, tick box survey completed by participants, including the 2009 IoM weight gain in pregnancy guidelines (Table One) and the options, “I should not gain any weight in my pregnancy”, plus “It does not matter how much weight I gain”. To assess perceived BMI,

### Table 1: 2009 Institute of Medicine Guidelines for Healthy Weight Gain in Pregnancy.1

<table>
<thead>
<tr>
<th>BMI (kg/m²)</th>
<th>Recommended weight gain (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight (&lt;18.5)</td>
<td>12.5–18</td>
</tr>
<tr>
<td>Normal weight (18.5–24.9)</td>
<td>11.5–16</td>
</tr>
<tr>
<td>Overweight (25–29.9)</td>
<td>7–11.5</td>
</tr>
<tr>
<td>Obese (≥30)</td>
<td>5–9</td>
</tr>
</tbody>
</table>
participants were asked, “What weight do you consider yourself?” with the options: underweight; normal weight; overweight; and obese. Education level was assessed via the options: attended high school; completed NCEA/Bursary or equivalent; trade certificate or similar; and university or tertiary institute degree or higher.

Ethnicity was established in accordance with the New Zealand Census, and ethnicity was self-reported. Free text was offered for parity and gestation. Gestation was asked to the Christchurch cohort as “How many weeks pregnant are you?”, and was established from the estimated date of delivery on the NT scan for the Dunedin cohort.

Stata 13.1 (StataCorp, Texas) was used for all statistical analyses. Contingency tables were constructed to compare actual versus perceived BMI category. From this, proportions were calculated of those that: accurately perceived their BMI category; overestimated their BMI category; and underestimated their BMI category. A similar process was used for the gestational weight gain recommendations. A kappa statistic was also calculated as a chance-adjusted measure of agreement for accurate identification of BMI category.

As very few women overestimated their BMI category, only demographic predictors of underestimating BMI category were examined. Multivariate logistic regression was used to determine the odds ratio of underestimating BMI category compared to accurately identifying their BMI category. The demographic predictor variables were: BMI category; age; education; ethnicity; and study location, and these were all mutually adjusted for each other. The same analysis was run for actual BMI values (without adjustment for BMI category). As the BMI distribution exhibited positive-skew, geometric means (95% confidence interval) are presented for descriptive purposes.

Odds ratios, 95% confidence intervals, and p-values were calculated. The same method was undertaken to determine demographic

| Table 2: Demographic characteristics (mean (SD)/n (%)). |
|-----------------|-----------------|-----------------|
|                | Christchurch n=384 | Dunedin n=260 | All n=644 |
| Age (years)    | 30.9 (5.3)        | 31.6 (4.9)      | 31.2 (5.2) |
| Gestation (weeks) | 12.0 (0.5)       | 14.1 (0.7)      | 12.9 (1.2) |
| Parity¹         | 1 (0, 1)          | 1 (0, 1)        | 1 (0, 1)   |
| Ethnicity²      |                  |                |            |
| NZ European     | 289 (77)          | 191 (74)        | 480 (76)   |
| Māori           | 17 (5)            | 12 (5)          | 30 (5)     |
| Pacific Island  | 5 (1)             | 3 (1)           | 8 (1)      |
| Other           | 64 (17)           | 53 (20)         | 117 (18)   |
| Education³      |                  |                |            |
| Did not complete high school | 96 (25) | 31 (12) | 127 (20) |
| Completed high school/trade certificate or diploma | 71 (19) | 40 (16) | 111 (17) |
| Tertiary degree | 211 (56)          | 187 (72)        | 398 (63)   |
| BMI category    |                  |                |            |
| Underweight (BMI<18.5) | 7 (2) | 0 | 7 (1) |
| Normal weight (BMI=18.5–24.9) | 201 (52) | 141 (54) | 342 (53) |
| Overweight (BMI=25–29.9) | 106 (28) | 85 (33) | 191 (30) |
| Obese (BMI ≥30) | 70 (18)          | 34 (13)         | 104 (16)   |

¹=median (IQR); ²=Nine participants gave no response when asked their ethnicity from the Christchurch cohort (2%) and one participant gave no response from the Dunedin cohort (0.4%); “Others” included European (52), Asian (30), American (12), Indian (8), African (7), Australian (3), Russian (2), and three unknowns; ³=Eight participants gave no response when asked their education level, six from the Christchurch cohort (2%) and 2 from the Dunedin cohort (0.8%).
predictors for both underestimating and overestimating gestational weight gain recommendations. Models were checked by the Hosmer-Lemeshow goodness of fit test with 10 groups.

Ethical approval for the Christchurch cohort was granted by the Upper South Island B Regional Ethics Committee (Ethics Reference: URB/11/EXP/032). Ethical approval for the Dunedin cohort was gained from the University of Otago Health Ethics Committee (Ethics Reference: 12/308).

Results

While 667 participants were recruited, only 644 agreed to have their weight and height measured and were therefore included in this analysis. The Dunedin cohort contributed 260 (40%) participants, and 384 (60%) were from the Christchurch cohort. The average age of participants was 31.2 years (range 18.2–49.9 years, Table 2), and the average gestation, 12.9 weeks. The majority of participants (76%) were of New Zealand European ethnicity. Participants were, in general, highly educated with 63% reporting a tertiary degree as their highest level of education, however one-fifth of the sample had not completed high school. Overall, 46% of participants were overweight (30% BMI 25–29.9 and 16% BMI>30).

Six participants did not respond to the questions regarding the perception of their BMI category, four from the Christchurch cohort and two from the Dunedin cohort. More than half the sample (66%) accurately reported their BMI category (Table 3). Nearly one-third of the sample (31%) underestimated their BMI category, while only 3% (n=16) overestimated their BMI category, and one-quarter of these women were underweight. The kappa statistic=0.39, indicated “fair” agreement9 between perceived and actual BMI category.

Overweight and obese women were much more likely to underestimate their BMI category than normal weight women (Table 4). For every BMI unit (kg/m2) higher, the odds that a woman underestimated her BMI category were 33% higher (p<0.001). After adjustment for other demographics, including BMI category, Māori and Pacific Island women were less likely to underestimate their BMI category compared to New Zealand European women (p=0.008). Age, education, and study location were not related to likelihood of underestimating BMI category (all p>0.05).

Twenty-four participants did not respond to the question asking what they considered a healthy weight gain for their pregnancy to be, eight from Christchurch (2%) and 16 from Dunedin (6%). One hundred and ninety-eight women (31%) identified the correct gestational weight gain recommendation for their pregnancy (Table 5). Eight percent of the women (n=50) reported that it did not matter how much weight they gained—the majority of these were of normal weight (n=28). Only four women answered that they thought that they should not gain any weight; three of these women were overweight and one was obese.

The average BMI of women who underestimated their gestational weight gain recommendation was 23 kg/m2, and this was significantly lower than that of women who accurately reported their gestational weight gain recommendation (BMI=25.7 kg/m2; p<0.001). Conversely, women who overestimated their gestational weight gain recommendation had a higher mean BMI than those women who were accurate (BMI=28.7kg/m2; p<0.001).

<table>
<thead>
<tr>
<th>Measured BMI category</th>
<th>Perceived underweight</th>
<th>Perceived normal weight</th>
<th>Perceived overweight</th>
<th>Perceived obese</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>3 (0.5)</td>
<td>4 (0.6)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Normal weight</td>
<td>6 (0.9)</td>
<td>322 (50)</td>
<td>12 (2)</td>
<td>0</td>
</tr>
<tr>
<td>Overweight</td>
<td>1 (0.2)</td>
<td>103 (16)</td>
<td>83 (13)</td>
<td>0</td>
</tr>
<tr>
<td>Obese</td>
<td>0</td>
<td>14 (2)</td>
<td>74 (12)</td>
<td>16 (3)</td>
</tr>
<tr>
<td>Total (n=638)</td>
<td>10 (2)</td>
<td>443 (69)</td>
<td>169 (26)</td>
<td>16 (3)</td>
</tr>
</tbody>
</table>

*Six participants did not answer this question, n=4 from the Christchurch cohort and n=2 from the Dunedin cohort*
### Table 4: Demographic differences between those that accurately predicted BMI category and those that underestimated.¹

<table>
<thead>
<tr>
<th></th>
<th>Accurate² n=421</th>
<th>Underestimated³ n=198</th>
<th>Odds ratio³ (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI4, kg/m²</td>
<td>23.7 (23.4, 24.1)</td>
<td>29.2 (28.7, 29.8)</td>
<td>1.33 (1.26, 1.41)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BMI category, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal weight (n=328)</td>
<td>322 (98)</td>
<td>6 (2)</td>
<td>Reference</td>
<td>-</td>
</tr>
<tr>
<td>Overweight (n=187)</td>
<td>83 (44)</td>
<td>104 (56)</td>
<td>68.9 (28.9, 164.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Obese (n=104)</td>
<td>16 (15)</td>
<td>88 (85)</td>
<td>375.5 (136.2, 1035.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age, years</td>
<td>31.3 (5.1)</td>
<td>31.0 (5.2)</td>
<td>0.98 (0.93, 1.03)</td>
<td>0.423</td>
</tr>
<tr>
<td>Education, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attended high school (n=121)</td>
<td>67 (55)</td>
<td>54 (45)</td>
<td>Reference</td>
<td>-</td>
</tr>
<tr>
<td>Completed high school/trade certificate/diploma (n=109)</td>
<td>73 (67)</td>
<td>36 (33)</td>
<td>1.02 (0.46, 2.29)</td>
<td>0.960</td>
</tr>
<tr>
<td>Tertiary degree (n=382)</td>
<td>276 (72)</td>
<td>106 (28)</td>
<td>0.94 (0.49, 1.82)</td>
<td>0.865</td>
</tr>
<tr>
<td>Ethnicity, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NZ European (n=463)</td>
<td>307 (66)</td>
<td>156 (34)</td>
<td>Reference</td>
<td>-</td>
</tr>
<tr>
<td>Māori/PI (n=37)</td>
<td>23 (62)</td>
<td>14 (38)</td>
<td>0.29 (0.12, 0.73)</td>
<td>0.008</td>
</tr>
<tr>
<td>Others (n=110)</td>
<td>84 (76)</td>
<td>26 (24)</td>
<td>1.03 (0.50, 2.12)</td>
<td>0.946</td>
</tr>
<tr>
<td>Study, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Christchurch (n=370)</td>
<td>246 (66)</td>
<td>124 (34)</td>
<td>Reference</td>
<td>-</td>
</tr>
<tr>
<td>Dunedin (n=249)</td>
<td>175 (70)</td>
<td>74 (30)</td>
<td>0.75 (0.45, 1.25)</td>
<td>0.265</td>
</tr>
</tbody>
</table>

¹Underweight participants’ excluded; ²Mean (SD) presented unless otherwise indicated; ³Mutually adjusted for other variables presented (excluding BMI, which was adjusted for everything except BMI category); ⁴Geometric mean (95% CI) presented

### Table 5: Accuracy in identification of gestational weight gain recommendation. “What do you consider to be a healthy weight gain for you in this pregnancy?”, n (%)  

<table>
<thead>
<tr>
<th></th>
<th>Underweight (n=7)</th>
<th>Normal weight (n=329)</th>
<th>Overweight (n=181)</th>
<th>Obese (n=103)</th>
<th>All (n=620)¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>It does not matter how much I gain</td>
<td>1 (0.2)</td>
<td>28 (5)</td>
<td>13 (2)</td>
<td>8 (1)</td>
<td>50 (8)</td>
</tr>
<tr>
<td>12.5–18kg</td>
<td>2 (0.3)</td>
<td>36 (6)</td>
<td>17 (3)</td>
<td>8 (1)</td>
<td>63 (10)</td>
</tr>
<tr>
<td>11.5–16kg</td>
<td>0</td>
<td>88 (14)</td>
<td>39 (6)</td>
<td>12 (2)</td>
<td>139 (22)</td>
</tr>
<tr>
<td>7–11.5kg</td>
<td>3 (0.5)</td>
<td>123 (20)</td>
<td>81 (13)</td>
<td>47 (8)</td>
<td>254 (41)</td>
</tr>
<tr>
<td>5–9kg</td>
<td>1 (0.2)</td>
<td>54 (9)</td>
<td>28 (5)</td>
<td>27 (4)</td>
<td>110 (18)</td>
</tr>
<tr>
<td>I should not gain any weight</td>
<td>0</td>
<td>0</td>
<td>3 (0.5)</td>
<td>1 (0.2)</td>
<td>4 (0.7)</td>
</tr>
</tbody>
</table>

¹Twenty-four participants did not answer this question, n=8 from the Christchurch cohort and n=16 from the Dunedin cohort
### Table 6: Demographic associations with over- or under-estimating gestational weight gain recommendations.

<table>
<thead>
<tr>
<th></th>
<th>Under-estimated (n=209)</th>
<th>Accurate (n=196)</th>
<th>Over-estimated (n=159)</th>
<th>Odds ratio for overestimating (95% CI)</th>
<th>p-value for</th>
<th>Odds ratio for underestimating (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMI, kg/m²</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.0 (22.6, 23.3)</td>
<td>25.7 (25.1, 26.4)</td>
<td>28.7 (27.9, 29.5)</td>
<td>1.21 (1.15, 1.27)</td>
<td></td>
<td>&lt;0.001</td>
<td>0.74 (0.70, 0.79)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>BMI category</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal weight (n=301)</td>
<td>177 (59)</td>
<td>88 (29)</td>
<td>36 (12)</td>
<td>Reference</td>
<td>-</td>
<td>Reference</td>
<td>-</td>
</tr>
<tr>
<td>Overweight (n=168)</td>
<td>31 (18)</td>
<td>81 (48)</td>
<td>56 (33)</td>
<td>3.90 (2.38, 6.40)</td>
<td>&lt;0.001</td>
<td>0.14 (0.09, 0.23)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Obese (n=95)</td>
<td>1 (1)</td>
<td>27 (28)</td>
<td>67 (71)</td>
<td>17.85 (9.86, 32.29)</td>
<td>&lt;0.001</td>
<td>0.01 (0.001, 0.04)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Age, years</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.7 (5.5)</td>
<td>31.7 (4.4)</td>
<td>31.7 (5.0)</td>
<td>1.03 (0.99, 1.08)</td>
<td>0.186</td>
<td></td>
<td>0.95 (0.90, 0.99)</td>
<td>0.012</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attended high school</td>
<td>36 (36)</td>
<td>27 (27)</td>
<td>37 (37)</td>
<td>Reference</td>
<td>-</td>
<td>Reference</td>
<td>-</td>
</tr>
<tr>
<td>Completed high school</td>
<td>34 (34)</td>
<td>29 (29)</td>
<td>36 (36)</td>
<td>1.36 (0.69, 2.69)</td>
<td>0.376</td>
<td>0.53 (0.25, 1.10)</td>
<td>0.090</td>
</tr>
<tr>
<td>Tertiary degree</td>
<td>134 (37)</td>
<td>139 (39)</td>
<td>85 (24)</td>
<td>0.72 (0.40, 1.28)</td>
<td>0.263</td>
<td>0.58 (0.31, 1.09)</td>
<td>0.091</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NZ European (n=423)</td>
<td>146 (35)</td>
<td>159 (38)</td>
<td>118 (28)</td>
<td>Reference</td>
<td>-</td>
<td>Reference</td>
<td>-</td>
</tr>
<tr>
<td>Māori-PI (n=32)</td>
<td>8 (25)</td>
<td>11 (34)</td>
<td>13 (41)</td>
<td>0.75 (0.32, 1.78)</td>
<td>0.517</td>
<td>1.70 (0.60, 4.87)</td>
<td>0.321</td>
</tr>
<tr>
<td>Others (n=100)</td>
<td>54 (54)</td>
<td>21 (21)</td>
<td>25 (25)</td>
<td>1.26 (0.70, 2.26)</td>
<td>0.441</td>
<td>2.57 (1.49, 4.44)</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>Study</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Christchurch (n=325)</td>
<td>127 (39)</td>
<td>99 (31)</td>
<td>99 (30)</td>
<td>Reference</td>
<td>-</td>
<td>Reference</td>
<td>-</td>
</tr>
<tr>
<td>Dunedin (n=239)</td>
<td>82 (34)</td>
<td>97 (41)</td>
<td>60 (25)</td>
<td>0.87 (0.56, 1.36)</td>
<td>0.548</td>
<td>0.65 (0.42, 0.99)</td>
<td>0.044</td>
</tr>
</tbody>
</table>

Independent of BMI, younger women were less likely to underestimate their gestational weight gain recommendations (p=0.012), whereas women of “other” ethnicity (p=0.001) were more likely to underestimate their gestational weight gain recommendation compared to New Zealand European women.

### Discussion

This study suggests that a third of pregnant women in New Zealand do not know their BMI category, and at least two-thirds do not know the recommended weight they should gain in pregnancy. Specifically, the higher a woman's BMI, the less likely she is to know her correct BMI status or recommended gestational weight gain. This is concerning, as women who are overweight and obese are at the highest risk for excess gestational weight gain.10,11 The World Health Organization reports that the obesity epidemic has the potential to negate many of the health benefits that have contributed to the increased longevity observed in the world.12 New Zealand has the third highest obesity rate in the OECD,
and rates are rising amongst those from all demographic groups.13 Of particular concern are the increasing levels of obesity amongst children because of the lifelong increased risk of comorbidities that obesity predisposes to.12

Research on the role that the foetal environment plays in the longer-term health of the offspring suggests obese mothers are more likely to have obese children, a worrying observation due to the potential to perpetuate the obesity epidemic.1,14-16 Our study identifies a further potential exacerbation of this effect due to the lack of maternal knowledge of their own BMI status and optimal weight gain. Other factors present in the foetal-neonatal period that have also been correlated with increased later-life obesity risk include small and large for gestational age, gestational diabetes (GDM), maternal diabetes mellitus, excessive maternal gestational weight gain, and failure to breastfeed—all of which more commonly occur in the overweight and obese mother, further compounding the risk of future obesity.1

In view of this, management of gestational weight gain has been suggested as an important time to intervene medically. There is evidence that interventions to optimise gestational weight gain are associated with a reduction in risk of pre-eclampsia, and trends towards a reduction in risk of GDM, gestational hypertension, preterm delivery, intrauterine foetal death and macrosomia.17

This study indicates that education is required to support the MoH guidance. Previous studies have identified that in New Zealand, LMCs8,18 and general practitioners19 do not weigh women before and throughout pregnancy, inform women of their BMI and BMI classification, or advise on appropriate pregnancy weight gain based on the IoM guidelines. Without this, we are not providing the full package of education that women require to adequately follow the MoH gestational weight gain guidance.

**Study strengths and limitations**

This study obtained data from 644 women, and thus had a large sample size. Of note, our sample was non-representative of the general New Zealand population. Our participants were highly educated and did not represent an ethnically diverse population, and this may mean our results are not generalisable to the New Zealand population as a whole. Further, our sample included 30% overweight and 16% obese women, lower than the latest population estimates for overweight and obesity in females of 30% and 31%, respectively.13

**Conclusion**

The most recent intervention put forth by the New Zealand MoH to reduce the impact of obesity during childhood is laudable. However, this study indicates that more education needs to be provided and emphasis given to weighing and measuring women, and also accurately advising them of their specific gestational weight gain targets, without this, we are not fulfilling our responsibilities as healthcare professionals, and essentially expecting women to ‘fly blind’.
Competing interests:
Dr. Paterson reports grants from Health Care Otago Charitable Trust during the conduct of the study.

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URL:

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Smoking in cars: knowledge, behaviours and support for smokefree cars legislation among New Zealand smokers and recent quitters

Judy Li, Sarah Nelson, Rhiannon Newcombe, Darren Walton

ABSTRACT

AIM: Exposure to second-hand smoke (SHS) poses serious health consequences to non-smokers, and normalises smoking. Currently, there is no legislation restricting smoking in private cars in New Zealand. This paper supplements previous New Zealand studies on exposure to SHS in cars by examining smokers and recent quitters’ knowledge and behaviours towards smoking in cars, and their support for two possible smokefree cars policy options.

METHOD: The New Zealand Smoking Monitor is a fortnightly survey that uses a self-refreshing panel approach. The questionnaire contains smoking- and cessation-related questions, including eight non-core questions addressing smoking in homes or cars.

These questions were answered by 364 respondents in 2014. Responses were compared by socio-demographic variables and recent quit attempt status.

RESULTS: Smoking in cars was common among the respondents in our sample: 63% had recently smoked in a car when they were the only person in it, and 27% had done so when there were other people present. Some groups of respondents exhibited information gaps around the harms (eg, compared with males, females had reduced odds of agreeing with the false statement: “it’s OK to smoke inside cars if there are windows open”, OR=0.41, 0.21–0.78); however, support for banning smoking in cars if there are children in them was consistently high across different sub-groups (92% overall).

CONCLUSION: Our data show the importance of providing specific information around the danger of smoking in cars, and strategies to enforce a complete smokefree rule in cars. Legislation may be required to further protect children from SHS exposure.

Strong empirical evidence has demonstrated the negative health consequences caused by exposure to second-hand smoke (SHS). In New Zealand, the Smoke-free Environments Act 1990 and the Smoke-free Environments Amendment Act 2003, ban smoking in workplaces, schools, early childhood education and care centres, public transports, indoor areas of hospitality venues (eg, bars, restaurants, cafes and casinos), and other locations. However, exposure to SHS in private settings continue to represent a public health challenge.

Studies focusing on the impact of SHS exposure in cars and residual tobacco smoke in cars provide specific evidence for the importance of reducing SHS exposure in cars. For example, an evidence review found that smoking in cars increased the concentration of atmospheric and biological markers of SHS. The authors also noted that the concentration found in cars was significantly higher than those measured in bars and clubs prior to when smokefree laws came into force.

At least five New Zealand studies have estimated the prevalence of SHS exposure in people’s homes and in private vehicles through self-report. For example, in the 2012/13 New Zealand Health Survey (NZHS), respondents were asked whether anyone smoked in their home, and in the car they usually travelled in. Among non-smoking adults (aged 15+ years), 4%
reported that there were people smoking in their homes, and 3% reported people smoking in cars. Exposure was significantly higher among young adults, for example, 9% of 15–19-year-olds, and 7% of 20–24-year-olds reported people smoking in the cars they usually travelled in (compared with 3% overall). Children (aged 0–14 years) represent another vulnerable group, with 6% of them exposed to SHS in homes and 5% in cars.10

An annual survey of Year 10 students used a different measure to assess SHS exposure. In 2012, 23% reported past 7-day SHS exposure in cars—a steady and significant drop from 31% in 2006.9 The New Zealand arm of the International Tobacco Control (ITC-NZ) Study offered different information by asking smokers to indicate whether they smoked in cars with non-smokers, and 75% said they never did.14

Apart from the self-reported data from both smokers and non-smokers, adding to the evidence is four published papers that have reported the point prevalence of smoking in cars in New Zealand using observational data.15-18 However, the generalisability of these studies is restricted by the sampling that only covers a limited geographical area. Notwithstanding this limitation, the overall findings are consistent: 1) point prevalence of smoking is lower in cars carrying children than those that do not,15-17 and, 2) there is a higher point prevalence in more socio-economically deprived areas.15-18 One study has tracked changes in the point prevalence of smoking in cars over time, and found a significant decrease from 6.4% in 2005, to 3.4% in 2013, in Wainuiomata, Wellington.15

To address the harm caused by SHS exposure in cars, a number of countries and jurisdictions (eg, Australia, some jurisdictions in Canada and the US, and South Africa) have banned smoking in cars when children are present, and positive outcomes were found post-implementation (reduced SHS exposure, increased prevalence of smokefree cars).19,20 In New Zealand, there is currently no legislation restricting smoking in private vehicles. The Māori Affairs Select Committee report recommended “that the Government investigate extending the Smoke-free Environments Act to legislate against smoking in certain areas, such as vehicles, vehicles carrying children, and specific public places” (such as playground, parks and beaches).21 and in response the New Zealand Government proposed to explore extending current smokefree restrictions to include vehicles.22

Alongside the Government’s intention to explore options around restricting smoking in private vehicles, there is also strong public support for banning smoking in cars where children are present. Importantly, a repeated cross-sectional national survey found a consistently high level of support was found among respondents of different social and population groups, and smoking status.23,24 Specifically, the 2014 data from the Health and Lifestyles Survey (HLS) showed that 97% of New Zealand adults support banning smoking in cars when there are children in them,24 an increase from 93% in 2012.23 A high level of public support for smokefree cars legislation was also found in another survey of New Zealand adults,25 and the ITC-NZ Study of current smokers.

This study supplements previous New Zealand studies14,25,26 by updating the information around support for smokefree cars legislation among smokers and recent quitters. By using a wide range of measures (including smoking behaviour in cars, exposure to other people’s smoking in cars, knowledge of SHS exposure, and support for smokefree cars legislation), this study also extends the existing knowledge by providing a more comprehensive assessment of the context around smoking in cars.

Methods

Instruments

This study focuses on 2014 New Zealand Smoking Monitor (NZSM) results from smokers and recent quitters to extend the findings from the previous studies conducted in New Zealand that provide a perspective on smoking in cars. The NZSM is a fortnightly monitor (n=180) implemented since 2011, and fieldwork is
delivered using computer-assisted telephone interviewing (CATI). Each interview lasts about 10 minutes. Ethics approval was obtained from the New Zealand Health and Disabilities Ethics Committee (Ref: 13/CEN/99).

The questionnaire has two components. The core component covers a range of smoking- and cessation-related topics and socio-demographic information, while the questions in the non-core component change every quarter to address emerging issues in tobacco control. This paper reported on the non-core questions on smoking in cars, in the field between August and October 2014.

Respondents who had smoked in the past 2 weeks (n=269) were asked if they had smoked in a list of locations during the past 2 weeks. The list included outside their home, inside their home, inside a car when they were the only person in it, and inside a car when there were other people in it. All respondents (n=364) were asked if they were exposed to SHS inside a car in the past 2 weeks.

Finally, all respondents indicated their agreement level to a list of five statements using the following response options: “strongly agree”; “agree”; “neither agree nor disagree”; “disagree”; and “strongly disagree”:

• The dangers of second-hand smoke have been exaggerated
• It’s OK to smoke around other people inside cars if there are windows open
• It’s OK to smoke inside cars when there are no other people in them
• Smoking in cars should be banned while children are in them
• Smoking in cars should be banned at all time.

Participants

Responses were gathered from a sample of New Zealand adult smokers or recent quitters (aged 18 years or over) who took part in the NZSM. A quota system was in place to ensure the sample consisted of three groups (n=60 per group, per fortnight), differentiated by participants’ current and past 3-month quitting behaviours:

• “non-attempters”: daily smokers who had not made a quit attempt lasting 24 hours or longer in the past 3 months
• “recent quit attempters”: daily smokers who had made a quit attempt lasting 24 hours or longer in the past 3 months
• “serious quitters”: ex-smokers or current smokers who had smoked regularly in the past 3 months, but had not smoked daily in the past 30 days, and they intended to stay smokefree in the next 3 months.

The NZSM uses a self-refreshing panel design. Respondents are maintained on the panel and interviewed up to six times. Those who drop out from the sample, either because they had completed six interviews or withdrawn, are replaced by new respondents. This study reports on data collected over five fortnights from 3 August to 11 October 2014.

During the study period, 364 respondents completed a total of 900 interviews. To ensure the behaviour and views of the participants are only captured once in the analysis, only the first set of responses collected from each participant were included.

Sampling procedure

Respondents were recruited through two methodologies. Non-attempters and recent quit attempters were recruited from a telephone-based omnibus survey, where a nationally represented sample of New Zealand adults aged 18 or over were recruited via random digit dialling. Respondents who were eligible to take part in the NZSM were asked for permission to be re-contacted, and they were then invited to take part at a subsequent phone call.

Due to the small incidence rate of serious quitters at a population level, this sample was recruited through the national Quitline client database. Each fortnight, a random sample of Quitline callers were invited to take part in the NZSM. Callers must have given prior consent for releasing their names and contact details. Potential respondents were contacted over the phone, the interviewers asked for their informed consent, and screened for
eligibility. Despite the different recruitment methods, all participants were interviewed by the same fieldwork company.

Analysis

The analysis was undertaken using STATA IC 13.1. Questions using an agreement/disagreement scale were dichotomised whereby “agree” and “strongly agree” responses were combined to indicate agreement with the statements. For all questions, participants who could not form an opinion (said they “don’t know”), or refused to answer, were excluded from the analysis for that particular question (up to 3% of total responses).

We first compared responses by the socio-demographic variables and past 3-month quit attempt status using crude odds ratios (OR). Multiple logistic regression models were then used to control for potential confounding (presented as the adjusted odds ratios/AOR).

Results

Sample characteristics

Socio-demographic characteristics of the sample, stratified by their recent quit attempts, are described in Table 1.

Smoking at home

Table 2 presents the association between socio-demographic characteristics, household composition and quit attempt status, and whether people smoked inside/outside their home and inside their car. Among those who had smoked in the past 2 weeks, 95% smoked outside their home, while only 28% did so inside their home.

---

Table 1: Socio-demographic characteristics by recent quit status.

<table>
<thead>
<tr>
<th></th>
<th>Non-attempters n=126</th>
<th>Recent quit attempters n=117</th>
<th>Serious quitters n=121</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>44.4</td>
<td>43.6</td>
<td>50.4</td>
</tr>
<tr>
<td>Female</td>
<td>55.6</td>
<td>56.4</td>
<td>49.6</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>19.8</td>
<td>24.8</td>
<td>24.0</td>
</tr>
<tr>
<td>Non-Māori</td>
<td>80.2</td>
<td>75.2</td>
<td>76.0</td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18–24 years</td>
<td>4.0</td>
<td>10.3</td>
<td>12.4</td>
</tr>
<tr>
<td>25–44 years</td>
<td>51.6</td>
<td>52.1</td>
<td>35.5</td>
</tr>
<tr>
<td>45–64 years</td>
<td>33.3</td>
<td>29.1</td>
<td>45.5</td>
</tr>
<tr>
<td>65+ years</td>
<td>11.1</td>
<td>8.5</td>
<td>6.6</td>
</tr>
<tr>
<td>Household equivalised income*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low $0–$34,600</td>
<td>22.2</td>
<td>32.5</td>
<td>29.8</td>
</tr>
<tr>
<td>Med $34,601–$66,500</td>
<td>34.1</td>
<td>33.3</td>
<td>27.3</td>
</tr>
<tr>
<td>High $66,501+</td>
<td>39.7</td>
<td>23.9</td>
<td>24.0</td>
</tr>
<tr>
<td>unspecified</td>
<td>4.0</td>
<td>10.3</td>
<td>19.0</td>
</tr>
<tr>
<td>Household composition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single adult</td>
<td>19.8</td>
<td>15.4</td>
<td>24.8</td>
</tr>
<tr>
<td>Multiple adults no children</td>
<td>38.1</td>
<td>28.2</td>
<td>28.1</td>
</tr>
<tr>
<td>With children</td>
<td>42.1</td>
<td>56.4</td>
<td>47.1</td>
</tr>
</tbody>
</table>

*Household equivalised income was calculated using an established formula that took into account the number and the age of children (0-18 years) residing in the household.14
Table 2: Smoking in home or cars in the past 2 weeks (proportion, odds ratio (OR) and adjusted odds ratio (AOR), n=269.

<table>
<thead>
<tr>
<th></th>
<th>Outside home</th>
<th>Smoked inside home</th>
<th>Smoke inside—car no people in it</th>
<th>Smoke inside car—with people in it</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% OR AOR</td>
<td>% OR AOR</td>
<td>% OR AOR</td>
<td>% OR AOR</td>
</tr>
<tr>
<td>Overall</td>
<td>95.2 - -</td>
<td>28.4 - -</td>
<td>62.5 - -</td>
<td>26.5 - -</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>95.9 Ref Ref</td>
<td>32.0 Ref Ref</td>
<td>66.4 Ref Ref</td>
<td>31.1 Ref Ref</td>
</tr>
<tr>
<td>Female</td>
<td>94.6 .74 (.24–2.33)</td>
<td>.72 (.42–1.23)</td>
<td>.60 (.33–1.10)</td>
<td>59.2 .73 (.45–1.21)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>93.7 Ref Ref</td>
<td>19.0 Ref Ref</td>
<td>66.7 Ref Ref</td>
<td>36.5 Ref Ref</td>
</tr>
<tr>
<td>Non-Māori</td>
<td>95.6 1.48 (.44–4.99)</td>
<td>2.56 (.48–13.69)</td>
<td>1.17 (.53–2.60)</td>
<td>23.4 .53 (.29–.97)</td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18–24 years</td>
<td>96.2 Ref Ref</td>
<td>11.5 Ref Ref</td>
<td>61.5 Ref Ref</td>
<td>38.5 Ref Ref</td>
</tr>
<tr>
<td>25–44 years</td>
<td>96.0 .95 (.11–8.51)</td>
<td>.14 (.01–2.74)</td>
<td>1.76 (.49–6.38)</td>
<td>63.7 1.10 (.46–2.62)</td>
</tr>
<tr>
<td>45–64 years</td>
<td>95.6 .86 (.09–8.05)</td>
<td>.35 (.02–6.83)</td>
<td>4.88 (1.36–17.47)</td>
<td>62.2 1.03 (.42–2.53)</td>
</tr>
<tr>
<td>65+ years</td>
<td>89.7 .35 (.03–3.56)</td>
<td>.17 (.01–3.57)</td>
<td>5.30 (2.01–33.52)</td>
<td>58.6 .89 (.30–2.61)</td>
</tr>
<tr>
<td>Household equivalised income*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low $0–$34,600</td>
<td>94.8 Ref Ref</td>
<td>39.0 Ref Ref</td>
<td>48.1 Ref Ref</td>
<td>20.8 Ref Ref</td>
</tr>
<tr>
<td>Med $34,601–$66,500</td>
<td>97.8 2.41 (.43–13.54)</td>
<td>1.76 (.24–12.68)</td>
<td>1.67 (.36–1.30)</td>
<td>65.6 2.06 (1.10–3.84)</td>
</tr>
<tr>
<td>High $66,501+</td>
<td>93.8 .82 (.21–3.18)</td>
<td>.46 (.08–2.75)</td>
<td>3.6 (1.38–37.75)</td>
<td>71.3 2.68 (1.39–5.18)</td>
</tr>
<tr>
<td>Unspecified</td>
<td>90.9 .55 (.09–3.21)</td>
<td>.21 (.02–1.99)</td>
<td>1.82 .35 (.11–1.13)</td>
<td>68.2 2.32 (.85–6.31)</td>
</tr>
<tr>
<td>Household composition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single adult</td>
<td>89.6 .20 (.05–.87)</td>
<td>.06 (.01–.56)</td>
<td>45.9 3.77 (1.84–7.75)</td>
<td>58.3 .88 (.45–1.73)</td>
</tr>
<tr>
<td>Multiple adults no children</td>
<td>94.4 .39 (.09–1.68)</td>
<td>.22 (.04–1.30)</td>
<td>33.7 2.27 (1.21–4.23)</td>
<td>66.3 1.24 (.71–2.17)</td>
</tr>
<tr>
<td>With children</td>
<td>97.7 Ref Ref</td>
<td>18.3 Ref Ref</td>
<td>61.4 Ref Ref</td>
<td>25.2 Ref Ref</td>
</tr>
<tr>
<td>Quit attempt status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-attempters</td>
<td>97.6 Ref Ref</td>
<td>32.8 Ref Ref</td>
<td>73.0 Ref Ref</td>
<td>27.2 Ref Ref</td>
</tr>
<tr>
<td>Recent quit attempters</td>
<td>98.0 1.17 (.19–7.15)</td>
<td>.85 (.13–5.68)</td>
<td>27.6 .78 (.44–1.39)</td>
<td>58.2 .51 (.29–.90)</td>
</tr>
<tr>
<td>Serious quitters</td>
<td>82.2 .11 (.03–.45)</td>
<td>.05 (.01–.26)</td>
<td>17.8 .44 (.19–1.04)</td>
<td>42.2 .27 (.13–.55)</td>
</tr>
</tbody>
</table>

Statistically significant differences at p<0.05 are denoted in bold.
Table 3: Exposure to second-hand smoke inside a car in the past 2 weeks (proportion, OR and AOR), n=364.

<table>
<thead>
<tr>
<th>Exposure to second-hand smoke inside a car in the past two weeks</th>
<th>%</th>
<th>OR</th>
<th>AOR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall</strong></td>
<td>32.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>34.7</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Female</td>
<td>31.1</td>
<td>.85 (.55–1.32)</td>
<td>.80 (.50–1.29)</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>47.6</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Non-Māori</td>
<td>28.5</td>
<td>.44 (.26–.73)</td>
<td>.42 (.24–.74)</td>
</tr>
<tr>
<td><strong>Age group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18–24 years</td>
<td>62.5</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>25–44 years</td>
<td>33.9</td>
<td>.31 (.14–.67)</td>
<td>.27 (.11–.63)</td>
</tr>
<tr>
<td>45–64 years</td>
<td>29.8</td>
<td>.25 (.11–.57)</td>
<td>.26 (.11–.62)</td>
</tr>
<tr>
<td>65+ years</td>
<td>9.4</td>
<td>.06 (.02–.25)</td>
<td>.07 (.02–.30)</td>
</tr>
<tr>
<td><strong>Household equivalised income</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low $0–$34,600</td>
<td>27.5</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Med $34,601–$66,500</td>
<td>36.5</td>
<td>1.52 (.85–2.71)</td>
<td>1.34 (.71–2.51)</td>
</tr>
<tr>
<td>High $66,501+</td>
<td>32.7</td>
<td>1.28 (.71–2.33)</td>
<td>1.08 (.55–2.11)</td>
</tr>
<tr>
<td>Unspecified</td>
<td>35.9</td>
<td>1.48 (.67–3.25)</td>
<td>1.28 (.54–3.05)</td>
</tr>
<tr>
<td><strong>Household composition</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single adult</td>
<td>20.5</td>
<td>.52 (.27–1.00)</td>
<td>1.07 (.49–2.34)</td>
</tr>
<tr>
<td>Multiple adults no children</td>
<td>40.0</td>
<td>1.34 (.83–2.19)</td>
<td>1.40 (.78–2.49)</td>
</tr>
<tr>
<td>With children</td>
<td>33.1</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td><strong>Quit attempt status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-attempters</td>
<td>36.5</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Recent quit attempters</td>
<td>37.6</td>
<td>1.05 (.62–1.76)</td>
<td>.93 (.53–1.64)</td>
</tr>
<tr>
<td>Serious quitters</td>
<td>24.2</td>
<td>.55 (.32–.96)</td>
<td>.43 (.23–.81)</td>
</tr>
</tbody>
</table>

Statistically significant differences at p<0.05 are denoted in bold.

In the univariate models, being in a single adult household compared to a household with children, and being a serious quitter as opposed to a non-attempter, were associated with a reduced odds of smoking outside the home. Correspondingly, being in an older age group (aged 45+ years) compared to those aged 18–24 years, having a low income compared to a high income, and households without children, were associated with increased odds of smoking inside the home. After adjustment, except for the increased odds of smoking inside the home for those from a single adult household compared to a household with children, these associations remained. Furthermore, the odds of smoking inside the home became statistically significantly higher for non-attempters compared with serious quitters.

**Smoking in cars**
Among those who had smoked in the past 2 weeks, 63% smoked inside a car when they were the only person in it, while 27% smoked when there were also other people present.

In the univariate models, having a medium or high income, compared to those
having a low income, had increased odds of smoking inside a car when they were the only person in it. Increased odds were also found among non-attempters when compared with recent quit attempters and serious quitters. After adjustments, these associations remained.

In the univariate models on smoking around other people in a car, Māori compared with non-Māori, those aged 18–24 years compared with those aged 65+ years, those in a household with children compared with those living on their own, had increased odds of reporting this behaviour. After adjustment, the differences by ethnicity and household composition were no longer statistically significant.

Exposure to second-hand smoke in a car

One-third of the respondents reported being exposed to SHS inside a car in the past 2 weeks (see Table 3). In the univariate models, Māori when compared with non-Māori, those aged 18–24 years compared with their older counterparts, non-attempters compared with serious quitters, had increased odds of reporting being exposed. After adjustment, these associations remained.

Knowledge of harms

Three questions were used to assess knowledge of harm relating to SHS exposure, and two of them were specifically around smoking in cars. Three in 10 (30%) respondents agreed with the statement that “The dangers of second-hand smoke have been exaggerated” (see Table 4). Only 13% agreed that “It’s OK to smoke around other people inside cars if there are windows open”, while half of the respondents agreed that “It’s OK to smoke inside cars when there are no other people in them”.

The only factor that consistently predicted knowledge level was gender, with female respondents being more wary of the impact caused by exposure to SHS (ie, reduced odds of showing agreement with the misbelief). Differences by quit attempt status were observed for two out of three measures, with serious quitters having increased odds of agreeing with the statements.

While the differences by age did not reach statistical significance for any of the comparisons on knowledge of harms (possibly due to the small sample size), there are some indicators that young adults (aged 18–24 years) were less informed about the harms relating to smoking in cars.

Support for legislation

The large majority of respondents (91%) agreed that smoking in cars should be banned when children are present. This high level of support was universal across all social and population groups, despite some statistically significant differences by household composition and quit attempt status.

In contrast, only 30% agreed that smoking in cars should be banned at all times. Differences by gender, household composition and quit attempt status were found. For example, female respondents were more likely to support a total ban than males.

Discussion

Through smokers’ self-report, we found that smoking in cars was common among our sample (60% smoked when they were the only person in the car and 26% smoked when there were also other people in it). The proportion of respondents who reported smoking inside their home, and those who reported smoking inside a car while there were people in it was similar (27–28%); however, the profiles of people who smoked in these two settings were different. For example, while older respondents were more likely to smoke inside their home, the reverse was true for smoking inside a car while there were people in it.

Findings from the current study reveal information gaps among some of the respondents. For example, we found that 13% of the respondents believed that as long as the windows are open, it is OK to smoke inside cars even when there are people around. We found an even larger proportion of respondents (49%) believed that it’s OK to smoke inside cars when there are no people in them, implying a lack of understanding of the harms of tobacco smoke residue that does linger in the cars for a prolonged period of time.7,8 In New Zealand, previous mass-media campaigns have attempted to educate the public on the health consequences of SHS exposure in homes and in cars.26
Table 4a: Agreement with the statements that assessed knowledge level and support for policy on smokefree cars (proportion and AOR) n=364

<table>
<thead>
<tr>
<th></th>
<th>The dangers of second-hand smoke have been exaggerated</th>
<th>It’s OK to smoke around other people inside cars if there are windows open</th>
<th>It’s OK to smoke inside cars when there are no other people in them</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% OR AOR</td>
<td>% OR AOR</td>
<td>% OR AOR</td>
</tr>
<tr>
<td>Overall</td>
<td>29.9 – 12.8 – 48.8</td>
<td>12.8 – 48.8</td>
<td>–</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>38.7 Ref Ref</td>
<td>18.1 Ref Ref</td>
<td>56.0 Ref Ref</td>
</tr>
<tr>
<td>Female</td>
<td>22.0 .45 (.28–.72)</td>
<td>8.3 .41 (.21–.78)</td>
<td>42.5 .58 (.38–.88)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>21.1 Ref Ref</td>
<td>11.1 Ref Ref</td>
<td>45.8 Ref Ref</td>
</tr>
<tr>
<td>Non-Māori</td>
<td>32.3 1.79 (.98–3.29)</td>
<td>1.40 (.73–2.70)</td>
<td>8.3 (.41–1.88)</td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18–24 years</td>
<td>25.8 Ref Ref</td>
<td>19.4 Ref Ref</td>
<td>59.4 Ref Ref</td>
</tr>
<tr>
<td>25–44 years</td>
<td>26.9 1.06 (.44–2.54)</td>
<td>13.0 .62 (.23–.69)</td>
<td>46.7 .60 (.28–1.29)</td>
</tr>
<tr>
<td>45–64 years</td>
<td>28.0 1.12 (.46–2.73)</td>
<td>12.4 .59 (.21–.66)</td>
<td>47.7 .62 (.28–1.37)</td>
</tr>
<tr>
<td>65+ years</td>
<td>58.6 4.07 (1.37–2.14)</td>
<td>6.7 .30 (.05–.61)</td>
<td>53.1 .78 (.29–2.09)</td>
</tr>
<tr>
<td>Household equivalised income*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low NZ$0–$34,600</td>
<td>34.7 Ref Ref</td>
<td>12.7 Ref Ref</td>
<td>38.0 Ref Ref</td>
</tr>
<tr>
<td>Med NZ$34,601–$66,500</td>
<td>31.5 .87 (.49–1.54)</td>
<td>9.7 (.51–1.64)</td>
<td>12.4 .97 (.43–1.57)</td>
</tr>
<tr>
<td>High NZ$66,501+</td>
<td>23.0 .56 (.30–1.05)</td>
<td>5.5 (.27–1.12)</td>
<td>9.2 (.31–1.89)</td>
</tr>
<tr>
<td>Unspecified</td>
<td>30.6 .83 (.36–1.88)</td>
<td>10.3 .78 (.24–2.56)</td>
<td>52.5 1.80 (.86–3.78)</td>
</tr>
<tr>
<td>Household composition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single adult</td>
<td>40.3 1.96 (1.08–3.57)</td>
<td>1.32 (.62–2.82)</td>
<td>53.4 1.66 (.96–2.87)</td>
</tr>
<tr>
<td>Multiple adults no children</td>
<td>30.0 1.25 (.73–2.13)</td>
<td>.96 (.51–1.79)</td>
<td>58.0 2.00 (1.24–3.23)</td>
</tr>
<tr>
<td>With children</td>
<td>25.6 Ref Ref</td>
<td>9.1 Ref Ref</td>
<td>40.9 Ref Ref</td>
</tr>
<tr>
<td>Quit attempt status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-attempters</td>
<td>37.6 Ref Ref</td>
<td>14.5 Ref Ref</td>
<td>65.6 Ref Ref</td>
</tr>
<tr>
<td>Recent quit attempters</td>
<td>28.4 .66 (.38–1.15)</td>
<td>1.02 (.50–2.09)</td>
<td>.41 (.24–.69)</td>
</tr>
<tr>
<td>Serious quitters</td>
<td>23.5 .51 (.29–.90)</td>
<td>.59 (.27–.32)</td>
<td>.24 (.13–.43)</td>
</tr>
</tbody>
</table>

Statistically significant differences at p<0.05 are denoted in bold.
Table 4b: Agreement with the statements that assessed knowledge level and support for policy on smoke-free cars (proportion and AOR) n=364.

<table>
<thead>
<tr>
<th>Category</th>
<th>Smoking in cars should be banned while children are in them</th>
<th>Smoking in cars should be banned at all times</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% OR AOR</td>
<td>% OR AOR</td>
</tr>
<tr>
<td>Overall</td>
<td>92.0 – 29.0</td>
<td>29.0 – –</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>90.5 Ref Ref</td>
<td>22.2 Ref Ref</td>
</tr>
<tr>
<td>Female</td>
<td>93.4 1.48 (.69–3.18) 1.54 (.69–3.45) 35.1 1.91 (1.20–3.05) 2.00 (1.20–3.33)</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>90.4 Ref Ref</td>
<td>30.5 Ref Ref</td>
</tr>
<tr>
<td>Non–Māori</td>
<td>92.5 1.32 (.56–3.10) 1.88 (.73–4.87) 28.6 .91 (.53–1.56) 1.06 (.57–1.95)</td>
<td></td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18–24 years</td>
<td>96.9 Ref Ref</td>
<td>28.1 Ref Ref</td>
</tr>
<tr>
<td>25–44 years</td>
<td>92.9 .42 (.05–3.36) .33 (.04–2.85) 23.2 .77 (.33–1.81) 1.05 (.41–2.71)</td>
<td></td>
</tr>
<tr>
<td>45–64 years</td>
<td>89.3 .27 (.03–2.13) .22 (.03–1.83) 35.1 1.38 (.59–3.24) 1.98 (.78–5.05)</td>
<td></td>
</tr>
<tr>
<td>65+ years</td>
<td>93.8 .48 (.04–5.62) .47 (.03–6.34) 35.5 1.41 (.48–4.08) 2.03 (.59–6.95)</td>
<td></td>
</tr>
<tr>
<td>Household equivalised income*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low NZ$0–$34,600</td>
<td>94.1 Ref Ref</td>
<td>39.6 Ref Ref</td>
</tr>
<tr>
<td>Med NZ$34,601–$66,500</td>
<td>91.3 .66 (.23–1.87) .67 (.22–2.04) 27.0 .56 (.32–1.00) .67 (.36–1.25)</td>
<td></td>
</tr>
<tr>
<td>High NZ$66,501+</td>
<td>91.6 .68 (.23–1.99) 1.04 (.33–3.32) 19.6 .37 (.20–.69) .50 (.25–1.00)</td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>90.0 .56 (.15–2.11) .47 (.11–1.93) 33.3 .76 (.35–1.66) .69 (.30–1.61)</td>
<td></td>
</tr>
<tr>
<td>Household composition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single adult</td>
<td>91.8 .60 (.21–1.76) .42 (.11–1.55) 30.6 .89 (.49–1.60) .60 (.28–1.31)</td>
<td></td>
</tr>
<tr>
<td>Multiple adults no children</td>
<td>87.8 .39 (.16–.93) .38 (.14–1.02) 21.7 .56 (.33–.96) .57 (.30–1.07)</td>
<td></td>
</tr>
<tr>
<td>With children</td>
<td>94.9 Ref Ref</td>
<td>33.1 Ref Ref</td>
</tr>
<tr>
<td>Quit attempt status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non–attempters</td>
<td>88.9 Ref Ref</td>
<td>12.8 Ref Ref</td>
</tr>
<tr>
<td>Recent quit attempters</td>
<td>91.5 1.34 (.57–3.14) 1.22 (.50–3.02) 31.9 3.19 (1.66–6.14) 3.02 (1.53–5.95)</td>
<td></td>
</tr>
<tr>
<td>Serious quitters</td>
<td>95.9 2.90 (1.01–8.32) 3.40 (1.07–10.77) 43.0 5.13 (2.72–9.70) 5.07 (2.56–10.04)</td>
<td></td>
</tr>
</tbody>
</table>

Statistically significant differences at p<0.05 are denoted in bold.
Our data suggest that these messages need to be continued, and that more specific and informative messages around smoking in cars might also be required to point out the importance of having a complete smokefree rule in cars, such as the danger of third-hand smoke. Males and non-attempters appeared to be less aware of the harm caused by SHS exposure, and therefore more targeted messages for these groups might be particularly useful.

In addition to the health benefits, requiring smokefree cars could potentially denormalise smoking so as to increase successful quitting and decrease smoking uptake. Previous New Zealand studies have found that exposure to smoking in cars is associated with susceptibility to future smoking among adolescent never-smokers, and predicted smoking uptake among pre-adolescents. New Zealand has a national smokefree goal, and therefore it is particularly important to implement strategies that promote denormalisation of smoking.

**Policy implications**

While both national and international studies reported a steady decline in people’s exposure to SHS in cars over time, having legislation relating to smokefree cars is a way of ensuring all children are protected. The 2012/13 NZHS data show that the rate of exposure to SHS in cars differed by ethnicity and neighbourhood deprivation. Specifically, Māori and Pacific children (compared with European/Other), and those who lived in a more deprived neighbourhood were more likely to be exposed to SHS. Consistent with the findings from previous studies that have assessed the level of public support among both smokers and non-smokers in New Zealand, our data showed that over 90% of respondents supported banning smoking in cars when there are children in them.

The proportion of respondents who supported banning smoking in cars at all times was substantially lower, at 30%. The differential levels of support towards these two legislation options are probably unsurprising. Previous studies have consistently found stronger support for measures and interventions that focus on children’s welfare. In the context of smoking in cars, there is a strong rationale for protecting children from SHS exposure because they are more likely to suffer health consequences than adults.

**Health promotion implications**

Data from the current study show different behavioural responses towards smoking in cars by ethnicity. Māori respondents were more likely to smoke in the car when there were other people in it, and they were also more likely to be exposed to SHS while in the car. However, knowledge levels and support for legislation did not differ between Māori and non-Māori. In addition to knowledge-based campaigns, other interventions that focus on behaviour change (eg, how to negotiate and enforce a smokefree rule) might also be beneficial for Māori. This type of interventions could be delivered in a range of settings including smoking cessation services, parenting support groups and family planning services.

**Strengths and limitations**

The current study includes a wide range of measures in relation to smoking in cars. This update of self-reported data by smokers and recent quitters provide a different perspective to recent studies using self-reports by smokers and non-smokers, and allow us to examine their knowledge around SHS exposure. This information would be useful for the development of new health promotion messages on SHS exposure.

One of the limitations of this study is the small sample size in general. The small number of Pacific respondents also meant that we are unable to assess the behaviours and views of Pacific smokers and recent quitters on this topic. Pacific children are more likely to be exposed to SHS in cars than European/Other children, and therefore, Pacific families should be considered as a priority audience for future smokefree cars messages.

Unfortunately, this study does not provide any specific information for this ethnic group. It is also important to note that the sample is not representative. In particular, we have deliberately over-sample ‘serious quitters’. Both limitations could be
addressed in future research by collecting data from large population-based surveys of smokers such as the ITC-NZ Study.

Another limitation is around the self-report of smoking behaviours. It is possible that smoking behaviours are under-reported by the respondents because of social desirability bias. Other objective data collected through observational methodology (eg, the Kid's Cam project) could be used to validate self-reported results.

Conclusion
Prevalence of SHS exposure in cars has been established in a number of previous New Zealand studies. This study uses a different methodology by asking smokers and recent quitters to report on their smoking behaviour in home and cars, their knowledge around SHS exposure, and support for banning smoking in cars. Our data show a high rate of smoking in cars and exposure to other people’s smoking in cars, and strong support for legislation. Together with other existing evidence on public support and effects of SHS exposure, these findings are in support of the Government’s response to the Māori Affairs Select Committee report around legislation on smokefree cars.

Competing interests:
Nil.

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Treatment injury is a frequent cause of patient morbidity and mortality. A recent study estimated the number of adverse events in healthcare at approximately 10% of hospitalisations globally, resulting in 23 million years lost through disability or death every year. Failures in teamwork and communication contribute to many of these adverse events, notably in the operating room (OR).3,4,5

The OR is a high acuity, complex environment, and therefore prone to errors, with particular need for good communication and teamwork. However, staffing patterns in the OR may render it particularly prone to errors in communication. In a large hospital, the composition of the OR team varies from day to day, or even over the course of the day, with limited time for staff to gain an understanding of each other's capabilities and establish the sense of mutual respect and trust required for open communication and effective teamwork. The OR team is typically comprised of three disciplinary groups (surgical, anaesthesia, nursing) with different backgrounds and training. Established hierarchies and professional boundaries may inhibit speaking up and the sharing of information.6

There is some evidence that training OR teams can improve teamwork,7 and convincing evidence that using the Surgical Safety Checklist (the Checklist), a tool...
designed to improve information sharing among OR team members, can reduce the morbidity and mortality associated with surgery. However, the way the Checklist is used varies, and in consequence, so does its effect on patient outcomes. We suggest that a receptive and supportive culture is required to fully realise the potential benefits of communication tools such as the Checklist and that an understanding of the benefits to patient outcomes of effective teamwork and communication would help to promote such a culture.

To this end we devised the Multidisciplinary Operating Room Simulation (MORSim) intervention, comprising a day of simulated, challenging surgical cases, debriefing and discussion for OR teams to increase their understanding of the importance of communication and teamwork. We based MORSim on a theoretical framework of teamwork proposed by Salas. This framework incorporates five key dimensions of effective teams and three underpinning mechanisms. The key dimensions are: leadership, team orientation, mutual performance monitoring, back up behaviour and adaptability. The underpinning mechanisms are: shared mental models, mutual trust and closed loop communication.

This study is part of a programme of research with the overall aim of implementing simulation-based training of OR personnel in teamwork and communication in all hospitals in New Zealand. Our end-of-course evaluation of MORSim described positive participant reactions to the course, self-reported evidence of learning and improved scores for teamwork and communication. In this study we looked for transfer to clinical practice, measured through change in observable teamwork and communication behaviours across all general surgical ORs in the two participating hospitals.

We used the Behavioural Marker Risk Index (BMRI) to measure the impact of our intervention, with an additional question specific to MORSim. The BMRI measures six domains of behaviour: briefing, information sharing, inquiry, contingency management, assertion and vigilance. These are measured at three phases of surgery, defined by the original authors as the induction phase (from when the patient enters the OR until the incision), intraoperative phase (from incision until wound closure) and the handoff phase (from wound closure until transition to the next level of care is complete). The rationale for using this particular measure was the previously documented link between BMRI scores and patient outcomes. In Mazzocco’s original BMRI study, poor BMRI scores for teamwork were significantly associated with patient death or complications after surgery. In this study, our focus was the improvement of inter-disciplinary information sharing, so we added a seventh domain to assess information sharing between the three teams (surgeons, anaesthetists and anaesthetic technicians, and nursing staff: Table 1).

We aimed to test the following hypothesis; “That, using the extended BMRI measurement tool, overall scores for teamwork and communication across all the general surgical operating room teams in the two study hospitals would improve from the period before MORSim to the period following MORSim.”

Methods

Ethics approval was obtained from Auckland Regional Ethics Committee (NTX/12/EXP/067) and the ethics committees of the two hospitals involved in the study. (Australia and New Zealand Clinical Trials Registry ID 12612001088831.)

The MORSim Intervention

The Intervention was a full-day multidisciplinary OR simulation course (MORSim) based at the Simulation Centre for Patient Safety (SCPS), University of Auckland. It consisted of three simulations with debriefs and presentations on communication strategies. The three simulations were each of 40 minutes duration and required OR teams to manage acute surgical cases. We created a realistic OR environment similar to that in our participants’ hospitals. We used real drug ampoules, fluids, sterile syringes, needles and fluid giving sets as found in the clinical environment, artificial blood presented in packaging and identifiers as provided by the blood bank, equipment such as rapid infusion devices, fluid warmers, anaesthetic machine, suction,
diathermy and sterile surgical instruments and drapes. Patient clinical notes and investigations were available electronically. We designed the simulations so that the participants worked together on the case without prompts or input from faculty, as they would do in their normal working environment. A faculty nurse in the simulation room assisted only when requested by the participants eg by helping them to locate equipment, take blood, confirming (or not) the presence of a rash. We used Laerdal 3G SimMan (Stavanger, Norway) and METI® HPS™ (Sarasota, FL, USA) manikins. We commissioned a special effects company (Main Reactor, Auckland New Zealand) to manufacture life-like surgical models that integrated with both the manikins to allow surgeons to operate on the models using surgical instruments and, when appropriate, control blood loss.

Two scenarios depicted patients with acute abdominal pathology: appendicitis complicated by sepsis and subsequent allergic reaction, and a stab wound with a lacerated inferior vena cava (IVC) complicated by cardiovascular collapse. The third scenario involved a trauma patient with leg amputation following an explosion, complicated by lung barotrauma.

Simulations were preceded by familiarisation with the simulation environment. Participants were then given standardised written clinical briefings. These briefings were substantially identical, but each team member received a unique, additional, clinically relevant and important item of information about the patient. We chose items that could plausibly be known by the particular team member, but not necessarily by the others. Examples included: the patient was carrying an asthma inhaler; the patient was recently on long haul flight and had calf pain 24 hours ago; and metronidazole had been charted in the Emergency Department but not yet administered.

All scenarios were followed by a 40-minute debrief using a structured framework to guide discussion about teamwork, information sharing and communication strategies, with particular reference to whether the unique items of information given to each team member had or had not been shared, and the reasons for this.

We ran 20 study days with 120 participants, who were drawn equally from the two study hospitals. On any day, the six invited participants were from the same hospital (and thus likely to work together clinically) and comprised a consultant surgeon, a surgical resident, a consultant anaesthetist or anaesthetic fellow, an anaesthetic technician and two OR nurses.

### Data collection

We used the extended BMRI to score teamwork in the ORs of the two study hospitals before and after the intervention. We coded within-discipline information sharing to the BMRI original domain “information sharing”, and between-disciplinary information sharing to a new domain “Inter-disciplinary information sharing”. We followed the scoring methodology used by Mazzocco et al. Each of the seven domains was scored during Mazzocco et al.’s three phases of surgery described previously: induction, intraoperative, and handoff. Each domain was

<table>
<thead>
<tr>
<th>Domain</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Briefing</td>
<td>Situation/relevant background is shared; patient, procedure, site/side are identified; plans are stated; questions are asked; ongoing monitoring and communication is encouraged.</td>
</tr>
<tr>
<td>Information sharing</td>
<td>Information is shared; intentions are stated; mutual respect is evident; social conversations are appropriate.</td>
</tr>
<tr>
<td>Inquiry</td>
<td>Input and other relevant information is asked for.</td>
</tr>
<tr>
<td>Contingency management</td>
<td>Relevant risks are identified; backup plans are made and executed.</td>
</tr>
<tr>
<td>Assertion</td>
<td>The members of the team speak up with their observations and recommendations during critical times.</td>
</tr>
<tr>
<td>Vigilance</td>
<td>Tasks are prioritized; attention is focused; patient/equipment is checked, monitoring is maintained; tunnel vision is avoided; red flags are identified.</td>
</tr>
<tr>
<td>Inter-disciplinary information sharing</td>
<td>Information is shared between the surgical, anaesthesia and nursing teams.</td>
</tr>
</tbody>
</table>

Table 1: Domains used in scoring the modified BMRI.  

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scored on a scale from 0–4 according to how frequently relevant behaviours were observed in each of the three phases. To enable comparison with Mazzocco et al.’s results, scores for each domain were then converted to binary form (3 or 4=1; 1 or 2=0) where 0 indicates that all behaviours were observed frequently and 1 indicates that the behaviours were never or only infrequently observed. An average BMRI score from 0 to 1 was then calculated for the three phases, as well as an overall BMRI for the case. To assess any potential confounding influences we also recorded case duration, the patient American Society of Anesthesiologists (ASA) score,14 the duration and type of operation and the number of OR staff present.

Sample size for OR observations
We aimed to collect observations on 200 cases before and 200 cases after the intervention guided by the Mazzocco study,13 where a relationship was shown in BMRI scores and patient outcomes comparing two groups each containing 150 cases.

Observers and training
The four observers involved in the study were medical students in their third year of study. Two observers (LC, MT) carried out all the observations before the MORSim course and two different observers (LS, MC) carried out all observations after the course. Two weeks of training were conducted with experienced researchers (DC, MB) for each pair of observers. The training included an introduction to teamwork behaviour studies and the extended BMRI tool as well as orientation to the OR environment, as recommended by Carthey et al.15 To ensure standardisation between the four observers, they participated in a series of training exercises before undertaking the clinical observations. In these, videos of eight surgical cases were rated by the observers using the extended BMRI rating form. The training cases had previously been rated by the two trainers using the same instrument to establish the standard. These cases included videos of simulated surgical cases and cases from the OR. Any discrepancies between raters and between the instructor score were discussed until consensus was reached. This process was repeated and inter-rater agreement was calculated at each step until acceptable agreement (RWG >0.8) was reached. (RWG=within-group inter-rater agreement.)

To ensure inter-rater agreement was maintained during the observation periods between raters, calibration sessions were held after each rater had completed 5–10 observations during the initial rating period, and then after every 50 observations, in accordance with recommended good research practice for observational work.16,17 These calibration sessions followed the same protocol as the training sessions except that if acceptable agreement (RWG >0.8) was not reached, the previously observed cases, back to the most recent acceptable calibration, were discarded from analysis.

Selection of procedures
Data were collected before the first MORSim course, between August and December 2012, and after the last MORSim course between September and November 2013. Cases to be scored were selected at the start of each workday during the collection period. In the pre-MORSim observations, if more than one general surgical case was scheduled at the same time, we selected cases of shorter duration to expedite data collection. In the post-MORSim observations, if more than one general surgical case was scheduled at the same time, we selected cases where at least some of the OR staff had attended MORSim. Therefore, staff observed included a mix of those who had and had not attended MORSim.

Statistics/analysis
Extended BMRI scores pre- and post-MORSim were compared using ANOVA. Covariates included in the preliminary analysis were the operation time of day, the duration of the case, patient ASA score and total number of people in the OR. Independent variables with significant univariate effects were included in the final model. To test for the effect of the course on any specific item(s), a logistic regression model was used with the binary score of the domain as the dependent variable and the same independent variables as above. For statistical tests, significance was set at 0.05 and analysis was performed using R v3.0.1 (http://cran.r-project.org). We used a Bonferroni correction in a secondary analysis of pre-post effect on individual domains.

Results
A total of 453 cases in the OR were observed. At an early rater calibration
Table 2: The number (and percent) of observed cases with unadjusted extended BMRI scores of 3 or 4 (frequently or always) in each BMRI domain across the three phases of the case pre MORSim (pre) and post MORSim (post).

<table>
<thead>
<tr>
<th>BMRI Domain</th>
<th>BMRI Phase</th>
<th>Induction</th>
<th>Intraoperative</th>
<th>Handoff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%) scored 3-4</td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
</tr>
<tr>
<td>Briefing</td>
<td></td>
<td>132 (58.9)</td>
<td>175 (82.2)</td>
<td>6 (2.7)</td>
</tr>
<tr>
<td>Information sharing</td>
<td></td>
<td>212 (94.6)</td>
<td>179 (84.0)</td>
<td>153 (68.3)</td>
</tr>
<tr>
<td>Inquiry</td>
<td></td>
<td>144 (64.3)</td>
<td>123 (57.7)</td>
<td>64 (28.6)</td>
</tr>
<tr>
<td>Vigilance</td>
<td></td>
<td>210 (93.8)</td>
<td>191 (89.7)</td>
<td>191 (85.3)</td>
</tr>
<tr>
<td>Contingency management</td>
<td></td>
<td>6 (2.7)</td>
<td>15 (7.0)</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>Assertion</td>
<td></td>
<td>2 (0.1)</td>
<td>2 (0.1)</td>
<td>4 (1.8)</td>
</tr>
<tr>
<td>Interdisciplinary information sharing</td>
<td></td>
<td>136 (60.7)</td>
<td>180 (84.5)</td>
<td>45 (20.1)</td>
</tr>
</tbody>
</table>

Table 3: Details of the cases observed for modified BMRI ratings before (Pre-MORSim) and after the MORSim intervention (Post-MORSim). Values are mean and standard deviation (Mean (SD)) for numbers of staff present and case duration, and as number and percentage of cases in each category (number (%)) for start time, and ASA status.

<table>
<thead>
<tr>
<th>MEASURE</th>
<th>Pre-MORSim</th>
<th>Post-MORSim</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of staff present</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Total staff in OR</td>
<td>8.3 (1.6)</td>
<td>10.0 (2.2)</td>
</tr>
<tr>
<td>Surgeons</td>
<td>1.7 (0.7)</td>
<td>2.0 (0.7)</td>
</tr>
<tr>
<td>Anesthesiologists</td>
<td>1.3 (0.5)</td>
<td>1.7 (0.6)</td>
</tr>
<tr>
<td>Nurses</td>
<td>3.2 (0.6)</td>
<td>3.5 (0.9)</td>
</tr>
<tr>
<td>Techs</td>
<td>1.1 (0.3)</td>
<td>1.3 (0.5)</td>
</tr>
<tr>
<td>Other</td>
<td>0.9 (1.0)</td>
<td>1.4 (1.1)</td>
</tr>
<tr>
<td>Case duration</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Minutes</td>
<td>95.6 (61.9)</td>
<td>110.7 (67.6)</td>
</tr>
<tr>
<td>Start time for case</td>
<td>Number (%)</td>
<td>Number (%)</td>
</tr>
<tr>
<td>0700-1000</td>
<td>101 (45.1%)</td>
<td>99 (46.5%)</td>
</tr>
<tr>
<td>1000-1300</td>
<td>75 (33.5%)</td>
<td>79 (37.1%)</td>
</tr>
<tr>
<td>1300-1500</td>
<td>34 (15.2%)</td>
<td>33 (15.5%)</td>
</tr>
<tr>
<td>1500-2000</td>
<td>14 (6.3%)</td>
<td>2 (0.9%)</td>
</tr>
<tr>
<td>Patient ASA status</td>
<td>Number (%)</td>
<td>Number (%)</td>
</tr>
<tr>
<td>I</td>
<td>61 (27.2%)</td>
<td>57 (26.9%)</td>
</tr>
<tr>
<td>II</td>
<td>111 (49.6%)</td>
<td>80 (37.7%)</td>
</tr>
<tr>
<td>III</td>
<td>46 (20.5%)</td>
<td>70 (33.0%)</td>
</tr>
<tr>
<td>IV</td>
<td>6 (2.7%)</td>
<td>5 (2.3%)</td>
</tr>
</tbody>
</table>

*ASA = American Society of Anesthesiologists*
session, agreement of one rater was below the threshold (RWG > 0.8) and 14 observations were discarded. Data from two observations were incomplete. This left 437 total observations for analysis (224 pre-MORSim, 213 post-MORSim), distributed evenly between the two hospitals.

Of the 213 post-MORSim cases observed, 145 involved at least one MORSim participant and 67 involved no MORSim participants. Of these 145 cases, 86 had at least one surgeon, 20 had at least one anaesthetist, 89 had at least one nurse and 28 cases had at least one anaesthetic technician who had attended MORSim.

The domains ‘contingency management’ and ‘assertion’ were observed on only 56 occasions in the 1,311 observation periods (437 cases, three phases) and were therefore excluded from further analysis as was the case in the Mazzocco et al. study.13

In respect of potential cofounders, BMRI was significantly related to the time of day the case started (p<0.001), the duration of the case (p<0.001), the number of staff in the OR (p<0.001) and patient ASA score (p<0.001). These factors were reasonably evenly distributed between groups (Table 3) and were included in the final model.

In the final model, overall the extended BMRI decreased (improved) pre- to post-MORSim by more than 20%, (0.41 v 0.32, p<0.001). There was statistically significant improvement in the extended BMRI for the induction and intraoperative phase pre- and post-MORSim in a repeated measure ANOVA (pre-post BMRI scores for induction, 0.255 v 0.005 p<0.001; intraoperative, 0.590 v 0.413 p<0.001 and handoff 0.380 v 0.346 p=0.22).

Individual domains in each of the three operative phases where BMRI scores of 3–4 were more frequently observed post-MORSim were: induction—‘briefing’, ‘interdisciplinary information sharing’, ‘information sharing’; intraoperative—‘briefing’, ‘interdisciplinary information sharing’; handoff—‘information sharing’, ‘vigilance’. However, we found that for ‘information sharing’ at the induction and handoff phases BMRI scores of 3–4 were less frequently observed post-MORSim with an odds ratio of less than 1 (Table 4).

### Table 4: Odds ratios (95% confidence levels) for pre-post effect on individual domains rating highly (3 or 4) in the extended BMRI tool, after controlling for confounders. Significant changes are denoted with *at 0.05, **at 0.01, ***at 0.001 level after a Bonferroni correction.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Induction</th>
<th>Intra-operative</th>
<th>Handoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Briefing</td>
<td>4.0 (2.4–6.9)***</td>
<td>12.0 (5.2–32.9)***</td>
<td>2.1 (1.3–3.4)*</td>
</tr>
<tr>
<td>Info sharing</td>
<td>0.3 (0.1–0.6)**</td>
<td>1.5 (0.9–2.6)</td>
<td>0.3 (0.2–0.5)***</td>
</tr>
<tr>
<td>Inquiry</td>
<td>0.7 (0.4–1.0)</td>
<td>1.5 (1.1–2.9)</td>
<td>0.8 (0.5–1.2)</td>
</tr>
<tr>
<td>Vigilance</td>
<td>0.4 (0.2–1.0)</td>
<td>1.3 (0.7–2.5)</td>
<td>2.9 (1.6–5.7)**</td>
</tr>
<tr>
<td>Inter-team</td>
<td>5.1 (2.9–9.4)***</td>
<td>7.3 (4.4–12.4)***</td>
<td>1.2 (0.8–2.0)</td>
</tr>
</tbody>
</table>

### Discussion

Following a multidisciplinary simulation-based team training intervention, extended BMRI scores for teamwork and communication in the clinical environment improved by more than 20% (0.41 v 0.32, p<0.001). Extrapolating from the work of Mazzocco et al.13 (as an indication of the potential order of magnitude of benefit) suggests that this could translate into a relative reduction of 14% in 30-day rates of complications and mortality in surgical patients.

We have previously reported improved BMRI scores in simulated cases over the course of the MORSim training day, positive participant evaluations and examples of learning and change in attitude from analysis of post-simulation debriefs.12 This current report extends our prior work by indicating that these changes appear to be maintained over time and are associated with changes in behaviour in actual clinical practice. Our study thus adds to evidence supporting the relationship between simulation-based team training interventions for OR staff and improved clinical practice which is likely to manifest in improved patient outcomes. In a recent systematic review of what works in OR teamwork training,7 we found only one OR simulation-based intervention that provided evidence of change in clinical practice. This was in the form of participant self-report of changes in the OR.18 A subsequent report on an insurer-funded multidisciplinary simulation-based OR team training intervention also reported that participants intended to make changes in their clinical practice.
after the course. Our findings go further by demonstrating improved scores for the extended BMRI measure of teamwork and communication in the clinical setting following our intervention, which is important because of the previous link between BMRI scores and improved patient outcomes.

We also noted a number of previously unreported factors influencing the BMRI scores which are of relevance to other researchers using the BMRI. Scores deteriorated for cases scheduled later in the day. Perhaps this was due to less perceived need for communication as the team became better acquainted with each other, or perhaps they became more fatigued. The effect of case duration on the BMRI scores may be attributable to the greater opportunity provided by longer cases for raters to observe the relevant behaviours. Scores were also better when there were more staff and more complicated cases.

Limitations

Ideally the raters would have been blinded to the intervention, however this was not possible in our naturalistic, observational pre-post study design. To limit bias, the raters were not involved in any other aspect of the MORSim intervention. Using different pairs of raters, pre and post intervention may have introduced error into the scores but using the same raters pre and post may have added other bias as the raters would have been looking for change. We attempted to mitigate rater error by regular calibration against set standards. These calibration sessions used the same video recordings, and ratings were consistent over time suggesting this did not have an important effect on the scores.

The observations for BMRI scoring of surgical teams occurred in actual ORs, which introduced elements beyond our control. We acknowledge there may have been other educational, quality improvement or organisational factors over the period of the study that contributed to our findings. Ideally a control group would be used, but this would require a much larger, multicentre study, and will be an area for future research. As discussed above, the fact that the study took place in an actual clinical environment could also be considered one of its strengths.

As this study involved observations of actual clinical practice, we could not observe the same teams or individuals before and after MORSim, or only MORSim participants. Thus, we were measuring the effect of the intervention on the general surgical theatres as a whole, rather than on individuals or specific teams. Even so, we were able to demonstrate an effect, and could postulate an even greater effect would be observed if all OR staff were able to participate in training. Participation in MORSim was voluntary, and so our preference for observations of OR cases that included at least some MORSim participants could have introduced an element of bias. While we selected mainly senior clinical staff, increasing team familiarity over the period of the study may have influenced BMRI scores.

Our estimation of the potential order of magnitude of benefit depends on extrapolation from the previous research by a different team in a different clinical context and should be taken as indicative rather than precise. It is possible that the additional question we added to the BMRI may have somehow influenced the previously established association between the BMRI and patient outcomes, but we would expect this to be a stronger effect if anything.

Future research in this area could usefully explore what percentage of staff should be exposed to the intervention to have an effect, the influence of participant discipline on subsequent impact on BMRI scores, and additional evidence of an association between BMRI scores and patient outcomes.

Conclusions

We have demonstrated improved scores for teamwork and communication in the general surgical ORs in two major hospitals following a multidisciplinary simulation-based intervention. Based on previous studies these improved scores could translate to a clinically important reduction in morbidity and mortality of surgical patients.

These results, along with previous research, provide support for incorporation of simulation-based team training into quality and safety initiatives for OR staff. Improving teamwork and communication in the OR could have a major impact on outcomes for surgical patients.
Competing interests:
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URL:


**Key design features of a new smokefree law to help achieve the Smokefree Aotearoa New Zealand 2025 goal**

Louise Delany, George Thomson, Nick Wilson, Richard Edwards

**ABSTRACT**

**AIM:** To design new tobacco control legislation to achieve the New Zealand Government’s 2025 smokefree goal.

**METHOD:** An original analysis of the legislative options for New Zealand tobacco control.

**RESULTS:** ‘Business as usual’ is most unlikely to achieve smoking prevalence that is less than 5% by 2025. Key components of a new Act would ideally include plans and targets with teeth, a focus on the industry, a focus on the product, reduction of supply, and a whole-of-society approach to promote consistency in policy implementation through: i) a public duty on government agencies to act consistently with smokefree law; ii) a general duty on those associated with the tobacco/nicotine industry in relation to tobacco control objectives; and iii) a principle requiring international treaties to be interpreted consistently with tobacco control objectives.

**CONCLUSION:** Strategies such as those identified in this Viewpoint should be explored further as part of urgently needed planning to achieve the New Zealand Government’s goal for Smokefree Aotearoa by 2025.

In 2010, the Māori Affairs Committee of Parliament justified the need for, and recommended the goal of, making New Zealand a smokefree nation by 2025. The Government response said that “the Government agrees with a longer term goal of reducing smoking prevalence and tobacco availability to minimal levels, thereby making New Zealand essentially a smoke-free nation by 2025”.

The Response did not specify the meaning of ‘minimal’, but as the then relevant Minister of the Crown (Hon Tariana Turia) noted:

"Public health proponents and tobacco control advocates have interpreted the Government's goal of reducing smoking prevalence and tobacco availability to minimal levels to mean a smoking rate of less than 5% of New Zealand adults, and that this should be achieved across all major ethnic groups."

In 2013, the Ministry of Health stated that to achieve the long-term smokefree goal, the specific goals for 2018 would be: “daily smoking prevalence falls to 10% in 2018”, and “the Māori and Pacific rates halve from their 2011 levels”. In 2015, the Ministry identified these 2018 goals as 19% for Māori and 12% for Pacific. In this paper the concepts of ‘minimal levels’ and ‘less than 5%’ will be understood as equivalent.

**Developments since 2011**

Since the Government response to the Māori Affairs Committee report, additional policy measures have been implemented. These include the point-of-sale display ban, annual above-inflation tobacco taxation increases, reductions in duty-free allowances, increased penalties for sales to minors, and other measures. A Smoke-free Environments (Tobacco Plain Packaging) Amendment Bill to implement standardised packaging is before Parliament but not progressed, although there may be further developments in 2016.

These steps are very positive, but not sufficient to meet a ‘minimal’ prevalence
level of under 5% for 2025, or a 10% level for 2018. Research indicates that, following a business-as-usual approach:

... the projected smoking prevalences in 2025 are 8.3% and 6.4% for non-Maori men and women, and 18.7% and 19.3% for Maori respectively. Under this BAU forecasting scenario, a below 5% smoking prevalence will be achieved ... sometime after 2060 for Maori men and women. ...7

The New Zealand Government has not developed an action plan to achieve the 2025 goal of minimal prevalence despite recommendations.8

The need for a new approach

It has been 25 years since the original 1990 New Zealand Smoke-free Environments Act (SFEA). That Act, as amended a number of times, has served New Zealand well, but new thinking is now required to address the challenging goal of Smokefree Aotearoa in the context of major changes, including:

• **International developments:** Since the SFEA’s enactment in 1990, the Framework Convention on Tobacco Control (FCTC) has been ratified (entailing obligations under international law and a strong mandate for effective national law); worldwide awareness of non-communicable diseases to which tobacco contributes has increased, as emphasised in the United Nations Political Declaration in 2011; and globalisation has developed momentum. International trade and investment law has changed in character, increased in scope, and become stronger in terms of enforceability. International trade and investment law is increasingly converged, and more focused than 25 years ago on policies within countries with the potential to negatively affect tobacco control.

• **Technologies:** E-cigarettes and other new forms of nicotine delivery have been developed. Since 1990, global communication has been transformed by the internet, further enabling transnational marketing and cross-border consumer transactions with the use of new media, ie: “… the combination and convergence of computing and information technology, communications networks and digitised media and information content.”11

• **Tobacco industry initiatives:** The industry had continued to find ways to get around tobacco control policies, including tobacco taxation.12 For instance, following bans on advertising of tobacco products in most media in developed countries, the tobacco industry has focused on tobacco promotion by other means, including product placement on films and marketing through contact with retailers, social media, and the internet.11

• **New tobacco control ideas:** The tobacco control community has learned over the last 25 years to “imagine things otherwise”.13 New approaches and ideas, often conceptualised as ‘endgame’ strategies, include supply-side measures; denormalisation of tobacco and the tobacco industry; the need to protect child rights (crystallised in the United Nations Convention on the Rights of the Child, ratified in 1993); and product modification such as denicotinisation.17 There is now an increased awareness of inequalities in smoking and its adverse effects, and the need to address them both within and between countries.

Do we need a new Act, or would amending the present SFEA suffice?

The changes proposed in this Viewpoint could be implemented by either one new Act, or a number of incremental amendments enacted over time. The changes proposed are extensive, the need for action is urgent if smokefree goals are to be met, and significant time would be required to progress separate legislative amendments. This Viewpoint considers, therefore, that a completely new Act would be preferable.
The ideas set out below are structured as one Act with an integrated set of strategies.

### New legislative strategies proposed

We suggest six strategies that are new for New Zealand tobacco control law to complement existing measures: a new Authority mandated to develop plans and targets, equity provisions, a focus on the industry, a focus on the product, provisions relating to supply, and promotion of consistency in policy and implementation.

### A new Authority mandated to develop plans and specify targets

The proposed new Act would establish a government authority (a Tobacco and Nicotine Authority—TANA). This would not involve a ‘new’ agency but sit within the Ministry of Health (as does the Psychoactive Substances Regulatory Authority, see Section 10 of the Psychoactive Substances Act 2013). The TANA would have specific statutory duties and powers to develop and implement plans to reach specified smoking prevalence goals and interim targets. These would relate to both the general population of New Zealand and specific population groups, with a primary focus on those groups with the highest current smoking prevalences. TANA’s powers would involve most aspects of tobacco supply and marketing, price issues, control of tobacco product design and content, and decisions on licensing. TANA would require dedicated legal resources, to ensure that legal challenges at domestic and international levels are effectively anticipated and met. TANA would also be a partner with Treasury in formulating advice to Government on issues relating to tobacco taxation. To ensure effective activity, for an initial 10-year period, TANA and its work would be financed from a fund that would receive 10% of tobacco tax revenue.

The cornerstone of this planning would be an explicit goal of under 5% smoking prevalence by 2025 for both the general population and specific population groups. Targets would be established for 2018 and 2020 as well as the overall goal for 2025. Strategies for achieving these targets would include specific measures, such as reducing tobacco availability, product modification, smokefree outdoor policies, increasing the minimum allowable age of tobacco purchase to 21 years, continued substantial tobacco tax increases and requiring minimum tobacco product prices.

Planning would also consider new nicotine devices (including fast-acting inhalers) and products. TANA would be required to report to Parliament annually on progress towards the targets.

There would be four stipulated dates: 2018, 2020, 2025 and 2040. The date of 2018 is required because the Government has already set targets for lower prevalence rates to be achieved by that year (general, Māori and Pacific). The Act would require, during 2018, a formal review of Smokefree Aotearoa goals to be undertaken to gauge progress and make targets for a second date of 2020. This 2020 date would be critical given there would be then only 5 further years before 2025.

If the 2020 targets are not met, this could trigger a further set of conditional provisions in the Act to come into force in mid-2021. If the 2020 targets are met, these conditional provisions need not come into effect.

The conditional provisions would include, in particular, allowing the retail of tobacco and nicotine products only from those outlets with a limited incentive to profit from tobacco sales. This would exclude all existing retailers, such as dairies, supermarkets and petrol stations, but allow for the possibility of sale through ‘not-for-profit’ agencies or ‘health’ oriented outlets, with incentives (specified in contractual conditions) to reduce rather than increase sales. Such outlets would be relatively amenable to regulatory control. Further conditional provisions could include ‘smokefree generation’ policies (involving further progressive increases of the purchase age to reduce availability and ensure long-term sustainability of reduced rates) and licensing requirements for tobacco users.

Inclusion of the 2040 date in TANA planning responsibilities responds to the
need to think beyond 2025, which could include licensing for those people still smoking. By 2040 we should be able to demonstrate that new generations are virtually smokefree—with close to nil smoking in people aged under 40 years, and under 1% smoking prevalence for all population groups.

**Enhancing equity in process and outcomes**

Provisions to address equity would respond to the major contribution that tobacco has made to ill-health and reduced economic well-being among Māori for many decades. Reduction of ethnic inequalities in health would be an explicit and major focus of planning, and for implementing activities and resources, as required by Section 3 of the New Zealand Public Health and Disability Act.19 The Act would require TANA to have appropriate Māori and Pacific leadership, and would require and empower all government agencies to ensure that policies and actions accord with the Government goals for reducing Māori and Pacific smoking rates. TANA would be required to ensure full stakeholder and community consultation on proposed strategies and measures for endorsement from Māori (and Pacific) communities.

TANA would address the need to reduce socioeconomic health inequalities in health (eg, smoking by level of area deprivation) in making recommendations on tax increases (including the use of tobacco tax revenue to increase equity),20 and in focusing tobacco control mass media campaigns towards high-need audiences.

**A focus on the industry**

Provisions that focus on the tobacco industry (including the related retail sector) would ensure that this industry is more transparent and accountable in relation to its activities, marketing, products, research, plans, taxation, lobbying activities and profits. The Act would include disclosure requirements that go beyond those in the current SFEA to include sales data and information on market research (see Canada’s Tobacco Reporting Regulations, which requires in Regulation 15 annual reports on research regarding the health effects of tobacco products, as well as marketing and the manner in which the product is used by consumers).21 Disclosure would also be required of tobacco industry accounts, including those of parent companies offshore, sufficient to enable independent calculation of profits within the New Zealand market. This would include relevant information such as international transfers and subsidies. Information on tobacco accounts would also be relevant to any future decision on additional taxes on corporate profits.

While substantial tax increases should continue, the tobacco prices that the industry could charge would be capped at the stage before release from Customs bond (ie, before tax) and revised as necessary by regulation, to limit the ability to make windfall profits from minimum tobacco price regulations.22,23 Minimum prices would, among other things, ensure that the purpose of tobacco taxation is not frustrated by, for instance, keeping the price of ‘budget-oriented’ products disproportionately low following tax increases. Currently, the impact of tobacco tax rises in New Zealand is partially eroded by low-cost brand price manipulation.12 Capped pre-tax tobacco prices would set a maximum price for a product, and enable government to control the revenue the industry receives. The intervention could be used to limit profits, while increasing revenue to government, and allowing minimum retail prices to be set.22,23

The Act could set out responsibilities relating to exporters that would require the industry to act in accordance with New Zealand law outside of the country (unless required otherwise by the relevant importing country). For example, if pictorial warnings with specified messages are required in New Zealand, these would also be required in countries to which the product is exported (modified as appropriate, for example translations for written parts of warnings). This policy option has been proposed in the US.24

**Focus on the product**

Provisions in the current Act that relate to the tobacco product itself are limited. For instance, although the regulation-making
powers in Section 39 enable prohibition of product constituents, there is no specific provision for reducing them (although that is probably the intent of the Act, see Section 31). Neither does the present Act authorise regulations on aspects of product design (for example, to remove filters, disallow perforations, or specifications for certain colours to be used for cigarette paper), although this is referred to in the Smoke-free Environments (Tobacco Plain Packaging) Amendment Bill.

A new Act would further regulate tobacco product constituents, as suggested by World Health Organization guidelines. This would include: i) direct prohibition in the Act of some constituents, and ii) regulation making powers to allow further constituents to be prohibited in the future (as required). Relevant criteria for constituent prohibition would include their potential for increased toxicity and addictiveness, and also potential for environmental harm. Examples of constituents that could be prohibited include menthol, addiction enhancers (eg, ammonia), sweeteners and flavours. In addition to prohibition of some constituents, the Act could require reduction of nicotine levels, or authorise regulations to that effect.

The Act would refer in a limited way to the role of alternative nicotine products in relation to the 2025 goals. Given existing uncertainty about the best way forward for such products (especially e-cigarettes), the Act might best take a cautious approach. This could continue the status quo (that is, a virtual ban except for personal imports of nicotine-containing e-cigarettes), with potential to regulate at a later date when there is more evidence on the population-level benefits and harms of such products. For example, regulation-making powers could authorise sales of alternative nicotine products by licensed retailers (eg, pharmacists) to licensed users.

A focus on supply

The control of the tobacco and nicotine supply would include licensing of tobacco/nicotine importers, wholesalers, and retailers. That is, neither manufacturers nor retailers would be able to sell or supply tobacco unless licensed to do so. TANA would process applications for licences. The Act would specify criteria relevant to licence applications including, for retail outlets, geographical considerations. These would relate to density (that is, numbers of retail outlets per local authority district) and also proximity of outlets to facilities, such as schools and childcare providers, and venues, such as those with alcohol licences. Other criteria relevant to both manufacturers and retailers would relate to standards required of licensees, for example previous compliance with tobacco control obligations.

In accordance with Government’s long-term goal of reducing tobacco availability, the Act could enable progressive reductions of numbers of outlets. TANA would be empowered to set goals for maximum numbers of retail outlets, to be reached by 2020, and then 2025, in relation to the size or population of the local district.

The Act would also provide for reduced numbers of tobacco brands and descriptors. In particular, no licence might be granted to import, manufacture, or sell new tobacco brands or variants from a specified date.

Policy consistency

Tobacco control law and policies, and their implementation, are influenced by many actors and agencies within New Zealand and elsewhere. Policies emanating outside the health sector can negate health aims or frustrate real synergies in promoting them. Policy inconsistencies and a lack of congruence are apparent, especially between tobacco control objectives and “wider economic and foreign policy agendas, focusing particularly on tensions with trade agreements”. The lack of policy congruence internationally is reflected at the national level: governments pursue the implementation of trade and investment-related agreements at the same time as, and arguably with greater vigour than, law related to health objectives.

While the proposed strategies would not change the tensions at the international level, they will provide domestic levers to strengthen New Zealand’s commitment to international health-related law and enable implementation of such concepts as ‘health in all policies’, ‘whole of government’ or ‘whole of society’. As noted
in the New Zealand Ministry of Health Review of Tobacco Control Services Report, a focus on “joined up government and on Health in All Policies (HiAP) internationally and in New Zealand would provide a platform to increase cross-sectoral activity to achieve Smokefree 2025”.29

‘Whole of society’ provisions would first include a public duty applicable to all government agencies to act consistently with the new Smokefree Act, the Framework Convention on Tobacco Control, and other relevant international law. Among other things, this would mean that legal advice, court action or other legal process would be required to have close regard to, and give effect to, national and international law relevant to tobacco control.

Drafting of such a ‘whole of society’ provision would affirm New Zealand’s commitment to the Framework Convention on Tobacco Control and protection of human rights (somewhat similar to the language in the long title of the New Zealand Bill of Rights Act 1990). This provision could be strengthened by a provision modelled on section 6 of the New Zealand Bill of Rights Act 1990 which states: “Wherever an enactment can be given a meaning that is consistent with the rights and freedoms contained in this Bill of Rights, that meaning shall be preferred to any other meaning.” Such provisions would be enforced by generally accepted strategies such as Parliamentary oversight, scrutiny by the Auditor-General, and where necessary through judicial review.

Second, the Act would include a general duty relevant to those associated with the tobacco/nicotine industry (manufacturers and importers; retailers; and advisers in communication, policy, or law). This duty would require those associated with the industry to act consistently with the purposes of the Act, targets promulgated under the Act, and relevant international law. Breaches of such a duty would include the supply of misleading information to the public and parliamentarians, and lobbying against steps that would implement relevant international law, in particular the FCTC, the International Covenant on Economic, Social and Cultural Rights and the United Nations Convention on the Rights of the Child.30 A version of this concept is proposed in discussing elements of a global tobacco endgame.31

A recent example of a relatively general duty to comply with ‘fundamental requirements’ is found in the New Zealand Radiation Safety Act 2016, a duty which in that Bill is backed up by a provision to the effect that contravention of a specified fundamental requirement is an offence. Clause 65 of the Bill provides that such an offence would be subject to, in the case of an individual, a fine not exceeding $100,000; or (b) in the case of a person or an organisation other than an individual, to a fine not exceeding $500,000 (section 62).

Third, the Act would set out principles for the New Zealand interpretation of international treaties. This would provide that all such treaties that New Zealand ratifies be interpreted (insofar as they affect New Zealand) so as to progress the implementation of international law that relates to tobacco control. Relevant international law would include, in particular, the FCTC and other relevant instruments relevant to tobacco control including the UN Political Declaration 2011.

The provision echoes to some extent the 2001 US presidential order requiring that implementation of international trade law by federal departments not conflict with tobacco control objectives through, for example, promoting the sale or export of tobacco products.32

Our proposals would go beyond this Executive Order by the inclusion of language similar to that of the New Zealand Bill of Rights Act 1990, as proposed above. Additional wording could mirror both article 31(3)(c) of the Vienna Convention on the Law of Treaties (which states that in interpreting treaties relevant rules of international law applicable in the relations between the parties are to be taken into account); as well as Chapter 1 of the United Nations Charter. The Charter refers to one of the purposes of the United Nations: “to achieve international co-operation in solving international problems of an economic, social, cultural, or humanitarian character…”

The provisions aimed at policy consistency could apply singly or together. In combination they could be relevant, for instance, to an attempt to invoke investor-
state dispute mechanisms in international trade law. Provisions that recognise corporate duties in relation to international law are consistent with the United Nations Framework for Business and Human Rights.33

Provisions in the present Act to be extended

The Act would carry forward existing strategies in the present Act that restrict the promotion of tobacco and related products, provide for smokefree environments, and restrict the purchase and supply age for relevant products. The new Act would also:

1. Extend the scope of the Act to nicotine delivery/vaping products and devices of all kinds so as to be explicit in disallowing use of such products in environments relevant to smoked tobacco products. Any regulations made (in accordance with regulation making provisions proposed above) to allow for sales of alternative nicotine products in limited circumstances, eg, to licensed users, would trigger an extension of TANA responsibilities to such products. This would include requirements for outlet licensing, ensure promotion is prohibited (except perhaps to note they may be a quitting tool for existing smokers) and require health information and warnings. The regulation-making powers would set out criteria for any future licensing of users (eg, age and history of use of tobacco or nicotine).

2. Extend the scope of smokefree outdoor environments and further promote the visual denormalisation of smoking. The present Act requires smokefree outdoor environments in some circumstances, that is, those associated with outdoor school and pre-school environments. Some other outdoor environments (some parks, playgrounds, beaches, malls, streets) are now also smokefree through local authority ‘educational’ and administrative policies. The new Act would explicitly recognise the role of local authorities in this area, and amend the bylaw making provisions in the Local Government Act 2002 to provide for greater certainty in the ability for local authority to create smokefree area bylaws, and provide a range of enforcement methods. The Act would also provide national standards, including for minimum smokefree distances from openings in buildings used by workers and the public. Additional smokefree requirements would apply to a range of outdoor areas such as transport waiting areas, playgrounds, and any property where alcohol is served.

3. Extend the scope of indoor environments. The Act would prohibit smoking in vehicles where a child or young person aged under 18 years is a passenger. The Act would also require TANA to promote smokefree domestic environments, where a child or young person lives, through educational and clinical strategies.

4. Extend marketing restrictions, including powers to classify movies according to smoking content, and controls on all aspects of marketing, such as brand variant names.34 Provision would also be made for ‘new media’ (that is, internet-based marketing via computing and information technology); for example, through requirements for content filters.

5. Provide for increasing the age at which tobacco (and other products/devices) may be sold or supplied by stages.

Conclusion

Ideas from experience in New Zealand and other countries have produced a range of ‘endgame’ ideas for a next phase of tobacco control. Strategies such as those identified in this Viewpoint should be explored further as part of urgently needed planning to achieve the New Zealand Government’s goal for a Smokefree Aotearoa by 2025.
Competing interests:
Nil.

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‘Poorly defined’: unknown unknowns in New Zealand Rural Health

David Fearnley, Ross Lawrenson, Garry Nixon

ABSTRACT

There is a considerable mismatch between the population that accesses rural healthcare in New Zealand and the population defined as ‘rural’ using the current statistics New Zealand rural and urban categorisations. Statistics New Zealand definitions (based on population size or density) do not accurately identify the population of New Zealanders who actually access rural health services. In fact, around 40% of people who access rural health services are classified as ‘urban’ under the Statistics New Zealand definition, while a further 20% of people who are currently classified as ‘rural’ actually have ready access to urban health services. Although there is some recognition that current definitions are suboptimal, the extent of the uncertainty arising from these definitions is not widely appreciated. This mismatch is sufficient to potentially undermine the validity of both nationally-collated statistics and also any research undertaken using Statistics New Zealand data. Under these circumstances it is not surprising that the differences between rural and urban health care found in other countries with similar health services have been difficult to demonstrate in New Zealand. This article explains the extent of this mismatch and suggests how definitions of rural might be improved to allow a better understanding of New Zealand rural health.

A paradoxical finding in New Zealand rural health research is that the rural/urban inequalities often demonstrated in international data do not seem to be a feature in nationally compiled New Zealand statistics. This seeming lack of evidence of rural/urban health differentials is something of a disincentive to further research in the area, but work addressing specific topics has shown evidence of disparity in rates of disease incidence, access to services and outcomes.

The apparent similarity in rural/urban health care outcomes is usually taken as reassuring evidence that any barriers to care in rural areas are generally overcome and the system provides equitable outcomes for all New Zealanders. However, it is also possible that the lack of evidence of rural health inequality is an artefact arising from the lack of a clear definition of ‘rural health care’, and that national statistics may thus be incapable of detecting true differences in health outcomes.

At the heart of the problem is the fact that researchers using census data typically use the Statistics NZ rural and urban categorisation, despite the fact that the definition of these categories does not take health service access in to account. This means the resultant rural/urban delineation does not accurately differentiate the population of New Zealanders who actually receive ‘rural health care’. Although it has been recognised that current definitions are inadequate, the extent of the uncertainty resulting from the suboptimal definitions is not widely appreciated. As discussed below, currently large numbers of people who access rural health services are classified as ‘urban’ under the Statistics NZ definition, while a significant percentage of the people who are classified as ‘rural’ actually have ready access to urban health services. Under these circumstances, it is not surprising that it is difficult to demonstrate differences between rural and urban health care.
Past, present and proposed definitions of ‘rural’

Prior to 2003, Statistics NZ defined ‘rural’ as census area units with less than 1,000 people. Apart from the arbitrary nature of the definition (resulting in areas with close to 1,000 residents changing from rural to urban from census to census without any change in access to health services), significant numbers of people who access rural health services live in small rural centres with over 1,000 residents, and are thus classified as ‘urban’ under this definition. For example, Wanaka, which is 90km from the nearest rural hospital and 300km from the nearest base hospital, is classified as ‘urban’. As this definition was widely used until the mid-2000s, most New Zealand research published before then is based on it.

Statistics NZ modified the rural/urban definition in 2003, and it now recognises three urban (major urban, satellite urban and independent urban areas) and four rural categories (highly rural/remote and rural areas with low/moderate/high urban influence).

This definition is actually less useful in defining populations receiving rural health care, as the ‘independent urban’ definition now includes some rural centres with less than 1,000 residents. Thus, places like Hamner Springs are now grouped with slightly larger centres like Wanaka, Takaka, Twizel, Murupara, Wairoa, Ohakune and Dargaville, all of which are clearly rural in New Zealand health terms, but are included as ‘urban’ in nationally-collated health data.

Moreover, this definition highlights the significant percentage of people classified as ‘rural’ who live adjacent to large urban centres and generally access urban health services. Areas classified as ‘Rural with high urban influence’ comprise around 22% of the rural population. These are small (relatively affluent) census area units adjacent to large urban centres and ‘a significant proportion’ of residents work and access services in the adjacent urban area. Therefore, including these people as ‘rural’ has the potential to further confound attempts to study the health effects of true rurality.

Overall, we estimate that it is likely that around 340,000 people who actually receive rural health care are included in the urban definition, while up to 124,000 of those defined as rural may actually receive urban health care. These rather imperfect definitions underlie most data published by the Ministry of Health (MoH) and other national bodies, so even fundamental statistics such as mortality rates, life expectancy and cancer survival rates need to be interpreted with this caveat in mind. More detailed studies such as the Urban–Rural Health Comparisons: Key results of the 2002/03 New Zealand Health Survey report published in 2007 are also dependent on these definitions, and this may explain the lack of significant findings in this work, which is probably the largest single piece of work looking at rural/urban differentials in New Zealand to date. Only a very small number of published New Zealand studies have used alternative or multiple definitions of rurality in an attempt to better define the issues in question.

The National Health Committee Rural Health, challenges of distance, opportunities for innovation report (2010) recognised the inherent problems in trying to study rural health using current Statistics NZ definitions, and have proposed an alternative definition, whereby Independent Urban areas are classified as rural, and rural areas with high urban influence are classified as urban. The National Health Committee (NHC) study used their proposed new definition to re-analyse some of the MOH Rural/Urban comparison data on incidence of heart disease and stroke in rural and urban areas (previously analysed with the pre 2003 Statistics NZ definition (Table 1)). The NHC definition of ‘rural’ produces a marked difference in the results, with an almost 100% variance in the relative incidence of heart disease and stroke in rural areas. The figures suggest that it is difficult to have a high degree of confidence in any statistics using current urban/rural definitions. Although the NHC report did not directly comment on these results, it did suggest there is a significant burden of ill health in small rural centres, and other recent work by the New Zealand Institute of Rural Health (NZIRH) supports this finding. While the NHC definition is an improvement in correctly identifying
populations using rural health services, larger ‘independent urban centres’ including Timaru, Greymouth, Blenhiem, Masterton and Whakatāne, all have DHB base hospitals, but are classified as ‘rural’ under the proposed NHC schema; therefore over 100,000 people with ‘urban’ access to DHB level ‘base hospital’ services will be analysed as having ‘rural’ health care, adding significant potential for obscuring true rural/urban differences. Excluding these larger independent urban centres with urban health services from the ‘rural’ definition will significantly improve the ‘accuracy’ of the NHC definition of the population that receives rural health services.

As small regional/rural centres and rural areas with low/moderate urban influence typically have the highest average levels of deprivation and unemployment,10 a more accurate rural definition will also imply a higher level of rural deprivation than is currently recognised. This is important as the combination of rurality and deprivation has been shown to adversely affect health outcomes in overseas studies.14 Like many things in rural health, some local knowledge of the available services and their context is useful and this level of knowledge has been used to produce a more nuanced definition of the rural parts of the Midland region DHBs.17 While similar techniques may prove useful in the future, a simple and relatively robust rural/urban definition can be achieved with minor modification of the NHC definition, as outlined above and in Table 2.

It may seem somewhat late in the day to be pointing out that national health statistics on rural health may not be fit for purpose, but this is symptomatic of the rather “undeveloped” state of rural health research in New Zealand.18 The widespread adoption of a consensus definition of rural is a necessary step toward any meaningful analysis of rural/urban health differentials in New Zealand. The NHC report called for a new rural/urban definition in 2010, but as yet their call has achieved little traction. Therefore, it is vital that any new definition is recognised and ‘advertised’ by Statistics NZ, so that future research can be based on a functional and consistent definition. Until this can be achieved, we will remain in an era of not knowing exactly what we don’t know about rural health in New Zealand.

Table 1: Relative reported incidence of rural heart disease and stroke (urban incidence = 1.0).

<table>
<thead>
<tr>
<th>Study</th>
<th>Heart disease</th>
<th>Stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>NZ Health Survey</td>
<td>0.62</td>
<td>0.88</td>
</tr>
<tr>
<td>NHC</td>
<td>1.66</td>
<td>1.71</td>
</tr>
</tbody>
</table>

(Figures from page 10 of the New Zealand health survey and page 68 of the NHC report have been standardised such that urban incidence = 1.0 to enable comparison)
### Table 2: Comparison of the rural population as defined by Statistics New Zealand and the population actually accessing rural health care.

<table>
<thead>
<tr>
<th></th>
<th>Statistics NZ (current)</th>
<th>Approximation of actual population accessing rural healthcare</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>URBAN</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major Urban</td>
<td>2,892,810 (72%)</td>
<td>Major Urban 2,892,810 (72%)</td>
</tr>
<tr>
<td>Satellite Urban</td>
<td>128,094 (3.2%)</td>
<td>Satellite Urban 128,094 (3.2%)</td>
</tr>
<tr>
<td>Independent Urban</td>
<td>440,000 (10.9%)</td>
<td>Independent Urban with DHB ‘base’ hospital =100,000 (2.4%)</td>
</tr>
<tr>
<td><strong>RURAL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural with high urban influence*</td>
<td>124,251 (3.1%)</td>
<td>Independent Urban without DHB ‘base’ hospital* ≈340,000 (8.5%)</td>
</tr>
<tr>
<td>Rural with moderate urban influence</td>
<td>154,968 (3.8%)</td>
<td>Rural with moderate urban influence 154,968 (3.8%)</td>
</tr>
<tr>
<td>Rural with low urban influence</td>
<td>220,470 (5.5%)</td>
<td>Rural with low urban influence 220,470 (5.5%)</td>
</tr>
<tr>
<td>Highly Rural/Remote</td>
<td>64,182 (1.6%)</td>
<td>Highly Rural/Remote 64,182 (1.6%)</td>
</tr>
<tr>
<td><strong>sub-total 86%</strong></td>
<td></td>
<td><strong>sub-total 81%</strong></td>
</tr>
<tr>
<td><strong>RURAL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>64,182 (1.6%)</td>
<td>Highly Rural/Remote 64,182 (1.6%)</td>
</tr>
<tr>
<td><strong>sub-total 14%</strong></td>
<td></td>
<td><strong>sub-total 19%</strong></td>
</tr>
</tbody>
</table>

*Up to 22% (124,251/563,871) of people currently described as rural probably usually receive urban health services

*Over 43% (340,000/779,620) people who actually use rural health services are classified as urban under the current definition

Figures represent 2006 population numbers (percentage of total New Zealand population). Corresponding numbers from 2013 census not yet available on SNZ website. Sub-totals are rounded.

**Competing interests:**
Nil.

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**URL:**
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Inappropriate vasopressin secretion due to limbic encephalitis secondary to LGI1 antibodies
Sonakshi Sharma, Ian Holdaway

Voltage-gated potassium channels (VGKC) are membrane-signaling proteins that respond to changes in voltage or ligand concentration across the cell membrane. Antibodies against proteins associated with the VGKC complex (such as leucine-rich, glioma-inactivated protein 1 (LGI1)) are a rare, but treatable cause of non-paraneoplastic autoimmune limbic encephalitis. Hyponatremia has been noted in up to 90% of these patients, with at least half being secondary to the syndrome of inappropriate antidiuretic hormone secretion (SIADH). The exact mechanism of SIADH in this condition is unclear.

We describe a case of LGI1 limbic encephalitis presenting with generalised tonic-clonic seizures, confusion, memory loss, and SIADH, with minimal sodium response to fluid restriction, but rapid normalisation after immunotherapy, suggesting a pathogenic role of the LGI1 antibodies in the induction of SIADH.

Case report
A 59-year-old man (on no regular medications) was admitted in June 2015 with two generalised tonic-clonic seizures. He had a past history of a seizure (2007), with a normal EEG, and an MRI brain showing non-specific white matter change. Examination during the admission was unremarkable. Investigations revealed serum sodium of 125mmol/L (135–145) secondary to SIADH (urine sodium 33mmol/L, urine osmolality 415mosm/L, plasma osmolality 269mosm/L, 0930h serum cortisol 524nmol/L, normal 200–700) and normal thyroid function with serum free thyroxine 13.3pmol/L (normal 9–19), and TSH 1.8mIU/L (normal 0.4–4). Clinical assessment indicated he was euvoalaemic. The cause of the SIADH and seizures was unclear. Levetiracetam was started and he was discharged with fluid restriction of 1.2L. His wife noted confusion and episodic memory loss at home, with difficulty remembering passwords and basic computer skills.

He was admitted with another seizure in July 2015, and serum sodium was 122mmol/L at the time. An MRI brain showed signs of limbic encephalitis that had developed since 2007 (Figure 1). CT scan of the chest, abdomen, and pelvis was entirely normal. His volume status was again felt to be normal and a repeat serum cortisol was 534nmol/L at 0730hrs. The Endocrinology service was consulted for the SIADH (minimally responsive to 800ml fluid restriction despite clinical euvolemia) and suggested that this was most likely secondary to the limbic encephalitis, which may be an autoimmune (rather than paraneoplastic) phenomenon. The CSF was positive for antibodies to the LGI1 protein. Treatment was commenced with intravenous Methylprednisone (followed by oral Prednisone), intravenous immunoglobulin (IVIG) and Azathioprine, and the serum sodium normalised promptly. The patient was reviewed in clinic in October 2015 and was noted to have significant improvement along with normal sodium levels off fluid restriction.

Discussion
LGI1 is a secreted neuronal protein that forms part of the VKGC complex and plays an important role in maturation and normal functioning of synapses.
is expressed in the hippocampus, hypothalamus, midbrain, pons, medulla and cerebellum, as well as the renal tubules (where the exact location is uncharacterised as yet), prostate, sebaceous glands and reproductive organs.\textsuperscript{3,7,8} There are several potential mechanisms by which LGI1 antibodies may cause SIADH, including direct action on the hypothalamic nuclei to increase ADH production, or via action on renal tubules to increase sensitivity to ADH. The hippocampus has efferent fibers to the hypothalamus, and another possibility is that disruption of normal synaptic function of LGI1 in the hippocampus may affect ADH release from the hypothalamus.\textsuperscript{5-7,9}

SIADH also occurs in limbic encephalitis caused by herpes simplex virus, with case reports confirming successful normalisation of serum sodium with fluid restriction and salt tablets.\textsuperscript{10} The particular correlation of SIADH with autoimmune limbic encephalitis is important, because these patients may be resistant (or only partially responsive) to fluid restriction alone.\textsuperscript{6} The presence of difficult-to-treat SIADH in a patient presenting with seizures and memory impairment, with an unremarkable CSF exam, may serve as a clue to the diagnosis of LGI1 limbic encephalitis. These patients require immunosuppressive therapy (rather than anti-epileptic drugs) for treatment of seizures, LGI1 antibodies and normalisation of serum sodium.

\textbf{Figure 1:} Coronal T2 MRI scan showing hyperintensity in the medial aspect of the temporal lobes, including the hippocampus, consistent with limbic encephalitis.
COMPETING INTERESTS:
Nil.

CONSENT
Verbal informed consent was obtained from the patient for publication of this case report and any accompanying images.

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REFERENCES:
Alcohol intake and risk of breast cancer and coronary heart disease among postmenopausal women

The question addressed in this study is whether postmenopausal women who increase their alcohol intake over a five year period have a higher risk of breast cancer and lower risk of coronary heart disease than those who maintain their stable alcohol intake?

21,523 postmenopausal women who participated in the Diet, Cancer, and Health study in Denmark were eligible for the study. Change in alcohol intake was recorded and incidence of breast cancer and coronary heart disease was noted during an 11 year follow-up. The researchers found that those who increased their alcohol intake over a 5-year period had a higher risk of breast cancer and a lower risk of coronary heart disease.

The authors of the study note that alcohol intake was self-reported and possibly underestimated. Nevertheless, the results support the hypotheses that alcohol is associated with breast cancer and coronary heart disease in opposite directions.

BMJ 2016;353:i2314

Serious asthma events with fluticasone plus salmeterol versus fluticasone alone

The safe and appropriate use of long-acting beta-agonists (LABAs) for the treatment of asthma has been widely debated.

This study was designed to evaluate the risk of administering the LABA salmeterol in combination with an inhaled glucocorticoid, fluticasone propionate.

Over 11,000 patients over the age of 12 years with persistent asthma were randomised to receive inhaled fluticasone alone or fluticasone with salbutamol for 26 weeks. Patients with life-threatening or unstable asthma were excluded. 67 patients suffered serious asthma-related events, 34 in the fluticasone-salmeterol group and 33 in the fluticasone only group. The risk of a severe exacerbation was 21% lower in the fluticasone-salmeterol group.

The conclusion reached was that patients who received salmeterol in a fixed-dose combination with fluticasone did not have a significantly higher risk of serious asthma-related events than did those who received fluticasone alone. The risk of severe asthma exacerbations was significantly lower in the combination treated patients.


Endovascular thrombectomy after large-vessel ischaemic stroke

In 2015, five randomised trials showed efficacy of endovascular thrombectomy over standard medical care in patients with acute ischaemic stroke caused by occlusion of arteries of the proximal anterior circulation. As each of these trials were moderate in size there is uncertainty about the benefits of this treatment in certain patients, including those who presented to treatment late, are elderly, have mild deficits and are not eligible for intravenous alteplase.

This meta-analysis examines data pooled from these trials. The researchers analysed individual data for 1,287 patients (634 assigned to endovascular thrombectomy, 653 assigned to standard care). The conclusions reached were that endovascular thrombectomy is of benefit to most patients with acute ischaemic stroke caused by occlusion of the proximal anterior circulation, irrespective of patient characteristics or geographical location.

Lancet 2016;387:1723-31
In the current issue of the British Medical Journal is a leading article upon the degree of visual acuity demanded by the Home military authorities, in which it is stated that V6 over 24, each eye without glasses, is to be considered the standard of vision. It is interesting to recall that in the South African war the visual standard was V6 over 36 with both eyes, provided with glasses the candidate can reach 6 over 6 in one eye and 6 over 12 with the other; which measurement was in force up to the commencement of the Territorial inauguration.

At the beginning of this war a very great number of recruits were passed through for examination in this centre in a very short time and probably, under the conditions of rush then obtaining, we may not have been so accurate in judging acuteness of vision as we might have been, but several cases have now come under my notice from other districts which bring home the necessity for the most careful ophthalmological examination. Not only in the interest of the men, great as that is, but also in the interests of the general public, which has to pay for pensions and expects the various societies to deal out money in order to compensate, in some measure, wounded and incapacitated soldiers for giving their services to their country.

The following two cases illustrate, aptly enough, the points touched upon where consequences may arise from want of careful ophthalmological examination when being enlisted:

Case 1. Gunner AH, aged 20 has been training with his battery for five months and is sent now by his regimental officer from his camp to obtain a report about his eyes, the gunner himself to pay the fee of one guinea. He is a strong, splendidly healthy young man with brown eyes (tending to obscure the pupil reflex in a bad light), obviously very keen on his work. On testing his sight, it is found to be 6 over 36, partly with both eyes. He is suffering from stationary lamellar cataract of both eyes; quite easy to see even with the naked eye. He says he cannot "level" his work!

Case 2. XY, invalided soldier, aged 29. History is that he landed on Gallipoli at the same time as a high explosive shell. As a result of the concussion he was in hospital seven weeks, and four months in a convalescent home in England. Now, "sight of left eye has come back but the right eye is still bad." Fundi found to be normal and vision under homotrepin and cocaine is: right 6 over 36, left 6 over 6. Retinoscopy of right eye is less than plus two in the vertical and less than minus three in the horizontal diameter. Vision therefore, with glass correction is: Plus .50 spherical combined with minus 3.00 cylinder axis vertical equals 6 over 9. In England he has been fitted up with a pair of spectacles: Right, plain, No. 4 tint; left, plus .50 spherical for reading which he has never used.

On being told and shown that he could be made to see nearly perfectly with proper glass-correction with his right "blind" eye, the man accepted the position at once. That is the point of maximum interest. The point was carefully explained to him that he had always had something "wrong" with the "blind" eye, in which point he concurred. Indeed, had he not known of it before the explosion is it conceivable that he, or any man living, would not have stood solid in the conviction that shell fire was the cause and the only cause of his present "blindness"? Of course it may have been the cause, for miracles do happen, but what an amazing and interesting thing for air concussion (he is very particular that no fragment struck him), permanently to bend a tight elastic ball hitherto acting normally and to dent it so slightly that six months later it is found to be myopic, or concave, in...
one tiny diameter and convex in the other; while the other eyeball, equally elastic, remained normal.

Apart from any functional disturbance of vision which we may be sure was present, there is little doubt that, most of this man’s life, the static refraction of his right eye has been one of mixed astigmatism; a condition entailing no comment or surprise. He was sent in with the backing of a society which was “prepared to pay anything in reason for any operation or course of treatment which will improve his sight.” Supposing that, for reasons of State, this man had been put under an anaesthetic! One can imagine the public insisting that the eye was “taken out to be cleaned” and the gears re-aligned and lubricated, then Hey presto! The sight is restored! “Name of a little bit of pipe, Lourdes would have been to it as nothing of a nothing, my old!” as Brigadier Gerard would say.

Other cases occur to my mind, but the two already given illustrate what hardship can be inflicted on a man who is allowed to train in camp when he has permanent defect of sight; a danger to himself and to his comrades; whilst the second case shows how the country, or a society with public funds, could easily be put to an expense equivalent at least to the cost of retaining an army ophthalmic surgeon to examine all cases, if such a man had happened to be dishonest.

Let me add another point of interest in eye work with members of the Expeditionary Forces. It is astonishing how many “Māori fundi” there are in the attested. Relics of a former military occupation!
The effect of hydrogen sulfide synthesized by cystathionine-gamma-lyase on inflammation and liver sinusoidal endothelial cells in polymicrobial sepsis in mice

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Aims: Hydrogen sulfide (H$_2$S), produced by cystathionine-gamma-lyase (CSE), is a key mediator of inflammation in sepsis.1 The liver sinusoidal endothelial cells (LSECs) are important target and mediator of sepsis.2 This study was aimed to investigate role of CSE-derived H$_2$S on inflammation and LSEC fenestrae in CLP-induced sepsis using CSE-KO mice.

Methods: Sepsis was induced by CLP, and mice were sacrificed after 8 hours. Liver, lung and plasma were processed to measure CSE expression, H$_2$S synthesis, MPO activity, NF-κB, ERK1/2 and cytokines/chemokines. Diameter, frequency, porosity and gap area of liver sieve were calculated from scanning electron micrographs of the LSECs.

Results: An increased CSE expression and H$_2$S synthesis in wild-type mice following CLP-induced sepsis. This was associated with an increased MPO activity, TNF-α, IL-6, IL-1β, MCP-1 and MIP-2. Conversely, CSE-KO mice had decreased H$_2$S synthesis, MPO activity and cytokine/chemokines following sepsis. ERK1/2 and NF-κB became activated following CLP in wild-type mice but not in CSE-KO mice. In addition, CLP-induced defenestration/damage to the LSEC was reduced in CSE-KO mice.

Conclusion: Gene deletion of CSE, an H$_2$S synthesizing enzyme, protects mice against CLP-induced sepsis and associated inflammatory response through ERK/NF-κB pathway as evidenced by reduced inflammation, defenestration and gaps formation in the LSECs.


Activation of immune cells in live carotid plaque

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Aims: Ex-vivo carotid plaque (CP) tissue provides a complex and realistic model in which to test how inflammatory processes in atherosclerosis are occurring. To evaluate the ability of cells within excised tissue to produce 7,8-dihydronopterin, a biomarker of immune cell activation and inflammation in atherosclerotic plaque,1 we stimulated CP tissue with phorbol 12-myristate 13-acetate (PMA), phytohemagglutinin (PHA) and interferon-γ. Neopterin, the oxidised form of 7,8-dihydronopterin, was also measured.

Methods: Live CP tissue obtained from carotid endarterectomy were cut into sections and cultured in RPMI 1640 media plus 10% human serum four days. Media was changed every 24 hours and analysed for neopterin and total neopterin by HPLC. PMA, PHA or interferon-γ was added to the media after 24 hours. Tissue viability was measured by a lactate assay.

Results: Stimulation of plaque with PMA, PHA and interferon-γ resulted in the activation of T-cells and macrophages within the excised tissue while unstimulated plaque showed no immune cell activation. The concentration of neopterin and 7,8-dihydronopterin released varied between sections in each plaque.

Conclusions: Immune activation can be measured and modelled within the plaque using PMA, PHA and interferon-γ. Levels of 7,8-dihydronopterin oxidised to neopterin indicate that oxidative stress is occurring in the plaque.
Cognitive impairment in Parkinson's disease: a study of early-phase amyloid PET and arterial spin labeling perfusion MRI

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Aims: There is a need to identify biomarkers of imminent conversion to dementia in Parkinson's disease. This study compared early-phase [18F] Florbetaben (FBB) PET, a novel perfusion measure, with arterial spin labeling (ASL) perfusion MRI. We aimed to assess association between perfusion and risk of conversion to dementia.

Methods: 50 PD patients were assigned a summary global cognitive score and Parkinson's disease dementia risk score (PDDRS) from the results of neuropsychological testing. FBB PET and ASL MRI data were acquired, pre-processed and analysed for association with these measures using the general linear model and a network-based approach.

Results: Cognitive decline and increased PDDRS were found to be significantly associated with distinct regions of cortical hypoperfusion in the ASL data that related significantly to cognition and PDDRS.

Conclusions: The physiological information provided by early-phase PET remains a worthwhile area of further investigation. The PDDRS-related perfusion network developed here presents a potential biomarker of imminent conversion to dementia in Parkinson's disease.

The effect of irreversibly electroporated cell dynamics on drug transport in electroporated tissue

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Aims: Recent developments in the modelling of the cellular uptake of drug by electroporation (EP) have enabled for the prediction of dynamic behaviour of electroporated cells. Statistical analysis shows that tissue electroporation can simultaneously result in reversibly (RE) and irreversibly (IR) electroporated cells. The influence of IR cell dynamics on drug uptake of neighbouring RE cells is investigated.

Methods: First principles approach is used to develop the theoretical model describing post EP cell dynamics and diffusion behaviour of the drug. The resulting set of coupled PDEs are evaluated numerically in a fully implicit parametric investigation.

Results: By varying the mass transfer coefficient of the irreversible cells it was shown that the dynamics of the IR cells did not make a significant difference to the RE cell concentrations. The influence of the presence of IR cells on the drug uptake of viable cells was found to be less than 4%.

Conclusions: The dynamics of irreversibly electroporated cells does not greatly influence the rate of drug delivery to viable cells.


Preventing lung damage via automation and optimisation of mechanical ventilation for critically ill patients in the third world

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Aims: Critically-ill adult patients in the third-world can require breathing support during power outages. However, existing manual ventilation methods can lead to ventilator induced lung injury (VILI) if poorly applied.1 Automated ventilation of patients which remains operational off-grid could improve consistency of care and patient outcomes.

Methods: Volume controlled mechanical ventilation utilises tidal volumes between 600mL and 400mL. However, in patients with high elastance, set tidal volumes can cause overdistension. Pressure centric control can lead to insufficient oxygenation of patients with high elastance.2 Respiratory rate is affected in order to maintain a healthy gas exchange.

A generic pressure-volume domain was designed to facilitate ventilation of heterogeneous third world
Amyloid imaging for cognitive impairment in Parkinson’s disease

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Aims: Parkinson’s disease (PD) is a neurodegenerative movement disorder, but cognitive impairment and dementia ultimately become the greatest burden for patients. The accumulation of misfolded amyloid protein, an Alzheimer pathology, can also occur in PD and may contribute to cognitive impairment. Here, we examined amyloid accumulation in the brain, using Positron Emission Tomography (PET) imaging as a potential cognitive biomarker in PD.

Methods: 50 participants with PD completed Florbetaben PET to measure amyloid burden in the brain. A battery of neuropsychological tests was used to produce (1) a global measure of current cognitive ability and (2) a dementia risk score (four-year probability of future dementia). PET images were evaluated clinically and standard uptake value ratio (SUVR) images were derived to assess the association between amyloid accumulation and cognition/dementia risk.

Results: Eleven participants (22 %) received a radiological visual evaluation of abnormally increased amyloid accumulation. Across all patients, there was a significant (corrected p<0.05) association between amyloid accumulation (SUVR) and global cognitive ability in multiple brain regions. Widespread amyloid accumulation was also associated with the dementia risk score.

Conclusions: Amyloid accumulation in the brain provides a suitable biomarker of cognitive ability and risk of future dementia in PD.

Homogenisation Theory Applied to Coupled Mammalian Cells

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Aims: Migraine pain is often preceded by disturbed vision known as an ‘aura’. Visual auras are thought to be caused by a wave of calcium moving slowly across the occipital lobe of the brain. This wave is termed Cortical Spreading Depression (CSD). The temporary high calcium concentrations cause electrophysiological hyperactivity followed by inhibition.

Methods: We modelled calcium wave propagation across a coupled cell model using a homogenised implementation of the model by Goldbeter et al. Spatially coupled cells were initially simulated with simple linear diffusion and then with added electro-diffusion terms. The outcomes were compared to a ‘toy-model’ approach with sinusoidal inputs.

Results: Interesting wave shapes emerged and resulted in waves propagating into regions where theoretical analysis implies oscillations should not exist. Electro-diffusion exhibited minimal contrast to the simpler linear diffusion model. In contrast, the ‘toy model’ approach yielded no such wave propagation.

Conclusions: We have determined that the shape of cell fluxes instigate wave propagation. In particular, waves with non-linear tendencies lead to wave propagation, whereas sinusoidal waves ameliorate wave propagation. This unique insight may lead to an improved understanding of CSD and lead to novel treatments for migraines that target the non-linear elements of intracellular calcium fluxes.

Reuse, disposal, and partial remanufacturing of medical devices

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Aims: A device may be designed for single use, but reprocessed, contrary to the designer’s original expectations. Reprocessing and reusing of single-use devices (SUDs) occurs frequently. Product reprocessing may lead to degradation of medical devices, adversely affect patient health and reduce the productivity of the medical staff and operations. Need: Different stakeholders (product designers, surgeons, theatre managers) have different priorities regarding single use or reusable medical devices. These expectations are not always congruent. Purpose: This work...
investigates the multiple reuse scenarios that occur in medical devices, and the decision thinking of stakeholders.

Methods: The main phases are: (1) Question stakeholders to determine the motivations for reprocessed SUDs and the key issues. (2) Develop a model of the decision process and the health risk. (3) Validation against medical device failure databases.

Results: Initial findings are that SUDs can be more financially expensive and environmentally costly than reusable ones. We propose a conceptual systems framework for the lifecycle risks of a medical device, see Figure 1.

Conclusions: The reprocessing is not a simple case of reuse vs. disposal, but a complex hybrid process of partial remanufacture where the decision appears to be determined by situational variables (e.g. country, cost, perceived risks).

Figure 1: System Life cycle model for medical device usage, including re-use, disposal and hybrid remanufacturing processes.