
George Thomson, Jane Oliver, Nick Wilson

Abstract

Introduction We aimed to describe long-term trends in smoking in vehicles in a deprived local community in the Wellington region of New Zealand, and to consider the impact of a local community-initiated smokefree vehicle campaign.

Methods An observational study in 2013 of smoking in vehicles repeated the methods of two previous studies (conducted in 2005 and 2011) in the same location (Wainuiomata) in New Zealand. The 2013 study followed a local smokefree vehicle campaign which began in early 2013.

Results Data were systematically collected on 57,672 vehicles in 2013. The point prevalence of smoking in vehicles decreased from 6.4% (95% CI: 5.9%–7.1%) in 2005 to 4.9% in 2011 (95% CI: 4.8%–5.1%) to 3.4% in 2013 (95% CI: 3.2%–3.5%). For vehicles with others (adults and children) there was a reduction from 1.4% in 2005 to 1.1% in 2011 and to 0.7% in 2013. In vehicles with children, the decline was from 0.22% in 2011 to 0.10% in 2013 (p<0.001 for all 2011-13 comparisons). Smoking in vehicles with other people present declined three times faster during 2011-13 than during 2005–2011.

Conclusions In the context of relatively slow change in national trends for smoking prevalence and for smoking in cars, the results appear to be consistent with the local campaign having some beneficial impact on smoking behaviour in vehicles. However, achieving fully smokefree vehicles, and the consequent health equity dividend, will probably require national-level smokefree vehicle legislation.

The hazard of secondhand smoke (SHS) is of particular concern inside vehicles, even with windows open. This is due to the confined space and the particular effects on children. Exposure to smoking in vehicles may also increase the risk of smoking initiation by children, due to the normalisation of smoking. While the exposure rates of children to smoking in vehicles have decreased in some jurisdictions, there is still significant exposure in others.

Legislation has been used to increase the proportion of smokefree vehicles in parts of a few countries, including jurisdictions (cities, states, provinces) in: the United States, Canada, Australia and Ireland, but the large majority of jurisdictions have been unable to consider or pass legislation.

There has been almost no evaluation of the impact of smokefree vehicle laws. A South Australian study found an increase in the proportion of cars with children that were reported to be smokefree, from 69% in 2005 to 82% in 2008. A Canadian study found smokefree car laws there reduced SHS exposure among youth by about a quarter within the first year after the law’s implementation.
Internationally, there have been a limited number of studies where the prevalence of smoking in cars was observed. A 2008 study (5928 vehicles observed) in Italy found point prevalence of smoking in vehicles of 6.9%, and of 0.1% for smoking with children.\textsuperscript{14} In a 2011 study in Barcelona (2442 vehicles), 5.5% of vehicles had smoking and 0.2% had smoking and children.\textsuperscript{15} A 2012 study (2230 cars observed) in Ireland found a point prevalence of smoking in cars of 1.39%, and this varied by car value.\textsuperscript{16}

In New Zealand, a 2012 observation study (2857 cars) in Auckland found a point prevalence of 5.7% of smoking in cars, and 2.2% with smoking with children in cars. This study also found that in Manurewa (a relative socioeconomically deprived suburb), the respective results were 13% and 6.4%.\textsuperscript{17}

In 2005 and 2011 we investigated the different point prevalences of smoking in vehicles in two suburbs in the Wellington urban area, New Zealand, and the proportion of vehicles with smokers and others.\textsuperscript{18,19} The 2011 study also measured the point prevalence of smoking in vehicles with those who appeared to be aged 12 and under. That study reported that in the suburb with greater socioeconomic deprivation, Wainuiomata, the prevalence of smoking in vehicles with children was 11 times that for the less deprived suburb. The findings were publicised in the New Zealand media, with an emphasis on the greater exposure of children to smoke in Wainuiomata vehicles.\textsuperscript{20,21}

As a result of the 2011 study findings, from April 2012, local community workers in Wainuiomata started to organise a campaign for smokefree vehicles in their suburb, with the help of schools, sports clubs and other local organisations. They were supported by the regional public health organisation (Regional Public Health).

In February 2013, there was a campaign launch event that included the Associate Minister of Health, Tariana Turia (who is also a leader in Māori health and development), and other Members of Parliament. This launch gained national television coverage.\textsuperscript{22}

The campaign was specifically for the suburb, which is separated by a large hill from the rest of the Wellington urban area, and has a single access road to it from the region. Campaign aspects included local role models, a webpage, billboards, posters, radio advertising, community newsletters, signage at school drop off zones, logo and branding at community and school events, smokefree car information packs, and a smokefree car story competition.\textsuperscript{23}

Studies on local community campaigns for smokefree indoor legislation have reported essential campaign elements such as media coverage and leadership,\textsuperscript{24–29} However, while there have been a number of intervention studies on reducing smoking in homes,\textsuperscript{30} little has been published on community campaigns to reduce such smoking. For example, a news item described a New South Wales state level campaign in Australia for smokefree homes that contained local projects.\textsuperscript{31}

There also appears to be little or no literature on local or national campaigns to get non-legislated public behaviour change in smoking in vehicles. In Australia and the USA, elements in the design of campaigns for smokefree homes and cars have been described.\textsuperscript{32,33} A Welsh smokefree vehicle campaign is currently being evaluated.\textsuperscript{34}
We could not find any published study of changes in the level of smoking in vehicles as the result of a local or national campaign to change such behaviour.

In New Zealand, all workplace vehicles accessible by the public have been required to be smokefree since 1990,35 but there is no law on smoking in private vehicles, and there was no national smokefree vehicle media campaign between 2008 and the end of 2013.36

In an annual national survey of 14–15 year old students, exposure to smoking in a vehicle in at least one day in the last week was reported by 31% in 2006, 26% in 2011 and 23% in 2012 (there was a change of question for only 2011, which may have increased the reporting for that year).10 In 2008, this exposure for students from high-deprivation schools was 40%.37

The current (at least monthly) self-reported national smoking prevalence for adults had decreased from 20% in 2006/07 to 18% in 2011/12, although ‘this decrease was not significant after standardising for age’.38 In 2012-13 the adult smoking prevalence was 17.6%.39 Census data indicates a greater fall from 2006 to 2013 (21% to 15%) although these data may be an underestimate of the prevalence of smoking due to non-response to the smoking question.40

The 2006 census reported that the prevalence of daily smoking in Wainuiomata adults was 30%,41 compared to the national average of 21%.42

Given this background, we aimed to further describe long-term trends in smoking in vehicles in this community (Wainuiomata), and to consider the potential impact of the 2013 local smokefree vehicle campaign.

Methods

We largely repeated the methods used in the 2005 and 2011 studies,18,19 with roadside observers at a roundabout on the road in and out of the Wainuiomata suburb. Observations of passing vehicles were made within 7.30–9.30am and 3.15–5.15pm (to allow for sufficient daylight) on 15 weekdays from 30 May to 22 June 2013. The times were selected to maximise the traffic flows and the proportion of vehicles with children, and so maximise the efficiency of observer time. In 2011 the afternoon observations were made within 4–6pm, and the observation was during 20 weekdays in February–April. In 2005, observations were made during 8–10 am and 4–6 pm, in August–September.

In contrast to the 2011 study, two observers were used. One used a mechanical counter to count the total number of vehicles that fitted the sample frame (regardless of whether smoking was observed or not). For each vehicle with observed smoking, the other observer recorded on a pre-formatted data sheet: the presence of smoking, the presence of other adults than the smoker; and the presence of children. The observers were trained on site, and provided with a procedure sheet and data collection sheets.

As in 2011, observers did not observe buses, taxis, trucks, and vehicles where it was difficult to see inside. Children were defined as those appearing to be aged 12 years or younger. Smoking was defined as one or more people in a vehicle holding a cigarette, pipe or cigar in their hand or mouth.

The data were entered into a Microsoft Excel file and analysed using the statistical program R version 2.13.2. The proportions of people smoking in vehicles were calculated for each category within each year group (i.e. 2005, 2011 and 2013). These categories were: (i) smoking in vehicles; (ii) smoking in vehicles with only a driver; (iii) others (adults and children) in vehicles with smoking occurring; and (iv) children in vehicles with smoking occurring. The total number of vehicles observed in the year of interest was used as the denominator. The 95% confidence intervals for each proportion were calculated. Differences between proportions were assessed using the Chi-squared test. Differences were considered statistically significant when p-values were <0.05. The relative declines in smoking and relative risks (RR) of exposure to smoking in vehicles were also calculated so as to compare year
groups. Ethical approval was obtained through the University of Otago (Category B ethics approval process).

Media coverage of smoking in vehicles may be one of the background influences for perceptions about smoking around others. To provide information on any changes, we searched the Factiva media database (http://global.factiva.com/) for the number of references to smoking in cars during the 2-year periods before the 2011 and 2013 data collection (February 2009–January 2011, and June 2011–May 2013) for the New Zealand region. The search phrase ‘smoking in cars’ was used, since the New Zealand media rarely use the phrase ‘smoking in vehicles’.

Results

Observations of 57,627 vehicles were made during 52.5 hours over the 15 days (there was no observations for 7.5 hours due to weather and other issues). Including training, the study involved a total of 108 hours of observer time. There were large reductions in all the smoking point prevalences between 2011 and 2013 (Table 1).

Changes are first shown below with the number of vehicles observed as the denominator for all three groups (vehicles with only drivers, vehicles with others and those with children), and then (for vehicles with others and those with children) with the number of vehicles in which smokers were observed as the denominator.

For all vehicles observed, there was a reduction in vehicles with smoking from 6.4% in 2005 and 4.9% in 2011 to 3.4% in 2013 (Table 1). In vehicles with only the driver, from 3.8% in 2011 to 2.6% in 2013. In vehicles with others (adults and children) 1.4% in 2005 to 1.1% in 2011 and 0.7% in 2013. In vehicles with children, from 0.22% in 2011 to 0.10% in 2013. All decreases for 2011-2013 were statistically significant (p <0.001).

The relative decline of smoking in vehicles in 2005-2011 was 3.9% a year, compared to 15% a year during 2011–13. The decline of smoking in vehicles with others in 2005-2011 was 6% a year, compared to 18% a year during 2011-13 (see Table for statistically significant relative risks).

For vehicles in which smokers were observed, the smoking with others (adults and children) changed little: 21.2% in 2005 to 23.1% in 2011 and 21.5% in 2013. For vehicles in which smokers were observed and with children, there was a decline from 4.6% in 2011 to 2.9% in 2013.

The search of the Factiva media database found 62 items with the phrase ‘smoking in cars’ in the New Zealand media for the 24 months before the 2011 data collection, compared to 91 items in the 24 months before the 2013 data collection, an increase of 47%.
Table 1. Prevalence of smoking in vehicles in the suburb of Wainuiomata for three observational studies (in 2005, 2011 and 2013)

<table>
<thead>
<tr>
<th>Year (observed vehicles)</th>
<th>Smoking in vehicles</th>
<th>Smoking in vehicles with only a driver</th>
<th>Others (adults and children) in vehicles with smoking occurring</th>
<th>Children in vehicles with smoking occurring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes (n)</td>
<td>Yes (%) [95% confidence interval (CI)]</td>
<td>Yes (n) (%) [CI]</td>
<td>Yes (n) (%) [CI]</td>
</tr>
<tr>
<td>2005 (n=5055)</td>
<td>325</td>
<td>6.4% [5.9–7.1%]</td>
<td>316* 6.3% [5.6–7.0%]</td>
<td>69 1.4% [1.1–1.7%]</td>
</tr>
<tr>
<td>2011 (n=79,750)</td>
<td>3927</td>
<td>4.9% [4.8–5.1%]</td>
<td>3020 3.8% [3.7–3.9]</td>
<td>907 1.1% [1.1–1.2%]</td>
</tr>
<tr>
<td>2013 (n=57,672)</td>
<td>1952</td>
<td>3.4% [3.2–3.5%]</td>
<td>1509 2.6% [2.5–2.8%]</td>
<td>419 0.7% [0.7–0.8%]</td>
</tr>
</tbody>
</table>

2005–2011 % relative decline (decline/year) 23% (3.9%) 35% (6%)

2011–2013 % relative decline (decline/year) 31% (15%) 31% (15%) 36% (18%) 54% (27%)

2011 vs 2013 (RR) [CI] 0.68 [0.65–0.72] 0.69 [0.65–0.73] 0.70 [0.62–0.79] 0.44 [0.33–0.59]

* In 2005 the data collection was for ‘drivers smoking in cars with smoking’ which included vehicles where others were also smoking.
Discussion

This appears to be the first observation study of in-vehicle smoking using three waves of data, and the first study of the potential impact of a local smokefree vehicle campaign. During 2005–13 there was decreasing smoking in vehicles in this community, with three times the percentage decline/year during the 2011–2013 period in which the local smokefree vehicles campaign was held.

The results suggest a much sharper decline per year between 2011 and 2013 for: smoking in vehicles, smoking with others, and smoking with children, compared to between 2005 and 2011. The 2011–2013 decline for smoking in vehicles with children was also much greater than for the 2011–13 decline for smoking in vehicles with others (adults and children).

These results suggest that the local campaign may have had some impact, in addition to those from other national-level influences. The wider factors include the ongoing slow national decline in smoking prevalence, and similarly slow national decline in smoking in vehicles. Another factor that may have influenced smoking in cars nationally was the 47% increase that we identified during 2011–13, compared to 2009–11, for national media coverage around smoking in vehicles.

Strengths and limitations of this study—Multiple other issues limit our ability to quantify campaign specific impacts (including slight differences in the data collection methods, and potential changes in passengers per vehicle with increasing fuel prices over the study period). The lack of data from a control area is a principal limitation (it unfortunately was out of scope for this highly resource-constrained study). Such data would have helped determine the extent to which the decrease in smoking in cars that we found was attributable to the smokefree campaign, rather than a decline evident across New Zealand.

The results may not be representative of smoking in cars across Wainuiomata, as data were only collected at one (albeit major traffic flow) point. The judgment of the ages of children (12 years and under versus over 12 years) will remain an issue, although this might be minimised by training with photographs of children of a known age between the ages of 10 and 14.

This study used direct observation of behaviour, rather than self-reported data, and thus avoided the bias inherent in that source. Testing of inter-observer variation in a previous study using this method found high agreement across all the observational categories. The degree of accuracy may have been increased with pairs of observers, compared to the single observers used in the 2011 study.

Such local observation studies are of relatively low cost (for this one the main cost was the 108 hours of observer time), and allow local communities to be aware of a sentinel health risk. Sentinel, because it can give an indication of trends in smoking around children in private places (including homes).

Future studies—If resources permit, future such studies of the impact of a local campaign would ideally also observe vehicles in a control community where there was no campaign impact. In future similar studies, data on other background factors that might influence smoking in vehicles with others could be gathered. These could include legislative changes (e.g., requiring smokefree outside areas) and general mass
media campaigns relating to tobacco use (besides those specific to smokefree vehicles). The content of news media coverage of smoking in vehicles could be systematically analysed for the extent of positive or negative comments, and for changes in the articles across the relevant time period.

**Policy implications**—While this local smokefree campaign may have helped to further increase levels of smokefree vehicles, it also demonstrates the positive effect that local data may have, in sparking change for a community. Where there are large inequalities, and ‘difficult to reach’ populations, such health campaigns may be effective in reaching the population and reducing the inequalities. National health campaigns may also be made more effective by using local media for particular areas.

However, the more than halving of smoking in vehicles with children in Wainuiomata during 2011–13, to 0.1%, still resulted in a point prevalence that was five times that of the equivalent prevalence in 2011 for a low-deprivation suburb in Wellington that we previously studied (at 0.02%). This indicates that a range of interventions would be needed on top of such local campaigns, to maximise reductions in inequalities associated with smoking.

Government reliance on such local campaigns is likely to be far less efficient than national-level action, especially legislation for smokefree vehicles and mass media campaigns. Furthermore, the implementation of a smokefree vehicle law in New Zealand could utilise the 3.5 million random vehicle stops which are conducted each year by the police, rather than require extra stops by police.

**Competing interests:** Nil.

**Author information:** George Thomson, Associate Professor, Department of Public Health, University of Otago, Wellington; Jane Oliver, Research Assistant, Department of Public Health, University of Otago, Wellington; Nick Wilson, Associate Professor, Department of Public Health, University of Otago, Wellington

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**Correspondence:** George Thomson; Dept. Public Health, University of Otago – Wellington, PO Box 7343, Wellington South, New Zealand. Email: george.thomson@otago.ac.nz

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