



## Highly hazardous air quality associated with smoking in cars: New Zealand pilot study

Secondhand smoke (SHS) is a complex mixture of over 3800 gaseous and particulate components, exposure to which causes a range of serious adverse health effects in children, adults, and pregnant women.<sup>1</sup> The 2003 Smokefree Environments Amendment Act resulted in most indoor workplaces being smokefree. However, an area of concern in New Zealand is the persisting exposure of non-smokers, particularly children, to SHS in homes, cars, and other settings. This is particularly a problem for Māori and low socioeconomic status populations.<sup>2,3</sup>

A recent New Zealand study found that in cars where smoking was occurring, it was commonly (24%) in the presence of other occupants. The proportion of cars with smoking occupants was higher in more deprived areas.<sup>4</sup> A marker that is commonly used to measure SHS levels is fine particulates (PM<sub>2.5</sub>). Methods for measuring air quality in cars using portable real time monitors have recently been reported.<sup>5,6</sup> These studies recorded very high levels of PM<sub>2.5</sub> during and after smoking, particularly when the windows were closed. We carried out a pilot study to investigate levels of PM<sub>2.5</sub> in cars in New Zealand under different conditions of smoking, ventilation and speed of travel. The study had Category B Ethical Approval through the University of Otago review process.

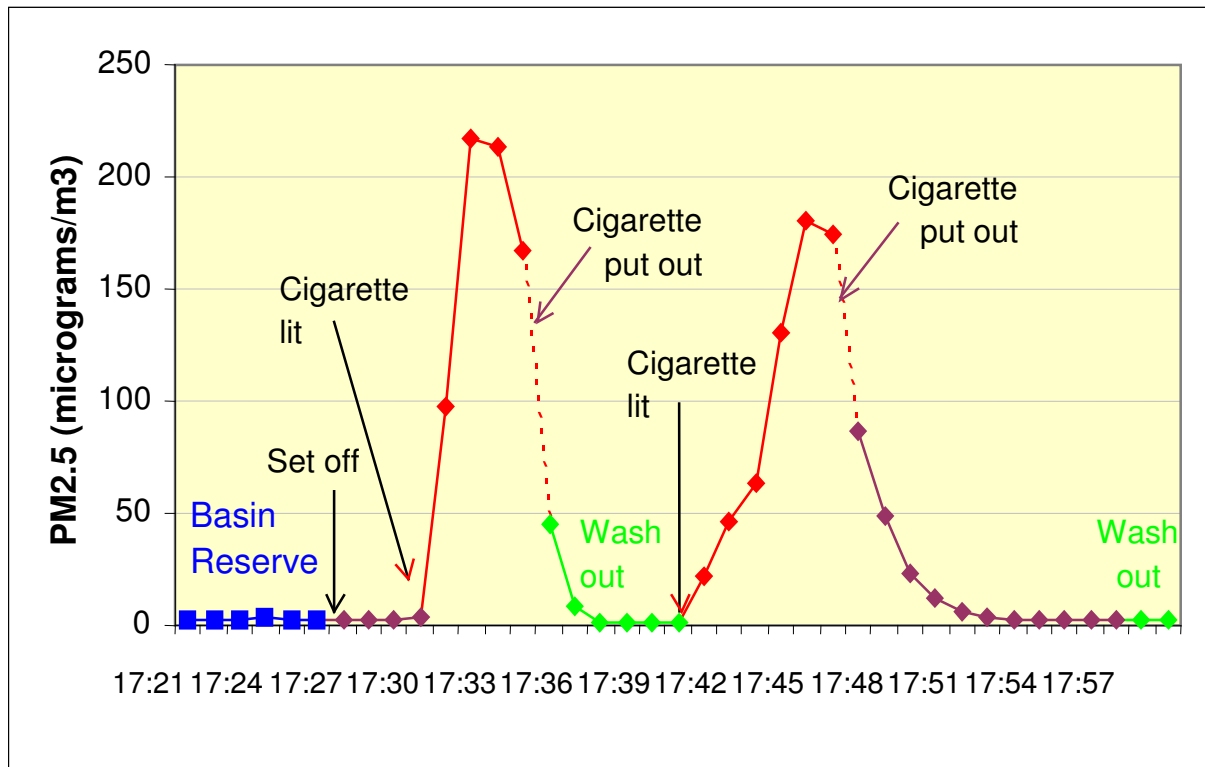
The principal investigator (RE) drove the car, (a Honda Odyssey station wagon, in which no smoking had previously occurred for at least 10 months) while another investigator (NP) smoked cigarettes ('lights' brand) under specified conditions. Data was collected using a *TSI SidePak AM510* (TSI, Inc, St Paul, USA) portable real time air quality monitor to record average levels of respirable particulates (PM<sub>2.5</sub>) over 1-minute periods. The instrument was used according to a protocol modified from one developed for a US study,<sup>7</sup> and as used in a UK study by RE (further details of the data collection methods are available in these publications).<sup>8</sup> The *SidePak* was located on a child's booster seat in the rear of the car with a length of Tygon™ tubing attached to the inlet and the other end left protruding at approximately the height of the nose of a small child sitting in the back of the car.

We began by monitoring ambient air for 10 minutes at a busy traffic intersection (Basin Reserve, Wellington) at 5pm (rush hour) in September 2006. We then drove the car around suburban areas of Wellington at a mean speed of 50 kph. The route was chosen to minimise stops at intersections and traffic lights. The fan and air-conditioning was switched off throughout the monitoring period.

Whilst driving, three cigarettes were smoked, the first with the passenger's window fully open and cigarette held outside car between puffs; the second with the passenger window open half way and cigarette held inside the car in between puffs; and the third was smoked with all windows closed. The weather was sunny throughout, with a light to moderate breeze.

Figure 1. shows the levels of fine particulates (PM<sub>2.5</sub>) while the first two cigarettes were smoked. Figure 2 shows the particulate levels while the third cigarette was smoked with the windows closed, and the subsequent levels over the next hour

**Figure 1. Particulate (PM<sub>2.5</sub>) levels (µg/m<sup>3</sup>) during smoking of cigarettes in a moving car with passenger window wholly or half open**



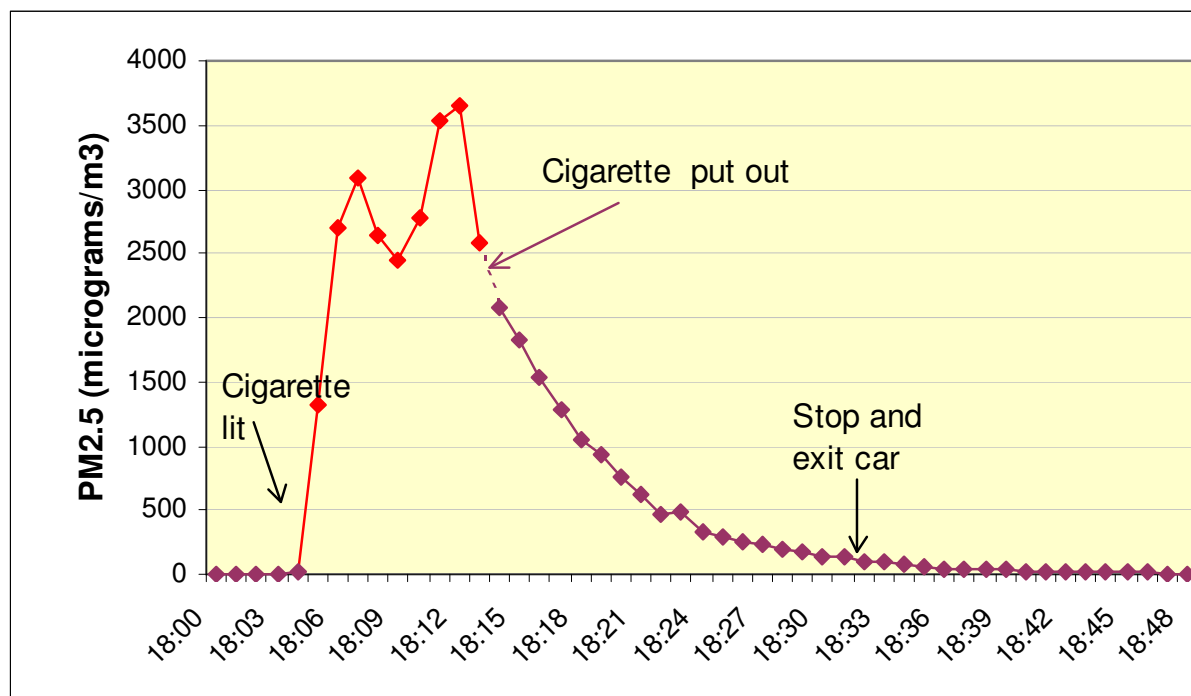
Mean levels during smoking the smoking first cigarette with the window fully down were 168.5 µg/m<sup>3</sup>, and were 143 µg/m<sup>3</sup> during smoking of the second cigarette with the window half down.

Mean PM<sub>2.5</sub> levels during smoking of the first cigarette were 199 µg/m<sup>3</sup>, (peak 217 µg/m<sup>3</sup>), during the second cigarette 162 µg/m<sup>3</sup> (peak 181 µg/m<sup>3</sup>), and during the third 2926 µg/m<sup>3</sup> (peak 3645 µg/m<sup>3</sup>).

Fifteen minutes after the third cigarette was extinguished, PM<sub>2.5</sub> levels were 631 µg/m<sup>3</sup>, and did not return to the baseline level until almost 40 minutes after the cigarette had been put out.

PM<sub>2.5</sub> levels observed during smoking were many times higher than in the ambient air (3-4 µg/m<sup>3</sup>), even next to a busy traffic roundabout. For comparison, the mean daily PM<sub>2.5</sub> levels in Auckland during 1998–2001 were 11.0 µg/m (range 2.1 to 37.6 µg/m).<sup>9</sup> Compared to the poorest air quality days in Auckland, PM<sub>2.5</sub> levels in the car during smoking were about five times worse with a window wholly or partially open, and up to 100 times worse with the windows closed.

**Figure 2. Particulate (PM<sub>2.5</sub>) levels (µg/m<sup>3</sup>) during smoking of a cigarette in a moving car with all windows closed (and no other ventilation operating)**



The World Health Organization guidelines for annual mean and 24 hour mean PM<sub>2.5</sub> levels are 10 µg/m<sup>3</sup> and 25 µg/m<sup>3</sup> respectively.<sup>10</sup> Some of the highest indoor levels of particulates due to SHS are found in pubs and bars where smoking is allowed. For example, a UK study found mean PM<sub>2.5</sub> levels 285 µg/m<sup>3</sup> over 30 minutes of monitoring in the evening (maximum 1400 µg/m<sup>3</sup>) in 64 pubs across north-west England.<sup>8</sup>

Air quality in the car with the window partially or wholly down was therefore similar to that found in a typical smoky pub, whereas when smoking occurred with the window closed it was at least twice as bad as even the smokiest pub.

The results confirm that unacceptably high levels of air pollution result from smoking in cars, and show that non-smokers are heavily exposed to SHS in this setting. The findings validate the public health rationale for the current Health Sponsorship Council mass media campaign in New Zealand that encourages smokers to protect their children from the harms of secondhand smoke by not smoking in their car, even when they are alone (<http://www.secondhandsmoke.co.nz/media/cars.shtml>).

The findings also suggest that laws to make cars smokefree, particularly when children are present (as have been adopted in other jurisdictions such as in Arkansas, Louisiana, and Puerto Rico) should be explored.

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