

## Second-hand smoke in cars: How did the “23 times more toxic” myth turn into fact?

Ross MacKenzie MA, Becky Freeman MSc

Changes to public health policy do not usually occur simply as a result of epidemiologic research detailing the health hazards facing a population. Policy change requires both strategic and opportunistic advocacy to transform research findings into health reforms.<sup>1</sup> Successful advocacy campaigns often require the translation of complex research findings into short and memorable media quotes. Managing the risks involved in either oversimplifying research results or misreporting findings is essential to maintaining the credibility of public health professionals. Unfortunately, inaccurate reporting of health information is not an uncommon phenomenon.<sup>2</sup>

While conducting research for a study on the Australian advocacy campaign to ban smoking in cars,<sup>3</sup> one of us (BF) encountered many media reports that stated that second-hand smoke was “23 times more toxic in a vehicle than in a home.” In a subsequent exhaustive search of the relevant literature, we failed to locate any scientific source for this comparison. Given that the issue of banning smoking in cars is gaining traction internationally, use of this media-friendly tobacco control “fact” presents potential problems of credibility. In this paper, we describe how a local media report of an unsourced statistic led to the same statistic being widely reported in the international media and peer review literature (Figure 1).<sup>4-27</sup>

### Methods

Our search of MEDLINE with combinations of keywords (i.e., smoking, cars, second-hand smoke, children) to identify the scientific source of the “23 times” claim yielded 19 articles. Google and Factiva searches using the MEDLINE search terms showed that the 23 times figure has been widely cited by international media, nongovernment organizations and politicians (Appendix 1, available at [www.cmaj.ca/cgi/content/full/cmaj.090993/DC1](http://www.cmaj.ca/cgi/content/full/cmaj.090993/DC1)).

We believe we have located all the peer-reviewed articles; however, a comprehensive search of media reports and other grey material is beyond the scope of this paper. Those examples of media reports and the inclusion of the 23 times claim in reports from nongovernment organizations illustrate the broad dissemination of the claim.

### Key points

- The suggestion that second-hand smoke is 23 times more toxic in a vehicle than in the home is widely accepted in the media and academic literature.
- Despite its media currency, the “23 times” claim is unsubstantiated.
- This nonvalidated figure came to be widely reported in the popular media and scientific publications.
- Authors and organizations publishing or otherwise disseminating research findings should adopt a strict policy of citing only original sources.

### Historical timeline

In January 1998, the *Rocky Mountain News*, a newspaper in Denver, Colorado, reported on proposed legislation to ban smoking in cars carrying children. The bill was introduced by state Senator Dorothy Rupert, who reportedly took action quickly when “she learned that smoking was 23 times more toxic in a vehicle than in a house and 8½ times more toxic than in an aircraft because of the smaller enclosed space.”<sup>4</sup> The source of this figure is a November 1997 press release — by local advocates of tobacco control in support of the draft bill — that cited a 1992 study of tobacco-specific N-nitrosamines in indoor air as the reference for the 23 times figure.<sup>28</sup> However, that study did not make the 23 times claim as quoted in the Denver newspaper.

The 23 times estimate has evolved from its modest origins as a brief quotation in a US newspaper to its current status as *evidence* of the dangers of exposure to second-hand smoke in cars. The concept shifted into the academic mainstream when a 1998 *Tobacco Control* editorial on protecting children from second-hand smoke<sup>6</sup> included a passage that closely replicated the *Rocky Mountain News* quotation. Both the newspaper report and the *Tobacco Control* editorial were subsequently cited in a 2003 issue of *Nicotine and Tobacco Research*,<sup>7</sup> which further entrenched it in the peer-reviewed literature.

From the School of Public Health, University of Sydney, Sydney, Australia

CMAJ 2010. DOI:10.1503/cmaj.090993

The real fillip for the comparison, however, was the release of the Ontario Medical Association's 2004 position paper on children's exposure to second-hand smoke,<sup>5</sup> which noted that:

[B]ased on the evidence that exposure to second hand smoke in a vehicle is 23-times more toxic than in a house due to the smaller enclosed space, the state of Colorado drafted a bill that would impose fines on adults caught smoking in cars when a child is present.

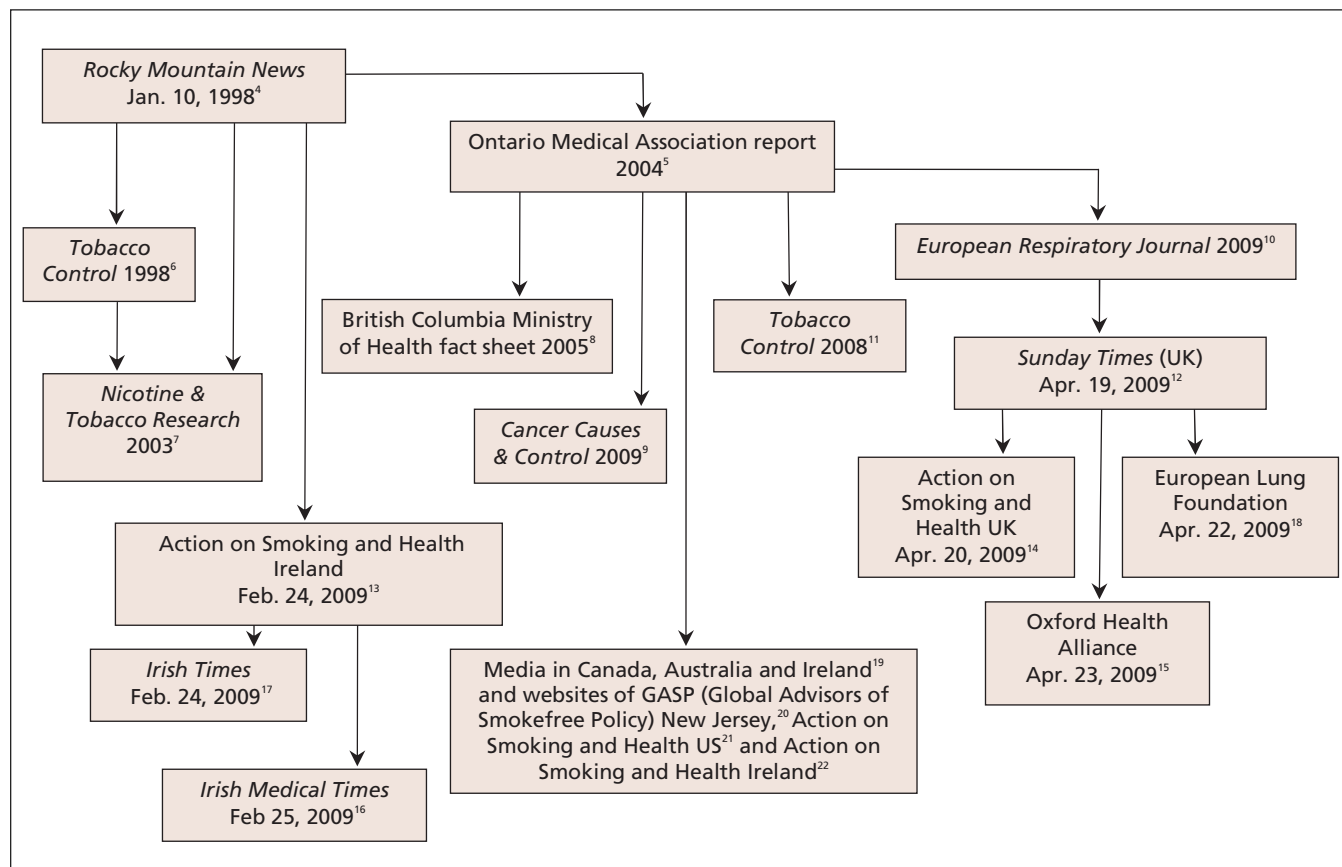
The resource cited for this information was the 1998 *Rocky Mountain News* report.<sup>4</sup>

Credibility conferred by the Ontario Medical Association's use of the statistic resulted in broad dissemination throughout Canada. It was cited in a fact sheet from the British Columbia Ministry of Health in 2005<sup>8</sup> and in 17 news reports, including the national newspaper *The Globe & Mail*.<sup>29</sup> The Canadian Broadcasting Corporation, in a January 2008 report, referred to the Ontario Medical Association's reliance on "a Colorado study that suggested tobacco smoke in cars is 23 times more toxic than smoke in houses, because cars have a much smaller volume."<sup>30</sup> Referral to the Ontario Medical Association's report was not restricted to Canada; use of the figure by international media and health agencies — the US-based Action on Smoking and Health,<sup>21</sup> GASP (Global Advisors on Smokefree Policy) New Jersey<sup>20</sup> and Action on Smoking and Health Scotland<sup>31</sup> and in recent peer-reviewed articles on exposure to second-hand smoke<sup>9-11</sup> — has further added to its credibility.

Perhaps the most explicit indication of the statistic's broad acceptance as fact is its frequent use without reference to its derivation; for example, the claim was uncited in an Australian media report,<sup>32</sup> a peer-reviewed journal article<sup>23</sup> and a press release issued by the Australian Medical Association<sup>24</sup> and on the website of Action on Smoking and Health Ireland.<sup>22</sup> Less precise and similarly unreferenced notations that describe second-hand smoke in cars as "20 times" or "more than 20 times more toxic" than in the home are also common, particularly in Australia, where the National Heart Foundation<sup>27</sup> and state<sup>25</sup> and federal politicians<sup>26</sup> have made such claims to support legislation restricting smoking in cars carrying children.

The continuing appeal of the figure was underlined in early 2009, when news of "irrefutable evidence to show that a car can be 23 times more toxic than a home environment in the context of passive smoke" in a press release from Action on Smoking and Health Ireland (that cited unspecified Colorado research),<sup>13</sup> was subsequently repeated in the *Irish Medical Times*<sup>16</sup> and the *Irish Times*.<sup>17</sup>

These reports preceded the April 2009 publication of a paper in the *European Respiratory Journal* (which cited the 2004 report from the Ontario Medical Association<sup>5</sup>) on possible links between breathing difficulties and exposure to second-hand smoke in cars among Irish schoolchildren.<sup>10</sup> On Apr. 19, the UK *Sunday Times* reported on the 23 times claim,<sup>12</sup> citing the *European Respiratory Journal* article, and



**Figure 1:** Dissemination of the claim that second-hand smoke is 23 times more toxic in cars than in homes.

the *Times* article was in turn referenced in a daily news release from Action on Smoking and Health UK<sup>14</sup> and on the websites of the European Lung Foundation<sup>18</sup> and the Oxford Health Alliance.<sup>15</sup>

## Implications

We traced the evolution of this “myth turned fact” to emphasize that only credible evidence should be presented to advance policy. Solid evidence has been the foundation of the progress made in tobacco control in recent decades. The biggest danger of inaccurately interpreting research on smoking in cars for the sake of a snappy media sound bite is to lose favour with an overwhelmingly supportive public and to provide ammunition for opponents of tobacco control.<sup>33</sup>

Despite the inaccuracy in reporting the level of magnitude of exposure to second-hand smoke in cars, policy-makers should not be deterred from enacting legislation to ban smoking in cars. Several studies on exposure to second-hand smoke have demonstrated that smoking in cars produces high and unsafe concentrations of second-hand smoke particulate<sup>34,35</sup> that are comparable to or higher than the levels measured in hospitality venues that allow smoking.<sup>36</sup> The best available scientific evidence suggests that smoking in a car for even a short time produces levels of respirable particles that are potentially harmful to children.<sup>34</sup>

A 2006 study on second-hand smoke in cars reported a mean concentration of respirable suspended particles measuring less than 2.5 microns in diameter at 272  $\mu\text{g}/\text{m}^3$  in cars when the windows were closed and 51  $\mu\text{g}/\text{m}^3$  when they were open, allowing for maximum possible ventilation.<sup>34</sup> Guidelines from the US Environmental Protection Agency describe concentrations of 40  $\mu\text{g}/\text{m}^3$  as unhealthy for children and other sensitive groups and 250  $\mu\text{g}/\text{m}^3$  as hazardous for any person.<sup>37</sup> These documents provide accurate measurements of the air quality in cars when someone is smoking and should replace the 23 times figure favoured by some tobacco control organizations.

A ban on smoking in cars is an extremely important public health policy that has the potential to dramatically reduce the amount of exposure to second-hand smoke experienced by children.<sup>38</sup> Legislation banning smoking in cars carrying children has been enacted in several states or provinces in Australia, the US and Canada.

## Recommendations

We recommend that researchers and organizations stop using the 23 times more toxic factoid because there appears to be no evidence for it in the scientific literature. Instead, advocates of smoking bans in cars should simply state that exposure to second-hand smoke in cars poses a significant health risk and that vulnerable children who cannot remove themselves from this smoky environment must be protected. Further, we recommend citing the 2006 study by Rees and Connelly<sup>34</sup> as reliable evidence that the level of particulate matter found in cars where smoking is allowed exceeds that in the safety guidelines of the US Environmental Protection

Agency, particularly for children.

Basic steps can be taken to avoid dissemination of inaccurate information. First, organizations publishing or communicating research findings should adopt a strict policy of only citing original sources for research findings; they should never rely on secondary citing of reports or media articles. Second, peer review processes should emphasize not only a critique of the original content of papers and reports, but also the importance of assessing accurate referencing of previously published research. Finally, the broader lesson of our study is that researchers and advocates can be highly effective partners in bringing about change in public policy, but such partnerships can be jeopardized by incomplete knowledge transfer. Researchers and advocates should not be fearful of working closely together — indeed, greater collaboration may help to ensure greater accuracy in reporting research findings. This is a shared responsibility and, as our paper demonstrates, advocates and journalists are not the only ones who can misreport research findings.

This article has been peer reviewed.

**Competing interests:** None declared.

**Contributors:** Both Ross MacKenzie and Becky Freeman conceived of the paper, conducted data collection and prepared the manuscript. Ross MacKenzie prepared the figure, the appendix and the first draft of the manuscript.

**Funding:** Ross MacKenzie is funded by a 2006 research grant from the Cancer Council New South Wales; Becky Freeman is funded by National Health and Medical Research Council grant 396402, Future of Tobacco Control.

## REFERENCES

- Chapman S. Advocacy in public health: roles and challenges. *Int J Epidemiol* 2001;30:1226-32.
- Wilson A, Bonevski B, Jones A, et al. Media reporting of health interventions: signs of improvement, but major problems persist. *PLoS ONE* 2009;4:e4831. Available: [www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2652829](http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2652829) (accessed 2010 Jan. 27).
- Freeman B, Chapman S, Storey P. Banning smoking in cars carrying children: an analytical history of a public health advocacy campaign. *Aust N Z J Public Health* 2008;32:60-5.
- Sanko B. Bill targets smokers in cars: Boulder senator says state should step in on behalf of children. *Rocky Mountain News* [Denver]1998; Jan. 10:6A.
- Ontario Medical Association. *Exposure to secondhand smoke: Are we protecting our kids? A position paper by the Ontario Medical Association*. Toronto (ON): The Association; 2004. Available: [www.oma.org/phealth/smoke2004.pdf](http://www.oma.org/phealth/smoke2004.pdf) (accessed 2010 Jan. 27).
- Sweda EL, Gottleib MA, Porfiri RC. Protecting children from exposure to environmental tobacco smoke. *Tob Control* 1998;7:1-2.
- Gehrman CA, Hovell MF. Protecting children from environmental tobacco smoke (ETS) exposure: a critical review. *Nicotine Tob Res* 2003;5:289-301.
- HealthLinkBC. *Protecting your family from second-hand smoke*. Victoria (BC): British Columbia Ministry of Health; 2005 Available: [www.healthlinkbc.ca/healthfiles/hfile30c.stm](http://www.healthlinkbc.ca/healthfiles/hfile30c.stm) (accessed 2010 Jan. 27).
- Leatherdale ST, Ahmed R. Second-hand smoke exposure in homes and in cars among Canadian youth: current prevalence, beliefs about exposure, and changes between 2004 and 2006. *Cancer Causes Control* 2009;20:855-65.
- Kabir Z, Manning PJ, Holohan J, et al. Second hand smoke exposure in cars and respiratory health effects in children. *Eur Respir J* 2009;DOI:0:09031936.00167608.
- Leatherdale ST, Smith P, Ahmed R. Youth exposure to smoking in the home and in cars: How often does it happen and what do youth think about it? *Tob Control* 2008;17:86-92.
- Battles J. Children harmed by smoke in cars. *Sunday Times* [UK] 2009 April 19. Available: [www.timesonline.co.uk/tol/news/world/ireland/article6122888.ece](http://www.timesonline.co.uk/tol/news/world/ireland/article6122888.ece) (accessed 2010 Jan. 27).
- ASH Ireland brief politicians on banning 'smoking in cars transporting children under 16'. Dublin (Ireland): ASH Ireland; 2009. Available: [www.ash.ie/News/Latest\\_News/ASH\\_Ireland\\_brief\\_Politicians.html](http://www.ash.ie/News/Latest_News/ASH_Ireland_brief_Politicians.html) (accessed 2010 Jan. 27).
- Ireland: children harmed by smoke in cars. London (UK): ASH UK; 2009. Available: [www.ash.org.uk/ash\\_biv4p3vk.htm#7194](http://www.ash.org.uk/ash_biv4p3vk.htm#7194) (accessed 2010 Jan. 27).
- Children damaged by passive smoking. London (UK): Oxford Health Alliance; 2009. Available: [www.oxha.org/alliance-alert/2009-q2-april-june/alert.2009-04-23.3170004258](http://www.oxha.org/alliance-alert/2009-q2-april-june/alert.2009-04-23.3170004258) (accessed 2010 Jan. 27).

16. Culliton G. Smoking 'should be banned in cars containing under 16s.' *Irish Medical Times*. 2009 Feb. 25. Available: [www.imt.ie/news/2009/02/smoking\\_should\\_be\\_banned\\_in\\_ca.html](http://www.imt.ie/news/2009/02/smoking_should_be_banned_in_ca.html) (accessed 2010 Jan. 27).
17. Healy A. Smoking ban sought in cars carrying children. *Irish Times* 2009 Feb. 24. Available: [www.irishtimes.com/newspaper/breaking/2009/0224/breaking38.htm](http://www.irishtimes.com/newspaper/breaking/2009/0224/breaking38.htm) (accessed 2010 Jan. 27).
18. European Lung Foundation. *Children harmed by smoke in cars*. Sheffield (UK): The Foundation; 2009. Available: [www.european-lung-foundation.org/index.php?id=13743](http://www.european-lung-foundation.org/index.php?id=13743) (accessed 2010 Jan. 27).
19. Seventeen reports in Canadian news media (identified via Factiva), available in Appendix 1 at [www.cmaj.ca/cgi/content/full/cmaj.090993/DC1](http://www.cmaj.ca/cgi/content/full/cmaj.090993/DC1).
20. *Protecting foster/resource family and children from secondhand smoke in homes and cars*. Summit (NJ): Global Advisors Smokefree Policy; 2009. Available: [www.njgasp.org/d\\_Foster\\_Homes\\_and\\_Cars.pdf](http://www.njgasp.org/d_Foster_Homes_and_Cars.pdf) (accessed 2010 Jan. 27).
21. *Canada: smoking bans in cars carrying children gains support*. Washington (DC): ASH US; 2009. Available: [www.no-smoking.org/oct04/10-20-04-5.html](http://www.no-smoking.org/oct04/10-20-04-5.html) (accessed 2010 Jan. 27).
22. *ASH Ireland launch campaign to ban smoking in cars transporting children*. Dublin (Ireland): ASH Ireland; 2008. Available: [www.ash.ie/News/Latest\\_News/ASH\\_launch\\_campaign.html](http://www.ash.ie/News/Latest_News/ASH_launch_campaign.html) (accessed 2010 Jan. 27).
23. Williams GC, Williams SA, Korn RJ. Secondhand smoke (SHS) deserves more than secondhand attention: modifying the 5As model to include counselling to eliminate exposure. *Fam Syst Health* 2005;23:266-77.
24. Australian Medical Association. *Smoking in cars*. Victoria (Australia): The Association; 2005. Available: [www.amavic.com.au/page/Media/Media\\_Releases/2005/Smoking\\_in\\_Cars/](http://www.amavic.com.au/page/Media/Media_Releases/2005/Smoking_in_Cars/) (accessed 2010 Jan. 27).
25. The World Today. *South Australia to introduce anti-smoking car laws*. Sydney (Australia): Australian Broadcasting Corporation; 2006. Available: [www.abc.net.au/worldtoday/content/2006/s1791115.htm](http://www.abc.net.au/worldtoday/content/2006/s1791115.htm) (accessed 2010 Jan. 27).
26. ABC News. *Smoking ban*. Sydney (Australia): Australian Broadcasting Corporation; 2006. Available: [www.abc.net.au/news/stories/2006/12/15/1812731.htm](http://www.abc.net.au/news/stories/2006/12/15/1812731.htm) (accessed 2010 Jan. 27).
27. Bunce J. Fed: Plan to ban smoking in cars to save children. *Australian Associated Press* 2006 Dec. 14.
28. Brunnemann KD, Cox JE, Hoffmann D. Analysis of tobacco-specific N-nitrosamines in indoor air. *Carcinogenesis* 1992;13:2415-8.
29. Christie J. Ontario rejects car-smoking ban: can't impose common sense, minister says. *The Globe & Mail* 2007 Feb. 2.
30. CBC News. *Ban smoking in cars with kids, health lobbies say*. Ottawa (ON): Canadian Broadcasting Corporation; 2008 Available: [www.cbc.ca/health/story/2008/01/22/smoke-cars.html](http://www.cbc.ca/health/story/2008/01/22/smoke-cars.html) (accessed 2010 Jan. 27).
31. *Second-hand smoke in cars*. Edinburgh (UK): ASH Scotland; 2009. Available: [www.ashscotland.org.uk/ash/files/Smoking%20in%20cars%20April%202009.pdf](http://www.ashscotland.org.uk/ash/files/Smoking%20in%20cars%20April%202009.pdf) (accessed 2010 Jan. 27).
32. Push to ban smoking in cars. *Daily Telegraph* Sydney (Australia). 2005 May 6.
33. *23 times more toxic than in a house*. London (ON): Citizens for Civil Liberties. Available: [www.citizensforcivil liberties.ca/notmoretoxic.html](http://www.citizensforcivil liberties.ca/notmoretoxic.html) (accessed 2010 Jan. 27).
34. Rees VW, Connolly GN. Measuring air quality to protect children from second-hand smoke in cars. *Am J Prev Med* 2006;31:363-8.
35. Sendzik T, Fong GT, Travers MJ, et al. An experimental investigation of tobacco smoke pollution in cars. *Nicotine Tob Res* 2009;11:627-34.
36. Vardavas CI, Linardakis M, Kafatos AG. Environmental tobacco smoke exposure in motor vehicles: a preliminary study. *Tob Control* 2006;15:415.
37. *Technical Assistance Document for the Reporting of Daily Air Quality — the Air Quality Index (AQI)*. Durham (NC): US Environmental Protection Agency; 2009. Available: [www.epa.gov/airnow/aqi\\_tech\\_assistance.pdf](http://www.epa.gov/airnow/aqi_tech_assistance.pdf) (accessed 8 Feb. 2010).
38. Sly PD, Devereil M, Kusel MM, et al. Exposure to environmental tobacco smoke in cars increases the risk of persistent wheeze in adolescents. *Med J Aust* 2007;186:322.

---

**Correspondence to:** Dr. Ross MacKenzie, School of Public Health, Edward Ford Building (A27), University of Sydney NSW 2006, Australia; [rmackenzie@health.usyd.edu.au](mailto:rmackenzie@health.usyd.edu.au)