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Protection from Outdoor Smoking

Why is Outdoor Smoking a Public Health Issue?

For many years, we advised smokers to “take it outside” to provide protection from circulating indoor smoke. Now, new research shows that physical exposure to outdoor tobacco can also be unsafe. Moreover, research on social modeling and visual and other sensory cueing suggests that outdoor social exposure is a serious problem as well.

Key Finding: Smoke-free outdoor spaces are an important public health measure, since their main objective is protection from social and physical exposure to tobacco industry products.

We now know that:

- *Physical exposure* to outdoor tobacco smoke can be hazardous
- Outdoor smoke can drift indoors and continue to circulate
- *Social exposure* to tobacco smoking (seeing smoking, smelling smoke) can normalize smoking; leading to initiation among nonsmokers, especially youth
- Seeing people smoking outdoors or smelling smoke can provide sensory cues for relapse among quitters and make it difficult for smokers who are trying to quit

There are additional concerns with outdoor smoking:

- Thirdhand smoke, carried in on hands, hair and clothing from smoking outdoors, can contaminate indoor environments
- The use of cigarette-like products, such as electronic or e-cigarettes, is a form of social exposure with the potential to normalize smoking and undermine outdoor smoking bans
- Outdoor exposure to smoke from herbal products, such as herbal hookah, can be just as hazardous as exposure to tobacco smoke

Social exposure often co-occurs with physical exposure, but there are many exceptions. Those exposed to thirdhand smoke and smoke that drifts in from outdoors may not actually see smoking occur, although the odour may be detectable. People may see others smoking outdoors at a distance or see smoking-related paraphernalia, such as ashtrays, cigarette packages and butts, but not be physically exposed to smoke. As restrictions on smoking increase, and knowledge of harmful health effects grows,

our tolerance for exposure has decreased, resulting in greater demand for protection in a growing number of outdoor locations (NSRA, 2013).

Physical Exposure



The introduction of indoor smoking bans in public places, hospitality venues and workplaces has reduced indoor exposure and led to improvements in health outcomes. However, exposure to secondhand smoke in outdoor areas can still expose individuals to substantial levels of fine particulate matter (PM_{2.5}) that is easily inhaled (Klepeis *et al.*, 2007; Cameron *et al.*, 2010; Baptiste *et al.*, 2011; Kaufman *et al.*, 2011; Wilson *et al.*, 2011). Venues with partial or full roof coverings may have increased concentration

levels of smoke, but exposure can be substantial even on patios or other open areas.

As in indoor settings, where exposure increases, as one gets closer to lit cigarettes, the “proximity effect” also occurs outdoors (Repace 2008; Klepeis *et al.*, 2009). Exposure to high levels of tobacco smoke typically occurs within two metres of the sources of smoke, and levels decrease at distances beyond that; however, if there are many smokers, high levels can occur beyond two metres. Stafford *et al.* (2010) found that measurable outdoor tobacco smoke concentrations (PM_{2.5}) were recorded, even with a single active smoker, and levels increased with the number of smokers, indicating a dose-response relationship.

Social Exposure

An important aspect of prevention is to denormalize tobacco smoking so that people are less likely to view it as socially acceptable. Since the vast majority of smokers begin smoking in adolescence, efforts to denormalize tobacco use and decrease negative role modelling are important to protect young adults from future smoking and addiction. Exposure to secondhand smoke contributes importantly to initiation of smoking in youth (Voorhees *et al.*, 2011), and social exposure is the likely mechanism. Decreasing social cues for smoking can increase smokers’ motivation to quit and reduce relapse among recent quitters (Abrams *et al.*, 1988; Zhou *et al.*, 2009). The introduction of smoking bans in indoor public places and at hospitality venues, such as restaurants, bars, hotels and casinos, has decreased overall smoking and encouraged smokers to quit (Fichtenberg *et al.*, 2002; Kennedy *et al.*, 2012; Nagelhout *et al.*, 2012). More recent efforts to eliminate smoking in outdoor public places, including restaurant and bar patios, entrances to buildings, parks, playgrounds, beaches, transit stops, and other outdoor places where smoking occurs reduce the visibility of smoking and likely contribute to denormalization and reduced uptake.

What Do We Know About the Constituents of Outdoor Secondhand Smoke?

Emerging evidence shows how smoking affects outdoor air quality in areas up to four metres away from a lit cigarette when using real-time measurement. Air quality monitors are used to measure the levels of fine particulate matter (PM_{2.5}), a marker for tobacco smoke. Particulate levels within one to two metres of a cigarette average 22-72µg/m³ (Klepeis *et al.*, 2007; 2009; Cameron *et al.*, 2010; Kaufman *et al.*, 2011; Wilson *et al.*, 2011). In one real-time measurement study, air quality levels spiked and exceeded 1,000 µg/m³ when measurements were taken within 0.5 metres of a lit cigarette (Klepeis *et al.*, 2007). The high level of variability in exposure concentration is due to environmental conditions, the position of the monitoring equipment in relation to the cigarette source (i.e., upwind or downwind), the proximity effect, and the number and concentration of lit cigarettes.

A per-cigarette, 24-hour incremental exposure concentration is a useful way to examine the accumulation of single exposures to outdoor tobacco smoke to an individual total 24-hour exposure limit (Klepeis *et al.*, 2007). By combining several exposure concentrations over the course of a day, one can compare the total 24-hour exposure to the particulate matter air quality daily limit standards. The levels found by Klepeis and colleagues may actually surpass the WHO and Canada-wide standards for particulate matter air quality levels (25µg/m³ 24-hour limit and 30µg/m³ 24-hour limit, respectively)(CCME, 2000; WHO Europe, 2005).

“Microplumes” (high concentration streams of smoke rising from cigarettes) have been observed close to cigarette sources, both indoors and outdoors. They can occur due to ground-level turbulence and changing wind directions. If there is little or no wind, a steady plume of smoke rises in the air, disperses, and then falls back down after it cools (Repace, 2005; Klepeis *et al.*, 2009). When there is a single cigarette point source, the distance at which the detectable levels of PM_{2.5} return to background concentrations are at a horizontal distance of 2.0-4.0 metres (Klepeis *et al.*, 2009). However, on a typical outdoor restaurant or bar patio, many cigarettes may be burning, and the distance from a smoker may be continuously less than this distance. Overall, outdoor tobacco smoke levels can be affected by the number of smokers present, environmental conditions, and the physical layout where the smokers are (e.g., barrier preventing more wind flow). A major difference between indoor and outdoor tobacco smoke is that levels of outdoor tobacco smoke drop immediately to background levels after the cigarette is extinguished, whereas indoor levels persist in the air for several hours (Klepeis *et al.*, 2007). However, in outdoor settings where there are several people smoking, significant levels can persist as long as smoking continues.



Outdoor tobacco smoke can drift from outdoors to indoor environments, especially during warm weather when doors and windows are often open. Bars and restaurants that have indoor smoking bans, but permit outdoor smoking on adjacent patios, have higher indoor PM_{2.5} concentrations than those with no outdoor smoking (Mulcahy *et al.*, 2005; Brennan *et al.*, 2010). Outdoor tobacco smoke concentrations can also be higher if patios are enclosed by walls or even umbrellas, which trap the smoke and make it more difficult for it to disperse. Outdoor patios where smoking is permitted and there are physical or structural barriers (e.g., patio umbrellas or permanent/semi-permanent walls) cannot guarantee smoke-free indoor environments (Kennedy *et al.*, 2010). With higher outdoor tobacco smoke concentrations on patios adjacent to indoor dining areas, there is opportunity for smoke to drift indoors, with or without structural barriers.

How Does Outdoor Smoke Affect Our Health?

There is no safe level of exposure to secondhand smoke. It contains over 4,000 chemicals and compounds, including volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs), of which 70 are known to cause cancer (IARC, 2004; California EPA, 2005; USDHSS, 2006; USDHSS, 2010). It also contains fine particulate matter that causes cardiovascular and respiratory damage and disease. In 2006, the California Air Resources Board listed outdoor tobacco smoke as a toxic air contaminant that can cause or contribute to adverse health effects (CARB, 2006; ANR, 2012). Even short-term exposure to secondhand smoke (30 minutes or less) causes damage, such as vascular injury to endothelial cells (the layer of cells in blood vessels and the lymphatic system), and is a risk factor for cardiovascular disease, increased severity of asthma attacks, and increased risk of respiratory illnesses in children (Pope *et al.*, 2001; USDHSS, 2006; Heiss *et al.*, 2008; IARC, 2009a).

High concentrations of outdoor tobacco smoke can develop in a short period of time. Researchers examined the salivary cotinine and urinary 4-(methylnitrosamine)-1-(3-pyridyl)-1-butanol (NNAL) levels in non-smoking patrons exposed to tobacco smoke on outdoor patios of restaurants and bars over the course of three hours (St. Helen *et al.*, 2012). They observed significantly higher salivary cotinine and urinary NNAL levels after exposure to outdoor tobacco smoke. NNAL is a metabolite of 4-methylnitrosamine-1-(3-pyridyl)-1-butanone (NNK), a known carcinogen in tobacco smoke, and higher levels of NNAL and salivary cotinine indicate an increased risk of cancer associated with these biomarkers.

As with indoor secondhand smoke, concentrated outdoor tobacco smoke can act as a respiratory irritant and poses a health risk for severe asthmatics, since it can trigger an asthma attack (Gilmour *et al.*, 2006). Furthermore, those with acute coronary heart conditions, who are exposed to secondhand smoke, are at greater risk of heart attack and stroke (Heiss *et al.*, 2008; CARB, 2006). Even brief exposures to tobacco smoke can lead to an increased risk of cardiovascular disease among healthy nonsmokers (Heiss *et al.*, 2008). The WHO (2005) has set a fine particulate level (PM_{2.5}) of 10µg/m³ as the lowest level at which total, cardiopulmonary and lung cancer death risk increases significantly with long-term outdoor exposure. Since outdoor smoke exposure within two metres can reach levels

comparable to indoors, the health effects are likely to be similar to those from exposure to indoor secondhand smoke if exposure persists for several hours.

Who is affected by Outdoor Secondhand Smoke?

In Ontario in 2011, substantial outdoor exposure was reported (CTUMS, 2011). A majority of Ontario adults (56%) said they were exposed to secondhand smoke outdoors on a sidewalk or in a park; 50% at building entrances; 31% on outdoor bar and restaurant patios, and 19% at a bus stop or shelter. One-third (32%) reported exposure in public places, such as shopping malls, bingo halls, sports arenas, concerts or sporting events; most of the exposure would have originated outdoors since smoking is banned in most of these venues.



While all people are affected by physical exposure to outdoor tobacco smoke at high concentrations, some groups are at risk, even at lower concentrations: the elderly, children, asthmatics, individuals with reduced respiratory function, individuals with increased risk of coronary heart disease, and pregnant women. Pre- and post-natal exposure to any tobacco smoke is particularly harmful for infants and the developing foetus. Children's exposure is most common in the home, and occurs, even when

smoking only takes place outdoors (Johansson *et al.*, 2004), because residues from outdoor smoking are brought indoors on hands, hair and clothing. Residents of multi-unit dwellings or town houses can also be exposed to outdoor tobacco smoke from neighbouring balconies, patios and at communal entranceways. As well, pedestrians and those passing through or standing at building entranceways where smokers typically congregate may be exposed to high concentrations of outdoor tobacco smoke.

Wait staff in restaurants and bars where outdoor smoking on patios is permitted are of particular concern. These employees may be continuously exposed to outdoor tobacco smoke for eight-hour shifts, several times a week. A recent review of outdoor exposure in hospitality venues concludes that, under typical conditions, secondhand smoke exposure can put both patrons and wait staff at increased risk of health damage (Licht *et al.*, 2013). Additionally, those working indoors are not protected from outdoor tobacco smoke when it drifts indoors through windows, doors, and air intake systems. Some studies have shown that levels of carcinogenic indoor particulate polycyclic aromatic hydrocarbons (PPAHs) and PM_{2.5} vary with the outdoor levels of these toxicants, when there is smoking on outdoor adjacent patios or at building entranceways (Zhang *et al.*, 2009; Kaufman *et al.*, 2011; Sureda *et al.*, 2012). Indoor PM_{2.5} levels increase with number of lit cigarettes on outdoor patios and within nine metres of building entranceways, which demonstrates that even with indoor smoking bans, the public is not protected from tobacco smoke. Implementing outdoor smoking bans at bars, restaurants and outdoor

public venues, where people are in close proximity to one another, is an important step to protect individuals from the health risks of outdoor tobacco smoke. Furthermore, since secondhand smoke is an occupational hazard for hospitality staff, who face cumulative exposure during working hours, outdoor smoke-free policies offer workplace protection and free owners from potential liability (Zellers et al., 2007; Repace *et al.*, 2013).

How Does Outdoor Smoking Affect Wildlife and the Environment?

Toxic and Non-biodegradable Waste

Cigarette butts are the most common form of litter worldwide and pose an ecological risk to the environment. Cigarette butts are much more than an eyesore on streets, sidewalks, beaches, and other public areas: they contaminate water systems, increase fire risk, are a threat to wildlife, pets and children, and maintain the visibility of smoking long after the cigarette is extinguished.

Filters were added to cigarettes initially in an attempt to reduce harm, but ultimately to reassure smokers when the first scientific studies on the health hazards of smoking were disseminated (Harris, 2011). Filters do not reduce harm from smoking, and they likely discourage smokers from quitting because of the belief that filters are protective (Novotny *et al.*, 2009). Cigarette filters are composed of cellulose acetate fibres, which are combined with other chemicals such as titanium dioxide and triacetin. They are surrounded by paper or rayon wrappings that contain other chemicals and glues, with the addition of alkali metal salts to maintain burning. The cellulose acetate in cigarette filters is non-biodegradable and persists in the environment long after the butts have been discarded. Furthermore, the chemicals found in discarded cigarette butts are introduced into the environment through leaching and storm water runoff to street drains, rivers, lakes, and oceans where they can cause acute toxicity to local organisms (Moerman *et al.*, 2011). Slaughter *et al.* (2011) reported that a single cigarette butt killed half the small fish in a single litre of water. In some cases, cigarette butts have been found inside marine and aquatic wildlife that mistake them for food.

Cigarette butts are the number one source of shoreline litter and pollution worldwide. Data from the Ocean Conservancy's International Coastal Cleanup show that worldwide, over the past 25 years, almost 53 million cigarette butts have been collected in one-day annual collections, which make up one-third of total debris items; food wrappers or containers are the next most common debris item at 9% (Ocean Conservancy, 2011). More than 230,000 butts were collected in Canada



over the same period. The cigarette butts that are collected as litter greatly underestimate the total number of cigarette butts actually discarded, estimated to be in the trillions (Novotny & Zhao, 1999).

Tobacco companies have made many efforts to deflect attention and responsibility for cigarette litter away from themselves by sponsoring anti-litter campaigns,ⁱ developing biodegradable filters and distributing portable ashtrays, so that the responsibility for proper disposal appears to rest with the smoker (Smith & Novotny, 2011). Apart from some volunteer clean-up crews, the direct costs and time to clean up cigarette litter is left to local communities. In the United States alone, clean-up costs for cigarette litter collectively totalled approximately US\$11 billion in 2009 (Schultz *et al.*, 2013). In Canada, a new butt collection program involves a partnership between a recycling company and a tobacco manufacturer.ⁱⁱ

Prohibiting smoking on beaches and in other public places would do much to reduce discarded butts. Using a multi-strategy approach, incorporating beautification, maintaining convenient and easily identifiable cigarette waste bins with clear signs, and having awareness and motivation campaigns, can also help to reduce cigarette litter (Schultz *et al.*, 2013).

Careless smoking is a major cause of preventable fires and fire related deaths. Littered cigarettes that are not properly extinguished or are carelessly discarded cause many outdoor forest fires. Prohibiting smoking in public parks would do much to reduce forest fires.

What Does the General Public Think About Outdoor Smoking?

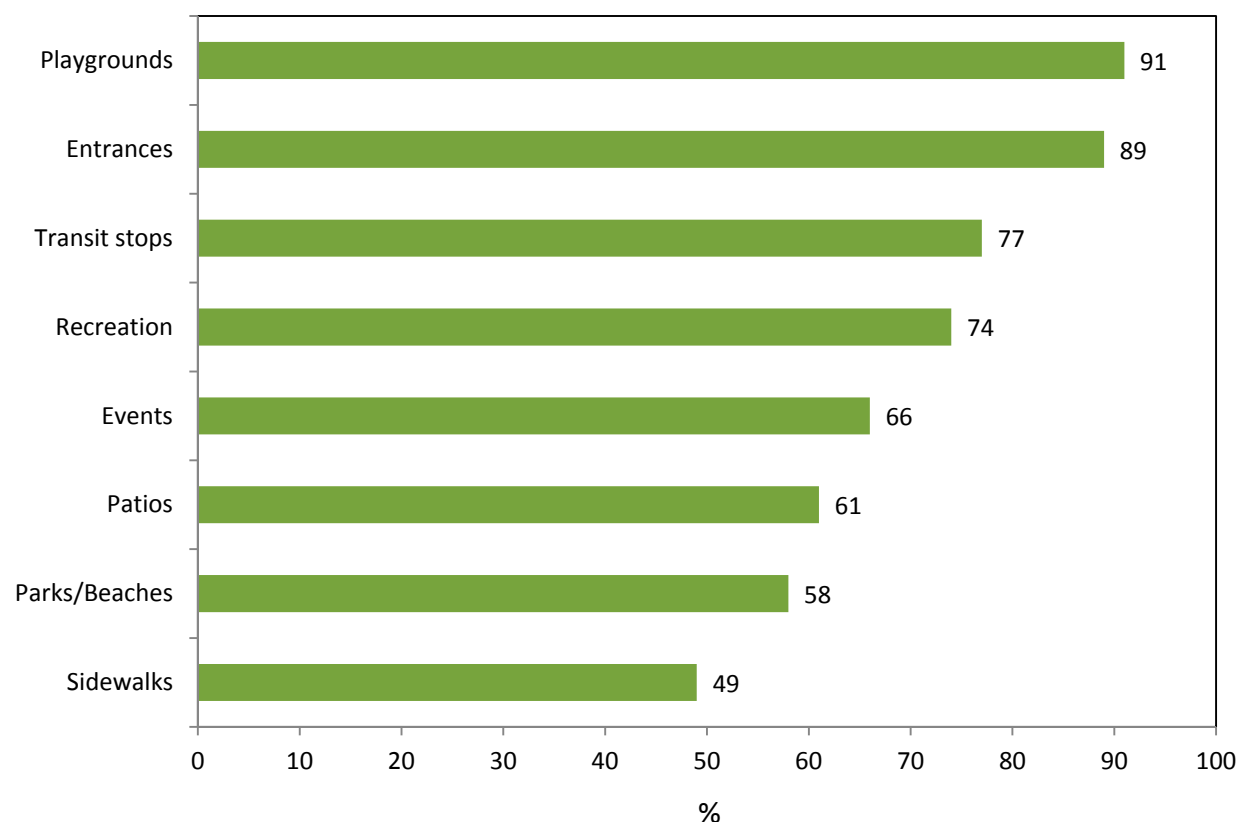
Smoke-free outdoor spaces are an important public health measure, since their main objective is protection from social and physical exposure to tobacco industry products, which in turn helps to reduce tobacco use among smokers (Hyland *et al.*, 2012). Smoke-free indoor air policies effectively reduce exposure to secondhand smoke and the adverse health effects associated with its exposure (Farrelly *et al.*, 2005; Fong *et al.*, 2006; Meyers *et al.*, 2009). Increasingly, support for outdoor smoking bans is growing in communities and at the provincial level (WHO 2011).

Across the province, a substantial majority of Ontario adults aged 18 and over support further restrictions on outdoor smoking. Results from the 2012 CAMH Monitor Survey show strong levels of support for outdoor smoking bans in various public environments. These levels increased two to six percentage points over 2011, an average increase in overall support of almost 5% in one year.

ⁱ http://www.kab.org/site/PageServer?pagename=sponsors_corporate_partners

ⁱⁱ <http://www.newswire.ca/en/story/1186703/leaving-no-butts-behind-terracycle-launches-second-year-of-ambitious-program-to-recycle-cigarette-waste>

Figure 1: Public Support for Outdoor Smoking Bans, Ontario 2012



Source: CAMH Monitor 2012

Do Outdoor Smoking Bans Cause Economic Harm?

Over 100 studies have found no impact on restaurant and bars sales resulting from indoor bans in these venues, and many of these establishments did not have outdoor patios where smokers could go outside to smoke (Scollo *et al.*, 2003; Luk *et al.*, 2006; CDC, 2012). In Canada, four provinces, seven large cities, and many smaller communities legislated bans in these outdoor venues between 1996 and 2012, and none have reported economic harm from the ban. Further, there are potential economic benefits to businesses that have smoke-free policies (IARC, 2009b). For example, costs to set-up and maintain a smoke-free designated area and costs from higher insurance rates are eliminated with smoke-free policies. There is also the potential for increased patronage from nonsmokers who were formerly deterred by the smoke (IARC, 2009b).

Where are We Now and How Do We Compare?

There is growing public support for outdoor smoke-free policies, and many states, provinces, and several hundred cities and communities around the world have enacted outdoor smoke-free policies. In Ontario alone, there are over 60 municipalities that are leading the way by enacting their own outdoor smoke-free legislation. Outdoor policies restrict or ban smoking in various locations, such as outdoor

patios of restaurants and bars, public parks and beaches, playgrounds, school campuses, transit stops, outdoor stadia and sports facilities, outdoor service lines (e.g., ATMs), common outdoor areas of apartment or condominium buildings, building entranceways, hospital grounds, and outdoor areas of municipal properties. Wherever feasible, outdoor smoking bans should conform to the requirements of the WHO Framework Convention on Tobacco Control (FCTC) Article 8 – Protection from Exposure to Tobacco Smoke (WHO FCTC 2007). Up-to-date information about current smoke-free by-laws across Canada can be found online on the Non-Smokers' Rights Association smoke-free laws database: <http://www.nsra-adnf.ca/cms/smoke-free-laws-database.html>.



In New York City, in some city wards in Tokyo, and in the Indian state of Kerala, pedestrian plazas such as Times Square have banned smoking on streets (City of New York, Parks and Recreation, 2012; BBC, 2002; Global Smoke-free Partnership 2009). Closer to home, Kentville, Nova Scotia banned smoking of tobacco and other substances on all municipal property, including streets, roads, sidewalks and trails in 2009; other communities in Nova Scotia have implemented lesser

restrictions.ⁱⁱⁱ The city of Calabasas, California, enacted a citywide policy in 2006 that prohibits all public smoking anywhere a nonsmoker can be exposed to outdoor tobacco smoke (Broder, 2006). The policy is comprehensive and does not allow room for misinterpretation, but it does permit some outdoor smoking in a few designated smoking areas with visible signage to denote the smoking area.

Many Ontario municipal health authorities are enacting their own outdoor smoke-free bylaws, including Ottawa, Kingston, Thunder Bay and others, with more under consideration. This parallels the earlier sequence in 2006, when province-wide legislation prohibiting indoor smoking in public places followed more than a decade of increasing municipal indoor smoke-free bylaws.

Having province or territory-wide smoke-free legislation ensures consistent protection and interpretation across all local jurisdictions. Newfoundland and Labrador, Nova Scotia, Alberta, and Yukon have had outdoor smoke-free legislation for patios of restaurants and bars for at least five years (Government of Newfoundland and Labrador 2005; Government of Nova Scotia 2006; Government of Alberta 2008; Government of Yukon 2008). Outdoor bans across Ontario would provide protection from physical exposure in many settings as well as greatly reducing social exposure and benefitting children and youth as well as those trying to quit smoking or avoid relapse.

ⁱⁱⁱ <http://www.nsra-adnf.ca/cms/sfl-database-search.html?advanced>

Since substances other than tobacco can produce toxic smoke (herbal products, marijuana) and since products that look like cigarettes or waterpipe (e-cigarettes or e-hookah) increase social exposure, comprehensive bans would be required to eliminate both physical and social exposure to these hazardous products.

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References

Abrams DB, Monti PM, Carey KB, Pinto RP, Jacobus SI. Reactivity to smoking cues and relapse: two studies of discriminant validity. *Behaviour Research and Therapy* 1988;26(3):225-33.

Americans for Nonsmokers' Rights (ANR). *Smoke-free Outdoor Air*. [cited 19 April, 2012] Available from: <http://www.no-smoke.org/learnmore.php?id=669>

Baptiste S, Ferguson S, Green T, Hall DB, Kudon LH, Naehler LP, *et al*. Particulate matter (PM_{2.5}) and carbon monoxide from secondhand smoke outside bars and restaurants in downtown Athens, Georgia. *Journal of Environmental Health* 2011 Oct;74(3):8-36.

Brennan E, Cameron M, Warne C, Durkin S, Borland R, Travers MJ, *et al*. Secondhand smoke drift: examining the influence of indoor smoking bans on indoor and outdoor air quality at pubs and bars. *Nicotine & Tobacco Research* 2010 Mar 1;12(3):271-277.

BBC News. *Smoking Ban on Tokyo's Streets*. In; 2 Oct 2002. [Cited 9 May, 2012; Available from: <http://news.bbc.co.uk/2/hi/asia-pacific/2292007.stm>]

Broder, John M. *"Smoking Ban Takes Effect, Indoors and Out"*. California: N.Y. Times. March 19, 2006. Retrieved July 1, 2013.

California Air Resource Board. *Fact Sheet – Environmental Tobacco Smoke: A Toxic Air Contaminant*. Sacramento, CA: California Environmental Protection Agency; 2006.

California Environmental Protection Agency. *Proposed Identification of Environmental Tobacco Smoke as a Toxic Air Contaminant Appendix III, Part B: Health Effects*. Sacramento, CA: California Environmental Protection Agency – Office of Environmental Health Hazard Assessment; 2005. Available from: http://www.oehha.org/air/environmental_tobacco/pdf/app3partb2005.pdf

Cameron M, Brennan E, Durkin S, Borland R, Travers MJ, Hyland A, *et al*. Secondhand smoke exposure (PM_{2.5}) in outdoor dining areas and its correlates. *Tobacco Control* 2010 Feb 1;19(1):19-23.

Canadian Council of Ministers of the Environment (CCME). *Canada-wide Standards for Particulate Matter (PM) and Ozone*. Environment Canada, 2000.

Centre for Addiction and Mental Health. CAMH Monitor, 2012. Toronto, Canada: Centre for Addiction and Mental Health.

Centres for Disease Control. *Smoke-Free Policies Do Not Hurt the Hospitality Industry*, Atlanta, GA: CDC, 2012 [cited 2013 March 28]. Available from: http://www.cdc.gov/tobacco/data_statistics/fact_sheets/secondhand_smoke/protection/hospitality/.

City of New York Parks & Recreation. *Smoke-free Parks and Beaches*. 2012 [cited 9 May, 2012; Available from: <http://www.nycgovparks.org/facility/rules/smoke-free>]

Farrelly MC, Nonnemaker JM, Chou R, Hyland A, Peterson KK, Bauer UE. Changes in hospitality workers' exposure to secondhand smoke following the implementation of New York's smoke-free law. *Tobacco Control* 2005 Aug 1;14(4):236-241.

Fichtenberg CM, Glantz SA. Effect of smoke-free workplaces on smoking behaviour: systematic review. *British Medical Journal* 2002;325:188.

Fong GT, Hyland A, Borland R, Hammond D, Hastings G, McNeill A, et al. Reductions in tobacco smoke pollution and increases in support for smoke-free public places following the implementation of comprehensive smoke-free workplace legislation in the Republic of Ireland: findings from the ITC Ireland/UK Survey. *Tobacco Control* 2006 June 1;15(suppl. 3):iii51-iii58.

Gilmour MI, Jaakkola MS, London SJ, Nel AE, Rogers CA. How exposure to environmental tobacco smoke, outdoor air pollutants, and increased pollen burdens influences the incidence of asthma. *Environmental Health Perspectives* 2006 Apr;114(4):627-633.

Global Smoke-free Partnership. The Trend towards Smokefree Outdoor Areas. Geneva, Switzerland: Global Smokefree partnership; 2009. Available from: http://www.globalsmokefreepartnership.org/resources/ficheiros/SF_Outdoors.pdf

Government of Alberta. *Tobacco Reduction Act*. In: Statutes of Alberta, 2005. Chapter T-3.8; 2008.

Government of Newfoundland and Labrador. *Smoke-free Environments Act*, 2005. In: SNL2005 Chapter S-16.2; 2005.

Government of Nova Scotia. *Smoke-free Places Act*. In: Chapter 12 of the Acts of 2002; S.1; 2006.

Government of Yukon. *Smoke-free Places Act*. In: SY 2008, Chapter 8, S.4; 2008.

Harris B. The intractable cigarette 'filter problem'. *Tobacco Control* 2011 May 1, 2011;20(Suppl 1):i10-i6.

Heiss C, Amabile N, Lee AC, Real WM, Schick SF, Lao D, et al. Brief secondhand smoke exposure depresses endothelial progenitor cells activity and endothelial function: sustained vascular injury and blunted nitric oxide production. *Journal of the American College of Cardiology* 2008 May 6;51(18):1760-1771.

Hyland A, Barnoya J, Corral JE. Smoke-free air policies: past, present and future. *Tobacco Control* 2012 Mar 1;21(2):154-161.

IARC. *IARC Handbooks of Cancer Prevention, Tobacco Control Vol. 13*. Lyons, France: The International Agency for Research on Cancer; 2009a.

IARC. Impact of smoke-free policies on business, the hospitality sector, and other incidental outcomes. Ch. 4 in: *Evaluating the Effectiveness of Smoke-free Policies* [Internet]. Lyon, France: IARC Handbooks of Cancer Prevention: Tobacco Control, 75-91; 2009b. Available at: <http://www.iarc.fr/en/publications/pdfs-online/prev/handbook13/handbook13-4.pdf>

IARC. *IARC Monograph on the Evaluation of Carcinogenic Risks to Humans: Volume 83– Tobacco Smoke and Involuntary Smoking*. Lyons, France: World Health Organization – International Agency for Research on Cancer; 2004.

Johansson A, Hermansson G, Ludvigsson J. How should parents protect their children from environmental tobacco-smoke exposure in the home? *Pediatrics* 2004 Apr 1;113(4):e291-e295.

Kaufman P, Zhang B, Bondy SJ, Klepeis N, Ferrence R. Not just "a few wisps": real-time measurement of tobacco smoke at entrances to office buildings. *Tobacco Control*. 2011 May 1;20(3):212-218.

Kennedy RD, Behm I, Craig L, Thompson ME, Fong GT, Guignard R, et al. Outdoor smoking behaviour and support for outdoor smoking restrictions before and after France's national smoking ban. *The European Journal of Public Health* 2012 Feb 1;22(suppl 1):29-34.

Kennedy RD, Elton-Marshall T, Mutti S, Dubray J, Fong GT. Understanding the impact of the Smoke-Free Ontario Act on hospitality establishments' outdoor environments: a survey of restaurants and bars. *Tobacco Control* 2010 Apr 1;19(2):165-167.

Klepeis NE, Gabel EB, Ott WR, Switzer P. Outdoor air pollution in close proximity to a continuous point source. *Atmospheric Environment* 2009;43(20):3155-3167.

Klepeis NE, Ott WR, Switzer P. Real-time measurement of outdoor tobacco smoke particles. *Air & Waste Management Association* 2007 May 1;57:522-534.

Licht AS, Hyland A, Travers MJ, Chapman S. Secondhand smoke exposure levels in outdoor hospitality venues: A qualitative and quantitative review of the research literature. *Tobacco Control* 2013 May;22(3):172-179.

Luk R, Ferrence R, Gmel G. The economic impact of a smoke-free bylaw on restaurant and bar sales in Ottawa, Canada. *Addiction* 2006;101(5):738-45.

Meyers DG, Neuberger JS, He J. Cardiovascular effect of bans on smoking in public places: a systematic review and meta-analysis. *Journal of the American College of Cardiology* 2009 Sept 22;54(14):1249-1255.

Moerman JW, Potts GE. Analysis of metals leached from smoked cigarette litter. *Tobacco Control* 2011 May 1;20(Suppl. 1):i30-i35.

Mulcahy M, Evans DS, Hammond SK, Repace JL, Byrne M. Secondhand smoke exposure and risk following the Irish smoking ban: an assessment of salivary cotinine concentrations in hotel workers and air nicotine levels in bars. *Tobacco Control* 2005;14 384–388.

Nagelhout GE, de Vries H, Boudreau C, Allwright S, McNeill A, van den Putte B, *et al.* Comparative impact of smoke-free legislation on smoking cessation in three European countries. *The European Journal of Public Health* 2012 Feb 1;22(suppl 1):4-9.

Non-Smokers' Rights Association. The Evolution of Smoke Free Outdoor Spaces, March 2013, http://www.nsra-adnf.ca/cms/file/files/SF_outdoor_spaces_2013-FINAL.pdf

Novotny T, Lum K, Smith E, Wang V, Barnes R. Cigarettes butts and the case for an environmental policy on hazardous cigarette waste. *International Journal of Environmental Research and Public Health* 2009;6(5):1691-1705.

Novotny TE, Zhao F. Consumption and production waste: another externality of tobacco use. *Tobacco Control* 1999;8(1):75-80.

Ocean Conservancy. Tracking Trash – 25 Years of Action for the Ocean: 2011 Report. Washington, D.C.: Ocean Conservancy; 2011. Available from: http://act.oceanconservancy.org/pdf/Marine_Debris_2011_Report_OC.pdf

Pope CA, III, Eatough DJ, Gold DR, Pang Y, Nielsen KR, Nath P, *et al.* Acute exposure to environmental tobacco smoke and heart rate variability. *Environmental Health Perspectives* 2001;109(7):711-716.

Repace J. *Measurements of Outdoor Air Pollution from Secondhand Smoke on the UMBC Campus*. Bowie, MD. Repace Associates, Inc.; 2005 June 1.

Repace J. Benefits of smoke-free regulations in outdoor settings: beaches, golf courses, parks, patios, and in motor vehicles. *William Mitchell Law Review* 2008 Nov 6;34(4):1621-1638.

Repace J, Zhang B, Bondy SJ, Benowitz N, Ferrence R. Air quality, mortality and economic benefits of a smoke-free workplace law for non-smoking Ontario bar workers. *Indoor Air* 2013; 23(2) 93–104.

St. Helen G, Bernert JT, Hall DB, Sosnoff CS, Xia Y, Balmes JR, *et al.* Exposure to secondhand smoke outside of a bar and a restaurant and tobacco exposure biomarkers in non-smokers. *Environmental Health Perspectives* 2012 Jul;120(7):1010-6

Schultz PW, Bator ReJ, Large LB, Bruni CM, Tabanico JJ. Littering in context: personal and environmental predictors of littering behavior. *Environment and Behavior* 2013 45 (1): 35-59.

Scollo M, Lal A, Hyland A, Glantz S. Review of the quality of studies on the economic effects of smoke-free policies on the hospitality industry. *Tobacco Control* 2003 March 1, 2003;12(1):13-20.

Slaughter E, Gersberg RM, Watanabe K, Rudolph J, Stransky C, Novotny TE. Toxicity of cigarette butts, and their chemical components, to marine and freshwater fish. *Tobacco Control* 2011 May 1;20(Suppl 1):i25-i29.

Smith EA, Novotny TE. Whose butt is it? tobacco industry research about smokers and cigarette butt waste. *Tobacco Control* 2011 May 1, 2011;20(Suppl 1):i2-i9.

Stafford J, Daube M, Franklin P. Secondhand smoke in alfresco areas. *Health Promotion Journal of Australia* 2010;21(2):99-105.

Statistics Canada. Canadian Tobacco Use Survey, 2011. Ottawa, Canada: Statistics Canada, Special Surveys Division.

Sureda X, Martínez-Sánchez JM, López MJ, Fu M, Agüero F, Saltó E, *et al.* Secondhand smoke levels in public building main entrances: outdoor and indoor PM_{2.5} assessment. *Tobacco Control* 2012 Nov;21(6):543-8

U.S. Department of Health and Human Services. How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report of the Surgeon General. Rockville, MD : Dept. of Health and Human Services, Public Health Service, Office of Surgeon General, 2010.

U.S. Department of Health and Human Services. *The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Coordinating Center for Health Promotion, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2006.

Voorhees CC, Cong Y, Carter-Pokras O, MacPherson L, Kanamori M, Guangyu Z, Chen L, and Fiedler R. Peers, tobacco advertising, and secondhand smoke exposure influences smoking initiation in diverse adolescents. *American Journal of Health Promotion* 2011 January/February; 25(3): e1-e11.

Wilson N, Edwards R, Parry R. A persisting secondhand smoke hazard in urban public places: results from fine particulate (PM_{2.5}) air sampling. *The New Zealand Medical Journal* 2011 Mar 4;124(1330) 5-7.

WHO. Framework Convention on Tobacco Control. Guidelines for Implementation of Article 8 - The Protection from Exposure to Tobacco Smoke. Geneva, Switzerland: WHO; July 2007. Available from: http://www.who.int/fctc/cop/art%208%20guidelines_english.pdf

WHO. *Making Cities Smoke-free*. Geneva, Switzerland: The World Health Organization; 2011. Available from: http://whqlibdoc.who.int/publications/2011/9789241502832_eng.pdf

WHO Europe. Air Quality Guidelines: Global Updates 2005. Copenhagen, Denmark: The World Health Organization; 2005. Available from: http://www.euro.who.int/__data/assets/pdf_file/0005/78638/E90038.pdf

Zellers L, Thomas MA, Ashe M. Legal risks to employers who allow smoking in the workplace. *American Journal of Public Health* 2007 Aug;97(8):1376-82.

Zhang B, Bondy S, Ferrence R. Do indoor smoke-free laws provide bar workers with adequate protection from secondhand smoke? *Preventive Medicine* 2009;49(2009):245-247.

Zhou X, Nonnemaker J, Sherrill B, Gilsenan AW, Coste F, West R. Attempts to quit smoking and relapse: factors associated with success or failure from the ATTEMPT cohort study. *Addictive Behaviors* 2009; 4;34(4):365-73.