



Short communication

Location and duration of secondhand smoke exposure among Minnesota Nonsmokers, 2018

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ABSTRACT

In 2007 Minnesota passed into law a comprehensive ban on indoor smoking of tobacco products in public places including bars, restaurants, and workplaces. Despite reductions in smoking prevalence in the past 12 years, people are still exposed to secondhand smoke (SHS). It remains important to understand where and how long nonsmokers face exposure to SHS.

The 2018 Minnesota Adult Tobacco Survey was analyzed to examine self-reported SHS exposure among nonsmoking adults. We report prevalence and 95 percent confidence intervals of SHS exposure overall, by specific locations, and by demographics. Length of exposure to SHS was summarized in median minutes.

Overall, 30 percent of nonsmokers reported exposure in the past seven days. A total of 1382 participants indicated a location of exposure. The most common locations other than one's own home or car included building entrances (18.7 [16.2–21.1] percent), somewhere else outdoors (17.7 [15.1–20.3] percent), and restaurant/bar patios (12.8 [10.5–15.0] percent). Exposure was more likely to be reported by young adults (44.6 percent) and males (33.7 percent). The locations with the longest duration of SHS exposure in the prior seven days were a gambling venue (117.2 [72.2–162.2] minutes), another person's home (26.1 [15.4–36.8] minutes), and a bus stop (10.8 [4.7–16.9] minutes).

Monitoring nonsmokers' self-reported exposure to SHS remains important as a way to measure the impact and compliance with smoke-free policies. Additional information on the location and duration of exposure can be used programmatically to address high levels of exposure and consider additional policies or strategies.

1. Introduction

The harms of secondhand smoke (SHS) exposure are well known and there are no safe levels of exposure (US Department of Health and Human Services, 2006). Currently, 27 US states, including Minnesota, have passed comprehensive smoke-free laws (covering workplaces, restaurants and bars) to eliminate exposure in indoor settings (Campaign fTFK, 2019). Additionally, numerous local municipalities in all 50 US states have passed policies restricting smoking in outdoor settings such as parks, playgrounds, outdoor patios of restaurants or bars and workplace campuses (American NRF, 2019).

While the national prevalence of SHS exposure has significantly declined since 1988, prevalence has plateaued since 2011, and as of

2014, 25.2 percent of US nonsmokers continue to be exposed to SHS (Tsai et al., 2018). A few national surveys collect biologic specimens to verify and monitor SHS exposure over time, but a deeper understanding of where nonsmokers continue to be burdened by SHS exposure is important to evaluate existing smoke-free policies and inform additional tobacco control efforts. The Minnesota Adult Tobacco Survey (MATS) offers one state's findings on the location and duration of SHS exposure in settings beyond the home and car. While previous state and national surveillance efforts examined overall exposure in various locations, this is the first study to provide more refined data on the specific location and duration of exposure.

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2. Methods

Data for this analysis were collected as part of the 2018 Minnesota Adult Tobacco Survey (MATS), which uses computer-assisted telephone interviewing and a random digit dialing (RDD) methodology to obtain a cross-sectional sample of civilian, non-institutionalized adults aged 18 years or older living in Minnesota. MATS 2018 included a dual-frame landline and cell phone sample. Prescreening calls identified households and selected individuals within households; the main survey instrument was subsequently administered. A rigorous calling protocol was used, and letters were mailed to refusers and non-responders when addresses were available. Attempts were made to convert refusers. The final sample of 6055 included 1,789 landline and 3266 cell phone interviews. Standard American Association for Public Opinion Research methods were used to calculate the weighted landline and cell phone response rates of 17.5 percent and 13.4 percent respectively, which reflect net response rates across both the screener and extended questionnaires (<https://www.aapor.org/>). Data were weighted to create unbiased population estimates based on the probability of selection, and nonresponse; consequently estimates are representative of Minnesota adults. In addition, weighting was calibrated based on sex, race, location, and education from the 2016 American Community Survey of the US Census Bureau (<https://www.census.gov/programs-surveys/acs>). More methodological detail is available at <http://www.clearwaymn.org/MATS>.

To examine SHS exposure in locations other than the home or car, survey participants who indicated they did not currently use combustible tobacco (including cigarettes, cigars, pipes, and hookah) were asked, “In Minnesota, in the past seven days, has anyone smoked near you at any place besides your home or car?” If they responded ‘yes,’ they were asked, “The last time this happened, in Minnesota, where were you? Were you at ... ?” and provided the response options listed in Fig. 1. Participants could only choose one location. Lastly, the participants were asked to quantify the duration of their exposure with the question, “How much total time in the past seven days were you exposed to other people’s tobacco smoke in [location indicated in previous question]?” Exposure in the past seven days in the home (“how many days did anyone smoke cigarettes, cigars, or pipes anywhere inside your home?”) and car (“have you been in a car with someone who was smoking?”) were also assessed.

Participants were included in the sample if they were not currently

using combustible tobacco (nonsmokers) and if they reported exposure to secondhand smoke in the previous seven days in a location other than their home or car (unweighted n = 1382). Weighted prevalence and 95 percent confidence intervals were estimated for the prevalence of SHS exposure overall and by location. Differences in prevalence were examined overall and by demographics for locations with prevalence of > 5 percent using Rao-Scott Chi-Square tests. The “other” location options were not examined by demographics due to lack of practical application in interpretation (e.g. somewhere else outdoors and some other place). Length of exposure to SHS was summarized by median minutes and 95 percent confidence intervals. Median instead of mean minutes was used because of the highly skewed distribution of the exposure length measure. SAS v9.4 (SAS Institute Inc., Cary, NC) was used for analysis with two-tailed significance tests and a significance level of 0.05. Results are reported as prevalence rates (or median) and 95 percent confidence intervals.

3. Results

Of the 6055 survey respondents, 5218 were nonsmokers. Of these nonsmokers, 5179 responded to the question about past 7-day SHS exposure. Of these 5179 participants, 1390 participants indicated past 7-day SHS exposure (30 percent weighted), and 1382 reported the specific location of exposure. Lastly, 1240 reported the duration of exposure. Of the 1382 participants that indicated a specific location of exposure, half were males (51 percent), half reported a household income of \$75,000 or more (51 percent), most completed at least some college (78 percent). Their ages were divided between four age groups as follows: 11 percent ages 18–24 years, 30 percent ages 25–44 years, 33 percent ages 45–64 years, and 25 percent 65 years or older.

Participants were more likely to be exposed to SHS in locations other than their home or car (prevalence [95% CI]: 30.0 [28.3–31.7] percent), as compared to at home (2.2 [1.6–2.8] percent) or in their car (5.4 [4.5–6.3] percent). Of those exposed to SHS in a location other than their home or car, the most common locations of exposure were (Fig. 1): a building entrance (18.7 [16.2–21.1] percent), somewhere else outdoors (17.7 [15.1–20.3] percent), a restaurant or bar patio (12.8 [10.5–15.0] percent), some other place (11.5 [9.3–13.6] percent), a parking lot (9.5 [7.5–11.6] percent), another person’s home (9.0 [6.9–11.1] percent), a gambling venue (7.1 [5.5–8.8] percent), outdoor shopping mall or strip mall (4.5 [3.0–6.0] percent), bus stop (4.3 [3.0–5.7] percent), park (2.4 [1.3–3.4] percent), another person’s car (1.8 [0.9–2.6] percent), and community sports event (0.8 [0.2–1.5] percent). The locations with the longest duration of SHS exposure in the prior seven days included a gambling venue (median

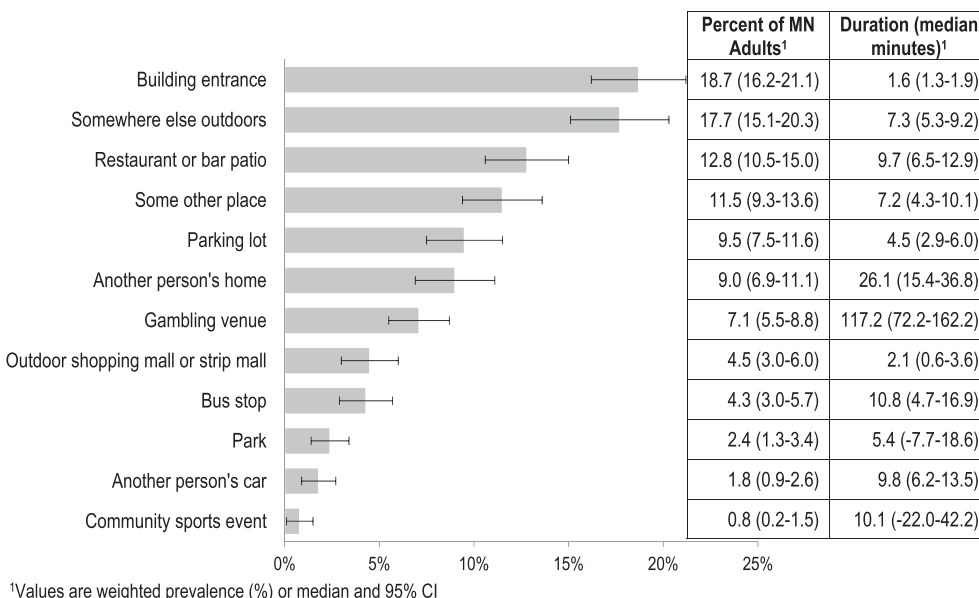


Fig. 1. Most recent exposure of nonsmoking Minnesota adults to secondhand smoke in locations other than home or car by type of setting: Prevalence and duration of exposure.

Table 1
Minnesota nonsmoking adults most recent secondhand smoke exposure in locations other than their home or car by demographics.

Characteristics	Location of most recent exposure to secondhand smoke (unweighted n = 1382)						
	Exposure in any location other than their home or car (unweighted n = 5179)	Outdoor locations			Indoor locations		
		Building entrance	Restaurant/bar outdoor patio	Parking lot	Another person's home	Gambling venue	Duration of exposure (min., unweighted n = 1240)
Overall	30.0 (28.3–31.7)	18.7 (16.2–21.1)	12.8 (10.5–15.0)	9.5 (7.5–11.6)	9.0 (6.9–11.1)	7.2 (5.6–8.8)	
Age	p < .001*	p = .136	p = .007*	p = .102	p = .169	p < .001*	
18 to 24	44.6 (38.4–50.8)	14.2 (8.4–20.1)	13.3 (7.0–19.5)	14.0 (7.4–20.6)	5.4 (1.3–9.6)	9.0 (6.4–11.6)	
25 to 44	36.1 (32.9–39.3)	20.7 (16.4–25.0)	16.9 (12.7–21.2)	9.6 (6.4–12.8)	7.8 (4.9–10.8)	4.9 (3.6–6.1)	
45 to 64	26.4 (23.7–29.1)	20.4 (15.9–24.8)	8.6 (5.7–11.4)	8.8 (5.5–12.0)	11.8 (7.3–16.4)	7.1 (5.1–9.2)	
65 or older	19.0 (16.6–21.4)	14.6 (10.1–19.0)	9.7 (5.9–13.4)	5.4 (2.3–8.6)	10.3 (5.1–15.6)	8.5 (5.0–12.0)	
Gender	p < .001*	p = .039*	p = .967	p = .009*	p = .337	p = .298	
Male	33.7 (31.2–36.2)	16.2 (13.0–19.4)	12.7 (9.7–15.7)	12.0 (8.9–15.2)	8.0 (5.3–10.7)	7.2 (5.3–9.0)	
Female	26.7 (24.5–28.9)	21.4 (17.6–25.2)	12.8 (9.4–16.2)	6.8 (4.5–9.2)	10.1 (6.8–13.3)	7.2 (5.3–9.1)	
Education	p < .001*	p < .001*	p = .002*	p = .170	p < .001*	p = .001*	
High school graduate/GED or less	28.1 (24.8–31.4)	9.6 (5.8–13.5)	7.0 (3.7–10.3)	8.4 (4.7–12.2)	15.1 (9.4–20.7)	10.5 (6.2–4.7)	
Some college or technical school	34.5 (31.5–37.6)	18.6 (14.5–22.8)	12.3 (8.6–16.0)	11.8 (8.1–15.6)	8.2 (5.3–11.2)	7.6 (5.7–9.5)	
College graduate or beyond	27.5 (25.2–29.9)	26.3 (22.0–30.7)	17.0 (13.1–20.9)	7.7 (5.1–10.3)	5.0 (2.9–7.1)	4.5 (3.3–5.7)	
Household income	p = .465	p = .076	p = .139	p = .352	p = .440	p = .816	
\$35,000 or less	30.9 (26.8–34.9)	12.2 (7.5–16.9)	9.5 (5.3–13.6)	13.3 (8.1–18.5)	11.4 (5.6–17.3)	9.5 (7.2–11.9)	
\$35,001 to \$50,000	30.0 (24.7–35.3)	20.2 (11.8–28.5)	7.1 (2.5–11.7)	7.3 (1.8–12.8)	11.0 (3.3–18.6)	4.9 (3.3–6.4)	
\$50,001 to \$75,000	28.6 (24.4–32.7)	19.1 (13.0–25.3)	11.7 (6.3–17.0)	10.5 (5.1–15.9)	9.3 (3.7–14.9)	7.7 (5.4–9.9)	
\$75,001 or more	32.4 (29.8–34.9)	21.4 (17.5–25.2)	14.2 (10.9–17.6)	8.7 (5.8–11.6)	7.1 (4.6–9.5)	4.9 (3.7–6.1)	

Notes. *p < 0.05; p-values from Rao-Scott Chi-Square tests; Values are weighted prevalence (percent) and 95 percent confidence intervals or median minutes and 95 percent confidence intervals; Locations are mutually exclusive.

[95% CI]: 117.2 [72.2–162.2] minutes), another person's home (26.1 [15.4–36.8] minutes), and a bus stop (10.8 [4.7–16.9] minutes).

SHS exposure, location, and duration by demographics are reported in [Table 1](#). Participants had a higher prevalence of SHS exposure in any location other than their home or car if they were younger, male, and reported attending some college or technical school (as compared to college graduates). The overall duration of exposure was highest for 18–24 year-olds, those with a high school diploma/GED or less, and participants with a household income of \$35,000 or less. Females and college graduates were more likely to report a building entrance as their last location of SHS exposure. Males were more likely to report exposure in a parking lot, and participants with a high school diploma/GED or less were more likely to report another person's home. Moreover, younger participants and college graduates were more likely to report a restaurant/bar patio; and lastly participants 65 years or older as well as those with a high school diploma/GED or less were more likely to report a gambling venue.

4. Discussion

This paper provides one state's findings on the location and duration of SHS exposure in settings other than the home and car; most of which occurs in outdoor spaces for brief periods of time. While exposure to SHS was low in the home and car, three in ten adult nonsmokers in Minnesota reported SHS exposure in the previous seven days in a location other than their home or car. SHS exposure differed by age, gender, and education, affecting more vulnerable populations (e.g. youth, ages 65 years or older, low education).

There are two notable implications of this more granular level of detail on the nature of SHS exposure. First, one can argue that much of this SHS exposure is involuntary and unavoidable. Nonsmokers report being subject to SHS in common locations such as building entrances, parking lots and bus stops. Some local ordinances prohibit smoking within 25 feet of building entrances and at bus stops, but this is not a state-wide policy. Second, seeing and experiencing SHS exposure in these public settings may normalize smoking behavior, to which youth are particularly susceptible ([U.S., 2006](#); [Siegel et al., 2008](#); [Agaku et al., 2019](#)).

As states adopt comprehensive smoke-free policies for indoor public spaces, as Minnesota did in 2007, nonsmokers' exposure to SHS in outdoor locations becomes more pronounced ([Sureda et al., 2012](#)). A growing literature base demonstrates that exposure to SHS in outdoor settings is significant and can contribute to negative health outcomes among nonsmokers, especially those with pre-existing health conditions ([St Helen et al., 2012](#); [Licht et al., 2013](#); [Kaufman et al., 2011](#); [Hurt et al., 2012](#)). For communities that adopt smoke-free policies, it is important to monitor nonsmokers' self-reported exposure to SHS as a tool for measuring impact of and compliance with these policies. As for demographic differences in SHS exposure, enforcing smoke-free policies helps reduce the health disparities in exposure overall ([Centers for Disease Control and Prevention, 2015](#)).

Additional information on the location and duration of exposure can complement and enhance the understanding of national surveys that track exposure using cotinine tests. This level of detail can be useful programmatically as tobacco control advocates continue to address persistent high levels of exposure and consider additional smoke-free policies or communication strategies to inform and enforce existing policies.

Comprehensive smoke-free laws and policies for workplaces and public places are effective in lowering prevalence of exposure, as they have in Minnesota ([St. Claire et al., 2016](#); [St. Claire et al., 2012](#); [Haw and Gruer, 2007](#); [Heloma and Jaakkola, 2003](#)). Many Minnesota municipalities have enacted outdoor smoke-free policies at parks and public transportation stops; such policies can be expanded to cover more residents and once passed, need to be consistently enforced. Voluntary smoke-free rules for homes and vehicles can further reduce

exposure among nonsmokers. ([St. Claire et al., 2012](#)) In Minnesota and elsewhere, additional efforts are needed to make gambling venues smoke-free in order to protect patrons and employees from the hazards of SHS exposure. Finally, designated smoking areas in outdoor locations and smoke-free buffer zones around building entrances should be considered. While this study examines SHS exposure specifically, it is important to note that exposure to secondhand aerosol from electronic vaping products is not without risks to children and non-users and should be carefully monitored as well ([Bradford et al., 2019](#); [Martínez-Sánchez et al., 2019](#)).

MATS data are subject to three limitations. First, the survey asked respondents to detail their last exposure in settings other than the home, workplace or car. Prevalence of exposure in these settings may be under-reported given the limitation of asking only about the most recent event. Duration of exposure in the home and car were also not assessed. Furthermore, the instrument did not ask respondents who reported being exposed "some other place" to specify that location, so interpretation of this response is limited. Secondly, the data is reliant on self-report. Errors in recall or response bias in reporting exposure in more memorable locations may skew results. Finally, results reflect the experience of nonsmokers in Minnesota and may not be generalizable to other populations. Of note, this study does not account for exposure to aerosol from electronic cigarettes.

SHS exposure in settings other than the home or car remains high. Monitoring exposure in these public settings is important to both understand persistent high levels of exposure as well as the need for enforcement of smoke-free policies. Understanding the nature of SHS exposure in settings not covered by existing smoke-free laws is useful as public health professionals monitor exposure and consider pursuing additional approaches to protect the health of nonsmokers.

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Ann W. St. Claire: Conceptualization, Project administration, Writing - original draft, Writing - review & editing, Supervision. **Samantha Friedrichsen:** Methodology, Software, Formal analysis, Writing - original draft, Writing - review & editing, Visualization. **Raymond G. Boyle:** Conceptualization, Writing - original draft, Writing - review & editing. **John Kingsbury:** Conceptualization, Writing - original draft, Writing - review & editing. **Michael J. Parks:** Conceptualization, Writing - original draft, Writing - review & editing. **Sharrilyn Helgertz:** Conceptualization, Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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