

# Non-Smokers' Rights Association

## Smoking and Health Action Foundation

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Spring 2010

### Second-hand Smoke in Multi-Unit Dwellings: Literature Review

These summaries are meant to provide brief descriptions of some of the key peer-reviewed studies that have a bearing on the issue of second-hand smoke in multi-unit dwellings. It is strongly recommended that anyone interested in citing these studies for their own use read the articles themselves and not rely solely on our interpretation of them.

1. "Beliefs about the health effects of 'thirdhand' smoke and home smoking bans." Winickoff JP, Friebely J, Tanski SE, Sherrod C, Matt, GE, Hovell MF, McMillen RC. *Pediatrics* 2009;123: e74-e79.

This study is the first published one to coin the term third-hand smoke, and defines it as residual tobacco smoke contamination that remains after a cigarette is extinguished. The study sought to demonstrate that beliefs about thirdhand smoke are associated with household smoking bans. Using data from the Social Climate Survey of Tobacco Control (an annual cross-sectional survey, n=1478), researchers found that 65% of non-smokers versus 43% of smokers agreed that thirdhand smoke harms children and that adults' beliefs about the health effects of exposure to thirdhand smoke are independently associated with home smoking bans. Strict smoking rules were more than three times more prevalent among non-smoker households (88.4%) than smoker households (26.7%).

2. "Gas-phase organics in environmental tobacco smoke. 1. Effects of smoking rate, ventilation, and furnishing level on emission factors." Singer BC, Hodgson AT, Guevarra KS, Hawley EL, Nazaroff WW. *Environmental Science & Technology*, 2002; 36(5): 846-853.

This study, and the second part that follows, are important contributions to the body of evidence regarding the indoor environmental persistence of second-hand smoke (SHS). The objective of this study was to monitor the effect of SHS (or environmental tobacco smoke—ETS—as it's referred to in this study) sorption in a 50 m<sup>3</sup> ventilated room constructed and furnished with materials typical of many residences and office buildings. The emission and sorption of 26 gas-phase organic compounds were measured in 24 experiments under varying conditions related to furnishing levels, smoking rates and room ventilation rates. This study indicates that sorption in a furnished room with a low ventilation rate results in decreased emissions of several important SHS organic compounds, including cresols and nicotine, by up to an order of magnitude when compared to emissions from a highly ventilated and lightly furnished room. The results

therefore indicate that sorption (and later off-gassing) in a typical indoor environment can greatly affect exposures of non-smokers to gas-phase organic compounds found in ETS.

3. "Gas-phase organics in environmental tobacco smoke: 2. Exposure-relevant emission factors and indirect exposures from habitual smoking." Singer BC, Hodgson AT, Nazaroff WW. *Atmospheric Environment* 2003; 37: 5551-5561.

This article describes month-long experiments to investigate sorption effects on potential SHS exposures under habitual smoking conditions. Cigarettes were smoked by machine in a 50 m<sup>3</sup> furnished room over a three-hour period 6-7 days/week with varying levels of continuous ventilation. Organic gas concentrations were measured during 3 hour 'active' smoking periods, including one hour immediately following, for 10 hour 'post-smoking' periods and measurements were also taken for 10 hour 'background' periods for comparison. The researchers found that reemission (off-gassing) of some volatile hazardous air pollutants accounted for approximately 47-71% of potential daily exposures.

In other words, non-smokers can be exposed to SHS even when no active smoking occurs (indirect exposure), due to the sorbing and later reemission (off-gassing) of organic compounds. The experiments also revealed that non-smoker exposure to certain gas-phase organic compounds can be reduced both by increasing the ventilation rate and by prohibiting smoking for at least one hour before entering a room. However, it should be noted that these measures were not effective for all compounds and that potential indirect exposure to lower volatility toxic compounds including polycyclic aromatic hydrocarbons persisted.

4. "Formation of carcinogens indoors by surface-mediated reactions of nicotine with nitrous acid, leading to potential *thirdhand smoke* hazards." Sleiman M, Gundel LA, Pankow JF, Jacob P, Singer BC, Destailats H. *Proceedings of the National Academy of Sciences of the United States of America (PNAS)* 2010; doi: 10.1073/pnas.0912820107 (Feb. 2010).  
[www.pnas.org/content/early/2010/02/04/0912820107.full.pdf+html](http://www.pnas.org/content/early/2010/02/04/0912820107.full.pdf+html)

Only the second peer-reviewed study to use the term third-hand smoke, this research sought to demonstrate that nicotine residue from second-hand smoke, which readily sorbs (sticks) to indoor surfaces, can react with ambient nitrous acid (HONO) to form potent carcinogenic tobacco-specific nitrosamines (TSNAs). HONO, present in the indoor environment from unvented combustion appliances and from chemical reactions, is often found at higher levels than outside. Nicotine is the most abundant organic compound found in second-hand smoke, deposits almost entirely on indoor surfaces, and persists in the indoor environment for weeks to months. In laboratory experiments, vaporized nicotine was adsorbed onto cellulose as a model indoor material and then exposed to HONO for 3 hours.

The researchers found NNA {1-(*N*-methyl-*N*-nitrosamino)-1-(3-pyridinyl)-4-butanol}, a tobacco-specific nitrosamine (TSNA) absent in fresh tobacco smoke,

to be a major product, along with two others—NNK {4-(methylnitrosamino)-1-(3-pyridinyl)-1-butanone} and NNN {N-nitroso nornicotine}. Moreover, given the low volatility of TSNA's and their ability to persist in the indoor environment, they represent an unappreciated health hazard through skin exposure, dust inhalation, and for infants, ingestion. The study emphasizes the need for more research in this area to better understand the health implications of these potent cancer-causing compounds that impregnate the various surfaces and furnishings of indoor environments.

5. Sidestream cigarette smoke toxicity increases with aging and exposure duration. Schick S, Glantz SA. *Tobacco Control* 2006; 15: 424-429.

This study does not specifically deal with second-hand smoke in multi-unit dwellings per se, but offers some extremely valuable information about the toxicity of 'aged' (30 minutes and 90 minutes) versus 'fresh' (10 seconds) sidestream tobacco smoke. Sidestream smoke refers to the smoke that comes off the end of an idling cigarette, versus what is blown out of a smoker's mouth and nose (mainstream smoke). The information is also particularly valuable in that the data come from previously unpublished experiments performed by Philip Morris at its formerly secret laboratory in Germany. In these experiments, lab rats were exposed to aged and fresh SHS for 5 hours/day, 7 days/week to 7 hours/day, 7 days/week. The rats' noses, larynxes and trachea were then sectioned and examined by a veterinary pathologist for pathological changes. Using total particulate matter as the measure of smoke exposure, the results of these studies indicate that, compared to fresh sidestream smoke, aged sidestream smoke (at least 30 minutes) increases toxicity 4x for 21-day exposures and 2x for 90-day exposures.

Given that particulate matter travels relatively well through cracks and ventilation systems in multi-unit dwellings, these studies offer additional evidence in favour of smoke-free buildings. Non-smoking residents are not only involuntarily exposed to "fresh" second-hand smoke, but also to aged SHS which deposits on surfaces and becomes more toxic over time.

6. "Secondhand smoke in apartment buildings: Renter and owner or manager perspectives." Hewett MJ, Sandell SD, Anderson J, Niebuhr M. *Nicotine & Tobacco Research* 2007; 9: S39-S47.

This study explored the views of Minnesota renters and apartment owners or managers about SHS transfer between units in multi-family buildings and about smoke-free housing. The study found that SHS transfer between units in multi-family buildings is common, with approximately half of renters reporting they were currently experiencing it (10% of them experiencing it often or most of the time). Forty-nine decision-makers, representing a convenience sample, were interviewed. Owners and managers who lacked a no-smoking policy (59% of sample) had low levels of interest in smoke-free policies and negative expectations regarding their impact on vacancy rates, turn-over and staff time requirements. Decision-makers who did have a no-smoking policy (41%)

generally had positive experiences and almost all were very likely to continue offering smoke-free buildings or units in the future. These decision-makers reported almost entirely neutral or positive effects on all key factors related to profitability. Finally, the study found that low-income renters living in publicly assisted housing had an almost identical level of interest in smoke-free buildings as households with higher incomes.

7. "Prevalence and predictors of smoke-free policy implementation and support among owners and managers of multiunit housing." King BA, Travers MJ, Cummings M, Mahoney MC, Hyland AJ. *Nicotine & Tobacco Research* 2009; 12(2): 159-63.

Similar to the 2007 Hewett study but broader in scope and with a larger sample size, this study was designed to assess the nature, extent and predictors of smoke-free policy implementation and support among owners and managers of multiunit housing across Western New York State. A cross-sectional survey was completed by 127 participants providing a 62% response rate. Just thirteen percent of respondents indicated they had a no-smoking policy in place for at least one of their buildings, yet 75% indicated interest in adopting such a policy. The major barriers identified included concerns over higher vacancy rates and a smaller pool of potential tenants, as well as questions regarding the legality of no-smoking policies. Among owners and managers who already had no-smoking policies in place, motivators included high tenant demand and knowledge that the policies would reduce either insurance or tenant turn-over rates. All owners and managers with policies in place indicated that they were likely to continue with their policies. Significantly, no-smoking policies were associated with buildings less than 30 years old. Given the high level of interest reported in no-smoking policies, this study suggests that more knowledge about no-smoking policies within the housing sector could increase the supply of smoke-free housing.

8. "Preferences and practices among renters regarding smoking restrictions in apartment buildings." Henrikus DJ, Pentel PR, Sandell SD. *Tobacco Control* 2003; 12, 189-194.

This is one of the first peer-reviewed studies on renter preferences regarding smoking policies for multi-unit buildings. Renters (n=301) living in large apartment buildings in a suburb of Minneapolis, Minnesota were asked to complete a mailed survey. The survey asked about the official smoking policy in place for their building, their preferences for smoke-free policies, their experiences with second-hand smoke infiltration from other units in their building, and the actions they had taken about their involuntary exposure. There was considerable disagreement amongst respondents regarding the presence or absence of current smoke-free policies in their buildings; however, an impressive 79% of non-smokers indicated a preference for a smoke-free building (versus just 18% of smokers). Forty-six percent of all respondents reported smelling SHS in their units that did not originate there, and 90% of those reported being bothered by it. However, despite experiencing and being bothered by involuntary exposure to SHS, the vast majority of respondents indicated that they did not

bother to notify or complain to their building manager or owner. The study points out that tenants' failure to notify management or complain about SHS may be an impediment to the adoption of more smoke-free policies for multi-unit apartment buildings.

9. "Indoor concentrations of nicotine in low income multi-family housing: Associations with smoking behaviors and housing characteristics." Kraev TA, Adamkiewicz G, Hammond SK, Spengler JD. *Tobacco Control* 2009; 18: 438-444.

This study sought to examine SHS exposure in low-income, multi-unit residences across the Greater Boston area. To assess exposure, a random sample of residents from 49 units completed an interviewer-administered questionnaire on household smoking behaviour. The results of the survey were compared to readings from passive diffusion monitors that collected vapor-phase nicotine (placed in participants' main living areas) and to the buildings' air exchange rates over the same one-week period. Sixty-nine percent of the participants in the study identified themselves as non-smokers and 31% self-identified as smokers. Thirty-two percent of all participants reported daily exposure to SHS in their home. Nicotine was detected in 89% of non-smoking homes (neither residents nor visitors smoked). Frequent reports of SHS coming from other units or hallways were associated with increased levels of nicotine concentrations in non-smoking homes, proving that SHS travels between units. The authors conclude that non-smokers living in multi-unit buildings with neighbours who smoke may be at risk of involuntary exposure to SHS in their own homes.

10. "Use of a population-based survey to describe the health of Boston Public Housing residents." Digenis-Bury EC, Brooks DR, Chen L, Ostrem M, Horsburgh CR. *American Journal of Public Health* 2008; 98: 85-91.

This study compares the health of public housing residents (n=393) in Boston with other residents in the same city (n=2526). Using random digit-dialing within regions, researchers found that public housing residents reported overall poorer health status (33%) than other city residents (9.3%) by virtually all measures, including ever diagnosed hypertension (36% v. 17.4%), current asthma (19.2% v. 9%) and ever diagnosed diabetes (13.8% v. 5.3%). Reported current smoking rates were 34.4% for public housing residents and 20.6% for other city residents. The survey also indicated that over half of all public housing households had children present and tenants were more likely to spend more time at home than other city residents (due to unemployment, inability to work because of disability, retirement, etc.). It is important to note that despite public housing tenants reporting an elevated smoking rate of 34.4%, this still leaves a majority of tenants in Boston Public Housing that do not smoke and who likely prefer to avoid exposure to SHS. This study makes an important contribution to the body of evidence regarding the health status of public housing tenants and offers compelling reasons for decision-makers to prohibit smoking in public housing.