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Cotton pillows: A novel field method for assessment of thirdhand smoke pollution

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Abstract

Thirdhand smoke (THS) is the residue left behind by secondhand smoke (SHS) that accumulates in indoor environments. THS chemicals can persist long after smoking has ceased and can re-emit semivolatile compounds back into the air. Measuring tobacco smoke pollution in real-world field setting can be technically complex, expensive, and intrusive. This study placed pillows in homes of former smokers and examined how much nicotine adsorbed to them over a three-week period. Organic cotton pillows were placed in the homes of 8 former smokers following the first week after verified smoking cessation until the fourth week. For comparison, pillows were also placed in 4 homes of nonsmokers. Nicotine concentrations were determined in the pillow case, fabric, and cotton filling, using isotope-dilution liquid chromatography tandem mass spectrometry. Cotton pillows placed in homes of former smokers absorbed on average 21.5 µg of nicotine. Nicotine concentration per gram of material significantly differed between pillow components ($p < 0.001$) and was highest for the pillow case (257 ng/g), followed by the pillow fabric (97 ng/g), and the pillow filling (17 ng/g). Nicotine levels in pillows placed in nonsmokers' homes did not differ from laboratory blanks ($p > 0.40$), or between pillow components ($p > 0.40$). In the absence of any smoking activity, cotton pillows absorbed significant amounts of nicotine emitted from THS reservoirs in the homes of former smokers. Given the much higher concentrations of SHS in the homes of active smokers, fabrics found throughout the home of a smoker are likely to store a substantial mass of tobacco smoke toxicants. Cotton pillows present a novel method that could be of interest to researchers requiring robust and unobtrusive methods to examine tobacco smoke pollution in real-world field settings.

Keywords

Nicotine; Secondhand smoke; Thirdhand smoke; Environmental tobacco smoke exposure; Passive smoking

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Competing Interest

The authors declare no competing interests.

Ethics approval

This study was conducted with the approval of the San Diego State University Institutional Review Board.

1. Introduction

Secondhand smoke (SHS) consists of a mixture of sidestream smoke emitted from the smoldering tip of a cigarette, cigar, or pipe and exhaled mainstream smoke (State of California Air Resource Board, 2006; U.S. Surgeon General, 1986; U.S. Surgeon General, 2006). This mixture contains thousands of chemical compounds (Rodgman and Perfetti, 2009) that have been causally linked to morbidity and mortality in nonsmokers involuntarily exposed (Office of the Surgeon General, 2010; U.S. Surgeon General, 2006). As SHS mixes with air, it rapidly distributes throughout a room, migrates to adjacent rooms, and spreads to neighboring units or floors in a multiunit building (Bohac et al., 2011; King et al., 2013, 2010; Snyder et al., 2016). While some of the SHS constituents may be removed through ventilation, others adsorb, deposit, and accumulate on surfaces, and others penetrate and become embedded in materials (Jacob et al., 2017; Matt et al., 2011a). Over time, indoor smoking creates a reservoir of tobacco smoke pollutants in settled house dust, on surfaces, and in materials, commonly referred to as thirdhand smoke (THS).

THS sorption and deposition dynamics have been studied in experimental environments, and THS has been detected in dust, on surfaces, and in the air of a wide variety of real-world indoor settings long after tobacco has been used (Destailats et al., 2006a, 2006b; Singer et al., 2002, 2003; Sleiman et al., 2010). In a controlled experiment, Schick et al. examined the deposition of nicotine, polycyclic aromatic hydrocarbons (PAHs), and tobacco-specific nitrosamines (TSNAs) from SHS aerosol on 100% terry cloth (Schick et al., 2014). Over a 10 day period, they exposed the cloth to SHS in a flow cell with one air exchange rate per hour. During the 1 h of exposure, 49% of the total particulate matter in SHS, 72% of nicotine, 62% of PAHs, and 80% and 79% of the TSNAs NNK and NNN were removed from the SHS aerosol and transferred to the cloth. After 26 h of smoke exposure over 10 days, nicotine had accumulated in the cloth at 874 µg of nicotine per square meter.

The present study examined if nicotine was transferred from THS reservoirs to cotton fabrics through re-emission in real indoor environments (Matt et al., 2016). To study this question, we placed a new organic cotton pillow for three weeks in each home of eight former smokers who had successfully quit smoking and four nonsmokers. Specifically, we examined (1) the total amount of nicotine that adsorbed to the pillow, (2) how nicotine adsorption differed between the exterior pillow case, the pillow fabric, and the pillow filling, and (3) the association between adsorbed nicotine in the pillow and measures of THS nicotine reservoirs in the home before the smoker quit smoking.

2. Methods and materials

2.1. Design

This study relied on a quasi-experimental design comparing homes of nonsmokers with long-term strict home smoking bans (control group, CG) to homes of former smokers who recently quit smoking (experimental group, EG). Participants in each group received a small travel-size organic cotton pillow with instructions to place it on the living room sofa or couch for three weeks and treat it like any other pillow in their possession. In the experimental group, participants received the pillow one week after they quit smoking, and

the pillow was retrieved three weeks later (or approximately one month after the quit date). In the CG, participants were provided with identical pillows, given the same instruction for placing and treating the pillows, and the pillow was returned after three weeks.

2.2. Participants

Eight former smokers who participated in a study of THS pollution and exposure after smokers quit and four nonsmokers participated in the study (Matt et al., 2018). The former smokers lived alone or with nonsmokers. Smoking cessation was verified based on exhaled carbon monoxide (CO) and salivary cotinine levels (NicAlert; TestCountry, San Diego California, USA). (Matt et al., 2018; Montalto and Wells, 2007) Table 1 shows characteristics of the participants and their homes.

2.3. Materials

The small travel-size organic cotton pillows were purchased from White Lotus Home (Pure Cotton Sleep Pillow, Travel Pillow 12 × 16; Highland Park, NJ; <https://www.whitelotushome.com/bedding/organic-pillows-100-usda-certified-cotton.html>). The pillows and pillow cases were manufactured with 100% organic, unprocessed fibers, and no treatments were applied to the pillows, pillow filling, or pillow cases to reduce wrinkling, clumping, or matting. One pillow was dissected to estimate the weight of various components. The pillow case measured 0.31 m × 0.43 m and weighed 47 g. The pillow fabric containing the filling measured 0.31 m × 0.43 m and weighed 37 g. The cotton filling weighed 342 g.

2.4. Measures

2.4.1. Nicotine in pillow components—The concentration of nicotine per gram of material (ng/g) was measured separately in the pillow case, pillow fabric, and cotton filling. Each pillow case was cut into eight pieces, and three pieces from one side of the case were prepared separately for nicotine analysis. One side of the pillow fabric was cut into four pieces, and then one piece per sample was prepared for nicotine analysis. A tennis ball size of the cotton filling was collected in the middle of the pillow filling for nicotine analysis.

For each pillow, field blank samples were prepared by using iso-propanol-cleaned scissors to cut off two corners of the pillow's fabric to approximately 3", and removing two handfuls of cotton filling. The corners were re-sewn and the pillow placed in an organic cotton case. The fabric pieces were placed in a small Ziploc bag and the filling pieces were placed in a separate Ziploc, and then stored with their pillow in a large Ziploc at the research office. The blanks were left at the office when the pillow was deployed, then transported to the home in their Ziploc bags when the research assistants visited to collect the pillow. At that home visit, a research assistant opened each Ziploc bag and used gloved fingers to place each blank in a separate glass jar for storage. One fabric blank and one filling blank were analyzed from each pillow. For each home, one lab blank was analyzed for the pillow fabric (Mdn = 0.41 ng/g) and one for the pillow filling (0.39 ng/g). Pillow samples and field blank samples were stored at -20 until analysis.

The sample preparation procedures were similar to those reported for surface wipes and house dust samples described elsewhere (Matt et al., 2011b). Briefly, a known amount of nicotine-d4 was spiked to each pillow cover piece placed in a cleaned 50 mL centrifuge tube, KOH (0.05 M) solution was added and then vortexed, acetonitrile was added and then vortexed again. The solution was transferred to a new centrifuge tube containing MgSO₄ and sodium chloride, followed by centrifugation at 3000 rpm for 5 min. The upper layer was filtered through a syringe filter with a PTFE membrane (0.2 µm pore size), and the final extract was analyzed by Agilent 6460 liquid chromatography tandem mass spectrometry (LC-MS/MS).

2.4.2. Air nicotine concentration—An air sample was collected overnight with a sorbent tube (SKC West 226–93) connected to a sampling pump (SKC Airchek Model XR5000) to measure the concentration of nicotine (µg/m³). Air nicotine levels at the end of the first week post quit (W1) visit were available in N = 4 former smokers' homes; they were not measured in the non-smokers' homes. Detailed sample collection and analytic methods have been described elsewhere (Matt et al., 2011b).

2.4.3. Surface nicotine concentration—Prescreened cotton wipes (cosmetic 100% cotton facial wipes) were wetted with 2 mL of 0.1% ascorbic acid and wiped over a 100 cm² area, typically a wooden door or cabinet unlikely to be frequently cleaned. At the baseline before quitting and week 4 after cessation (W4) visits, one sample was collected in the primary room used for smoking before cessation. At W1, two samples were collected in the primary room. These two measures of µg nicotine/m² were strongly correlated ($r_{12} = 0.98$) and were averaged. No surface wipe samples were collected in nonsmokers' homes. Detailed samples collection and analytic methods have been described elsewhere (Matt et al., 2011b).

2.4.4. Participants' smoking rate indoors at home—Participants reported their smoking rate indoors at home on typical work and non-work days (or week and weekend days if participants did not work outside the home) for the past seven days before the baseline visit, and their total weekly indoor smoking rate was computed. This measure has shown acceptable test-retest reliability and validity in relation to cotinine and nicotine assays in past studies (Matt et al., 2000; Matt et al., 1999).

2.5. Statistical analyses

Data were analyzed using Stata Version 15 using random-effects mixed models, in which homes were the random factor and the different components of the pillow (filling, cover fabric, case), replication samples, smoking status of participants (nonsmoker, former smoker), and test material (lab blanks vs. field tests) were modelled as within-home and between-home factors. All nicotine measures were log-transformed, and geometric means and confidence intervals are reported. The Type I error rate was set at 5%.

3. Results

3.1. Thirdhand smoke reservoirs

At baseline before quitting, smokers reported smoking on average 67 cigarettes/week ($n = 8$, $Mdn = 76.5$, $Range = [10-119]$). At base-line, the geometric mean surface nicotine concentration in smokers' homes was $21.0 \mu\text{g}/\text{m}^2$ ($n = 8$, $Mdn = 11.2$, $Range = [2.4-626.6]$) in the primary room where cigarettes were smoked (Matt et al., 2016).

At the one week post-quit visit when the pillows were placed, the geometric mean surface nicotine concentration in these now former smokers' homes was $7.5 \mu\text{g}/\text{m}^2$ ($n = 8$, $Mdn = 2.0$, $Range = [0.2-606.2]$). The geometric mean air nicotine concentration was $10.1 \text{ ng}/\text{m}^3$ ($n = 4$, $Mdn = 16$, $Range = [1-44]$) (Matt et al., 2016). When pillows were removed three weeks later, the geometric mean surface nicotine concentration was $5.7 \mu\text{g}/\text{m}^2$ ($n = 8$, $Mdn = 1.9$, $Range = [0.1-336.3]$).

3.2. Nicotine adsorption to pillow components

To determine if nicotine was absorbed consistently across the pillow case, we examined the variability of nicotine from three replicate samples of each pillow case. The Intraclass Correlation was 0.99 among samples from different areas of the pillow case, indicating a high degree of consistency.

Table 2 and Fig. 1 show the geometric means and 95% confidence intervals for nicotine levels found in the case, the fabric, and the filling of pillows left in nonsmokers' and former smokers' homes. Statistical analyses revealed a significant smoking status-by-component interaction effect ($\chi^2 = 73.23$, $df = 2$, $p < 0.001$). Further investigation showed that in nonsmokers' homes, the overall low levels of nicotine did not differ significantly between the pillow components ($\chi^2 = 1.26$, $df = 2$, $p = 0.53$) and were no different from the lab blanks ($\chi^2 = 0.13$, $p = 0.72$). In contrast, smokers' homes had significantly higher levels of nicotine on each pillow component (all p values < 0.001) as well as significant differences between the components ($\chi^2 = 90.87$, $df = 2$, $p < 0.001$). In smokers' homes, the nicotine concentration in the pillow case was significantly higher than in the pillow fabric ($\chi^2 = 22.90$, $df = 1$, $p < 0.001$), which in turn was significantly higher than in the cotton filling ($\chi^2 = 11.92$, $df = 1$, $p < 0.001$).

3.3. Total nicotine adsorption of pillow

After adjusting for nicotine found on lab blanks ($0.4 \text{ ng}/\text{g}$), no nicotine adsorbed to any parts of a pillow in the nonsmokers' homes. In former smokers' homes, we estimated that the entire pillow adsorbed an average of $21.5 \mu\text{g}$ of nicotine (95% CI: $[4.6;97.0]$). Of this total, 56% was found in the pillow case, 17% in the pillow fabric, and 28% in the pillow filling. Based on the surface area of the pillow (0.27 m^2), the case absorbed an amount equivalent to an average surface concentration of $45.2 \mu\text{g}/\text{m}^2$ in former smokers' homes.

3.4. Correlates of pillow nicotine concentration

Bivariate linear associations were explored between pillow nicotine concentrations and reported indoor cigarette smoking rate at baseline and surface nicotine concentrations on the

day the pillow was placed (i.e., W1) and the day the pillow was removed from the home (i.e., W4).

Reported indoor smoking amount before quitting was positively correlated with nicotine in the pillow filling ($r = 0.80$; $p < 0.001$, $N = 11$ former smokers and nonsmokers), inner pillow fabric ($r = 0.92$; $p < 0.001$, $N = 11$), and the pillow case ($r = 0.85$; $p = 0.001$, $N = 11$). Surface nicotine concentrations in the homes of smokers at W1 and W4 were not correlated with nicotine in pillow materials ($r = +0.04$ and -0.10 for the filling, $r = +0.07$ and -0.03 for the fabric, and ($r = +0.42$ and $+0.40$ for the case ($N = 8$, all $p > 0.25$)).

4. Discussion

Across a wide range of different indoor settings, research on THS has demonstrated that tobacco smoke pollutants accumulate in indoor environments where smoking is permitted and continue to pollute these environments long after cigarettes have been smoked (Jacob et al., 2017). Here we demonstrate re-emission and adsorption of nicotine to clean materials placed in the home after a smoker quit and a smoking ban was in place (Matt et al., 2016). This is the first study to demonstrate that THS reservoirs not only re-emit compounds in the air, but that these compounds continue to pollute clean materials and objects brought into THS polluted environments. Consistent with Schick and colleagues' findings for SHS adsorption to cotton fabric in a laboratory setting, this study demonstrated that THS compounds adsorb to cotton fabrics in private homes of former smokers (Schick et al., 2014). Over a three-week period, approximately 21.5 μg of nicotine was absorbed by a small cotton pillow, on average (total weight 426 g). The total mass of the deposited nicotine indicates that on average 45 ng were absorbed per hour from the air during the time the pillow was deployed. Based on an air nicotine concentration of 10.1 ng/m^3 measured at the time the pillow was left in the home, the pillow served as a nicotine sponge, absorbing nicotine from approximately 4.2 m^3 of air per hour, assuming that air nicotine was the only source. Considering surface area, the nicotine found in the pillow case was equivalent to 45 $\mu\text{g}/\text{m}^2$, which is twice the average amount detected on household surfaces at baseline and six-times the level on surfaces measured at the time the pillow was brought to the home. This difference may be due to surface nicotine representing only that part of the nicotine reservoir that can be removed from the exterior of an object by a wipe, whereas the nicotine extracted from the pillow case may represent nicotine adsorbed into the entire cotton material. It is also possible that in addition to adsorption from airborne compounds, nicotine could have been deposited on the pillow case through direct contact with polluted materials (e.g., sofa, clothes, hands) in the home. These may explain why we observed that the nicotine concentrations in the pillows were positively correlated with reported smoking rate but not the surface nicotine concentrations. Future research is needed to determine if and how much of the nicotine on the pillow case was deposited through contact with contaminated surfaces, adsorption of gas-phase compounds, or resuspended THS particles.

Home environments typically contain large quantities of cotton, polyester, wool, and other fabrics in the form of clothes, carpeting, upholstery, drapes, blankets, towels, bed sheets, toys, etc. If these materials have been in a home during years of smoking, they would be expected to contain a substantial mass of nicotine and other THS compounds, based on our

data. Considering that there are other porous materials in a home (e.g., particle board, gypsum board, ceiling tiles), it is to be expected that indoor smoking creates massive depositions of tobacco smoke toxicants throughout a home that will continue to affect indoor environments and their residents after smoking ends. This research contributes to the important policy debate that smoking should be prohibited in all indoor environments to prevent the build-up and the later release of tobacco smoke toxicants. This study also suggests that pre-screened cotton pillows could provide a simple tool to measure nicotine from THS sources and presumably SHS in home environments. More generally, porous materials with large surface areas that readily absorb volatile SHS and THS compounds may provide a method for removing and cleaning-up THS polluted environments, and for severely contaminated homes, removal of porous objects such as sofas, particle board, etc. may be necessary to remediate the home. These findings also have implications for peer-to-peer internet commerce (e.g., eBay, AirBnB) and secondhand merchandise sales. Findings from this study show that it is likely that products from smokers' homes contain tobacco smoke toxicants. More research is needed on exposure to and remediation of THS pollution, including pathways of exposure, exposure to different THS constituents, and relative adsorption and contamination of different materials in a home. Finally, this study raises concerns about the disposal of building materials and furnishings from homes of long-term heavy smokers where significant masses of THS have accumulated, including human carcinogens and other toxic compounds.

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References

- Bohac DL, et al., 2011 Secondhand smoke transfer and reductions by air sealing and ventilation in multiunit buildings: pft and nicotine verification. *Indoor Air* 21, 36–44. [PubMed: 20846212]
- Destailats H, et al., 2006a Indoor secondary pollutants from household product emissions in the presence of ozone: a bench-scale chamber study. *Environ. Sci. Technol* 40, 4421–4428. [PubMed: 16903280]
- Destailats H, et al., 2006b Effect of ozone on nicotine desorption from model surfaces: evidence for heterogeneous chemistry. *Environ. Sci. Technol* 40, 1799–1805. [PubMed: 16570600]
- Jacob P 3rd, et al., 2017 Thirdhand Smoke: new Evidence, Challenges, and Future Directions. *Chem. Res Toxicol* 30, 270–294. [PubMed: 28001376]
- King BA, et al., 2013 National and state estimates of secondhand smoke infiltration among U.S. multiunit housing residents. *Nicot. Tob. Res* 15, 1316–1321.
- King BA, et al., 2010 Secondhand smoke transfer in multiunit housing. *Nicot. Tob. Res* 12, 1133–1141.
- Matt GE, et al., 2000 Measuring secondhand smoke exposure in babies: the reliability and validity of mother reports in a sample of low-income families. *Health Psychol.* 19, 232–241. [PubMed: 10868767]

- Matt GE, et al., 2011a Thirdhand tobacco smoke: emerging evidence and arguments for a multidisciplinary research agenda. *Environ. Health Perspect* 119, 1218–1226. [PubMed: 21628107]
- Matt GE, et al., 2011b When smokers move out and non-smokers move in: residential thirdhand smoke pollution and exposure. *Tob. Control* 20, e1.
- Matt GE, et al., 2016 When smokers quit: exposure to nicotine and carcinogens persists from thirdhand smoke pollution. *Tob. Control*
- Matt GE, et al., 2018 A Casino goes smoke free: a longitudinal study of secondhand and thirdhand smoke pollution and exposure. *Tob. Control*
- Matt GE, et al., 1999 Measuring environmental tobacco smoke exposure in infants and young children through urine cotinine and memory-based parental reports: empirical findings and discussion. *Tob. Control* 8, 282–289. [PubMed: 10599573]
- Montalto NJ, Wells WO, 2007 Validation of self-reported smoking status using saliva cotinine: a rapid semiquantitative dipstick method. *Cancer Epidemiol. Biomark. Prev* 16, 1858–1862.
- Office of the Surgeon General, 2010. How tobacco smoke causes disease: the biology and behavioral basis for smoking-attributable disease: a report of the surgeon general.
- Rodgman A, Perfetti TA, 2009 *The Chemical Components of Tobacco and Tobacco Smoke*. CRC Press, Taylor & Francis Group, Boca Raton (FL).
- Schick SF, et al., 2014 Thirdhand cigarette smoke in an experimental chamber: evidence of surface deposition of nicotine, nitrosamines and polycyclic aromatic hydrocarbons and de novo formation of NNK. *Tob. Control* 23, 152–159. [PubMed: 23716171]
- Singer BC, et al., 2002 Gas-phase organics in environmental tobacco smoke. 1. Effects of smoking rate, ventilation, and furnishing level on emission factors. *Environ. Sci. Technol* 36, 846–853. [PubMed: 11918006]
- Singer BC, et al., 2003 Gas-phase organics in environmental tobacco smoke. 2. Exposure-relevant emission factors and indirect exposures from habitual smoking. *Atmos. Environ* 37, 5551–5561.
- Sleiman M, et al., 2010 Formation of carcinogens indoors by surface-mediated reactions of nicotine with nitrous acid, leading to potential thirdhand smoke hazards. *Proc. Natl. Acad. Sci. USA* 107, 6576–6581. [PubMed: 20142504]
- Snyder K, et al., 2016 Smoke-free multiunit housing: a review of the scientific literature. *Tob. Control* 25, 9–20. [PubMed: 25566811]
- State of California Air Resource Board, 2006 Technical support document for the “Proposed identification of environmental tobacco smoke as a toxic air contaminant, Part A. Vol. 2013. California Environmental Protection Agency, Air Resources Board, Office of Environmental Health Hazard Assessment.
- U.S. Surgeon General, 1986 *The Health consequences of involuntary smoking : a report of the Surgeon General, 1986*. U.S. Dept. of Health and Human Services Public Health Service Office on Smoking and Health, Rockville, MD.
- U.S. Surgeon General, 2006 *The health consequences of involuntary exposure to tobacco smoke: a report of the surgeon general*. 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, Atlanta, GA.

Fig. 1.

Unadjusted nicotine concentrations and their 95% confidence intervals for different components of pillows left in homes of nonsmokers and former smokers. ¹ The superscript at the end refers to 1. Nicotine concentrations in nonsmokers' homes were all within the range of lab blanks (Mdn = 0.40 ng/g).

Table 1

Participant and home characteristics.

Characteristics	Nonsmokers N = 4		Former smokers N = 8
Gender (% female)	50		50
Race/Ethnicity (%)			
African American/Black	0		50
Caucasian, White	50		25
Latino, Hispanic	0		25
Asian	50		0
Age (years) 25th-50th-75th Centile	28-47-54		43-53-58
Home Surface Area (sq. ft.) 25th-50th-75th Centile	1417-1710-2063		307-473-572

Geometric mean nicotine concentrations (ng/g) and their 95% confidence intervals for different components of organic cotton pillows left in homes of nonsmokers and former smokers.

Table 2

Pillow Component	Nonsmokers		Former Smokers	
	Unadjusted	Adjusted for lab blanks ^a	Unadjusted	Adjusted for lab blanks ^a
Case	0.41 ng/g [0.21; 0.65]	0 ng/g	256.63 ng/g [59.13; 1106.37]	257.03 ng/g
Fabric	0.30 ng/g [0.05; 0.60]	0 ng/g	97.21 ng/g [20.51; 447.43]	96.81 ng/g
Filling	0.28 ng/g [0.04; 0.58]	0 ng/g	17.45 ng/g [3.04; 83.22]	17.05 ng/g

^aNicotine levels on lab blanks (Mdn = 0.40ng/g).