Arbeitsgemeinschaft
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Thirdhand smoke exposure

- Thirdhand smoke exposure can cause serious health problems, particularly in vulnerable groups like children and pregnant women.
- Thirdhand smoke involves toxic tobacco residues that linger on surfaces and are difficult to eliminate from contaminated environments.
- Current smokefree policies often fail to address the dangers of thirdhand smoke, necessitating updated regulations.
- More research and public education are needed to fully understand and mitigate the long-term health impacts of thirdhand smoke.

Background

While the effects of active smoking and second-hand smoke are well documented, the concept of third-hand smoke (THS) is a relatively new phenomenon in the environmental and public health field.[1] Second hand smoke refers to passive smoking in which a non-smoker is exposed to mainstream or side stream smoke due to smoking by another person. THS, on the other hand, refers to the exposure to smoke-related substances, as opposed to the direct tobacco smoke, by being present in a place in which someone has smoked or by coming into contact with a smoker. In other words, the toxic substances and microparticles in tobacco smoke adhere to a smoker's hair and clothes, as well as to living spaces such as walls, curtains, and furniture, and these can contaminate smokers and non-smokers alike.

THS poses significant health risks by altering and destroying DNA structures, increasing the incidence of cancer among non-smokers, and emitting the same toxic substances found in

[1] Acuff L, Fristoe K, Hamblen J, Smith M, Chen J. Third-Hand Smoke: Old Smoke, New Concerns. J Community Health. 2016 Jun;41(3):680-7. doi: 10.1007/s10900-015-0114-1. PMID: 26512014.

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SHS. Cotinine and nicotine concentrations, indicative of tobacco smoke exposure, reportedly increase among individuals who spend time in environments previously exposed to smoking, such as accommodations, and used cars. The dangers of THS are particularly alarming due to its nearly invisible nature and enduring presence, making it crucial to understand this phenomenon to develop effective public health responses and inform regulations. Such measures are essential to protect vulnerable populations, including children, pregnant women and elderly people, from these hidden hazards. This document delves into the growth of scientific studies on THS, emphasizing the critical findings and their implications for public health policy, underscoring the need for comprehensive strategies to mitigate THS exposure.

List of scientific studies on THS in chronological order with key findings:

Jacob, P., 3rd, Benowitz, N. L., Destaillats, H., Gundel, L., Hang, B., Martins-Green, M., Matt, G. E., Quintana, P. J., Samet, J. M., Schick, S. F., Talbot, P., Aquilina, N. J., Hovell, M. F., Mao, J. H., & Whitehead, T. P. (2017). Thirdhand Smoke: New Evidence, Challenges, and Future Directions. Chemical research in toxicology, 30(1), 270–294. https://doi.org/10.1021/acs.chemrestox.6b00343

The publication by Jacob et al. (2017) outlined the evidence of THS up to 2017. Amongst studies measuring THS in homes of non-smokers, evidence showed that tobacco smoke contamination is pervasive with readily measurable concentrations of tobacco smoke carcinogenic nitrosamines. Moreover, laboratory evidence has shown that during the ageing of tobacco smoke, chemical reactions produce secondary organic pollutants, such as acrolein, furan, acrylonitrile and 1,3- butadiene. Studies demonstrated adverse effects of THS on organ and cellular systems, including lung and liver damage, metabolic effects, and permanent changes in peripheral blood immune cell composition.

Matt, G. E., Quintana, P. J., Hoh, E., Zakarian, J. M., Dodder, N. G., Record, R. A., ... & Novotny, T. E. (2020). Persistent tobacco smoke residue in multiunit housing: legacy of permissive indoor smoking policies and challenges in the implementation of smoking bans. Preventive Medicine Reports, 18, 101088.

Matt et al. (2020) examined the levels, distribution, and factors associated with THS pollution in multiunit housing (MUH), in San Diego, California. Their research showed that THS is a pervasive indoor pollutant in MUH, even in residences of nonsmokers with strict indoor smoking bans. It found significant nicotine residues on surfaces, indicating long-term persistence of THS, often exceeding levels found in smokers' homes. THS levels were higher in senior housing and in buildings where smoking on balconies and porches was prohibited, suggesting ineffective smoking policies and a legacy of prior smoking. The research highlighted the necessity of identifying and remediating highly polluted units and implementing comprehensive smoking bans to prevent THS buildup. It also underscored the role of public education and policy enforcement to mitigate THS exposure and protect residents' health.

Park M-B, Sim B. Evaluation of Thirdhand Smoke Exposure after Short Visits to Public Facilities (Noraebang and Internet Cafés): A Prospective Cohort Study. Toxics. 2022; 10(6):307. https://doi.org/10.3390/toxics10060307

A study from Park & Sim (2022) has confirmed that even two relatively short stays (approximately 2 h each) in a facility in which people had previously smoked can lead to thirdhand smoke exposure.

Yeh, K., Li, L., Wania, F., & Abbatt, J. P. (2022). Thirdhand smoke from tobacco, e-cigarettes, cannabis, methamphetamine and cocaine: Partitioning, reactive fate, and human exposure in indoor environments. Environment International, 160, 107063.

Yeh et al. (2022) reviewed the state of knowledge of the composition and partitioning behaviour of various types of indoor THS, with a focus on THS from tobacco, e-cigarettes, cannabis, and illicit substances (methamphetamine and cocaine). They found studies showing THS consists of residual pollutants that settle on surfaces and dust after smoking events. The composition of THS varies depending on the source, such as tobacco, e-cigarettes, cannabis, methamphetamine, and cocaine, each contributing different chemicals to the indoor environment. In regard to tobacco THS, the authors found that tobacco THS consists of a complex mixture of volatile and semi-volatile organic compounds, nicotine, and carcinogenic nitrosamines that persist in indoor environments long after smoking has ceased. These pollutants can react with other indoor chemicals, creating secondary toxins. Human exposure to THS can occur via inhalation, dermal absorption, and ingestion, leading to potential health risks such as respiratory issues, heart disease, developmental problems in infants, and potential genotoxic effects, as demonstrated in both human and animal studies.

Arfaeinia, H., Ghaemi, M., Jahantigh, A., Soleimani, F., & Hashemi, H. (2023). Secondhand and thirdhand smoke: a review on chemical contents, exposure routes, and protective strategies. Environmental Science and Pollution Research, 30(32), 78017-78029.

Arfaeinia et al. (2023) conducted a review on the hazards of both SHS and THS. In regard to THS, they documented various studies which revealed that THS comprises pollutants such as nicotine and tobacco-specific nitrosamines that persist on indoor surfaces for extended periods and can re-enter the air or react with other pollutants, creating additional harmful substances. Exposure to THS occurs through inhalation, dermal contact, and ingestion, posing significant health risks including increased cancer risk and respiratory issues, especially in children and pregnant women. Vulnerable populations, such as children, face higher risks due to behaviors like mouthing objects and spending time on floors, while pregnant women may experience postpartum depression and reduced breast milk

production. The review emphasizes creating smoke-free environments as crucial protective strategies, noting that conventional ventilation methods are insufficient. Comprehensive cleaning and remediation are necessary to reduce THS exposure in contaminated environments.

Continente, X., Henderson, E., López-González, L., Fernández, E., Tigova, O., Semple, S., ... & Castillo, E. G. (2023). Exposure to secondhand and thirdhand smoke in private vehicles: Measurements in air and dust samples. Environmental Research, 235, 116681.

Continente et al. (2023) monitored SHS and THS exposure in cars in two European countries (Spain and UK). They found significant nicotine and tobacco-specific nitrosamine (TSNA) levels in cars of smokers, with even higher concentrations in vehicles where smoking occurred inside. Airborne nicotine concentrations in cars where drivers smoked inside were markedly higher, reaching a median of 3.53 µg/m3 over 24 hours and 21.44 µg/m3 while driving, compared to non-smokers' cars where levels were below the limit of quantification. Dust samples showed nicotine concentrations up to six times higher in smokers' cars, with significant levels of TSNAs, which are known carcinogens. These findings highlight the persistent nature of THS pollutants and their potential health risks, especially for children and non-smokers in confined spaces like cars.

Matt, G. E., Greiner, L., Record, R. A., Wipfli, H., Long, J., Dodder, N. G., ... & Benowitz, N. L. (2023). Policy-relevant differences between secondhand and thirdhand smoke: strengthening protections from involuntary exposure to tobacco smoke pollutants.

Matt et al. (2023), discuss policy-relevant differences between SHS and THS exposure in their recent article. They highlight that existing smokefree policies, which effectively protect against SHS, do not adequately address the risks posed by THS. Since THS consists of persistent toxic residues that linger long after smoking has ceased, the authors emphasize the need for policies to redefine "smokefree" environments to include freedom from all tobacco smoke pollutants, including THS. They recommend the identification and remediation of THS reservoirs in indoor environments and call for comprehensive smoking bans without exemptions. Additionally, they stress the importance of educating the public and stakeholders about THS risks and implementing disclosure policies for environments with significant THS contamination.

Richardot, W. H., Hamzai, L., Ghukasyan, T., Dodder, N. G., Quintana, P. J., Matt, G. E., ... & Hoh, E. (2024). Novel chemical contaminants associated with thirdhand smoke in settled house dust. Chemosphere, 352, 141138.

Richardot et al. (2024) studied the chemical contaminants of THS in settled house dust. They identified a total of 140 qualified compounds. Notably, seven of these compounds were specific to tobacco, including nornicotyrine and 3-ethenylpyridine, which were found to be significantly more abundant in smokers' homes. Additionally, two new tobacco-related contaminants, tris (2-chloroethyl) phosphate and propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-propanediyl ester, were detected exclusively in smokers' homes. The study underscores the persistent nature of THS in environments long after smoking has ceased, highlighting the potential health risks, especially for children who are more susceptible due to their behaviours and developing systems. These findings emphasize the need for effective remediation strategies to mitigate the health impacts of THS exposure.

Conclusion

This short review of THS studies shows the progression in our understanding of its risks and mechanisms. From identifying the pervasive nature of THS in various environments to uncovering its long-term health impacts, the research underscores the necessity for robust public health strategies to mitigate THS exposure. Despite advancements, gaps remain in our knowledge, particularly regarding the long-term effects of THS on mental and developmental health.

Future research should focus on closing these gaps, and improving detection methods for THS pollutants. Additionally, there is a critical need for public health policies that extend beyond traditional smoking bans to address the residual impact of THS. By redefining "smoke-free" environments to include freedom from THS, and implementing comprehensive educational campaigns, policymakers can better protect public health against the risks posed by THS.