



Thirdhand Smoke: A Select Bibliography of Recent Studies

Scientists have coined the term “thirdhand smoke” to describe the residue from cigarettes, cigars and other combustible tobacco products that can linger on surfaces and furnishings long after these products have been extinguished. This invisible toxic brew consists of gasses and particulate matter, including carcinogens and heavy metals such as arsenic, lead and cyanide. The residue clings to walls and ceilings and is absorbed in carpets, clothing, draperies, upholsteries, vehicle interiors, and other items.



The science of thirdhand smoke is still emerging, and more research is needed to establish links between thirdhand smoke exposure and disease and to quantify the risks of such exposure. This bibliography contains a select listing of literature on thirdhand smoke, including some of the latest research, along with brief descriptors and links, where available. The studies, organized in reverse chronological order, include information on health effects and other data that may be of interest to landlords, tenants, day care users, home buyers and others concerned about thirdhand smoke.*

1. Cam Escoffery et al., *Third-Hand Smoke as a Potential Intervention Message for Promoting Smoke-Free Homes in Low-Income Communities*, HEALTH EDUC. RES. (2013), online publication doi:10.1093/her/cyto56, abstract available at <http://her.oxfordjournals.org/content/early/2013/05/11/her.cyt056.abstract>. Study finding participants, mostly female African-American high-school graduates, had not heard of thirdhand smoke, but believed education initiatives would promote smoke-free homes.
2. Giuliana Ferrante et al., *Third-Hand Smoke Exposure and Health Hazards in Children*, 79(1) MONALDI ARCHIVES CHEST DISEASE 38 (2013), abstract available at <http://www.ncbi.nlm.nih.gov/pubmed/23741945?dopt=Abstract>. Calling for more studies on the

* The list below is merely a selection of research reports available on these products. It is neither an exhaustive list nor a meta-analysis, nor should it be considered legal advice. If you have specific legal questions, we recommend that you consult with an attorney familiar with the laws of your jurisdiction.

health effects of thirdhand smoke and noting the inordinate impact of thirdhand smoke on children because they spend so much time indoors and are in contact with surfaces that contain thirdhand smoke residues.

3. B. Hang et al., *Thirdhand Smoke Causes DNA Damage in Human Cells*, 28(4) MUTAGENESIS 381 (2013), abstract available at <http://www.ncbi.nlm.nih.gov/pubmed/23462851>. Study finding that exposure to thirdhand smoke is genotoxic to human cell lines.
4. Georg E Matt et al., *Thirdhand Smoke and Exposure in California Hotel*, http://tobaccocontrol.bmj.com/content/early/2013/04/26/tobaccocontrol-2012-050824.short?g=w_tobaccocontrol_ahead_tab. Study finding thirdhand smoke in non-smoking rooms of hotels that allow smoking rooms, and recommending that non-smokers stay in smoke-free hotels.
5. Georg E Matt et al., *Towards Smoke-Free Rental Cars: An Evaluation of Voluntary Smoking Restrictions in California*, TOBACCO CONTROL (2013), online publication doi:10.1136/tobaccocontrol-2011-050231, abstract available at <http://her.oxfordjournals.org/content/early/2013/05/11/her.cyt056.abstract>. Study recommending that car rental companies implement stronger policies to ensure smoke-free cars are available to prevent exposure to thirdhand smoke.
6. Broderick Perkins, *Broderick Perkins: Thirdhand Smoke Can Reduce Your Home's Value by as Much as 29%*, THE CALIFORNIAN.COM, July 12, 2013, http://www.thecalifornian.com/article/20130712/LIFESTYLE04/307120014/Broderick-Perkins-Thirdhand-smoke-can-reduce-your-home-s-value-by-much-29-?nclick_check=1. Article stating that thirdhand smoke residue reduces home values and deters prospective homebuyers.
7. Penelope J. E. Quintana et al., *Wipe Sampling for Nicotine as a Marker of Thirdhand Tobacco Smoke Contamination on Surfaces in Homes, Cars, and Hotels*, NICOTINE TOBACCO RES. (2013), online publication doi:10.1093/ntr/ntt014, abstract available at <http://ntr.oxfordjournals.org/content/early/2013/02/24/ntr.ntt014.abstract.html?papetoc>. Study finding that surface wipe sampling is a reliable sampling method to distinguish smoking environments.
8. Suzaynn F Schick et al., *Thirdhand Smoke in an Experimental Chamber: Evidence of Surface Deposition of Nicotine, Nitrosamines and Polycyclic Aromatic Hydrocarbons and De Novo Formation of NNK*, TOBACCO CONTROL (2013), online publication doi:10.1136/tobaccocontrol-2012-050915, abstract available at <http://tobaccocontrol.bmj.com/content/early/2013/05/27/tobaccocontrol-2012-050915.abstract>. Findings suggesting that cigarette smoke deposits on room surfaces potentially showing a link between thirdhand smoke and morbidity and mortality.
9. Stratford Star, *Snuffing 'Third-Hand' Smoke; Stratford Health Department Sparks National Campaign*, STRATFORDSTAR.COM, Mar. 1, 2013, <http://www.stratfordstar.com/5371/snuffing-third-hand-smoke-stratford-health-department-sparks-national-campaign/>. Reporting Stratford Health Department initiative to raise awareness of thirdhand smoke and the dangers it poses for everyone, especially children.

10. Jeremy E Drehmer et al., *Pediatrician Interventions and Thirdhand Smoke Beliefs of Parents*, 43(5) AM. J. PREV. MED. 533 (2012), *abstract available at* <http://www.ncbi.nlm.nih.gov/pubmed/23079177>. Study finding 91 percent of parents believe thirdhand smoke can be harmful to babies' and children's health, while smokers are less likely, and parents who received advice are more likely, to believe this.
11. Tyler Fleming et al., *Third-Hand Tobacco Smoke: Significant Vector for PAH Exposure or Non-Issue?*, 8(4) INTEGRATED ENVTL. ASSESSMENT & MGMT. 763 (2012), *available for purchase at* <http://onlinelibrary.wiley.com/doi/10.1002/ieam.1337/abstract>.
12. Eunha Hoh et al., *Environmental Tobacco Smoke as a Source of Polycyclic Aromatic Hydrocarbons in Settle Household Dust*, 46(7) ENVTL. SCI. TECH. 4174 (2012), online publication doi:10.1021/es300267g, *abstract available at* <http://pubs.acs.org/doi/abs/10.1021/es300267g>. Study finding presence of polycyclic aromatic hydrocarbons is significantly higher in smokers' homes.
13. Nancy E Hood et al., *Associations Between Self-Reported In-Home Smoking Behaviours and Surface Nicotine Concentrations in Multiunit Subsidized Housing*, TOBACCO CONTROL (2012), online publication doi:10.1136/tobaccocontrol-2012-050666, *abstract available at* <http://tobaccocontrol.bmj.com/content/early/2012/10/22/tobaccocontrol-2012-050666.abstract?papetoc>. Study finding that surface nicotine concentrations were moderately correlated with the amount of cigarettes smoked.
14. Jae Woo Jung, Young Su Ju & Hye Ryun Kang, *Association Between Parental Smoking Behavior and Children's Respiratory Morbidity: 5-Year Study in an Urban City of South Korea*, 47(4) PEDIATRIC PULMONOLOGY 338 (2012), *available for purchase at* <http://onlinelibrary.wiley.com/doi/10.1002/ppul.21556/full>.
15. Elizabeth de la Riva-Velasco, *Relationship Between Exhaled Nitric Oxide and Exposure to Environmental Tobacco Smoke in Children with Asthma or Corticosteroids*, 49(7) J. ASTHMA 673 (2012), *abstract available at* <http://www.ncbi.nlm.nih.gov/pubmed/22799435>. Study concluding that thirdhand smoke may be an important variable in determining biomarkers for airway inflammation in children with asthma.
16. UCTV, *Clearing the Air of Thirdhand Smoke – UCTV Prime Cuts*, YOUTUBE (Oct. 18, 2012), http://www.youtube.com/watch?v=G2vIk_b6UyE. Video interview of Lara Gundel reporting on her research findings regarding the health consequences of thirdhand smoke.
17. Nick Vassilev, *Third-Hand Smoke – A New Hazard to be Aware of*, NEWSWIRE.NET, Nov. 11, 2012, <http://www.newswire.net/newsroom/pr/69640-third-hand-smoke-a-new-hazard-to-be-aware-of.html>. Noting the research of Mayo Clinic doctor, Lowell Dale, and asserting that commercial-grade cleaning of carpet, which applies heat and water, is needed to remove toxins deposited in the form of thirdhand smoke.
18. WTVR, *Scientist Warn of Third-Hand Smoke*, WTVR.COM (Aug. 7, 2012), <http://wtvr.com/2012/08/07/scientists-warn-of-third-hand-smoke/>. Video report citing American Lung Association conclusions about health dangers of thirdhand smoke for children of smokers.

19. Adrian Burton, *Does the Smoke Ever Really Clear?: Thirdhand Smoke Exposure Raises New Concerns*, 119(2) ENVTL. HEALTH PERSP. A70 (2011), available at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3040625/pdf/ehp-119-a70.pdf>. Article providing a brief history of thirdhand smoke, and some recent research findings.
20. Ware G Kushner et al., *Electronic Cigarettes and Thirdhand Smoke: Two Emerging Health Care Challenges for the Primary Care Provider*, INT. J. GEN. MED. (2011), online publication doi:10.2147/IJGM.S16908, abstract available at <http://www.ncbi.nlm.nih.gov/pubmed/21475626>. Article advising primary care advisors to be aware of the dangers of thirdhand smoke, pointing out that exposure can occur through the skin, by breathing, and by ingestion long after smoke has cleared from a room.
21. Georg E. Matt et al., *Review: Thirdhand Tobacco Smoke: Emerging Evidence and Arguments for a Multidisciplinary Research Agenda*, 119(9) ENVTL. HEALTH PERS. 1218 (2011), available at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3230406/>. Overview of state of thirdhand smoke research and call for additional research.
22. Carmela Protano & Matteo Vitali, *The New Danger of Thirdhand Smoke: Why Passive Smoking Does Not Stop at Secondhand Smoke*, 119(1) ENVTL. HEALTH PERS. A422 (2011), available at <http://ehp.niehs.nih.gov/1103956/>. Article proposing that researchers should focus on determining the effects of secondhand and thirdhand smoke independently from one another.
23. Tanya Tillet, *Thirdhand Smoke in Review: Research Needs and Recommendations*, 119(9) ENVTL. HEALTH PERS. A399 (2011), online publication doi:10.1289/ehp.119-a399b, available at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3230423/>. Calling for interdisciplinary research to study thirdhand smoke and noting calls for stricter policies to protect against thirdhand smoke exposure.
24. Virender K. Rehan, Reiko Sakurai & John S. Torday, *Thirdhand Smoke: A New Dimension to the Effects of Cigarette Smoke on the Developing Lung*, 301(1) AM. J. PHYSIOLOGY L1 (2011), online publication doi:10.1152/ajplung.00393.2010, available at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3129897/>. Study finding that exposure of fetuses to thirdhand smoke can lead to asthma and other health conditions.
25. Lauren M. Petrick, Alona Svidovsky & Yael Dubowski, *Thirdhand Smoke: Heterogeneous Oxidation of Nicotine and Secondary Aerosol Formation in the Indoor Environment*, 45(1) ENVTL. SCI. & TECH. 328 (2011), available for purchase at <http://pubs.acs.org/doi/abs/10.1021/es102060v>. Study finding nicotine has a high sorption capacity to household furnishings and clothing, and may contribute to the formation of secondary organic aerosol (SOA) gas and condensed phase products, and that persons can be exposed anywhere from a matter of hours to days.
26. Janet L. Thomas et al., *Metabolites of a Tobacco-Specific Lung Carcinogen in Children Exposed to Secondhand or Thirdhand Tobacco Smoke in Their Homes*, 20 CANCER EPIDEMIOL. BIOMARKERS PREV. 1213 (2011), online publication doi:10.1158/1055-9965-EPI-10-1027, available at <http://cebp.aacrjournals.org/content/20/6/1213.full.pdf+html>. Finding no evidence of *iso*-NNAL in urine as a result of exposure to thirdhand smoke, but noting research limits regarding ability to detect.

27. M H Becquemin, *Third-Hand Smoking: Indoor Measurements of Concentration and Sizes of Cigarette Smoke Particles after Resuspension*, TOBACCO CONTROL (2010), online publication doi:10.1136/tc.2009.034694, available for purchase at <http://tobaccocontrol.bmj.com/content/early/2010/06/05/tc.2009.034694.extract?sid=62a02b25-9cea-497c-912a-b5fa109afd03>.
28. John Henry Dreyfuss, *Thirdhand Smoke Identified as Potent, Enduring Carcinogen*, 60(4) NEWS & VIEWS 203 (2010), available at <http://onlinelibrary.wiley.com/doi/10.3322/caac.20079/pdf>. Article noting, among other things, that residual nicotine and carcinogenic tobacco-specific nitrosamines (TSNAs) will not simply wash away with soap and water, but can be removed with acidic, rather than alkaline, treatments.
29. Addie L. Fortmann, *Residual Tobacco Smoke in Used Cars: Futile Efforts and Persistent Pollutants*, NICOTINE TOBACCO RES. (2010), online publication doi:10-1093/ntr/ntq144, abstract available at <http://ntr.oxfordjournals.org/content/early/2010/08/30/ntr.ntq144.abstract?papetoc>. Study finding that smokers' efforts to reduce presence of dust from smoking did not moderate effect of smoking in cars, and recommending required disclosure and certified smoke-free cars to protect consumers.
30. Press Release, Hohenstein Institute, *When Baby Smokes Too: A Study by the Hohenstein Institute Highlights the Risks of Nicotine Transfer from Clothing* (Sept. 22, 2010), available at http://www.njgasp.org/hohenstein_when_baby_smokes_too-9-2010.pdf. This press release describes the conclusions of a German research study, finding that babies' skin cells were damaged as a result of exposure to lingering nicotine residuals on parents' clothing.
31. Georg Matt et al., *Residual Tobacco Smoke Pollution in Used Cars for Sale: Air, Dust, and Surfaces*, 10(9) NICOTINE TOBACCO RES. 1467, online publication doi:10.1080/14622200802279898, abstract available at http://www.ncbi.nlm.nih.gov/pubmed/19023838?ordinalpos=15&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVBrief. Finding that used cars for sale by smokers who did not smoke in their cars had lower levels of nicotine in the air inside the car, but similar levels on the surfaces and suggesting need for disclosure statements and smoke-free certification to protect consumers.
32. Georg E. Matt et al., *When Smokers Move Out and Non-Smokers Move In: Residential Thirdhand Smoke Pollution and Exposure*, TOBACCO CONTROL (2010), online publication doi:10.1136/tc.2010.037382, abstract available at <http://tobaccocontrol.bmj.com/content/early/2010/10/29/tc.2010.037382.abstract>. Study finding that thirdhand smoke remains in homes two months after smokers moved out and the vacant rooms had been cleaned for new residents.
33. Guadalupe Ortega et al, *Passive Smoking in Babies: The BIBE Study (Brief Intervention in Babies. Effectiveness)*, 10(772) BMC PUB. HEALTH 1 (2010), online publication doi:10.1186/1471-2458-10-772, available at <http://www.biomedcentral.com/content/pdf/1471-2458-10-772.pdf>. Study recommending that pediatric professionals can help prevent infant morbimortality resulting from exposure to thirdhand smoke by providing parents advice about its dangers.

34. Mohamad Sleiman et al., *Formation of Carcinogens Indoors by Surface-Mediated Reactions of Nicotine with Nitrous Acid, Leading to Potential Thirdhand Smoke Hazards*, (early edition) PNAS 1 (2010), online publication doi:10.1073/pnas.0912820107, available at <http://www.pnas.org/content/early/2010/02/04/0912820107.full.pdf+html>. Study finding that tobacco smoke residual nicotine sorbed into indoor surfaces formed carcinogenic nitrosamines that are specific to tobacco.
35. Mohamad Sleiman et al., *Secondary Organic Aerosol Formation from Ozone-Initiated Reactions with Nicotine and Secondhand Tobacco Smoke*, 44(34) ATMOSPHERIC ENV'T 4191 (2010), available for purchase at <http://www.sciencedirect.com/science/article/pii/S1352231010005923>. Study finding a new component of thirdhand smoke associated with formation of ultrafine particles (UFP), raising additional health concerns about thirdhand smoke.
36. Ikuo Ueta et al., *Determination of Volatile Organic Compounds for a Systematic Evaluation of Thirdhand Smoke*, 26 ANALYTICAL SCI. 569 (2010), abstract available at <http://www.ncbi.nlm.nih.gov/pubmed/20467132>. Study successfully extracting gaseous volatile organic compounds (VOCs) from different types of clothing and from smokers' breath, using a polymer-packed sample preparation needle.
37. Roni Caryn Rabin, *A New Cigarette Hazard: 'Third-Hand Smoke'*, NEW YORK TIMES, Jan. 2, 2009, available at http://www.nytimes.com/2009/01/03/health/research/03smoke.html?_r=2&scp=2&sq=tobacco&st=nyt&. Article asserting that doctors from MassGeneral Hospital for Children in Boston coined the term "third-hand smoke."
38. Caitlin O. Smith, "Thirdhand Smoke" Exposure Another Threat to Children, 30(11) AAP NEWS 8 (2009), available at <http://aapnews.aappublications.org/content/30/11/8.2.full>. Article listing ways to limit or prevent children's exposure to toxins associated with thirdhand smoke.
39. Jonathan P. Winickoff et al., *Beliefs About the Health Effects of "Thirdhand" Smoke and Home Smoking Bans*, 123(1) PEDIATRICS e74 (2009), online publication doi: 10.1542/peds.2008-2184, available at <http://pediatrics.aappublications.org/content/123/1/e74.full.pdf+html>. Study finding that people's beliefs about the health effects of thirdhand smoke are independently associated with residential non-smoking policies.
40. AM. SOC'Y OF HEATING, REFRIGERATION AND AIR-CONDITIONING ENGINEERS, INC., ENVIRONMENTAL TOBACCO SMOKE: POSITION DOCUMENT 6 (2008). Reiterating the only way to eliminate the health risks associated with thirdhand smoke is to prohibit smoking.
41. Suzaynn F. Schick & Stan Glantz, *Concentrations of the Carcinogen 4-(Methylnitrosamino)-1-(3-Pyridyl)-1-Butanone in Sidestream Cigarette Smoke Increase after Release into Indoor Air: Results from Unpublished Tobacco Industry Research*, 16(8) CANCER EPIDEMIOLOGY PREV. 1547 (2007), abstract available at http://www.ncbi.nlm.nih.gov/pubmed/17684127?itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum&ordinalpos=1. Study analyzing tobacco industry documents showing that carcinogens from cigarette smoke increase in concentration after release into the air, suggesting aging secondhand smoke contributes to human exposure to nitrosamine.

42. Brett C. Singer, *Direct and Indirect Exposures to Secondhand Smoke*, Lawrence Berkeley Nat'l Lab, Atmospheric Sci. & Indoor Env't Depts. (2006) (abstract not available).
43. AM. SOC'Y OF HEATING, REFRIGERATION AND AIR-CONDITIONING ENGINEERS, INC., ENVIRONMENTAL TOBACCO SMOKE: POSITION DOCUMENT 6 (2005). Stating the only way to completely eliminate the health risks associated with third hand smoke is to ban smoking.
44. Georg E. Matt et al., *Households Contaminated by Environmental Tobacco Smoke: Sources of Infant Exposures*, 13 TOBACCO CONTROL 29 (2004), online publication doi:10.1136/tc.2003.003889, available at <http://tobaccocontrol.bmj.com/content/13/1/29.full.pdf+html>. Study finding that environmental tobacco smoke (ETS) contamination and exposure were five to seven times higher in households of smokers who smoke outdoors than in non-smoking households.
45. Brett C. Singer et al., *Effect of Sorption on Exposures to Organic Gases from Environmental Tobacco Smoke (ETS)* (Int'l Acad, of Indoor Air Sciences, Conference Paper LBNL-49576 (2002), available at <http://www.ncbi.nlm.nih.gov/pubmed/11918006>. Study finding that concentrations of nicotine and other toxic compounds found in cigarette smoke rose with time, presumably as a result of increased reemission associated with increased sorbed mass concentrations.