North American Studies on the Health Effects of Woodsmoke

Indoor Air Quality

Table 1. Studies of symptoms associated with households using wood heat.

Reference	Findings
JT Zelikoff, et al, 2002.	**The toxicology of inhaled woodsmoke," Journal of Toxicology and Environmental Health, Part B, 5:101-114, 2002.** This is a "mini-review article (which) brings together many of the human and animal studies performed over the last three decades in an ttempt to better defined the toxicological impact of inhaled woodsmoke on exposed children and adults..."
Kjallstrand J, Petersson G. Sept.28, 2001	Phenolic antioxidants in wood smoke. Phenolic antioxidants are scavengers of oxygen radicals and should be considered when health hazards of small-scale incomplete biomass burning are estimated.Sci Total Environ. 2001 Sep 28;277(1-3):69-75. PMID: 11589408 [PubMed - indexed for MEDLINE]
Schauer JJ, et al, May 2001	Measurement of emissions from air pollution sources. 3. C1-C29 organic compounds from fireplace combustion of wood. Environ Sci Technol. 2001 May 1;35(9):1716-28. PMID: 11355184 [PubMed - indexed for MEDLINE]
Kjallstrand J, Petersson G. Apr 2001	Phenols and aromatic hydrocarbons in chimney emissions from traditional and modern residential wood burning. Environ Technol. 2001 Apr;22(4):391-5. PMID: 11329802 [PubMed - indexed for MEDLINE]
Pintos J, et al, Dec 1998	Use of wood stoves and risk of cancers of the upper aero-digestive tract: a case-control study. Int J Epidemiol. 1998 Dec;27(6):936-40. PMID: 10024184 [PubMed - indexed for MEDLINE]
Leonard SS, et al Sept 2000	Wood smoke particles generate free radicals and cause lipid peroxidation, DNA damage, NFkappaB activation and TNF-alpha release in macrophages. PMID: 10996671 [PubMed - indexed for MEDLINE]
Dennis RJ, et al, Jan 1996	Woodsmoke exposure and risk for obstructive airways disease among women. Chest. 1996 Jan;109(1):115-9. PMID: 8549171 [PubMed - indexed for MEDLINE]
Honicky et al., 1985	Moderate and severe respiratory symptoms were significantly greater (P<.001) in 34 children, aged 1-7 years in houses with woodstoves than in 34 children houses without. Conclusion: “Present findings suggest that indoor heating with wood-burning stoves may be a significant etiologic factor in the occurrence of symptoms of respiratory illness in young children.” Michigan, US.
Butterfield, et al., 1989	Significant correlation (P<.01), between woodstove use and frequency of wheeze, severity of wheeze, frequency of cough and waking up at night with cough , based on 59 subjects aged 1 to 5.5 years.
Lipsett et al., 1991	Presence of woodstove or fireplace in the home was associated with shortness of breath in females and both shortness of breath and moderate or severe cough in males (p<0.01 for all cases). 182 asthmatics living in

	Denver, Colorado.
Betchley et al., 1997	Forest firefighters had significant declines in lung function (FEV(1)). Average declines, pre-shift to mid-shift of 0.089 L, 0.190 L, and 0.439 L/sec in TVC, FEV(1) and FEF (25-75). The use of wood for indoor heat also was associated with the declines in FEV(1).
Morris et al., 1990	58 Navajo children under 2 years with diagnosed pneumonia or bronchiolitis were compared with matched control children. Use of a wood burning stove was associated with a 4 times higher risk of lower respiratory tract infection (P<.001).
Janigan DT, et al Apr 1997	Bronchiolitis obliterans in a man who used his wood-burning stove to burn synthetic construction materials. CMAJ. 1997 Apr 15;156(8):1171-3. PMID: 9141990 [PubMed - indexed for MEDLINE]
Hogg JC Apr 1997	Bronchiolitis obliterans and wood-burning stoves. CMAJ. 1997 Apr 15;156(8):1147-8. No abstract available. PMID: 9141985 [PubMed - indexed for MEDLINE]
Robin et al., 1996	Matched pair analysis revealed an increased risk of Acute Lower Respiratory Infection (ALRI) for children living in households that cooked with any wood (odds ratio 5.0; 95% confidence interval 0.6 to 42.8. Cooking with wood-burning stoves was associated with higher indoor air concentrations of respirable particles and with an increased risk of ALRI in Navajo children. Studied 45 children under 2 years.
Tuthill, 1984.	Risk of respiratory symptoms increased by 10%, but this was not statistically significant. Study of children aged 5-11, 258 with woodstoves, 141 without. Exposure to formaldehyde from any source, including wood burning, significantly increased risk.
Daigler et al., 1991	A comparison of patients in New York with physician-diagnosed otitis media (n = 125, 74% response), and controls (n = 237, 72% response) showed exposure to a woodburning stove was significantly associated (P<.05 with increased otitis (an inflammation of the middle ear marked by pain, fever, dizziness, and abnormalities of hearing.)
Hogg, 1997	The author comments on the case report by Dr. David T. Janigan and colleagues of classic bronchiolitis obliterans in a man who used a wood-burning stove to dispose of construction materials in Canada.
Ostro BD, et al Jun 1994	Indoor air pollution and asthma. Results from a panel study. Am J Respir Crit Care Med. 1994 Jun;149(6):1400-6. PMID: 8004290 [PubMed - indexed for MEDLINE]
Dean et al., 1992	Case of methemoglobinemia, sudden onset of cyanosis, irritability, metabolic acidosis, and a lethal methemoglobin level of 71.4% in a 10 week old infant. Family history revealed a wood-burning stove which emitted pine tar fumes as the potential environmental methemoglobin-producing source. The infant's cradle was situated five feet from the stove. The baby was treated and recovered.
Ramage et al., 1996	Case study of 61-yr-old woman suffering shortness of breath on exertion and interstitial lung disease. Bronchoalveolar lavage revealed numerous carbonaceous particulates and fibers, as well as cellular and immunoglobulin abnormalities. Inflammation and fibrosis were found surrounding them on open biopsy. The particle source was traced to a malfunctioning wood-burning heater in the patient's home.
van Houdt et al., 1986	"The use of wood stoves caused an increase of indoor mutagenicity in 8 out of 12 homes."
Boone et al., 1989	"Woodsmoke prove to be a major source of indirect genotoxins in homes. The increase is probably due to higher concentrations of polycyclic aromatic hydrocarbons in the wood smoke aerosol …" USA.

Alfheim et al, 1984	"Whereas wood heating in an "airtight" stove was found to cause only minor changes in the concentration of PAH and no measurable increase of mutagenic activity of the indoor air, both these parameters increased considerably when wood was burned in an open fireplace, yielding PAH concentrations comparable to those of ambient urban air. Woodburning in the closed stove did, however, result in increased concentrations of mutagenic compounds and PAH on particles sampled in the vicinity of the house."

Ambient Air Quality

Table 2. Studies relating outdoor concentrations of woodsmoke to adverse health effects in the whole population.

Reference	Findings
Schwartz J. Jun 2001	Air pollution and blood markers of cardiovascular risk. Environ Health Perspect. 2001 Jun;109 Suppl 3:405-9. PMID: 11427390 [PubMed - indexed for MEDLINE]
Utell MJ, winter 2000	A strong and consistent association has been observed between adjusted mortality rates and ambient particle concentration. The strongest associations are seen for respiratory and cardiac deaths, particularly among the elderly. Particulate air pollution is also associated with asthma exacerbations, increased respiratory symptoms, decreased lung function, increased medication use, and increased hospital admissions. J Aerosol Med. 2000 Winter;13(4):355-59. PMID: 11262441 [PubMed - indexed for MEDLINE]
Glovsky M, et al, May-Jun 1997	Particulate air pollution: possible relevance in asthma. Allergy Asthma Proc. 1997 May-Jun;18(3):163-6. PMID: 9194943 [PubMed - indexed for MEDLINE
Schwartz, 1993	Significant association between visits to 8 hospital emergency departments in Seattle for asthma and PM10 pollution. In 1993, wood burning was found to be the dominant source of PM10 pollution in Seattle in all seasons of the year, ranging from 60% in summer to 90% in winter.
Koenig et al., 1993	Significant association in Seattle (where the majority of particulate air pollution originates from woodsmoke) between outdoor fine particle pollution and decreased lung function (measured by spirometry) in asthmatic children aged 8-11.
Heumann et al., 1991	Children with the highest exposure to wood smoke had a significant decrease in lung function, measured by FEV1 and FVC. 410 children aged 8-11 in Klamath Falls, Oregon.
Johnson, 1990	Particle pollution from woodsmoke in the air was associated with significant decreases in lung function in children aged 8-11. 495 subjects in Montana.
Browning, et al., 1990	No statistically significant differences, but a pattern of increased symptoms and chronic illness in children aged 1-5 in the area with high wood smoke.
Lipsett et al., 1997	Conclusion from abstract: "These results demonstrate an association between ambient wintertime PM10 and exacerbations of asthma in an area where one of the principal sources of PM10 is Residential Wood Combustion." Santa Clara County, California.
Betchley, et al., 1997	Forest firefighters had significant declines in lung function (FEV(1)). Average declines, pre-shift to mid-shift of 0.089 L, 0.190 L, and 0.439 L/sec in TVC, FEV(1) and FEF (25-75).). The use of wood for indoor heat also was associated with the declines in FEV(1).
Lewtas et al., 1991	Mutagenicity testing of air containing smoke emitted from woodheaters in Boise, Idaho, US, using the Ames test on salmonella and tumor initiation assays in mice found that woodsmoke was 12 times more carcinogenic

	than an equal concentration of cigarette smoke.
Larson & Koenig, 1994.	"We conclude that the preponderance of the data suggest a causal relationship between elevated wood smoke levels and adverse respiratory health outcomes in young children."

Laboratory evidence

Table 3. Laboratory studies of physiological responses to woodsmoke.

Reference	Findings
Ho CY, Kou YR. Feb 2002	Mechanisms of wood smoke-induced increases in nasal airway resistance and reactivity in rats. Eur J Pharmacol. 2002 Feb 1;436(1-2):127-34. PMID: 11834256 [PubMed - indexed for MEDLINE]
Tesfaigzi Y, et al Jan 2002	Health effects of subchronic exposure to low levels of wood smoke in rats. Toxicol Sci. 2002 Jan;65(1):115-25. PMID: 11752691 [PubMed - indexed for MEDLINE]
Hsu TH, Kou YR. May 2001	Airway hyperresponsiveness to bronchoconstrictor challenge after wood smoke exposure in guinea pigs. Life Sci. 2001 May 18;68(26):2945-56. PMID: 11411794 [PubMed - indexed for MEDLINE]
Stone, 1995	Mice were exposed for 6 hours to wood smoke, emissions from an oil furnace or no pollution (control) and then an aerosol of the bacterium Streptococcus zooepidemicus, which causes severe respiratory infections. After 2 weeks, 5% of the mice in the control group exposed to air and bacteria had died, along with a similar percentage of the mice breathing the oil fumes. But 21% of the wood-smoked mice were felled.
Stone, 1995	Rats were exposed to no pollution or 800 ug/m3 wood smoke for 1 hour, then to golden staph bacteria. The bacteria were more virulent in animals which breathed the woodsmoke. This was attributed to a suppression in activity of the rats' macrophages, immune cells that roam the body, looking to engulf and destroy foreign particles.
Kou et al. , 1997	"These results suggest that an increase in OH. burden following smoke inhalation is actively involved in evoking the acute irritant effects of wood smoke on breathing in rats."
Rao et al., 1995	Metabolites of woodsmoke condensate accumulate in cultured rat eye lenses, compromising ability to accumulate rubidium-86 (mimic of K) and choline. Says may explain implication of smoke in cataract.
Lal et al., 1993	Rats exposed to woodsmoke suffered "bronchiolitis, hyperplasia and hypertrophy of bronchiolar epithelial lining cells, some necrosed lining cells desquamated into lumens, congestion of parenchymatous blood vessels, oedema, hyperplasia of lymphoid follicles, peribronchiolar and perivascular infiltration of polymorphonuclear cells, and mild emphysema" Conditioned worsened with accumulated exposure ."The results indicate progressive pathomorphological pulmonary lesions with subsequent exposure to wood smoke in controlled conditions."
Churg et al., 1997.	Autopsies were carried out of lung tissue from 10 never-smoking long-term residents of Vancouver. Retained particles in human lung parenchyma were counted, sized, and identified by analytical electron microscopy. 96% of particles had aerodynamic diameter less than 2.5microns.
Godleski et al., 1996	Rats with bronchitis were exposed for 6 hours per day to 272ug/m3 PM2.5. 37% of rats exposed to particles died, compared to none exposed to filtered air.

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Some of the more recent citations in this document reference PubMed at MEDLINE. PubMed is a service of the National Library of Medicine, provides access to over 12 million MEDLINE citations back to the mid-1960's and additional life science journals. PubMed includes links to many sites providing full text articles and other related resources. PubMed can be found at: http://www.ncbi.nlm.nih.gov/PubMed/.

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Boone PM, Rossman TG, Daisey JM. **The genotoxic contribution of wood smoke to indoor respirable suspended particles**. *Environment International* 1989 15:361-368.

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