

New information on how air pollution harms the lungs, including inducing pulmonary fibrosis

Shim I, Kim W, Kim H, Lim YM, Shin H, Park KS, Yu SM, Kim YH, Sung HK, Eom IC, Kim P, Yu SD. Comparative Cytotoxicity Study of PM2.5 and TSP Collected

from Urban Areas. Toxics. 2021 Jul 14;9(7):167. doi: 10.3390/toxics9070167. PMID: 34357910; PMCID: PMC8309706.

Jia H, Liu Y, Guo D, He W, Zhao L, Xia S. PM2.5-induced pulmonary inflammation via activating of the NLRP3/caspase-1 signaling pathway. Environ Toxicol. 2020 Sep 30. doi: 10.1002/tox.23035.

Chang-Chien J, Huang JL, Tsai HJ, Wang SL, Kuo ML, Yao TC. Particulate matter causes telomere shortening and increase in cellular senescence markers in human lung epithelial cells. Ecotoxicol Environ Saf. 2021 Oct 1;222:112484. doi: 10.1016/j.ecoenv.2021.112484. Epub 2021 Jul 6. PMID: 34237641.

Geng Y, Cao Y, Zhao Q, Li Y, Tian S. Potential hazards associated with interactions between diesel exhaust particulate matter and pulmonary surfactant. Sci Total Environ. 2021 Oct 16:151031. doi: 10.1016/j.scitotenv.2021.151031

Shahabi R, et al. The effect of nanoparticles on pulmonary fibrosis: a systematic review and Meta-analysis of preclinical studies. Arch Environ Occup Health. 2022 Mar 4:1-11. doi: 10.1080/19338244.2021.2001637

Zhai X, Wang J, Sun J, Xin L. PM2.5 induces inflammatory responses via oxidative stress-mediated mitophagy in human bronchial epithelial cells. Toxicol Res (Camb). 2022 Jan 19;11(1):195-205. doi: 10.1093/toxres/taf001. eCollection 2022 Feb. PMID: 35237424

Pollution is correlated with hospitalizations for bronchiectasis, especially in females and patients over 65 yrs. old.

Wang Z, et al. Association of hospital admission for bronchiectasis with air pollution: A province-wide time-series study in southern China. Int J Hyg Environ Health. 2020 Nov 3;231:113654. doi: 10.1016/j.ijheh.2020.113654.

More evidence that air pollution impairs lung function, and lung function growth in children.

Garcia E, Rice MB, Gold DR. Air pollution and lung function in children. J Allergy Clin Immunol. 2021 Jul;148(1):1-14. doi: 10.1016/j.jaci.2021.05.006. PMID: 34238501; PMCID: PMC8274324.

Lung function declines in children with asthma when exposed to multiple types of air pollution.

Kim Y, Park EH, Ng CFS, Chung Y, Hashimoto K, Tashiro K, Hasunuma H, Doi M, Tamura K, Moriuchi H, Nishiwaki Y, Kim H, Yi SM, Kim H, Hashizume M. Respiratory function declines in children with asthma

associated with chemical species of fine particulate matter (PM_{2.5}) in Nagasaki, Japan. *Environ Health.* 2021 Oct 21;20(1):110. doi: 10.1186/s12940-021-00796-x

Even short term pollution is harmful to lung function.

Renzi M, et al. A nationwide study of air pollution from particulate matter and daily hospitalizations for respiratory diseases in Italy. *Sci Total Environ.* 2021 Oct 16:151034. doi: 10.1016/j.scitotenv.2021.151034

Based on hospital admissions rates for respiratory diseases, this study concluded that wildfire PM_{2.5} is up to 10 times more harmful on human health than PM_{2.5} from other sources.

Aguilera, R., Corringham, T., Gershunov, A. et al. Wildfire smoke impacts respiratory health more than fine particles from other sources: observational evidence from Southern California. *Nat Commun* 12, 1493 (2021). <https://doi.org/10.1038/s41467-021-21708-0>

More evidence of particulate pollution exacerbating a person's vulnerability to lung disease.

Wu Y, Jin T, He W, Liu L, Li H, Liu C, Zhou Y, Hong J, Cao L, Lu Y, Dong X, Xia M, Ding B, Qian L, Wang L, Zhou W, Gui Y, Zhang X, Chen R. Associations of fine particulate matter and constituents with pediatric emergency room visits for respiratory diseases in Shanghai, China. *Int J Hyg Environ Health.* 2021 Jul 13;236:113805. doi: 10.1016/j.ijheh.2021.113805. Epub ahead of print. PMID: 34271373.

Bronchiectasis is a less common lung disease than asthma or COPD. It is a condition where the bronchi of the lungs are permanently damaged, widened, and thickened. These damaged air passages allow bacteria and mucus to build up and pool in your lungs. This results in frequent infections and blockages of the airways. Daily hospitalizations for bronchiectasis are correlated with multiple types of pollution-- particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, and daily hospitalizations for bronchiectasis.

Wang Z, et al. Association of hospital admission for bronchiectasis with air pollution: A province-wide time-series study in southern China.

Int J Hyg Environ Health. 2020 Nov 3;231:113654. doi: 10.1016/j.ijheh.2020.113654. Online ahead of print. PMID: 33157415

Approximately 30% of lung cancer is precipitated by air pollution.

Santibáñez-Andrade M, et al. Deciphering the Code between Air Pollution and Disease: The Effect of Particulate Matter on Cancer Hallmarks. *Int J Mol Sci.* 2019 Dec 24;21(1). pii: E136. doi: 10.3390/ijms21010136. More evidence of air pollution provoking lung cancer

Liang D, et al. Lung Cancer in Never-Smokers: A Multicenter Case-Control Study in North China. *Front Oncol.* 2019 Dec 10;9:1354. doi: 10.3389/fonc.2019.01354. eCollection 2019. Wang Z, et al.

Traffic-related environmental factors and childhood obesity: A systematic review and meta-analysis. Obes Rev. 2020 Jan 30. doi: 10.1111/obr.12995. [Epub ahead of print]

Brake dust is a significant component of traffic related air pollution. At least regarding the lung, it appears to be as toxic as tail pipe emissions.

Selley L, et al. Brake dust exposure exacerbates inflammation and transiently compromises phagocytosis in macrophages. Metallomics. DOI: 10.1039/c9mt00253g

Ozone has historically been considered the "weaker sister" of the two high volume pollutants--ozone and particulate matter. But ozone is a powerful oxidizing agent and has been proven to cause a decrease in lung function and damage to lung tissue. Ozone has been associated with almost all the health consequences of particulate matter, if only to a slightly lesser extent.

But this new study shows that the lung is exquisitely sensitive to even small increments of ozone. Researchers followed nearly 7,000 patients and found emphysematous destruction of lung tissue and loss of lung function (measured by CAT scans and spirometry) in both smokers and non-smokers at this shocking rate: Just 3 ppb increase in ozone exposure over ten years caused as much lung damage as smoking a pack a day of cigarettes for 29 years.

Wang M, et al. Association Between Long-term Exposure to Ambient Air Pollution and Change in Quantitatively Assessed Emphysema and Lung Function. JAMA, 2019; 322 (6): 546 DOI: 10.1001/jama.2019.10255

What do you want your lungs to look like?



Non-smoker
Rural Resident
Clean Air



Non-smoker
Urban Resident
Polluted Air

New and more detailed information about how air pollution damages the lungs. It actually causes a loss of the number of minute air sacs (alveoli) in the lungs when exposure occurs during prenatal or early post natal life.

Lopes dB, et al. Pre- and postnatal exposure of mice to concentrated urban PM2.5 decreases the number of alveoli and leads to altered lung function at an early stage of life. *Environ Pollut*. 2018 Jun 4;241:511-520. doi: 10.1016/j.envpol.2018.05.055. [Epub ahead of print]

More evidence that air pollution impairs lung function in children.

Finke I, et al. Air pollution and airway resistance at age 8 years – the PIAMA birth cohort study. *Environ Health*. 2018 Jul 17;17(1):61. doi: 10.1186/s12940-018-0407-9.

This study demonstrated that one mechanism of air pollution's effect on the lungs is the triggering of cell death in the lining of the airways.

Xu F, et al. Necroptosis Contributes to Urban Particulate Matter-Induced Airway Epithelial Injury. *Cell Physiol Biochem*. 2018 Mar 29;46(2):699-712. doi: 10.1159/000488726. [Epub ahead of print]

Chronic Obstructive Pulmonary Disease (COPD) is usually thought of as a disease related to smoking. But it is also related to air pollution exposure.

Lin H, Qian ZM, Guo Y, Zheng Y, Ai S, Hang J, Wang X, Zhang L, Liu T, Guan W, Li X, Xiao J, Zeng W, Xian H, Howard SW, Ma W, Wu F. The attributable risk of chronic obstructive pulmonary disease due to ambient fine particulate pollution among older adults. *Environ Int*. 2018 Feb 5;113:143-148. doi: 10.1016/j.envint.2018.01.029. [Epub ahead of print] PMID: 29425898 [PubMed – as supplied by publisher]

Li J, et al. Major air pollutants and risk of COPD exacerbations: a systematic review and meta-analysis. *Int J Chron Obstruct Pulmon Dis*. 2016 Dec 12;11:3079-3091. doi: 10.2147/COPD.S122282. eCollection 2016.

More evidence that air pollution triggers lung cancer.

Lamichhane DK, et al. Lung Cancer Risk and Residential Exposure to Air Pollution: A Korean Population-Based Case-Control Study. *Yonsei Med J*. 2017 Nov;58(6):1111-1118. doi: 10.3349/ymj.2017.58.6.1111.

Biomass smoke (like wood) causes DNA damage in cell death in the lung.

de Oliveira Alves N, et al. Biomass burning in the Amazon region causes DNA damage and cell death in human lung cells. *Scientific Reports*, 2017; 7 (1) DOI: 10.1038/s41598-017-11024-3

More evidence that even short term air pollution decreases lung function in otherwise healthy adults

Panis L, Provost EB, Cox B, Louwies T, Laeremans M, Standaert A, Dons E, Holmstock L, Nawrot T, De Boever P. Short-term air pollution exposure decreases lung function: a repeated measures study in healthy adults. *Environ Health*. 2017 Jun 14;16(1):60. doi: 10.1186/s12940-017-0271-z. PMID: 28615020 [PubMed – in process]

Short term air pollution decreases lung function in healthy adults.

Panis L, Provost EB, Cox B, Louwies T, Laeremans M, Standaert A, Dons E, Holmstock L, Nawrot T, De Boever P. Short-term air pollution exposure decreases lung function: a repeated measures study in healthy adults. *Environ Health*. 2017 Jun 14;16(1):60. doi: 10.1186/s12940-017-0271-z.

Decreased lung function in children postnatally exposed to pesticides.

Raanan R, Balmes JR, Harley KG, Gunier RB, Magzamen S, Bradman A, Eskenazi B. Decreased lung function in 7-year-old children with early-life organophosphate exposure. *Thorax*. 2015 Dec 3. pii: thoraxjnl-2014-206622. doi: 10.1136/thoraxjnl-2014-206622. [Epub ahead of print]

From the world's most prestigious medical journal, the New England Journal of Medicine, a landmark study showing improved air quality pays off with improved lung function and actual growth of lung capacity in children. This not only improves cardiovascular capability, but is a key factor in avoiding adult onset of lung and heart disease and increasing life expectancy, which is highly correlated with lung function.

Gauderman WJ, et al. Association of Improved Air Quality with Lung Development in Children. *N Engl J Med* 2015; 372:905-913 March 5, 2015 DOI: 10.1056/NEJMoa1414123

We have said many times that not all air pollution is created equal. This study found that stoves that combust various solid fuels, the greatest toxicity to cells, including causing the death of lung cells, was found with burning wood pellets.

Marchetti S, et al. In vitro lung toxicity of indoor PM10 from a stove fueled with different biomasses. *Sci Total Environ*. 2019 Feb 1;649:1422-1433. doi: 10.1016/j.scitotenv.2018.08.249. Epub 2018 Aug 20.