

**We know that air pollution affects the heart and blood vessels through multiple mechanisms. Heart attacks causing sudden death is the signature outcome of air pollution exposure. However, it was indeed sobering to see this study of almost 4,000 people that showed even in middle aged adults that didn't have known heart disease, air pollution exposure well below the EPA standards, increased the size of heart chambers, which is indicative of impaired function, and a prelude to heart failure. Extrapolating from this study to the Wasatch Front suggests that our air pollution is responsible for about a 10% increase in the size of our heart chambers.**

*Aung N, et al. Association Between Ambient Air Pollution and Cardiac Morpho-Functional Phenotypes, insights From the UK Biobank Population Imaging Study. Originally published 3 Aug 2018 Circulation. 2018;0:CIRCULATIONAHA.118.034856*

**Resting heart rate is often thought of as a marker, although not a perfect one, of physical fitness. Air pollution is associated with a higher resting heart rate.**

*Xie X, et al. Long-term exposure to fine particulate matter and tachycardia and heart rate: Results from 10 million reproductive-age adults in China. Environ Pollut. 2018 Aug 11;242(Pt B):1371-1378. doi: 10.1016/j.envpol.2018.08.022. [Epub ahead of print]*

**This is another study showing increased risk for congenital heart defects with more air pollution.**

*Ren Z, et al. Maternal exposure to ambient PM10 during pregnancy increases the risk of congenital heart defects: Evidence from machine learning models. Sci Total Environ. 2018 Feb 19;630:1-10. doi: 10.1016/j.scitotenv.2018.02.181. [Epub ahead of print]*

**Some of the increased risk for heart attack may be related to the rate of rise in air pollution. In other words, a rapid rise in pollution may have more of an impact than the eventual pollution concentration itself.**

*Rasche M, et al. Rapid increases in nitrogen oxides are associated with acute myocardial infarction: A case-crossover study. Eur J Prev Cardiol. 2018 Jan 1;2047487318755804. doi: 10.1177/2047487318755804. [Epub ahead of print]*

**Two research papers showing that air pollution is associated with aggravation of heart failure.**

*Buteau S, et al. Associations between ambient air pollution and daily mortality in a cohort of congestive heart failure: Case-crossover and nested case-control analyses using a distributed lag nonlinear model. Environ Int. 2018 Jan 17. pii: S0160-4120(17)31563-5. doi: 10.1016/j.envint.2018.01.003. [Epub ahead of print]*

Ji X, et al. Potential Role of Inflammation in Associations between Particulate Matter and Heart Failure. *Curr Pharm Des.* 2018 Jan 10. doi: 10.2174/1381612824666180110150550. [Epub ahead of print]

**This study shows that air pollution is associated with increasing calcification of heart valves.**

Tibuakuu M, et al. Exposure to ambient air pollution and calcification of the mitral annulus and aortic valve: the multi-ethnic study of atherosclerosis (MESA). *Environ Health.* 2017 Dec 21;16(1):133. doi: 10.1186/s12940-017-0346-x.

**More evidence that air pollution is associated with increased susceptibility to heart failure**

Sørensen M, et al. Long-Term Exposure to Road Traffic Noise and Nitrogen Dioxide and Risk of Heart Failure: A Cohort Study. *Environ Health Perspect.* 2017 Sep 26;125(9):097021. doi: 10.1289/EHP1272.

**Ozone is associated with increased rates of hospitalizations for heart attacks.**

Chiu HF, Weng YH, Chiu YW, Yang CY. Short-Term Effects of Ozone Air Pollution on Hospital Admissions for Myocardial Infarction: A Time-Stratified Case-Crossover Study in Taipei. *J Toxicol Environ Health A.* 2017 Jun 9:1-7. doi: 10.1080/15287394.2017.1321092. [Epub ahead of print]

**This study shows that heart function is impaired with air pollution.**

Yang WY, et al. Left ventricular function in relation to chronic residential air pollution in a general population. *Eur J Prev Cardiol.* 2017 Jan 1:2047487317715109. doi: 10.1177/2047487317715109. [Epub ahead of print]

**Air pollution can adversely affect heart rhythm.**

Carll AP, et al. Inhaled ambient-level traffic-derived particulates decrease cardiac vagal influence and baroreflexes and increase arrhythmia in a rat model of metabolic syndrome. *Part Fibre Toxicol.* 2017 May 25;14(1):16. doi: 10.1186/s12989-017-0196-2.

**Ozone is associated with increased rates of hospitalizations for heart attacks.**

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**This study shows that for the signature outcome of air pollution exposure, a heart attack, the event is likely to be more immediate in older age groups, and more delayed in younger patients. Nonetheless, younger patients are still sensitive to the cardiovascular effects of air pollution.**

Collart P, et al. Short-term effects of air pollution on hospitalization for acute myocardial infarction: age effect on lag pattern. *Int J Environ Health Res.* 2017 Feb;27(1):68-81. doi: 10.1080/09603123.2016.1268678.

**Among elderly men, air pollution aggravates cardiovascular risk factors, i.e. increased blood pressure, decreased heart rate variability, worse cholesterol profile, and inflammatory biomarkers. Those effects were generally more pronounced in men who are already at increased risk of cardiovascular disease**

*Bind MA, et al. Quantile Regression Analysis of the Distributional Effects of Air Pollution on Blood Pressure, Heart Rate Variability, Blood Lipids, and Biomarkers of Inflammation in Elderly American Men: The Normative Aging Study. Environ Health Perspect. 2016 Mar 11. [Epub ahead of print]*

**Acrolein, one of the most toxic components in wood smoke, causes deterioration of heart muscle function after 3 hr exposure. Deterioration persisted at least as long as 24 hrs. This study was done in mice.**

*Thompson LC, et al. Acrolein Inhalation Alters Myocardial Synchrony and Performance at and Below Exposure Concentrations that Cause Ventilatory Responses. Cardiovasc Toxicol. 2016 Feb 19. [Epub ahead of print]*

**Hourly increases in traffic related air pollution is associated with significantly increased risk for heart attacks and impaired heart function. This association was attenuated by high levels of “residential greenness.”**

*Zhu Y, et al. Short-term exposure to traffic-related air pollution and STEMI events: Insights into STEMI onset and related cardiac impairment. Sci Total Environ. 2022 Feb 28:154210. doi: 10.1016/j.scitotenv.2022.154210*

*Lim Y\_H, et al. Long-Term Exposure to Air Pollution, Road Traffic Noise, and Heart Failure Incidence: The Danish Nurse Cohort. Journal of the American Heart Association, 2021; DOI: 10.1161/JAHA.121.021436*

*Chen R, Jiang Y, Hu J, Chen H, Li H, Meng X, Ji JS, Gao Y, Wang W, Liu C, Fang W, Yan H, Chen J, Wang W, Xiang D, Su X, Yu B, Wang Y, Xu Y, Wang L, Li C, Chen Y, Bell ML, Cohen AJ, Ge J, Huo Y, Kan H. Hourly Air Pollutants and Acute Coronary Syndrome Onset In 1.29 Million Patients. Circulation. 2022 Apr 22. doi: 10.1161/CIRCULATIONAHA.121.057179. Epub ahead of print. PMID: 35450432.*

**More evidence that the cardiovascular disease from air pollution involves stimulating white blood cell activity and inflammation.**

*Abohashem S, et al. A leucopoietic-arterial axis underlying the link between ambient air pollution and cardiovascular disease in humans. European Heart Journal, 2021 DOI: 10.1093/eurheartj/ehaa982*

**Wearing face masks to reduce pollution inhalation reduces the cardiovascular effects of the pollution.**

*Jiang M, Meng X, Qi L, Hu X, Xu R, Yan M, Shi Y, Meng X, Li W, Xu Y, Chen S, Zhu T, Gong J. The health effects of wearing face masks on cardiopulmonary system of healthy young adults: A double-blinded, randomized crossover trial. Int J Hyg Environ Health. 2021 Jul 12;236:113806. doi: 10.1016/j.ijheh.2021.113806. Epub ahead of print. PMID: 34265631.*

**This study looks at the pathophysiology and mechanism of how PM 2.5 causes cardio-toxicity. Analyzes specifically the role of a microRNA on PM2.5-and the pathway taken to induce myocardial inflammation and cardiac dysfunction. PM2.5 caused myocardial damage via interstitial edema, inflammatory cell infiltration, and myocardial fiber destruction.**

*Feng L, Wei J, Liang S, Sun Z, Duan J. miR-205/IRAK2 signaling pathway is associated with urban airborne PM2.5-induced myocardial toxicity.*

*Nanotoxicology. 2020 Sep 3:1-15. doi: 10.1080/17435390.2020.1813824. Online ahead of print. PMID: 32880505* Another study showing that air pollution increases the risk of heart attack

*Cramer J, et al. Long-Term Exposure to Air Pollution and Incidence of Myocardial Infarction: A Danish Nurse Cohort Study. Environ Health Perspect. 2020 May;128(5):57003. doi: 10.1289/EHP5818. Epub 2020 May 6.*

**Particulate pollution and road traffic noise increases the risk of hospital visits for cardiac arrhythmias and heart failure.**

*WU Jun Hui, WU Yao, WANG Zi Jing, TIAN Yao Hua, WU Yi Qun, WU Tao, WANG Meng Ying, WANG Xiao Wen, WANG Jia Ting, HU Yong Hua. Ambient Particulate Matter Pollution and Hospital Visits for Cardiac Arrhythmia in Beijing, China[J]. Biomedical and Environmental Sciences, 2021, 34(7): 562-566. doi: 10.3967/bes2021.077*

**Small increases in air pollution are followed within hours by an increase in the risk of heart attacks.**

*Chen K, et al. Hourly Exposure to Ultrafine Particle Metrics and the Onset of Myocardial Infarction in Augsburg, Germany. Environmental Health Perspectives, 2020; 128 (1): 017003 DOI: 10.1289/EHP5478*

**Many studies have shown that air pollution impairs the normal electrical signaling of the heart. That is one way that air pollution causes sudden death. This study suggests that the effect on heart electrical activity begins in infancy.**

*Cowell WJ, et al. Prenatal Exposure to PM2.5 and Cardiac Vagal Tone during Infancy: Findings from a Multiethnic Birth Cohort. Environmental Health Perspectives, 2019; 127 (10): 107007 DOI: 10.1289/EHP4434*

**Two good review articles on how air pollution affects the cardiovascular system.**

*Hamanaka RB, et al. Particulate Matter Air Pollution: Effects on the Cardiovascular System. Front Endocrinol (Lausanne). 2018 Nov 16;9:680. doi: 10.3389/fendo.2018.00680. eCollection 2018.*

*Rajagopalan S, et al. Air Pollution and Cardiovascular Disease: JACC State-of-the-Art Review. J Am Coll Cardiol. 2018 Oct 23;72(17):2054-2070. doi: 10.1016/j.jacc.2018.07.099.*

**Black Americans suffer higher cardiovascular risk from air pollution than do caucasians.**

*Erqou S, et al. Particulate Matter Air Pollution and Racial Differences in Cardiovascular Disease Risk. Arterioscler Thromb Vasc Biol. 2018 Mar 15. pii: ATVBAHA.117.310305. doi: 10.1161/ATVBAHA.117.310305. [Epub ahead of print]*

**More evidence that air pollution increases blood pressure and arterial stiffness, and one of these studies showed that radioactive pollution particles also increased blood pressure.**

*Baumgartner J, et al. Household air pollution and measures of blood pressure, arterial stiffness and central haemodynamics. Heart. 2018 Feb 9. pii: heartjnl-2017-312595. doi: 10.1136/heartjnl-2017-312595. [Epub ahead of print]*

*Nyhan MM, et al. Associations Between Ambient Particle Radioactivity and Blood Pressure: The NAS (Normative Aging Study). J Am Heart Assoc. 2018 Mar 15;7(6). pii: e008245. doi: 10.1161/JAHA.117.008245.*

*Salameh P, et al. Hypertension prevalence and living conditions related to air pollution: results of a national epidemiological study in Lebanon. Environ Sci Pollut Res Int. 2018 Feb 13. doi: 10.1007/s11356-018-1411-x. [Epub ahead of print]*

**This study showed that a biological pathway for air pollution's involvement in strokes and heart attacks is the release of inflammatory chemicals that alter the functioning of genes involved in the regulation of blood vessels.**

*Chen R, et al. Fine Particulate Air Pollution and the Expression of microRNAs and Circulating Cytokines Relevant to Inflammation, Coagulation, and Vasoconstriction. Environ Health Perspect. 2018 Jan 17;126(1):017007. doi: 10.1289/EHP1447.*

**Another study showing air pollution's connection to premature death, in this case due to cardiovascular disease, and is more pronounced in women.**

*Zhang C, et al. Association between air pollution and cardiovascular mortality in Hefei, China: A time-series analysis. Environ Pollut. 2017 Aug 7. pii: S0269-7491(16)32799-3. doi: 10.1016/j.envpol.2017.06.022. [Epub ahead of print]*

**In utero exposure to air pollution, specifically diesel exhaust, has been shown in animals to lead to heart failure in adulthood. This study showed that a likely mechanism is the alteration of genes that play a role in the functioning of heart cells.**

*Goodson J, et al. In utero exposure to diesel exhaust particulates is associated with an altered cardiac transcriptional response to transverse aortic constriction and altered DNA methylation. The FASEB Journal, 2017; fj.201700032R DOI: 10.1096/fj.201700032R*

**Elderly people exposed to more air pollution have impaired heart electrical activity (prolonged QT interval).**

*Mordukhovich I, Kloog I, Coull B, Koutrakis P, Vokonas P, Schwartz J. Association between Particulate Air Pollution and QT Interval Duration in an Elderly Cohort. Epidemiology. 2015 Nov 24. [Epub ahead of print]*

**Even a modest program of curtailing community wood smoke in the San Joaquin Valley resulted in a significant reduction in PM2.5, about 15%, and a similar reduction in hospitalization for ischemic heart disease. Salt Lake City would undoubtedly have an even greater benefit because the average winter temperature in Salt Lake is about ten degrees colder than the San Joaquin Valley, therefore more wood is being burned.**

*Yap PS, Garcia C. Effectiveness of Residential Wood-Burning Regulation on Decreasing Particulate Matter Levels and Hospitalizations in the San Joaquin Valley Air Basin. Am J Public Health. 2015 Feb 25:e1-e7. [Epub ahead of print]*

**Another recent study compared daily hospital admissions and death rates related to cardiovascular and pulmonary diseases among two cities in South America where one city's pollution was predominantly from wood smoke and another was from mobile and typical point sources. Compared to the non-wood burning city, the city with primarily wood smoke experienced an increase of 47% for cardiorespiratory deaths, and an increase of 104% for respiratory hospital admissions for every 10 ug/m3 increase in PM10**

*Díaz-Robles L, et al. Short Term Health Effects of Particulate Matter: A Comparison between Wood Smoke and Multi-Source Polluted Urban Areas in Chile. Aerosol and Air Quality Research, 15: 306–318, doi:10.4209/aaqr.2013.01.0316*