Poonam Shodh Rachna (ISSN 2456-5563)
(A multidisciplinary, peer reviewed and refereed Journal)
Vol.1, Issue.VII, September 2022, Pc : PSR-2209012
Special Issue of National Conference on Humanity and Social Sciences 2022

The Impact of Air Polution on Heart Disease

Mohini Sen Chaudhary,Research Scholar
Department of Sociology, University of Science and Technology, Meghalaya

Abstract
According to the data, chronic exposure to particle air pollution increases the risk of cardiovascular disease, inflammation, and mortality from ischemic heart disease. Heart disease is the most common underlying health problem among persons who are exposed to short-term particle air pollution. Researchers observed that a sizeable percentage of people seemed to be negatively impacted by air pollution. Total mortality and cardiovascular disease were both raised by PM 2.5. Increasing levels of air pollution pose a serious health threat to humans by increasing the prevalence of respiratory diseases, cardiovascular diseases, and stroke.
Introduction

Introduction

Particles in the air are a sludge-like conglomeration of solids and liquids. It floats in the air, constantly shifting in size and chemical make-up as it moves through space and time (Brunekreef and Hoffmann, 2016). The effects of airborne particles are chemical functions, and the straightforward approaches rely on the mass and size of the pollutant (Lelieveld et al., 2019). Particulate matter in the air may be roughly sorted into four groups, according on their aerodynamic diameters: 0.1–2.5 micrometres (ultrafine particles), 0.1–10 micrometres (thoracic particles), and >10 micrometres (coarse [PM2.5-10]) (Lelieveld et al., 2019).

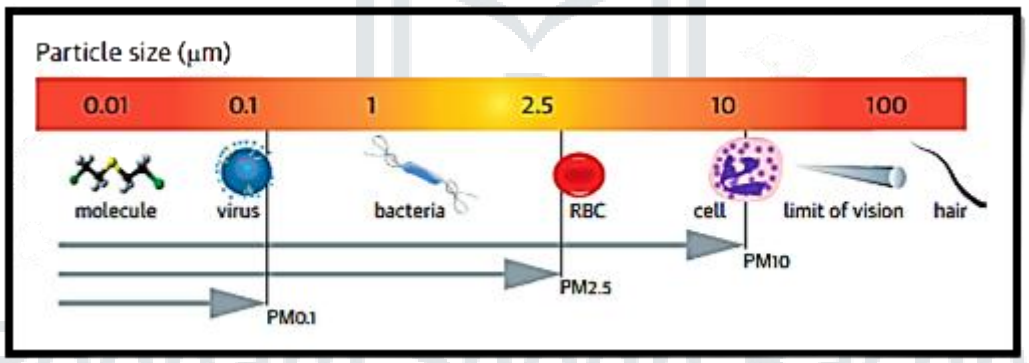

Figure: Satellite-derived PM2.5 (µg/m3)
(Source: European Heart Journal, 2015)

Particulate matter (PM) in the air may be measured by calculating the mass of particles within certain size ranges (Brunekreef and Hoffmann, 2016). Air pollution regulations set by the federal government are still in effect, barring any major changes (PM10 to 2.5). Primary and secondary particles from combustion sources may contribute to PM2.5, but the "course portion" is almost entirely made up of organic material (Newby et al., 2015). Most recently, scientists have been paying a lot of attention to the combustion process's byproduct, ultrafine particles (UFPs) with a diameter of 0.1 micrometres or less (Newby et al., 2015). It has a very short half-life but a significant effect on human alveoli.

Nucleation Mode	Accumulation Mode	Coarse Mode
The primary (carbon) particles condensed from the gases or vaporized from the gas	Agglomeration and Coagulation condensation from the vapour or gases droplets (fine	Re-suspension or wind erosion sea spray, biological particles, anthropogenic emissions, volcanic

particles	geological particles)	activity

Table1. Origin and characteristics of particulate matter

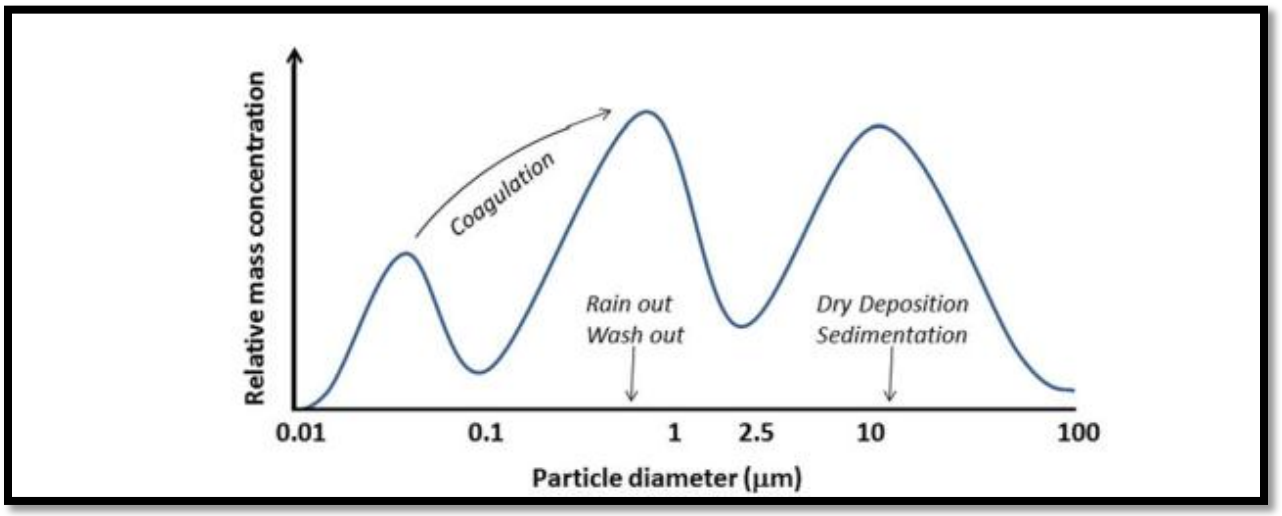

Figure: Origin and characteristics of particulate matter. Adapted from Heil
(Source: European Heart Journal, 2015)

Secondary particles are typically formed with gas physicochemical change, such as nitric acid from nitrate and sulphate production, sulphur dioxide, ozone, and so on. Diesel soot is the main particles emitted directly into the atmosphere (Newby et al., 2015). Particulate matter comes from a wide variety of human-caused and naturally occurring sources, including the breakdown of tyres, vehicle emissions, the re-suspension of dust, industrial combustion, power generation, metal processing, smelting, construction, agriculture, demolition activities, wood-burning, pollens, wind-blown soil, moulds, volcanic emission, and so on (Brunekreef and Hoffmann, 2016). Oxides of sulphur and nitrogen released into the atmosphere after the burning of fossil fuels are the most concerning air pollutants from a health standpoint.

Ozone, for example, is produced via the full photochemical interactions of volatile organic components and nitrogen oxides, and is an example of a secondary pollutant derived from diverse components in the atmosphere. Carbon monoxide is a byproduct of burning carbon-based fuels that is present almost everywhere. Because CO binds to haemoglobin with 250 times more affinity than oxygen does, it may block oxygen from reaching tissues throughout the body (Brunekreef and Hoffmann, 2016). Atherosclerotic illness has been linked to a physiological increase in carboxyhemoglobin. When air pollution reached crisis levels in the ait region, sulphur-di-oxide contributed to an increase in disease throughout the region (Rajagopalan et al., 2018). Ever since the 1950s, ozone has been thought of as the primary factor in photochemical smog. Smog may occur in the troposphere when solar UV radiation reacts with nitrogen oxides and other reactive hydrocarbons.

Photosynthetically produced O3 in a populated region may cause temporal O3 patterns downwind and in the air's trajectory mass. The Pre-owned Air pollution raises the dangers to the heart via atherogenic and acute routes. Two case-control studies link SHS to an increased risk of clinical stroke, with the odds ratio increasing from 1.72 (95% CI 1.07 to 2.77) to 2.59 (95% CI 1.51 to 4.47). (Rajagopalan et al., 2018).

The Aims of the Study

1. One goal is to determine the effects that polluted air has on people.

2. Second, we need to learn more about the link between air pollution and heart disease.

3. Third, to learn more about the causes and effects of air pollution, scientists want to examine the many different types of pollution particles.

Methodology

Secondary sources of information are used for this process. Descriptive research has been the primary emphasis of this investigation. The secondary information included here comes from a wide variety of published works, such as academic papers, governmental websites, academic publications, and scholarly articles. To be more precise, this study will focus on the many ways in which air pollution threatens people's health. Carbon monoxide is one of the pollutants in the air that has been linked to an increase in lung cancer.

Findings/Discussion:

The limits of air quality and the dangers we face

A major environmental health concern is air pollution. The international community has to make a serious effort to reduce air pollution (Amoateyet al.,2018). By doing so, people lower their chances of developing several illnesses and conditions. Reduced air pollution, on the other hand, has been shown to benefit the cardiovascular and respiratory systems. According to a source, the current World Health Organization guideline has significantly established a threshold of 10 g/m3 for air pollution. Its intention was to protect citizens from harmful gases in the air. In response, WHO member nations have adopted a resolution and a plan of action to safeguard human life from the pernicious consequences of air pollution (Thurstonet al.,2016). Therefore, the World Health Organization (WHO) has created instruments like AirQ+ to investigate the impact of air pollution on human health. The Health Economic Assessment Tool has also gained popularity as a means of implementing bicycle and walking programmes. In addition, the Green+ instrument for enhancing green space vitality and public health has been added (Majiet al.,2018). The World Health Organization (WHO) has established a clean home energy solutions toolbox as a benchmark for the mitigation of household air pollution. Practically speaking, it would make it simpler for homeowners to reduce pollution in their homes. Therefore, it contributes favourably to the general upkeep of ambiance. Tools of this sort are invaluable for assessing the state of the environment and planning for a sustainable future. It's a standard method for the medical industry to deal with the issue of polluted indoor air.

Figure: WHO guidelines on air pollution
(Source: economictimes.indiatimes.com, 2021)

In response, WHO has co-sponsored the Pan European Program on Transport Health and Environment. The goal of its creation is to reduce the negative effects of transportation on public health, including air pollution (Parkeret al.,2018). However, they have been developing instruments to assess people's health benefits. The World Health Organization designated environmental factors such outdoor air pollution and particle matter as carcinogenic in

2013. What's more, the World Health Organization has made an attempt to give a transparent regulation of air quality worldwide. This study adds to the growing body of information that shows how hazardous contaminants may negatively impact human health. By learning more about the causes and impacts of air pollution, people become considerably more careful. Hopefully this information has allowed folks to take precautions in advance.

Particulate matter is a key indication of air pollution in this context. Sulfate, nitrates, ammonia, sodium chloride, black carbon, water, and mineral dust are all typical components of PM. Small particles (those with a diameter of less than 10 microns) have shown to be a lung-damaging factor because they may get deep into the lungs. Individuals' risk for getting cardiovascular and respiratory illnesses increases with prolonged contact to the particles (de FC Lichtenfelset al.,2018). Air quality is often quantified in terms of PM10 concentrations per cubic metre of air on a daily or yearly basis. When it comes to people's health, particulate matter is one of the worst offenders. Besides PM, individuals are also often exposed to ozone, nitrogen dioxide, and sulphur dioxide. Particulate matter concentrations are often seen in metropolitan regions of poor and middle-income nations. Ozone is a substantial contributor to the increased risk of asthma-related death and hospitalisation. This causes inflammation of the lungs and bronchial symptoms.

When it comes to human health, there is a quantifiable correlation between a high concentration of particulate matter and an elevated death rate (Rajagopalanet al.,2018). Remarkably, it seems that a considerable reduction in mortality may be achieved by drastically lowering the concentration of particulate matter. Accordingly, keeping things in such a state aids policymakers in creating a healthier general populace.

Mortality and morbidity caused by air pollution

PM2.5 has an effect on a very large percentage of the world's population. Countries like India and China are bearing a disproportionate share of PM2.5's effects as a consequence of the current ecological and economic transition. According to the most up-to-date estimates from the GBD, ambient exposure has resulted in a 95% uncertainty range of between 3.7 million and 4.8 million fatalities and an estimated 103.1 million DALYs in 2015, or 7.6% of the global death toll (Rajagopalan et al., 2018). In particular, solid fuel consumption is responsible for 2. 8 million fatalities and 85. 6 million disability adjusted life years (DALYs) (Huang et al., 2018). Heart disease and stroke were responsible for more than half of the damage. More than 2,540,000 people have died and another 4,1 million have developed COPD as a result of being exposed to ozone pollutants. To far, PM2.5 has been linked to an estimated 4.2 million annual premature deaths. A million people have died in China, 500,000 in India, 50,000 in the United States, and roughly 200,000 in Europe. The "Greenpeace Southeast Asia study of IQAir data" estimates that PM 2.5 will cost about $600,000 in 2020 across five major cities across the globe (Greenpeace Southeast Asia. 2021). In addition to the 13,000 preventable fatalities caused by Jakarta's air pollution, the city has also suffered economic losses amounting to $3.4 billion, or 8.2% of GDP (Greenpeace Southeast Asia. 2021). Air pollution is expected to cost more than $5 billion in economic damages across more than 14 cities by the year 2020. As a result, Tokyo has incurred the largest projected financial cost, with an estimated 40,000 unnecessary fatalities (Greenpeace Southeast Asia. 2021). According to the cost of pollution calculator, Los Angeles residents pay the most per capita due to air pollution.

Name	Population	Estimated Deaths	Estimated Cost (USD)
Tokyo	37 Million	40,000	43 Billion
Delhi	30 Million	54,000	8.1 Billion
Shanghai	26 million	39,000	19 billion
Mexico City	22 Million	15,000	8.0 billion
Sao Paulo	22 Million	15,000	7.0 billion

Table2. Estimated Air Pollution Impacts in the Five Biggest Cities worldwide (2020)
(Source: greenpeace.org, 2021)

Short-term exposure to PM2.5, ozone, and NO2 at 10 mg/m3 and substantialPM2.5 fluctuation at 1.0% had enhanced mortality (Rajagopalan et al., 2018). The mobility of those with cardiovascular illness has improved (+0.8%), while that of those with respiratory disease has improved (+1.5%). (Lelieveld et al., 2019). Although there

is only a minor correlation between the two, the high levels of pollution in East Asian nations have a far-reaching influence on people's health. According to a synthesis of North American, European, and Canadian statistics, PM2.5 levels have risen by 10 mg/m3 (Huang et al., 2018). Deaths from any cause are correlated with it at a rate of 0.2% to 0.6%. A study titled "Air pollution and health: the European a project" found that an increase in NO2 resulted in a 0.3, 0.4, and 0.4% rise in overall, respiratory, and cardiovascular death rates, respectively. It caused a rise in nitrogen dioxide (NO2) of 10 mg/m3 in each of 30 European cities.

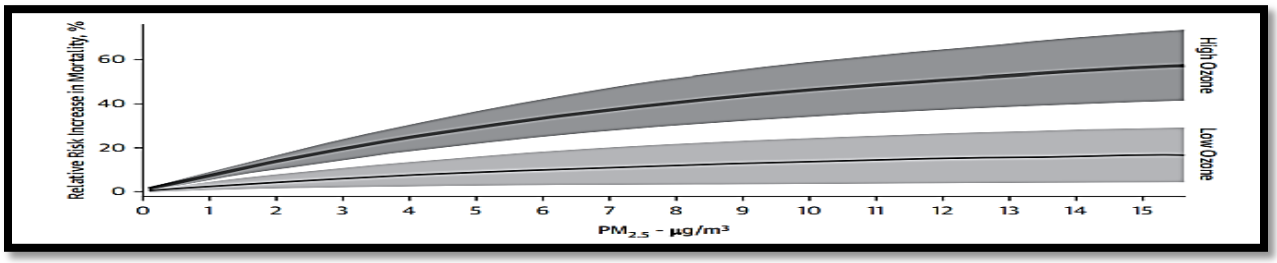

Figure: Chronic PM2.5 Exposure and Cardiovascular Mortality
(Source: Journal of the American college of cardiology, 2018)

The death rate has been linked to ambient PM2.5concentrations in studies of the long-term impacts of air pollution. Long-term exposure to PM2.5 is related with a greater increase in all-cause mortality than short-term exposure, as shown by research published in 2010 by the American Heart Association (Ljungman et al., 2019). The rise in cardiovascular mortality was estimated to be roughly 11%, while the overall increase in mortality was 6%, based on a meta-analysis of studies published in 2013. (Ljungman et al., 2019). PM2.5 influences over all-cause mortality are now estimated to be double what they were before the "European study of cohorts for air pollution effects (ESCAPE)" was conducted. Even Nevertheless, the overwhelming evidence suggests that cardiovascular problems brought on by exposure to air pollution account for half of all fatalities.
Coronary disease and air pollution
Human health consequences of air pollution.

Particulate matter and gaseous pollutants in the air are often considered to be the two main types of air pollution (Lehtomäkiet al., 2020). The health of all individuals on Earth is negatively impacted by environmental pollution. Heart disease, lung cancer, and respiratory illnesses are only some of the long-term effects of living in such an atmosphere. According to studies, people with high blood pressure have air pollution to thank for it since it restricts blood vessel dilation and puts extra strain on the cardiovascular system. And since the blood vessel walls are injured on the inside, they contract and harden (Chenet al.,2020). Inhaling the hazardous particulate matter in the air dramatically raises the risk of cardiovascular disease. As an example, Diesel Exhaust Emissions are largely to blame for the general decline in people's health. Life expectancy decreases if humans are exposed to air pollution. In light of this, the WHO has issued a set of air quality guidelines that might add 0.6 years to people's lives.

A major contributor to cardiovascular disease is exposure to polluted air, both outside and inside.

Pollutants in both indoor and outdoor air contribute significantly to the increased risk of cardiovascular disease. Carbon monoxide, ozone, nitrogen dioxide, sulphur dioxide, and many other particle pollutants contribute to both outdoor and interior air pollution. There is often a wide variety of suspended particles that make up the particulate matter. To be sure, its dimensions and make-up are not constant (Khreiset al.,2019). This has a multiplicative effect on disorders such as high blood pressure, a propensity toward blood clots, menopause, etc. As a result, given the complexity of the condition, the healthcare system often fails to offer adequate therapy.

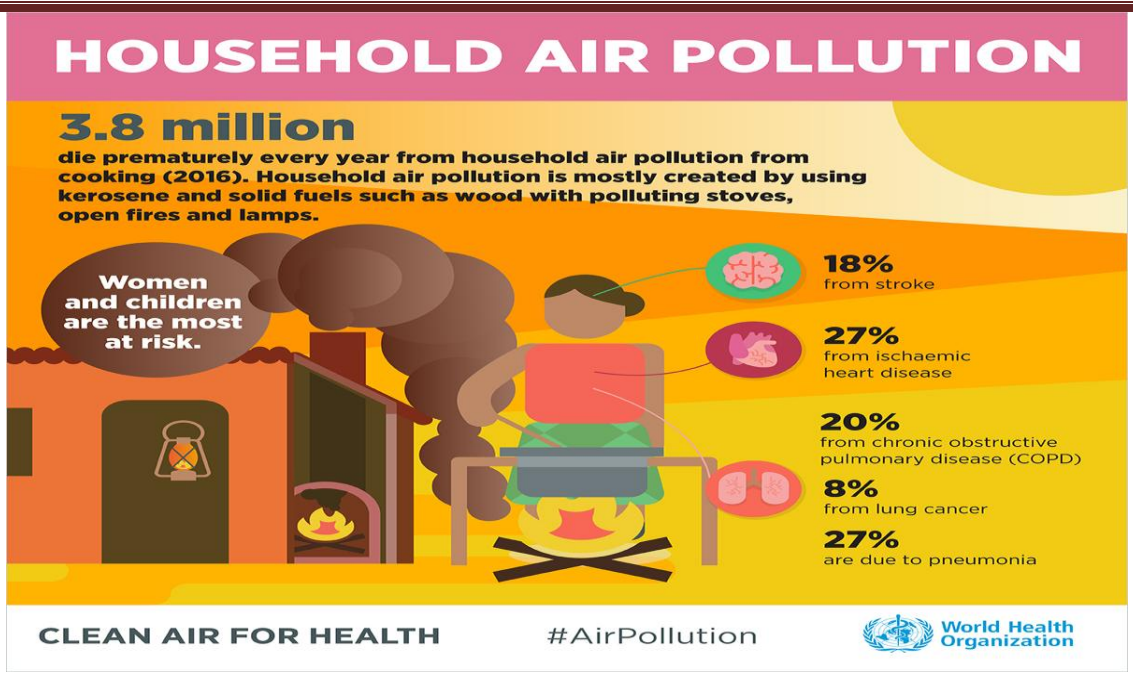

Figure: Indoor Air Pollution
(Source: medicalcollege.directory, 2020)

Consequently, governments should prioritise the healthcare system and actively work to adopt specific preventative measures for the improvement and growth of cardiac care. Particulate matter contains gaseous and poisonous components such as black carbon, secondary aerosols, and metals (Liuet al.,2019). Humans inhale such hazardous substances, which then pass through the airway epithelium. Subsequently, the hazardous components induce reactive oxygen species and enter the vascular. When breathed in, these chemicals alter the human respiratory system, leading to a hypertensive response. Other alterations in the regulation of heart muscle function are also evident.

Carbon Monoxide's Repercussions

Carbon monoxide is an invisible, odourless, and very poisonous gas created by the incomplete combustion of hydrocarbons found in fuels. Charcoal grills and hibachi stoves are two examples of heating devices that may produce carbon monoxide.

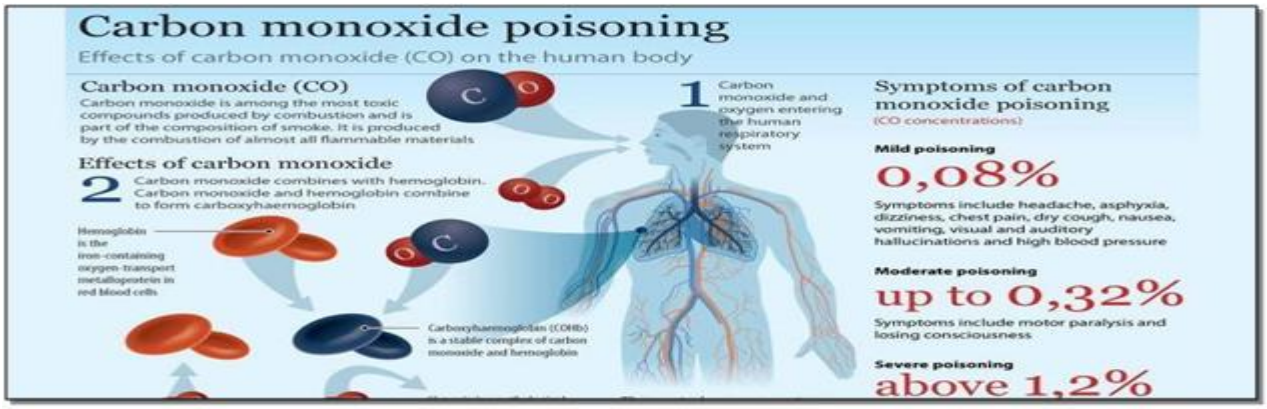

Figure: Effect of Carbon Monoxide on human health
(Source: online-sciences.com, 2019)

But most of the carbon monoxide pollution in the world comes from cars (Warburtonet al.,2019). Ischemic heart disease is more likely in those who are repeatedly exposed to such gaseous particles. Carbon monoxide mostly causes heart disease by lowering blood oxygen levels. When the hazardous substance is breathed in, it interferes with the body's ability to oxygenate tissues and make carboxyhemoglobin. However, this is detrimental to human health and has a negative impact on the cardiovascular system.

Influence of secondhand smoke

Toxic compounds, including nicotine and other nicotine-like molecules in cigarette smoke, and gaseous components, such as carbon monoxide, are both present in tobacco smoke (Ljungmanet al.,2019). Cigarette smoking is a well-known contributor to the rising prevalence of cardiovascular disease in the general population. Acute coronary syndrome, sudden cardiac death, stroke, and many more are among the numerous syndromes that have a strong correlation with cardiovascular illness. Those who smoke excessively are at greater risk of developing peripheral artery disease and stomach disorders with noticeable symptoms, according to reports. Research also shows that smoking raises the heart rate, stiffens the main arteries, and causes an irregular heart rhythm, all of which contribute to poor heart function. The danger of hypertension is also increased by smoking. In this way, it makes smokers more likely to have a stroke. The effects of smoking cigarettes are estimated to result in over 480,000 deaths annually, as reported by the Centers for Disease Control and Prevention (Zhanget al.,2021). One of the key ingredients in cigarettes, nicotine, is harmful to human health. These substances have been shown to damage the artery walls and promote the development of fatty plaque inside the arterial system. Cholesterol levels are influenced in a similar manner. As a result, there can be a higher possibility of developing blood clots. However, human heart attacks and strokes are often caused by blood clotting.

Recommendations

Taking use of public transportation is an excellent strategy to reduce contributions to air pollution. Air pollution may be mitigated in part because fewer cars are being driven, which means less gas is being used. The release of less gas and fuels would assist to minimise air pollution and save money in the long term.Another method to reduce pollution levels is the idea of recycling and reusing materials. This method not only aids in resource conservation, but also allows for more responsible use of those resources. The manufacturing of new items from recycled materials often uses less energy.
Refusing to use plastic bags is another practical step people may take to reduce their contribution to air pollution. Plastics are notorious for being environmentally destructive and contaminating. This is due to the fact that plastics have a very long decay period. Use of paper bags, which are both biodegradable and recyclable, is another viable option.

Refe**rences**

- Brunekreef, B. and Hoffmann, B., 2016. Air pollution and heart disease. *The Lancet*, *388*(10045), pp.640-642.https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(16)30375-0/fulltext?elsca1=etoc
- Greenpeace Southeast Asia. 2021. *PM2.5 air pollution behind an estimated 160,000 deaths in world's 5 biggest cities in 2020 - Greenpeace Southeast Asia*. [online] Available at: <https://www.greenpeace.org/southeastasia/press/44319/pm2-5-air-pollution-behind-an-estimated-160000-deaths-in-world-5-biggest-cities-in-2020/> [Accessed 4 October 2021].
- Huang, J., Li, G., Qian, X., Xu, G., Zhao, Y., Huang, J., Liu, Q., He, T. and Guo, X., 2018. The burden of ischemic heart disease related to ambient air pollution exposure in a coastal city in South China. *Environmental research*, *164*, pp.255-261.https://www.sciencedirect.com/science/article/pii/S0013935118301014
- Lelieveld, J., Klingmüller, K., Pozzer, A., Pöschl, U., Fnais, M., Daiber, A. and Münzel, T., 2019. Cardiovascular disease burden from ambient air pollution in Europe reassessed using novel hazard ratio functions. *European heart journal*, *40*(20), pp.1590-1596.https://academic.oup.com/eurheartj/article/40/20/1590/5372326?te=1&nl=climate-fwd%3A&emc=edit_clim_20200318
- Ljungman, P.L., Andersson, N., Stockfelt, L., Andersson, E.M., Nilsson Sommar, J., Eneroth, K., Gidhagen, L., Johansson, C., Lager, A., Leander, K. and Molnar, P., 2019. Long-term exposure to particulate air pollution, black carbon, and their source components in relation to ischemic heart disease and stroke. *Environmental health perspectives*, *127*(10),

p.107012.https://ehp.niehs.nih.gov/doi/full/10.1289/EHP4757?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%20%200pubmed

- Newby, D.E., Mannucci, P.M., Tell, G.S., Baccarelli, A.A., Brook, R.D., Donaldson, K., Forastiere, F., Franchini, M., Franco, O.H., Graham, I. and Hoek, G., 2015. Expert position paper on air pollution and cardiovascular disease. *European heart journal*, *36*(2), pp.83-93.https://academic.oup.com/eurheartj/article/36/2/83/2293343?login=true
- Rajagopalan, S., Al-Kindi, S.G. and Brook, R.D., 2018. Air pollution and cardiovascular disease: JACC state-of-the-art review. *Journal of the American College of Cardiology*, *72*(17), pp.2054-2070.https://www.sciencedirect.com/science/article/pii/S0735109718383554
- Amoatey, P., Omidvarborna, H., Baawain, M.S. and Al-Mamun, A., 2018. Indoor air pollution and exposure assessment of the gulf cooperation council countries: a critical review. *Environment international*, *121*, pp.491-506.https://www.sciencedirect.com/science/article/pii/S0160412018318142
- Maji, K.J., Dikshit, A.K., Arora, M. and Deshpande, A., 2018. Estimating premature mortality attributable to PM2. 5 exposure and benefit of air pollution control policies in China for 2020. *Science of the Total Environment*, *612*, pp.683-693.https://www.sciencedirect.com/science/article/abs/pii/S0048969717322751
- Parker, J.D., Kravets, N. and Vaidyanathan, A., 2018. Particulate matter air pollution exposure and heart disease mortality risks by race and ethnicity in the United States: 1997 to 2009 National Health Interview Survey with mortality follow-up through 2011. *Circulation*, *137*(16), pp.1688-1697.https://www.ahajournals.org/doi/full/10.1161/CIRCULATIONAHA.117.029376
- de FC Lichtenfels, A.J., Van Der Plaat, D.A., de Jong, K., van Diemen, C.C., Postma, D.S., Nedeljkovic, I., van Duijn, C.M., Amin, N., la Bastide-van Gemert, S., De Vries, M. and Ward-Caviness, C.K., 2018. Long-term air pollution exposure, genome-wide DNA methylation and lung function in the LifeLines cohort study. *Environmental health perspectives*, *126*(2), p.027004.https://ehp.niehs.nih.gov/doi/full/10.1289/EHP2045
- Rajagopalan, S., Al-Kindi, S.G. and Brook, R.D., 2018. Air pollution and cardiovascular disease: JACC state-of-the-art review. *Journal of the American College of Cardiology*, *72*(17), pp.2054-2070.https://www.jacc.org/doi/abs/10.1016/j.jacc.2018.07.099
- Lehtomäki, H., Geels, C., Brandt, J., Rao, S., Yaramenka, K., Åström, S., Andersen, M.S., Frohn, L.M., Im, U. and Hänninen, O., 2020. Deaths attributable to air pollution in nordic countries: disparities in the estimates. *Atmosphere*, *11*(5), p.467.https://www.mdpi.com/2073-4433/11/5/467
- Khreis, H., Cirach, M., Mueller, N., de Hoogh, K., Hoek, G., Nieuwenhuijsen, M.J. and Rojas-Rueda, D., 2019. Outdoor air pollution and the burden of childhood asthma across Europe. *European Respiratory Journal*, *54*(4).https://erj.ersjournals.com/content/54/4/1802194.short
- Warburton, D.E., Bredin, S.S., Shellington, E.M., Cole, C., de Faye, A., Harris, J., Kim, D.D. and Abelsohn, A., 2019. A systematic review of the short-term health effects of air pollution in persons living with coronary heart disease. *Journal of clinical medicine*, *8*(2), p.274.https://www.mdpi.com/2077-0383/8/2/274
- Ljungman, P.L., Andersson, N., Stockfelt, L., Andersson, E.M., Nilsson Sommar, J., Eneroth, K., Gidhagen, L., Johansson, C., Lager, A., Leander, K. and Molnar, P., 2019. Long-term exposure to particulate air pollution, black carbon, and their source components in relation to ischemic heart disease and stroke. *Environmental health perspectives*, *127*(10), p.107012.https://ehp.niehs.nih.gov/doi/full/10.1289/EHP4757
- Zhang, Q., Sun, S., Sui, X., Ding, L., Yang, M., Li, C., Zhang, C., Zhang, X., Hao, J., Xu, Y. and Lin, S., 2021. Associations between weekly air pollution exposure and congenital heart disease. *Science of The Total Environment*, *757*, p.143821.https://www.sciencedirect.com/science/article/abs/pii/S0048969720373526
- Liu, G., Sun, B., Yu, L., Chen, J., Han, B., Liu, B. and Chen, J., 2019. Short-term exposure to ambient air pollution and daily atherosclerotic heart disease mortality in a cool climate. *Environmental science and pollution research*, *26*(23), pp.23603-23614.https://link.springer.com/article/10.1007/s11356-019-05565-5
- Chen, K., Wang, M., Huang, C., Kinney, P.L. and Anastas, P.T., 2020. Air pollution reduction and mortality benefit during the COVID-19 outbreak in China. *The Lancet Planetary Health*, *4*(6), pp.e210-e212.https://www.thelancet.com/journals/lancet/article/PIIS2542-5196(20)30107-8/fulltext
- Thurston, G.D., Burnett, R.T., Turner, M.C., Shi, Y., Krewski, D., Lall, R., Ito, K., Jerrett, M., Gapstur, S.M., Diver, W.R. and Pope III, C.A., 2016. Ischemic heart disease mortality and long-term exposure to source-related components of US fine particle air pollution. *Environmental health perspectives*, *124*(6), pp.785-794.https://ehp.niehs.nih.gov/doi/full/10.1289/ehp.1509777