



Exhausting the heart: the role of air pollution in cardiovascular disease

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Introduction

The global impact of air pollution is a familiar and ever-present issue affecting modern life. The morbidity and mortality links with air pollution are well evidenced to numerous health conditions including COPD, neurodegenerative diseases, kidney disease and congenital defects to name

but a few (1). Over the last two decades there has been a surge in research assessing toxic effects of air pollution on heart disease and associated deaths. The gravity of the problem is that air pollution affects everyone, with the World Health Organisation reporting in 2022 that only 1% of the global population are currently living in conditions which are under the recommended targets for air pollution exposure (2). The Global Exposure Mortality Model performed by Burnett & colleagues demonstrated that exposure to outdoor air pollution could be as dangerous as cigarette smoking in relation to deaths worldwide (3–5).

What is air pollution?

Air pollutants represent several naturally occurring chemicals and particles within the atmosphere which are known to lead to detrimental health effects (1,6). Pollutants include substances such as particulate matter (e.g. particulate matter 2.5 and 10 (PM_{2.5} and PM₁₀) and ultra-fine particles) and gases, one of which being nitrogen dioxide (NO₂) (6).

Take Home Messages

- Only 1% of the global population breathe air within recommended range for air pollution levels.
- A significant body of evidence shows irrefutable evidence that air pollution increases risk of cardiovascular disease and cardiovascular death and may be as bad for you as smoking.
- Increased risk of acute effects such as myocardial infarction and long term all-cause cardiovascular mortality are just two examples of fumes on the heart.
- Individual impacts can help but global change in behavior is required to reduce air pollution levels, and as a result the toxic burden on our hearts.



These are produced from both artificial and natural sources, which humanity exacerbates via burning of fossil fuels, exhaust fumes from diesel engines and forest fires (1,5,6).

Cardiovascular impact

An umbrella review of research from 2010 to 2021 established a significant association between inhalation of air pollutants and cardiovascular conditions including hypertension, stroke and myocardial infarction (7). More notably, all-cause cardiovascular death was seen to be irrefutably associated in 100% of meta-analyses after both acute and chronic exposure to PM_{2.5} and NO₂ (7). Targeted studies demonstrate clear acute impacts on cardiovascular dysfunction. Peters et al. found that more patients presented with acute myocardial infarction after periods of higher atmospheric PM levels (8). Regarding impact on arrhythmia, Link and colleagues noted 26% higher odds of patients having atrial fibrillation (episodes of at least 30 seconds), in the 2 hours post-exposure to elevated concentrations of PM_{2.5} (9).

Studies have also assessed specific pathophysiological effects on the cardiovascular system. In patients with existing ischaemic heart disease, inhalation of diesel exhaust fumes and particulate matter caused significant increase in level of ST depression during physical activity (10,11). Under these conditions, endothelial tissue plasminogen activator was also produced in lower quantities, this being a key player in fibrinolytic processes (10).

Underlying mechanisms

There is not yet a defined molecular mechanism for how air pollutants cause the clinical conditions discussed so far; however there are theories currently being considered. One concept is that inhaled particles trigger an inflammatory response, resulting in oxidative stress and subsequently endothelial dysfunction and pro-thrombotic effects (1,7,12). Other theories propose a pathological activation of the autonomic nervous system resulting in vasoconstriction from inappropriate increase in sympathetic drive whilst there is also a possibility that particulate matter could directly travel to the blood stream and end-organs as demonstrated in animal models (1,7,12).

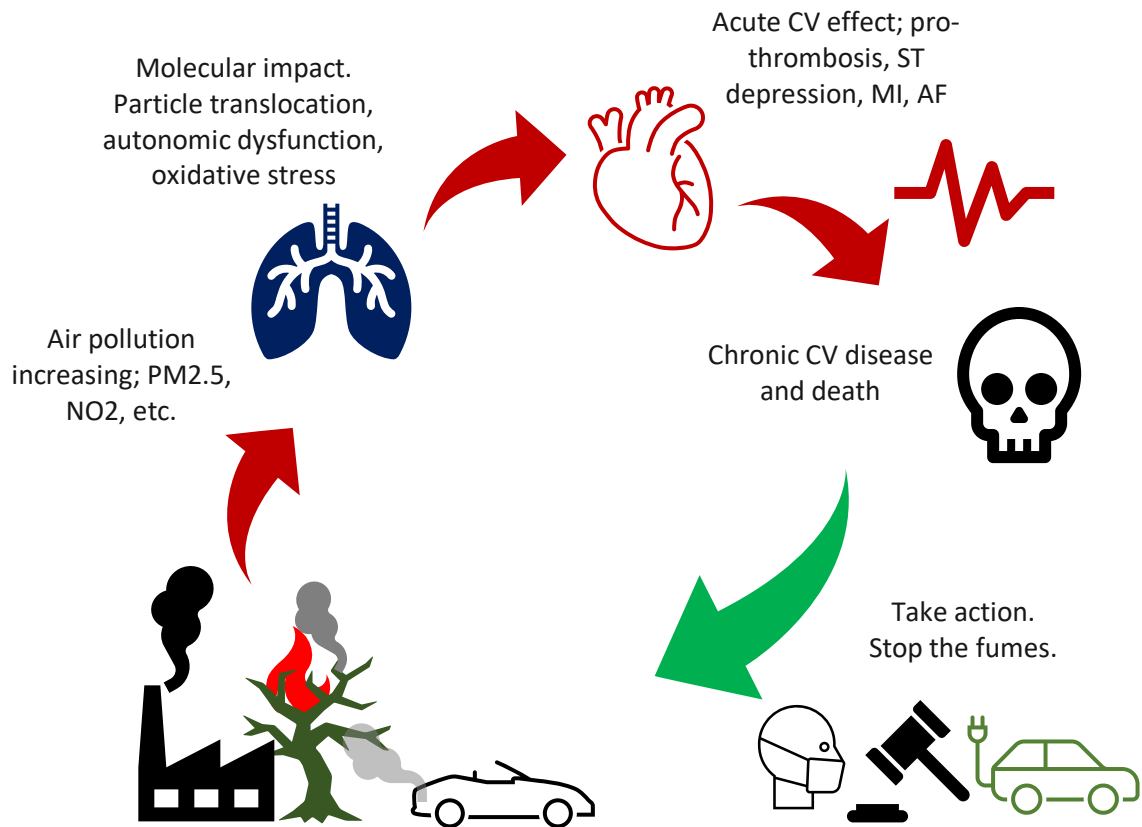


Figure 1. Air pollution cycle; cardiovascular impact and environmental strategies

Time to act

The ultimate target for intervention must be air pollution itself, at source; however, personal interventions can make a difference. Evidence for wearing masks is very limited showing only mild reductions in blood pressure and ST-depression levels (13). Researchers in the field also advocate for use of air purifiers which have shown mixed results (**Table 1**) (14–16). Omega-3 supplements appear to reduce pro-inflammatory mediators but show no impact on blood pressure (17).

Switching to electric vehicles, using public transport and reducing use of aviation travel are well-known but individually will only make minimal impact. It is global action, as stipulated in the Paris Agreement, that needs to be taken to reduce production of these harmful chemicals to make a significant impact on worldwide human health (18). “You’re full of it” is a focused campaign



created by The British Heart Foundation targeting impacts to challenge government strategy to reduce PM_{2.5} in our atmosphere to safer levels (19).

Intervention	Cardiovascular effects	Impact	Author
Face covering	Lower MAP & ST depression	Individual	Langrish et al. (13)
Air purifier	Increased HRV & Increased BP	Individual	Liu et al. (15)
Air purifier	Lower BP	Individual	Morishita et al. (16)
Omega-3 supplements	Reduced inflammatory markers & no change in BP	Individual	Lin et al. (17)

Abbreviations; MAP – mean arterial pressure, BP – blood pressure, HRV – heart rate variability

Conclusion

It is clear to see that multiple pollutants in the air we breathe have associations to both the development of cardiovascular disease and ultimately increasing risk of cardiovascular death. Global environmental political policies and the World Health Organisation advocate for reduction in air pollutants and the concern is that action is not being taken quickly enough. The actions we can take as individuals are one step forward but a coordinated global response to pollution would have the most significant impact on our cardiovascular health as a planet.

Declarations

None

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