

CLEAN AIR, SMART CITIES, HEALTHY HEARTS: ACTION ON AIR POLLUTION FOR CARDIOVASCULAR HEALTH



Air pollution is one of the most important risk factors for heart attack, stroke, diabetes and respiratory diseases, and exposure to air pollution has also been linked with increased vulnerability to the more severe consequences of COVID-19. In 2019, an estimated 6.7 million deaths, or 12 percent of all deaths worldwide, were attributable to outdoor or household air pollution. As many as half of these deaths were due to heart disease and stroke.

Air pollution is a complex and dynamic mixture of numerous compounds in gaseous and particle form originating from diverse sources. Three common air pollutants, particulate matter (PM), ozone, and nitrogen dioxide (NO₂), are the focus of most monitoring programs, communication efforts, health impact

assessments, and regulatory efforts. Air pollution can also be classified into pollution of outdoor/ambient or indoor origin, both of which have serious health effects.

The tiny particles that make up air pollution can enter the blood stream and damage the inside walls of the blood vessels, causing them to become narrower and harder. This restricts the movement in the blood vessels, which can increase blood pressure, form blood clots, affect the normal electrical functioning of the heart, and eventually lead to cardiac events.

The complexity and scale of this issue creates an unfortunate lack of understanding among those with the power to make change for good, including doctors and policymakers, which in turn results in a subsequent lack of concerted action.

Political commitments and policy measures to mitigate pollution emissions will ultimately be necessary to reduce harmful exposures. Nevertheless, healthcare providers can play several important roles before, and while, such mitigation is achieved.



TAKING ACTION:

The World Heart Federation recommends the following interventions for key stakeholders, with a sustained focus on cross-sectoral collaboration.



KEY

- ▲▲▲ **Intervention is recommended.** This intervention is evidence-based, low-risk to individuals, and feasible from a resource perspective.
- ▲▲ **Intervention should be considered.** This intervention has a growing evidence base, but may pose some challenges from a resource perspective.
- ▲ **Intervention may be considered for specific groups,** but requires further evidence before recommending to broader populations.

Target group	Action Items	Relative Strength of Evidence	Justification	Objective
Physicians (I)	Use risk assessments to identify patients likely to benefit from interventions to reduce air pollution exposures, screening for susceptibility and vulnerability. Personal measures may be necessary to reduce pollution exposures, particularly as reductions in ambient air pollution are unlikely in the short-term for much of the world; facemasks, particularly properly fit N95 respirators, can block the majority of PM2.5 inhalation ⁽³⁷⁾ .	▲▲▲ ▲▲	The effects of air pollution on the cardiovascular system are quantifiable and modifiable at the individual level ⁽³⁸⁾ . Reducing air pollution exposures decreases the risk of cardiovascular mortality, acute coronary syndrome, stroke, arrhythmias, heart failure, and atherosclerosis ⁽³⁷⁾ . Clinicians promoting cardiovascular health therefore have an opportunity and responsibility to protect their patients from air pollution.	Physicians and patients become aware of, and empowered, to ameliorate the impacts of air pollution on health. Personal measures are necessary to reduce pollution exposures, particularly as reductions in ambient air pollution continue at a slow rate in the short-term for much of the world ⁽³⁷⁾ . Specific measures include personal masks, air filtration, clean stoves and fuels, behaviour modification, and dietary approaches. Although early trials have shown promising results on surrogate endpoints, large randomized trials are needed to evaluate the efficacy of these, and pharmacologic, interventions on preventing cardiovascular events. As we await additional data, clinicians can recommend these interventions to their most susceptible and vulnerable patients.
	Outdoor air pollution often infiltrates buildings, leading to hazardous indoor exposures ⁽³⁸⁾ . High-efficiency particulate air (HEPA) filters can remove the majority of indoor PM2.5 ^(17, 37, 39) . For households burning fossil fuels (e.g., oil, coal) or biomass (e.g., wood, dung) for cooking or heating indoors, key interventions include ventilation, electrification, and access to clean stoves and clean fuels ⁽⁴⁰⁾ . Portable HEPA air purifiers can also be considered in cases where preferred interventions cannot be achieved at scale.	▲▲ ▲▲		
	Behavioural modifications are a simple strategy to reduce air pollution exposures. Advise susceptible individuals to stay indoors and close windows on days with elevated ambient pollution levels ⁽³⁸⁾ . Where outdoor air pollution is low, windows can be opened to ventilate indoor environments. Patients can be notified of daily levels via air quality alert networks, which provide warnings and recommendations on how to minimize exposures ^(18, 37) .	▲▲ ▲▲		
	Individuals exposed to vehicular emissions should be counselled to avoid rush hour transit, close/open vehicle windows, and use car air conditioning/purifiers ^(17, 41-43) . For susceptible individuals, high-intensity outdoor exercise should be delayed during heavy pollution conditions. Clinicians can make additional behavioural recommendations targeting pollution exposures identified in the patient history ^(44, 45) . Dietary and pharmaceutical interventions show promise but require further investigation. For example, small trials have demonstrated that antioxidants (e.g., vitamins C and E) and omega-3 fatty acids may reduce oxidative stress and inflammation attributed to air pollution exposures ^(46, 47) . Likewise, a large prospective cohort demonstrated that a Mediterranean diet reduced cardiovascular mortality attributed to air pollution exposure, but it is premature to recommend pharmaceutical interventions at this time ⁽⁴⁸⁾ . Optimising therapies to treat current cardiovascular conditions may also lessen the risk of air pollution triggering cardiovascular events, although more research is required.	▲▲ ▲▲▲ ▲		
	Finally, mitigation of traditional cardiovascular risk factors (e.g., hypertension, diabetes, obesity, atherosclerosis) can reduce susceptibility to cardiovascular events attributed to air pollution exposures ⁽³⁷⁾ .	▲▲▲		

Target group	Action Items	Justification	Objective
Physicians (II)	In addition to direct patient care, clinicians and associated organizations should play a leadership role in reducing pollution exposures in their communities. First, medical facilities, which historically have contributed heavily to pollution emissions, should become models for low emissions and renewable energy ⁽³³⁾ . Second, medical education and training should now include the pathophysiology and management of pollution-attributable cardiopulmonary disease ⁽³⁷⁾ . Third, providers should track pollution exposures affecting their service populations ⁽²⁷⁾ . Many exposure models are publicly available ^(28, 29) and can be used to identify high-risk neighborhoods to target for intervention. Fourth, providers should develop community-tailored programs for such neighborhoods, including individual interventions (see Part I above), public education campaigns, public-private partnerships, and advocacy to local policymakers. Finally, physicians lend their support to existing air pollution campaigns , such as the Medics for Clean Air manifesto ⁽⁵⁰⁾ .	Physicians can be powerful advocates for policy action on behalf of their patients ⁽⁴⁹⁾ . Cardiologists and members of the global cardiology community are especially well placed to advocate for air pollution control measures due to their central role in mitigating its health impacts.	Stronger cross-sector coalitions for policies countering air pollution.
Scientific societies	Scientific and specifically cardiology societies can take action on the air pollution agenda by providing tools and support for their members to learn about concrete actions and policies they can enact. They should also work to feature air pollution through their various platforms , such as on high-level panels at Congresses and events, thereby raising the profile and acceptance of air pollution as a modifiable risk factor for cardiovascular disease.	Societies have the power and presence, through journals, publications, conferences, workshops, and other communications with their members, to raise the profile of air pollution as a CVD risk factor and encourage policy action.	Physicians in the global cardiovascular community are more receptive to taking action on air pollution.
Foundations and patient advocacy groups	Civil society groups should work with physicians to advocate for measures at the city level (i.e., active transit improvements, investment in non-combustion sources of energy and transport, stricter emissions controls – see below) to strengthen their arguments and coalitions for policymakers. They can also provide patients and civil society members with information about personal protection measures (see Physicians I).	CVD and other patient advocates bring an important and compelling personal element to the ‘story’ of air pollution and health, as well as crucial knowledge of policy processes to facilitate concrete action.	Physicians, scientific societies, and patients are connected with policymakers and engaged in the policy process through civil society facilitation.
Policymakers at the city level	There are several key policies mayors and city-level policymakers can embrace to mitigate the harmful effects of air pollution. Regulate emissions to encourage the transition to clean energy sources through the implementation of Low Emission Zones, traffic charging and parking policies. Zoning laws should prevent the collocation of residential zones with industrial and traffic activities. Together with the promotion of efficient public transportation networks and adequate infrastructure for walking/cycling , this can help to encourage clean active transit and outdoor cardiovascular exercise among residents and commuters. Where possible, building codes should be updated to require indoor air filtration and fitting to reduce the penetration of ambient pollution. Advisory and prevention monitoring that reports to the community if a pollutant is exceeding health levels is important, and health care providers must receive adequate resources to identify and manage individuals at elevated risk of pollution-attributable cardiovascular disease (see Physician I and Scientific Society sections). Explore the use of taxes on fossil fuels and unhealthy commodities, penalties for excessive production of air polluting waste, various “green” incentives, and emission offsetting programmes as a means of financing and enforcing these policies. Finally, mayors and city-level policymakers should work closely with physicians and members of the cardiovascular community to implement such policies, ensuring broad community engagement and a focus on positive health impacts ⁽⁵⁰⁾ .	Cities are often the nexus of highly polluted areas and those places where susceptible and vulnerable populations reside. Successful action at the city level can have the greatest impact on those with the greatest need ⁽⁵⁰⁾ . Over the long term, addressing air pollution yields high return on investment for both citizen health and city budgets ⁽⁵¹⁾ . Furthermore, involving physicians in policy consultation provides scientific credibility and wider community buy-in.	Air pollution policies are implemented internationally at the level of global agreements and government ministers (especially of the environment, health, and transportation) create a foundation for continued collaboration.
National governments; policymakers at the global level (participating in WHA, G10, COP, etc.)	Member State representatives active in global policymaking should work closely with physicians and members of the global cardiovascular community to implement air pollution policies that put health at the center, such as the WHO guidelines on mitigation of indoor air pollution. Through forums such as the World Health Assembly (resolutions), UN High-Level Meetings (political declarations), COP Summits, etc, national governments can demonstrate domestic successes in countering air pollution and keep emission control firmly on the international agenda.	Involving physicians in the policy consultation process provides scientific credibility. Addressing air pollution through concrete policy yields high ROI for health and budgets ⁽⁵¹⁾ . Strong domestic and global policies on air pollution will respond to international citizen demonstrations demanding climate action.	Air pollution policies are implemented internationally at the level of global agreements and government ministers (especially of the environment, health, and transportation) create a foundation for continued collaboration.

ACTION ON AIR POLLUTION

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WORLD HEART FEDERATION
32, rue de Malatrex, 1201 Geneva, Switzerland
(+41 22) 807 03 20
info@worldheart.org
www.worldheart.org



World Heart Federation

@worldheartfed

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@worldheartfederation