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Clinical Review

Air pollution: a scoping review of clinical recommendations for family and community medicine

Poluição do Ar: uma revisão de escopo para recomendações clínicas para a medicina de família e comunidade

Contaminación del Aire: una revisión de objetivo para recomendaciones clínicas para la medicina familiar y comunitaria

Mayara Floss[1], Rafaela Brugalli Zandavalli[1], Jéssica Rodrigues Borges Leão[2], Camila Vescovi Lima[3], Nelzair Vianna[3], Enrique Falceto Barros[4], Paulo Hilario Nascimento Saldiva[5]

[1]Grupo Hospitalar Conceição – Porto Alegre (RS), Brazil.
[2]Pontifícia Universidade Católica de São Paulo – São Paulo (SP), Brazil.
[3]Fundação Oswaldo Cruz – Salvador (BA), Brazil.
[4]Working Party on the Environment Chair – Santa Maria do Herval (RS), Brazil.
[5]Universidade de São Paulo – São Paulo (SP), Brazil.

Abstract

Introduction: Deaths attributable to long-term air pollution are estimated to be as high as 9 million a year, mainly concentrated in low- and middle-income countries such as Brazil. Air pollution is classified as household (indoor) or ambient(outdoor). Inhalation of pollutants is related to the increased incidence and development of clinical conditions, such as cardiovascular, respiratory and other diseases, which are part of the practice of family doctors. **Objective:** To reviewthe clinical evidence for an approach to air pollution related to human health in the context of the practice in primary health care. **Methods:** A scoping review was carried out with a cross-sectional focus on the role of primary health care in relation to air pollution and health, focusing on clinical issues related to air pollution. **Results:** A total of 35 articles were included in this review. Clinical recommendations at the individual level were: reduction in the use of solid fuels in wood stoves, use of strategies to protect polluting sources (such as forest fires, roads and industry), air filtration, promotion of active transport and smoking cessation. These actions must be complementary to government policies related to air pollution reduction. Clinical interview questions were proposed. Specific recommendations on the use of masks, physical activity and COVID-19 were explored. Research topics were proposed that could be carried out in primary health care and the role of family doctors in this context. **Considerations:** The inclusion of "exposure to air pollution" in the International Classification of Primary Care and in the International Classification of Diseases could improve notification and epidemiological studies on the subject.

Keywords: Air pollution; Environmental health; Primary health care; Family practice.

Corresponding author:
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Resumo

Introdução: As mortes atribuíveis à poluição do ar em longo prazo chegam a 9 milhões ao ano, concentrando-se principalmente em países de baixa e média renda como o Brasil. Classifica-se a poluição do ar em: domiciliar (*indoor*) ou ambiente (*outdoor*). A inalação de poluentes está relacionada com o aumento da incidência e desenvolvimento de condições clínicas, como doenças cardiovasculares, respiratórias e outras, que fazem parte da prática da medicina de família e comunidade. **Objetivo:** Verificar as evidências clínicas para a abordagem da poluição do ar relacionada à saúde humana no contexto da prática na Atenção Primária à Saúde. **Métodos:** Revisão de escopo do papel clínico da medicina de família e comunidade em relação à poluição do ar e saúde, voltada para questões clínicas associadas com a poluição do ar. Incluíram-se 35 artigos nesta revisão. **Recomendações clínicas:** Em nível individual, destacam-se a redução do uso de fogões a lenha, o uso de estratégias de proteção de fontes poluidoras (como queimadas, vias de trânsito e indústria), a filtragem do ar, o estímulo ao transporte ativo, a cessação do tabagismo. Essas recomendações devem ser complementares às políticas governamentais relacionadas à poluição do ar. Propõem-se perguntas para a entrevista clínica. Exploram-se recomendações específicas sobre uso de máscaras, atividade física e COVID-19. Sugerem-se temas de pesquisa que podem ser realizadas na Atenção Primária à Saúde e o papel da medicina de família e comunidade nesse contexto. **Considerações:** A inclusão na classificação internacional de atenção primária e no Código internacional de Doenças poderia melhorar a notificação e os estudos epidemiológicos sobre o assunto.

Palavras-chave: Poluição do ar; Saúde ambiental; Atenção primária à saúde; Medicina de família e comunidade.

Resumen

Introducción: Las muertes atribuibles a la contaminación del aire a largo plazo alcanzan los 9 millones por año, concentradas principalmente en países de ingresos bajos y medios como Brasil. La contaminación del aire se clasifica en: doméstica (indoor) o ambiental (outdoor). La inhalación de contaminantes está relacionada con el aumento de la incidencia y el desarrollo de condiciones clínicas, como enfermedades cardiovasculares, respiratorias y otras; que forman parte de la práctica de la medicina familiar y comunitaria (MFC). **Objetivo:** verificar la evidencia clínica para el abordaje de la contaminación atmosférica relacionada con la salud humana en el contexto de la práctica en Atención Primaria de Salud (APS). **Métodos:** Se realizó una revisión de objetivo con un enfoque transversal sobre el papel de la APS con relación a la contaminación atmosférica y la salud, con foco en los aspectos clínicos relacionados con la contaminación atmosférica. En esta revisión se incluyeron 35 artículos. **Recomendaciones clínicas:** A nivel individual, hay reducción en el uso de estufas de leña, uso de estrategias de protección de fuentes contaminantes (como incendios, carreteras e industria), filtración de aire, estimulación del transporte activo, abandono del tabaquismo. Estos deben ser complementarios a las políticas gubernamentales relacionadas con la contaminación del aire. Se proponen preguntas de entrevista clínica. Se exploran recomendaciones específicas sobre el uso de máscaras, actividad física y COVID-19. Se proponen temas de investigación que pueden llevarse a cabo en la APS y el papel del MFC en este contexto. **Consideraciones:** la inclusión en la Clasificación Internacional de Atención Primaria (CIAP) y en el Código Internacional de Enfermedades (CIE) podría mejorar la notificación y los estudios epidemiológicos sobre el tema.

Palabras-clave: Contaminación del aire; Salud ambiental; Atención primaria de salud; Medicina familiar y comunitaria.

INTRODUCTION

Primary health care (PHC) professionals must be aware of community health determinants, such as sanitation and exposure to infectious vectors (e.g., dengue). They should also be aware of cultural conditions that provide greater resilience and/or vulnerability to health and disease processes. In this context, it is important that family and community medicine (FM) professionals perceive other health factors related to air pollution, such as inequities associated with exposure to vehicle traffic, biomass burning and chimneys.

Deaths from air pollution are attributable to both long-term (weeks, months and years) and short-term (hours and days) exposure. The risks of pollution are classified as from exposure to outdoor air (or ambient air), which totals 4.2 million deaths/year, and household air (or indoor air), which totals 3.8 million deaths/year.[1] Together, these deaths reach 8 million a year, mostly concentrated in low- and middle-income countries (LMICs).[2] More recent analyses estimate that deaths due to environmental air pollution by fine particles could be as high as 9 million a year, while 1 million a year for tropospheric ozone.[3] For comparative purposes, tobacco is responsible for 7 million deaths per year.[4,5]

The main pollutants of clinical interest are fine particles, especially particulate matter smaller than 2.5 μ ($PM_{2.5}$), which penetrate the alveoli and the bloodstream, triggering a complex pathophysiological

cascade. Ambient $PM_{2.5}$ air pollution is globally diffuse and emitted from a combination of sources, including traffic, industry, agricultural burning, forest fires, wildfires and resuspended dust.[5] Household $PM_{2.5}$ air pollution arises from cooking, heating, or lighting, through the inefficient burning of biomass, such as with wood [6,7] or charcoal stoves, practices still common among almost half of the world's population.[7]

Inhalation of $PM_{2.5}$ pollutants is related to an increase in the incidence of clinical conditions that are commonly seen by FM doctors. These include skin lesions,[8] hypertension,[5] atherosclerosis,[9] stroke,[10] acute myocardial infarction,[11] lung cancer,[12] diabetes,[13] dementia,[14,15] low birth weight,[16] infertility, [17] demand for PHC visits related to respiratory diseases in children,[18] asthma,[19-21] chronic obstructive pulmonary disease (COPD),[22] rhinitis,[23] upper airway infections,[24] lower airway diseases[23] and use of the Mobile Emergency Care Service.[25]

In 2018, the United Nations recognized air pollution (ambient and household) as a risk factor for chronic non-communicable diseases (NCDs), in addition to unhealthy diets, smoking, harmful use of alcohol and physical inactivity.[26] Air pollution is considered the second leading cause of death from noncommunicable diseases.[26]

In the Brazilian context, it is important to point out that the burning of biomass, especially in biomes such as the Amazon and Pantanal, is responsible for high rates of hospitalizations for circulatory and respiratory problems, particularly in the elderly over 60 years of age and children under five,[27] in addition to the birth of low birth weight babies.[28] The intersection between deforestation, climate change and man-made fires has growing and alarming effects on health.[29] Another important issue in relation to air pollution in Brazil is the increase in use of coal for energy, one of the most polluting sources of air pollution.[29] In addition, there is an increase, especially in 2019, in the number of Brazilian families who depend on firewood or charcoal for cooking.[30]

FM professionals have an important role to play in reducing the global burden of NCDs from air pollution. As with traditional NCD risk factors (such as obesity), practitioners can identify patients at high risk from air pollution and provide recommendations and interventions to reduce NCD risk. However, there is currently no consistent clinical approach to air pollution.

If we draw a parallel with policies and training to advise on smoking cessation, it is interesting to reflect on some paradoxes in relation to air pollution, which is usually not part of the training of health professionals. This is to be expected because, while tobacco is a single agent, polluting sources are part of our daily life and culture and demand measures that are not one-off. We are not the ones who are going to stop cars, as we would do with tobacco. Many of the diseases associated with tobacco are associated with pollution, but the solution is more complex. It is easy to ask how many packs of cigarettes someone smokes or if someone smokes nearby. No one asks, however, how many hours a person spends on the bus, associated with greater exposure to $PM_{2.5}$.

In this sense, the objective of this clinical scoping review was to determine the evidence for an approach to the health effects from air pollution related in the context of PHC.

METHODS

Nature of study and design

This was a descriptive and exploratory study focused on clinical practice, which systematized[31,32] and contextualized data on the activity of FM in PHC. A scoping review[31] was carried out focusing on the role of PHC professionals, mainly FM physicians, in relation to air pollution focused on clinical issues.

Data collection

Data collection was carried out from January to March 2021 and data analysis and selection of articles in March 2021. We followed the steps of searching, categorizing, evaluating, analyzing and synthesizing the findings. The search was carried out in the Latin American and Caribbean Literature on Health Sciences (LILACS), ACCESSSS and PubMed Clinical Queries databases- and the ACCESSSS database includes several others, mainly referring to systematic reviews. The inclusion criteria were to have a theme related to air pollution and PHC, without a time cut-off. Review of clinical summary texts should include the topic of air pollution in the title, abstract, essential topics and/or summary.

All possible combinations of the following descriptors were used: ((“air pollution” OR “air pollutants”) AND (“primary care” OR “primary health care” OR “family practice”)). For the ACCESSSS database (https://www.accessss.org), the filter “systematic reviews” “clinical study categories” was used for the descriptors. For PubMed Clinical Queries (https://www.ncbi.nlm.nih.gov/pubmed/clinical), the filters “systematic reviews” and “clinical study categories” were adopted for the descriptors. And for the LILACS database (http://lilacs.bvsalud.org), the filter “systematic review” was used.

The following search refinement steps are outlined in Figure 1. For categorization, evaluation and analysis, a spreadsheet was used with the reading of abstracts and articles selected by pairs of evaluators. For this scoping analysis, 14 systematic review articles were selected (Table 1).

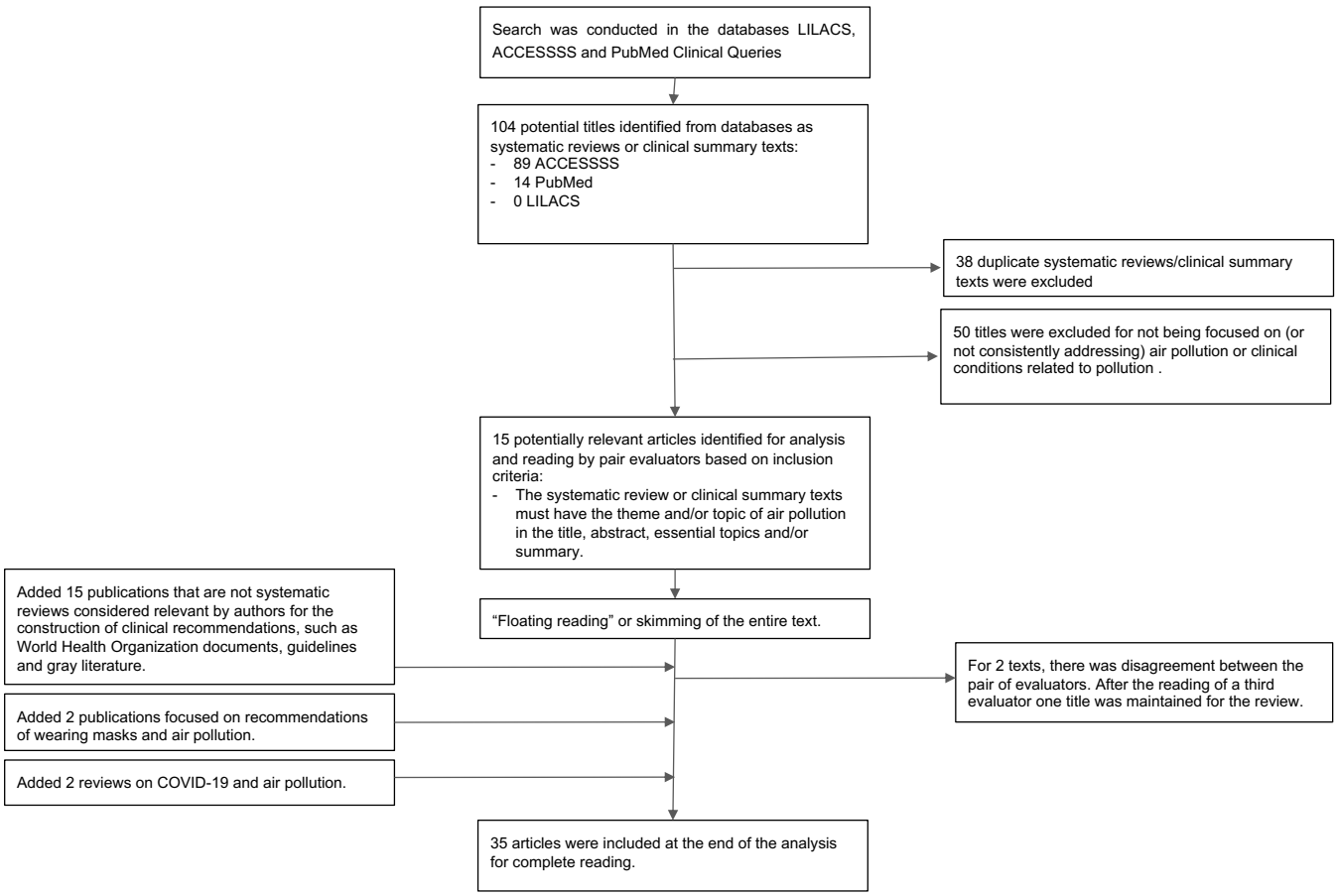


Figure 1. Process of selection of sources.

Table 1. Characteristics of the articles selected for the scoping review.

Author, year	Database/Source	Language	Topic
Abelsohn et al.[39]	Medscape	English	Air pollution and health effects
Abelsohn et al.[45]	TelessaúdeRS/UFRGS	English	Air pollution in primary health care
Bourdrel T et al.[48]	PubMed	English	COVID-19
Burns et al.[36]	Cochrane	English	Air pollution and health
Cai et al.[63]	PubMed	English	Air pollution and SAH
Copat et al.[49]	ScienceDirect (Elsevier)	English	COVID-19
Emmelin et al.[67]	ACCESSSS	English	Household air pollution and child mortality
Floss et al.[35]	Lancet	English	Policy recommendations for Brazil in health and climate change
Floss et al.[29]	Lancet	English	Policy recommendations for Brazil in health and climate change
Fu et al.[62]	PubMed	English	Air pollution, pregnancy and changes in babies
Holm et al.[38]	Journal of Exposure Science & Environmental Epidemiology	English	Smoke from forest fires and child health
Hueston et al.[59]	BMJ Review	English	Bronchitis
Ilgenfritz et al.[44]	TelessaúdeRS/UFRGS	Portuguese	Air pollution and health
Ilowite[58]	Dynamed Review	English	Environmental asthma control
Kurmi et al.[60]	ACCESSSS	English	Environmental risk from air pollution and bronchitis
Kyung et al.[47]	Tuberculosis and Respiratory Diseases	English	Use of masks
Lawin et al.[55]	PubMed	English	Air pollution and awork
Hadley et al.[11]	AHA Journals	English	Air pollution and cardiovascular health
Milner et al.[41]	BMJ	English	Carbon emission reduction and health benefits
Nici[61]	Dynamed Review	English	COPD
Pekkanen[65]	EBM Review	English	Household air pollution
Pönkä[50]	EBM Review	English	Environmental air pollution
Rautio et al.[64]	PubMed	English	Environment and depression
Rochester et al.[74]	BMJ Review	English	COPD
Allen et al.[40]	Springer; CEHR	English	Individual interventions to reduce exposure to air pollution
Tsoi et al.[67]	PubMed	English	Diesel air pollution, drivers and lung cancer
U.S. Department of Health and Human Services[43]	USA government	English	Physical activity and air pollution
Ward et al.[57]	PubMed	English	Air pollution and children
WHO[34]	WHO	English	Air pollution and diseases
WHO[33]	WHO	English	Household air pollution and air quality
Jiang et al.[37]	Journal of Thoracic Disease	English	Air pollution and chronic airway disease
Zeka et al.[42]	International Journal of Epidemiology	English	Air pollution and inflammatory markers
Zhang et al.[46]	PubMed	English	Use of masks

SAH: systemic arterial hypertension; COPD: chronic obstructive pulmonary disease.

In addition, the information was supplemented with the inclusion of two official documents from the World Health Organization,[33,34] (in addition, for occasional clarifications, its website dedicated to air pollution[1]), two health policy recommendations from the Lancet Countdown for Brazil[29,35] and research in the Cochrane database.[36] Furthermore, the review included a review article focusing on the clinical approach of cardiovascular diseases and air pollution,[11] a clinical approach article focusing on respiratory diseases,[37] a review dealing with consequences for children and effects of air pollution during fires,[38] two papers on patient counseling and air quality monitoring,[39,40] one on reducing carbon emissions,[41] one on the pathophysiology[42] of air pollution and a guideline for physical activity[43] that was evaluated by the authors and has important aspects for this review, as well as the materials that address air pollution from the TelessaúdeRS/UFRGS courses: *Saúde Planetária*[44] and Planetary Health for Primary Care.[45]

Two complementary articles on the discussion of the use of masks in the context of air pollution were also included,[46,47] as well as two reviews that addressed the issue of COVID-19 and air pollution, namely a more recent review article and a systematic review.[48,49] For specific aspects, such as examples of actions, other articles are cited throughout this clinical review.

RESULTS AND DISCUSSION

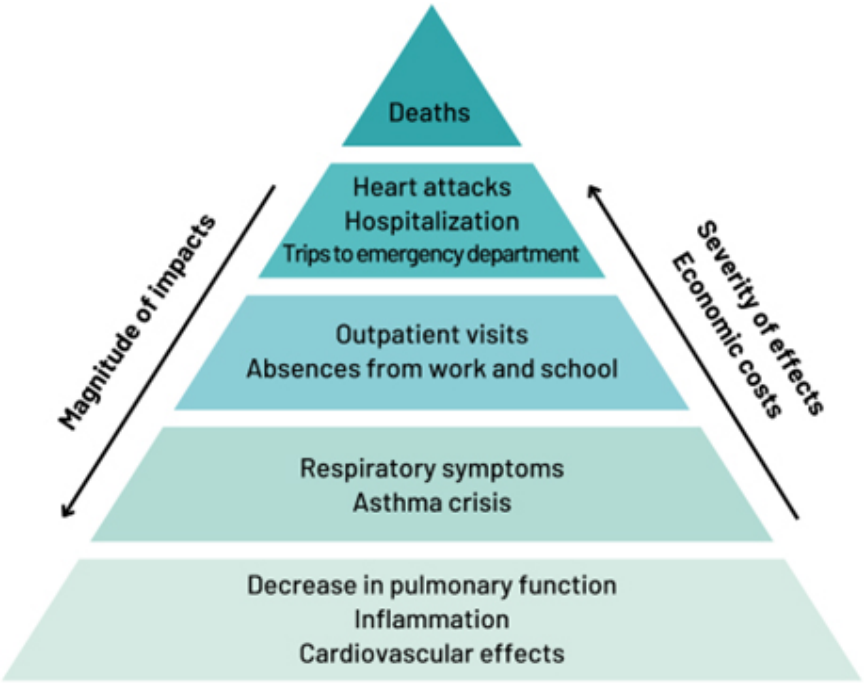
A complete reading of the 35 articles based on this clinical review was performed. The works were condensed according to the sections of the article and notes, and recommendations were made on the topic.

Clinical recommendations

Air pollution has been implicated in causing health effects in nearly every organ in the body. Air pollution is known to cause systemic inflammation and oxidative stress, as fine and ultrafine particles cross into the bloodstream, reaching and affecting many organs and systems (Figure 2).[11] The range of harmful effects of air pollution extends far beyond human health and is also a risk to climate change and ecosystems.

Air pollutants can be classified into two types: particles and gases. Most are anthropogenic in origin, produced by humans, but some are natural, such as fine dust and pollen. We are usually exposed to pollutants where we live, travel, exercise or work. Often, the air in a city or region may be polluted or we may be exposed in microenvironments, where pollutant levels are comparatively higher — for example, near highways (traffic-related air pollution), industries and power plants, or inside our home when using fire for cooking or heating. Some pollutants, especially particulate matter ($PM_{2.5}$), can become suspended in the air, travel long distances in the wind and accumulate elsewhere (long-range or transboundary pollution)[39,44,45] (Table 2).

PM is a complex mixture of organic and inorganic compounds in a solid or liquid state suspended in air. It is generally classified by its size or aerodynamic diameter: PM_{10} indicates particles <10 μm in diameter; $PM_{2.5}$ indicates <2.5 μm in diameter; and $PM_{0.1}$, <0.1 μm in diameter. All are thinner than a strand of hair, and the $PM_{2.5}$ is smaller than a red blood cell (Figure 3).[44,45,50] A particle's size is generally inversely proportional to the damage caused when inhaled; that is, the smaller the inhaled particle, the greater its ability to infiltrate the respiratory system, reaching the alveoli and, consequently, the systemic



Source: Ilgenfritz et al.[44]
Figure 2. Pyramid of effects of air pollution.

circulation, where it can trigger a pathophysiological cascade. This explains why these pollutants are so relevant to health.[42]

The main effects occur due to long-term exposure, but even a slight short-term change in air pollution concentration (increase of 10 μg/m^3 in the concentration of $PM_{2.5}$) is associated, in the two subsequent days (Lag2), with an increase of 0.68% in overall daily mortality, 0.55% in mortality from cardiovascular causes, and 0.74% in daily mortality from respiratory causes.[51] Elevations in nitrogen dioxide concentration are also associated with cardiovascular and pulmonary mortality.[52]

Air pollution levels are constantly changing, often unpredictably, because of weather and other factors. Other changes in atmospheric composition and climate happen at the same time and can also impact population health and air pollution.[36,44] Important sources of air pollution in relation to climate change are the following:[45]

- Much of the smoke from fires is made up of particles, with a higher proportion of PM than typical urban environmental air pollution.[38] In Brazil, fires are the biggest cause of air pollution.[35] The increase in deforestation has reached records since 2016.[53]
- Coal is a major source of greenhouse gases and PM. The total supply of primary energy from coal in Brazil has tripled in the last 40 years. It is estimated that coal combustion was responsible for more than 440,000 premature deaths worldwide in 2016.[29] Without the elimination of coal use, the Paris Agreement's goal of stopping global warming by up to 1.5°C cannot be met.[45]

It should also be noted that there are risks of household pollution caused mainly by burning solid fuels in homes. Commonly used in rural areas, "wood stoves" need to be taken into account by FM professionals in the clinical approach to air pollution[33]. Risk mitigation at the household level may be the primary option when emissions cannot be controlled at the source, such as during wildfires.[33] In most

Table 2. Main air pollutants and their sources.

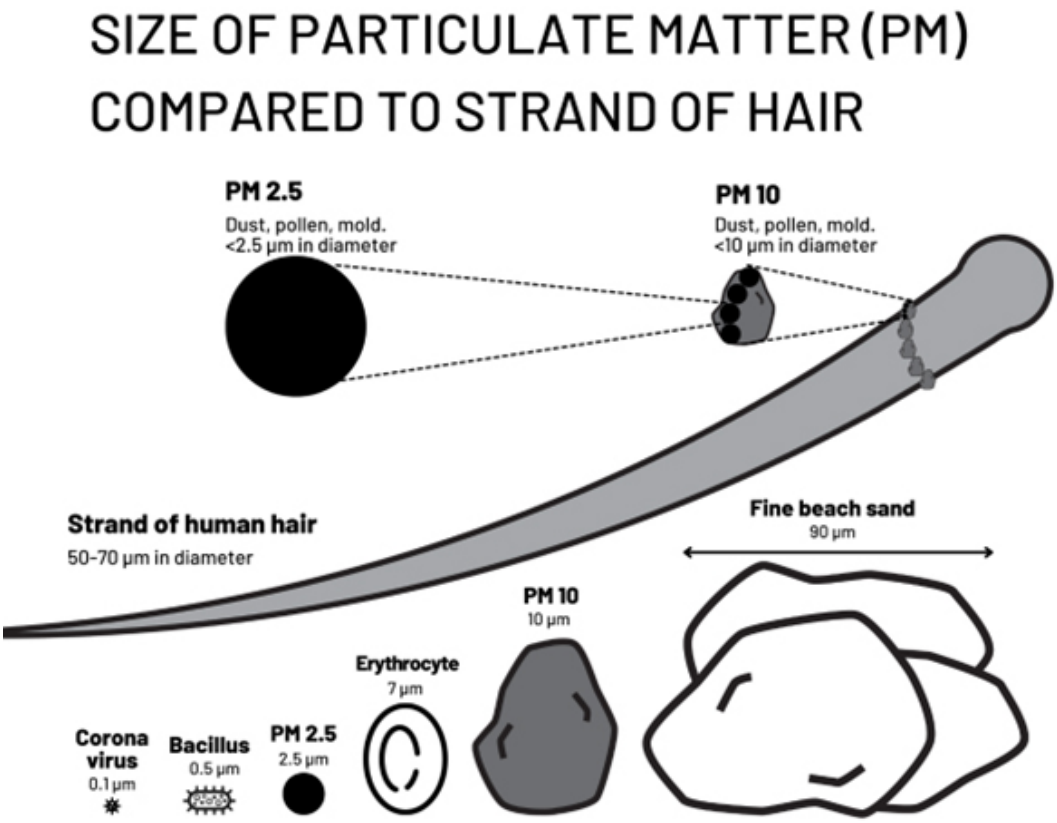
Common air pollutants and their sources.		
Pollutant	**Description**	**Sources**
Particulate matter (PM)	PM is the most often cited pollutant regarding health effects.	• Burning of fuel (motor vehicles, boats, rail transport, aircraft, domestic heating, energy production [e.g., coal]), industrial processes and any other burning (e.g., waste incineration, log burning, wood stoves/fireplaces) • Pollen and other bioaerosols • Dirt roads (mostly coarse particles) • Wind-blown dust (mostly coarse particles) • Tire abrasion on floors (mostly coarse particles) • Construction work (mostly coarse particles) • Secondary formation via chemical reactions in the atmosphere (mostly fine particles)
Ozone (O_3)	Ozone, a colorless gas, is an important constituent of the upper layers of the atmosphere (the ozone hole). At lower levels, where we live and breathe, tropospheric ozone is a powerful oxidant when inhaled.	Ozone is a secondary pollutant, formed through photochemical reactions between nitrogen oxides and volatile organic compounds in the air, requiring heat and sunlight (higher in summer afternoons).
Nitrogen oxides (NO_x)	NO_x contribute to ozone formation at the soil level and secondary particles.	• Thermal electricity generating stations and large heating boilers • Motor vehicle exhaust • Other transport sources (planes, trains, sea vessels) • Ice resurfacing equipment, propane-powered forklifts • Gas stoves • Secondary formation via chemical reactions in the atmosphere
Sulfur dioxide (SO_2)	SO_2 is harmful to humans and, like acid rain, causes damage to ecosystems.	• Burning of sulfur-containing fuels (especially coal, fuel oil and, to a lesser extent, diesel) • Vessels that burn residual fuel oil • Sintering process used in metal smelting (which involves roasting metal sulfur ores in a stream of air)
Carbon monoxide (CO)	CO is a colorless and odorless gas. Because of its high affinity for hemoglobin, CO makes it difficult to transport oxygen.	It is produced by incomplete combustion of fossil fuel or wood and can accumulate mainly indoors, being detrimental to health. • Motor vehicles (especially at low temperatures and in garages and traffic tunnels) • Home heating systems • Wood stoves

Source: Abelsohn et al.[39]

cases, however, individual and household-level interventions should be complementary to government policies related to reducing emissions, which benefit entire communities.

Clinical recommendations in primary health care

The patient's exposure to air pollution should be considered, both at home and at work. For example, truck drivers are more exposed to air pollution, especially in relation to diesel engines.[54,55] There is evidence of increased risks to drivers, for example, of the development of lung cancer related

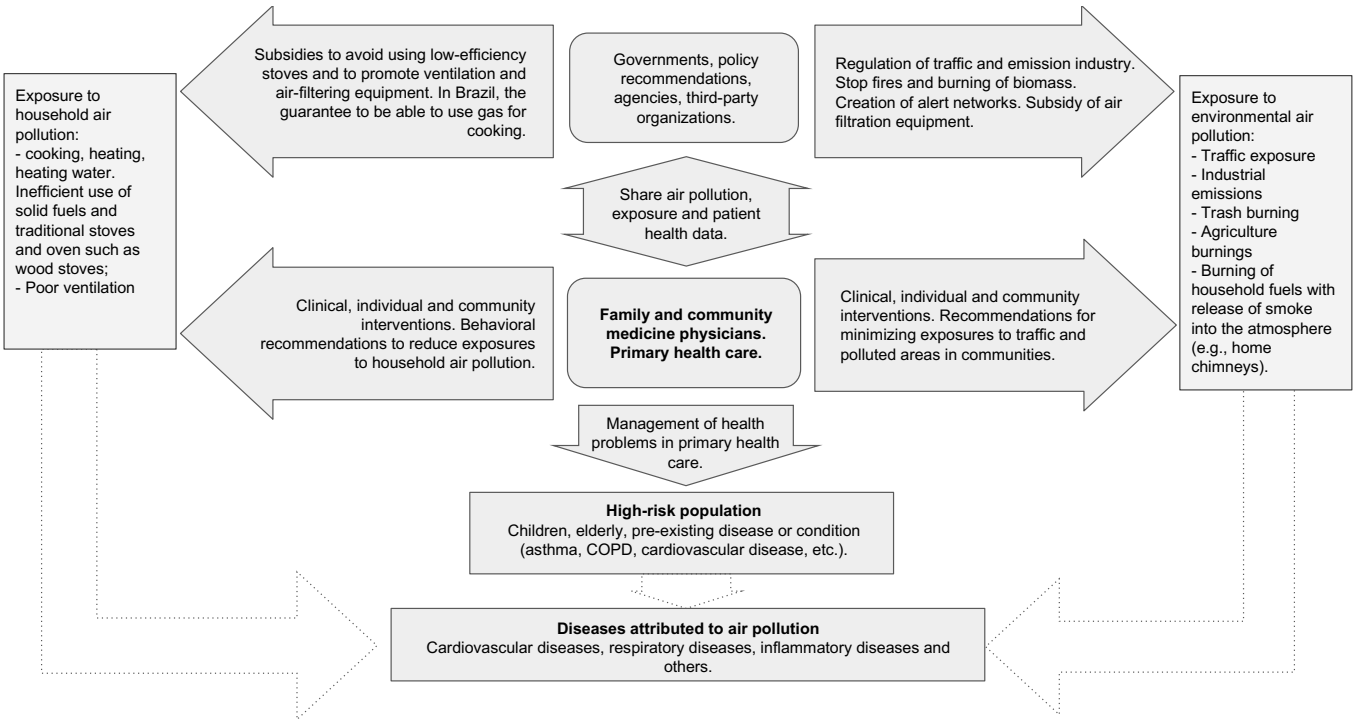


Source: Ilgenfritz et al.[44]
Figure 3. Size of particulate matter compared to a strand of hair.

to air pollution.[54,55] Another study using autopsies revealed that one hour of commuting in transit during the active life of a resident of the capital of São Paulo is equivalent, in terms of pulmonary anthracosis, to smoking five cigarettes a day.[56] In these cases, clinical recommendations must be discussed, for example, in regard to wearing an N95 mask for prevention.[40] Patients who live near roads or who cook with inefficient stoves should also be informed of the risks.[33,34] Consideration should be given to the possible social context of reducing exposure to air pollution. Depending on the location of the Health Care Unit and of the community, community actions should also be considered, such as the construction of indoor spaces with air filtration and green areas to reduce the risk of adverse events from air pollution exposure.[29,34,35]

The approach of governments, policy recommendations, agencies and third-party organizations must also be considered.[11,39] The main focus of these negotiations should be to reduce air pollution and create healthier environments, stimulating public policies to control air quality (Figure 4).[39]

Groups vulnerable[39] to air pollution, both household and environmental, include: children[57] (in which pollution, in addition to being associated with infections and respiratory diseases, is related to neuropsychological effects, including attention deficit hyperactivity disorder [ADHD], autism, school performance and memory[38]), the elderly, people with a preexisting disease or condition (for example, patients with asthma,[58] bronchitis,[59] COPD[37,60-62], cardiovascular disease[63] or diabetes[13]) and pregnant women[62] (due to the risk of causing low birth weight). Some people will be at greater risk (more vulnerable) because of living in areas of higher concentrations[38] (patients close to areas of burning or biomass



Source: Adapted from Hadley et al.[11]

Figure 4. Conceptual diagram illustrating the effects of indoor household air pollution, outdoor air pollution, and risk factors that contribute to adverse clinical events. Family and community physicians and primary health care, governments, policy recommendations, agencies and third-party organizations, through dialogue and with evidence, should adopt a transdisciplinary approach to improve cardiovascular and lung health by promoting reductions in exposures to air pollution and underlying risk factors.

burning, or areas of intense traffic), social risks[33] (for example, burning their own garbage and the need to use firewood or other materials for cooking, heating and/or light up) and occupational hazards[54-56] (for example, drivers, people who work in coal plants, people who work with biomass burning such as in sugarcane fields or gardens). Although there are still no reviews that cite other specific populations, such as homeless people and indigenous populations, we recommend assessing the risks according to the contexts. Air pollution is also related to depression,[64] so checking both environmental and household pollution in patients presenting with symptoms of depression is important.[65]

Essential topics

It is important to think about three main points for making decisions with patients: awareness of the problem, personal protection (use of masks) and exposure reduction. FM practitioners can recommend changes in individual behavior that promote healthier and more sustainable lifestyles, many of which can be justified by their likely co-benefits, which go beyond the relationship with air pollution, also linking to climate change. This includes adopting healthy diets, with less environmental impact, and active transport. Beyond the individual level,[41] community approaches are needed both to communicate the risks of air pollution and to think about protective places such as creating green spaces, preventing forest clearing[35] and raising awareness.

It is important to emphasize that policies to reduce air pollution are essential, and that individual and community recommendations should not transfer responsibility of environmental protection from governments to individuals.[40,45] A list of clinical recommendations follows:

- Since many people spend most of their time indoors, it is necessary to reduce the production of indoor pollutants, such as burning wood and other solid fuels, and/or use more efficient stoves and fireplaces.[33,46,60,66] It is important to think of ways to ensure access to clean forms of energy for cooking, heating and lighting.[33,67,68] It is clear that issues such as financial limitations and cultural competence must be taken into account.[33]
- If there is production of indoor pollutants, their inhalation should be reduced, by guiding patients to check the ventilation system of the place and to allow air out of the indoor environment by opening doors and windows regularly.[33,46,60,66] Indoor air filtration could be recommended as an environmental control measure for patients with chronic respiratory diseases, especially in homes. Financial barriers and feasibility must be considered.[37] Inside automobiles, the use of an air filter (inside ventilation) and closing windows can be recommended.[40,67] In communities with air quality monitoring, patients can check the hours with lower air pollution peaks, measured by local monitors, and patients can be guided to ventilate the house and do physical activity, especially at these times.
- During episodes of forest fires or bushfires, community members should primarily remain indoors and ideally use air filters.[37] Air filters (electrostatic air filter, high efficiency air filter — HEPA) can reduce pollutant particles effectively and, consequently, reduce the adverse effects on the health of the lower respiratory tract.[37,44,45] Special groups are considered more susceptible, such as rural populations, including indigenous populations, and other vulnerable populations close to fire areas.
- Public facilities such as schools[39] must have their air quality measured. Special attention must be given to schools, health care units and other services close to areas with high traffic or biomass burning. Rural schools close to sugarcane fields or plantations where there are burnings, or even in places with forest burning, should be advised to implement air filtration. This is also because children have difficulties using masks, and also N95 masks need to have adequate face covering to be effective.[40]
- Active transport should be encouraged, such as the use of bicycles (and the like), longer walking or public transportation, and the use of low-carbon and less-polluting modes of transport should be advised; in addition to the benefit for the ecosystem, the patient also benefits.[44,45]
- Community awareness of household air pollution and environmental pollution can be increased through educational activities, depending on the context of each community.[44,45]
- It is important to provide specific guidelines, such as avoiding the burning of garbage, in addition to encouraging waste separation, recycling and reuse. Where incineration is unavoidable, combustion technologies with strict emission controls are essential.[33,34]
- Smoking cessation should be encouraged, as well as the reduction of other risk factors for cardiovascular and respiratory diseases. Smoking itself is one of the sources of air pollution, both indoors and outdoors, as well as having its own pathogenic role.[37]

How to include air pollution in the clinical interview?

Although it has not yet been validated, a tool with three clinical questions for evidence-based screening is proposed to identify patients exposed to dangerous levels of air pollution, especially in relation

to cardiovascular risk.[11] For questions answered yes, there are other questions that explore the types of exposure. The aim of the tool is to help elucidate factors that may exacerbate exposures and guide patient recommendations (Table 3).

Table 3. Clinical screening tool for identifying risk from air pollution.

Clinical screening tool for identifying risk from air pollution Affirmative answer for any of these questions is associated with increased cardiovascular risk of the person.		
Household air pollution		
Do you burn solid fuels (e.g., firewood, charcoal, manure, agricultural waste, kerosene or garbage) in your home for cooking, heating, lighting or other purposes?	Yes	No
If "yes"	*What kind of fuel do you use?* *What kind of stove to you have in your home?* *How often do you burn solid fuels?* *How long do you spend around the fire?* *Do you burn solid fuels indoors?* *How do you vent smoke in your home?*	
Environmental air pollution (outdoors)		
Do you live or work in an urban industrial center?	Yes	No
If "yes"	*Are you aware of any sources of pollution near your home?* *Do you perform physical activity/effort outdoors?*	
Are you exposed to forest fires or agricultural fires?	Yes	No
Do you spend time around heavy traffic (e.g., on roads, working at traffic lights, living on the street, driving)?	Yes	No
If "yes"	*Do you travel in heavy traffic?* *Are you exposed to the open air (windows open) while commuting/driving?* *Do you live near a road with heavy traffic?*	

Source: Adapted from Hadley et al.[11]

Use of masks

Wearing mask equipment (N95 mask or equivalent) can be helpful in avoiding the harmful effect of environmental air pollutants.[37,40,46] Therefore, in addition reducing the transmission of COVID-19 in the pandemic, they can also reduce the adverse effects of air pollution. Surgical mask and face mask are designed to prevent and avoid the spread of aerosol droplets and can only prevent inhalation of large PM, usually hundreds of microns in size; they are of no use in preventing the inhalation of fine particles such as $PM_{2.5}$.[37]

Masks can be divided into at least two categories.[37] One type works by mechanical filtration that reduces PM and the other absorbs gaseous chemicals through the activated carbon inside. The N95 and R95 face masks are efficient filter masks that can absorb up to 95% of the airborne particles in the inhaled air.[47] However, the disadvantage of these types of masks is that they are uncomfortable because they have high respiratory resistance, do not last long and produce garbage.[37,40,46,47]

The efficiency of air filtration and chemical absorption is reduced when the protection measure is used beyond a certain period of time, as specified by the manufacturer. In addition, frequent replacement of these masks can be expensive. It is important to note that there is no consensus on how to guide patients. In this sense, sharing the decision with them is the best way.[37]

Physical activity

Air quality and advice to reduce physical activity may conflict with broader recommendations that promote physical activity.[39] Thus, the decision-making should be shared with the patient and the benefits and harms of reducing physical activity should be considered. If possible, the patient is advised to consider air quality when planning physical activity. People who can change the location or time of exercise may wish to reduce these risks by exercising away from heavy traffic and industrial locations, especially during rush hour and other times when air pollution levels are known.[43] If air quality is monitored, the patient can be advised to check the levels of pollution to find the best time for their physical activity. Coaches, athletes, people who exercise more often and people with comorbidities (children and adults with asthma, COPD or cardiovascular disease) should be aware about the impacts and best times for physical activity.

COVID-19 and air pollution

There is a contribution of chronic exposure to air pollution to the spread and lethality of COVID-19, although the potential effect of exposure to the virus carried by air pollution has not yet been demonstrated.[48,49] It appears, in particular, that $PM_{2.5}$ and NO_2 are most closely correlated with COVID-19,[49] with a recent study showing association of air pollution with up to 15% of COVID deaths.

In addition, air pollution and COVID-19 may be associated through the impact of air pollutants on NCDs. Experimental studies have shown that exposure to air pollution leads to a decrease in the immune response, facilitating viral penetration and replication.[48] Viruses can persist in the air through complex interactions with particles and gases, depending on:

1. chemical composition;
2. electrical charges of particles; and
3. meteorological conditions such as relative humidity, ultraviolet (UV) radiation and temperature.

In addition, by reducing UV radiation, air pollutants can promote viral persistence in the air and reduce vitamin D synthesis.[48]

Air quality monitoring and community approach

FM doctors have an important role in managing the health effects of air pollution, both clinically and in their communities. Reducing the risk of developing air pollution-related conditions requires multisectoral policies and programs to reduce emissions and exposures from air pollution at the local, regional and international levels.[11,34,39] The greatest benefits can be achieved through partnerships across relevant sectors to regulate emissions, enforce air quality standards, share exposure data, provide personalized patient interventions, and subsidize technologies to reduce patient exposure.[11]

Collaboration between health professionals, civil society and the university can be helpful.[34] A group of doctors in Porto Alegre, Brazil, where there was no official monitoring of air quality, met with engineers from the Federal University of Rio Grande do Sul and civil society and built low-cost sensors, for less than R$ 1,100.00 each (approximately 250-300 USD), They were installed in community health centers to monitor the local air pollution.[44] Air quality monitoring is an important tool for understanding, communicating and motivating improvement in air quality.[34,44]

The Air Quality Health Index (AQHI) was created in 2008 in Canada. It it is calculated on the basis of $PM_{2.5}$, ozone and nitrogen dioxide levels and reports the risk to health from air pollution for the current day and the next day, on a color scale from 1 to 10, based on guidelines for short-term exposure to these pollutants by the general population and high risk groups. Canadian FM doctors are able to advise patients to reduce their outdoor exposure and their high-performance activities (as exercise increases the respiratory rate) at that location and time, to reduce the amount of pollutants that will enter the lungs and their bodies.[39] These recommendations are based on the individual risk profile with the idea of protecting health by reducing exposure to pollutants. Clinical advice of this type is recommended in clinical practice guidelines for the management of asthma and respiratory and heart disease.[39] The scale can be easily explained to people at risk, for example in an asthma action plan or asthma education.[39] It is important to point out that there is no international standardization in these recommendations, and that these approaches still need more research to establish their cost-effectiveness.

Community actions developed by doctors to raise awareness and demand studies and solutions to protect populations at risk have high credibility and potential. An example of this is the network of local doctors in Rio Grande do Sul, Medicina em Alerta, which is concerned with the risks that the installation of the largest open-pit coal mine in Brazil could bring, especially when it is less than 20 km from the capital of Rio Grande do Sul.[69]

The creation of greener and healthier environments is an essential part of the community approach, in addition to improving NCDs. It is also a way of promoting mental health.[25,34,35]

Future perspectives of research that can be conducted in primary health care

More research is essential to identify interventions that reduce exposure to pollution and the risk of clinical outcomes, as well as the development of public policies — particularly in LMICs.[34] The field of PHC is essential as it is potentially closer to polluting sources, as well as being able to be a space for the awareness of patients and communities about the risks of air pollution and air quality as a health determinant. The inclusion of planetary health as an attribute of PHC can also facilitate actions to reduce air pollution and its effects on human health.[70,71] The need to use reliable and standardized measurement methods should be emphasized.[36] The role of FM professionals in these contexts is essential to motivate research in clinical, community and epidemiological aspects (Table 4).

Also noteworthy is the educational scope and role of FM both in the training of new professionals (undergraduate) and in the areas of preceptorship and training and continuing education of FM physicians.

Limitations

There is still ample room for research to think about air pollution in clinical practice. This scoping review points out essential research points and weaknesses such as the lack of articles focused on PHC and the Latin American context. There are still few clinical recommendations for dealing with air pollution in clinical practice and even less in the context of FM, with most of the evidence in this study being indirect. It is suggested that a systematic review be carried out using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) criteria and the quality of evidence performed to further improve decision-making by professionals in relation to air pollution. In researching this topic, the subject is limited to a secondary or indirect character in the databases such as the British Medical Journal

Table 4. Research areas and perspectives that can be carried out in the PHC.[11,34,36,37,44,45]

Develop and validate screening tools
Develop screening questions for pollution exposure
Develop risk calculator for individual cardiovascular risk attributable to pollution (similar to 10-year risk calculator for atherosclerotic cardiovascular disease)
Pollution exposure risk maps searchable by patient address and/or georeferencing of regions most affected by air pollution and identification of patients at risk
Analysis of blood samples and/or urinary and exhaled exposure biomarkers (e.g., hydroxylated polycyclic aromatic hydrocarbons)
Characterize exposure-response relationships for populations and individuals
Effect of household air pollution on cardiovascular events
Effect of $PM_{2.5}$ from different fuel sources on cardiovascular events
Effects of air pollutants from non-particulate matter (e.g., CO, NO2, SO2, ozone and by-products of burning fossil fuels)
Effects of exposure to occupational air pollution on cardiovascular events
Effects of ambient air pollution and household air pollution studied as composite risk factors
Effects of pollution on clinical outcomes
Subgroup analyses by geography, socioeconomic status and traditional cardiovascular risk factors
Document and identify effective interventions
Clean stoves and fuel combinations for cooking and heating at home
Pollution monitors and warning systems for homes, vehicles and personal electronic devices
Indoor air filtration systems and better home and vehicle ventilation
Analyze the use of face masks when cooking or outdoors on polluted days
Drug approaches to reducing the impact of air pollution
Improvement of clinical approaches to air pollution and literature reviews
Development of community tools to address air pollution
Development of curricula in medical education (undergraduate and graduate, including residency) that include aspects of air pollution
Development of policy recommendations and their translation into clinical practice
Assess the risk of specific populations, such as indigenous people and homeless people

(BMJ) and DynaMed, being restricted to the role of risk factor for diseases rather than the main subject of a topic, as in the comparative example of smoking.

CONSIDERATIONS

FM has an important role to play in managing the health effects of air pollution, both clinically, in the office, and in their communities. The World Health Organization recommends 5 $\mu g/m^3$ as the maximum average annual exposure level to fine particles ($PM_{2.5}$) and 15 $\mu g/m^3$ as a 24-hour average[34]. However, it is known that there is no cut-off point where there is no risk; that is, the lower the levels of air pollution, the better the cardiovascular and respiratory health of the population, both in the long and in the short term. As promoters of evidence-based interventions, FM and PHC professionals can use their influence to support air pollution emission reduction and climate change mitigation actions that bring health benefits.[41]

Including air pollution as a risk factor, explicitly, in all discussions on the etiopathogenesis of diseases related to NCDs, both clinically and in research, is a way to promote the subject. It is also proposed to include the item "exposure to air pollution" in the International Classification of Primary Care (ICPC), as well as in the International Classification of Diseases (ICD), explicitly and not restricted to occupational hazards. This could improve reporting and epidemiological studies on the subject.

In the context of the SARS-CoV-2 pandemic and the evidence on the connections between air pollution and the aggravation of COVID, it is important to reflect on healthy recovery from the pandemic, endorsed by entities that represent around than 40 million health care professionals worldwide. This recovery pragmatically places health and the environment at the center of the economic recovery from COVID-19.[72] The role of FM is highlighted in this scenario of air pollution,[73] inviting professionals to approach the concepts of planetary health.

The scoping review of this article can be considered a precursor for future reviews and primary research, including clinical trials, as it allows the identification of a lack of evidence. In addition it illuminates the strategic role of PHC for future research. Future reviews should also include indoor air pollution. Indoor air quality is complicated by regulatory aspects that include other exposure parameters, including chemical pollutants, microbiological parameters (bacteria and fungi), as well as standards to consider for the influence of ambient air in indoor air. Particularly in light of the pandemic, an analysis aimed at clinical recommendations related to SARS-CoV-2 transmission and indoor air quality is also required.

CONFLICT OF INTERESTS

Nothing to declare.

AUTHORS' CONTRIBUTIONS

MF: Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review and editing. RBZ: Conceptualization, Data Curation, Formal Analysis, Writing – original draft, Writing – review and editing. JRBL: Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review and editing. CVL: Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review and editing. NV: Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review and editing. EFB: Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review and editing. PHNS: Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review and editing.

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