



Early View

Editorial

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Please cite this article as: Andersen ZJ, Gehring U, De Matteis S, *et al.* Clean air for healthy lungs – an urgent call to action: European Respiratory Society position on the launch of the WHO 2021 Air Quality Guidelines. *Eur Respir J* 2021; in press (<https://doi.org/10.1183/13993003.02447-2021>).

This manuscript has recently been accepted for publication in the *European Respiratory Journal*. It is published here in its accepted form prior to copyediting and typesetting by our production team. After these production processes are complete and the authors have approved the resulting proofs, the article will move to the latest issue of the ERJ online.

Clean air for healthy lungs – an urgent call to action: European Respiratory Society position on the launch of the WHO 2021 Air Quality Guidelines

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The 'take home' message:

Air pollution poses major burden to lung patients and current legislation fails to protect them. We call for urgent action and alignment of air quality standards with WHO Guidelines, to ensure healthier lungs and simultaneously tackle the unprecedented climate change crisis.

Aim

This statement outlines how air pollution affects patients with lung disease, highlights the main messages of the newly released 2021 World Health Organization (WHO) Air Quality Guidelines, points out how the ambitious European Union Green Deal can provide solutions through a modern air quality legislation, and discusses the role of respiratory clinicians in improving air quality-related lung health.

Burden of Air Pollution is Enormous and Increasing

Air pollution is a major risk factor to public health globally, contributing to morbidity and mortality from respiratory, cardiovascular and cerebrovascular disease, and lung cancer [1]. Every year, air pollution leads to 509,000 premature deaths in Europe and serious aggravations of lung and heart diseases that affect millions of children and adults [2]. Because of the links with multiple diseases and the ubiquitous nature of the exposure, air pollution is the 4th leading risk factor for morbidity and mortality in the 2019 Global Burden of Disease study, surpassed only by high blood pressure, tobacco use, and poor diet [3]. Moreover, as we are learning more about the effects of air pollution on health outcomes such as diabetes, neurodegenerative diseases, neonatal deaths, cancers other than lung, etc., our estimates of disease burden caused by air pollution are still rising [3].

Respiratory Patients are Susceptible to Adverse Effects of Air Pollution

Respiratory disease patients, both children and adults, are arguably the most susceptible to the effects of air pollution. The respiratory tract is the first portal of entry for air pollutants and consequently the effects of air pollution on the respiratory system have been studied most intensively for decades [4, 5]. Air pollution affects lungs starting in pregnancy and continuing throughout the entire lifetime. Typical biologic effects of air pollution include a suppressed immune system [6–9], inflammation and oxidative stress effects, impaired lung growth in children [10, 11], lung function decrements in children and adults, and carcinogenic effects [12, 13]. Thereby, long-term exposure to air pollution in healthy people increases risk of development of new respiratory diseases, such as asthma in children [14] and adults [15], chronic obstructive pulmonary disease [16], acute lower respiratory infections [17], and lung cancer [17, 18], and it increases the risk of premature death due to respiratory or cardiovascular disease [19]. Furthermore, air pollution presents a substantial burden in the daily life of respiratory disease patients, where exposure to short-term peaks in air pollution can trigger exacerbations of manifest disease, such as asthma attacks, increased use of relieve medication, emergency room visits, hospitalizations, and even death [4, 5]. Finally, people with respiratory disease are more susceptible to develop other diseases which have been linked to air pollution, such as cardiovascular diseases, diabetes, neurodegenerative diseases, etc. [1].

Most recently, emerging evidence is also showing that air pollution likely contributes to the risk of hospitalization and death from COVID-19 [20, 21]. Of note, the current COVID-19 pandemic has added another group of potentially susceptible patients, including not only COVID-19 cases, but also the so called 'long-COVID-19' patients, denoting COVID-19 survivors with one or more disease signs/symptoms (e.g. an impaired lung function, decreased diffusing capacity of the lung for carbon monoxide - DLCO, and persistent dyspnea) ≥ 12 weeks after recovery, where air pollution related inflammation may play a role in disease prognosis [22].

As everyone is exposed to varying levels of air pollution, and prevalence of potentially impacted health outcomes is high - the burden of air pollution on respiratory diseases is huge. The traffic-related air pollutant nitrogen dioxide (NO₂) has been estimated to be associated with 4 million or 13% of all new asthma cases in children, globally every year [23]. Similarly, 40% of COPD deaths, 30% of ALRIs deaths, and 19% of all lung cancer deaths globally have been estimated to be attributable to total air pollution [1] A recent coroner's ruling in a landmark case in London, UK, acknowledging air pollution as a primary cause in the death of Ella Kissi-Debrah, a 6-year-old severe asthma patient, has major significance in recognizing the severe health consequences of air pollution. The ruling stated that Ella's death in

February 2013 was caused by acute respiratory failure, severe asthma, and air pollution exposure to traffic-related NO₂ and particulate matter (PM) pollution around her home, which exceeded the WHO guidelines [24]. The ruling also stated that the failure to reduce pollution levels to legal limits, as well as the failure to provide her mother with information about the potential for air pollution to exacerbate asthma, possibly contributed to Ella's death. This is the first ruling of its kind globally, that has referred to air pollution as a public health emergency. It will likely play a role in increasing pressure on governments to tackle unlawful levels of air pollution, as well as on respiratory clinicians to better inform their patients on harms related to air pollution.

European Union Air Quality Legislation and WHO Air Quality Guidelines

European Union policy on air quality includes ambient air quality directives that set air quality standards to provide protection from excessive pollution concentrations in the entire Union and thereby protect the health of European citizens. The EU's Ambient Air Quality Directives (AAQD) (2008/50/EC Directive on Ambient Air Quality and Cleaner Air for Europe and 2004/107/EC Directive on heavy metals and polycyclic aromatic hydrocarbons in ambient air) set legally binding pollutant concentration thresholds, so called limit values that shall not be exceeded in a given period of time (Table 1). For the assessment of the health-related scientific basis, the EU relies on the World Health Organization and its Air Quality Guidelines on outdoor air pollution. However, while the 2005 WHO Guidelines already recommended that annual average concentrations of PM_{2.5} should not exceed 10 µg/m³ and annual average concentration for NO₂ should not exceed 40 µg/m³, the currently still effective limit values of 2008 were set at 25 µg/m³ and 40 µg/m³, respectively. Therefore, while following the 2005 WHO recommendations for NO₂, the high limit value for PM_{2.5} already refutes the EU's overarching aim of comprehensive protection.

In September 2021, the WHO has updated its 2005 recommendations, providing a comprehensive synthesis of the research on the health effects of air pollution, including extensive amount of high quality evidence that has been published during last 15 years (REF TO NEW GUIDELINES TO BE ADDED). The new WHO 2021 Air Quality Guidelines make a historically bold statement, by setting strikingly lower recommendations than those set in 2005, with greatest changes for annual average concentrations of PM_{2.5} set at 5 µg/m³ and for NO₂ set at 10 µg/m³ (Table 1). The new Guidelines also highlight the linear exposure-response relationship of air pollution with mortality and other major health effects, down to the lowest observable concentrations. Most importantly, this implies that any improvements in air quality will result in health benefits, even at concentrations well below current or future limit values [19]. The new Guidelines also point to increasing evidence for adverse health effects of air pollution well and far beyond those on the cardio-respiratory system, acknowledging new associations with diabetes, neonatal deaths, and increasing research on cognitive development, neurodegenerative diseases, cancers other than lung, and even psychological disorders. The main messages of the updated WHO Air Quality Guidelines are clear and alarming - there are no levels of air pollution below which air pollution is safe for human health.

How do we move forward?

The European Commission has adopted the European Green Deal (EGD) in December 2019 as a strategy to be the first climate neutral continent in the world. An integral part of the EGD is a 'Zero Pollution Ambition', at the core of which is clean air. Within the EGD, the European Commission proposed in 2019 to revise its air quality standards and committed to align them more closely with the WHO Air Quality Guidelines. Now, even more so than before, the new Guidelines clearly expose the large gap between evidence-based recommendations for air quality and current EU limit values for major pollutants.

While many EU member states today comply with most of the current legally binding fixed limit values, the new Guidelines clearly show that this is not enough to protect the health of EU citizens. The new WHO Guidelines provide the comprehensive evidence on health effects at levels well below current limit values that is needed to fundamentally revise our thinking about air quality regulation. So far, most air quality legislations like the EU AAQD have adopted fixed limit values, which offer little benefit to those citizens already living at concentrations below these limit values. For a more efficient protection of health, an incremental reduction of the exposure of the entire population is crucial. The European Commission had already recognized this in 2008 and included a so-called average exposure indicator for PM_{2.5} in its 2008 AAQD. However, no binding targets for reduction were set, rendering this potentially very effective instrument a toothless tiger. For an efficient and effective prevention of air pollution-related diseases, a combination of legally enforceable fixed limit values and legally enforceable reductions of average population exposure is mandatory. An example of enforcement measure could be EU financial penalties on member countries not preparing and following through on implementation plans to meet the air quality standards.

The Guidelines were delivered just in time for legislative action and for a fundamental revision of air quality policy in the EU. The time to act and deliver an ambitious air quality legislation in Europe as an example for actions around the globe is now. The Guidelines serve as wake-up call to act now to call for and implement bold policies and structural changes in our cities, transportation, industry, agriculture, and energy systems to ensure long-term reductions in air pollution. Cleaner air will provide immediate health benefits to all European citizens, ensure healthier lungs, prevent a substantial number of new respiratory diseases, and provide for a better life of patients with lung diseases. Furthermore, clean air policies have important co-benefits in tackling the unprecedented and irreversible climate change crises [25] we are facing, making them central to ensuring a healthier and more resilient environment, planet and populations. Health care professionals need to play a central role in informing and advising patients about the harms related to air pollution and together with their patients, present an important voice demanding cleaner air for healthier lungs.

What can respiratory clinicians do?

Clinicians' role is key both for prevention and management of respiratory health effects associated with air pollution exposure. They are the 'first line' source of scientifically reliable information for patients who are often overwhelmed, and sometimes misinformed, by the plethora of opinions provided on social media, and crave for clear advice from real experts. Moreover, health care professionals are the prime advocates of their patients for clean air policies and should raise their voices for effective prevention and protection from environment-related harm.

To be able to fulfil this role, we recommend:

- Inclusion of environment-related health issues in the core medical training of future health care professionals
- Inclusion of environment-related health issues in continuing medical education courses, provided, for example, by medical societies
- Clinicians always to ask their patients about environmental exposures, in addition to questions about active and second-hand tobacco smoking
- Development of evidence-based clinical guidelines for treatment and prevention of environment-related disease
- Advocating for appropriate reimbursement policies by health insurances for guideline-recommended personal protection devices
- Engagement with patient representatives for awareness raising, educating and advising patients, specifically the most susceptible and vulnerable patient groups
- Raising their voices for clean air policies as advocates of their patients' health

Who we are

The European Respiratory Society (ERS) is an international organization that brings together physicians, other healthcare professionals, epidemiologists, patient representatives, scientists and other experts working in respiratory medicine. We are one of the leading medical organizations in the respiratory field, with a growing membership representing over 160 countries. Our mission is to promote lung health and alleviate suffering from disease, and drive standards for prevention of respiratory diseases as well as respiratory medicine globally. Science, education and advocacy are at the core of everything we do. This position was developed and led by the ERS Environment and Health Committee and the European Lung Foundation.

Conflict of Interest Statement

Ulrike Gehring, Sara De Matteis, Erik Melen, Ana Maria Vicedo-Cabrera, and Charlotte Suppli Ulrik declare no Conflict of Interest. Zorana Jovanovic Andersen and Klea Katsouyanni are members of the WHO Global Air Pollution and Health (GAPH) Technical Advisory Group. Zorana Jovanovic Andersen and Arzu Yorgancioglu hold unpaid positions in the European Respiratory Society. Kjeld Hansen holds unpaid positions with the European Respiratory Society and European Lung Foundation. Pippa Powell is employed by the European Lung Foundation. Brian Ward is employed by the European Respiratory Society. Sylvia Medina is an employee of Santé publique France. Barbara Hoffmann is a member of the research committee of the Health Effects Institute, Boston, USA.

Table 1. Comparison of limit values set by the 2008 EU Ambient Air Quality Directive and WHO Air Quality Guidelines 2005 and 2021 for several major pollutants.

		EU Air Quality Directives	WHO 2005 Air Quality Guidelines	WHO 2021 Air Quality Guidelines
<i>Pollutant</i>	<i>Averaging period</i>	<i>Objective and legal nature: concentration</i>	<i>Concentrations</i>	<i>Concentration</i>
PM _{2.5}	Annual	Limit value: 25 µg/m ³	10 µg/m ³	5 µg/m ³
PM _{2.5}	Daily (24-hour)	Limit value: -	25 µg/m ³	15 µg/m ³
PM ₁₀	Annual	Limit value: 40 µg/m ³	20 µg/m ³	15 µg/m ³
PM ₁₀	Daily (24-hour)	Limit value: 50 µg/m ³	50 µg/m ³	45 µg/m ³
NO ₂	Annual	Limit value: 40 µg/m ³	40 µg/m ³	10 µg/m ³
NO ₂	Daily (24-hour)	Limit value: 50 µg/m ³	-	25 µg/m ³

Source: Air Quality Directives (2008/50/EC, 2004/107EC); WHO, 2006, Air quality guidelines: Global update 2005; WHO 2021 Air quality guidelines: global update 2021.

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