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

Zorana Jovanovic Andersen[1], Ulrike Gehring[2], Sara De Matteis[3,4], Erik Melen[5], Ana Maria Vicedo-Cabrera[6,7], Klea Katsouyanni[8,9], Arzu Yorgancioglu[10], Charlotte Suppli Ulrik[11,12], Sylvia Medina[13], Kjeld Hansen[14,15], Pippa Powell[14], Brian Ward[16] and Barbara Hoffmann[17]

[1]Dept of Public Health, Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen, Denmark. [2]Institute for Risk Assessment Sciences (IRAS), Utrecht University, Utrecht, The Netherlands. [3]Dept of Medical Sciences and Public Health, University of Cagliari, Cagliari, Italy. [4]Heart and Lung Institute, Imperial College London, London, UK. [5]Dept of Clinical Sciences and Education, Karolinska Institutet, Södersjukhuset, Stockholm, Sweden. [6]Institute of Social and Preventive Medicine, University of Bern, Bern, Switzerland. [7]Oeschger Center for Climate Change Research, University of Bern, Bern, Switzerland. [8]National and Kapodistrian University of Athens, Medical School, Athens, Greece. [9]Environmental Research Group, School of Public Health, Imperial College London, London, UK. [10]Medical Faculty, Dept of Pulmonology, Celal Bayar University, Manisa, Turkey. [11]Dept of Respiratory Medicine, Copenhagen University Hospital-Hvidovre, Hvidovre, Denmark. [12]Institute of Clinical Medicine, University of Copenhagen, Copenhagen, Denmark. [13]Direction of Environmental and Occupational Health, Santé Publique France, Saint Maurice, France. [14]European Lung Foundation, Sheffield, UK. [15]Kristiania University College, Technology, Oslo, Norway. [16]European Respiratory Society, Brussels, Belgium. [17]Institute for Occupational, Social and Environmental Medicine, Centre for Health and Society, Medical Faculty, Heinrich-Heine-University of Düsseldorf, Düsseldorf, Germany.

Corresponding author: Zorana Jovanovic Andersen (zorana.andersen@sund.ku.dk)

Shareable abstract (@ERSpublications)
Air pollution poses a major burden to respiratory patients and legislation fails to protect them. Urgent action and alignment of air quality standards with WHO guidelines are needed to ensure healthier lungs and tackle the climate change crisis. https://bit.ly/3B04dKB

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Aim

This statement outlines how air pollution affects patients with lung disease, highlights the main messages of the 2021 World Health Organization (WHO) Air Quality Guidelines, points out how the ambitious European Union (EU) 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.

The 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 fourth 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 cancer, *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 biological 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], COPD [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 reliever medication, emergency room visits, hospitalisations, and even death [4, 5]. Finally, people with respiratory disease are more susceptible to development of other diseases that 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 hospitalisation and death from coronavirus disease 2019 (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 patients with "long-COVID", 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, and persistent dyspnoea) $\geqslant$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 (NO_2) 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 acute lower respiratory tract infection 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 recognising 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 NO_2 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.

EU air quality legislation and WHO air quality guidelines

EU policy on air quality includes ambient air quality directives that set air quality standards to provide protection from excessive pollution concentrations in the entire EU 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

TABLE 1 Comparison of limit values set by the 2008 European Union (EU) Ambient Air Quality Directive and World Health Organization (WHO) Air Quality Guidelines 2005 and 2021 for several major pollutants

Pollutant	Averaging period	EU Air Quality Directives (objective and legal nature: concentrations)	WHO 2005 Air Quality Guidelines (concentrations)	WHO 2021 Air Quality Guidelines (concentrations)
$PM_{2.5}$	Annual	Limit value: 25 $\mu g \cdot m^{-3}$	10 $\mu g \cdot m^{-3}$	5 $\mu g \cdot m^{-3}$
$PM_{2.5}$	Daily (24-h)	Limit value: NA	25 $\mu g \cdot m^{-3}$	15 $\mu g \cdot m^{-3}$
PM_{10}	Annual	Limit value: 40 $\mu g \cdot m^{-3}$	20 $\mu g \cdot m^{-3}$	15 $\mu g \cdot m^{-3}$
PM_{10}	Daily (24-h)	Limit value: 50 $\mu g \cdot m^{-3}$	50 $\mu g \cdot m^{-3}$	45 $\mu g \cdot m^{-3}$
NO_2	Annual	Limit value: 40 $\mu g \cdot m^{-3}$	40 $\mu g \cdot m^{-3}$	10 $\mu g \cdot m^{-3}$
NO_2	Daily (24-h)	Limit value: 50 $\mu g \cdot m^{-3}$	NA	25 $\mu g \cdot m^{-3}$

$PM_{2.5/10}$: particles with a 50% cut-off aerodynamic diameter of 2.5 or 10 µm; NA: not applicable. Sources: EU Air Quality Directives (2008/50/EC, 2004/107EC); WHO Air Quality Guidelines: Global Update 2005 [24]; WHO 2021 Air quality guidelines: global update 2021 [25].

health-related scientific basis, the EU relies on the WHO 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 $\mu g \cdot m^{-3}$ and annual average concentration for NO_2 should not exceed 40 $\mu g \cdot m^{-3}$, the currently still effective limit values of 2008 were set at 25 $\mu g \cdot m^{-3}$ and 40 $\mu g \cdot m^{-3}$, respectively. Therefore, while following the 2005 WHO recommendations for NO_2, the high limit value for $PM_{2.5}$ already refutes the EU's overarching aim of comprehensive protection.

In September 2021, the WHO updated its 2005 recommendations, providing a comprehensive synthesis of the research on the health effects of air pollution, including extensive amounts of high-quality evidence that has been published during the past 15 years [25]. The new WHO 2021 Air Quality Guidelines make a historic, 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 $\mu g \cdot m^{-3}$ and for NO_2 set at 10 $\mu g \cdot m^{-3}$ (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 cancer, 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 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, such as 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 already recognised 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 measures 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 a 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 [26] we are facing, making them central to ensuring a healthier and more resilient environment, planet and populations. Healthcare 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?

The role of clinicians is a key one, 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, healthcare 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 healthcare 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 insurance 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 organisation 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 organisations 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.

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