WHO Global Air Quality Guidelines

WHO air quality guidelines and new air quality parameters

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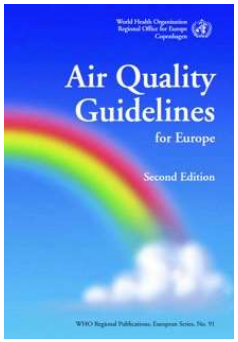
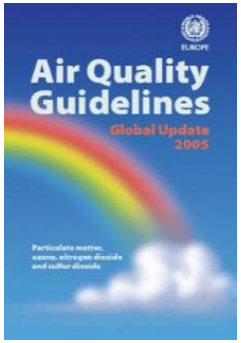
WHO Air Quality Guidelines (AQGs)

1987



2000



2006

2021

Robust public health recommendations

Support informed decision-making

Intended for worldwide use

Comprehensive assessment of the evidence

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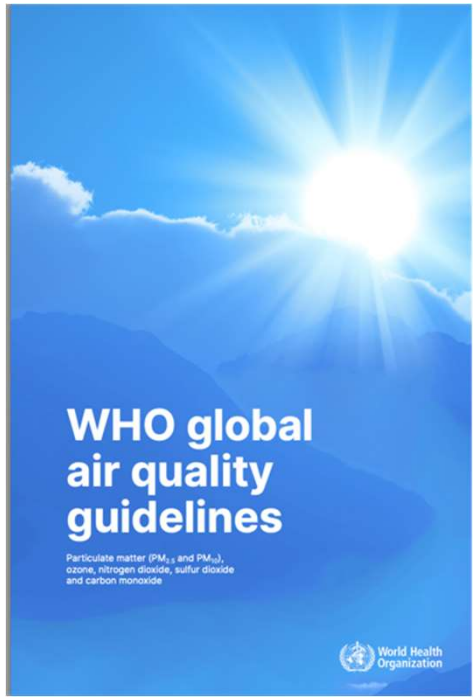
What is new in these AQGs 2021?



- Since the *global update 2005*, there has been a marked increase in the quality and quantity of evidence that shows how air pollution affects different aspects of health.
- There are also now clearer insights about global concentrations, sources of emissions, inequities and the contribution of air pollutants to the global burden of disease.
- For that reason, and after a systematic review of the accumulated evidence, **several of the updated AQG levels are now lower than 15 years ago**.
- Novel features include new AQG levels for peak-season O_3 and 24-h NO_2 and CO, as well as additional interim targets and new good practice statements.

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What do the WHO global AQGs specifically provide?

Summary of recommended AQG levels and interim targets

Pollutant	Averaging time	IT1	IT2	IT3	IT4	AQG level
$PM_{2.5}$, µg/m³	Annual	35	25	15	*10*	5
$PM_{2.5}$, µg/m³	24-hour[a]	75	50	37.5	*25*	15
PM_{10}, µg/m³	Annual	70	50	30	*20*	15
PM_{10}, µg/m³	24-hour[a]	150	100	75	*50*	45
O_3, µg/m³	Peak season[b]	100	70	–	–	60
O_3, µg/m³	8-hour[a]	160	120	–	–	100
NO_2, µg/m³	Annual	*40*	30	20	–	10
NO_2, µg/m³	24-hour[a]	120	50	–	–	25
SO_2, µg/m³	24-hour[a]	125	50	–	–	40
CO, mg/m³	24-hour[a]	7	–	–	–	4

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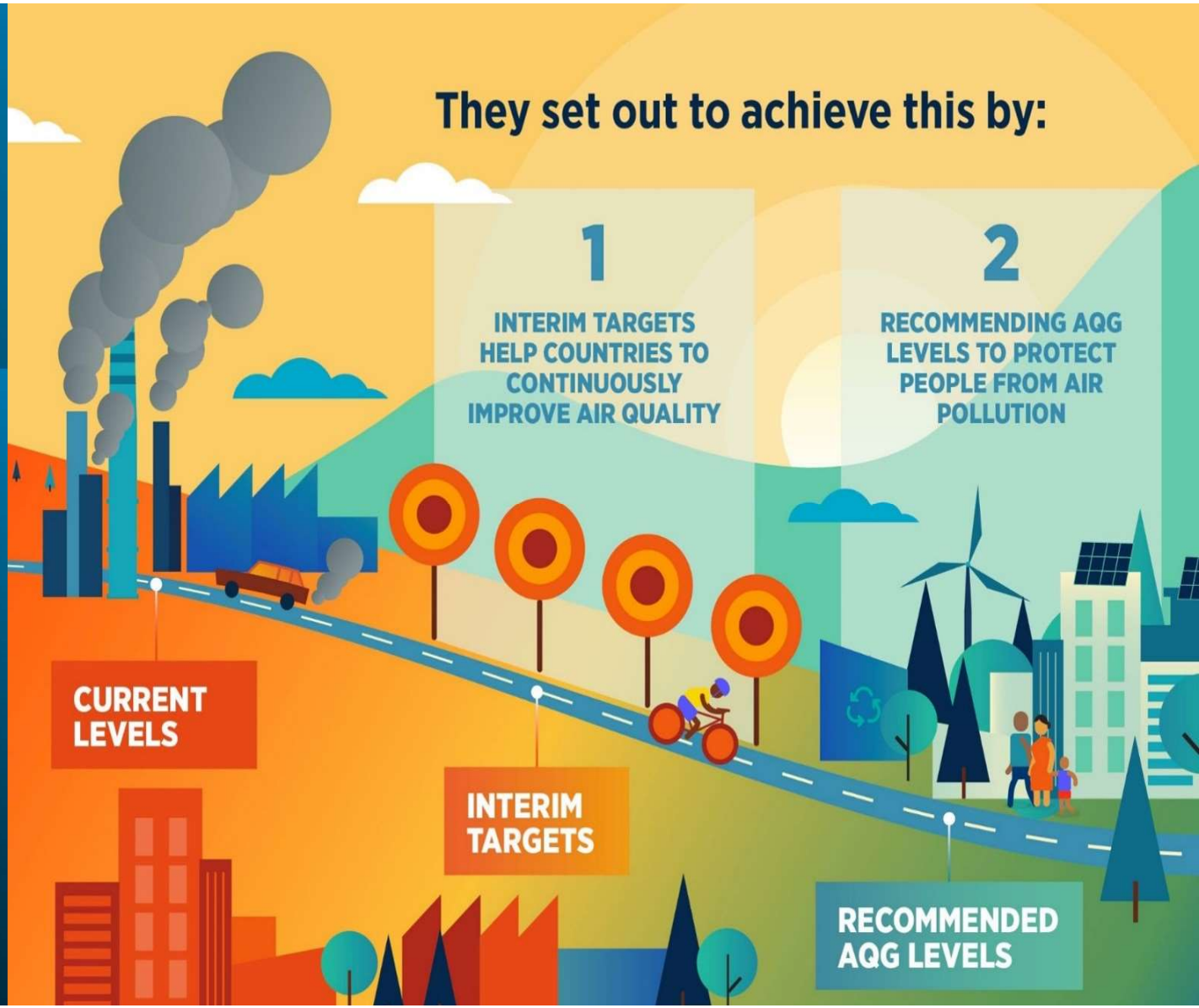
Air quality guideline levels for both long- and short-term exposure in relation to critical health outcomes.

Interim targets to guide reduction efforts for the achievement of the air quality guideline levels.

Good practice statements in the management of certain types of particulate matter for which evidence is insufficient to derive quantitative air quality guideline levels, but points to health risk.

Interim targets to guide continuous improvement of air quality



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Good practice statements about certain PM types

- In its 1st meeting, the guideline development group (GDG) noted that there were indications of health risk from exposure to black carbon/elemental carbon (BC/EC), ultrafine particles (UFP) and particles originating from sand and dust storms (SDS).
- The GDG acknowledged that it was unlikely that AQG levels for these pollutants could be formulated owing to the **absence of clear quantitative evidence on independent health effects**.
- However, the results of reviews of evidence conducted by other groups would be examined in order to reach a better-informed decision about whether recommendations should be formulated and in which form.
- The GDG, at its 3rd meeting, decided to include guidance on BC/EC, UFP and SDS in the form of good practice statements.
- The good practice statements specifically promote the **monitoring of additional air quality parameters**, their **mitigation** and their **further assessment and research.**

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BLACK/ELEMENTAL CARBON

- WHO REVIHAAP (2013) concluded that evidence links BC with cardiovascular health effects and premature mortality, for both short- (24-hour) and long-term (annual) exposures.
- In studies that take BC and $PM_{2.5}$ into account simultaneously, associations remained robust for BC.
- Even when it may not be the causal agent, BC is a valuable additional air quality metric for evaluating the health risks of primary combustion particles from traffic, including organic particles, that are not fully taken into account with $PM_{2.5}$ mass levels.
- USEPA ISA (2019) also summarized the evidence of associations between a series of health effects and BC, confirming the conclusions of the earlier WHO review.

GOOD PRACTICE STATEMENTS

- Make systematic measurements, in addition to existing monitoring of pollutants covered by AQGs.
- Undertake the production of emission inventories, exposure assessments and source apportionment.
- Take measures to reduce emissions, and, where appropriate, develop standards (or targets) for ambient concentrations.

Illustrative annual mean concentrations where statistically significant associations with health outcomes have been found were 1.08–1.15 $\mu g/m^3$ for black carbon and 0.5–0.8 $\mu g/m^3$ for elemental carbon (Luben et al., 2017).

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ULTRAFINE PARTICLES

- Considerable evidence on the toxicological effects at the time of *Global update 2005*. However, evidence from epidemiology was insufficient to recommend guidelines for UFP.
- HEI (2013) and Ohlwein et al. (2019) assessed scientific research papers published from 1997 to 2017 documenting the rising number of studies being conducted.
- The studies demonstrated short-term effects, including mortality, and several health outcomes and parameters; and long-term effects on mortality (all-cause, cardiovascular, IHD and pulmonary) and several types of morbidity.
- However, various UFP size ranges and exposure metrics were used, preventing a thorough comparison of results across studies (US EPA, 2019).

GOOD PRACTICE STATEMENTS

- Quantify in terms of particle number concentration (PNC) for a size range with a lower limit of ≤ 10 nm and no restriction on the upper limit.
- Expand the common air quality monitoring strategy by integration of their monitoring.
- Distinguish between low and high PNC to guide decisions on the priorities of source emission control.

  For illustration:
  Low concentrations: < 1000 particles/cm^3 (24-hour mean)
  High concentrations: > 10 000 particles/cm^3 (24-hour mean) or
  > 20 000 particles/cm^3 (1-h mean)
  (de Jesus et al., 2019; Thinking Outside the Box team, 2019).

- Utilize emerging science and technology for the assessment of exposure.

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SAND AND DUST STORMS

- Toxicology: Fussell & Kelly (2021) concluded that SDS may be a significant risk factor for inflammatory and allergic lung diseases such as child and adult asthma. Studies have demonstrated that sand dust particles induce inflammatory lung injury and aggravate allergen-induced tissue eosinophilia.

- Epidemiology: Tobias et al (forthcoming) indicate an overall effect of desert dust on cardiovascular mortality and respiratory morbidity, but the evidence is still inconsistent when accounting for sources of PM in different geographical areas. In addition, previously published reviews reported similar findings.

- An existing limitation in the epidemiological literature is the lack of studies on the long-term health effects of SDS.

GOOD PRACTICE STATEMENTS

- Maintain suitable air quality management and dust forecasting programmes.

- Maintain air quality monitoring programmes and reporting procedures.

- Conduct epidemiological and toxicological studies.

- Implement wind erosion control through carefully planned expansion of green spaces.

- Clean streets in urban areas with high population density and low rainfall to prevent resuspension by road traffic.

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BEYOND THE AQGS – WHO REVIHAAP (2013)

- Secondary organic aerosols (SOA) and secondary inorganic aerosols (SIA) may provide valuable metrics for the effects of mixtures of pollutants from a variety of sources
  - no new toxicological evidence to support a causal role for SIA such as ammonium, sulfates and nitrates
  - Growing information on the associations of organic carbon with health effects, and carbonaceous primary emissions are one of the important contributors to the formation of SOA. The evidence is insufficient to distinguish between the toxicity of primary and secondary organic aerosols.

- No patterns emerge for transition metals as a general category: depending on the study and outcome, associations may have been found for all, a few, or no metals.

- Despite the toxicological evidence that controlled exposure studies using transition metals can result in detrimental health effects, it is unlikely that these components can explain all of the health effects observed in epidemiological studies at present ambient levels.

- However, transition metals remain a group of components for which reduction measures will most likely lead to improving the health status of the population.

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BEYOND THE AQGs – Report of the WG on PAHs of the TFH (2021)

- Overall, the scientific evidence suggests that the PAHs in ambient air are associated with increased cancer incidence in exposed populations.
- Positive associations have been reported between ambient PAHs and breast cancer, childhood cancers and lung cancer.
- Epidemiological studies have shown that PAHs are associated with reduced lung function, exacerbation of asthma, and increased rates of obstructive lung diseases and cardiovascular diseases.
- Limited epidemiological evidence also suggests adverse effects on cognitive or behavioural function in children.
- For several PAHs that are carcinogenic air pollutants, a lowest possible exposure should be aimed at to minimize the risk of cancer development in view of a no-effect threshold.
- It was not possible to establish whether current WHO guidelines for benzo[a]pyrene provide sufficient protection against diseases other than cancer.

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How can the new AQGs be used?

FOR DESIGNING CLEAN AIR POLICIES

The AQGs are an evidence-informed tool for decision-makers to guide **legislation and policies**, to reduce levels of air pollutants and decrease the health burden that results from air pollution exposure worldwide.

FOR GUIDING FURTHER RESEARCH

Air pollution researchers and academics can use it to help identify **critical data gaps** that future research agendas could address.

FOR ENHANCING CLIMATE ACTION

Efforts to improve air quality can enhance **climate change mitigation**, and climate change mitigation efforts can, in turn, improve air quality. All this enhance people's health.

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Solutions require intersectoral cooperation

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How does WHO support guideline implementation?

- **In the European Region, 94% of countries have standards for at least one pollutant. The AQGs can help to update standards and add more pollutants to the list.**

- **Dissemination: Executive summaries translated into 11 European languages** (BUL, CZE, FRE, GER, ITA, POL, POR, RUM, RUS, SPA, SRP)
- **Communication and advocacy to promote the uptake of AQGs**
- **Resource package including tools and materials to support implementation of the guidelines**
- **Science-policy dialogues within and among Member States and with sectors and stakeholders**
- **Capacity building training in health and other sectors**
- **Methodological developments and assessments ('HRAPIE-2', external consultation on metals and benzene)**

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