WHO Global Air Quality Guidelines

Scientific evidence and decision-making process

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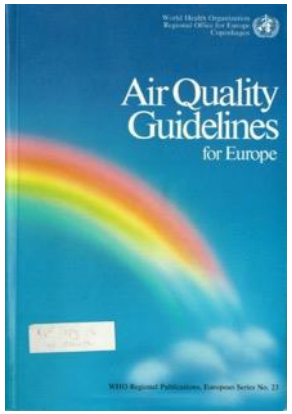
WHO Air Quality Guidelines (AQGs)



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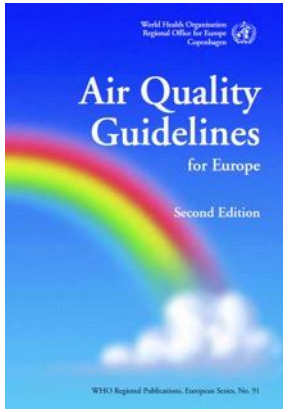

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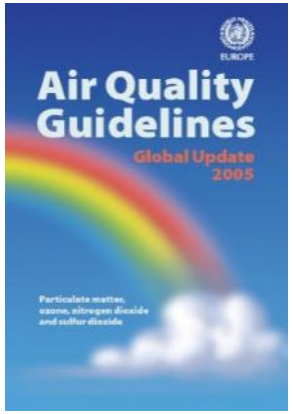

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- Robust public health recommendations
- Support informed decision-making
- Intended for worldwide use
- Comprehensive assessment of the evidence

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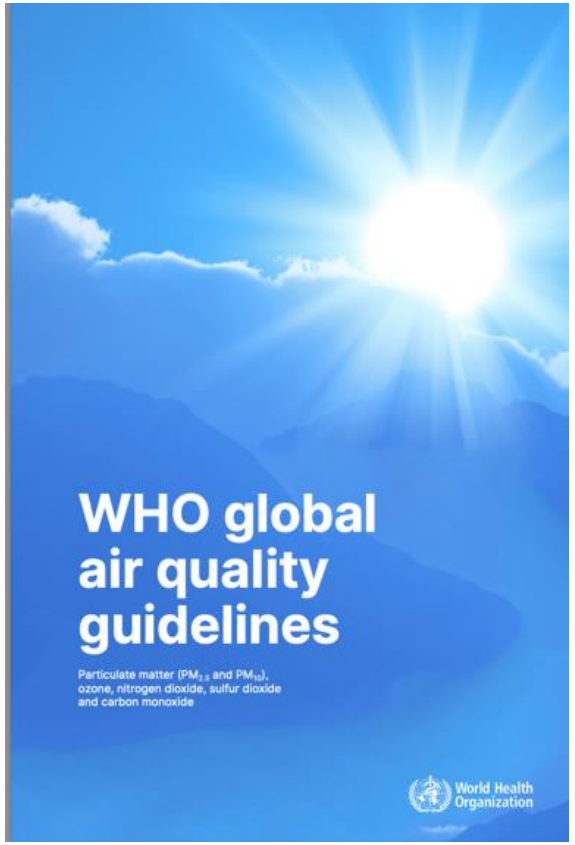
What are the WHO Global AQGs



- Based on extensive scientific evidence, the AQGs identify the levels of air quality necessary to **protect public health worldwide.**
- Provide recommendations on **air quality guideline levels** (and interim targets) for **$PM_{2.5}$, PM_{10}**, **O_3**, **NO_2**, **SO_2** and **CO,** and qualitative good practice statements for certain types of particulate matter.
- Guideline levels can be used as an **evidence-informed reference** to help decision-makers in setting legally binding standards and goals for air quality management.
- They are an **instrument to design effective measures** to achieve reduction of air pollution and, therefore, protect human health.

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What the WHO Global AQGs 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

- **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** on the management of certain types of particulate matter for which evidence is insufficient to derive quantitative air quality guideline levels, but points to their health relevance

Interim targets to guide continuous improvement of air quality

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Good practice statements

For the management of certain types of particulate matter for which evidence is insufficient to derive quantitative AQG levels, but points to a health risk.

SAND AND DUST STORMS

- 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.

BLACK/ELEMENTAL CARBON

- 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.

ULTRAFINE PARTICLES

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

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Main steps in the development of WHO guidelines

Meta-analysis

Systematic review

Formulate review questions/
Select outcomes

Scope of the guidelines

Set up groups (GDG and ERG)
DOI/COI management

Assess certainty of the body of evidence (GRADE)

Formulate recommendations

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Main steps in the development of the guidelines

Meta-analysis

Systematic review

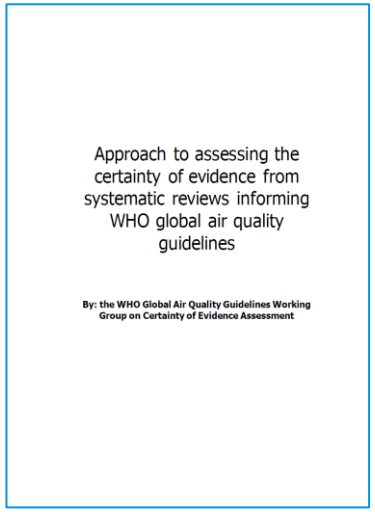
Formulate review questions/
Select outcomes

Scope of the guidelines

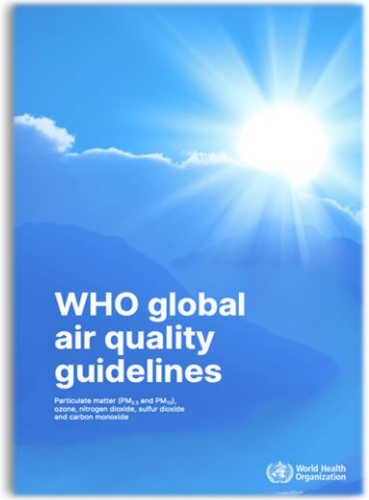
Set up groups (GDG and ERG)
DOI/COI management

Assess certainty of the body of evidence (adapted GRADE)

Formulate recommendations - identify AQG levels


Approach to assessing the certainty of evidence from systematic reviews informing WHO global air quality guidelines

By: the WHO Global Air Quality Guidelines Working Group on Certainty of Evidence Assessment



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GRADE adaptation in the context of an update of WHO AQGs

- Designed to assess the certainty of the evidence from the systematic reviews to inform WHO AQGs
- Guided systematic review team on the use of GRADE criteria for observational studies of exposure
- The ratings were used in the process of deriving AQG levels
- Extensively discussed at the GDG meetings, pilot tested by the systematic review team and improved iteratively

- Start the rating of the certainty of the evidence for observational studies as moderate
- The certainty of the evidence from this level could be downgraded or upgraded, based on the criteria per GRADE domain
- Domains to be treated equally and independently
- Incorporation of some additional criteria to complement existing guidance

https://ars.els-cdn.com/content/image/1-s2.0-S0160412020318316-mmc4.pdf

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Systematic reviews of evidence

Pablo Orellano, Julieta Reynoso, Nancy Quaranta, Ariel Bardach, Agustin Ciapponi. Short- term exposure to particulate matter (PM10 and PM2.5), nitrogen dioxide (NO2), and ozone (O3) and all-cause and cause-specific mortality: Systematic review and meta-analysis

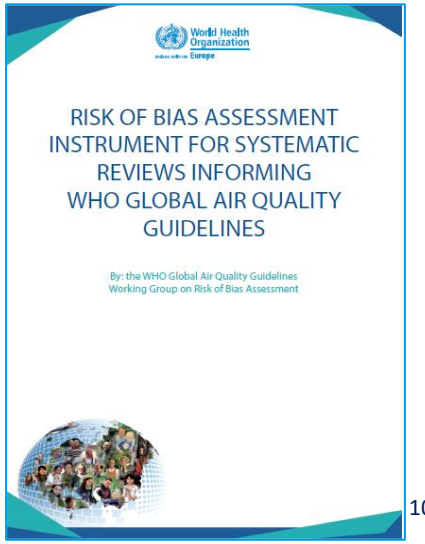
Kuan Ken Lee, Nicholas Spath, Mark R. Miller, Nicholas L. Mills, Anoop S.V. Shah. Short-term exposure to carbon monoxide and myocardial infarction: A systematic review and meta-analysis.

Jie Chen, Gerard Hoek. Long-term exposure to PM and all-cause and cause-specific mortality: A systematic review and meta-analysis.

Peijue Huangfu, Richard Atkinson. Long-term exposure to NO2 and O3 and all-cause and respiratory mortality: A systematic review and meta-analysis

Pablo Orellano, Julieta Reynoso, Nancy Quaranta. Short-term exposure to sulphur dioxide (SO2) and all-cause and respiratory mortality: A systematic review and meta-analysis

Xue-yan Zheng, Pablo Orellano, Hua-liang Lin, Mei Jiang, Wei-jie Guan. Short-term exposure to ozone, nitrogen dioxide, and sulphur dioxide and emergency department visits and hospital admissions due to asthma: A systematic review and meta-analysis



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From evidence to recommendations in a nutshell

Procedure to move from the evidence in systematic reviews to AQG levels

Step	Description
Step 1	Assess RR estimates and, when available, CRF for each critical health outcome per pollutant as provided by the systematic review
Step 2	Determine the lowest level of exposure measured in the studies included in the systematic review or in the subset of studies in the systematic review that estimate risk at this lowest level. For individual studies that used statistical models to evaluate the shape of the CRF, ensure that the lowest level of exposure is associated with a monotonic increase of the CRF curve
Step 3	Determine the minimal relevant increase in health outcomes
Step 4	Determine the starting point for AQG level determination as the long-term concentration of pollutant from which the minimal relevant amount of the health outcome will result
Step 5	Compare the AQG levels for a specific pollutant across critical health outcomes. Take as the final AQG level the lowest AQG level found for any of the critical health outcomes
Step 6	Assess the certainty of the evidence at low levels of exposure. The adapted GRADE assessment is for the entire body of evidence, not the subset of studies conducted at the lowest exposure levels. The evidence provided by these latter studies needs to be discussed, starting from the RoB assessment that was conducted at individual study level
Step 7	Consider new relevant evidence not included in the systematic reviews in a qualitative or, where possible, quantitative manner
Step 8	Reconsider causality of associations between pollutants and outcomes, taking into account whether or not associations have been classified as causal or likely causal in recent reviews by authoritative bodies

Long-term AQG levels

- Means of lowest 5th percentiles of study population distributions.
- After evaluating the certainty of evidence at those low exposure levels and comparing these values across critical health outcomes, the AQG level was set.

Short-term AQG levels

- 99th percentiles of distributions of 24-h mean concentrations matching the long-term AQG levels.
- If a long-term AQG level was not set for a given pollutant, its specified and justified low concentration.
- The database of the MCC Collaborative Research Network was used for calculation of ratios of percentiles of daily concentrations to annual means.

Example: long-term AQG level for $PM_{2.5}$

Step 1. RR estimates and CRF	Meta-analysis for all non-accidental mortality: RR=1.08 (95% CI: 1.06-1.09) CRFs available in 4 out of 6 studies with the lowest $PM_{2.5}$ levels, show linear (or supralinear) relationships down to very low concentrations
Step 2. The lowest level of exposure measured	4.2 – 4.9 µg/m³ Sum of weights of the 5 lowest studies >25%
Step 3. Minimal relevant increase in health outcome	Any increase in risk (of mortality)
Step 4 . Starting point for AQG determination	Not more than 5 µg/m³
Step 5. Compare the AQG level across critical health outcomes	Starting points for determination: P5 = 4.0-4.3 µg/m³ in the five studies with lowest P5 or 4.1-6.2 in 5 studies with positive associations; AQG not more than 5 µg/m³ (cause-specific mortality)
Step 6. Certainty of the evidence	High, also in low-level studies
Step 7. New evidence	New studies published until summer 2020, confirm *Chen & Hoek 2020*
Step 8. Reconsider causality	All associations considered to be causal; not changed by recent evaluations

How can the WHO AQGs be used?

AS AN EVIDENCE-INFORMED TOOL

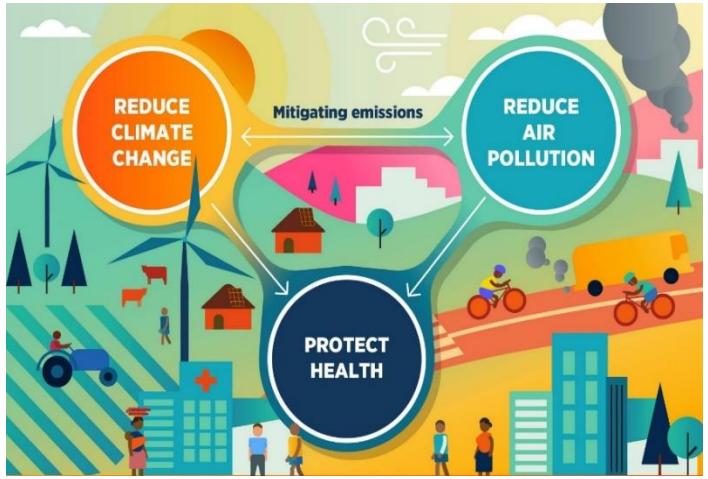
To guide the development of legislation and policies to reduce levels of air pollutants, strengthen intersectorial cooperation, decrease the disease burden and reduce inequities

TO STIMULATE RESEARCH

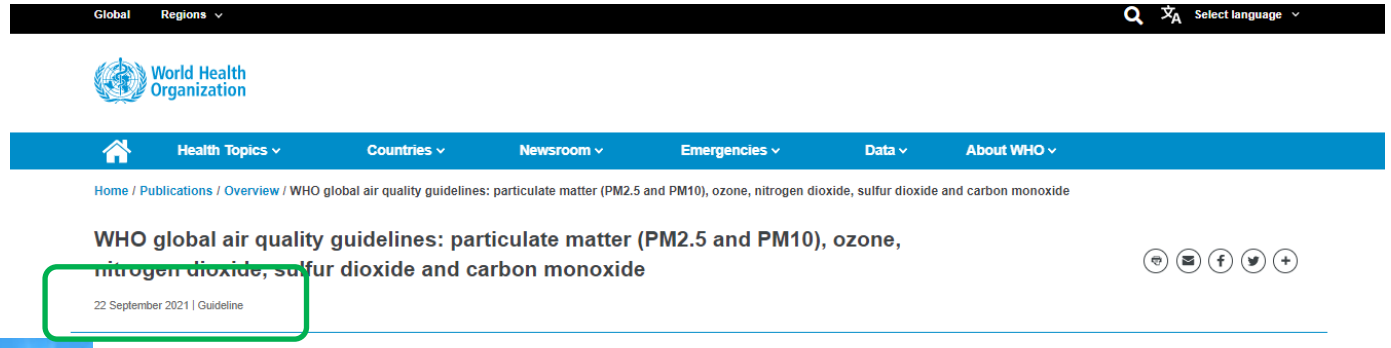
To identify critical data gaps that could be addressed in the future research agendas to better protect the population from the harmful effects of air pollution

FOR CLIMATE ACTION

AQGs are a powerful tool for climate action. Efforts to improve air quality enhance CC mitigation, and CC mitigation efforts can, in turn, improve air quality to the benefit of people's health.



Nine months from the launch …



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Media:

BBC, EL PAÍS, Frankfurter Allgemeine, CNN, South China Morning Post, Brisbane Times,...

Science:

- BMJ, Lancet, Int J Public Health, Eur J Public Health, Allergy…
- Guideline >200 citations
- Systematic reviews >350 citations

Practice and Policy:

- 2021 WHO list of 10 key global health moments
- End-users' downloads: >90,000
- Policy consideration/uptake in Member States and the EU

Implementing the guidelines

Key enabling factors

- Key institutional / technical tools and human capacity
- Legally binding, globally harmonized AQ standards
- Existence and operation of air quality monitoring systems
- Air quality management systems
- Public access to air quality data
- Capacities to conduct health risk assessment to set priorities for action
- Cooperation among different sectors and stakeholders, including the health sector

AQGs - an evidence-informed decision support tool

Main users

AQGs - a practical instrument for advancing emission reductions and the design of effective measures and policies

Useful for:

- authorities
- technical experts and decision-makers
- health/environmental impact assessment practitioners
- air pollution researchers and academics
- civil society, patient and other advocacy groups

What can countries do with the AQGs?

Key points

- Countries can **use the AQGs as a tool** to guide, drive and support the selection and adoption of measures to reduce exposure to air pollution:
  - Establish or ***update their legally binding air quality standards and develop policies***
  - ***Strengthening multisectoral cooperation*** at national, regional, and international levels, and advocating for air quality
  - Taking effective steps to ***reduce health inequities*** related to air pollution
- Actions to reduce air pollution require cooperation of various sectors and stakeholders.

Implementing the guidelines

Moving from guidelines to legally-binding standards

- Air quality standards are the cornerstone of air quality management
- Standards may be based solely on scientific evidence and public health considerations
- Other factors that may be considered include:
  - legal aspects
  - cost–benefit /cost–effectiveness
  - technological feasibility
  - infrastructural measures
  - socio-political considerations, including equity

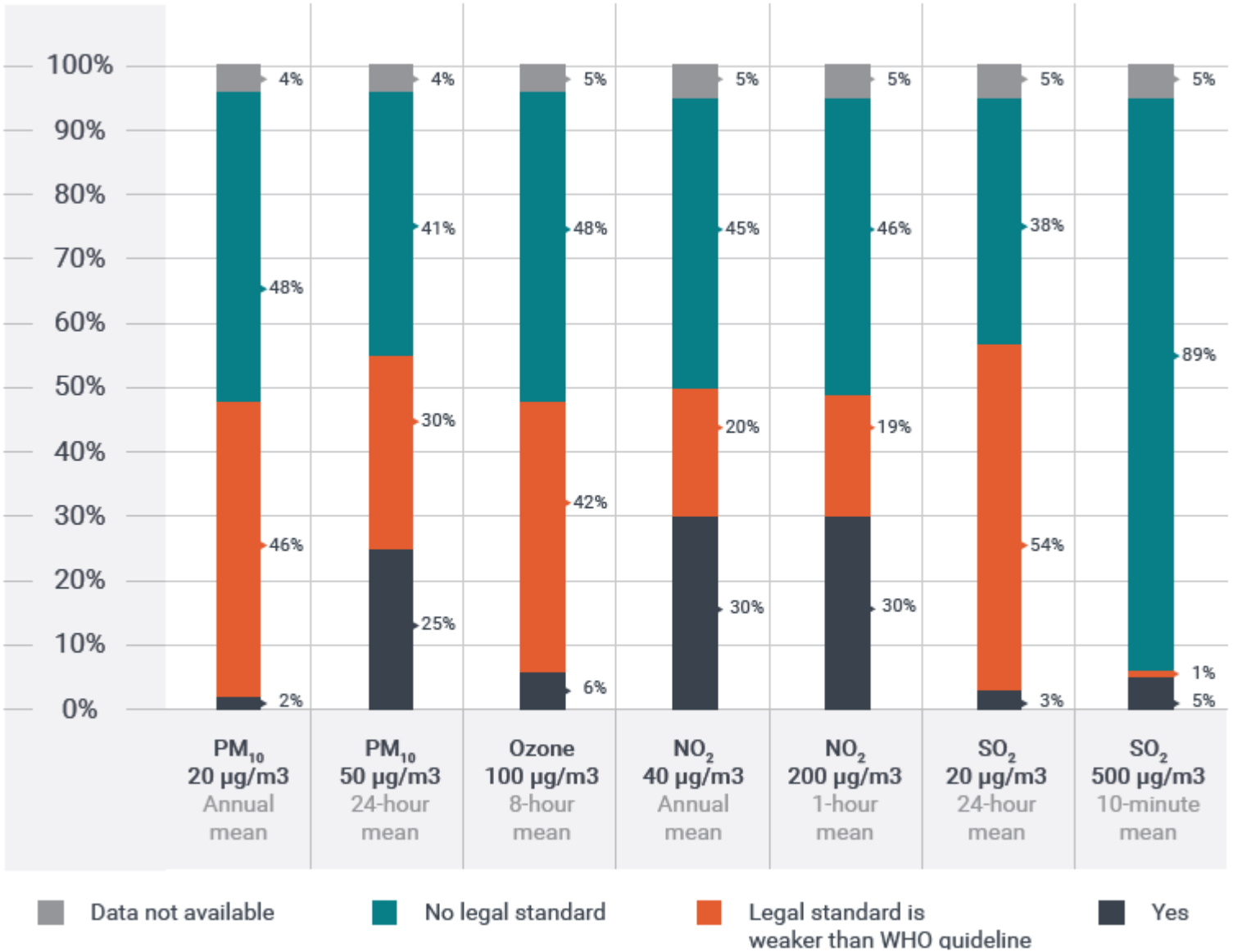
Different uptake of AQGs in AAQS across the world

WHO REGION	COUNTRIES IN THE REGION (N)	COUNTRIES WITH STANDARDS FOR AT LEAST ONE POLLUTANT AND AVERAGING TIME		COUNTRIES WITHOUT STANDARDS		COUNTRIES WITH NO INFORMATION	
		n	%	n	%	n	%
African Region	47	17	36	21	45	9	19
Region of the Americas	35	20	57	13	37	2	6
South-East Asian Region	11	7	64	3	27	1	9
European Region	**53**	**50**	**94**	**2**	**4**	**1**	**2**
Eastern Mediterranean Region	21	11	52	1	5	9	43
Western Pacific Region	27	12	44	13	48	2	7
Total	194	117	60	53	27	24	12

Kutlar Joss et al., 2017

AAQS: Ambient Air Quality Standards

Legal incorporation of 2005 WHO air quality guidelines in national ambient air quality standards



Regulating Air Quality: the First Global Assessment of Air Pollution Legislation | UNEP - UN Environment Programme

Solutions require intersectoral cooperation

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The health sector has a key role

The health sector has a role in:

raising awareness of the impact of air quality on health;

advising the public and patients about how the impact of air pollutants can be mitigated at an individual level;

gathering evidence on health effects from air pollution;

and joining advocacy efforts at the national and international levels to ensure that the health arguments are heard.

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Engagement of the health community is crucial

How does WHO support this process?

- Dissemination: Executive summaries translated into 10 languages (ARA, BUL, CZE, FRE, GER, ITA, POL, POR, RUS, SPA)
- Communication and advocacy to promote the uptake of AQGs
- Science-policy dialogues within and among Member States and with sectors and stakeholders
- Capacity building training in health and other sectors
- Resource package including tools and materials to support implementation of the guidelines
- Methodological developments - update of HRAPIE project

HRAPIE: Health Risks of Air Pollution in Europe

Members of the main groups

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External Review Group

65 individual experts provided input at different stages of the process

14 stakeholder organizations participated in the consultation of the document

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Thank you

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