WHO Air Quality Guidelines, 2021

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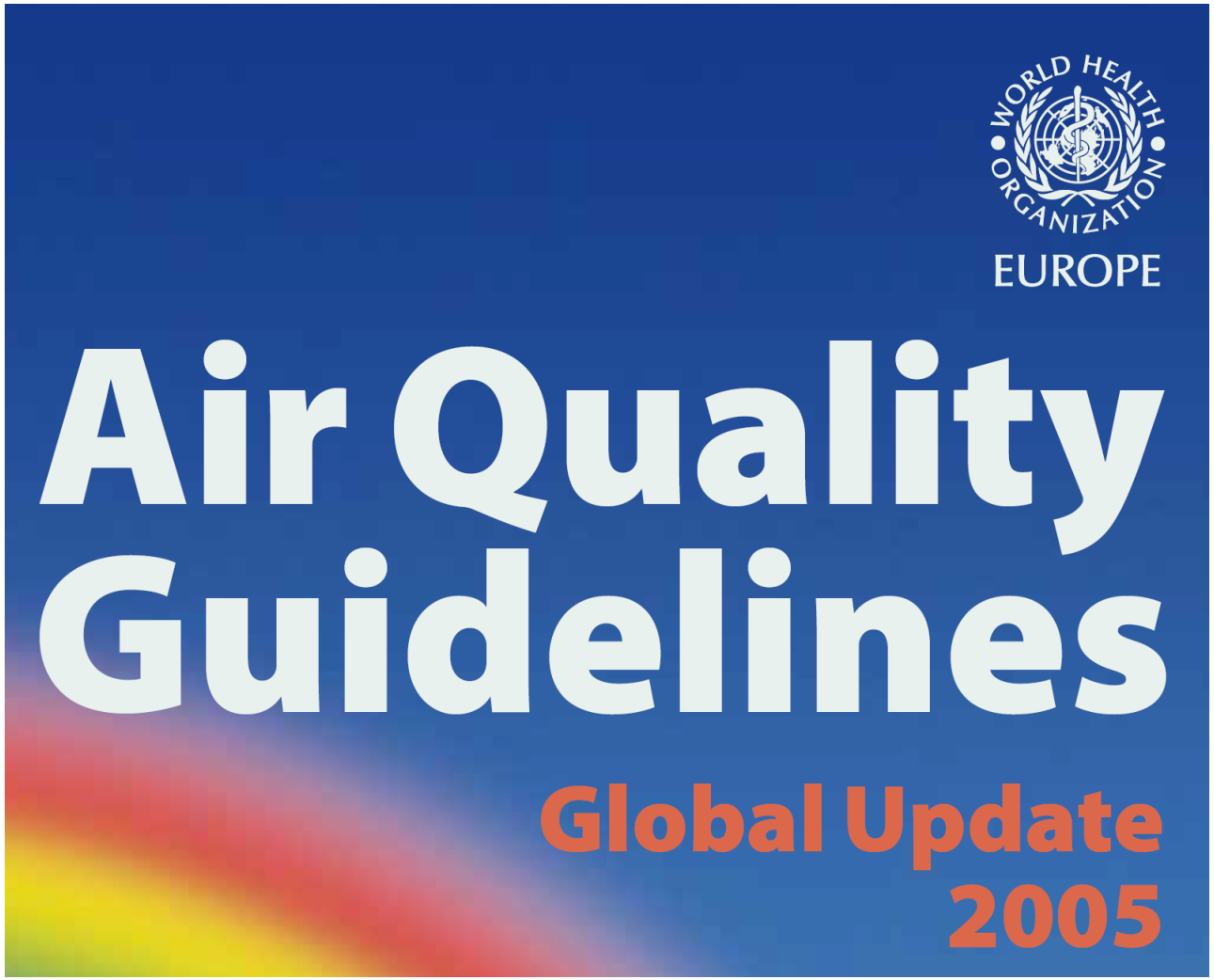
Starting point…



Pollutant	Averaging time	2005 AQG value
PM2.5	1 year	10 µg/m³
PM10	24 hour (99th percentile)	25 µg/m³
	1 year	20 µg/m³
	24 hour 99th percentile)	50 µg/m³
O_3	8 hour, daily max	100 µg/m³
NO_2	1 year	40 µg/m³
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SO_2	24 hour	20 µg/m³
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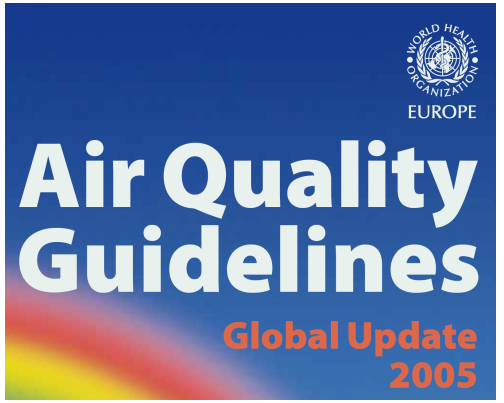
Levels recommended to be achieved everywhere in order to significantly reduce the adverse health effects of air pollution

AQG 2005



- Narrative reviews
- Expert opinion
- Inclusive of epidemiology, in-vivo and in-vitro toxicology, human chamber studies
- Inclusive of most mortality and morbidity endpoints
- No clear protocols for reviews and guideline development

What's new – since 2005?

- A Tsunami of new studies
- EPA ISAs CO (2010), NO2 (2016), SO2 (2017), PM (2019), O3 (2020)
- WHO REVIHAAP 2013
- GBD Exposure-Response function 2014
- WHO Guideline Development Handbook (2014)

Strength of evidence on health effects of $PM_{2.5}$, NO_2 and O_3

ST: short-term, LT: Long-term

C – causal

Lc – likely causal

S – suggestive for causal

Systematic reviews:

for $PM_{2.5}$ US EPA 2019

for NO_2 US EPA 2016

for O_3 US EPA 2013/2019

Outcome	$PM_{2.5}$		NO_2		O_3	
	LT	ST	LT	ST	LT	ST
Mortality	**C**	**C**	**S**	**S**	**S**	**Lc/S**
Cardiovascular Effects	**C**	**C**	**S**	**S**	**S**	**Lc/S**
Respiratory Effects	**Lc**	**Lc**	**Lc**	**C**	**C**	**C**
Cancer	**Lc/[1]**	**---**	**S**	**---**	**Lc**	**---**
Nervous System	**Lc**	**S**	**---**	**---**	**S**	**S**

[1] Group 1 carcinogen (Lung Cancer), IARC 2013

Courtesy of Jason Sacks

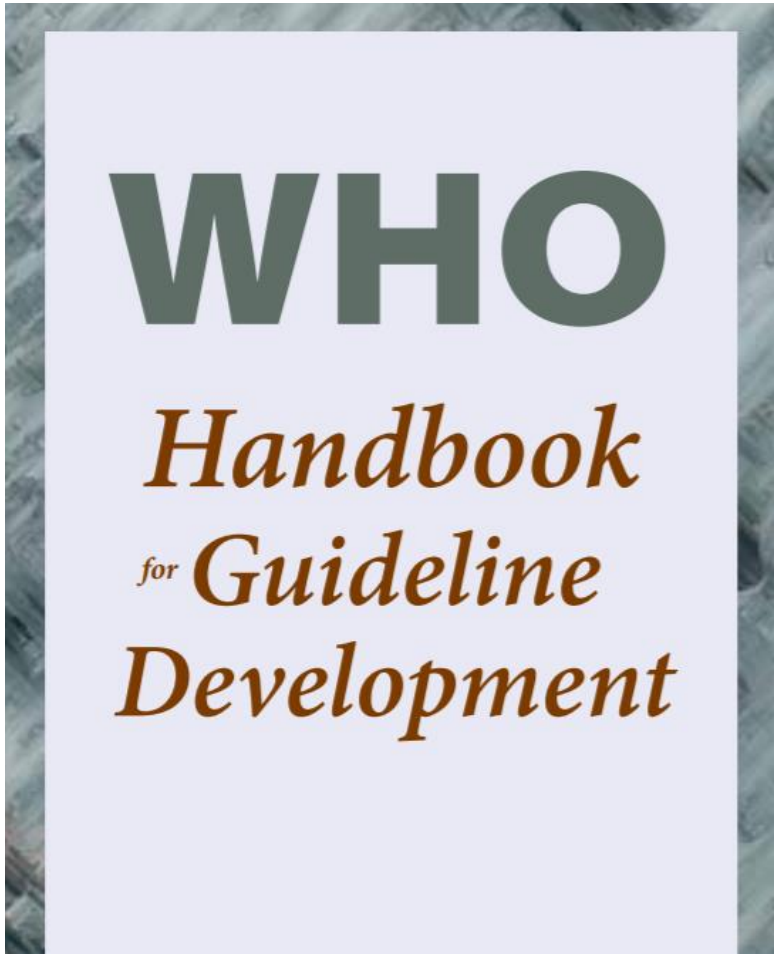
Timeline of the Revision process (2015-2021)

- Fall 2015: Scoping meeting
- 2016: Selection of pollutant-outcome pairs
- 2017: Systematic Reviews commissioned
- 2019: GDG review of Systematic Reviews, adaptation of GRADE
- 2020: From evidence to guidelines; guideline development, external review
- Spring 2021: Final report reviewed by WHO GRC
- September 2021: publication of AQG 2021

Pollutant outcome pairs – evidence for causality and/or public health relevance

- Long-term PM2.5, PM10 & mortality (12 pairs)
- Long-term NO2, O3 & mortality (8 pairs)
- Short-term PM2.5, PM10, NO2, O3, SO2 & mortality (15 pairs)
- Short-term NO2, O3, SO2 & asthma admissions (6 pairs)
- Short-term CO & MI admissions (1 pair)
- **A TOTAL OF 42 POLLUTANT-OUTCOME PAIRS REVIEWED**

WHO statement in 2016



- WHO uses the GRADE (Grading of Recommendations, Assessment, Development and Evaluation) approach to assess the quality of a body of evidence, develop and report recommendations. GRADE methods are used by WHO because these represent internationally agreed standards for making transparent recommendations.

Grades of Recommendation Assessment, Development and Evaluation

Certainty of evidence assessed with ***modified*** GRADE tool ("Grading of Recommendations Assessment, Development and Evaluation")

www.gradeworkinggroup.org

2008 BMJ series

2011 JCE series

RATING QUALITY OF EVIDENCE AND STRENGTH OF RECOMMENDATIONS

GRADE: an emerging consensus on rating quality of evidence and strength of recommendations

Guidelines are inconsistent in how they rate the quality of evidence and the strength of recommendations. This article explores the advantages of the GRADE system, which is increasingly being adopted by organisations worldwide

Environmental health and clinical medicine are two different disciplines

Clinical medicine

- Evaluation of patients' benefit (positive effects)
- Worry about false positive

- Exposure is well defined

- Human studies

Environmental Health

- Evaluation of population risk (negative effects)
- Worry about false negative

- Exposure is estimated

- Human, animal, in vitro studies
- Susceptible groups

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

GRADE: Assessing the quality of evidence in environmental and occupational health

Rebecca L. Morgan [a], Kristina A. Thayer [b], Lisa Bero [c], Nigel Bruce [d], Yngve Falck-Ytter [e], Davina Ghersi [f,g], Gordon Guyatt [a], Carlijn Hooijmans [h], Miranda Langendam [i], Daniele Mandrioli [j], Reem A. Mustafa [a,k], Eva A. Rehfuess [l], Andrew A. Rooney [b], Beverley Shea [m], Ellen K. Silbergeld [n], Patrice Sutton [o], Mary S. Wolfe [b], Tracey J. Woodruff [o], Jos H. Verbeek [p], Alison C. Holloway [q], Nancy Santesso [a], Holger J. Schünemann [a,r,*]

1. Establish initial level of certainty		2. Consider lowering or raising level of certainty		3. Final level of certainty rating
Study design	*Initial certainty in an estimate of effect*	*Reasons for considering lowering or raising certainty*		*Certainty in an estimate of effect across those considerations*
		↓ Lower if	↑ Higher if*	
Randomized trials ➔	High certainty	Risk of Bias Inconsistency Indirectness Imprecision Publication bias	Large effect Dose response All plausible confounding & bias • would reduce a demonstrated effect or • would suggest a spurious effect if no effect was observed	High ⊕⊕⊕⊕
				Moderate ⊕⊕⊕◯
Observational studies ➔	Low certainty			Low ⊕⊕◯◯
				Very low ⊕◯◯◯

*upgrading criteria are usually applicable to observational studies only.

Adapted from "Methodological idiosyncracies, frameworks and challenges of non-pharmaceutical and non-technical treatment interventions" (Schünemann 2013)

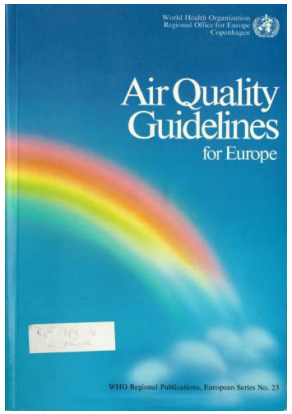
From Evidence to Recommendations

- Deciding above which pollutant concentration level significant adverse effects on health occur
- Separate approach for long-term and short-term concentration levels

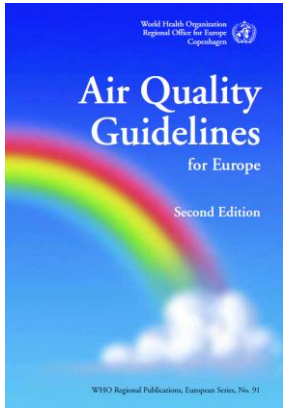
Low-level PM2.5 studies

PM2.5 REFERENCE	MEAN	SD	M-1.645*SD	P5	HR	LCL	UCL
(Pinault 16)	5.9			3	1.26	1.19	1.34
(Cakmak)	6.5	2	3.2	3.2	1.16	1.08	1.25
(Pinault 17)	7.1			3.5	1.18	1.15	1.21
(Weich.)	9.5	1.7	6.7	6.7	0.95	0.76	1.19
(Villeneuve)	9.5	3.5	3.7	4.8	1.12	1.05	1.2
(Di)	11.5	2.9	6.7	7.1	1.08	1.08	1.09
(Hart)	12.0	2.8		7.8	1.13	1.05	1.22

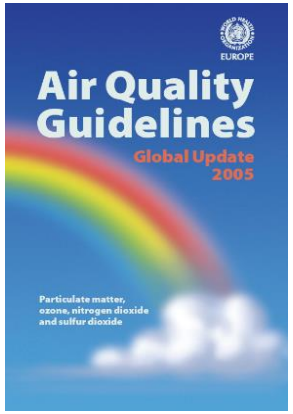
WHO Air Quality Guidelines (AQG): New levels will be substantially lower for PM2.5 and NO2



1987



2000



2006

2021

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

Pollutant	Averaging time	2005 AQG value
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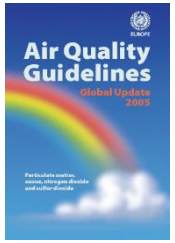
	10 minute	500 µg/m^3

Levels recommended to be achieved everywhere in order to significantly reduce the adverse health effects of air pollution

2005 WHO Guidelines and EU Ambient Air Quality Directive



2005 WHO Guidelines

2021

Pollutant	Averaging time	Guideline value	
PM2.5	1 year	**10 µg/m³**	**5 µg/m³**
PM10	24 hour (99th percentile) 1 year 24 hour 99th percentile)	25 µg/m³ **20 µg/m³** 50 µg/m³	
O_3	8 hour, daily max	100 µg/m³	
NO_2	1 year	**40 µg/m³**	**10µg/m³**
	1 hour	200 µg/m³	
SO_2	24 hour 10 minute	20 µg/m³ 500 µg/m³	

O_3 long-term **60 µg/m³ peak season**

EU Ambient Air Quality Directive (AAQD)

Pollutant	Averaging time	Limit value
PM2.5	**3 year**	**25 µg/m³**
PM10	1 year 24 hour	40 µg/m³ 50 µg/m³
O_3	8 hour, daily max	120 µg/m³
NO_2	**1 year**	**40 µg/m³**
	1 hour	200 µg/m³
SO_2	24 hour 1 hour	125 µg/m³ 350 µg/m³

What the AQGs provide…

World Health Organization
Regional Office for Europe

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.

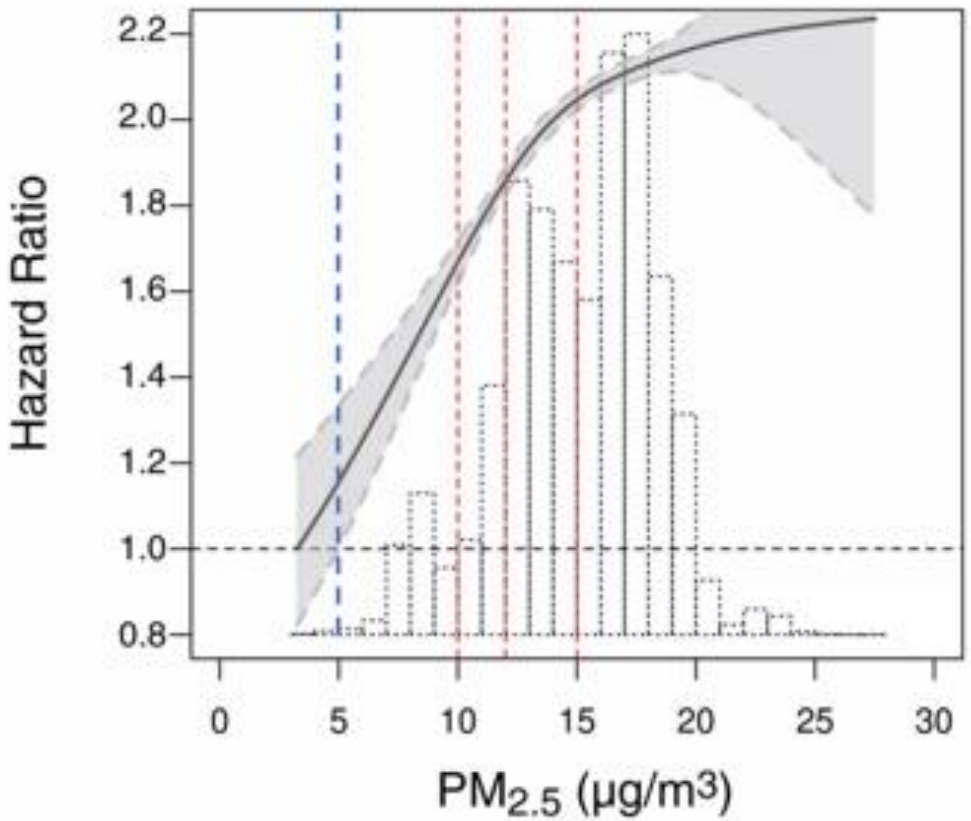
Interim targets to guide reduction efforts for the achievement of the air quality guideline levels.

Good practice statements in 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.

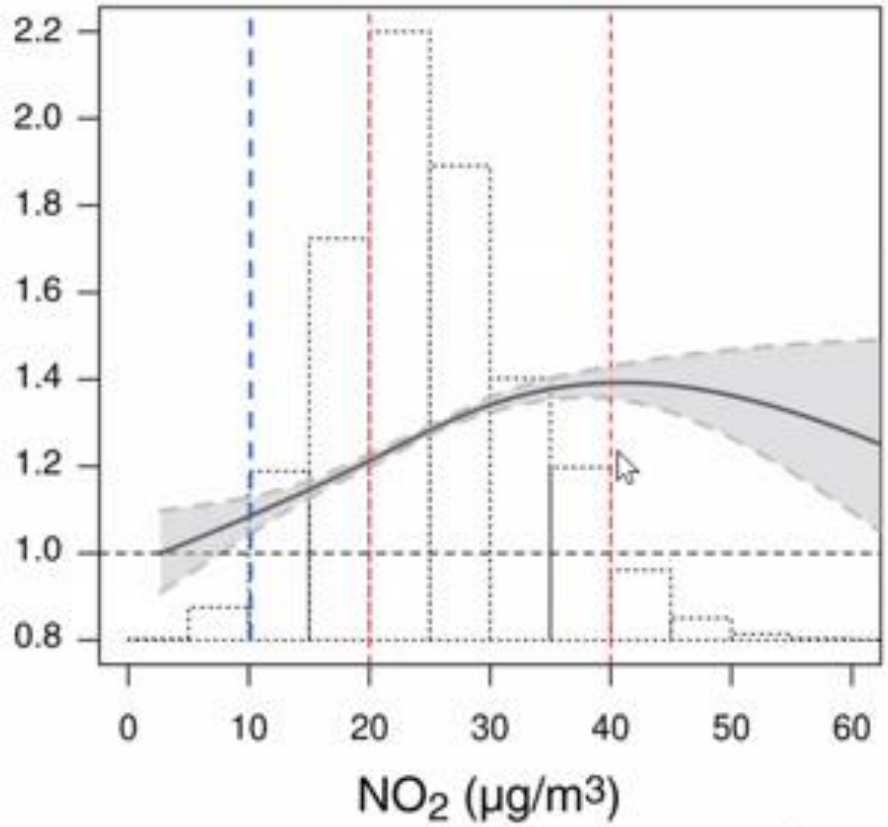
Association of all natural cause mortality to PM2.5 and NO2 in pooled cohorts of ELAPSE study:

Comparison to the New WHO AQGs

AQG 2021



AQG 2021



Brunekreef et al 2021

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ERS

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International Journal of Public Health
COMMENTARY
published: 23 September 2021
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ERS EUROPEAN RESPIRATORY SOCIETY
every breath counts

ISEE

WHO Air Quality Guidelines 2021 – Aiming for healthier air for all

A joint statement by medical, public health, scientific societies and patient representative organisations > 100 endorsements!

American Heart Association.

ESC European Society of Cardiology

european cancer ORGANISATION

ELF EUROPEAN LUNG FOUNDATION

WORLD HEART FEDERATION

ATS American Thoracic Society

American Cancer Society®

WHO Air Quality Guidelines 2021–Aiming for Healthier Air for all: A Joint Statement by Medical, Public Health, Scientific Societies and Patient Representative Organisations

Barbara Hoffmann[1], Hanna Boogaard[2], Audrey de Nazelle[3], Zorana J. Andersen[4], Michael Abramson[5], Michael Brauer[6], Bert Brunekreef[7], Francesco Forastiere[3], Wei Huang[8], Haidong Kan[9], Joel D. Kaufman[10], Klea Katsouyanni[3,11], Michal Krzyzanowski[3], Nino Kuenzli[12], Francine Laden[13], Mark Nieuwenhuijsen[14], Adetoun Mustapha[3,15], Pippa Powell[16], Mary Rice[13], Aina Roca-Barceló[3], Charlotte J. Roscoe[13], Agnes Soares[17], Kurt Straif[18] and George Thurston[19]*

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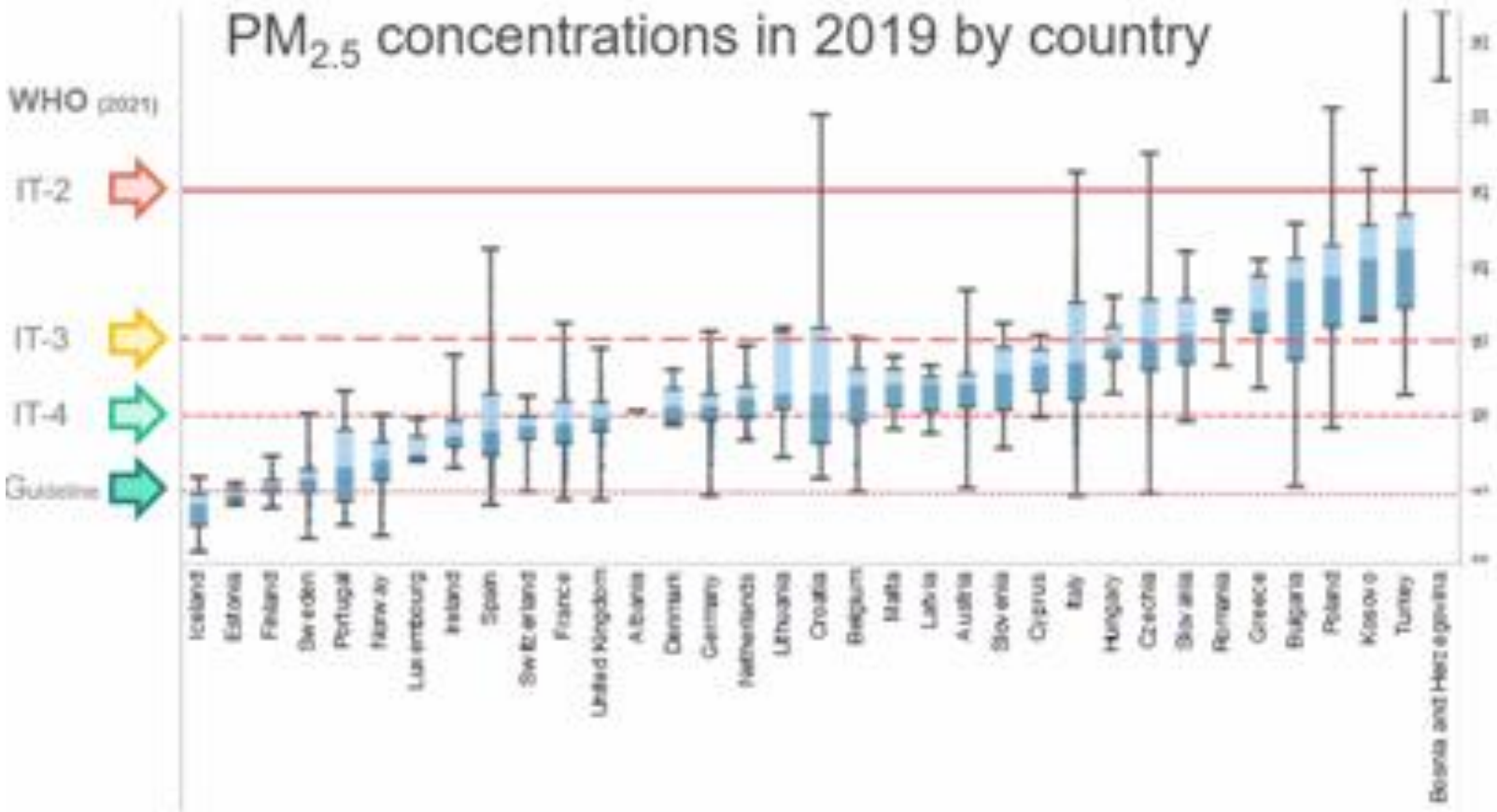
ERS Website: https://www.ersnet.org/news-and-features/news/urge-implement-air-pollution-policies-who-aqgs/

It is time to act in Europe

		WHO 2005 Air Quality Guidelines	WHO 2021 Air Quality Guidelines	EU Air Quality Directives – Limit Values
$PM_{2.5}$	Annual	10 µg/m³	5 µg/m³	25 µg/m³
$PM_{2.5}$	Daily (24-hour)	25 µg/m³	15 µg/m³	-
PM_{10}	Annual	20 µg/m³	15 µg/m³	40 µg/m³
PM_{10}	Daily (24-hour)	50 µg/m³	45 µg/m³	50 µg/m³
NO_2	Annual	40 µg/m³	10 µg/m³	40 µg/m³
NO_2	Daily (24-hour)	-	25 µg/m³	50 µg/m³

Ambition level versus air quality today



European Commission

Source(s): EEA Europe's air quality status 2021

"The Commission will draw on the lessons learnt from the evaluation of the current air quality legislation.

It will also propose to strengthen provisions on monitoring, modelling and air quality plans to help local authorities achieve cleaner air.

The Commission will notably propose to revise air quality standards to align them more closely with the World Health Organization recommendations."

Communication on the European Green Deal (COM/2019/640 final)

#EUGreenDeal

European Commission

European Commission

Third EU Clean Air Forum

MADRID, 18-19 November 2021

10:30

Zero pollution: air quality & health

This session will focus on the health impacts and the general challenge that air pollution poses. Panelists will offer their perspective on the reasons to improve air quality, on the evolving health impact evidence, and on how we can live up to the zero pollution ambition of the European Green Deal.

KEYNOTE REMARKS

- **Dr Tedros ADHANOM GHEBREYESUS**

  Director-General, World Health Organization (WHO)

PANEL DISCUSSION

- **Silvia CALZÓN FERNÁNDEZ**, State Secretary for Health, Spain
- **Zorana ANDERSEN**, Chair Environment and Health Committee, European Respiratory Society
- **John F. RYAN**, Director for Public Health, European Commission
- **Dr Francesco FORASTIERE**, National Research Council (CNR-IRIB), Italy
- **Dr Maria NEIRA**, World Health Organization (WHO) [TBC]

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