



 World Health Organization  
REGIONAL OFFICE FOR Europe

EUROPEAN ENVIRONMENT  
AND HEALTH PROCESS

# World Health Organization Air Quality Guidelines

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# Presentation Outline

1. Existing WHO Air Quality Guidelines
2. Mandate and context for update of guidelines
3. WHO Guideline development process and scope of the updated guidelines



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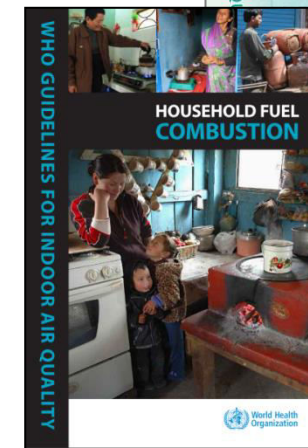
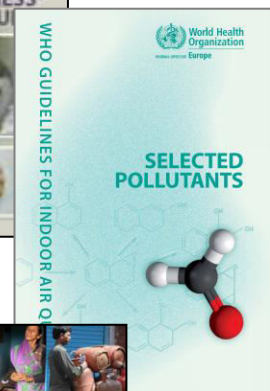
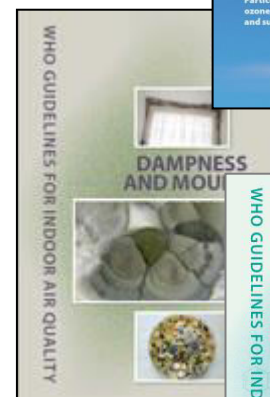
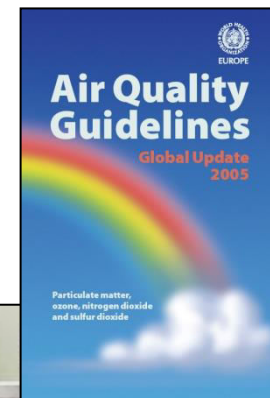
# WHO Air Quality Guidelines

- ✓ Represent the most widely accepted set of **public health recommendations**, intended to **assist policy-makers, health-care providers, and other relevant stakeholders** to make informed decisions for the protection of public health from the adverse effects of air pollution.
- ✓ Based on a **comprehensive** and **objective assessment of the available evidence**.
- ✓ **Intended for worldwide use**, and therefore recognize the heterogeneity on technological feasibility, economic development and other political and economical factors.
- ✓ In 2007, WHO adopted internationally recognized standards and methods to ensure that guidelines are **free from biases** and **meet public health needs**.



# WHO Air Quality Guidelines

- **Ambient air quality guidelines**
  - Air Quality Guidelines for Europe (1987)
  - Air Quality Guidelines for Europe, 2<sup>nd</sup> Edition (2000)
  - Air Quality Guidelines, Global Update 2005 (2006)
  - Global Air Quality Guidelines (???)
- **Indoor air quality guidelines**
  - Dampness and mould (2009)
  - Selected chemical pollutants (2010)
  - Household fuel combustion (2014)



# Air pollutants covered in 1987 and 2000 editions

## AQGs for Europe 1st Edition, 1987

- |   |                  |
|---|------------------|
| 1. Acrylonitrile                          |                  |
| 2. Benzene                                | <b>ORGANIC</b>   |
| 3. Carbon disulfide                       |                  |
| 4. 1,2-Dichloroethane                     |                  |
| 5. Dichloromethane                        |                  |
| 6. Formaldehyde                           |                  |
| 7. Polynuclear aromatic hydrocarbons      |                  |
| 8. Styrene                                |                  |
| 9. Tetrachloroethylene                    |                  |
| 10. Toluene                               |                  |
| 11. Trichloroethylene                     |                  |
| 12. Vinyl chloride                        |                  |
| 13. Arsenic                               | <b>INORGANIC</b> |
| 14. Asbestos                              |                  |
| 15. Cadmium                               |                  |
| 16. Carbon monoxide                       |                  |
| 17. Chromium                              |                  |
| 18. Hydrogen sulfide                      |                  |
| 19. Lead                                  |                  |
| 20. Manganese                             |                  |
| 21. Mercury                               |                  |
| 22. Nickel                                |                  |
| 23. Nitrogen dioxide                      |                  |
| 24. Ozone                                 |                  |
| 25. Radon                                 |                  |
| 26. Sulfur dioxide and particulate matter |                  |
| 27. Vanadium                              |                  |

## AQGs for Europe 2nd Edition, 2000

- |  |                  |                                 |                  |
|--|------------------|---------------------------------|------------------|
| 1. Acrylonitrile*                                    |                  | 29. Nitrogen dioxide            |                  |
| 2. Benzene   | <b>ORGANIC</b>   | 30. Ozone                       | <b>CLASSICAL</b> |
| 3. Butadiene   |                  | 31. Particulate matter          |                  |
| 4. Carbon disulfide*                                 |                  | 32. Sulfur dioxide              |                  |
| 5. Carbon monoxide                                   |                  | 33. Radon                       | <b>INDOOR</b>    |
| 6. 1,2-Dichloroethane*                               |                  | 34. Environmental tobacco smoke |                  |
| 7. Dichloromethane                                   |                  | 35. Man-made vitreous fibres    |                  |
| 8. Formaldehyde                                      |                  |                                 |                  |
| 9. Polycyclic aromatic hydrocarbons                  |                  |                                 |                  |
| 10. Polychlorinated biphenyls                        |                  |                                 |                  |
| 11. Polychlorinated dibenzodioxins and dibenzofurans |                  |                                 |                  |
| 12. Styrene  |                  |                                 |                  |
| 13. Tetrachloroethylene                              |                  |                                 |                  |
| 14. Toluene  |                  |                                 |                  |
| 15. Trichloroethylene                                |                  |                                 |                  |
| 16. Vinyl chloride                                   |                  |                                 |                  |
| 17. Arsenic  | <b>INORGANIC</b> |                                 |                  |
| 18. Asbestos*  |                  |                                 |                  |
| 19. Cadmium  |                  |                                 |                  |
| 20. Chromium   |                  |                                 |                  |
| 21. Fluoride   |                  |                                 |                  |
| 22. Hydrogen sulfide                                 |                  |                                 |                  |
| 23. Lead   |                  |                                 |                  |
| 24. Manganese  |                  |                                 |                  |
| 25. Mercury  |                  |                                 |                  |
| 26. Nickel   |                  |                                 |                  |
| 27. Platinum   |                  |                                 |                  |
| 28. Vanadium   |                  |                                 |                  |

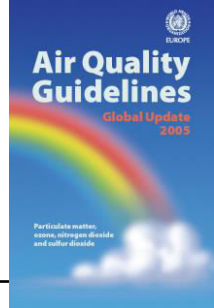
## AQGs, Global Update 2005

1. Particulate matter
2. Ozone
3. Nitrogen dioxide
4. Sulfur dioxide

\* Not re-evaluated (1987 evaluation retained)



# WHO AQG Global Update (2005): Summary



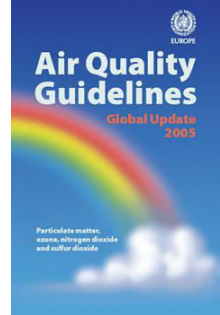
Pollutant	Averaging time	AQG value
Particulate matter <b>PM<sub>2.5</sub></b>	1 year	10 µg/m <sup>3</sup>
	24 hour (99 <sup>th</sup> percentile)	25 µg/m <sup>3</sup>
<b>PM<sub>10</sub></b>	1 year	20 µg/m <sup>3</sup>
	24 hour (99 <sup>th</sup> percentile)	50 µg/m <sup>3</sup>
<b>Ozone, O<sub>3</sub></b>	8 hour, daily maximum	100 µg/m <sup>3</sup>
<b>Nitrogen dioxide, NO<sub>2</sub></b>	1 year	40 µg/m <sup>3</sup>
	1 hour	200 µg/m <sup>3</sup>
<b>Sulfur dioxide, SO<sub>2</sub></b>	24 hour	20 µg/m <sup>3</sup>
	10 minute	500 µg/m <sup>3</sup>

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



Bonn, Germany  
14-15 April 2015

# WHO Air Quality Guidelines (2005): Summary for PM



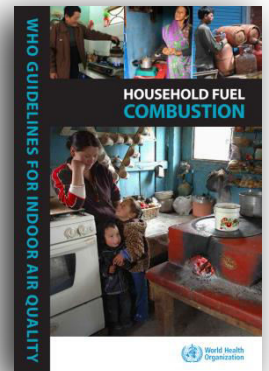
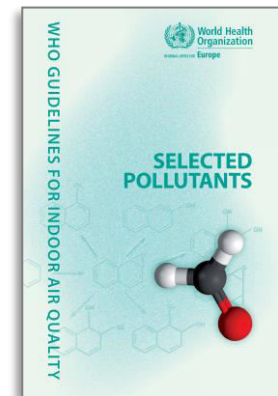
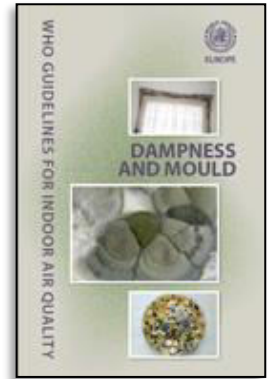
Annual mean level	PM <sub>10</sub> (µg/m <sup>3</sup> )	PM <sub>2.5</sub> (µg/m <sup>3</sup> )	Basis for the selected level
Interim target-1 (IT-1)	70	35	Levels associated with about 15% higher long-term mortality than at AQG
Interim target-2 (IT-2)	50	25	Risk of premature mortality decreased by approximately 6% compared to IT1
Interim target-3 (IT-3)	30	15	Mortality risk reduced by approximately 6% compared to IT2 levels.
<b>Air quality guideline (AQG)</b>	<b>20</b>	<b>10</b>	Lowest levels at which total, CP and LCA mortality have been shown to increase (Pope et al., 2002). The use of PM <sub>2.5</sub> guideline is preferred.





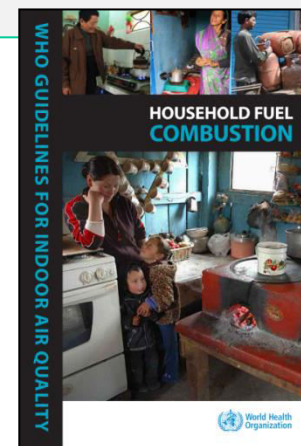
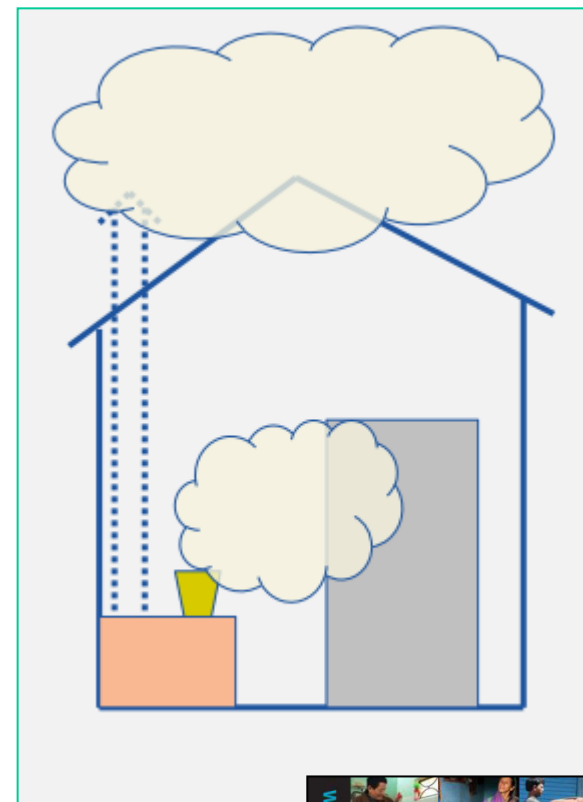
# WHO Indoor air quality guidelines

- Biological agents
  - Dampness and mould (2009)
- Selected pollutants (2010)
  - Formaldehyde
  - Naphthalene
  - Benzene
  - NO<sub>2</sub>
  - CO
  - Halogenated compounds (PCE, TCE)
  - PAHs
  - Radon
- Household fuel combustion (2014)



# WHO Indoor air quality guidelines: household fuel combustion

- Provide guidance on policies and impact of different fuels and technologies on health
  - for cooking, heating and lighting
- The home does not exist in isolation:
  - Household emissions enter ambient air, re-enter homes and lower IAQ: hence, total emissions should be minimized.
  - Local ambient air quality (from homes and other sources) affect IAQ: this must be considered in order to achieve clean indoor air
- Based on evidence, exclusive use of clean fuels is required to achieve WHO ambient Air Quality Guidelines (PM<sub>2.5</sub>)



# WHO Indoor air quality guidelines: household fuel combustion - Recommendations

1. Emission rate targets to meet the WHO ambient Air Quality Guidelines for CO and PM<sub>2.5</sub>
2. Household energy transition from traditional and low emission biomass to clean fuel use.
3. *“Unprocessed coal should not be used as a household fuel”*
4. *“Household combustion of kerosene should be discouraged while further research into its health impacts is conducted”*
5. Governments and other agencies developing and implementing policy on climate change mitigation should consider action on household energy and carry out relevant assessments to maximize health and climate gains



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# The Health Impacts of Air pollution

- ✓ Air pollution from both ambient sources and from household use of solid fuels is a recognized major health risk
- ✓ The global risk factor of **ambient particulate matter pollution** in terms of attributable DALYS increased a 6% between 2000 and 2013

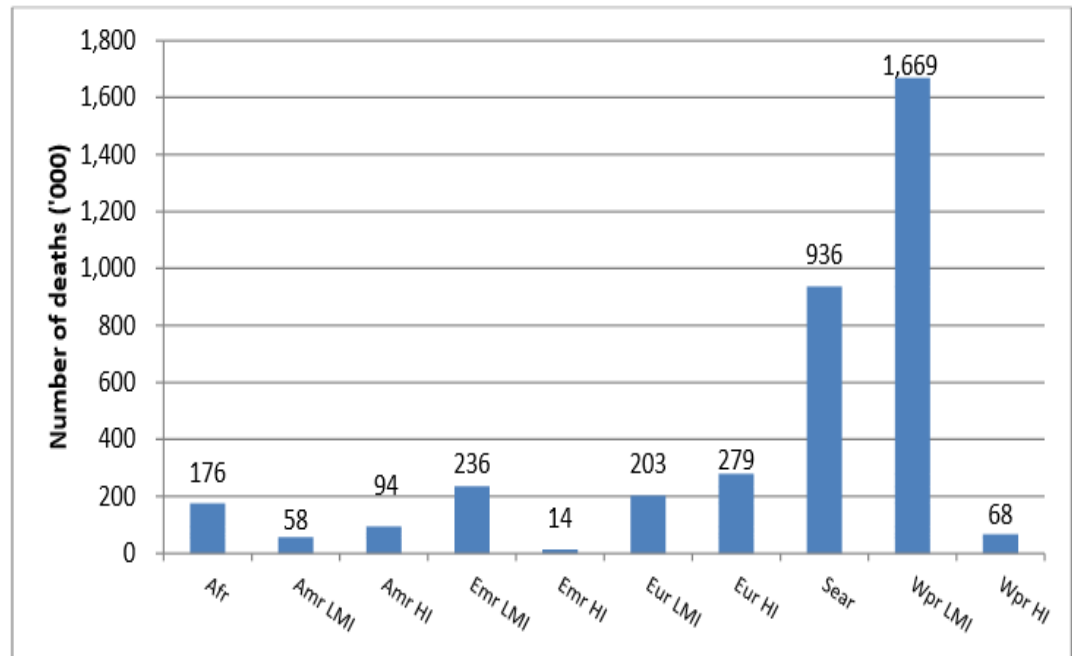
Mean rank (95% UI)	2000 leading risks	2013 leading risks	Mean rank (95% UI)	All age median % change	Age-standardised median % change
1-0 (1-1)	1 Childhood undernutrition	1 High blood pressure	1-0 (1-1)	20% (15 to 26)	-13% (-16 to -9)
2-0 (2-2)	2 High blood pressure	2 Smoking	2-6 (2-4)	5% (-1 to 11)	-23% (-28 to -19)
3-3 (3-4)	3 Smoking	3 High body-mass index	2-8 (2-5)	26% (22 to 31)	-7% (-11 to -5)
4-0 (3-6)	4 Unsafe water	4 Childhood undernutrition	4-2 (3-6)	-45% (-51 to -39)	-50% (-55 to -44)
5-2 (4-8)	5 High body-mass index	5 High fasting plasma glucose	4-6 (3-6)	31% (25 to 36)	-4% (-8 to 0)
6-9 (5-11)	6 Alcohol use	6 Alcohol use	6-9 (5-9)	6% (2 to 11)	-17% (-20 to -13)
7-6 (5-11)	7 Household air pollution	7 Household air pollution	9-1 (8-12)	-10% (-21 to 2)	-28% (-38 to -18)
7-9 (5-11)	8 High fasting plasma glucose	8 Unsafe water	10-4 (8-14)	-37% (-44 to -30)	-43% (-49 to -37)
9-2 (6-12)	9 Unsafe sanitation	9 Unsafe sex	10-8 (8-13)	-3% (-11 to 7)	-20% (-26 to -11)
11-5 (8-14)	10 Unsafe sex	10 Low fruit	10-8 (7-16)	7% (1 to 14)	-22% (-26 to -16)
12-0 (6-17)	11 Suboptimal breastfeeding	11 High sodium	11-4 (5-20)	15% (7 to 24)	-16% (-22 to -10)
12-6 (7-18)	12 Low fruit	12 Ambient particulate matter	11-9 (10-14)	6% (1 to 12)	-17% (-21 to -13)
13-8 (12-15)	13 Ambient particulate matter	13 High total cholesterol	13-4 (9-17)	13% (6 to 22)	-18% (-23 to -12)
13-9 (6-22)	14 High sodium	14 Low glomerular filtration	15-8 (14-18)	24% (19 to 30)	-7% (-11 to -3)
15-9 (13-19)	15 High total cholesterol	15 Low whole grains	16-3 (13-20)	17% (12 to 23)	-14% (-18 to -10)
17-3 (14-21)	16 Iron deficiency	16 Unsafe sanitation	17-0 (14-20)	-42% (-48 to -36)	-47% (-53 to -42)
17-3 (15-21)	17 Handwashing	17 Low physical activity	18-5 (16-21)	20% (15 to 27)	-13% (-17 to -9)
18-8 (16-21)	18 Low whole grains	18 Iron deficiency	18-6 (14-22)	-10% (-14 to -7)	-19% (-22 to -16)
19-6 (18-22)	19 Low glomerular filtration	19 Suboptimal breastfeeding	18-6 (14-23)	-40% (-47 to -32)	-44% (-51 to -37)
21-0 (19-22)	20 Low vegetables	20 Low vegetables	20-2 (18-22)	4% (-2 to 10)	-24% (-28 to -20)
21-1 (19-22)	21 Low physical activity	21 Handwashing	22-5 (21-25)	-37% (-44 to -31)	-43% (-49 to -37)
23-9 (23-27)	22 Low nuts and seeds	22 Drug use	23-1 (22-25)	33% (27 to 40)	10% (5 to 15)
25-0 (23-30)	23 Vitamin A deficiency	23 Low nuts and seeds	24-0 (21-28)	2% (-3 to 8)	-25% (-29 to -21)
25-3 (23-28)	24 Drug use	24 Low omega-3	25-9 (23-29)	16% (7 to 27)	-15% (-21 to -7)
27-2 (24-32)	25 Low omega-3	25 Low fibre	26-1 (24-28)	15% (3 to 29)	-16% (-24 to -5)
	26 Low fibre	36 Vitamin A deficiency			

■ Environmental AND HEALTH PROCESS  
■ Behavioural  
■ Metabolic

Source: Global Burden of Disease Study  
The Lancet, September 2015

# The Health Impacts of Air pollution

- ✓ The number of deaths attributable to ambient air pollution (AAP) increased steadily worldwide since 1990 (*GBD Study, 2015*).
- ✓ WHO estimates that **3.7 million persons died prematurely in 2012** due to the effects of AAP.
- ✓ Although the **Western Pacific and South East Asian regions bear most of the burden**, this represents a **global public health issue**.



AAP: Ambient air pollution; Amr: America, Afr: Africa; Emr: Eastern Mediterranean, Sear: South-East Asia, Wpr: Western Pacific; LMI: Low- and middle-income; HI: High-income.

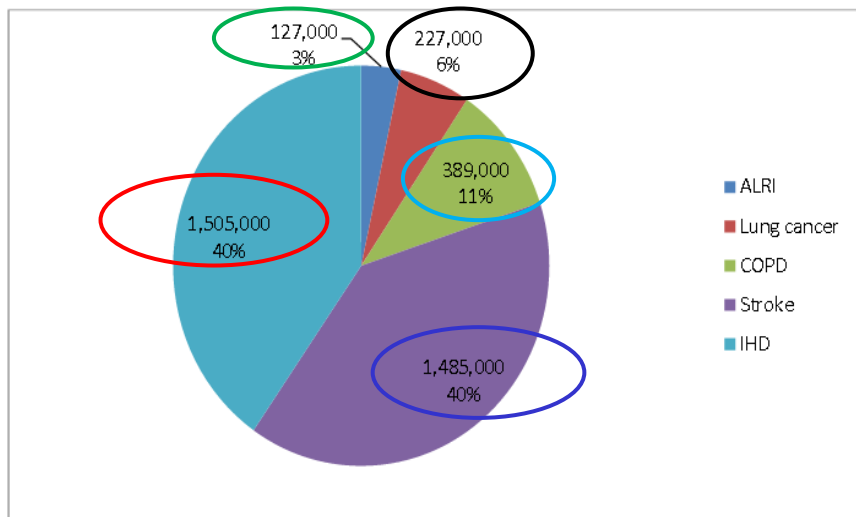
(WHO, 2012)



# The Health Impacts of Air pollution

## Global Burden of disease from Ambient Air Pollution (2012)

Figure 3. Deaths attributable to AAP in 2012, by disease

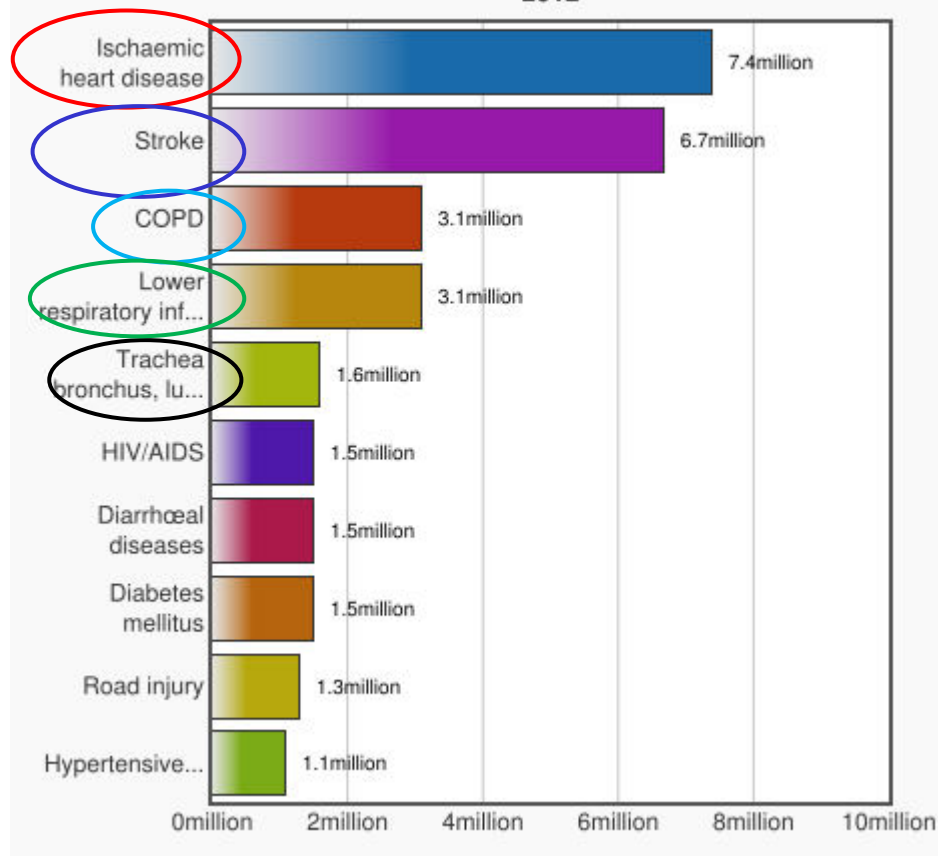


Percentage represents percent of total AAP burden (add up to 100%).

AAP: Ambient air pollution; ALRI: Acute lower respiratory disease; COPD: Chronic obstructive pulmonary disease; IHD: Ischaemic heart disease.

Sources: WHO; 2012, 2014

## The 10 leading causes of death in the world 2012



➤ **Satellite-derived estimates suggest that 30% of the global population lived in regions above the WHO IT1 standard ( $35 \mu\text{g}/\text{m}^3$ ) for PM<sub>2.5</sub> in 2010-2012, up from 22% in 1998-2000 (Van Donkelaar et al, 2015).**



# REVIHAAP and HRAPIE:

## 26 Key policy-relevant questions for the EU

- Covers regulated air pollutants at EU level
  - **PM, ozone, NO<sub>2</sub>, SO<sub>2</sub>, metals (As, Cd, Hg, Pb, Ni), PAHs**
- New findings regarding health effects
- Concentration-response functions and thresholds
- Air pollution constituents and sources
- Integration of evidence and policy implications
  - **WHO air quality guidelines**
  - EU policies
- Critical data gaps



Review of evidence  
on health aspects of  
air pollution –  
REVIHAAP Project

Technical Report



This publication arises from the project REVIHAAP and has received funding from the European Union.



EUROPEAN ENVIRONMENT  
AND HEALTH PROCESS



# Implications of REVIHAAP project for WHO guidelines (1/2)

- REVIHAAP experts recommend revision of WHO air quality guidelines, Global Update 2005
- PM:
  - Need to revise guidelines for PM<sub>2.5</sub> and PM<sub>10</sub> (24-hr and annual)
  - Additional guideline to capture effects of road vehicle PM emissions, building on black carbon evidence
  - Evidence on others, such as ultrafine and organic carbon, too scarce for guideline development



# Implications of REVIHAAP project for WHO guidelines (2/2)

- **Ozone:**
  - **Additional guideline for long-term (months to years) average ozone to be considered**
- **NO<sub>2</sub>:**
  - **Short-term and long-term effects to be considered during guideline revision**
- **SO<sub>2</sub>:**
  - **Need to revisit the evidence base for setting the guidelines for very short-term and short-term**



## Health and the environment: addressing the health impact of air pollution

The Sixty-eighth World Health Assembly,

Having considered the report on health and the environment: addressing the health impact of air pollution;<sup>1</sup>

Reaffirming its commitment to the outcome document of the Rio+20 Conference “The future we want”, in which all States Members of the United Nations committed to promoting sustainable development policies that support healthy air quality in the context of sustainable cities and human settlements, and recognized that reducing air pollution leads to positive effects on health;<sup>2</sup>

Noting with deep concern that indoor and outdoor air pollution are both among the leading avoidable causes of disease and death globally, and the world’s largest single environmental health risk;<sup>3</sup>

Acknowledging that 4.3 million deaths occur each year from exposure to household (indoor) air pollution and that 3.7 million deaths each year are attributable to ambient (outdoor) air pollution, at a high cost to societies;<sup>4</sup>

Aware that exposure to air pollutants, including fine particulate matter, is a leading risk factor for noncommunicable diseases in adults, including ischaemic heart disease, stroke, chronic obstructive pulmonary disease, asthma and cancer, and poses a considerable health threat to current and future generations;

Concerned that half the deaths due to acute lower respiratory infections, including pneumonia in children aged less than five years, may be attributed to household air pollution, making it a leading risk factor for childhood mortality;

<sup>1</sup> Document A68/18.

<sup>2</sup> UNEA resolution 1/7, PP6.

<sup>3</sup> Global Health Observatory <http://www.who.int/gho/phe/en/> (accessed 18 March 2015).

<sup>4</sup> WHO. Burden of disease from ambient air pollution for 2012. [http://www.who.int/phe/health\\_topics/outdoorair/databases/AAP\\_BoD\\_results\\_March2014.pdf?ua=1](http://www.who.int/phe/health_topics/outdoorair/databases/AAP_BoD_results_March2014.pdf?ua=1) (accessed 1 December 2014).

# First World Health Assembly Resolution on Air Pollution and Health



# WHA Resolution and mandate for update of guidelines

- ✓ The **WHA Resolution recognizes** that :

(PP12) Noting that WHO's air quality guidelines for both ambient air quality<sup>2</sup> (2005) and indoor air quality<sup>3</sup> (2014) provide guidance and recommendations for clean air that protect human health and recognizing that these need to be supported by activities, such as the promotion and facilitation of implementation;

- ✓ ...and requests the Director-General to **significantly strengthen WHO's capacities in the field of air pollution and health** in order to **provide:**

(c) Further identification, development and regular updating of WHO air quality guidelines and cost-benefit tools, including monitoring systems, to support effective and efficient decision making;

*Source: Sixty-Eighth WORLD HEALTH ASSEMBLY  
Agenda item 14.6 , 26 May 2015.*



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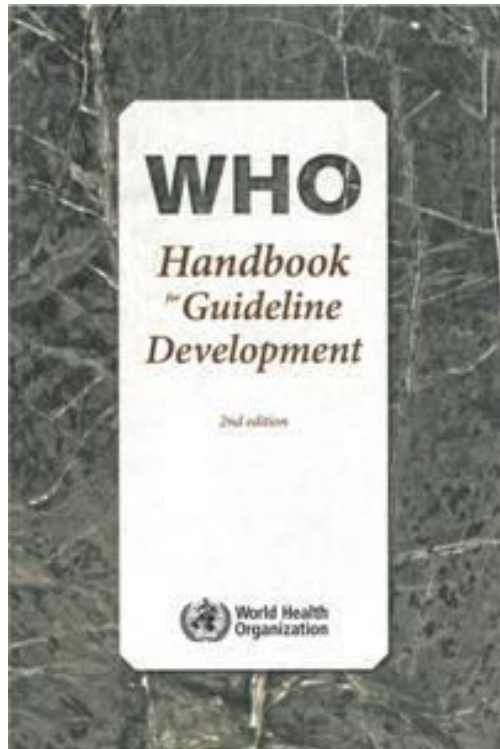


# WHO Air Quality Guidelines update

- ✓ The **estimated timeline** of the process of updating the WHO ambient AQGs is at least 3 years, to start early 2016.
- ✓ Funding obtained so far from WHO and the European Commission (DG-Environment).
- ✓ Will consist of 3 main stages:
  - **Planning**
  - **Development**
  - **Publishing/Updating.**



# Developing WHO Guidelines



- ✓ Last edition was published in 2014, as a step-by-step guidance manual on how to plan, develop and publish a World Health Organization (WHO) guideline.
- ✓ It covers the methods, processes and procedures for producing a document that meets WHO standards.



# Guideline Development Process I

Table 1.1. The guideline development process at WHO

Stage/primary contributor	Step	Chapter
<b>Planning</b>		
WHO Member State, WHO country office or public/private entity	Request guidance on a topic	1
WHO technical unit	Determine if a guideline is needed; review existing WHO and external guidelines	2
	Obtain approval for guideline development from the director of the relevant technical unit at WHO	2
	Discuss the process with the GRC Secretariat and with other WHO staff with experience in developing guidelines	2
	Form the WHO guideline steering group	3
WHO guideline steering group	Identify sufficient resources; determine the timeline	2
	Draft the scope of the guideline; begin preparing the planning proposal	2,4
	Identify potential members of the GDG and its chair	3
	Obtain declaration of interests and manage any conflicts of interest among potential GDG members	6
WHO guideline steering group and GDG	Formulate key questions in PICO format; prioritize outcomes	5,7
WHO guideline steering group	Finalize the planning proposal and submit it to the GRC for review	4
GRC	Review and approve the planning proposal	4
<b>Development</b>		
Systematic review team	Perform systematic reviews of the evidence for each key question	8
	Evaluate the quality of the evidence for each important outcome, using GRADE as appropriate	9
WHO guideline steering group	Convene a meeting of the GDG	10,11
GDG	Formulate recommendations using the GRADE framework	10,11
WHO steering group	Draft the guideline document	10,11
External review group	Conduct external peer review	12
<b>Publishing and updating</b>		
WHO guideline steering group and editors	Finalize the guideline document; perform copy-editing and technical editing; submit the final guideline to the GRC for review and approval	12
GRC	Review and approve the final guideline	12
WHO guideline steering group and editors	Finalize the layout; proofread	12
	Publish (online and in print as appropriate)	12
WHO technical unit and programme manager	Disseminate, adapt, implement, evaluate	13
WHO technical unit	Update	12

**Consultation with worldwide experts from different fields related to Air Quality and Health on the latest evidence for a number of air pollutants and other issues, relevant for inclusion in update of ambient Air Quality Guidelines (Sept 2015)**

GDG: guideline development group; GRADE: Grading of Recommendations Assessment, Development and Evaluation; GRC: Guideline Review Committee; PICO: population, intervention, comparator, and outcome.

Source: WHO handbook for guideline development. 2nd edition, 2014





# Guideline Development Process II

- **Guideline process must include a systematic review of scientific evidence to support recommendations**
  - **Large number of existing recommendations for a variety of air pollutants is a challenge for updating guidelines**
  - **Priority to be given to controversial areas, or those in which new evidence has emerged:**
    - **PM (PM<sub>2.5</sub>, PM<sub>10</sub>)**
    - **NO<sub>2</sub>**
    - **O<sub>3</sub>**
    - **SO<sub>2</sub>**
    - **CO**



# Take away messages

- **Ambient air quality is a leading environmental risk factor for health, globally and for Africa and Middle-East as well**
- **Ambient air pollution contributes to premature death and disease (cardiovascular and respiratory diseases, and lung cancer)**
- **WHO has published several editions of guidelines to protect public health from air pollution and will provide updated guidelines:**
  - **As a result of explicit mandate from WHA Resolution**
  - **Reflecting scientific evidence accumulating on the variety and severity of health effects linked with air pollution**



# WHA Resolution: Acknowledgement of importance of natural sources

(PP9) Cognizant that most air pollutants are emitted as a result of the human activities identified as sources of air pollution<sup>3</sup> in the WHO guidelines on ambient and indoor air pollution, and that there are also naturally occurring phenomena that negatively affect air quality<sup>4</sup> and noting that there is a significant interrelation between outdoor and indoor air quality;

<sup>4</sup> These include, inter alia, Radon, [a carcinogenic], dust- and sandstorms, volcanic eruptions and forest fires.

(PP10) Acknowledging recent global efforts to promote air quality, in particular the 2014 United Nations Environment Assembly resolution on air quality, as well as the many national and regional initiatives to mitigate the health impacts of indoor and outdoor air pollution, and noting that regional and sub-regional co-operation frameworks provide good opportunities to address air quality issues according to the specific circumstances of each region;

(PP15 bis bis) Underlining that higher temperatures, heatwaves, dust- and sandstorms, volcanic eruptions and forest fires can also exacerbate the impact of anthropogenic air pollution on health,

