Public Health Relevance of Air Pollution

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Air Pollution

Air pollution

- Air pollution is a mixture of solid particles and gases in the air *(ref: Environmental Protection Agency, EPA)*

- Air pollution refers to the release of pollutants into the air that are detrimental to human health and the planet as a whole (ref: Natural Resources Defense Council, NRDC)

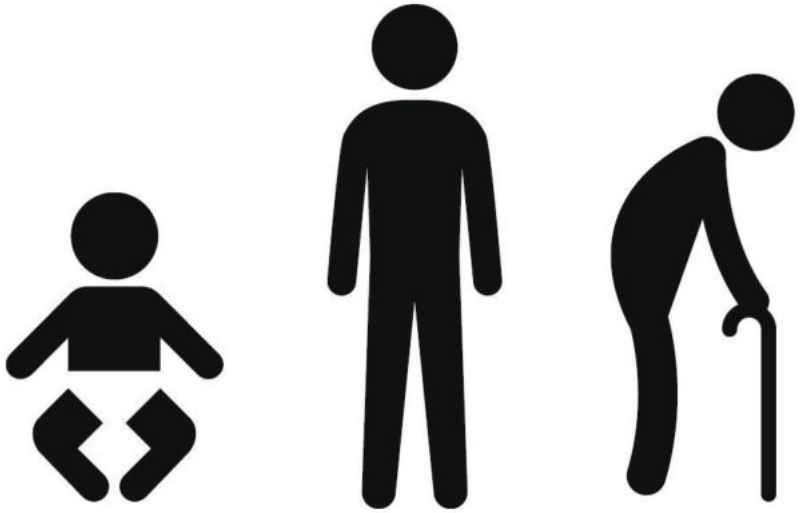
- Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere (ref: WHO)

Streets of Tbilisi. Author: Dr. Love, graffiti/street artist from Georgia

A view from a window in Tbilisi. Author: Zinka Barnovi

Who is affected?

- Everyone….

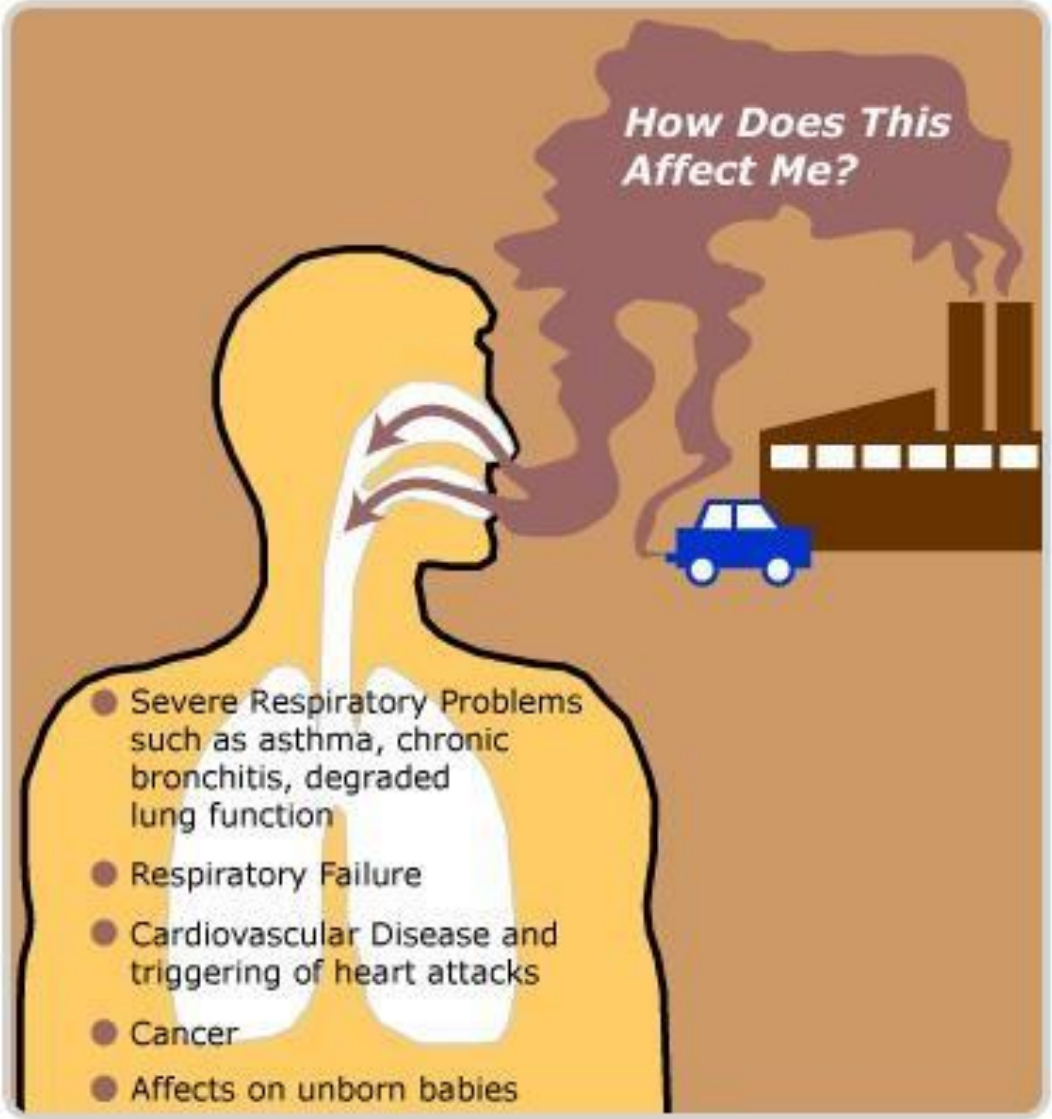


Air pollution affects 100% of the population from unborn babies to the very elderly

european respiratory society every breath counts

Why it matters?

- Every year more people die prematurely by outdoor air pollution than HIV/AIDS and Malaria combined (Lelieveld J. et al. 2015)
- 4.2 million deaths every year due to ambient (outdoor) air pollution
- 3.8 million deaths every year due to exposure to smoke from dirty cookstoves and fuels
- **91% of premature deaths occurring in low- and middle-income countries,** and the greatest burden in the WHO South-East Asia and Western Pacific regions.
- In 2016, 91% of the world population was living in places where the WHO air quality guidelines levels were not met.
- Particulate matter and ambient air pollution are proven group 1 human carcinogens
- *Ref: WHO; Lancet commission on pollution and health; Lelieveld J. et al. 2015 https://www.nature.com/articles/nature15371)*



GBD 2017 Risk Factor Collaborators

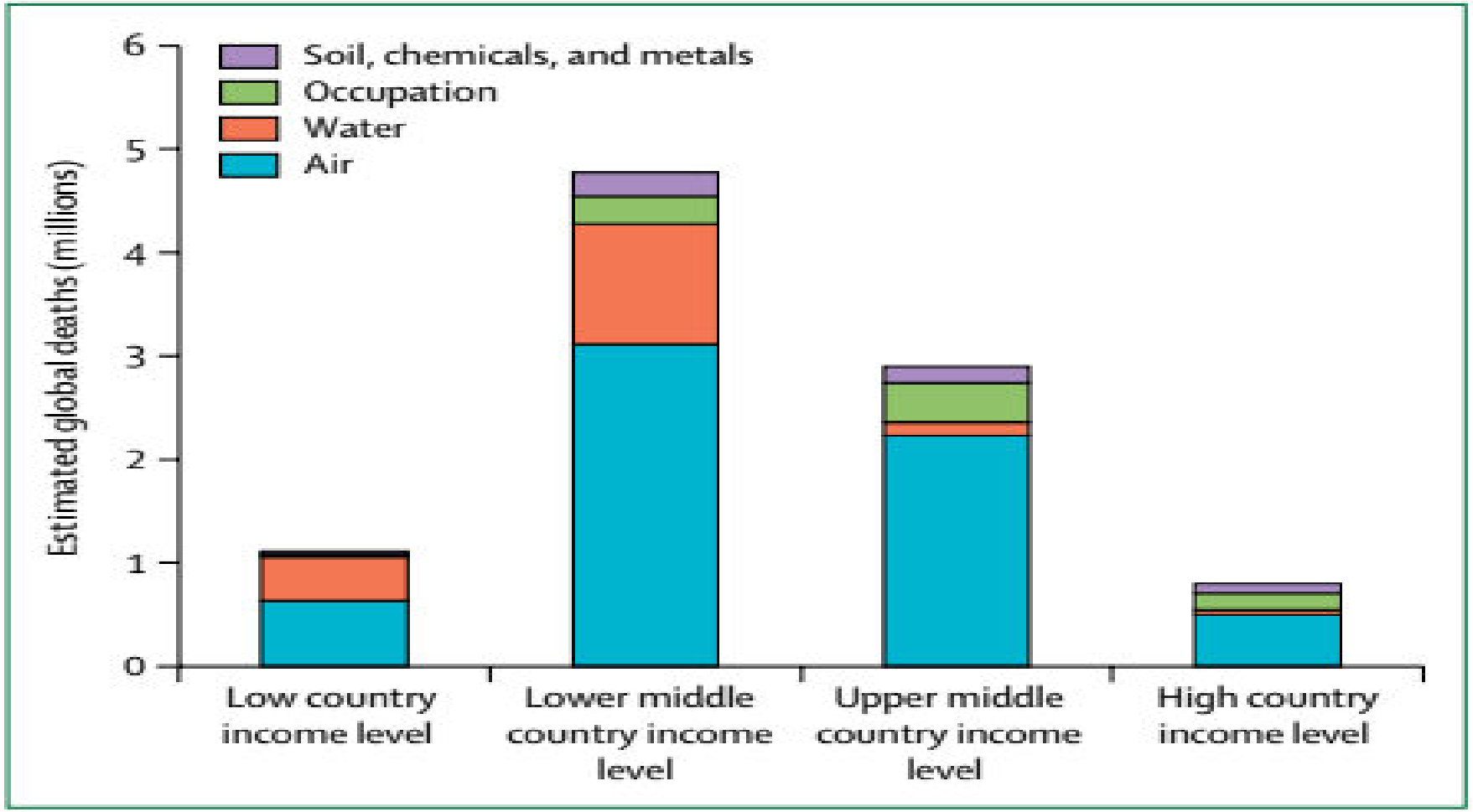
A Both sexes

Leading risks 1990	Leading risks 2007	Mean percentage change in number of DALYs, 2007–17	Mean percentage change in all-age DALY rate, 2007–17	Mean percentage change in age-standardised DALY rate, 2007–17	Leading risks 2017	Mean percentage change in number of DALYs, 2007–17	Mean percentage change in all-age DALY rate, 2007–17	Mean percentage change in age-standardised DALY rate, 2007–17
1 Child wasting	1 High systolic blood pressure	22·0	−2·8	−19·4	1 High systolic blood pressure	20·0	6·3	−8·0
2 Short gestation for birthweight	2 Short gestation for birthweight	−24·2	−39·6	−24·2	2 Smoking	8·2	−4·1	−16·4
3 Low birthweight for gestation	3 Smoking	10·3	−12·1	−25·8	3 High fasting plasma glucose	25·5	11·2	−3·2
4 Smoking	4 Child wasting	−47·7	−58·3	−47·9	4 High body-mass index	36·7	21·1	6·8
5 High systolic blood pressure	5 Low birthweight for gestation	−22·5	−38·2	−22·7	5 Short gestation for birthweight	−21·3	−30·3	−24·0
6 Unsafe water source	6 High fasting plasma glucose	51·4	20·7	0·8	6 Low birthweight for gestation	−21·8	−30·8	−24·7
7 Household air pollution	7 High body-mass index	66·2	32·5	11·7	7 Alcohol use	5·5	−6·6	−13·1
8 Child underweight	8 Alcohol use	37·4	9·5	−2·9	8 High LDL cholesterol	17·2	3·8	−9·3
9 Unsafe sanitation	9 Unsafe water source	−38·2	−50·7	−41·8	9 Child wasting	−40·1	−46·9	−43·1
10 Vitamin A deficiency	10 Unsafe sex	302·2	220·6	187·4	10 Ambient particulate matter	12·8	−0·1	−9·3
11 High fasting plasma glucose	11 High LDL cholesterol	17·2	−6·6	−22·8	11 Low whole grains	15·5	2·3	−9·7
12 No access to handwashing facility	12 Household air pollution	−37·1	−49·9	−47·0	12 High sodium	22·7	8·7	−5·9
13 Child stunting	13 Ambient particulate matter	17·3	−6·5	−8·8	13 Low fruit	7·7	−4·6	−15·7
14 Alcohol use	14 Low whole grains	23·4	−1·6	−17·0	14 Unsafe water source	−29·1	−37·2	−35·7
15 High LDL cholesterol	15 Unsafe sanitation	−41·2	−53·1	−44·6	15 Impaired kidney function	20·3	6·6	−5·4
16 High body-mass index	16 Low fruit				16 Household air pollution			
17 Ambient particulate matter	17 Child underweight				17 Unsafe sex			
18 Low whole grains	18 High sodium				20 Unsafe sanitation			
20 Low fruit	19 No access to handwashing facility							
30 Unsafe sex	20 Impaired kidney function							
	21 Vitamin A deficiency							
	23 Child stunting							

Ref: Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. www.thelancet.com Vol 392 November 10, 2018

Air Pollution's "share" among other environmental hazards…

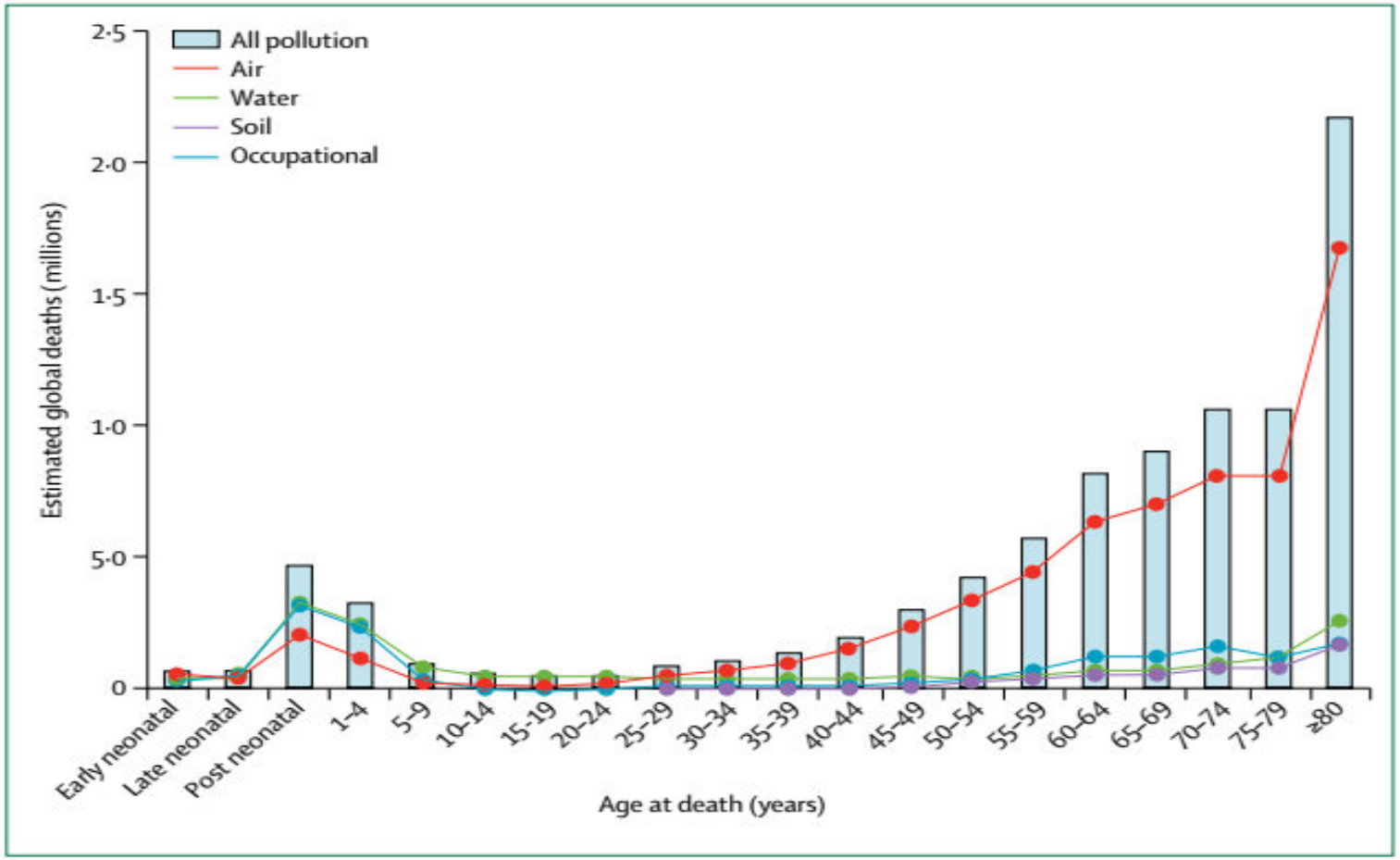
(Estimated deaths by pollution risk factor and country income level, 2015 GBD Study, 2016.)



Source: The Lancet Commission on Pollution and Health (2017)

Estimated global deaths by pollution risk factor and age at death

(2015 GBD Study, 2016)



Source: The Lancet Commission on Pollution and Health (2017)

Macro-environment

outdoor air pollution

traffic-related/urban air pollution; industry & power generation; agriculture & intensive animal breeding; aeroallergens & natural sources; …

“Common” air pollutants…

The major pollutants in (economically) “developed” countries:

- Sulphur Dioxide (SO2)
- Nitrogen Oxides (nox) including Nitrogen Dioxide (NO2)
- Volatile Organic Compounds (VOCs)
- Particulate matter (PM)
- Ammonia (NH3).

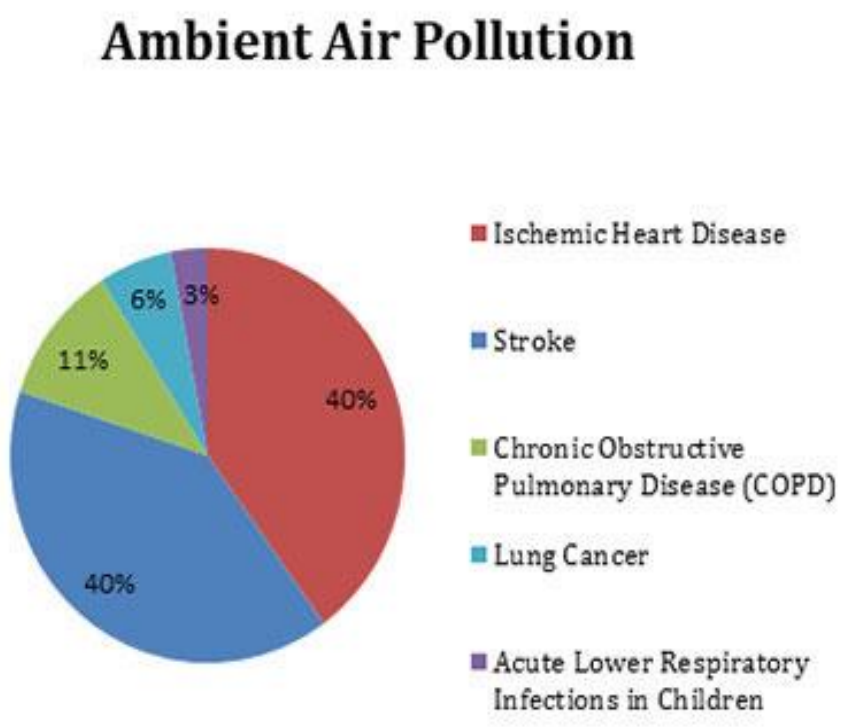
“Air Quality and Health” report, ERS, 2010

Public health implications of air pollution…?

- Just as medicine should be evidence based, public health action and policy must be grounded in science.
- Understanding the public health implications of air pollution is challenging for researchers and policy-makers
- Scientific knowledge must be communicated to policy-makers in a comprehensible way.

Air Pollution Caused Deaths – Breakdown by Disease

Air pollution is a critical risk factor for non-communicable diseases (NCDs).

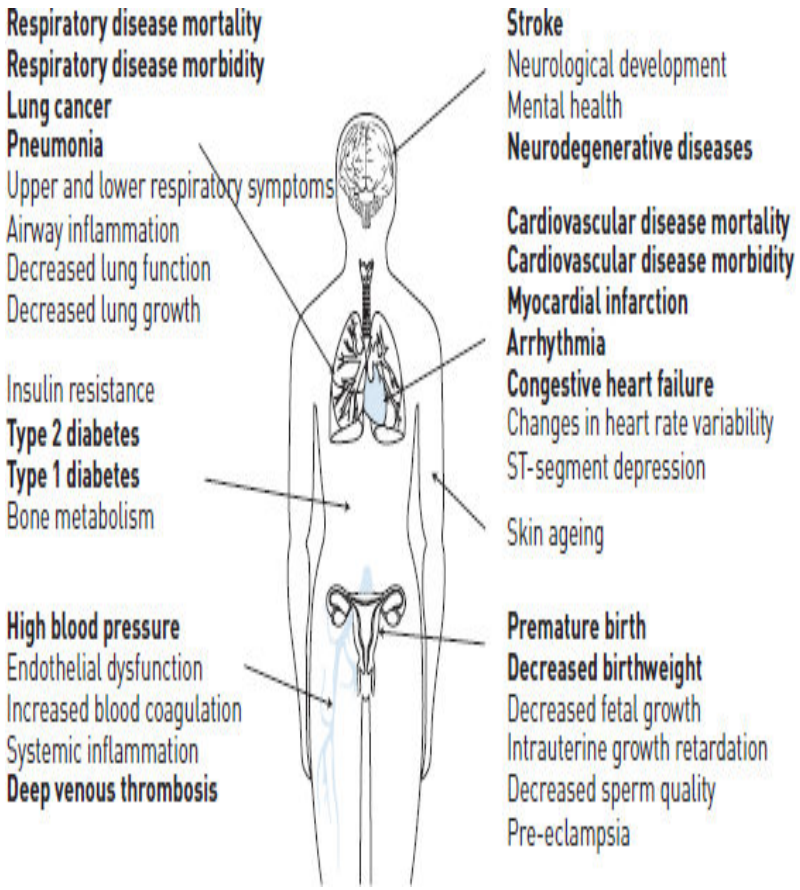


Outdoor air pollution-caused deaths – breakdown by disease:

- 40% – ischaemic heart disease;
- 40% – stroke;
- 11% – chronic obstructive pulmonary disease (COPD);
- 6% - lung cancer; and
- 3% – acute lower respiratory infections in children.

*Source: **WHO** http://www.who.int/mediacentre/news/releases/2014/air-pollution/en/*

Overview of diseases, conditions and biomarkers affected by outdoor air pollution



- **Air pollution is a complex issue, as are its health effects, ranging across numerous and unspecific health conditions.**
- **Where does pollutants come first?**
  - The **nose and lungs** are where pollution first comes into contact with the human body.
  - pollutants may impact at various depths within the respiratory system.
    - coarse particles affect the upper airways
    - fine particles reach the smaller airways and alveoli
    - Watersoluble gases (such as So2) react with the mucus layer of the upper airways
    - less soluble gases (such as no2) reach the alveoli.

Eur Respir J, 2017

Air pollution and adverse health effects

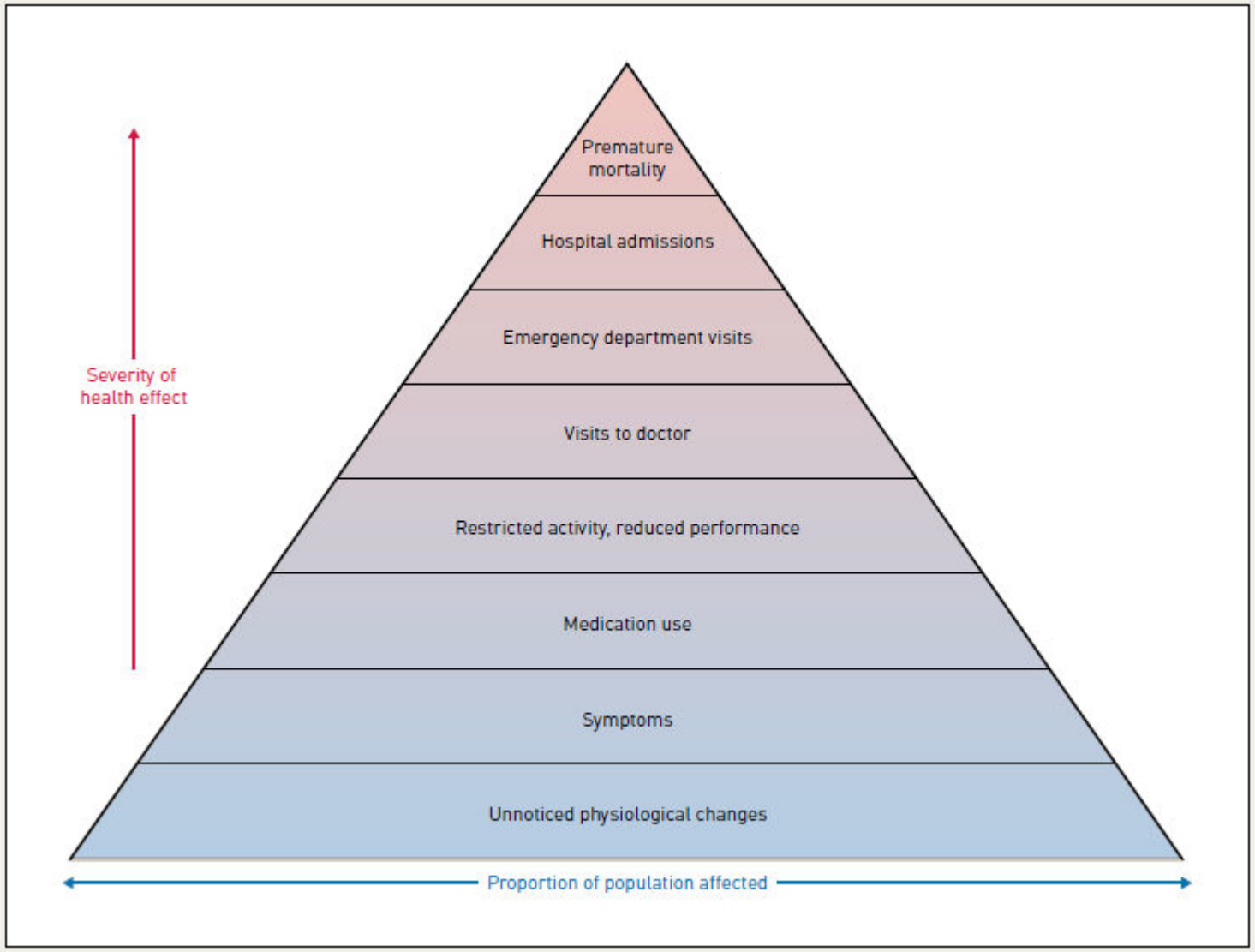


Figure 6a.1. Pyramid of health effects associated with air pollution [21].

deaths

hospital admissions

primary care visits

medication use

symptoms

growth & development

http://www.ersnet.org/images/stories/pdf/web-AQ2010-ENG.pdf

Acute and chronic Health effects

- The acute effects of air pollution may be felt within hours or days of exposure
- Other health effects result from long-term chronic exposures and lead to chronic pathologies
- These effects are interrelated, but the distinction is important when planning and interpreting epidemiological studies
- Acute effect studies are focused on short term associations between air pollution and frequencies of events such as hospitalization, myocardial infarction, stroke or death.
- Long-term effects studies are focused on pre-clinical or clinical pathological conditions (e.g. calcification of the arteries), functional states (e.g. lung function), prevalences of chronic diseases (e.g. chronic obstructive pulmonary disease (COPD), or life expectancy
- the effects could be the consequence of one or several ambient pollutants whose presence correlates with the marker used in the studies.

"Air Quality and Health" report, ERS, 2010

Public health relevance of air pollution

- Epidemiology, toxicology, and molecular science, increase knowledge on air pollution and health, but are observed associations “relevant” in the prism of public health stays unanswered

because…

- From public health (and decision makers) perspective “relevance” must be considered to efficiently allocate resources and ameliorate health of public

Ref: Künzli N., Eur Resp J 2002

Major criteria in judging the public health relevance of environmental exposure

Domain of judgement	Criterion
Exposure	Probability of exposure Intensity of exposure Frequency of exposure Duration of exposure Life period of exposure Number of people exposed Degree of choice (voluntary exposure?) Benefit of source that causes the exposure
Health effect	Type of health effect Degree and intensity of effect Size of effect (e.g. relative risk) Specificity of effect (other causes ?) Acute versus chronic effect Frequency of health outcome among non exposed Reversibility of effect Acceptance of effect Costs of effects
Abatement/prevention	Number of susceptible among exposed Feasibillity of abatement strategies Costs of abatement Benefits of abatement Specificity of the abatement strategy Reversibility of health problems Time of benefit of abatement Acceptance of abatement strategy Level of abatement (e.g. individual behavior versus structural)

Ref: Künzli N., Eur Resp J 2002

Air pollution as a classic public health “paradigm”

- Health risks of air pollution are small on an individual scale, but affects everyone, and risks increase with the prolonged exposure, so health risk of air pollution is significant on a public health scale

- Public health benefits of clean air policies are large, given the long-term everyday exposure of entire populations

- “Air pollution and health” is a classic public health paradigm- problem of small effects among individuals but large impact in the total population

Ref: Künzli N., Eur Resp J 2002

Addressing air pollution- context

- The individual has very little influence on outdoor air quality
- Air quality and public health benefits happen with lag which can be longer than one election period- (not a “popular” policy decision)
- Air quality polluter industries have money and can lobby their interests

Air pollution and climate change: a common battle

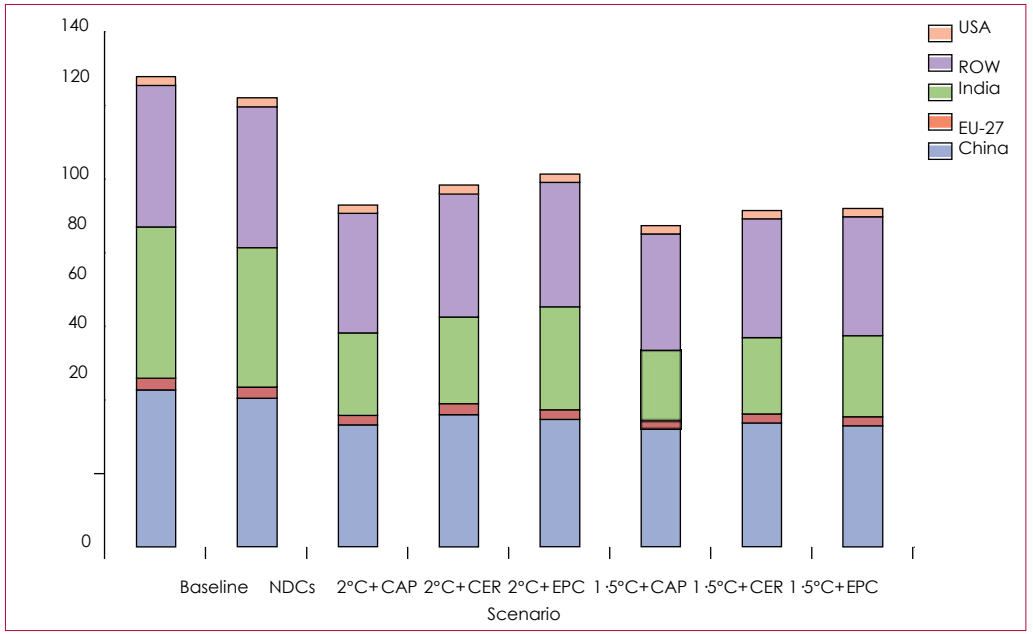
- Policy makers have been treating air pollution and climate change as separate issues
- Climate change and air pollution are important, inter- related problems.
- Air pollution affects the regional and global climate- most greenhouse gas emissions are linked to air pollution emissions.
- The key sources of both problems overlap: fossil fuel combustion in energy, industrial production, transport- are responsible for most carbon dioxide emissions and much of the air pollution.
- **Thus, many strategies that cut combustion come with attractive co-benefit**

Health co-benefits from air pollution and mitigation costs of the Paris Agreement: a modelling study

***(Markandya A, et al. Lancet Planet Health* 2018; 2: e 126–33)**

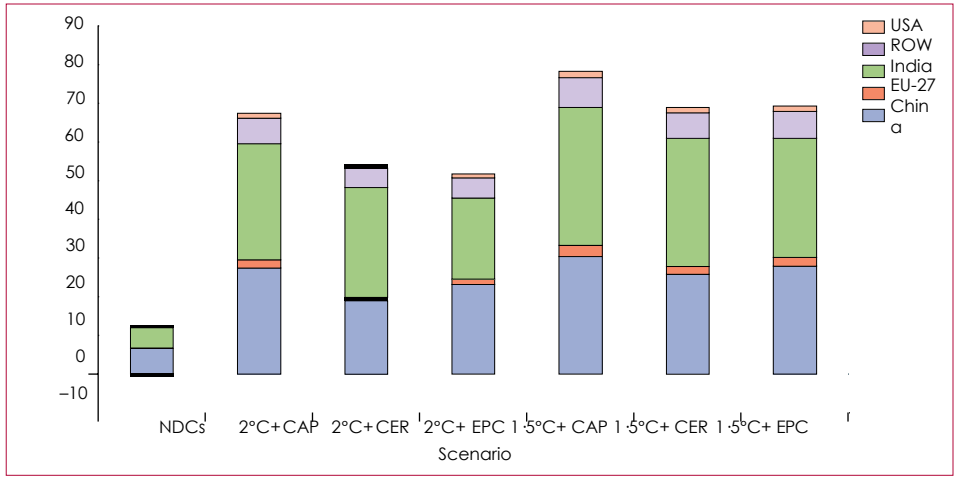
- Examined synergies between air pollution and climate change control policies
- Compared at the global and regional levels, several climate change mitigation scenarios in terms of air pollution and health impacts, and determined to what extent the extra cost of more restrictive mitigation target could be compensated by additional health co-benefits
- The results showed that, in all the scenarios, global health co-benefits are greater than the mitigation cost of achieving the target.

Cumulative premature deaths per region and scenario 2020-2050



NDCs=nationally determined contributions. CAP=capability scenario. CER=constant emission ratios scenario. EPC=equal per capita scenario. EU-27=the 27 countries of the European Union in 2007–13. ROW=the rest of the world

Cumulative health co-benefit per region and scenario, 2020–50



NDCs=nationally determined contributions. CAP=capability scenario. CER=constant emission ratios scenario. EPC=equal per capita scenario. EU-27=the 27 countries of the European Union in 2007–13. ROW=the rest of the world

Summary…

- Addressing air pollution is key to protecting public health
- Most sources of outdoor air pollution are beyond the control of individuals and demands coordinated action by local, national and regional level policy-makers working in sectors like transport, energy, waste management, urban planning, and agriculture.
- The target of policies should be a source-specific mixture of emissions rather than one single pollutant
- "For ambient air pollution, estimates should include the aesthetic value and the ecosystem benefits of cleaner air." *(Lancet Commission on Pollution and Health, 2018)*
- Clean air strategies simultaneously are climate change abatement strategies too
- Global Health co-benefits in terms of air pollution and health impacts, can be greater than climate change mitigation costs
- Science community and health professionals must be at the upfront for informing decision makers about the long term benefits of clean air strategies

WHO http://www.who.int/en/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health
Landrigan J.P. et al, 2018; The Lancet Commission on Pollution and Health Lancet 2018; 391: 462–512

Thank you…