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Environmental Health Determinants

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Outlines

- Overview of Environmental Health
- Nature and Magnitude of Environmental Diseases
- Preventive Approaches in Environmental Health

Overview of Environmental Health

Definition of Environmental Health

The WHO has given the definition of environmental health (1999) as:

“Those aspects of the human health and disease that are determined by factors in the environment. It also refers to the theory and practice of assessing and controlling factors in the environment that can potentially affect health.”

Environmental disease

- **Environmental disease**

- โรคหรือภาวะการเจ็บป่วยที่เกิดขึ้นจากปัจจัยทางด้านสิ่งแวดล้อม โดยไม่ใช่โรคที่ส่งผ่านไปยังตัวผู้ป่วยทางกรรมพันธุ์ หรือเกิดจากพฤติกรรมหรือวิถีชีวิตของผู้ป่วยโดยตรงหรือติดต่อโดยการติดเชื้อ

- **Pollution-related disease**

- โรคหรือการเจ็บป่วยที่เกิดจากการสัมผัสมลพิษสิ่งแวดล้อม ซึ่งอาจจะเป็นแบบเฉียบพลันหรือเรื้อรัง

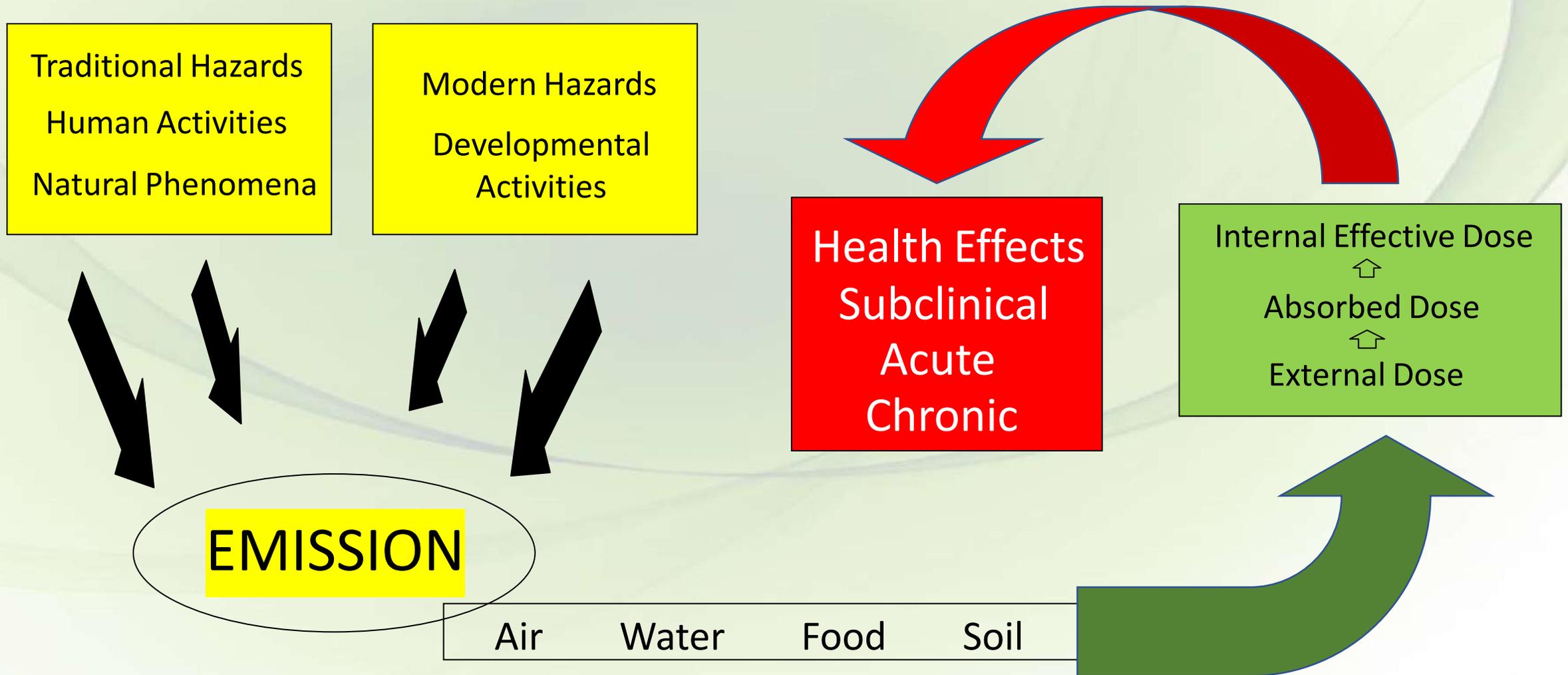
Vulnerable group

- หรือกลุ่มเปราะบางคือผู้ที่มีความเสี่ยงต่อการเกิดโรคจากสิ่งแวดล้อมได้มากเป็นพิเศษได้แก่
 - เด็ก
 - ผู้สูงอายุ
 - ผู้ที่มีโรคประจำตัวบางชนิด
- ผู้ที่ป่วยเป็นโรคทางพันธุกรรมหรือเป็นโรคจากสาเหตุอื่น ๆ อาจเป็นปัจจัยกระตุ้นให้เกิดโรคจากสิ่งแวดล้อมหรือการเจ็บป่วยจากโรคเดิมที่มีอยู่มีอาการรุนแรงมากขึ้น โดยถือว่าผู้ป่วยกลุ่มนี้เป็นกลุ่มเปราะบาง (**Vulnerable group**) เช่นกัน

แหล่งก่อโรค

- แหล่งกำเนิดมลพิษ
 - เกิดตามธรรมชาติ
 - เกิดจากการกระทำของมนุษย์
- สิ่งคุกคาม
 - Traditional Hazard
 - Modern Hazard

The conceptual framework of Environmental health hazard pathway



Nature and Magnitude of Environmental Diseases

NATURE AND MAGNITUDE OF ENVIRONMENTAL DISEASES

- **Traditional Hazards**--related to poverty and “insufficient” development
- **Modern Hazards**-- related to “development” that lacks health and environment safeguards, and to unsustainable consumption of natural resources

Traditional Hazards

- lack of access to **safe drinking-water**
- inadequate basic **sanitation** in the household and the community
- **food** contamination with pathogens
- **indoor air pollution** from cooking and heating using coal or biomass fuel
- inadequate **solid waste** disposal
- occupational injury hazards in **agriculture and cottage industries**
- **natural disasters**, including floods, droughts and earthquakes

Modern Environmental Hazards

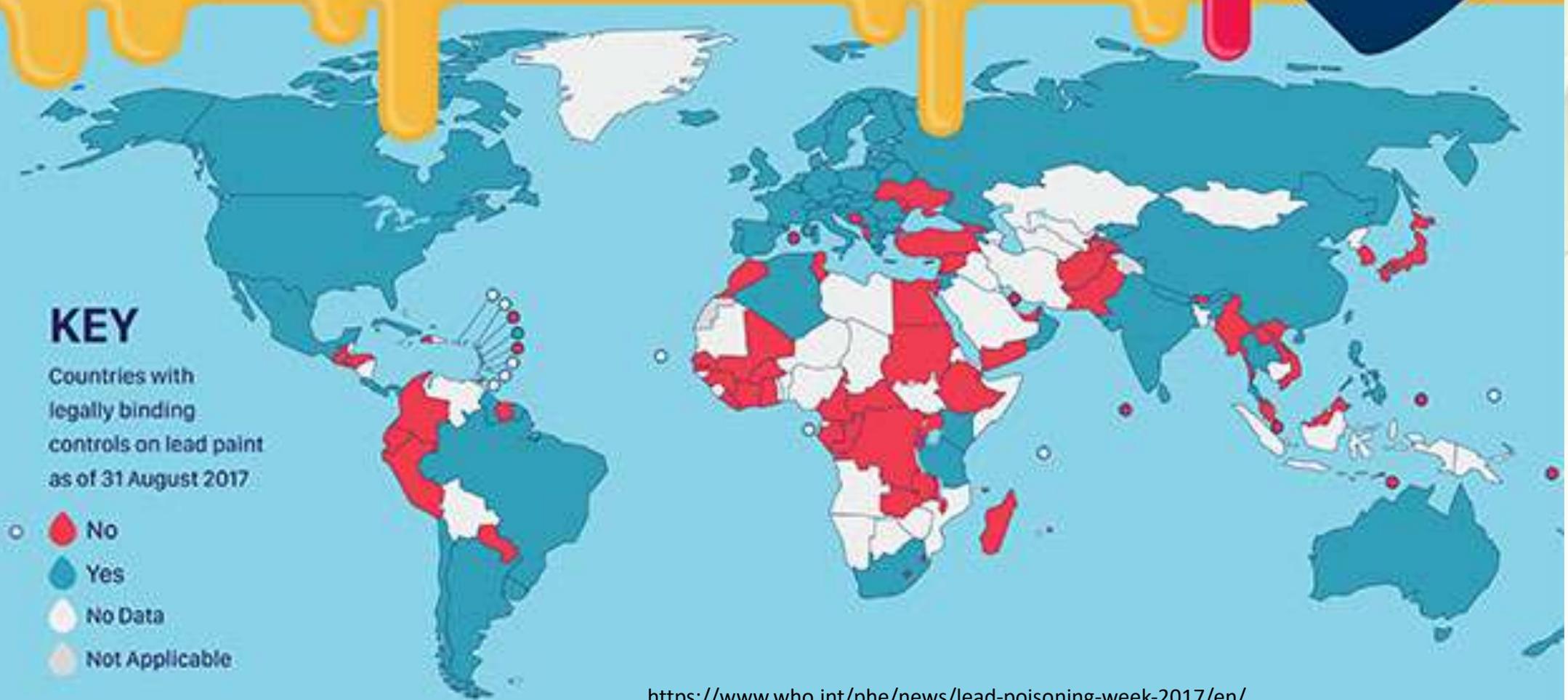
- water pollution from **populated areas**, industry and intensive agriculture
- urban air pollution from **motor cars, coal power stations** and **industry**
- solid and hazardous waste accumulation
- **chemical and radiation** hazards following introduction of industrial and agricultural technologies
- **emerging and re-emerging infectious disease** hazards
- **deforestation**, land degradation and other major ecological change at local and regional levels
- **climate change**, stratospheric ozone depletion and transboundary pollution

Burden of disease from lead exposure

- The Institute for Health Metrics and Evaluation (IHME) estimated that in 2017, lead exposure accounted for 1.06 million deaths and 24.4 million years of healthy life lost (disability-adjusted life years (DALYs)) worldwide due to long-term effects on health. The highest burden was in low- and middle-income countries. IHME also estimated that in 2016, lead exposure accounted for 63.2% of the global burden of idiopathic developmental intellectual disability, 10.3% of the global burden of hypertensive heart disease, 5.6% of the global burden of the ischaemic heart disease and 6.2% of the global burden of stroke

• Source: Institute for Health Metrics and Evaluation (IHME). GBD Compare. Seattle, WA: IHME, University of Washington; 2017.

FACT: As of August 2017, only 1/3 of countries have legally binding controls on lead paint



<https://www.who.int/phe/news/lead-poisoning-week-2017/en/>



<https://phys.org/news/2020-09-cadmium-pickers-higher.html>

Cadmium toxicity

Research has shown that cadmium affects the developing brain in children. Here are some other parts of the body it can effect.

RELATED HEALTH ISSUES

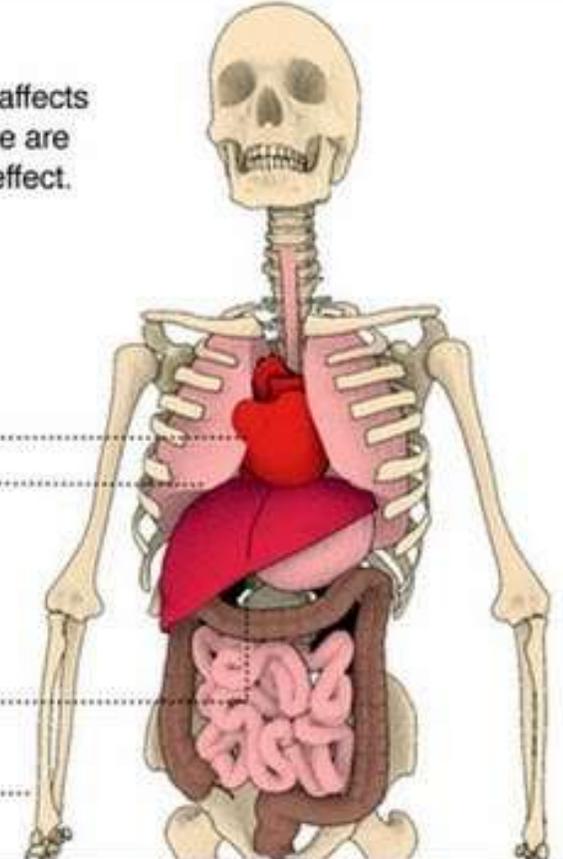
A recent study has linked it to breast cancer.

Cardiovascular disease

Obstructive pulmonary disease

The kidneys lose function, which can also cause gout, a form of arthritis.

Bones lose density and fracture.

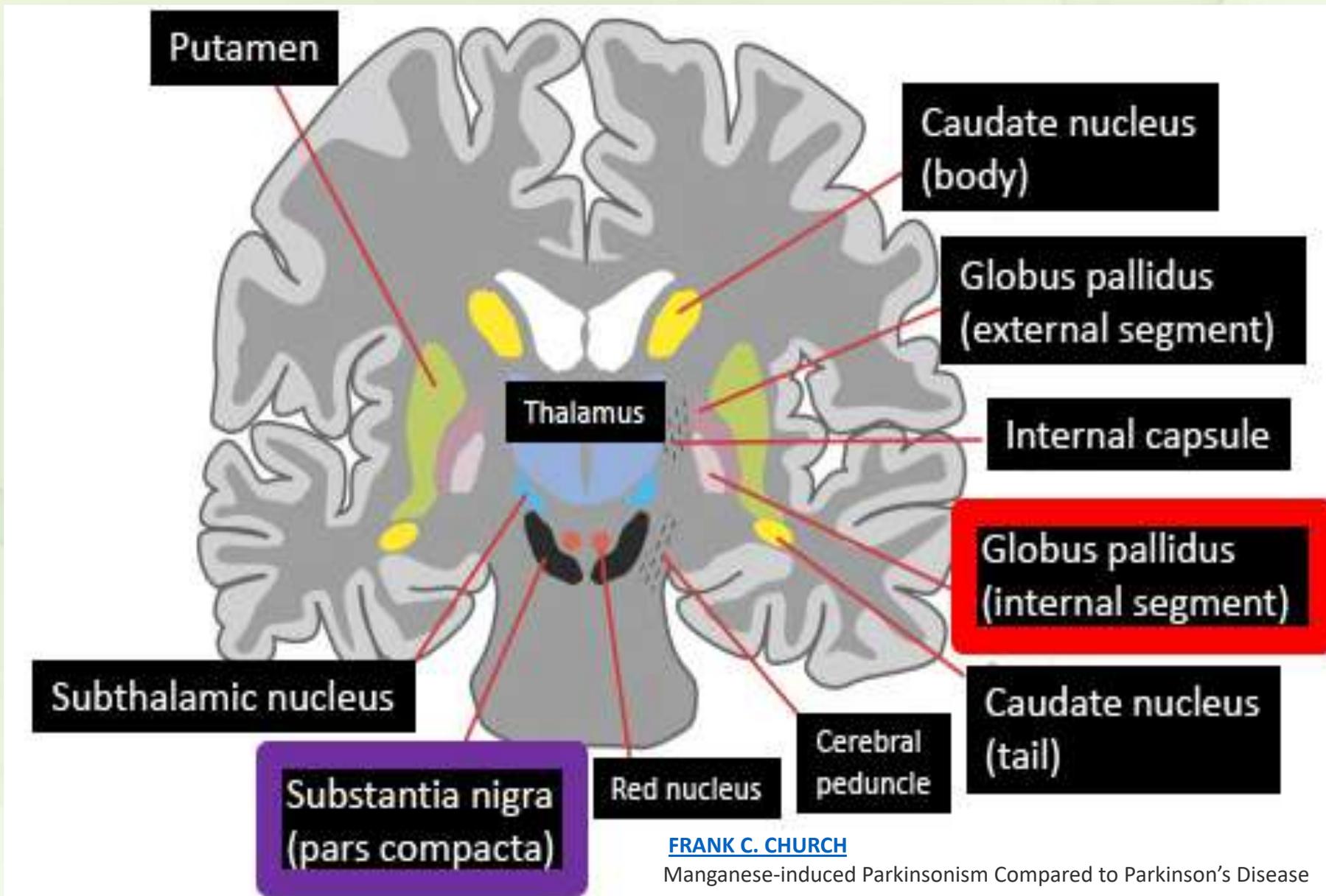


<https://u.osu.edu/toxicblog/metal-toxicology/>,
<https://i.ytimg.com/vi/2njDLWbflRA/hqdefault.jpg>

Further reading -> <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5596182/>

Manganese Toxicity

- Environmental exposure:
 - Mn ore is used in the production of steel, aluminum cans, fungicides, fertilizers and electronics.
 - Organic Mn containing pesticides, such as Mn ethylenebis-dithiocarbamate (MANEB)
 - Airborne Mn exposure from the fuel additive methylcyclopentadienyl manganese tricarbonyl (MMT)
- Occupational exposure: miners in manganese dioxide mines, workers in dry-cell battery factories, smelters and welders
- Further reading: J. Crossgrove and W. Zheng, Manganese toxicity upon overexposure





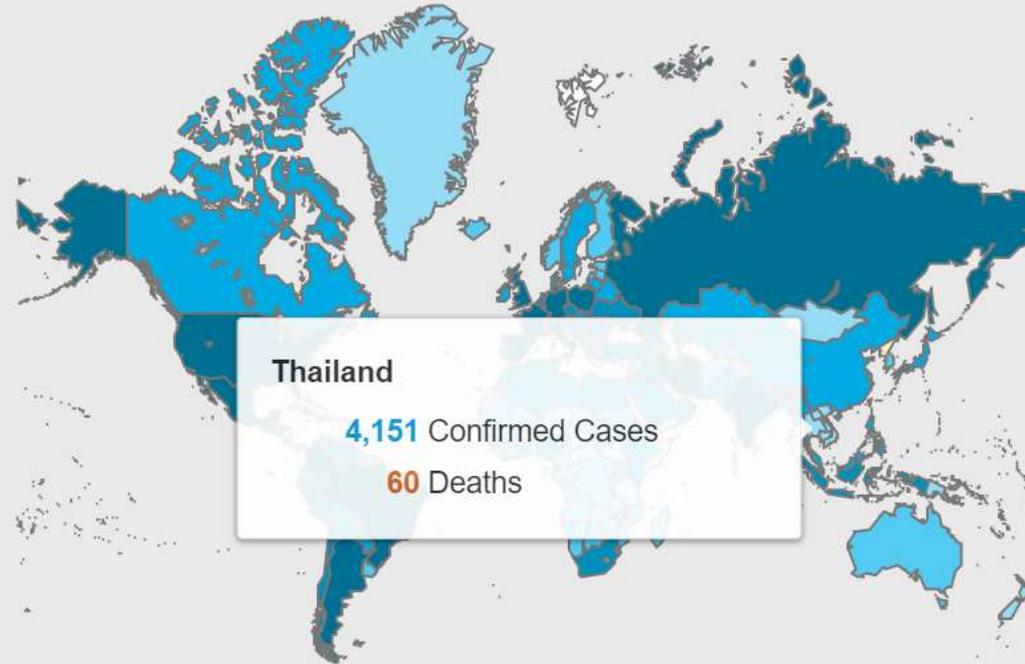
WHO Coronavirus Disease (COVID-19) Dashboard

Data last updated: 2020/12/9, 4:22pm CET

[Overview](#)

[Data Table](#)

[Explore](#)



Download Map Data

Source: World Health Organization

Globally, as of 4:22pm CET, 9 December 2020, there have been 68,165,877 confirmed cases of COVID-19, including 1,557,385 deaths, reported to WHO.



Climate change and health

- High temperatures also raise the levels of ozone and other pollutants in the air that exacerbate cardiovascular and respiratory disease. Pollen and other aeroallergen levels are also higher in extreme heat. These can trigger asthma.
- Increasingly variable rainfall patterns are likely to affect the supply of fresh water. A lack of safe water can compromise hygiene and increase the risk of diarrhoeal disease.
- Rising temperatures and variable precipitation are likely to decrease the production of staple foods in many of the poorest regions.
- Climatic conditions strongly affect water-borne diseases and diseases transmitted through insects, snails or other cold-blooded animals.

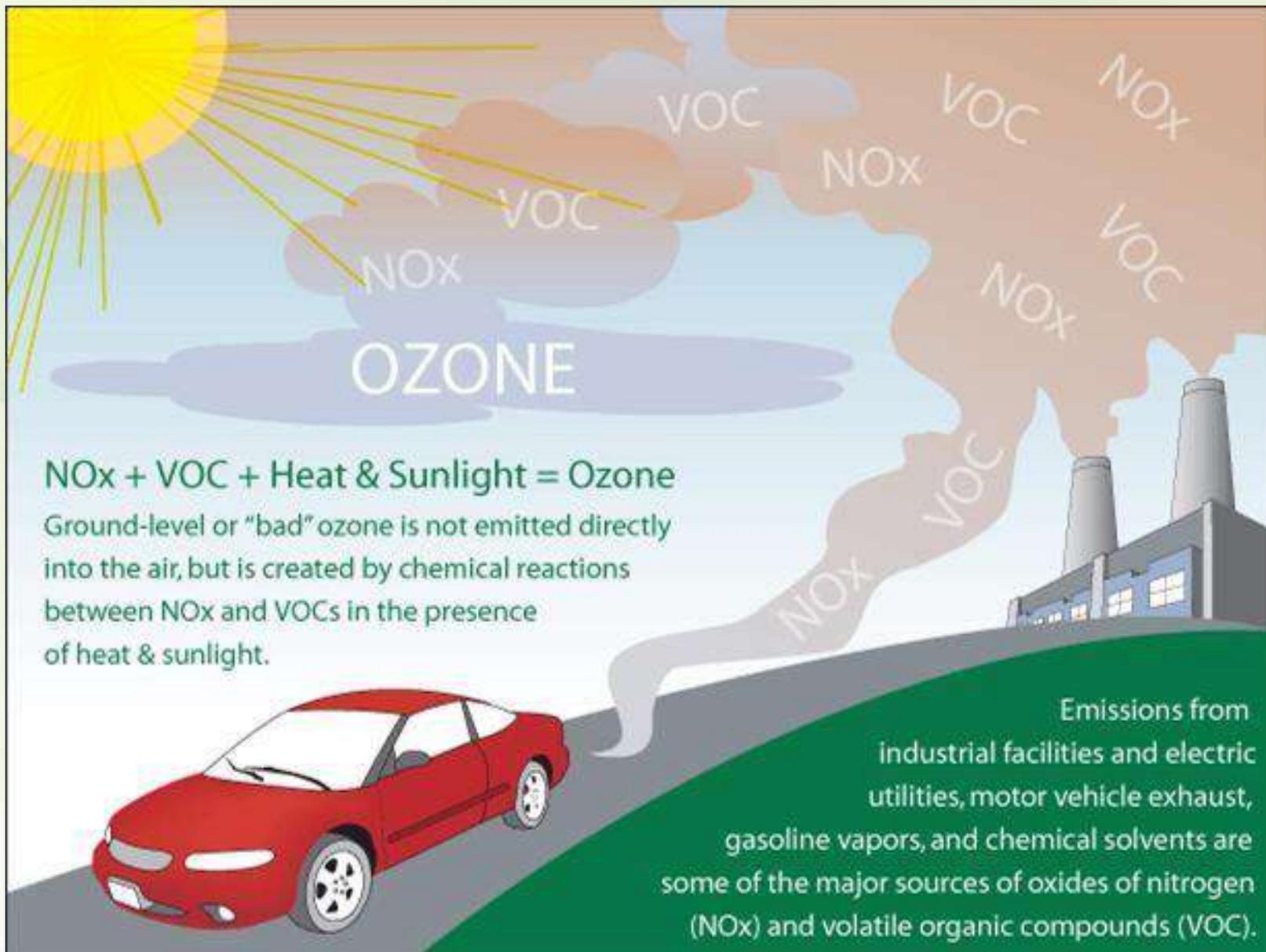
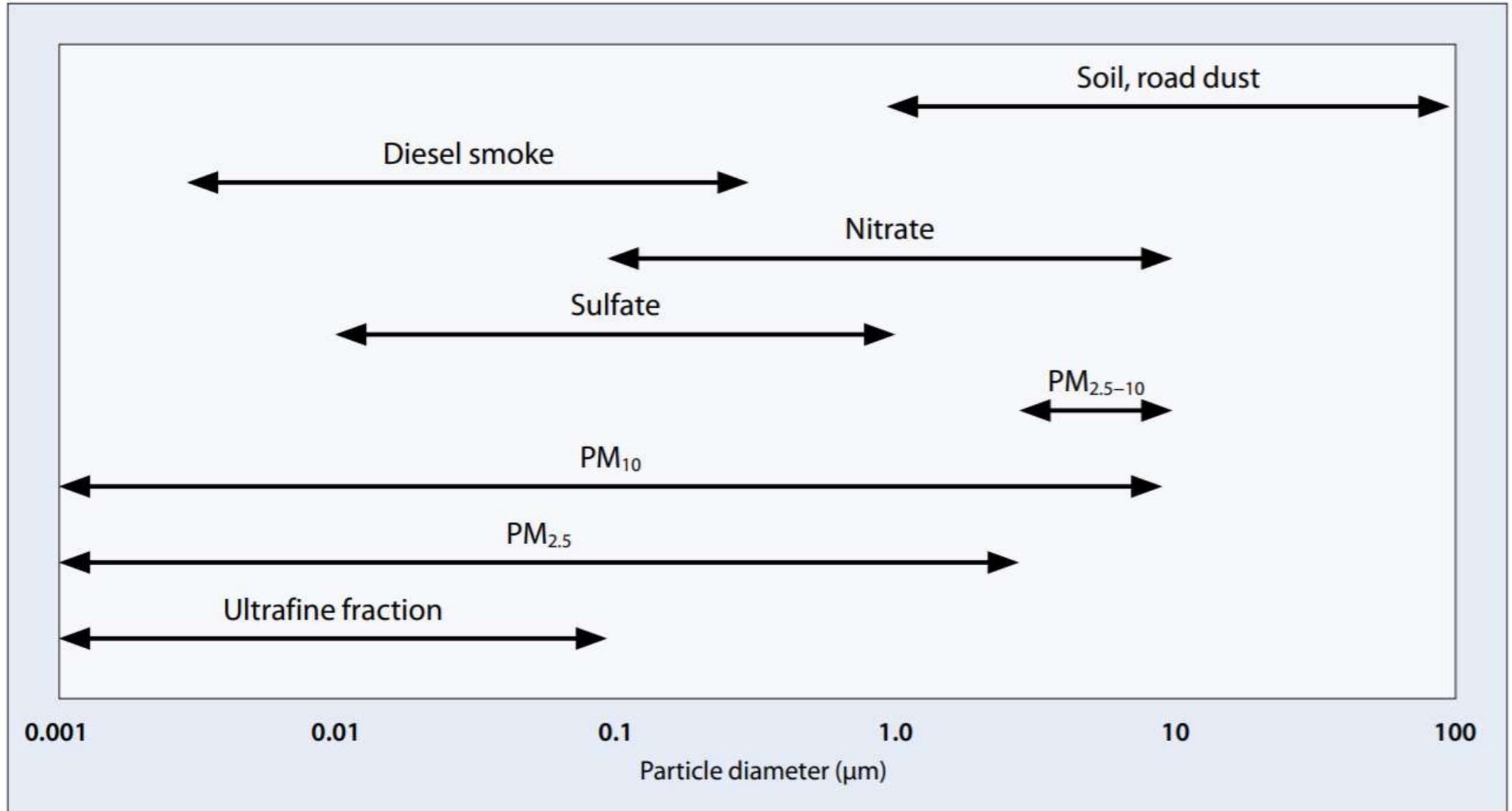
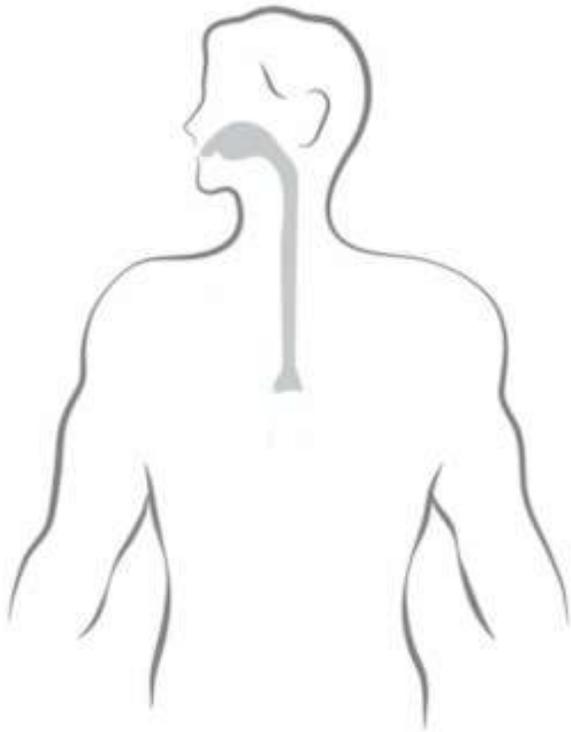


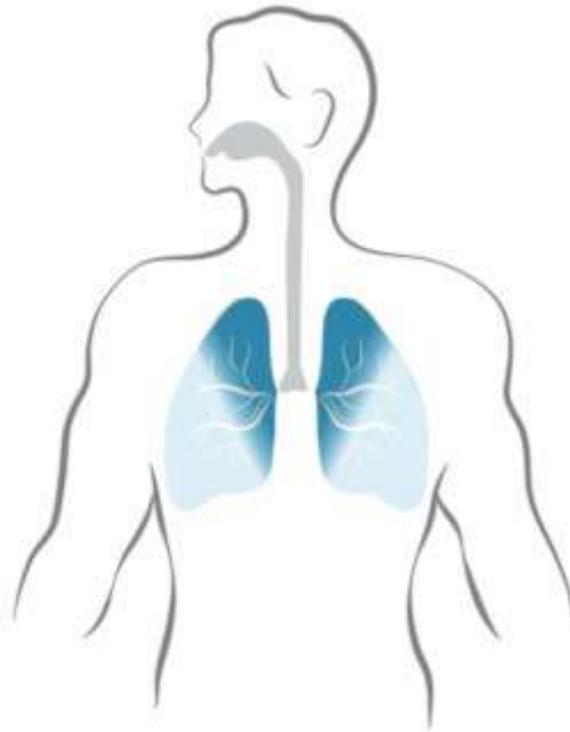
Fig. 1. Size range of airborne particles, showing the health-related ultrafine, PM_{2.5} and PM₁₀ fractions and the typical size range of some major components



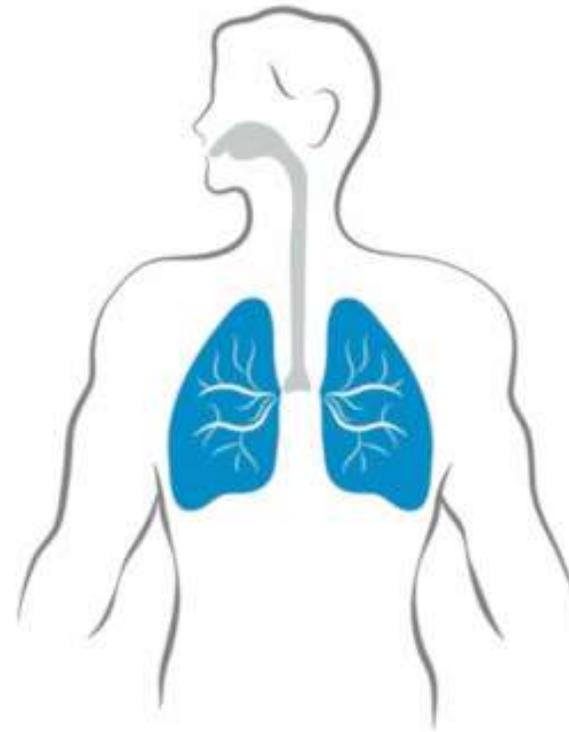
PM10



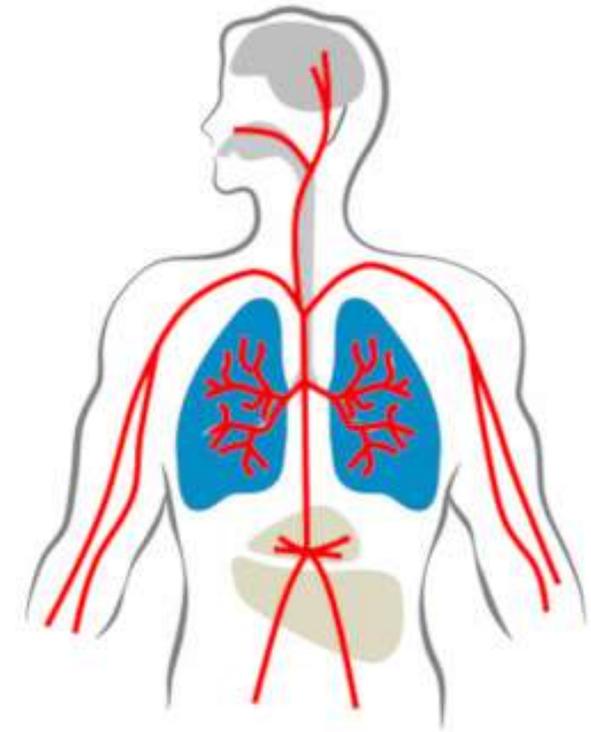
PM2.5



PM1



PM0.1



Coarse particules
Upper respiratory tract

Fine particules
Lower respiratory tract

Very fine particules
Alveolus

Ultrafine particules
Blood/Whole body

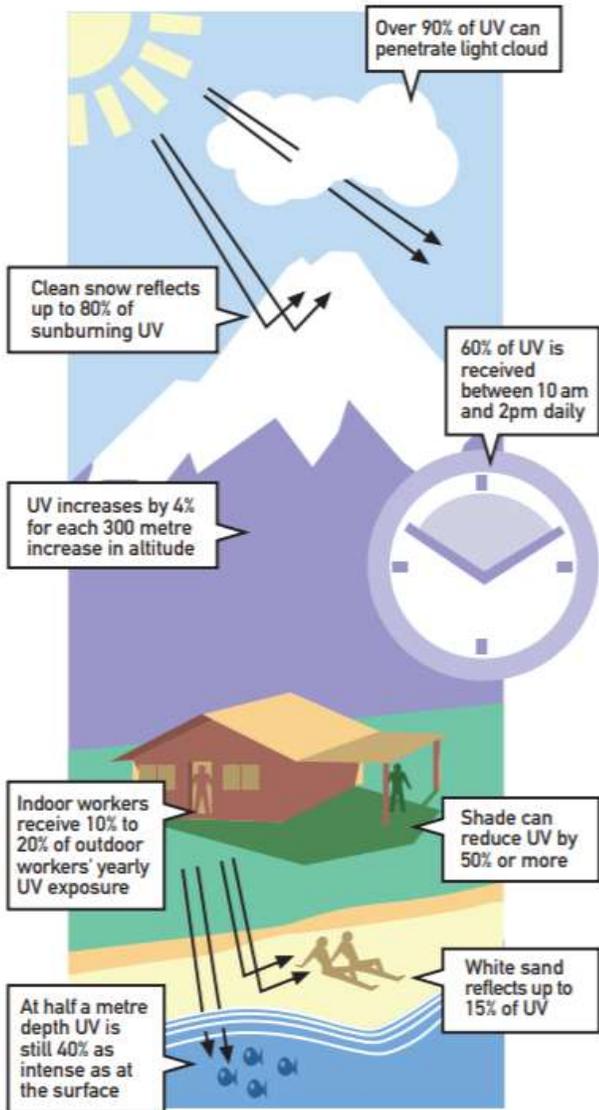


Figure 2: Environmental factors that influence UV radiation intensity

INTERSUN'S MISSION STATEMENT

"To reduce the global burden of disease resulting from exposure to UV radiation"

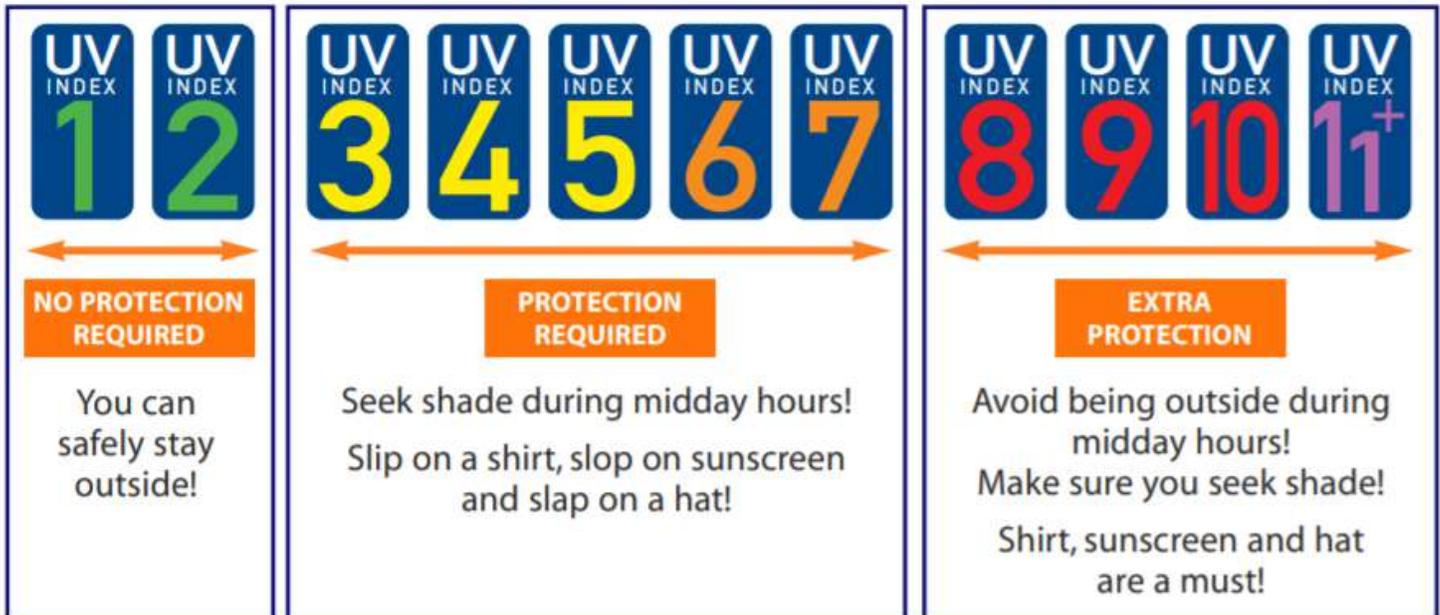


Figure 6: The UV Index logo and scale

Further reading: <https://www.who.int/uv/intersunprogramme/activities/en/>

HOW THE ENVIRONMENT IMPACTS OUR HEALTH

People are exposed to risk factors in their homes, work places and communities through:



WHO IS MOST IMPACTED BY THE ENVIRONMENT

Environmental impacts on health are uneven across age and mostly affect the poor.

Low- and middle-income countries bear the greatest share of environmental disease.



Men
are slightly more affected due to occupational risks and injuries.

Women
bear higher exposures to traditional environmental risks such as smoke from cooking with solid fuels or carrying water.

Children under five and adults between 50 and 75 years old are most affected by the environment.



YEARLY

5.2 MILLION
Deaths in adults

between 50 and 75 years. The most common causes are noncommunicable diseases and injuries.

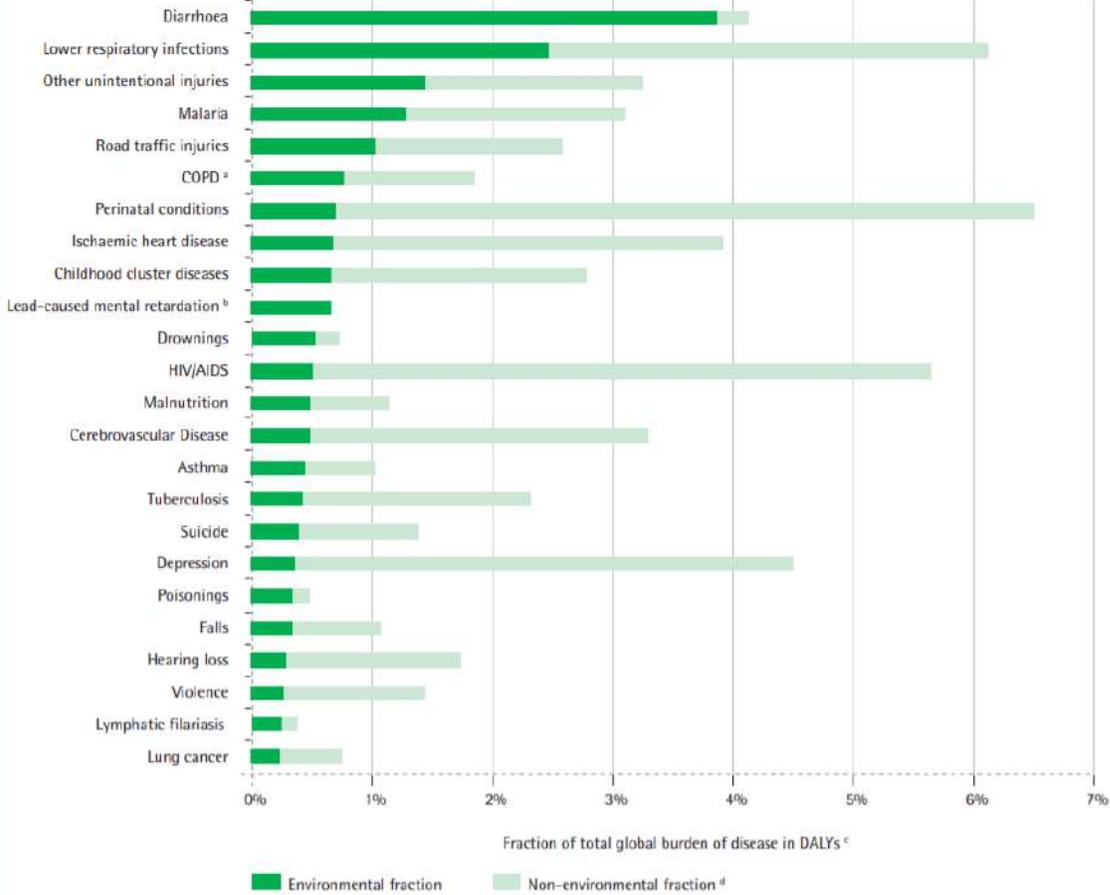
1.6 MILLION
Deaths in children

under five. The most prominent causes are lower respiratory infections and diarrhoeal diseases.



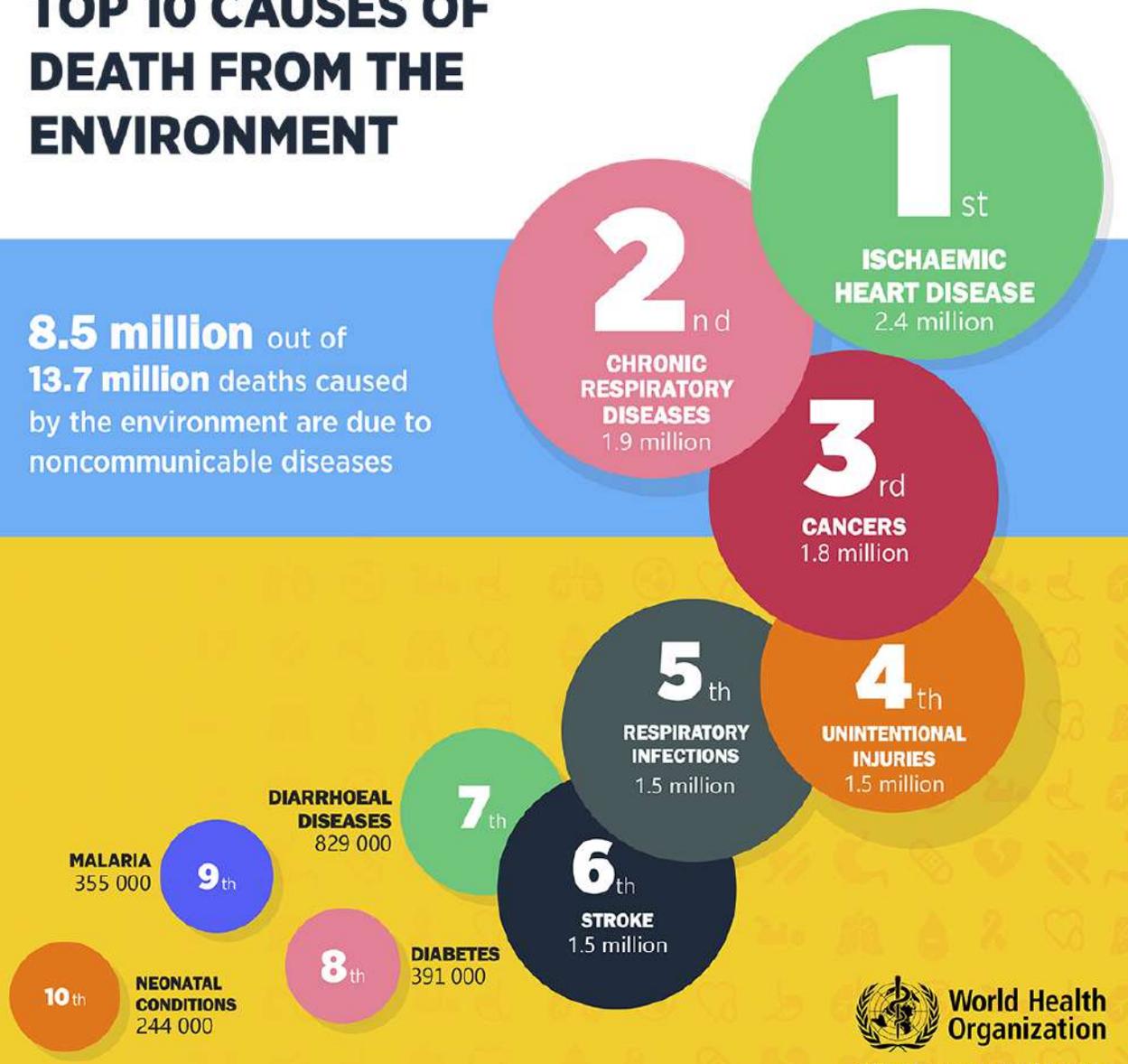
#EnvironmentalHealth

DISEASES WITH THE LARGEST ENVIRONMENTAL CONTRIBUTION



TOP 10 CAUSES OF DEATH FROM THE ENVIRONMENT

8.5 million out of **13.7 million** deaths caused by the environment are due to noncommunicable diseases



Preventive Approaches in Environmental Medicine

Preventive Approaches Environmental Medicine

- **Standards**

- **Primary standards**--to protect human health (General Population VS. Workers)
- **Secondary standards**--to protect agricultural crops and property

Health effects VS health risks

- “_____ express the likelihood or probability of a health effect to occur under defined circumstances and exposure to a certain hazard, e.g. radiation. Risks are estimated using available data and mathematical models.” (WHO, 2011)
- “_____ are changes in the health status of an individual or population, identifiable either by diagnostic or epidemiological methods.” (WHO, 2011)

What Is Risk?

“A characteristic of a situation or action wherein two or more outcomes are possible, the particular outcome that will occur is unknown, and at least one of the possibility is undesired.”



RISK = HAZARD x EXPOSURE

<https://toxedfoundation.org/hazard-vs-risk/>

What Is Risk Assessment?

“A systematic process for describing and quantifying the risks associated with hazardous substances, processes, action, or events.”

Two Components of Risk Assessment

- The possibility of adverse health or environmental consequences.
- Uncertainty over the occurrence, magnitude, or timing of those consequences.

NAS-NRC Model of Risk Assessment

- Hazard Identification
- Dose-Response Assessment
- Exposure Assessment
- Risk Characterization

Hazard

“A possible (or potential) harm or injury, or an immediate precursor to harm or injury.”

Hazard Identification

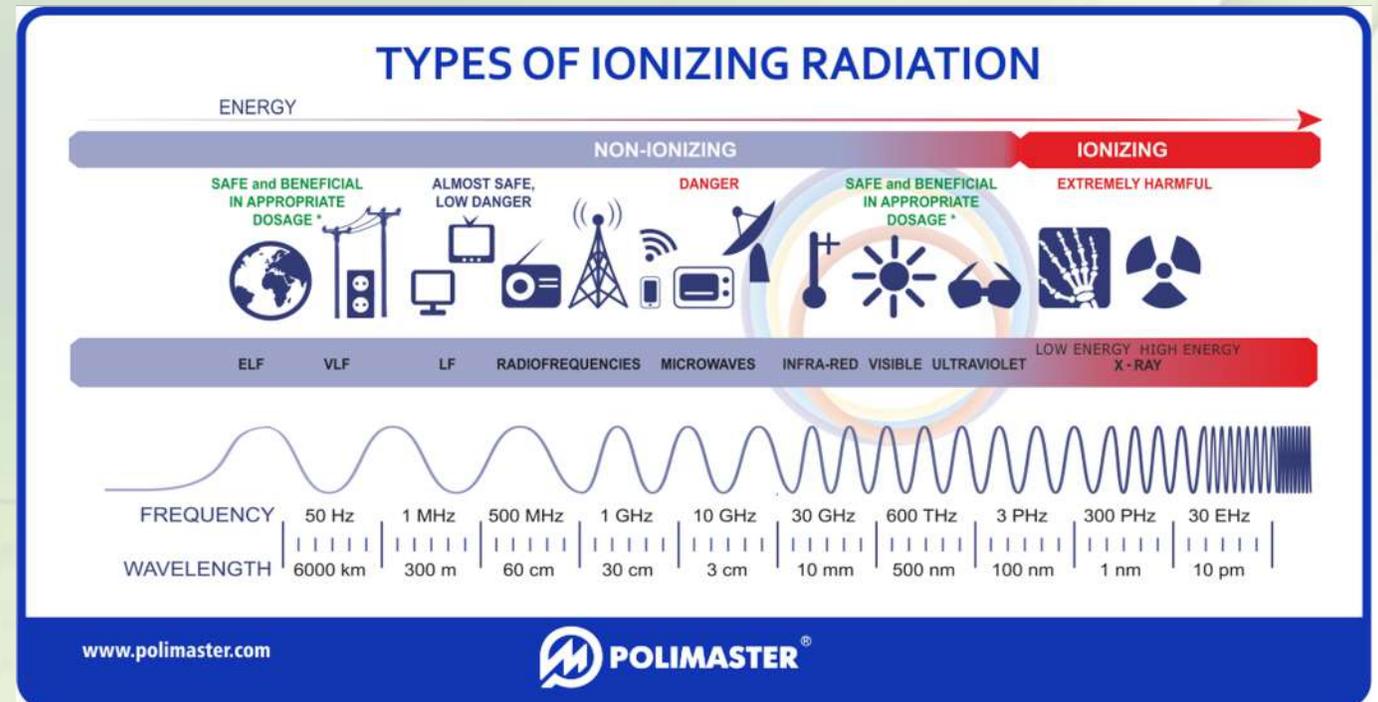
The question to be answered is: *Does a hazard exist?*

Agents and Categories of Hazards

- Physical Agents
- Chemical Agents
- Biological Agents

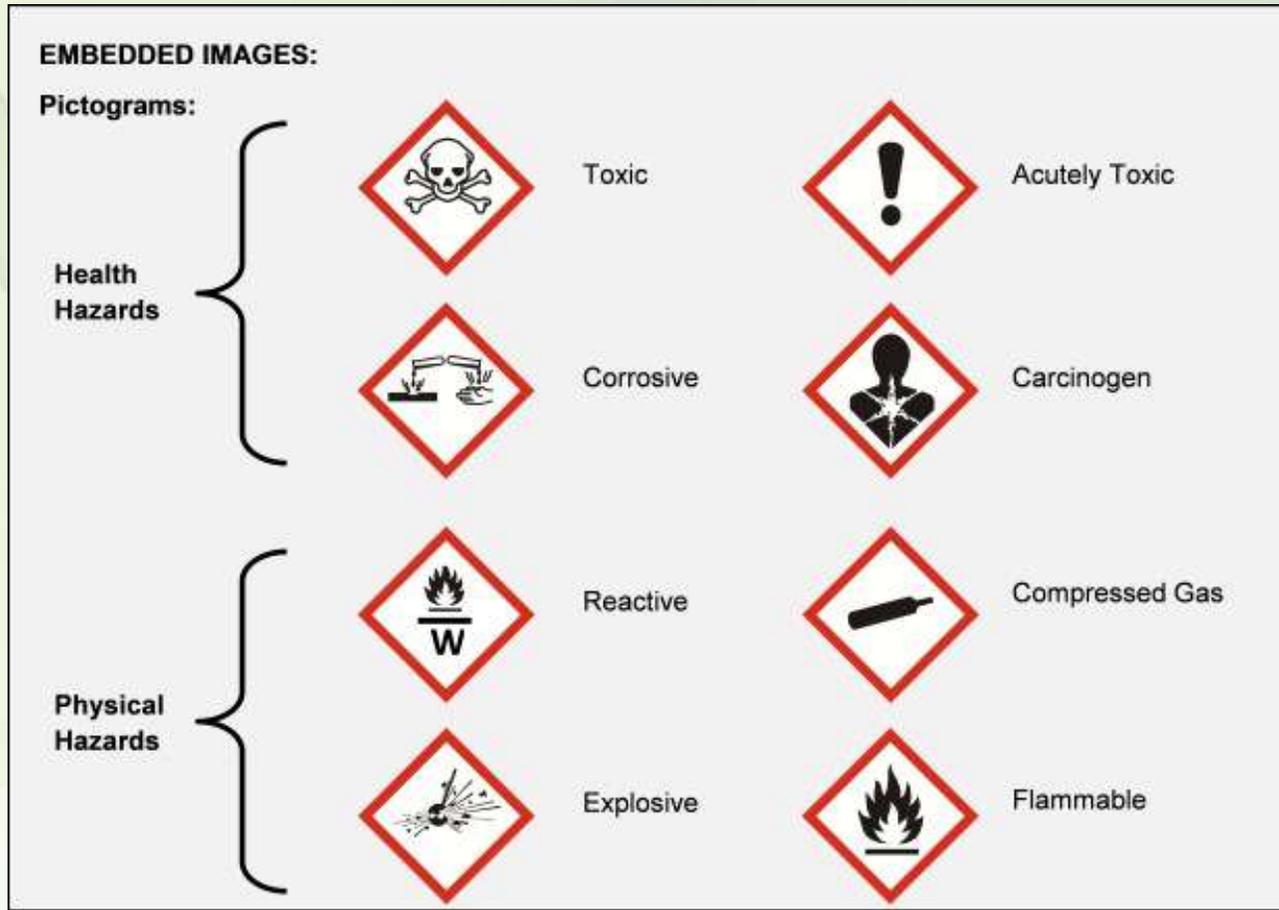
Physical Agents

- Acoustic Radiation force
- Temperature
- Pressure
- Vibration
- Radioactivity
- Physical Impact
- Magnetic Radiation
- Electromagnetic Radiation



<https://en.polimaster.com/resources/radiation-basics/types-of-ionizing-radiation>

Chemical Agents



- Agents Presenting Health Risk
- Agents Presenting Physical Risk

<https://www.nps.gov/articles/hazard-communication.htm>

Chemical Agents -> Presenting Physical Risk

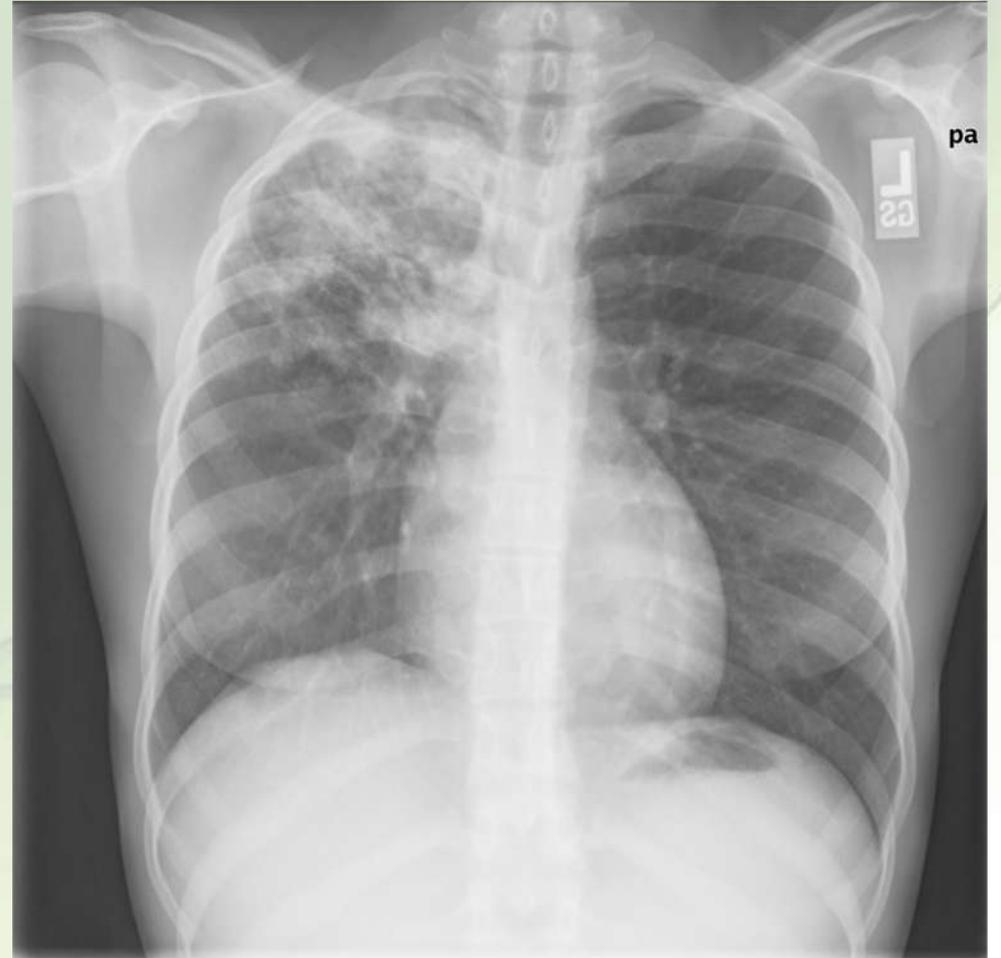
- Asphyxiant
- Combustible
- Corrosive
- Explosive
- Flammable
- Irritant
- Oxidizer
- Water Reactive

Chemical Agents -> Presenting Health Risk

- Carcinogen
- Mutagen
- Poison
- Sensitizer
- Teratogen
- Toxic

Biological Agents

- Route of exposure:
bloodborne/airborne/
droplets/direct contact
- Pathogens categories:
Bacteria/fungus/virus



<https://radiopaedia.org/cases/pulmonary-tuberculosis-29>

Hazard Identification (cont.)

- Epidemiological Studies
- *In Vivo* Animal Bioassays
- Short-Term *In Vitro* Cell and Tissue Culture Tests
- Structure-Activity Relationship Analyses

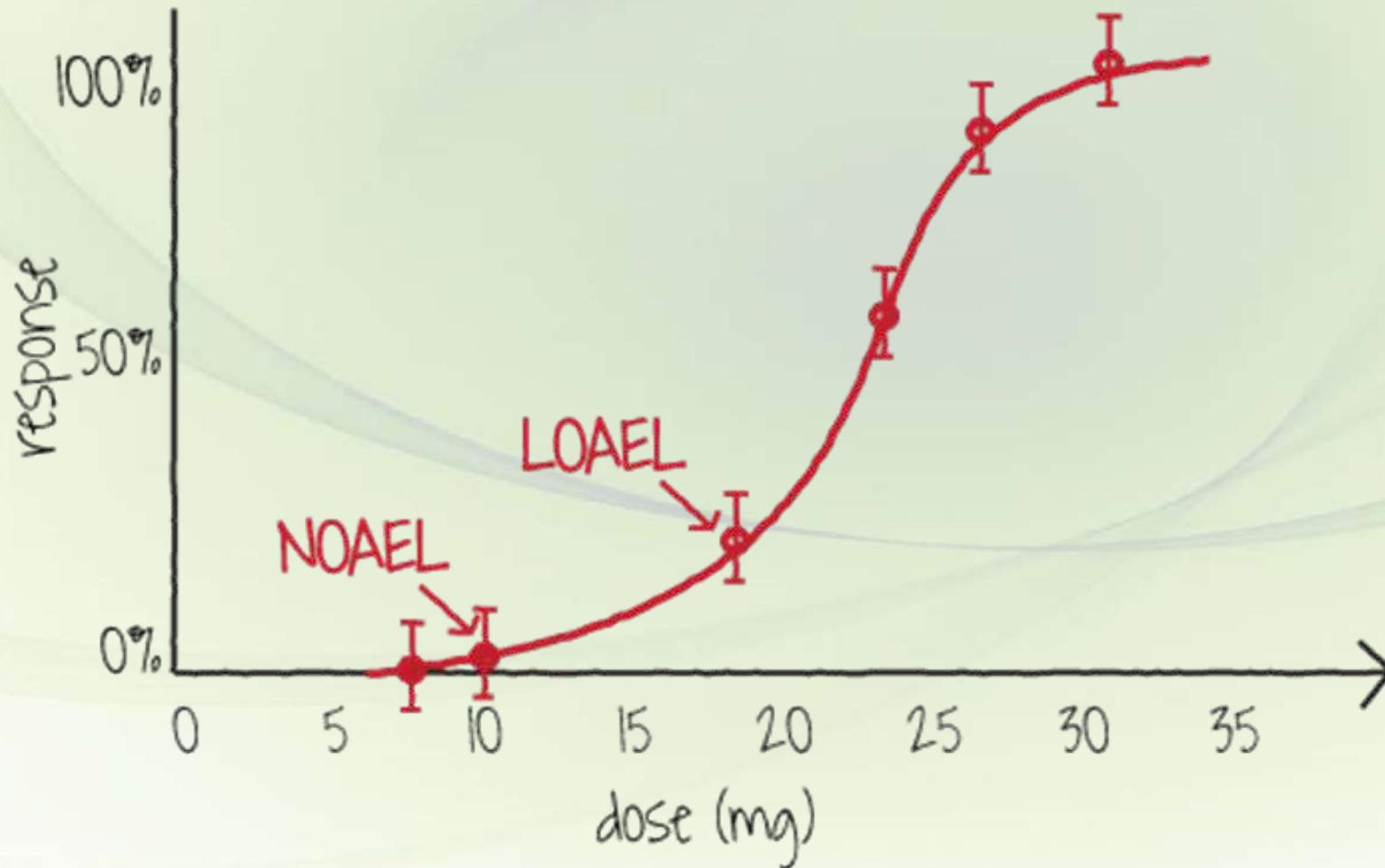
Dose-response Assessment

The question to be answered is:
What is the safety level?

Agents Presenting Health Risk

- Determining Dose
- Response Measurements
- Dose-Response Models
- Extrapolation

Dose-Response Assessment



- **No Observed Adverse Effect Level (NOAEL)** — *Highest dose at which there was not an observed toxic or adverse effect.*
- **Lowest Observed Adverse Effect Level (LOAEL)** — *Lowest dose at which there was an observed toxic or adverse effect.*

<https://toxtutor.nlm.nih.gov/02-006.html>

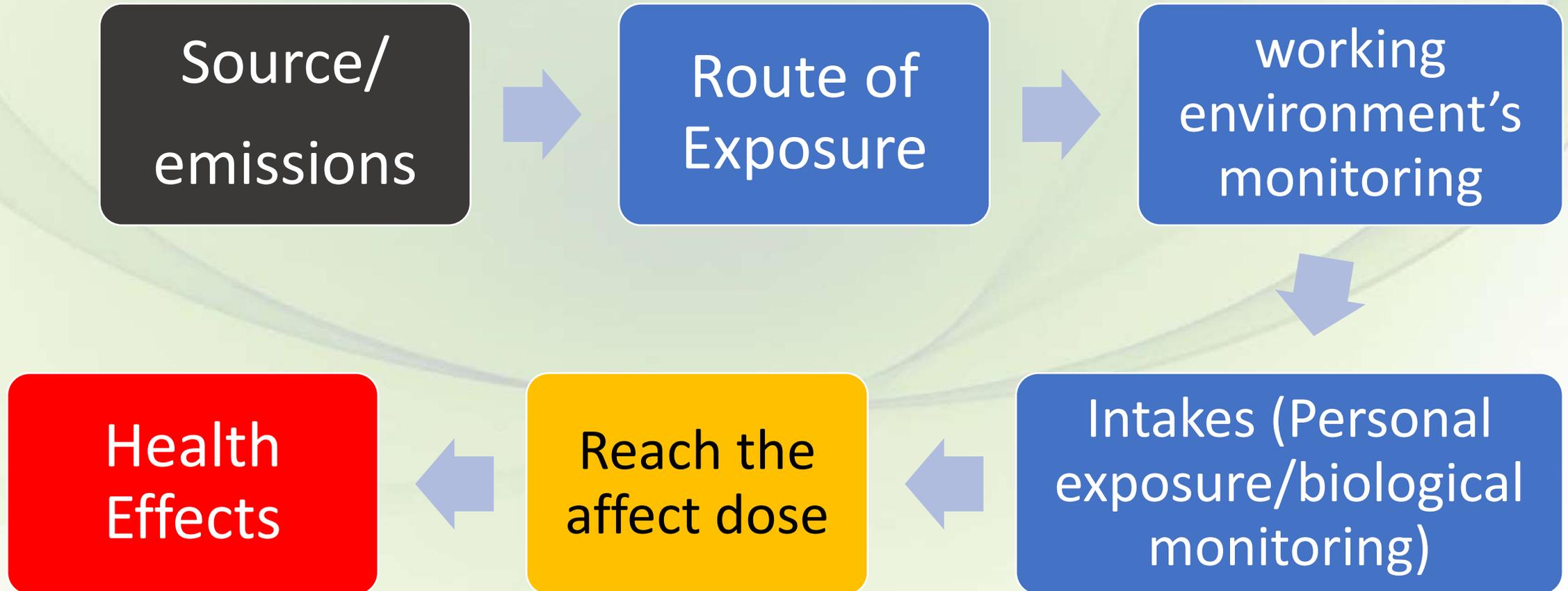
Exposure Assessment

The question to be answered is:

How much is the population exposed?

- 2 Kinds of Approaches:
 - **Monitoring**
 - **Modeling**

Exposure Assessment



Agencies Involved in Standard Settings

- EPA--NAAQS, rivers and streams
- EPA and NRC--ionizing radiation standards
- IRPA--nonionizing radiation standards
- ACGIH--TLVs
- OSHA--PELs

Risk Characterization

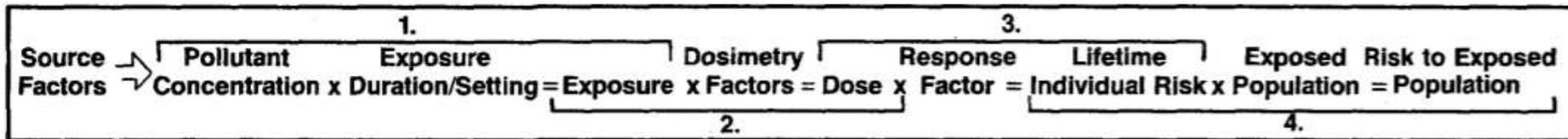
The question to be answered is:
*What is the probability that the
adverse effect will occur in the
exposed population?*

Risk Characterization

- individual probabilities of an adverse effect based on estimated exposure and dose-response factors. / the number of cases of the adverse effect in the exposed population.

Ref. Dennis F. Naugle & Terrence K. Pierson. A Framework for Risk Characterization of Environmental Pollutants. journal of the Air & Waste Management Association. 2012

- 3 Kinds of Approaches
 - Non-Carcinogenic Risk-*Margin of Safety*: The ratio of the reference dose (RfD) to the average daily dose (ADD)
 - Carcinogenic Risk-*Excess Lifetime Cancer Risk*
 - Uncertainty Analysis



1. Exposure

$$\text{Pollutant Concentration} \times \text{Exposure Duration} = \text{Exposure}$$

$(\text{mg}/\text{m}^3) \qquad (\text{days}) \qquad (\text{mg}/\text{m}^3 \times \text{days})$

Total exposure over a lifetime

2. Dose

$$\text{Exposure} \times \text{Dosimetry Factors} = \text{Dose}$$

$(\text{mg}/\text{m}^3 \times \text{days}) \qquad (\text{contact rate: } \text{m}^3/\text{day})$
 $(\text{absorption rate: } \%)$
 $(\text{inverse average body weight: } \frac{1}{\text{kg}}) \text{ or}$
 $(\text{inverse days in lifetime: } \frac{1}{\text{days}})$

Average dose per day over a lifetime

3. Lifetime Individual Risk

$$\text{Dose} \times \text{Dose-Response Relationship} = \text{Lifetime Individual Risk}$$

$\left(\frac{\text{mg}}{\text{kg} \times \text{day}} \right) \times \left(\frac{\text{mg}}{\text{kg} \times \text{day}} \right)^{-1} \left(\frac{\text{probability}}{\text{lifetime}} \right) = \left(\frac{\text{probability}}{\text{lifetime}} \right)$

Individual risk over a lifetime

4. Risk to Exposed Population

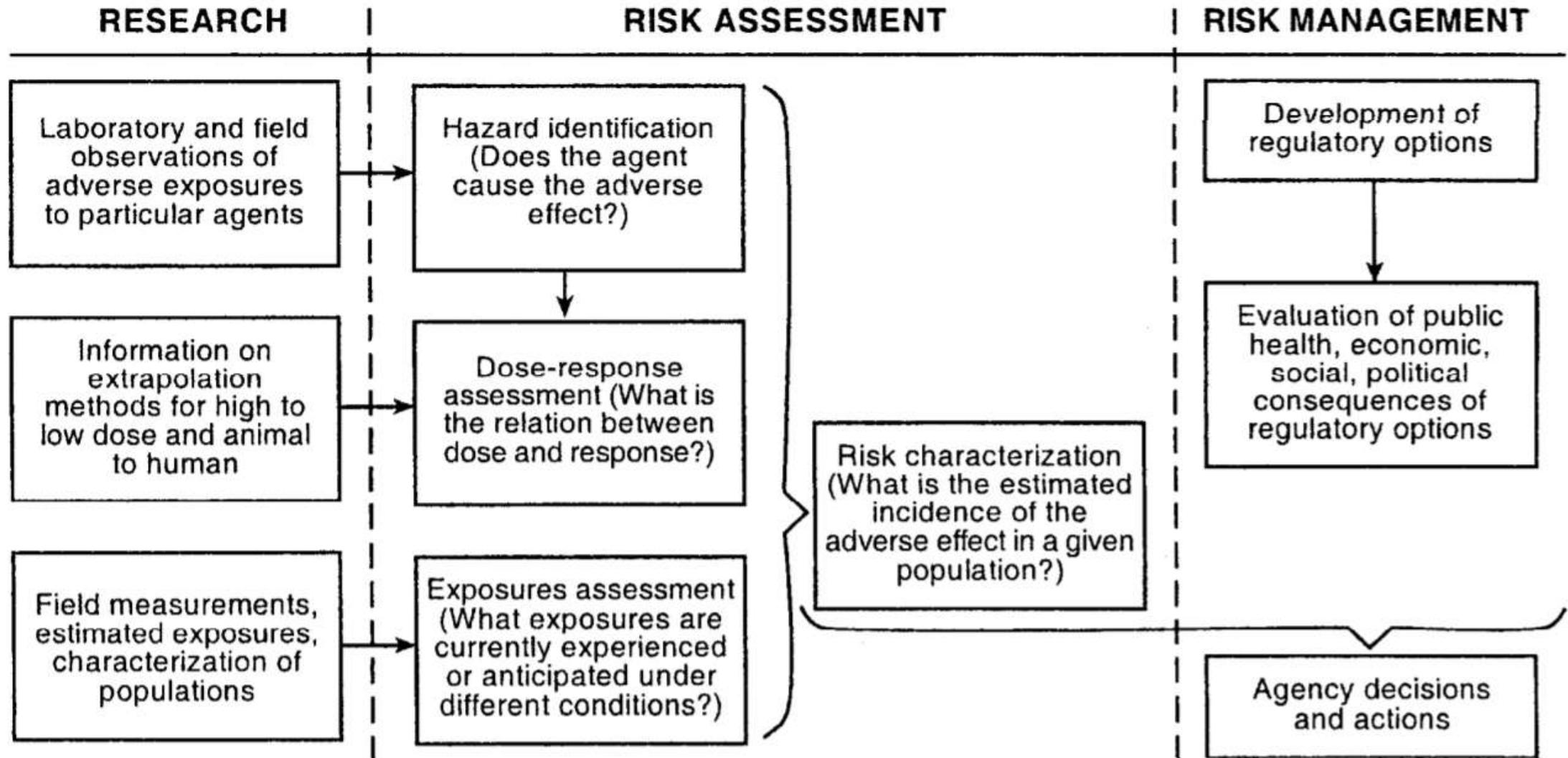
$$\text{Lifetime Individual Risk} \times \text{Exposed Population} = \text{Risk to Exposed Population}$$

$\left(\frac{\text{probability}}{\text{lifetime}} \right) \times \left(\# \text{ people} \times \frac{1 \text{ lifetime}}{\# \text{ years}} \right) = \left(\frac{\# \text{ cases}}{\text{year}} \right)$

Estimated cases in exposed population per year

Figure 4. Elements of the predictive risk equation.

Traditional risk analysis framework



Pamela R. D. Williams, Dennis J. Paustenbach. RISK CHARACTERIZATION: PRINCIPLES AND PRACTICE. Journal of Toxicology and Environmental Health, Part B, 5:337-406, 2002

Standard Limitations

- “By-product” data
- High uncertainties
- Variability and sensitivity of population groups
- No indoor standards
- Not apply to all sources of a contaminant
- Individual environmental media standards
- Lack of definitive data or sound epidemiologic evidence
- Threshold assumption on non-threshold agents
- Risks are not quantified to compare the stringency of standards
- Fewer contaminant limits developed for protection of the natural environment
- Synergistic effects are not considered



**World Health
Organization**

**SEVENTY-SECOND WORLD HEALTH ASSEMBLY
Provisional agenda item 11.6**

**A72/15
18 April 2019**

Health, environment and climate change

**Draft WHO global strategy on health, environment and climate
change: the transformation needed to improve lives and
well-being sustainably through healthy environments**

Report by the Director-General

Strategies objectives

- 1. **Primary prevention**: to scale up action on health determinants for health protection and improvement in the 2030 Agenda for Sustainable Development
- 2. **Cross-sectoral action**: to act on determinants of health in all policies and in all sectors
- 3. **Strengthened health sector**: to strengthen health sector leadership, governance and coordination roles
- 4. **Building support**: to build mechanisms for governance, and political and social support
- 5. **Enhanced evidence and communication**: to generate the evidence base on risks and solutions, and to efficiently communicate that information to guide choices and investments
- 6. **Monitoring**: to guide actions by monitoring progress towards the Sustainable Development Goals

Hierarchy of Controls

Elimination

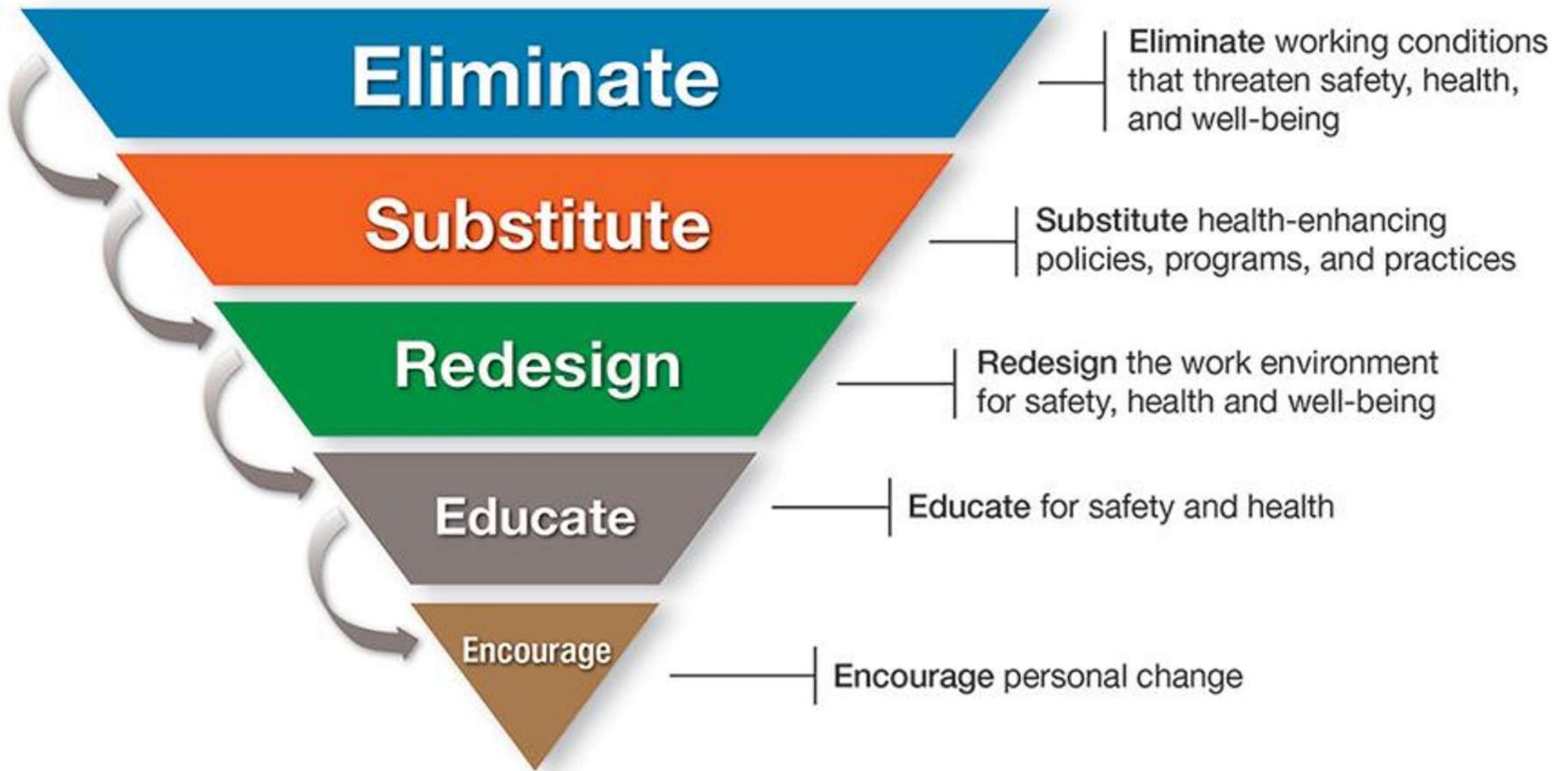
Substitution

Engineering controls

Administrative controls

PPE

- Physically remove the hazard
- Replace the hazard
- Isolate people from the hazard
- Change the way people work
- Protect the worker with Personal Protective Equipment (PPE)



<https://www.cdc.gov/niosh/twh/letsgetstarted.html>

Q&A

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