

ENVIRONMENTAL HEALTH

By Hana Taha

1. Environment — Definition & Scope

Environment refers to all the physical, chemical, and biological factors that are external to a person. More broadly, it includes natural elements like air, water, and soil, along with all physical, chemical, biological, and social features of our surroundings.

Key Fact: Globally, environment is a key determinant of health and well-being.

Leading Contributors to the Global Burden of Disease:

- Food and water sanitation
- Lead exposure
- Air pollution
- Indoor pollution from solid fuels

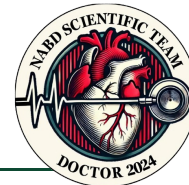
2. Environmental Health — Definition

Environmental Health is the study of how the environment affects our health. It examines the interaction between humans and environmental factors including air, food, water, sunlight, soil, noise, and various hazards.

Definition (WHO): The branch of public health that focuses on the relationships between people and their environment.

Environmental Health encompasses:

- Air quality
- Food safety
- Water quality
- Sunlight exposure
- Noise pollution
- Soil contamination
- Hazardous substances



3. Hazards

Every day, we encounter things in our environment that can either benefit us or harm us. Some are essential for health (oxygen, food, medicines), while others are harmful — these are called hazards.

Definition: Hazards are things in the environment that are harmful to health.

Types of Hazards:

- Chemicals
- Radiation
- Disease-causing bacteria (biological agents)
- Loud noises (physical agent)
- Stress (psychosocial agent)

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Important: Hazards can be natural (e.g., volcanic eruptions, windblown dust) or man-made (e.g., industrial chemicals, exhaust fumes).

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4. Why Is Environmental Health Important?

Maintaining a healthy environment is central to increasing quality of life and years of healthy life. It is not just about treating disease — it is about prevention through controlling exposures.

CRITICAL STATISTIC: Globally, nearly 24% of all deaths are attributed to environmental factors — approximately 13.7 million deaths per year.

24% of deaths → environmental factors.

This makes environmental health one of the most impactful public health disciplines worldwide.

5. Environmental Sustainable Development Goals (SDGs)

In 2015, world leaders agreed on the 2030 Agenda and its 17 Sustainable Development Goals (SDGs), building on the unfinished work of the Millennium Development Goals (MDGs).

Protecting the environment can lead to positive outcomes cascading across many SDGs.



Environmental SDGs (7 Goals):

Goal #	Goal Name	Relevance to Environmental Health
Goal 6	Clean Water and Sanitation	Ensures safe drinking water and adequate sanitation for all people
Goal 7	Affordable and Clean Energy	Promotes clean energy to reduce air pollution from fossil fuels
Goal 9	Industry, Innovation and Infrastructure	Supports sustainable industrial practices to reduce pollution
Goal 12	Responsible Consumption and Production	Reduces waste and toxic substances through sustainable practices
Goal 13	Climate Action	Addresses climate change which drives many environmental health risks
Goal 14	Life Below Water	Protects oceans and marine ecosystems from pollution
Goal 15	Life on Land	Protects terrestrial ecosystems, reduces land-based hazards

At 6 AM, a person wakes up and **takes a shower and brushes their teeth with clean water.** 💧 (Goal 6: Clean Water and Sanitation)

At 7 AM, they **switch on the lights and make coffee using clean energy.** ⚡ (Goal 7: Affordable and Clean Energy)

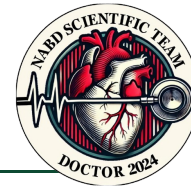
At 9 AM, they arrive at work in a modern **industry and infrastructure** company. 🏗️ (Goal 9: Industry, Innovation, and Infrastructure)

At 12 PM, it's lunchtime, and they choose to **eat responsibly and avoid wasting food,** practicing **responsible consumption and production.** 🍴 (Goal 12)

At 1 PM (13:00), they **notice the hot weather and think about climate action.** 🌍 (Goal 13)

At 2 PM (14:00), they **go for a walk by the beach and admire life below water.** 🐟 (Goal 14)

At 3 PM (15:00), they **visit a park or forest and appreciate life on land.** 🌳 🦌 (Goal 15)



6. Toxicology

Toxicology is traditionally defined as 'the science of poisons.' More precisely, it is the study of the adverse effects of chemicals or physical agents on living organisms. It aims to understand how various agents can cause harm to humans and other organisms.

Adverse effects may range from immediate death to subtle indirect changes not apparent until months or years later.

Toxicology Overlaps with Multiple Disciplines:

Toxicology is a multidisciplinary science that intersects with:

- **Epidemiology** — population-level disease patterns
- **Pathology** — structural and functional disease changes
- **Pharmacology** — drug-body interactions
- **Physiology** — normal body functions
- **Chemistry** — chemical structure and reactions
- **Statistics** — data analysis and interpretation

7. Relationship Between Epidemiology and Toxicology

Core Connection

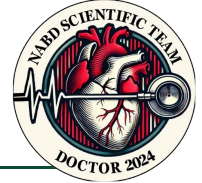
- Both disciplines seek to explore the causes of human disease
- They support each other in establishing causality
- Both involve evidence-based analysis
- Toxicologists conduct lab-based studies; epidemiologists conduct population-based studies
- Both spend considerable effort characterizing the relationship between a presumed causal agent and a biological response

Toxicology

Lab-based studies
Controlled experiments on animals or cells
Identifies mechanisms of harm
Studies dose-effect in controlled settings

Epidemiology

Population-based studies
Observational studies in human populations
Identifies patterns of disease
Studies exposure-disease associations



8. Environmental Toxicology

Environmental Toxicology is the study of how environmental hazards — both natural and human-made chemicals — can enter our bodies and make us sick.

Example: The impact of industrial fumes inhaled by workers or nearby residents is a classic environmental toxicology scenario.

9. Core Concepts in Environmental Health

There are 6 fundamental core concepts that underpin environmental health and toxicology:

1. Toxicity
2. Exposure
3. Dose / Response
4. Individual Susceptibility
5. Risks & Benefits
6. Environmental Justice



10. Toxic Substances

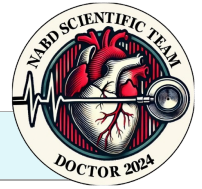
A toxic substance is a material that has toxic properties. It may be a discrete toxic chemical or a mixture of toxic chemicals.

Examples:

- Lead chromate — a discrete (single) toxic chemical
- Gasoline — a toxic substance (not a single chemical) because it contains a mixture of many chemicals
- Asbestos — a toxic material that does not have an exact chemical composition; it comprises a variety of fibers and minerals

Organic vs. Inorganic Toxic Substances:

Organic Toxins	Inorganic Toxins
Originally derived from living organisms	Chemicals (minerals) derived from non-living sources
Mostly obtained from natural sources	No carbon-based biological origin
Can also be synthesized (man-made)	Often heavy metals or mineral compounds
Example: aflatoxins from mold, snake venom	



Example: lead, mercury, arsenic

11. Exposure

Definition: Exposure is the total amount of a hazard that comes in DIRECT CONTACT with the body.

The 3 Components of Exposure:

1. Source	2. Environmental Pathway	3. Dose, Site & Route
Where hazard originates (e.g., factory fumes)	How hazard travels (e.g., through air)	How it enters the body (e.g., inhaled fumes)

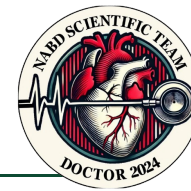
12. Exposure vs. Dose — Key Distinction

EXPOSURE	DOSE
Refers to the concentration of an agent at the BOUNDARY between the individual and the environment	The amount of the agent that actually ENTERS a target organ/tissue within a specified time
It is what is 'outside' the body at the point of contact	It is what gets 'inside' the body
Measured in terms of: Intensity, Frequency, Duration	Influenced by: Bioavailability, Genetics, Individual Susceptibility

Mnemonic: Exposure = outside (concentration at boundary). Dose = inside (amount absorbed).

Factors That Affect the Dose:

1. How LONG you are exposed (duration)
2. How OFTEN you are exposed (frequency)
3. Body WEIGHT of the individual



13. Duration of Exposure — Classification

Type	Duration	Frequency
Acute	Less than 24 hours	Usually a single exposure
Sub-acute	One month or less	Repeated exposures
Sub-chronic	More than 1 month to 3 months	Repeated exposures
Chronic	More than 3 months	Repeated long-term exposures

14. Exposure and Response Patterns

Patterns of EXPOSURE	Patterns of RESPONSE
Acute / High Dose Chronic Low Dose Epidemiology studies both patterns in human populations	Acute/High dose → Clinically manifest (obvious, immediate symptoms) Chronic Low dose → Subtle and/or Long-term effects: Cancer, Reproductive effects, Neurodegenerative disease, Immunologic susceptibility

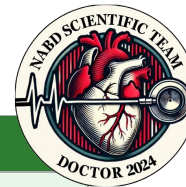
15. Routes of Environmental Hazard Intake

There are three main routes by which environmental hazards enter the body:

Inhalation	Ingestion	Dermal Absorption
Route: Breathing Chemicals can get stuck in the lungs AND/OR be absorbed into the bloodstream	Route: Swallowing (eating/drinking) Chemicals can EASILY be absorbed into the bloodstream through the GI tract	Route: Skin contact (including eyes) Can SOMETIMES enter the bloodstream — less reliable than inhalation/ingestion

16. Relative Speed of Effect by Route of Exposure

The route of exposure determines how quickly a hazard produces its effect. The ranking from fastest to slowest:



Site	Route	Speed of Effect
Bloodstream	Intravenous (IV)	+++++++ (Fastest)
Lungs	Inhalation	+++++++
Other	Intraperitoneal	++++++
Other	Subcutaneous	+++++
Other	Intramuscular	++++
Other	Intradermal	+++
Gastrointestinal	Ingestion (oral route)	++
Skin	Dermal	+ (Slowest)

Mnemonic for fastest routes: IV > Inhale > Intraperitoneal > SubCut > IM > ID > Oral > Dermal "I Inhale In Subcutaneous Intramuscular Intradermal Oral Dermal"

Mnemonic: "IV Intensive Patients Study Medicine In Our Department."

(I tried making it meaningful as much as I can).

IV = IV

Intensive = Inhaled

Patients = Intraperitoneal

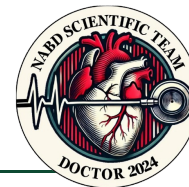
Study = Subcutaneous

Medicine = Intramuscular

In = intradermal

Our = Oral (GI)

Department = Dermal Absorption



17. Dose-Response Relationship

The dose-response relationship describes how the body responds to varying amounts of a hazardous substance. The dose received can influence how the body responds to a hazard.

Key Principle: Generally, the HIGHER the dose, the MORE SEVERE the response.

The Dose-Response Curve:

- The dose-response curve normally takes the form of a SIGMOID (S-shaped) curve
- For most effects, small doses are NOT toxic
- The point at which toxicity first appears is called the THRESHOLD DOSE LEVEL
- Above the threshold, the response increases with higher doses

Key Terms on the Dose-Response Curve:

Term	Meaning
NOAEL	No Observable Adverse Effect Level — the highest dose at which no adverse effect is observed. This is BELOW the threshold.
LOAEL	Lowest Observable Adverse Effect Level — the lowest dose at which an adverse effect IS observed. This marks the threshold.
Threshold Dose	The dose level at which toxicity first appears on the curve (= LOAEL). Below this: <u>safe</u> . Above this: <u>harmful</u> .
Linear Range	The steep, near-linear portion of the sigmoid curve where response increases proportionally with dose.
Maximum Response	The plateau at the top of the curve where all individuals/receptors are affected — increasing dose gives no additional effect.

Same

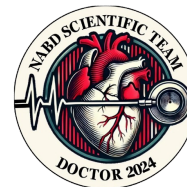
18. Individual Susceptibility

Definition: Individual susceptibility refers to the fact that some people are more likely than others to get sick when exposed to the same environmental hazard at the same dose.

Factors Determining Susceptibility:

- Genetics — inherited ability to detoxify or repair damage

Same dose
Patient 1 → toxic
Patient 2 → not toxic



- **Body size** — affects how dose is distributed
- **Age** — very young and very old are more vulnerable
- **Gender** — hormonal and physiological differences
- **General health status** — pre-existing conditions

Examples of Highly Susceptible Populations:

Group	Reason for Increased Susceptibility
Children	Developing organs, faster breathing rate (inhale more), immature detoxification systems, higher surface-to-mass ratio
Elderly	Declining organ function, slower metabolism, decreased immune response
Pregnant Women	Fetus is highly susceptible; some chemicals cross the placenta; altered maternal physiology
Immunocompromised	Reduced ability to fight off biological hazards; may react more severely to chemical exposure

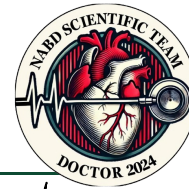
19. Risks & Benefits

In addressing environmental, health, and safety problems, regulatory bodies must assess the risks associated with specific hazards. This includes analyzing the costs and benefits of alternative ways of reducing those risks.

Key Concept: Risk-benefit analysis is essential — almost every intervention has both potential benefits and risks. Regulators must weigh these carefully.

Human Health Risk Assessment — The 4-Step Process:

Step	Name	Key Question
Step 1	Hazard Identification	What health problems are caused by the pollutant?
Step 2	Dose-Response Assessment	What are the health problems at different exposure levels?
Step 3	Exposure Assessment	How much of the pollutant do people inhale? How many people are exposed?
Step 4	Risk Characterization	What is the extra risk of health problems in the exposed population?



20. Air Pollution

inside homes, associated with certain type of fuel used.

Definition: Air pollution is the contamination of the indoor or outdoor environment by any chemical, physical, or biological agent that modifies the natural characteristics of the atmosphere.

Common Sources of Air Pollution:

- Household devices (cooking stoves, heaters)
- Motor vehicles
- Industrial facilities
- Forest fires

Major Air Pollutants of Public Health Concern:

10. Particulate Matter (PM2.5 and PM10)
11. Carbon Monoxide (CO)
12. Ozone (O3)
13. Nitrogen Dioxide (NO2)
14. Sulfur Dioxide (SO2)

Health Impact: Both outdoor AND indoor air pollution cause respiratory and other diseases, which can be fatal.

Detailed Sources of Air Toxics:

Human-Made (Anthropogenic) Sources:

- Mobile sources: cars, trucks, buses, aircraft
- Stationary sources: factories, refineries, power plants
- Indoor sources: cleaning products, paints, pesticides, building materials

refineries

Refineries are large-scale industrial facilities that purify or convert raw natural resources into more valuable, usable products. The term most commonly refers to petroleum refineries, which transform raw crude oil into essential everyday commodities like gasoline, diesel, jet fuel, heating oil, lubricants, and asphalt.

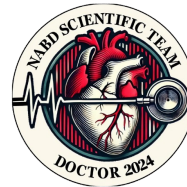


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Natural Sources:

- Windblown dust
- Volcanic eruptions
- Wildfires
- Biological decay



21. Social Disparities in Environmental Exposures and Health

Not all communities are exposed equally to environmental hazards. Some neighborhoods face a disproportionate burden of environmental pollution and consequent health problems.

Key Facts About Environmental Disparities:

- Lower-income communities often have greater exposure to environmental hazards
- Communities of color and ethnic minorities are disproportionately affected
- Toxic waste dumps, polluting factories, and busy highways are frequently built near disadvantaged communities
- These communities have less economic and political power to oppose such decisions
- Higher rates of health problems result from compounded environmental exposures

22. Environmental Justice (EJ)

Historical Origin:

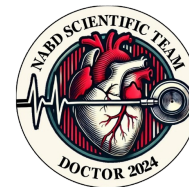
The Environmental Justice Movement emerged in the early 1980s in North Carolina, USA. It arose from a local dispute over toxic waste dumping near an African-American neighborhood. The movement emphasized that environmental problems cannot be solved without addressing disparities and maintaining social justice.

Core Definition (EPA): Environmental Justice mandates the equitable treatment and involvement of people of ALL races, cultures, incomes, and educational levels in the development, implementation, and enforcement of environmental programs, laws, rules, and policies.

Simple Meaning: Everyone has a right to live in an environment that does not make them sick, regardless of race, culture, or income.

The Environmental Justice Process — 3 Questions to Ask First:

15. Who is PRODUCING the hazard?
16. Who is BEING EXPOSED?



17. Who are the DECISION MAKERS?

Then Take Action:

- Establish a dialog between decision makers, scientists, and the affected community
- Empower community members to bring about change
- Share information and decisions with community members transparently

1. Historical Origin (Very Important for Memorization)

The Environmental Justice (EJ) Movement started in the early 1980s in North Carolina, USA.

Why did it start?

A community protested against the dumping of toxic waste near an African-American neighborhood.

The movement realized that:

- Environmental problems are not only scientific issues.
- They are also social justice issues.
- To solve environmental problems, society must address inequalities and disparities.

Easy way to remember:

1980s → North Carolina → Toxic waste → African-American community → Fight for fairness.

2. EPA Core Definition

According to the Environmental Protection Agency (EPA):

Environmental Justice means ensuring the fair treatment and meaningful involvement of people of:

- All races
- All cultures
- All income levels
- All educational backgrounds

in the:

- Development,
- Implementation,
- Enforcement

of environmental:

- Programs,
- Laws,
- Rules,
- Policies.

What does "Fair Treatment" mean?

No group of people should suffer a greater environmental burden because of:

- Race,
- Ethnicity,
- Income,
- Social status.

Example:

✗ Building factories only near poor neighborhoods.

✓ Environmental risks should be shared fairly.

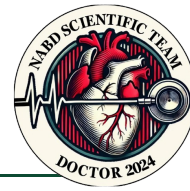
What does "Meaningful Involvement" mean?

People affected by environmental decisions should:

- Have access to information.
- Participate in decision-making.
- Have their concerns considered.

Example:

If a factory is planned near a town, residents should be consulted before approval.



QUICK REVISION SUMMARY

TOPIC	KEY POINT
Environment	All physical, chemical, biological factors external to a person
Environmental Health	Study of how the environment affects health
Hazard	Any environmental factor that is harmful; can be natural or man-made
24% / 13.7 million	Proportion/number of deaths attributed to environmental factors annually
Toxicology	Science of poisons; studies adverse effects of chemicals on living organisms
Environmental Toxicology	How environmental hazards enter the body and cause illness
Exposure	Amount of hazard in DIRECT CONTACT with the body (outside boundary)
Dose	Amount of hazard that ENTERS the body (inside)
Dose factors	Duration + Frequency + Body weight
Acute exposure	Single exposure < 24 hours
Sub-acute	Repeated, < 1 month
Sub-chronic	Repeated, 1-3 months
Chronic	Repeated, > 3 months
Fastest route	Intravenous > Inhalation > Intraperitoneal > Subcutaneous > IM > ID > Oral > Dermal
Dose-response curve	Sigmoid shape; NOAEL (no effect) → LOAEL (threshold) → linear range → maximum response
Individual Susceptibility	Children, elderly, pregnant women, immunocompromised are most vulnerable
4-Step Risk Assessment	Hazard ID → Dose-Response → Exposure Assessment → Risk Characterization
Air pollution	Chemical, physical, or biological contamination of atmosphere; kills via respiratory disease
Environmental Justice	Equal right to a healthy environment regardless of race, income, or culture
EJ origin	Early 1980s, North Carolina, USA — toxic waste near African-American community