A Handbook on

Children's Health and the Environment

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MESSAGE

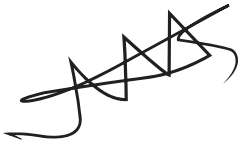
Professor Dr. Nazmul Hosain
Director General
Directorate General of Medical Education (DGME)
Bangladesh

I share this message on the occasion of publishing the Handbook on "Children's Health and the Environment", developed through the joint collaboration between the Directorate General of Medical Education (DGME) and UNICEF.

Children are the future of our nation, and their health and wellbeing are closely tied to the quality of the environment in which they grow. Today, rapid urbanization, environmental pollution, and climate change pose serious challenges to child health. This handbook is an important step toward raising awareness, building knowledge, and guiding action to ensure a safe and nurturing environment for every child in Bangladesh.

I extend my sincere appreciation to UNICEF for their continued partnership and technical support, and to all the experts, academicians, and professionals who contributed to the preparation of this handbook. I hope that it will serve as a valuable resource for health professionals, educators, policymakers, and communities, helping us to safeguard the health of our children and secure a healthier future for generations to come.

Together, let us reaffirm our commitment to protecting the health of children through a cleaner, safer, and more sustainable environment.



Professor Dr. Nazmul Hosain

MESSAGE

Professor Dr. Rukshana Ahmed
Additional Director General (Administration)
Directorate General of Medical Education (DGME)
Mohakhali, Dhaka

It gives me great satisfaction to be associated with the publication of the Handbook on "Children's Health and the Environment", a joint initiative of the Directorate General of Medical Education (DGME) and UNICEF.

The health of our children is deeply influenced by the environment in which they live, learn, and grow. In the face of environmental challenges such as pollution, climate change, and unsafe living conditions, it is our collective responsibility to ensure that every child enjoys the right to a healthy start in life. This handbook is a timely and significant contribution that will guide health professionals, educators, and curriculum planners in promoting child health through environmental awareness and action.

I take this opportunity to thank UNICEF for their continued collaboration and support, as well as the dedicated team of experts and academicians who contributed to the development of this valuable resource.

It is my hope that this handbook will inspire all stakeholders to strengthen their efforts in safeguarding the health of children and building a healthier and more sustainable future for our nation.

Professor Dr. Rukshana Ahmed

MESSAGE

Professor Dr. Rubina Yasmin
Additional Director General (Medical Education)
Directorate General of Medical Education (DGME)
Mohakhali, Dhaka

I am delighted to share this message for the Handbook on "Children's Health and the Environment", jointly developed by the Directorate General of Medical Education (DGME) and UNICEF.

Children's health is the foundation of our country's future, and medical education has a critical role in preparing future doctors and health professionals to address the challenges posed by environmental hazards. This handbook is not only a guide but also a call to action for educators, practitioners, and policymakers to integrate environmental health into child health care and learning.

I sincerely acknowledge UNICEF for their technical and collaborative support, and I commend all contributors whose expertise and dedication made this publication possible. I believe this resource will strengthen the capacity of our medical education system to respond effectively to emerging child health challenges related to the environment.

Let us continue to work together for a Bangladesh where every child can grow up healthy, safe, and nurtured in a sustainable environment.

Rubina Yasmin

Professor Dr. Rubina Yasmin

MESSAGE

Professor Dr. A.F.M Shahidur Rahman
Director (Research, Publication &
Curriculum Development)
Directorate General of Medical Education (DGME)
Mohakhali, Dhaka

It gives me immense pleasure to contribute to the Handbook on "Children's Health and the Environment", jointly published by the Directorate General of Medical Education (DGME) and UNICEF.

This handbook represents an important step in integrating knowledge, research, and practice on the crucial links between children's health and their environment. In my capacity as Director of Research, Publication & Curriculum Development, I recognize the value of resources like this in guiding evidence-based decision making, strengthening academic learning, and ensuring that environmental health issues are adequately reflected in our medical and public health curricula.

I sincerely thank UNICEF for their collaboration and technical support, and I deeply appreciate the efforts of the contributors whose expertise made this publication possible.

I firmly believe that this handbook will serve as a valuable reference for students, teachers, researchers, and policymakers, inspiring future initiatives to safeguard the health of our children and build a healthier and more sustainable Bangladesh.

Professor Dr. A.F.M Shahidur Rahman

MESSAGE

Chandrasegarar Soloman
Chief of Health, a.i.
UNICEF Bangladesh

Children in Bangladesh face a wide range of environmental health threats- from air and noise pollution to hazardous chemicals, unsafe water, poor sanitation, and the growing impacts of climate change. These risks not only compromise their physical and cognitive development but also place a heavy burden on families, communities, and the health system.

The Handbook on Children's Environmental Health (CEH) is a vital step toward addressing these challenges. Developed by the Directorate General of Medical Education (DGME) with support from UNICEF, this handbook introduces the principles and interventions needed to protect children's health from environmental hazards. It is designed to equip medical students, interns, and faculty members with the knowledge and tools to recognize, prevent, and respond to environmental health risks affecting children.

Drawing on global resources such as the WHO-UNICEF online training course on CEH and shaped through extensive consultation with experts from 47 medical faculties across Bangladesh, this handbook reflects a strong national commitment to integrating environmental health into medical education. It comprises nine essential chapters covering topics such as air and noise pollution, lead and hazardous chemicals, pesticides, e-waste, climate change, WASH, and pediatric environmental history taking.

By embedding these issues into the undergraduate medical curriculum, the handbook will help future health professionals understand the unique vulnerabilities of children, identify related diseases, take pediatric environmental histories, and communicate risks effectively. It also serves as a guide for curriculum developers to ensure that environmental health becomes a core learning component for medical graduates.

UNICEF is proud to support this initiative and remains committed to working with DGME and other partners to ensure that every child in Bangladesh grows up in a safe, clean, and nurturing environment. I extend my sincere appreciation to all contributors and reaffirm our dedication to advancing child health through education, awareness, and action.

Chandrasegarar Soloman

TABLE OF CONTENTS

Background and Purpose of this Handbook

This handbook is an introduction to the principles and interventions needed to protect children's health from environmental hazards, including air pollution, noise pollution, chemicals, heavy metals, inadequate water, sanitation and hygiene and climate change. The Directorate General of Medical Education (DGME), with support from UNICEF, developed this Handbook on Children's Health and Environment (CEH), with the aim of equipping medical students, interns, and faculty members with the tools and knowledge on environmental hazards and how they impact children's health and equip them to take preventive and protective measures. A key resource for developing this handbook was the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) online training course on CEH. (https://ceh.unicef.org/introduction-childrens-environmental-health-course).

The development process included several technical and stakeholder consultation workshops, with renowned professors and consultants from 47 medical faculties across Bangladesh. The handbook comprises nine essential chapters, covering: Introduction, Air Pollution, Noise Pollution, Lead and Hazardous Chemicals, Pesticides, E-Waste, Climate Change, Water, Sanitation, and Hygiene (WASH) and Pediatric Environmental History taking.

This handbook aims to equip medical students and interns with the knowledge and skills to understand how environmental factors affect children's health, recognize related diseases, take pediatric environmental histories, and communicate risks effectively. In addition, this handbook will guide the DGME curriculum team to integrate the issues in the undergraduate medical curriculum as a core learning component for medical graduates and interns.

Chapter 1: Introduction to Children's Health and the Environment

The healthy development of children is crucial to the future wellbeing of any society. According to United Nations Convention of the Rights of the Child, 'Children' are those population who are younger than 18 years of age[1]. At present, the world population is about 7.91 billion and around one fourth of this total population is under 15 years of age[2]. According to population and housing census Bangladesh 2022 database, 28.61% of population is under 15-year-old in Bangladesh.

Children are especially vulnerable to environmental hazards such as unsafe water, poor sanitation, air pollution, vector-borne diseases, hazardous chemicals, e-waste, and climate change. These environmental threats contribute significantly to child illness, increasing healthcare costs, reducing parental productivity, and straining national resources. This handbook aims to address these challenges by exploring the impact of environmental and climate-related risks on child health.

Learning Objectives

At the end of this chapter, learners will be able to-

a)	State the global importance and public health impact of children's exposure to the environmental threats.
b)	Explain the knowledge and concept about the special vulnerability due to higher exposure to risks in environment on children's developing bodies.
c)	Identify the threats to children's health in low, middle and high-income countries.
d)	Describe how different stakeholders can take action to protect children's health from environmental hazards.

a. The global importance and public health impact of children's exposure to environmental threats

In 2021, children under 15 made up 26% of the global population (2.02 billion). As future leaders, they need a healthy environment to thrive. Environmental risks cause 28% of diseases in children under five, often due to exposure to their daily surroundings. Reducing this burden requires a holistic, multi-sectoral approach involving individuals, communities, professionals, and policymakers.

[1] Convention on the Rights of the Child, New York, 20 November 1989. New York: United Nations; 1989 (https://treaties.un.org/pages/ViewDetails.aspx?src=IND&mtdsg_no=IV-11&chapter=4&clang=_en, accessed 18 October 2022).

[2] World population prospects 2022 – special aggregates. New York: United Nations; 2022 (https://population.un.org/wpp/, accessed 18 October 2022).

Main environmental risks that are faced by children affect their health:

i. Global climate change is affecting the health of children in every region of the world,

ii. Air pollution, both household and ambient, triggers and aggravates respiratory diseases

ii. Inadequate access to safe and clean water, sanitation and hygiene facilities leads to illness and disease such as diarrhoea among the children

iv. Vector-borne diseases which are major causes of death in children under the age of 5

v. Chemical hazards including exposure to persistent organic pollutants (POPs) and pesticides

vi. E-waste is the fastest growing solid waste stream in the world, containing many toxic agents to children

vii. The built environment can contribute to hazards such as road accidents, noise pollution, drowning and burns

viii. Child labor puts children at risk of exposure to harmful conditions at work

ix. Emerging issues like plastics, endocrine disrupting chemicals and predatory marketing practices are threats to child development and health

x. Heavy metals (lead, mercury, arsenic, cadmium) exposure on birth outcome and cognitive development of children.

b. The knowledge and concept about the special vulnerability of children in environment

Children are more vulnerable than adults to environmental risks due to:

1. Growing children breathe more air, consume more food and drink more in proportion to their body weight than adults.

2. Children's body systems such as the central nervous, immune, reproductive and digestive systems are still developing as well as underdeveloped thermoregulatory systems. Exposure to environmental toxins during early stages of development can cause irreversible damage.

3. Children's behavior differs from that of adults, which means they can be exposed to environmental risks in different ways. For example, young children crawl on the ground, exposing them to dust and chemicals which accumulate on floors and soil, potentially harming their health.

Children have little control over their environment. Unlike adults, they may be unaware of risks and unable to make choices to protect their health so greatly rely on their caregivers for self-care. Children in **rural** and **urban** areas are exposed to different environmental conditions and risk factors[3].

[3] Inheriting a sustainable world? Atlas on children's health and the environment. Geneva: World Health Organization; 2017 (https://apps.who.int/iris/handle/10665/254677/, accessed 18 October 2022).

Urban areas may have:	Rural areas may have:
Better access to:	**Better access to:**
Health care and health services	Green spaces
Education	Less crowding
Water, sanitation and hygiene facilities and services	Cleaner air
Public transport	Less traffic
But may experience:	**But may experience:**
Overcrowding	Poor access to health care
Air pollution, both ambient and household, Heat stress	Poor access to safe water, sanitation and hygiene services and facilities
Traffic (pollution and injury)	Poor access to education because of frequent floods/cyclone and storm surges
Noise pollution	Pesticide exposure

Environmental exposures start in the womb. Maternal exposure to some chemicals and heat in the environment can pass to fetus in utero and cause health effects that last for a lifetime.

This infographic illustrates some of the environmental exposures that can threaten the health of a fetus, and which may cause lifelong health effects. These environmental exposures include[4]:

Fig 1: Environmental exposures start in the womb and have effects throughout life

[4] Etzel RA, editor. Pediatric environmental health, 4th edition. Itasca: American Academy of Pediatrics; 2019.

a) toxic chemicals, such as lead and mercury

b) pollution from industries

c) household air pollution

c. Magnitude of the threats to children's health

According to World Health Organization (WHO), almost 1.6 million children under 5 years of age died due to environmental factors in 2016. Environmental hazards disproportionately affect low and middle-income countries (LMICs). In 2016, almost two-thirds of all deaths attributable to the environment in LMICs of the African and South-East Asia Regions[5].

d. Actions of different stakeholders to protect children's health from environmental hazards

Governments and national stakeholders at the national level can:

a) Recognize environmental health issues that affect children's health and development with a particular focus on vulnerable groups

b) Develop and implement sustainable policies that work to address and improve environmental health issues in their national context

c) Take and support actions that reduce toxic environmental health threats at national and local levels

> Children are our most valuable national asset. Protecting them from environmental threats is crucial for their growth and development. For over two decades, WHO, UNICEF and other stakeholders have been working tirelessly to improve children's environmental health. By creating a healthier, cleaner and safer environment, we can secure a brighter and more sustainable future for children and ultimately for the world.

[5] World economic situation and prospects 2022. New York: United Nations; 2022 (https://www.un.org/development/desa/dpad/publication/world-economic-situation-and-prospects-2022/, accessed 18 October 2022).

Chapter 2: Air Pollution

Air pollution poses serious global threats to health, climate, and ecosystems, with South Asia and parts of Africa facing the highest disease burden, according to the State of Global Air (SoGA) 2024 report. Children are especially vulnerable due to unique exposures—pollutants can cross the placenta, and their lower breathing height puts them closer to concentrated pollutants near the ground.

Learning Objectives

At the end of this chapter, learners will be able to:

a) Define and classify air pollution

b) Comprehend the magnitude of air pollution

c) List major air pollutants and mention the sources

d) Identify the major health effects of air pollution in children

e) Determine the prevention and management strategies to reduce air pollution

a. Definition and classification of air pollution

Air pollution can be defined as the presence of one or more contaminants, such as dust, fumes, gas, mist, odor, smoke or vapor in the atmosphere in quantities, characteristics and duration such as to be harmful to human, animal or plant life[6]. USEPA has identified six pollutants as common air pollutants in USA, which are also known as "Criteria Pollutants". These are- Particulate Matter, Ground level Ozone, Carbon monoxide, Sulfur dioxide, Nitrogen dioxide and Lead.

There are two primary types of air pollution:

1. **Ambient (outdoor) air pollution** refers to pollution in outdoor air, but able to enter the indoor environment[7]. They typically include carbon monoxide (CO), nitrogen oxides (NOx), lead, arsenic, mercury, sulfur dioxide (SO2), polycyclic aromatic hydrocarbons (PAHs) and particulate matter (PM).
2. **Household (indoor) air pollution** refers to pollution in and around the home generated by inefficient combustion of fuels (wood, biomass, coal, kerosene, etc.) for cooking, heating and lighting[8].

b. Sources of Air Pollution

WHO identifies at least six air pollutants of major public health concern:

i. Fine particulate matter ($PM_{2.5)}$

ii. Coarse particulate matter (PM_{10})

iii. Ozone at ground level (O^3)

6. Glossary on air pollution. Copenhagen: WHO Regional Office for Europe; 1980
7. Air pollution and child health: prescribing clean air. Summary. Geneva: World Health Organization; 2018
8. WHO indoor air quality guidelines: household fuel combustion. Geneva: World Health Organization; 2014

iv. Nitrogen dioxide (NO_2)

v. Sulfur dioxide (SO_2)

vi. Carbon monoxide (CO).

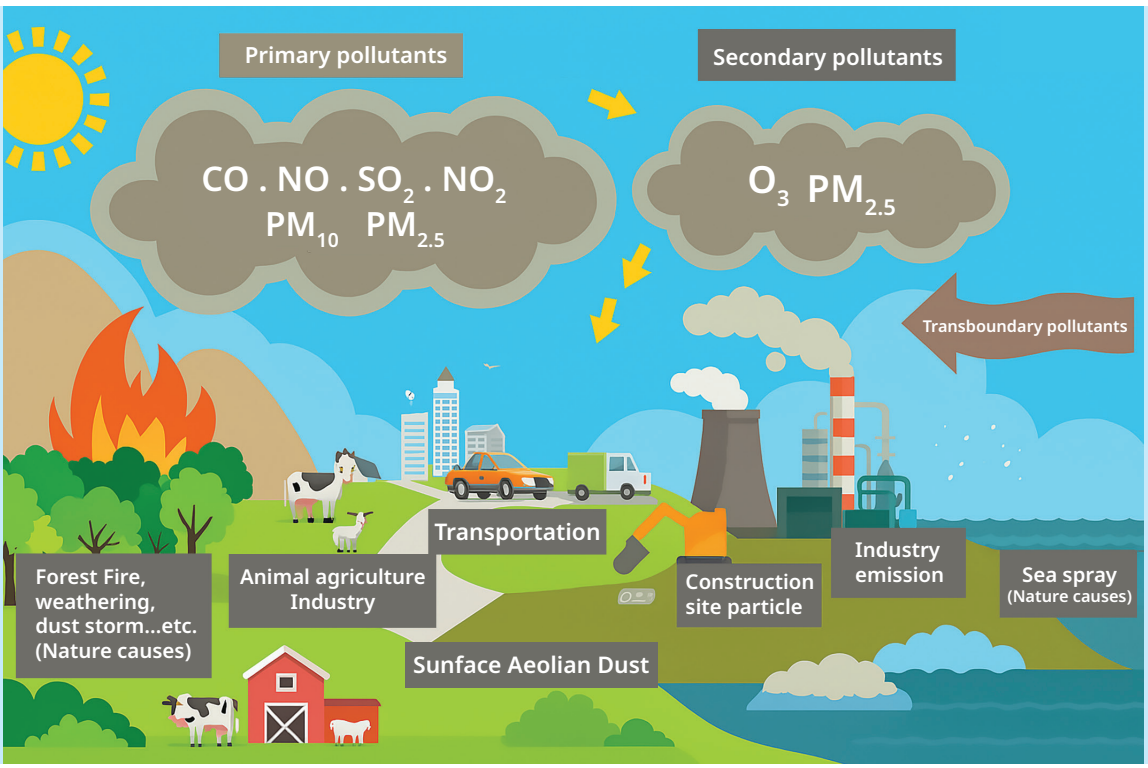


Fig 2: Sources of Ambient Air Pollution

Sources of ambient air pollution may differ significantly from region to region and from context to context. There are seven primary sources of ambient air pollution[9]:

- Industry and energy supply, which include the combustion of fossil fuels produces SO_2 and NO_2
- Transport, such as planes, lorries and personal vehicles using fossil fuels
- Waste management, especially open burning practices
- Household combustion devices and polluting fuels, used for heating, cooking and lighting in homes
- Agricultural practices and livelihood, which may include controlled burning of biomass and uncontrolled forest and savannah fires
- Dust and dust storms, which can contribute significantly to concentrations of particulate matter (PM) in the air
- Wildfires, which can release significant amounts of hazardous pollutants and greenhouse gases into the atmosphere, including PM2.5 and carbon dioxide.

Sources of household air pollution: Polluting fuels (such as wood, coal, charcoal, kerosene), animal dung and crop waste (burned using inefficient technologies, including inefficient stoves, open fires), generators and water heaters, and oil and kerosene lamps, result in high levels of household air pollutants[10].

9. Ambient (outdoor) air pollution. Geneva: World Health Organization; 2022

10. Household air pollution. Geneva: World Health Organization; 2022

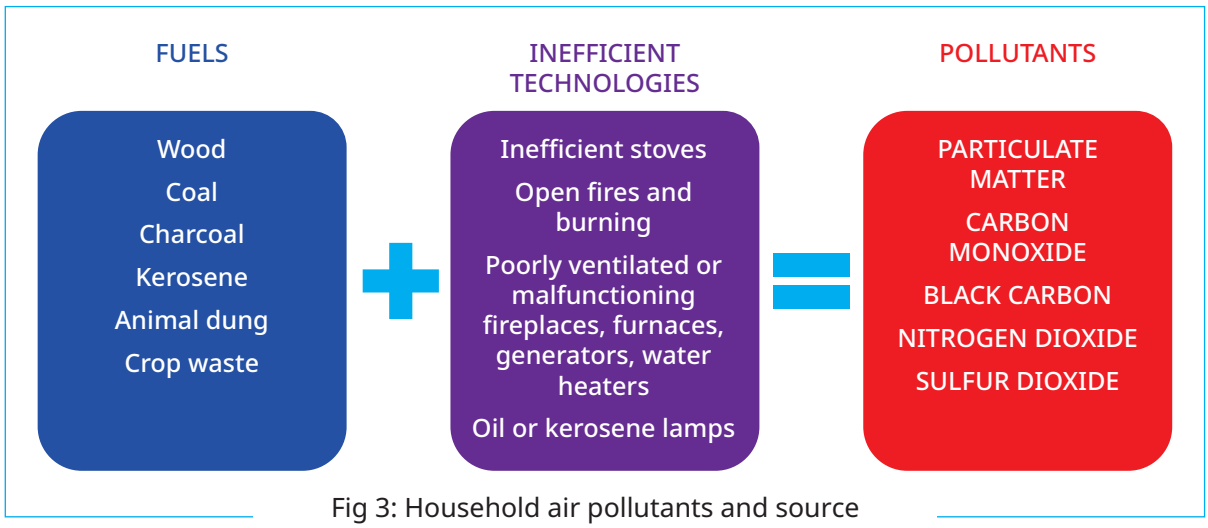


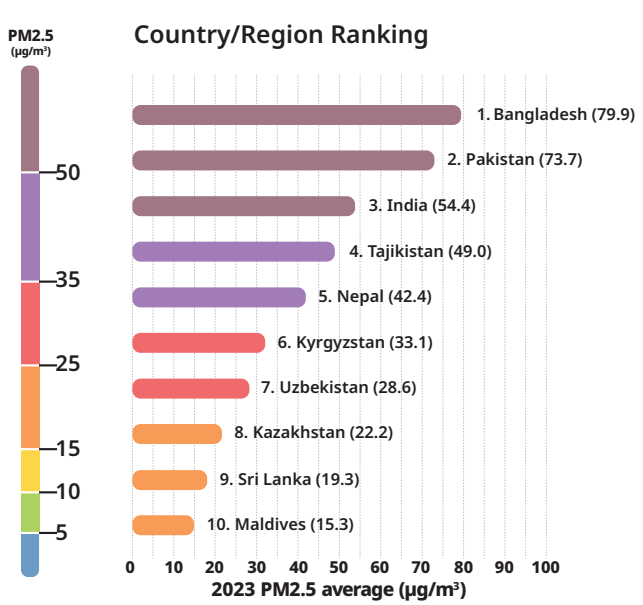
Fig 3: Household air pollutants and source

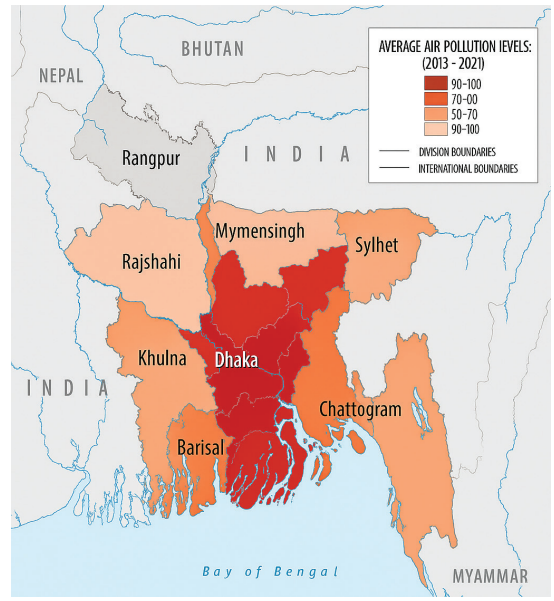
In Bangladesh, residential use of solid fuels for cooking is the main source of PM2.5 pollution, with 74.2% of the population still relying on fuels like wood, straw, and dung—mostly indoors. This household air pollution caused around 69,000 premature deaths in 2019 and contributed to 13,500 ambient PM2.5-related deaths[11].

c. Ways to measure how much the air is polluted:

Air quality index (AQI)

AQI is a value representing the air quality status in a given area. The AQI focuses on potential health effects that one might experience within a few hours or days after breathing polluted air.





$PM_{2.5}$ average concentration levels (µg/m³) in Bangladesh

Fig 4 & 5: $PM_{2.5}$ country ranking in 2023, $PM_{2.5}$ average concentration levels(µg/m³) in Bangladesh

[11] Ambient air pollution attributable deaths in children under 5 years. Geneva: World Health Organization; 2022

In Bangladesh, AQI is calculated based on the prevailing concentrations of five pollutants: Particulate Matter (PM10 and PM 2.5), NO2, CO, SO2 and O3. AQI value tells how clean or polluted the air is, and what the associated health impacts might be on the public[12]. Bangladesh, being the most polluted country in the world in 2023, the average AQI is 164, which was 16 times the WHO air quality guideline value. Especially in dry session between November to February the level accelerated up to 248, which was very harmful for health[13].

Air quality index (AQI)	Category		Color
	In English	In Bangla	
0-50	Good	ভালো	Green
51-100	Moderate	মোটামুটি	Yellow Green
101-150	Caution	সতর্কতামূলক	Yellow
151-200	Unhealthy	অস্বাস্থ্যকর	Orange
201-300	Very Unhealthy	খুব অস্বাস্থ্যকর	Red
301-500	Extremely Unhealthy	অত্যন্ত অস্বাস্থ্যকর	Purple

Table 1: Air Quality Index (AQI) for Bangladesh[14]

d. Magnitude of the problem

Global scenario: WHO estimated that 99% of the world's population were living in countries where the WHO air quality guidelines levels were not met. About 7 million deaths globally were attributable to ambient air pollution[15]. Almost 161000 children under 15 years of age died globally from exposure to ambient air pollution due to acute lower respiratory infection, the majority of whom were under 5 years of age[16]. About 89% of these deaths occurred in LMICs, and the South-East Asia and Western Pacific Regions were the most affected[17].

Bangladesh scenario: In 2021 alone, air pollution was responsible for over 235,000 deaths and of them 19,000 deaths were of children under five in Bangladesh, highlighting a significant public health challenge. Bangladesh was ranked as the most polluted country in the world and Dhaka was considered as the second most polluted city each year between 2018 to 2021. An estimated 78,145 to 88,229 deaths were attributable to ambient air pollution. This translates to economic losses, estimated between 3.9 and 4.4 percent of the country's gross domestic product (GDP) during the year[18].

12. WHO global air quality guidelines: particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. Geneva: World Health Organization; 2021
13. IQ Air. The 2023 World Air Quality Report, region and city PM2.5 ranking.2023
14. Ambient Air Quality in Bangladesh. Clean Air and Sustainable Environment Project, Department of Environment, Ministry of Environment, Forest and Climate Change of the Government of Bangladesh;2018
15. Compendium of WHO and other UN guidance in health and environment, 2024 update. Geneva: World Health Organization; 2024
16. Ambient air pollution attributable deaths in children under 5 years. Geneva: World Health Organization; 2022
17. Ambient (outdoor) air pollution. Geneva: World Health Organization; 2022
18. Health Effects Institute and UNICEF. State of Global Air 2024. Special Report. Boston, MA: Health Effects Institute, 2024.

e. Major health effects for children

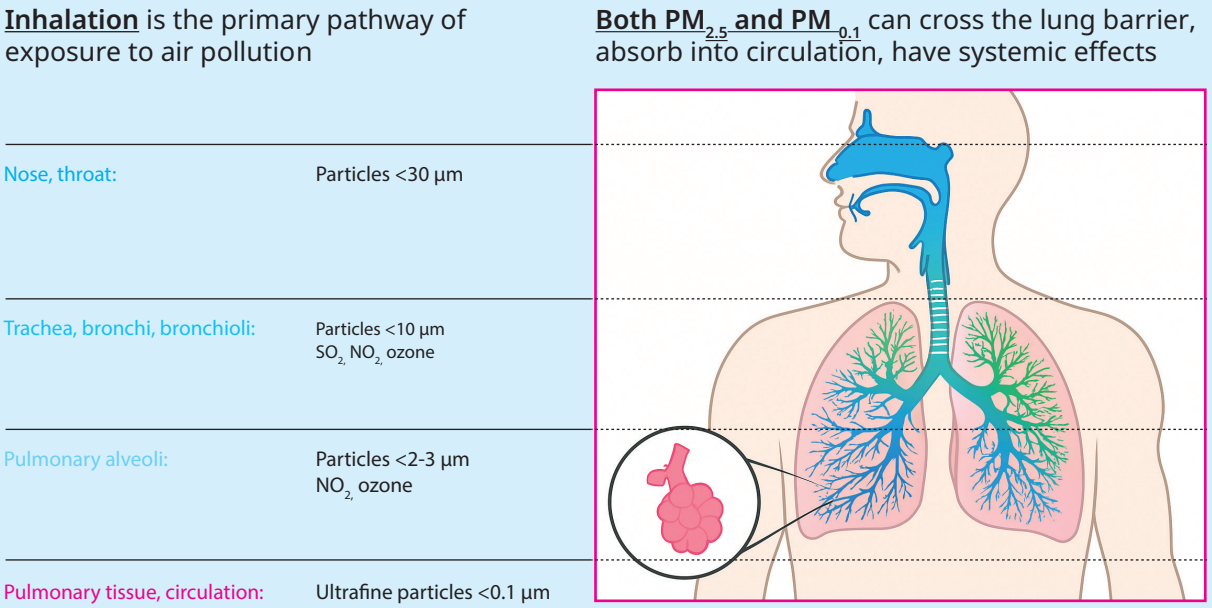


Fig 6: Pathways of exposure: how air pollutants enter into the body

The pathways of human exposure to air pollution include inhalation, dermal and ocular absorption, as well as ingestion. The primary pathway of exposure is inhalation, as is illustrated on the slide. Pollutants in both indoor and outdoor air reach different parts of the respiratory system depending on several factors. Particulate matter (PM) size is the most important factor in determining how far particles can penetrate the respiratory system. These include[19]:

- Characteristics of pollutants, for example particle size or water solubility of gases
- Physiological factors of an individual, for example presence of disease, age or level of activity and exercise

f. Mechanisms of action

Multiple mechanisms of action have been suggested through which breathing polluted air leads to health damages.

i. Oxidative stress:

- Primary mechanism of action
- Many air pollutants give rise to oxidative stress in the respiratory system
- Linked to a broad range of health effects
- Mediates local and systemic inflammatory responses

[19] Air pollution and child health: prescribing clean air. Summary. Geneva: World Health Organization; 2018

ii. Inflammation:

- Linked to broad number of health effects:
  - Respiratory
  - Cardiovascular
  - Central nervous system
- Local and systemic inflammation

iii. Immunosuppression

iii. Mutagenicity in cells

Air pollution has been linked to a diverse range of child health outcomes.

Child health effects linked to air pollution
Adverse birth outcomes **Preterm birth:** The risk of preterm birth (PTB) increased with every 5 µg/m3 increase of PM2.5 in the second trimester after adjusting for confounding variables[20]. **Intrauterine fetal growth retardation (IUGR)** **Low birth weight:** Exposure to PM10 may cause its passage through the blood, increased blood viscosity and activated systemic oxidative stress followed by impaired fetal growth. **Congenital anomalies**: Maternal exposure to tobacco smoke has been linked to increased risk of congenital anomalies in children. **Stillbirth**
Childhood respiratory effects **Upper respiratory tract infections:** A study found that exposure to the carbon fraction of PM2.5 may be linked to an increased risk of upper respiratory infection in children under the age of 5. **Otitis media:** Associated with exposure to nitrogen dioxide **Pneumonia:** Incidence of acute lower respiratory infections in children is strongly associated with exposure to fine particulate matter (PM2.5) from combustion of polluting fuels using inefficient technologies for household cooking, heating and lighting needs. **Asthma**: Environmental risks such as ambient and household air pollution, microbial exposures, second-hand smoke, pollen and animal allergens[21].

[20] Maternal PM2.5 exposure is associated with preterm birth and gestational diabetes mellitus, and mitochondrial OXPHOS dysfunction in cord blood

[21] Calogero C, Sly PD. Developmental physiology: lung function during growth and development from birth to old age. Eur Resp Monograph. 2010;1:1–15

Other health outcomes

Neuro developmental impairment (IQ loss and Autism): Systematic reviews have suggested links between prenatal exposure to ambient air pollution and reduced attention and executive functions, learning and memory, and language and numerical ability in preschool and school-aged children and changes in fine psychomotor skills, behavioral changes and reduced intelligence quotient (IQ). A small number of studies have investigated links between prenatal and early childhood exposure to PM2.5 and nitrogen dioxide in ambient air and risk of autism spectrum disorder and attention-deficit hyperactivity disorder (ADHD)[22].

Childhood malignancy: A systematic review found that exposure to benzene was associated with an excess risk of childhood leukemia in children under 6 years of age

Infant and child mortality: Pregnancy-associated hypertension is a leading cause of perinatal and maternal mortality and morbidity. A large body of research on the general population has linked changes in blood pressure to ambient air pollution[23].

Stunting: Exposures of pregnant women to higher levels of certain PM2.5 chemical constituents originating from specific sources are associated with lower birth weight which is independently linked with stunting[24].

g. Prevention and Management of Air Pollution

The following actions can be taken to reduce air pollution exposure and related health risks[25].

Individual practice:

- Cleaning indoor air with portable or central air cleaning system
- Reducing exposure in microenvironments near sources such as traffic
- Cleaning indoor air using portable or central air cleaning systems helps reduce exposure to harmful pollutants inside the home. This is especially important in urban areas with high outdoor pollution levels.
- Before going outside, always check the Air Quality Index (AQI) using reliable apps or websites. If the AQI is at an unhealthy level, it is best to avoid outdoor activities to protect your respiratory health.
- If going outside is necessary during poor air quality, wearing a protective mask such as an N95 or KN95 can help reduce inhalation of fine particles that are harmful to the lungs.

[22] Castagna A, Mascheroni E, Fustinoni S, Montirosso R. Air pollution and neurodevelopmental skills in preschool- and school-aged children: a systematic review. Neurosci Biobehav Rev. 2022;136:104623.

[23] Pederson M, Stayner L, Slama R, Sørensen, Figueras F, Nieuwenhuijsen MJ et al. Ambient air pollution and pregnancy-induced hypertensive disorders: a systematic review and meta-analysis. Hypertension. 2014;64(3):494-500.

[24] Prenatal Exposure to Fine Particulate Matter and Birth Weight https://pmc.ncbi.nlm.nih.gov/articles/PMC3055585/

[25] WHO, ITU. Be healthy, be mobile: a handbook on how to implement Breathe Freely, Healthy for COPD and asthma. Geneva: World Health Organization; 2017

- Avoid spending time near traffic-heavy areas, as pollution levels are significantly higher in these microenvironments. Choose routes with less congestion and greenery whenever possible.
- Keep your home smoke-free. Do not allow smoking indoors, as it worsens indoor air quality and poses health risks to all household members, especially children and the elderly.

Local Policies:

- Eliminating open waste burning
- Engaging local schools and communities in air pollution initiatives, such as tree planting days and walk or bike to school days
- Promoting the use of public transport and active forms of transport, such walking and cycling
- Supporting local air quality monitoring projects and community initiatives
- Developing local warning systems that alert people to hazardous air quality, for example text message systems, radio programs, social media alerts or signage on major roads.
- Promoting the use of air quality indexes, communicating their uses and making them accessible to the public.

National Policies:

- Set and enforce air quality standards in line with WHO air quality guidelines
- Invest in air quality and health risk monitoring
- Improve waste management
- Ensure access to clean fuels and technologies for domestic cooking, heating, lighting
- Invest in green energy, build green cities and green spaces
- Implement vehicle emissions standards

h. Health professionals should think following issues

General Health and Symptoms

1. Have you been experiencing any shortness of breath, coughing, wheezing, or chest tightness?
2. Do you have any pre-existing respiratory conditions such as asthma?
3. Have you noticed any recent worsening of your respiratory symptoms?
4. Do you frequently experience headaches, dizziness, fatigue, or eye irritation?
5. Have you had any skin irritation or unexplained allergic reactions?

Exposure History

6. Do you live or work in an area with high levels of air pollution, such as near factories, highways, or industrial zones?
7. Have you recently been exposed to smoke, dust, fumes, or strong odors from chemicals?
8. Do you spend a lot of time outdoors, particularly during high-traffic hours?
9. Have you noticed symptoms worsening on days with poor air quality or extreme weather conditions?
10. Do you use indoor sources of pollution such as wood stoves, gas stoves, or tobacco smoke?

Work and Lifestyle Factors

11. Do you work in an environment with exposure to dust, chemicals, or fumes (e.g., construction, factories, brick-kiln)?
12. Have you noticed an increase in symptoms after spending time in certain locations, such as your workplace or home?
13. Are you frequently exposed to secondhand smoke?
14. Have you traveled recently to areas with known high air pollution levels?

Medical and Family History

15. Do you have a history of respiratory illnesses or allergies?
16. Does anyone in your family suffer from asthma, lung disease, or other pollution-related illnesses?
17. Have you had previous episodes of respiratory infections or conditions that required medical treatment?

Air pollution affects child health, the environment, and the economy. Its sources are well-identified globally, and reducing pollution requires coordinated interventions. Healthcare professionals play a key role in prevention, treatment, and advocacy. Tackling air pollution demands collaborative, multisectoral efforts to ensure cleaner air and a healthier future.

Chapter 3: Noise Pollution

Sound is a vibration detected by the ear, with normal levels ranging from 30 to 70 dBA (dB refers to decibel and dBA refers to A-weighted decibel. dBA is a unit for measuring sound levels that takes into account how the human ear perceives loudness at different frequencies). Noise pollution—unwanted or disruptive sound—has become a major public health issue, especially in urban areas. Dhaka ranks highest in noise pollution among 61 major cities, with average levels reaching 119 dBA, far above safe limits[26]. This has led to serious health impacts, including hearing loss. According to Bangladesh Poribesh Andolon (BAPA), 5–7% of patients at BSMMU reportedly suffer from deafness due to noise exposure.

Learning Objectives

By the end of this chapter, readers will be able to

a) Define noise/sound pollution and identify its sources.

b) Understand the global and national magnitude of noise/sound pollution.

c) List major health effects of noise/sound pollution, especially on children.

d) Recognize prevention and management strategies to mitigate noise pollution.

a. Definition and Sources of Sound Pollution/Noise

The World Health Organization (WHO) defines sound pollution/noise as "unwanted and harmful outdoor sound created by human activities, including traffic, industry, and consumer products".

Common sources

Noise pollution comes from many everyday sources, including loud toys, household appliances, entertainment devices, and communication tools like cell phones. In Bangladesh, the primary source of noise pollution stems from vehicular traffic[27]. Transport vehicles, including personal motorized wheelers, public buses, trains, airplanes, and cargo transport vehicles like trucks, goods trains, and cargo planes, are another major source of noise pollution. Urbanization and deforestation also indirectly increase noise by expanding noisy infrastructure into once-quiet areas.

[26] Salehin, S. et al. (2014) "Industrial Noise Levels in Bangladesh; is Worker Health at Risk?," Pol. J. Environmental Study, 23(5), pp. 1719–1726.

[27] Noise Effects Handbook: A Desk Reference to Health and Welfare Effects of Noise, U.S. EPA, Office of Noise Abatement and Control, July 1981, www.nonoise.org/library/handbook/handbook.htm

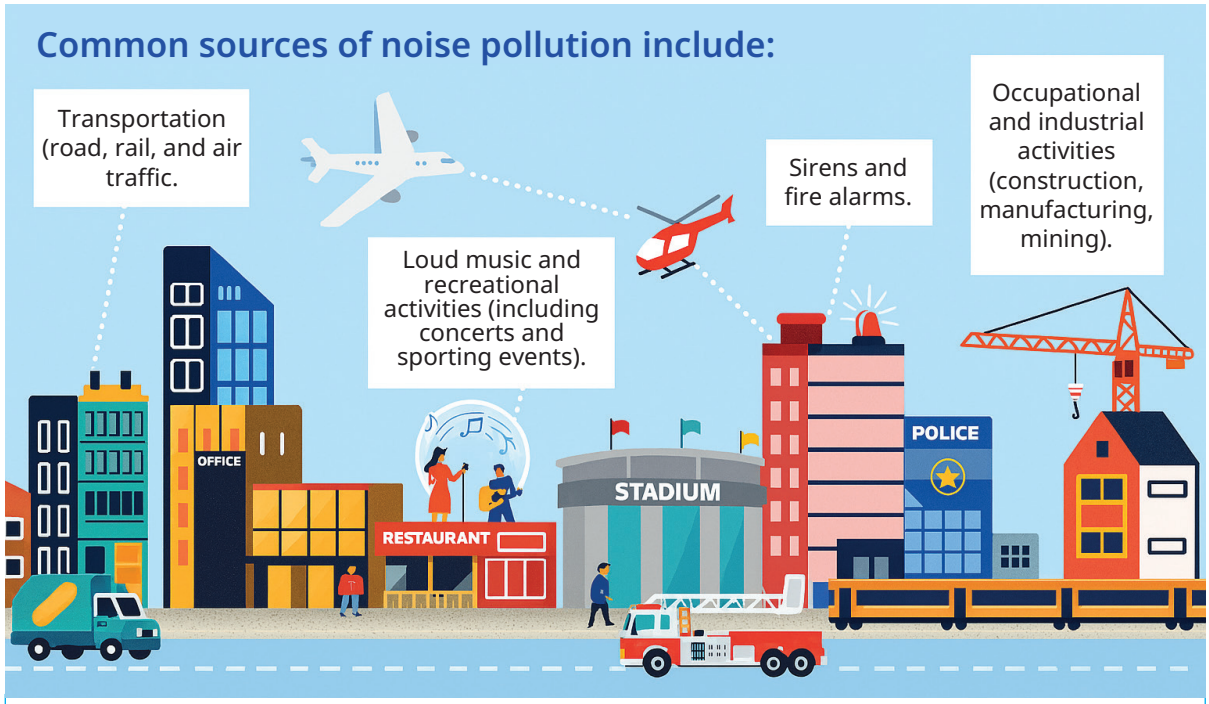


Fig 7: common source of noise pollution

b. Magnitude of Noise/Sound Pollution

Globally, noise pollution is increasing as urban centers expand. UN Environment Program (UNEP, 2022) report declared Dhaka the world's noisiest city. Against the permissible limits of 55 decibels as set by the WHO, the noise levels in Dhaka were found to be at least twice that, at 110-132 decibels. 75% of noise pollution in Dhaka originates from vehicles. Around 11.7% of the population in Bangladesh has lost their hearing due to noise pollution, says the Department of Environment (DoE) study[28].

Location (Inside the facility)	Measured noise level average (dB)	
	Morning	Afternoon
Eden Mohila College	69	67
Udayan School	57	55
Willes Little Flower School and College	66	69
Motijheel Ideal School and College	77	72
Curzon Hall (Dhaka University)	87	77
Dhaka medical college hospital	89	91
Bangabandhu Sheikh Mojib Medical College Hospital	90	95
Ever care Hospital	55	53
Ramna Park	57	54

Table 2: Measured noise level average (dB) at major areas of Dhaka

[28] Islam, R, DoE. (2024) "Multidimensional analysis of road traffic noise and probable public health hazards in Barisal city corporation, Bangladesh," Heliyon, 10(15), e35161 https://doi.org/10.1016/j.heliyon.2024.e35161.

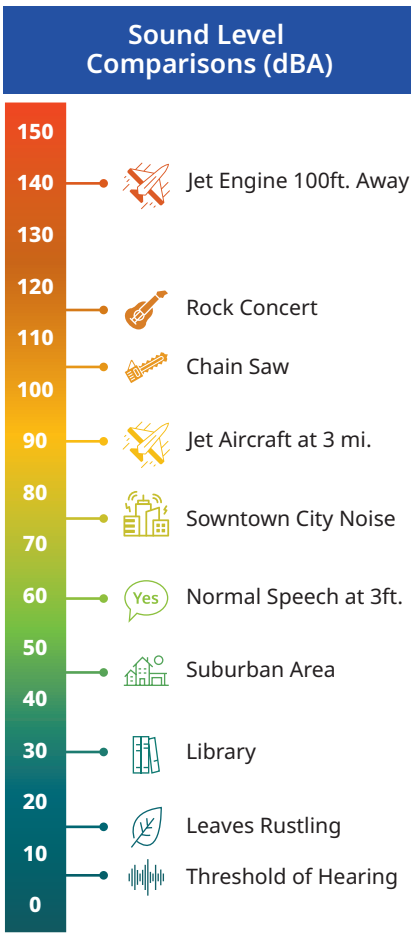
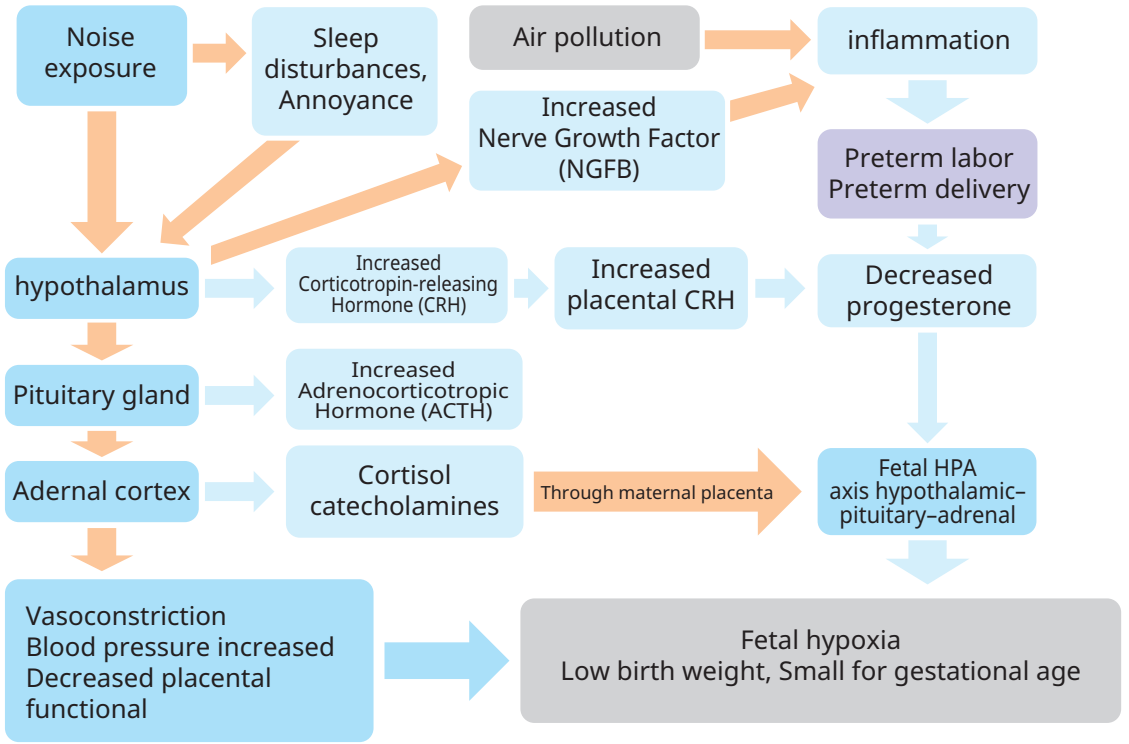


Fig 8: Sound Level Comparisons (dBA)

C. Health Effects of Noise Pollution

Noise can pose a serious threat to a child's physical and psychological health, including learning and behavior. The World Health Organization (WHO) has documented **seven** categories of adverse health and social effects of noise pollution[29]-

- **Interfere with speech and language**: Repeated exposure to noise during critical periods of development may affect a child's acquisition of speech, language, and language-related skills, such as reading and listening.
- **Impair learning**: The inability to concentrate in a noisy environment can affect a child's capacity to learn.
- **Impair hearing**: Tinnitus, often described as a ringing or buzzing sound in the ear, is a symptom associated with many forms of hearing loss. Noise-Induced Hearing Loss (NIHL) is a permanent hearing impairment resulting from prolonged exposure to high levels of noise or by sudden high level (impulse) noise.
- **Disrupt sleep**: The WHO guidelines for community noise recommend less than 30 A-weighted



[29] Noise Effects Handbook: A Desk Reference to Health and Welfare Effects of Noise, U.S. EPA, Office of Noise Abatement and Control, July 1981, www.nonoise.org/library/handbook/handbook.htm

decibels (dB(A)) in bedrooms during the night for a sleep of good quality. Noise can awaken a child or disrupt his or her sleep patterns. There is also emerging evidence that short-term effects of environmental noise, particularly when the exposure is nocturnal, may be followed by long-term adverse cardiometabolic outcomes.

- **Impacts on cardiovascular system**: Epidemiological studies have found that transportation noise increases the risk for cardiovascular morbidity and mortality, with solid evidence for ischemic heart disease, heart failure, and stroke. According to the World Health Organization, at least 1.6 million healthy life years are lost annually from traffic-related noise in Western Europe. Elevated blood pressure and other cardiovascular ailments can be found in children who are chronically exposed to loud noise.
- **Mental Health**: Increased anxiety, stress, and risk of attention deficit hyperactivity disorder (ADHD), depression and general mental stress have been associated with activation of certain neurological and endocrine pathways. Anxiety and depression are both correlated with fear and stress via the autonomic nervous system. Noise-induced stress responses activate the hypothalamic–pituitary–adrenal (HPA) axis and the sympathetic nervous system (SNS).
- **Adverse Birth Outcomes:** Potential risk of low birth weight and developmental issues.

d. Prevention and Management Strategies

Effective mitigation requires coordinated efforts at local, national, and personal levels.

Individual Practices:

- Limiting the use of time for loud appliances.
- Implement options for volume limitation and parental volume control in every device
- Controlling volume levels for TV, audio, etc.
- Create a quiet learning and sleeping environment.
- Ensure regular hearing checks

Local Policies:

- Installing soundproof systems in buildings.
- Implementing noise reduction initiatives like “quiet zones” in residential areas.
- Encouraging public use of quieter machinery and vehicles.

National Policies:

- Enforcing noise level standards in public and industrial zones.
- Restricting loudspeakers and construction activities during nighttime.
- Public area such as airport, railway station, bus station should be located away from residential areas.
- Improve traffic management and establish traffic signal infrastructure.

e. Assessing the Health Impacts of Environmental and Occupational Noise Exposure

To assess the exposure and impact of noise on the patients, the physicians can use the below questionnaire during history taking:

Assess the exposure to Noise:

1. What types of noises are you exposed to regularly? (e.g., traffic, machinery, loud music)
2. How frequently are you exposed to loud noise? (daily, weekly)
3. How long do you stay in noisy environments at a time? (hours per day)
4. Do you use hearing protection (like earplugs or noise-canceling headphones) when in noisy places?
5. Do you live or work near a construction site, airport, or other noisy areas?
6. What is the noise level in your workplace or neighborhood? (low, moderate, high)
7. Have there been any changes in your environment that increased noise exposure recently?

Health and Symptoms:

8. Do you experience ringing or buzzing in your ears (tinnitus)?
9. Have you noticed any recent difficulty hearing conversations?
10. Do you feel stress, irritability, or fatigue after being in noisy environments?
11. Do you have frequent headaches or migraines linked to noise exposure?
12. Have you experienced sleep disturbances or trouble concentrating due to noise?
13. Do you suffer from any cardiovascular issues, such as high blood pressure?

Lifestyle and Habits:

14. How often do you use headphones or earbuds, and at what volume?
15. Do you attend concerts, clubs, or other loud entertainment venues?

Past Medical History:

16. Have you been diagnosed with any prior hearing conditions or related illnesses?
17. Are you taking medications that might affect your hearing or increase sensitivity to noise?

Mental and Emotional Impact:

18. Do you feel anxious or depressed due to constant noise exposure?
19. Have you noticed mood swings or decreased productivity linked to noise?

Physicians should include environmental exposure—especially noise—in patient history to better understand symptoms like sleep issues, stress, fatigue, hearing loss, or cognitive problems. Assessing noise exposure helps guide further tests (e.g., hearing, blood pressure, stress) and improves diagnostic accuracy. When significant exposure is identified, targeted referrals to specialists (e.g., ENT, neurology, psychiatry) with clear notes on environmental factors ensure more effective, comprehensive care.

Noise pollution is not merely a nuisance—it is a significant public health concern with both immediate and long-term consequences, particularly for vulnerable populations like children. Its association with chronic conditions such as hypertension, anxiety, depression, and sleep disturbances is increasingly supported by scientific evidence. Physicians must be aware of these links and consider environmental factors, including noise exposure, as part of routine history-taking and clinical assessments. Treating symptoms without addressing the underlying environmental contributors may limit the effectiveness of care. Managing noise pollution requires a shared responsibility—from individual behavior changes to strong community action and national policy implementation. Only through a coordinated, multi-level approach can we protect public health and build healthier, quieter living environments for all.

Chapter 4: Lead and Other Hazardous Chemicals

Hazards caused by toxic chemical in children are a major concern at present. Due to development and industrialization, more and more chemicals have been used in every aspect of our life, though it's known to us or not. These chemicals have adverse effects in our environment as well as our health. Children and pregnant women are most vulnerable to get effected by the short- and long-term effects of chemicals[30].

Learning Objectives

At the end of the chapter, learners will be able to-

a)	List the common harmful chemicals
b)	Comprehend the magnitude of the problem
c)	Explain the characteristics of lead and other toxic chemicals
d)	Mention the sources and identify the route of chemical exposure
e)	Refer to the health hazards of chemicals
f)	Prevent the exposures and manage the problem

a. Common harmful Chemicals

In a general, collective term that refers to a group of metals and metalloids with an atomic density greater than 4 g/cm^3 or 5 times or more than water, the term heavy metal is often referred to as trace elements as they exist in minute concentrations in biological systems[31].

Chemicals of major public health concern are listed below:

- Lead
- Arsenic
- Nitrogen dioxide carbon monoxide
- Hydrocarbon- kerosine, Turpen, Paraffin, etc.
- Asbestos
- Fluoride
- Mercury
- Benzene
- Cadmium
- Dioxin

[30] The public health impact of chemicals: knowns and unknowns: data addendum for 2019. Geneva: World Health Organization; 2021 (https://apps.who.int/iris/handle/10665/342273, accessed 14 September 2022).

[31] Chemicals of major public health concerns [website], Geneva, World Health Organization (WHO), 2022 (http;//www.who.int/teams/environment-climate-change-and health/chemical-safety-and-health/health-impacts/chemicals, [accessed 14 September 2022].

b. Characteristics and Magnitude of each heavy metal

According to WHO, globally two million deaths are attributed to chemical exposure. During pregnancy and childhood exposure to toxic chemicals can give rise to disability and premature deaths. Lead, mercury, some pesticides and persistent organic pollutants (POPs) are responsible for trans-generational toxicity to children[32].

Pollutant	Characteristics	Magnitude	Adverse Health Effects	Sources/ Routes of Exposure[33]
Lead	Blue-gray, heavy, soft metal; low melting point; anti-corrosive.	Over 35 million children in Bangladesh have high levels of lead above the WHO threshold (IHME 2021). Lead contributes to 87,831 low birth weight (LBW) cases, and 60,631 preterm births (PTB) annually. Loss of 20 million IQ points in each annual birth cohort in Bangladesh (NIPSOM CEH study, 2024).	Impaired cognitive development, low birth weight, preterm birth, still birth, behavioral issues (ADHD, ASD), IQ loss.	Paint, dust, soil, water, air, informal used lead acid battery recycling, contaminated spices and food, aluminum cookware, cosmetics. Exposure through ingestion and inhalation.
Mercury	Silvery white; forms amalgams; neurotoxic methylmercury.	About 32,660 kg/year of mercury released in Bangladesh: 44% from waste incineration. Annual IQ losses in Bangladeshi children up to 2.9 million points. ((NIPSOM CEH study, 2024)	Neurological disorders, cerebral palsy, renal failure, low birth weight, Growth, cognitive and developmental impact	Fish consumption, industrial emissions. Exposure: inhalation, ingestion.
Cadmium	Silver-white, malleable, soluble in acid; persists in soil.	Highest levels found in Turag River (17 mg/kg); found in multiple rivers. Children with the highest urinary cadmium levels had IQ scores 7 points lower than those with the lowest exposure levels (NIPSOM study, 2024)	Kidney disease, bone weakening, lung cancer, hypertension, low birth weight, preterm birth, IQ loss	Industrial waste, tobacco smoke, contaminated food/water. Exposure: inhalation, ingestion.

[32] Summary of principles for evaluating health risks in children associated with exposure to chemicals. Geneva: World Health Organization; 2011

[33] Infant and young child feeding [website]. Geneva: World Health Organization; 2021(https://www.who.int/en/news-room/fact-sheets/detail/infant-and-young-child-feeding, accessed 1September 2022)

Pollutant	Characteristics	Magnitude	Adverse Health Effects	Sources/ Routes of Exposure[33]
Arsenic	Silver-grey, brittle metalloid; naturally occurring poison.	Contributes to about 7,653 LBW cases, 3,054 PTB cases, and 4,767 stillbirths and 2,604 infant deaths annually. Annual IQ losses in children from arsenic exposure total 4.9 million points, with a loss of 14.1 IQ points per child. This reduces lifetime income by 28% of the national mean. (NIPSOM CEH study, 2024).	Vomiting, diarrhea, skin lesions, cancer, cardiovascular disease, Low birth weight, preterm birth, still birth, ASD, child mortality	Contaminated water, soil, air. Exposure: ingestion and inhalation.
Fluoride	Helpful in small amounts; harmful in excess; added to water.	WHO recommends 0.5–1.5 ppm in water.	Dental and skeletal fluorosis.	Drinking water, dental products. Exposure: ingestion.
Nitrate	Common in fertilizers; contaminates water.	High risk for infants under 6 months.	Methemoglobinemia (blue baby syndrome).	Agricultural runoff, contaminated water Exposure: ingestion.
Asbestos	Six fibrous minerals; naturally occurring.	Used in construction and insulation.	Lung cancer, mesothelioma, asbestosis.	Construction materials; inhalation.
Benzene	Colorless, sweet odor, highly flammable.	High levels in industrial areas.	Cancer, blood disorders, immune and neurological effects.	Industrial emissions, tobacco smoke Exposure: inhalation.
Dioxins	Persistent organic pollutants; highly toxic.	Formed during combustion and industrial processes.	Cancer, reproductive and developmental problems.	Food (meat, dairy), air Exposure: ingestion and inhalation.

C.

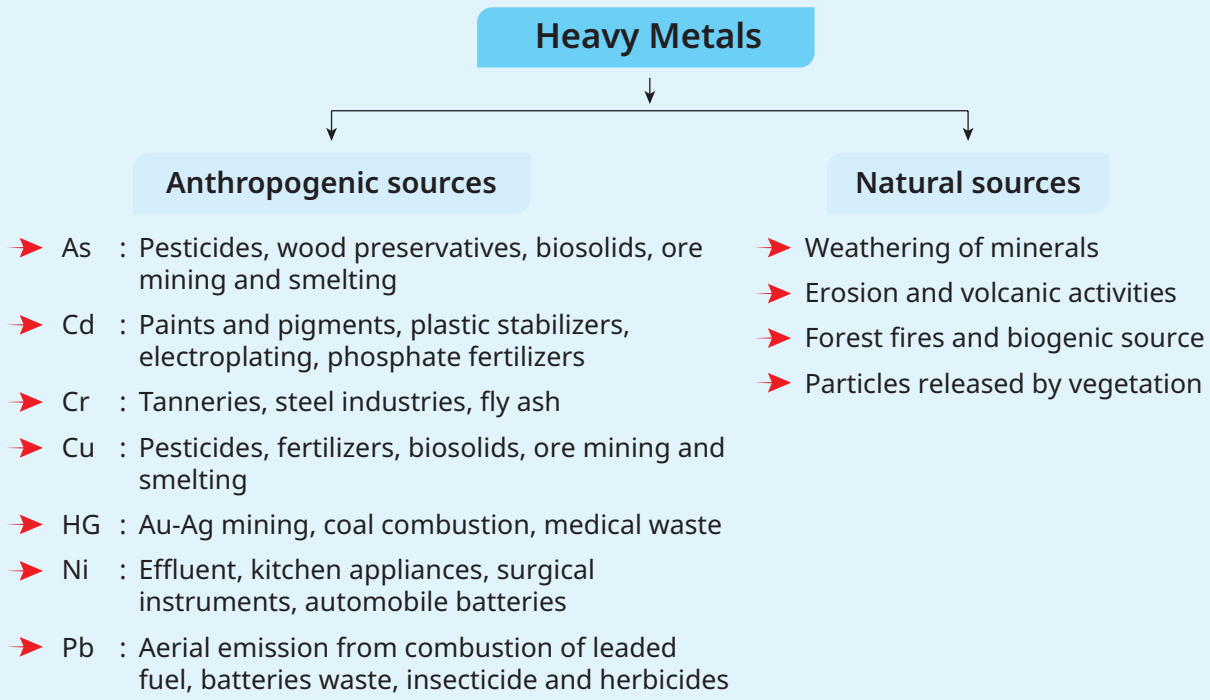


Fig 9: Sources of heavy metals

d.

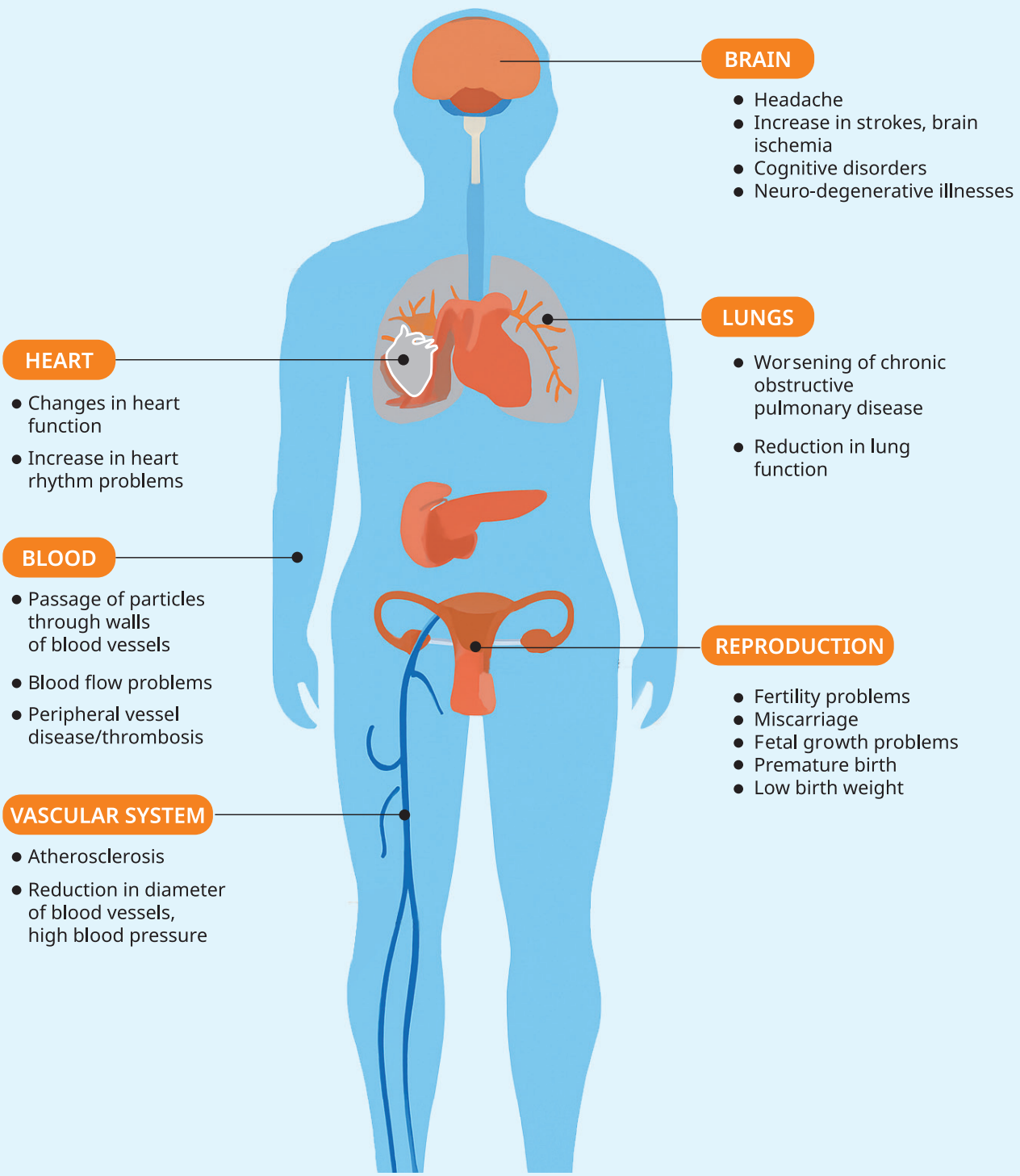


Fig 10: Health impact of heavy metals

e. Prevention and Management

Individual practice:

Household Safety prevention:

- Prevent children and pregnant women from exposure to contaminated areas, such as battery recycling sites.
- Regularly check household products (ex: paints, cookware, cosmetics) for heavy metal content.
- Parents should prevent bringing heavy metals from work or exposing children to work items at home that may have been exposed.
- Practice good sanitation and hygiene practices to reduce exposure not only to toxicants and pathogens (ex: pesticides, mosquitoes).

Behavioral Change & Advocacy:

- Promote hygiene practices to reduce exposure risks.
- Engage in grassroots advocacy to push for stricter environmental regulations.

Local Policies:

- Young children and pregnant women should avoid iron and calcium supplements unless medically advised, as low calcium levels can enhance the release of stored toxic chemicals into circulation, while anemia can increase the absorption of chemicals—particularly lead.
- Launch awareness campaigns on heavy metal exposure through schools, media, and community networks.
- Advocate for regional and international cooperation to address heavy metal contamination.

National Policies:

Legislation & Enforcement:

- Implement and enforce strict environmental, health, and safety standards for lead-acid battery recycling, e-waste processing, and heavy metal related industries.
- Regulate and eliminate heavy metals in consumer products such as paint, ceramics, toys, cosmetics, spices, and traditional medicines.
- Ban child labor in hazardous industries, including informal e-waste processing, agriculture and mining.
- National Heavy Metal Free Strategy should integrate legislation, regulation, surveillance, industry engagement, and remediation efforts across sectors to effectively eliminate heavy metal poisoning.

National Policies:

Industrial & Waste Management:

- Develop a national strategy to environmentally management of lead-acid batteries, discouraging informal recycling.
- Regulate industrial emissions to minimize heavy metal pollution in air, soil, and water.
- Establish strict tracking and import/export regulations for Used Lead-Acid Batteries (ULAB).

Monitoring & Remediation:

- Establish a national database to track heavy metal contamination and poisoning cases.
- Identify and remediate toxic hotspots, prioritizing protection for children and pregnant women.
- Strengthen drinking water safety regulations to include strict limits on heavy metal contamination.

f. Suggestions for health professionals during history taking

General Health and Symptoms

1. Have you experienced unexplained fatigue, weakness, or lack of concentration recently?
2. Have you noticed any numbness or tingling in your hands, feet, or around your mouth?
3. Have you experienced frequent abdominal pain, constipation, or nausea without a known cause?
4. Do you have persistent joint or muscle pain not related to physical activity?
5. Have you had frequent headaches, memory issues, or mood changes such as irritability or depression?
6. Have you experienced changes in vision or hearing lately?
7. Have you or your child experienced delayed growth, behavioral changes, or learning difficulties?

Exposure History

8. Do you live near factories, mines, waste dumping grounds, or areas known for industrial pollution?
9. Have you or a family member handled or been exposed to batteries, paints, pesticides, or contaminated water/soil?

10. Have you consumed fish regularly, especially large freshwater or predatory fish (e.g., tuna, catfish)?
11. Are you aware of any contamination (lead, arsenic, mercury, cadmium, etc.) in your local water or soil?
12. Have you used any traditional or herbal medicines, cosmetics, or colored powders that could contain heavy metals?

Work and Lifestyle Factors

13. Do you or your family members work in industries like welding, construction, jewelry making, battery recycling, or electronics?
14. Are you or your family members frequently exposed to dust, chemicals, dyes, or fumes at work or home?
15. Do you use water from tube wells or hand pumps for drinking or cooking purposes?
16. Have you used ceramic or metal cookware that is old or possibly unregulated for safety?

Medical and Family History

17. Have you ever been diagnosed with lead poisoning, arsenic exposure, or any other metal toxicity?
18. Do you have any history of kidney, liver, or neurological issues that required medical evaluation?
19. Has your child or family member ever been tested for lead or arsenic exposure?
20. Does anyone in your household have similar unexplained symptoms or chronic health conditions?

Chemicals are widely distributed in the environment. Not only from the polluted soil, air and water, but also chemicals enter food cycle and thus get into the human body, which can produce acute and chronic hazards. Health professionals have a critical role to play in assessing, managing and preventing chemical toxicity. The best way to reduce exposure to chemicals is to keep the children out of the sources. Chemical exposure is preventable and is the key to ensure healthy development of children.

Chapter 5: Electrical/Electronic Waste and Children's Health

Each year, millions of electrical and electronic devices are discarded as products break or obsoleted or discarded by consumers. Discarded devices considered as e-waste can become a threat to the environment and to human health if they are not treated, disposed of, and recycled appropriately[34]. The Basel Convention defines e-waste as: "any electrical and electronic equipment that is waste, including all components, sub-assemblies and consumables that are part of the equipment when it becomes unusable or discarded". Reuse and recycling are the best ways to protect the environment, but inappropriate recycling causes harmful impact on the environment. E-waste recycling activities requires high level of technical maturity, but in developing country like Bangladesh it is so hard to have a full value chain to recycle in a proper way. Improper e-waste recycling/ management can cause the release of as many as 1000 different chemicals into the environment[35]. These include heavy metals like lead, chromium, cadmium, lithium, mercury and nickel.

Learning Objectives

At the end of this chapter, learners will be able to-

a) Define e-waste and state the magnitude of e-waste.

b) Mention the sources and route of exposure of e-waste.

c) Identify the ways of getting exposure to e-waste and chemicals release from e-waste

d) Describe the hazards of e-waste on children's health

e) Mention the preventive measures and management of e-waste exposure

a. Definition and Magnitude of e-waste problems

E-waste refers to discarded electrical or electronic devices. It includes unwanted or broken items that are no longer useful, whether they still work or not. These items are often thrown away or donated, unless they have been sold from second hands shops, they eventually are discarded. E-waste is dangerous because toxic chemicals from the metals inside can leak into the ground when buried[36].

Globally in 2019, an estimated 53.6 million tons of e-waste were produced globally. However, only 17.4% or 9.3 million tons, were documented as formally collected and recycled appropriately. The amount of e-waste produced annually is expected to increase to 74.7 million tons by 2030[37]. In 2022, the world generated 62 million tons of e-waste,

[34] Tackling informality in e-waste management: the potential of cooperative enterprises. Geneva: International Labour Organization; 2014 (https://www.ilo.org/sector/ Resources/ publications/ WCMS_315228/lang--en/index.htm, accessed 6 September 2022).

[35] Frazzoli C, Orisakwe OE, Dragone R, Mantovani A. Diagnostic heath risk assessment of electronic waste on the general population in developing countries scenarios. Environ Impact Assess Rev. 2010;30(1):388-99.

[36] Needhidasan S, Samuel M, Chidambaram R. Electronic waste - an emerging threat to the environment of urban India. J Environ Health Sci Eng. 2014 Jan 20;12(1):36. doi: 10.1186/2052-336X-12-36. PMID: 24444377; PMCID: PMC3908467.

and this figure is increasing rapidly. By 2024, the generation of e-waste is growing five times faster than documented recycling efforts[38].

Bangladesh is generating approximately 2.81 million tons of e-waste every year, a study by VOICE reveals. The study also says that e-waste generation in Bangladesh is increasing at a rate of 20 per cent annually[39]. Another study by the Bangladesh University of Engineering and Technology (BUET) estimated that Bangladesh will produce 4.62 million tons of e-waste by 2035.

Aspect	Details
Sources[40]	Computers, laptops, monitors, printers, phones, tablets, TVs, refrigerators, gaming equipment, batteries, cables, lamps, etc.
Routes of Exposure[41]	Ingestion, Inhalation, Transdermal exposure, Transplacental exposure.
Exposure Pathways in Children[42]	Ingestion of food, water, soil, dust; Inhalation of gases and particles; Hand-to-mouth behaviors; Dermal exposure; Ingestion of breast milk; Transplacental exposure.
Exposure Settings	Occupational exposure at waste sites, exposure at home or through family members, community environmental exposure.

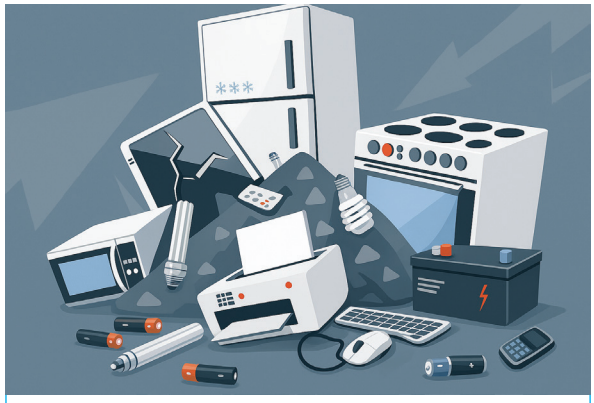


Fig 11: Sources of e-waste

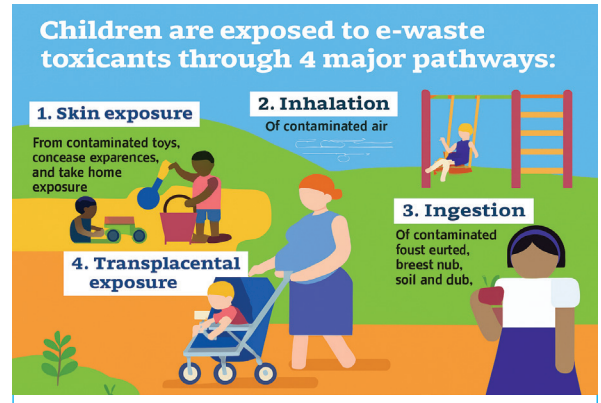


Fig 12: Route of exposure to e-waste

37. Cornelis P. Baldé, Ruediger Kuehr, Tales Yamamoto, Rosie McDonald, Elena D'Angelo, Shahana Althaf, Garam Bel, Otmar Deubzer, Elena Fernandez-Cubillo, Vanessa Forti, Vanessa Gray, Sunil Herat, Shunichi Honda, Giulia Iattoni, Deepali S. Khetriwal, Vittoria Luda di Cortemiglia, Yuliya Lobuntsova, Innocent Nnorom, Noémie Pralat, Michelle Wagner (2024). International Telecommunication Union (ITU) and United Nations Institute for Training and Research (UNITAR). 2024. Global E-waste Monitor 2024. Geneva/Bonn.

38. VOICE. 2022. Review of E-waste Rules 2021 and Business Models' Compliance of Electronic Goods Manufacturers with Environmental Sustainability. Dhaka: Voices for Interactive Choice and Empowerment.

39. Forti V, Balde CP, Kuehr R, Bel G. The Global E-waste Monitor 2020: quantities, flows and the circular economy potential. Bonn, Geneva, Vienna: United Nations University, International Telecommunication Union, International Solid Waste Association; 2020 (https://ewastemonitor.info/, accessed 6 September 2022).

40. Technical guidelines on transboundary movements of electrical and electronic waste and used electrical and electronic equipment, in particular regarding the distinction between waste and non-waste under the Basel Convention. Geneva: United Nations Environment Programme; 2019 (http://www.basel.int/Implementation/TechnicalMatters/DevelopmentofTechnicalGuidelines/TechnicalGuidelines/tabid/8025/Default.aspx, accessed 6 September 2022).

41. Li, J., & Achal, V. (2020). Environmental impacts of improper e-waste management in developing countries: A review. Environmental Science and Pollution Research, 27(27), 34875-34889.

42. Sepúlveda, A., Schluep, M., Renaud, F. G., Streicher, M., Kuehr, R., Hagelüken, C., & Gerecke, A. C. (2010). A review of the environmental fate and effects of hazardous substances released from electrical and electronic equipments during recycling: Examples from China and India.

b. E-waste and possible health hazards for children

E-waste exposure, may be linked to the following health effects on pregnant women, infant and children[43]

- Adverse neonatal outcomes, including increased rates of stillbirth and premature birth
- Defect in neurodevelopment, learning and behavior outcomes, especially associated with lead released through informal e-waste recycling activities
- Reduced lung and respiratory function and increased asthma incidence
- Reduced thyroid function
- Altered cellular expression and function
- Heavy metals can accumulate in the kidneys and liver, leading to organ damage and dysfunction
- Direct skin contact with hazardous chemicals from e-waste can lead to rashes, burns, and other skin conditions
- Exposure to certain substances in e-waste (polychlorinated biphenyls, Cadmium, lead etc.) is associated with childhood malignancy like leukemia, lymphoma, CNS tumor, Wilms tumor etc.
- Exposure to air pollution at e-waste recycling sites has been linked to reduced lung function in children 5 to 9 years of age, including decreased forced vital capacity and forced expiratory volume
- Damage children's immune system, growth parameters and even DNA and Gene
- Other health outcomes - Research reported high rates of insomnia, weakness, muscle atrophy, headache, cough, chest pain, dizziness and occupational injuries due to e-waste exposure.

c. Prevention and management

Individual actions:

- Encourage responsible e-waste disposal through certified recycling programs and reduce electronic waste by purchasing durable and eco-friendly devices.
- Educate families about the risks of improper disposal and benefits of recycling electronics.
- Limit children's direct contact and keep it away from children
- Support the development of sustainable and non-toxic electronic products.

[43] Children and digital dumpsites: e-waste exposure and child health. Geneva: World Health Organization; 2021. Licence: CC BY-NC-SA 3.0 IGO.

Figure 13: Action to reduce e-waste and become community champions[44]

Local policies:

- Create a designated space or area for e-waste, organize designed e-waste collection days
- Organize community education sessions on the dangers of e-waste and ways to reduce exposure
- Organize e-waste repair workshops and encourage the 3 Rs – Reduce, Reuse, Repair

[44] WHO. Become an e-waste community champion. Geneva: World Health Organization; 2021 (https://www.who.int/multi-media/details/become-an-e-waste-community-champion, accessed 6 September 2022).

National policies:

- Adopt and enforce high-level agreements, such the Basel Convention
- Develop and implement national e-waste management legislation
- Incorporate health protection measures into national legislation
- Monitoring and testing e-waste sites and surrounding communities for air, water, dust and soil contamination
- Preventing child labor especially in the e-waste industries

d. Key questions asked by health professionals

Health professionals can ask their patients and families key questions that can help in detecting and identifying health disorders associated with e-waste exposures. Examples of questions that can be asked include:

Household Exposure

- Does your household frequently dispose of old or broken electronic devices?
- How are electronic waste items stored in your home?
- Are children allowed to handle or play with discarded electronics?

Environmental Factors

- Do you live near an informal e-waste dumping or recycling site?
- Is there visible burning of electronic waste in your neighborhood?
- Do you notice strong chemical odors or smoke from e-waste disposal near your residence?

Health Symptoms and Complaints

- Has your child experienced frequent respiratory issues such as coughing, wheezing, or shortness of breath?
- Has your child shown signs of skin irritation or unexplained rashes?
- Are there reports of nausea, dizziness, or headaches in your household related to e-waste exposure?

Behavioral and Developmental Concerns

- Has your child displayed developmental delays or cognitive impairments?
- Are there behavioral issues such as difficulty concentrating or hyperactivity?

Preventive Actions and Awareness

- Are you aware of safe e-waste disposal methods?
- Do you participate in any community-based e-waste management programs?
- Have you received guidance on minimizing e-waste exposure for children?

Children are exposed to e-waste by different ways and routes and become victims of different hazardous chemicals released from e-waste. To protect our children, proper disposal and recycling of electric and electronic goods are needed. Children's exposure to risky jobs and risky environments should be prevented. Early recognition and proper management of health hazards resulting from e-waste exposure must be ensured.

Chapter 6: Climate Change and Child Health

A normal climate reflects typical weather patterns over 30 years, supporting ecosystems, agriculture, and human life. Climate change, as defined by the UNFCCC, is a long-term shift in climate due to human activities altering the atmosphere, beyond natural variability. It poses serious threats to food, water, health, economies, and communities—especially affecting children. Addressing climate change is vital for achieving Sustainable Development Goals (SDGs), particularly SDG 13 and nine others linked to climate resilience and child health in Bangladesh.

Learning Objectives

a)	State the magnitude of problems related to climate change
b)	List the health hazards of climate change on child health
c)	Identify adaptive prevention strategies to combat the effect of climate change on child health, Climate mitigation and adaptation
d)	List the management plan to address child health problems due to climate change

a. Definition for Climate mitigation and adaptation

Climate change is a global reality. The earth is becoming warmer, the sea level is rising, ice is melting, and we have abundant direct evidence of these facts. The records of the past three decades prove that the earth is getting less predictable than in pre-industrial era[45]. As extreme weather events become more frequent and widespread, their impacts are felt across ecosystems, economies, and communities around the world.

In response to these growing challenges, the concepts of **climate mitigation** and **adaptation** have become central pillars in global climate policy and action.

Climate mitigation refers to efforts and actions taken to reduce or prevent the emission of greenhouse gases (GHGs), aiming to minimize the long-term impact of climate change. The UNFCCC defines climate mitigation as "an intervention to reduce the sources or enhance the sinks of greenhouse gases." it is both less expensive and more effective to protect human health through climate mitigation than to address the health consequences once they have occurred. Here are some mitigation strategies and the following health benefits.

[45] The state of the global climate 2021. Geneva: World Meteorological Organization; 2022 (https://public.wmo.int/en/our-mandate/climate/wmo-statement-state-of-global-climate, accessed on 3 August 2024).

Mitigation strategy	Health benefits
Replace fossil fuel-derived energy with zero emission renewables	Reduction of harmful air pollutants, lowering the number of pollution-related illnesses and deaths
Encourage more mass transit, less individual vehicle travel and more active transport	Improved air quality, increased physical activity that improves overall health and reduces risk factors for obesity
Decrease deforestation and protect ecosystems to reduce atmospheric carbon	Increased green space and natural landscapes, which are known to improve and support mental health; more diverse food supply
Reduce food waste and excess; encourage plant-based diets	Improved nutrition; reduction of chronic diseases, such as diabetes, cardiovascular disease and many cancers

Climate adaptation refers to the adjustments made to social, economic, and environmental practices in response to the impacts of climate change. World Health Organization (WHO) highlights the importance of adaptation in the context of health.

Bangladesh is a good example in Climate adaptation. As a country vulnerable to flooding, storm surges and wind damage from frequent cyclones, Bangladesh assembled a multi-sector, multi-pronged approach to disaster preparedness, which has saved lives. In 1991, Cyclone, a Category 5 storm, resulted in 140,000 fatalities in Bangladesh. However, in 2007, Cyclone Sidr, also a Category 5 storm, caused only 3,400 deaths, showcasing an extraordinary improvement in disaster response. The adaptations have been across three categories:

1. General disaster education, aided by increased literacy rates, has better prepared the public for cyclones
2. Early warning systems, from high-tech information to bicycle-relayed messaging, alert communities to imminent danger
3. Designated shelters give people a safe place to go during cyclones

b. Magnitude of climate change

2 major issues mostly impact children's health in Bangladesh are Heat stress and Water related disasters. Over one third of children globally (n=920 million) are exposed to water scarcity, and 820 million populations are exposed to heatwaves[46].

1. Heat stress

Regions such as South and East Asia, along with the Middle East, face significant risks of heat stress, which are projected to rise by 20%–60% when the world average temperature

[46] Pronczuk-Garbino J, editor. Children's health and the environment: a global perspective: a resource manual for the health sector. Geneva: World Health Organization; 2005 (https://apps.who.int/iris/handle/10665/43162/, accessed on 3 August 2024).

climbs from 1.5 to 3 °C[47]. Bangladesh, located in Southern Asia, faces a heightened risk of heat stress, exacerbated by a doubling in heat index from 1979 to 2017 due to rising temperatures and humidity levels. Proximity to the Bay of Bengal and the Asian monsoon system intensifies heat exposure, while high population density and limited adaptability increase susceptibility to heat extremes amid escalating climate change[48].

Daily temperatures exceeded 30°C on 269 days in 2023, 33°C on 153 days, and 36°C on 37 days. Thus, heatwave temperatures (≥ 36°C) endured on as much as 10% of annual days in 2023. Major health impacts for children are as follow:

- Increased risk of heat stress, dehydration, and heatstroke.
- Higher infant mortality due to immature thermoregulatory systems.
- Exacerbation of respiratory diseases such as asthma.

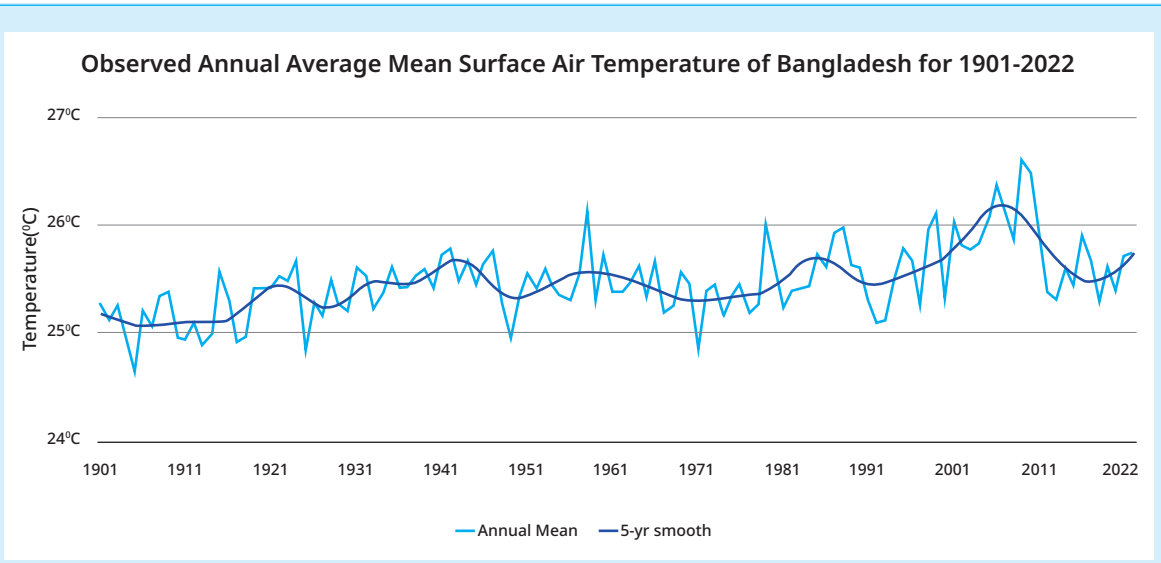


Fig 14: Average surface air temperature of Bangladesh

2. Water-related disasters

More crucial issue is that Bangladesh is assumed to be under water by 2080, mainly affecting the coastal area, due to rise in the sea level. Global warming and rise of sea level may be associated with cyclones and floods every year. Collectively, only from May to August 2024, a series of natural disasters—including Cyclone Remal and multiple floods—impacted approximately 18.4 million people across 29 districts in Bangladesh.

In 2024, Cyclone Remal struck on May 26, affecting approximately 4.6 million people, particularly in the districts of Bagerhat, Barguna, Barisal, Bhola, Khulna, Patuakhali, Pirojpur, and Satkhira. The cyclone resulted in 18 fatalities and damaged or destroyed an estimated 173,866 homes.

[47] Freychet, N., Hegerl, G.C., Lord, N.S., Lo, Y.T.E., Mitchell, D. and Collins, M. (2022). Robust increase in population exposure to heat stress with increasing global warming. Environmental Research Letters, 17(6), p.064049. doi:https://doi.org/10.1088/1748-9326/ac71b9.

[48] Kamal, M., Shahid, S. and Kashem, A. (2023). Changes in Wet Bulb Globe Temperature and Risk to Heat-Related Hazards: An Overview of Bangladesh. doi:https://doi.org/10.2139/ssrn.4330320.

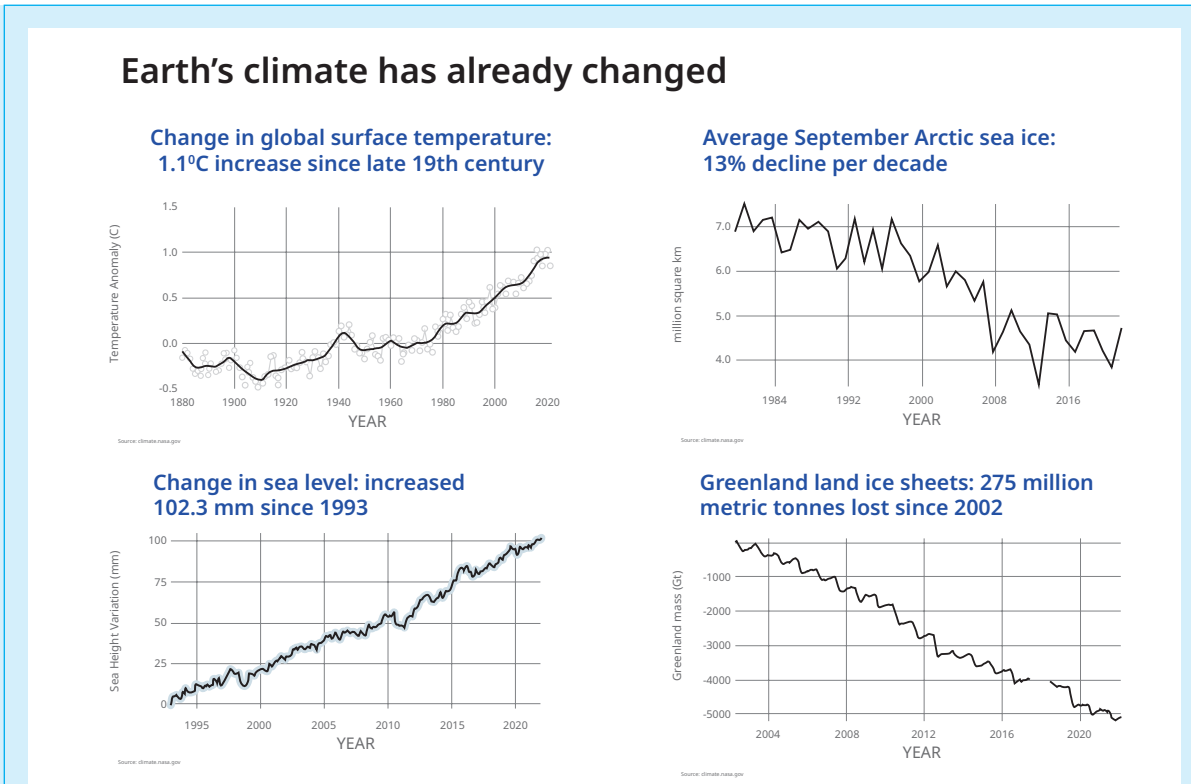


Fig 15: Increase of average sea level

Subsequently, in August 2024, severe monsoon rains led to devastating floods in eastern Bangladesh, affecting over 5.6 million people across Chattogram and Sylhet Divisions. These floods were reported as the worst in 34 years, with more than 52 fatalities and over 500,000 individuals seeking shelter after their homes were submerged.

Beyond these direct impacts, waterborne diseases have been on the rise. Following the August 2024 floods, there was a significant increase in cases of diarrheal diseases and skin infections. By September 30, 2024, over 160,000 cases of diseases and injuries were reported, with approximately 14% (23,015 cases) attributed to diarrheal diseases and 27% (43,137 cases) to skin-related conditions.

These events underscore Bangladesh's vulnerability to climate-induced disasters and highlight the urgent need for comprehensive disaster management and public health interventions.

3. Other factors[49]

- Air pollution due to increase in ground level ozone and population. Almost 90% of children globally (n=2 billion) are exposed to air pollution
- Increased allergens caused by higher CO2 level
- Climate change in agriculture which results in lack of food supplies to children

[49] Wesselink AK, Wellenius GA. Impacts of climate change on reproductive, perinatal and pediatric health. Paediatr Perinat Epidemiol. 2022;36(1):1–3.

c. Health hazards of children due to climate change

Heat stress

- Adverse birth outcome: preterm birth, stillbirth
- Increased infant mortality
- Heat edema, Rash, Cramps, Tetany, Syncope, Exhaustion and Stroke

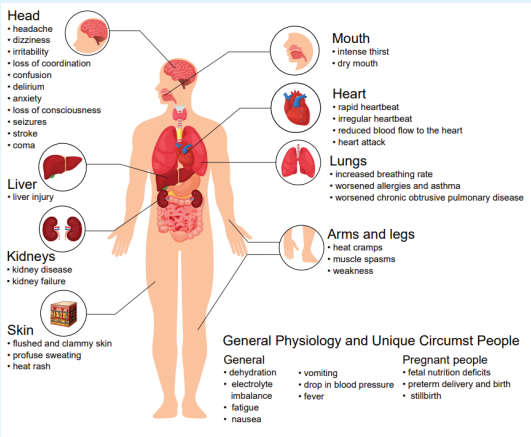


Fig 16: Health impact for heat stress

Water related disaster

- Diarrhea, dysentery, poliomyelitis, enteric fever, amebiasis, giardiasis, worm infestation and Arsenicosis

SL No.	Transmission Route	Description	Disease Group	Examples
1.	Water-borne	Transmission by consumption of contaminated water or person-to-person transmission due to lack of water and domestic cleanliness	Feco-oral	-Diarrhoeal -Dysentery -Typhoid
2.	Water-washed	Person-to-person transmission due to lack of water and domestic cleanliness	Skin and eye infections for personal	-Trachoma -Scabies
3.	Water-based	Transmission via an intermediate host which lives in water	Water based	-Schistosomiasis
4.	Water-related	Transmission by insects which breed insect vector in water or bite near water	Water related vector	-Malaria -Filariasis

Table 3: Health impact for water related disaster

Indirect effects on children's health[50]

Mediated through ecosystems

- Air pollution
- Food-borne infections
- Malaria
- Kala-azar
- Childhood malignancy

Mediated through human institutions

- Undernutrition
- Occupational exposure
- Indoor & indoor exposure
- Displacement
- Mental stress
- Social violence

[50] Ahdoot S, Pacheco SE, Council on Environmental Health. Global climate change and children's health. Pediatrics. 2015;136(5): e1468–84.

d. Prevention of child health problems due to climate change

Individual practice:

- Get children to be vaccinated to prevent vactor-borne disease
- Be aware of shelter location for emergencies
- Paint the roof white to avoid heat
- Do personal actions to prevent climate change like not using single use plastic, taking a quick shower, using public transport, etc.
- Protect drinking water supply and quality
- Identify vulnerable children, such as children with special healthcare (opens in a new tab) needs and assist families in disaster preparedness

Local Policies:

- Community preparedness: training, disaster shelters, mock exercises
- Early detection of climate-sensitive diseases and victims
- Prompt treatment of affected children
- Child health risk communication
- Enhancing reporting system
- Promote and support agricultural fields
- Provision for well-ventilated built environments
- Use anticipatory guidance to teach use of ultraviolet radiation, heat, air quality indices, early warning systems and responses

National Policies:

- Formulation of effective policies to mitigate climate change
- Early warning on effects of climate change
- Enhancing reporting system (nationwide integration)
- Provision of safe water (infrastructure development)
- Make sure clean food and nutrition supply (national food security programs
- Develop a local 'climate-related health risk profile and low toxicity vector control programes
- Conduct climate informed health surveillance: improve disease reporting and surveillance by integrating climate and weather data

e. Management plan of child health problems due to climate change

The management will be individualized. The management of children's health problems encompasses two facets of dynamics, managing children's health and addressing climate change. It should be borne in mind that the proper management modality lies in following the management standards.

Treatment Plan:

1. **Medical Interventions**
   - Provide immediate treatment for climate-sensitive diseases such as respiratory infections, dehydration, and heatstroke.
   - Ensure the availability of essential medicines, including antibiotics, oral rehydration solutions, and anti-malarial drugs.
   - Strengthen pediatric care units in hospitals to handle increased climate-related health cases.
   - Implement rapid cooling techniques such as evaporative cooling and cold-water immersion for severe heatstroke cases.

2. **Mental Health Support**
   - Implement psychological counseling and support programs for children affected by climate disasters.
   - Train healthcare workers to identify and manage climate-related mental health issues in children.
   - Establish safe spaces and community programs to help children cope with climate-induced stress and trauma.

3. **Nutritional Rehabilitation**
   - Develop feeding programs for children affected by food insecurity due to climate change.
   - Monitor and treat malnutrition cases in vulnerable populations.
   - Ensure a continuous supply of nutrient-rich foods through school meal programs and food banks.

4. **Management of Heat-Related Illnesses**
   - Establish heat emergency response protocols in healthcare facilities.
   - Develop facility preparedness plans to manage heat-related illnesses effectively.
   - Train healthcare workers on identifying and treating heat exhaustion, heat cramps, and heatstroke.
   - Implement risk communication and community engagement strategies to educate the public on preventing heat-related illnesses.
   - Ensure the availability of cooling centers and hydration stations in heat-prone areas.

Questions can be asked from healthcare providers

Healthcare professionals can ask a series of questions to understand a patient's exposure and symptoms to different kinds of climate change exposures. Here are some key questions that can be asked:

Heat Exposure (Heatwaves, High Temperatures)

1. Has the child experienced excessive sweating, dizziness, or confusion?
2. Is the child complaining of headaches, nausea, or vomiting?
3. Does the child have dry, hot skin or appear extremely thirsty?
4. Have there been any episodes of fainting or muscle cramps?
5. Is the child's breathing rapid or irregular?

Cold Exposure (Hypothermia, Frostbite, Extreme Cold)

6. Are the child's hands, feet, or ears excessively cold or turning pale/blue?
7. Is the child shivering uncontrollably or appearing drowsy/confused?
8. Has the child's breathing or heart rate slowed down?
9. Does the child have difficulty speaking, moving, or staying awake?
10. Are there signs of frostbite (skin discoloration, numbness, blisters)?

Flooding or Excessive Moisture Exposure

11. Has the child developed a persistent cough, fever, or difficulty breathing?
12. Are there signs of skin infections, rashes, or wounds not healing?
13. Has the child been exposed to contaminated water (drinking, bathing, playing)?
14. Are there any signs of diarrhea, vomiting, or stomach pain?
15. Has the child had any unexplained weight loss or fatigue?

Drought & Malnutrition Risks

16. Has the child's weight decreased significantly in recent weeks?
17. Is the child showing signs of dehydration (sunken eyes, dry mouth, low urine output)?
18. Does the child have swollen hands/feet (possible kwashiorkor or malnutrition)?
19. Is the child experiencing frequent infections or delayed wound healing?
20. What is the child's daily diet and access to clean drinking water?

Medical History & Underlying Conditions

21. Does the child have any pre-existing conditions (asthma, anemia, heart problems, etc.)?
22. Is the child currently taking any medications or receiving any treatment?
23. Has the child been vaccinated for preventable diseases?
24. Has there been any recent hospital admission due to climate-related illness?
25. Are there any known allergies (food, medication, environmental triggers)?

Environmental & Behavioral Factors

26. How long has the child been exposed to the extreme climate?
27. What protective measures (clothing, shelter, hydration) are available?
28. Is the child engaging in physical labor or excessive outdoor activities?
29. Are there any family members experiencing similar symptoms?
30. What support services (healthcare, food aid, shelter) are available to the child?

Climate change affects human health through diverse pathways. Children are the worst victims for their developing thermoregulatory systems and low immunity. Moreover, they are highly dependent on their parents' care. Creating awareness is the vital cornerstone for the prevention of climate change and its effects on children.

Chapter 7: The Pediatric Environmental History

The pediatric environmental history (PEH) is focused on children's environmental health and additional relevant information. Environmental exposures during early life, including preconception, prenatal, infancy, early childhood and adolescence stages, may have potentially life-long health impacts.

Health and well-being of children depend on the social environment, family and other social settings, community level interaction and physical environment. Healthcare providers and public health professionals play a key role in diagnosing, treating and protecting children from hazardous environmental exposures[51].

Learning Objectives

At the end of this chapter the learners will be able to

a)	Describe the relationship between child health and the environment
b)	Mention the importance of taking the PEH
c)	Take specific history related to environmental hazards in children
d)	Use case studies to understand PEH taking and why children are not little adults through case studies
e)	Learn to better understand the environmental health conditions of the community as a health professional

a. Relationship between child health and environment

The most recent WHO analysis determined that in 2016 globally 28.1%, or almost 1.6 million, of all deaths in children under 5 were attributable to the environment[52]. Environmental hazards like, inadequate access to safe drinking water and sanitation facilities, high levels of ambient and household air pollution, vector-borne diseases, industrial pollution, informal recycling activities, poor waste management, exposure to high heat and toxic chemicals, etc. contribute to childhood morbidity and mortality[53].

A carefully tailored and locally appropriate PEH can help healthcare providers to identify hazards and develop interventions to mitigate, reduce and eliminate them.

[51] Inheriting a sustainable world? Atlas on children's health and the environment. Geneva: World Health Organization; 2017 (https://apps.who.int/iris/handle/10665/254677, accessed 13 February 2023).

[52] Landrigan PJ, Sly JL, Ruchirawat , Silva ER, Huo X, Diaz-Barriga F et al. Health consequences of environmental exposures: changing global patterns of exposure and disease. Annal Glob Health. 2016;82(1):10-19.

[53] Coiplet E, Freuchet M, Sunyach C, Mancini J, Perrin J Courbiere B et al. Assessment of a screening questionnaire to identify exposure to lead in pregnant women. Int J Environ Res Public Health. 2020;17(24):9220.

b. The importance of taking the PEH

The pediatric environmental history (PEH) is the primary tool to identify hazards and thus to prevent, recognize and treat environmental-related pediatric diseases and health conditions.

- Take a thorough exposure history by asking appropriate questions and recording the information in an appropriate place (the PEH)
- Contribute to research and knowledge generation by collecting data and information on environment and health
- Inform the community and decision-makers about environmental threats to child health, and advocate for change to improve environmental conditions and prevent further harm

c. Specific history related to environmental hazards in children

The questions included in a PEH should be specific to the local situation and take into consideration three key areas:

1. What are the main potential environmental hazards?
2. How, when and where are the children exposed to environmental hazards?
3. What are the main health effects or risks?

History should be specific according to the category of environment[54]

1. **Category:** The built environment in homes, schools and community areas, and water, sanitation and hygiene (WASH)

    a. **Possible questions:**

    - Is the area at high risk of flooding?
    - Is there high humidity? Can you see surface molds?
    - Any old, damaged or peeling painted walls or furniture at home?
    - What kind of toilet is used at home? Is the toilet indoors or outdoors?
    - What sanitation services are available? Are you aware of any sewage problems?
    - Do you have handwashing facilities at your home, including water and soap?
    - Do you have tap water? Is it portable, Is the local water tested for bacteria and chemicals? How often is it tested? If not, where do you get drinking water from?
    - Is the area adequately ventilated?

[54] Lopes da Silva Galdiano L, Baltar VT, Polidoro S, Gallo V. Household pesticides exposure: an online survey and shelf research in the Metropolitan Region of Rio de Janeiro, Brazil. Cad Saude Publica. 2021;37(7):e00099420

2. **Category:** Air quality

    a. **Possible questions:**

    - Do you live near heavy traffic?
    - Do you notice any smoke in the surrounding areas? Or indoors?
    - Does anyone smoke tobacco in the home?
    - What fuels and technologies do you use in the home for cooking, heating or lighting? Do you notice air pollution within the home from cooking, heating or lighting activities?
    - Do you have a working carbon monoxide detector at home?

3. **Category:** Food and diet

    a. **Possible questions:**

    - Does the child consume excessive fatty foods?
    - Pregnant women, breastfeeding women or young children's diet based on high-risk fish (fish high on the food chain or marine mammals)?
    - Are fruit and vegetables washed before being eaten?

4. **Category:** Family or child's occupation or work

    a. **Possible questions:**

    - Do any artisanal, small-scale activities or work occur in the child's home?
    - What is the parent or caregiver's occupation? Is there potential for any take-home exposure?
    - Does the child work? If so, what kind of work do they do? Do they engage in any high-risk activities, such as open burning, pesticide application, handling heavy metals, operating heavy machinery?

5. **Category:** Waste

    a. **Possible questions:**

    - Are there any landfills or dumps nearby?
    - What local waste management systems are in place? Do you notice open burning near your home or surrounding areas?
    - Is any waste stored at home? Does any recycling work occur in the home? Are batteries or e-waste recycled in the home?

6. **Category:** Other concerns

    a. **Possible questions:**

    - Are you aware of any infectious disease outbreaks in your area, for example, diarrheal disease?

- Are there any common vector-borne diseases, for example, malaria or dengue fever?
- Is your area at risk of climate-related events, for example, flooding, drought, cyclones, or extreme temperatures?
- Do you have any domestic animals? Do they stay inside the home?
- Do you have livestock? Do they come inside the home? Do you notice any animal excreta near drinking water sources?
- Do you notice any industrial vapors, smoke or noise emissions near your home?
- Do you know of any industries present in your area, for example, mining or agriculture?
- Are you aware of pesticide application in your area?

Local environmental information:

Some of this information could be completed through questions or self-administered questionnaires using evidence and information from the previously mentioned stakeholders. For example:

- What is the status of community water, sanitation and hygiene services?
- Is clean drinking water accessible for the population serviced by this clinic?
- Is there any risk of well water contamination?
- Are community sanitation measures appropriate?
- Do homes have access to electricity and water supply?
- What are the main fuels used for heating, cooking or lighting?
- Is there heavy traffic in proximity to residential areas?
- Is there any local data on ambient air pollution?
- Can families reach the clinic?
- Does the neighborhood have safe and accessible waste collection?

Case study 1 – Children are not little adults

Baby Nargis was a 3.3kg term infant with no history of problems during pregnancy, labor, or delivery. Her APGAR score was 9/10. She had no family history of hereditary illness or neurologic disease. At a well-baby exam at 12-weeks old she was found to be hypertonic by her primary care physician and referred for evaluation to a pediatric neurologist. The pediatric neurologist noted she had upper and lower extremity hypertonicity, and ankle clonus. The diagnosis of cerebral palsy was made by the neurologist at 16-weeks old, and physical therapy was started.

What happened next? At 6 months old, Nargis's parents reported having had their house sprayed for insects the day before they brought her home from the hospital. They asked

the doctor if their daughter's health problems might be related to this. A pesticide expert was consulted. Based on the history, tests for urine metabolites for organophosphates were ordered and consequently:

- Nargis's metabolite levels were elevated and equal to that of an applicator after an 8-hour shift.
- Six months after the application, diazinon pesticide residues in the home measured six times what would be expected immediately after normal application.
- The family left the house. Six (6) weeks later Nargis's muscle tone was normal. Her "cerebral palsy" was cured.

Why were Nargis's parents unaffected by pesticide residues?

Nargis's case illustrates four ways that children are uniquely vulnerable to environmental exposures*:*

1. Nargis had **unique exposures to the pesticide**. Her exposure was different because infants have a larger surface area to volume ratio making dermal exposure a greater threat. Infants reside in a lower breathing zone than adults and have limited mobility so are more likely to be exposed to off-gassing fumes from floors and surfaces.
2. Nargis had **unique vulnerabilities to the pesticide**. As a rapidly growing and developing infant, her high minute ventilation resulted in a greater internal dose of pesticide contamination from the air which her body was unable to metabolize quickly enough.
3. Nargis had a **longer life expectancy in which to develop associated disease**. Her longer lifetime meant that even though her acute symptoms resolved by 1 year of age, her developing systems may have been damaged by the pesticide exposure making it possible that illness or harm related to high exposure in the first 6 months of life could manifest later.
4. Nargis was **dependent upon the adults in her life** to protect her from harmful pesticide exposure. The adults in her life initially failed to appropriately protect her when they did not identify the pesticide exposure. Thanks to thoughtful parents and a responsive pediatrician, they eventually asked the correct questions and were able to change the situation and correct the misdiagnosis. Additionally, systemic failures in this case study created a situation in which hazardous pesticides were used inside the home – also a result of adults failing to protect vulnerable children.

By understanding the effects that the environment can have on children's health and taking a pediatric environmental history, the pediatrician or the neurologist in this case study could have changed this scenario earlier in Nargis's life and reduced her acute exposure to a hazardous pesticide during important periods of development.

Some **methods of changing the scenario to prevent adverse health outcomes** are described there.

- Due to the medium and long-term consequences of toxic pesticide exposure, the greatest good is achieved through **primary prevention**. Prenatal counseling with

the parents about the risks of home pesticide use to the health of their child could have specifically prevented its use in the home. The precautional principle – the assumption that a chemical exposure could be harmful unless scientifically proven to be safe – could have led the parents to choose alternative solutions to any active insect problem. Public education on how to create and maintain a healthy home to avoid toxic exposures can include: non-chemical integrated pest management choices; tighter regulation and enforcement on pesticide use and approved applicators when unavoidable.

- In this case study, **secondary prevention was key** to Nargis's original misdiagnosis. Some changes to secondary prevention in this case could have identified Nargis's symptoms earlier, for example: the pediatrican and the pediatric neurologist could have asked about the home environment, potential exposures and completed an environmental history. If either were curious to ask, they could have made the diagnosis when Nargis was 12 weeks old when the hypertonicity was first noted; a lack of risk factors for cerebral palsy should have led to either the pediatrician or the specialist to probe more deeply for potential extrinsic causes to a lifelong diagnosis.
- **Tertiary prevention** was also relevant in this case study. This would involve knowledge of potential medium and long-term sequelae to early pesticide exposure and assuring that the child and family receive all possible assistance and support to minimize any ongoing harm.

Case study 2 – Correcting misdiagnosis

Patient details: Mala was 1 month old. She was breastfed from birth with the addition of some powdered formula supplement. Mala's mother, Cindy, noticed occasional blue coloring in the baby's nails and fingertips and decided to talk to her pediatric health care provider about the blue coloring at Mala's next well baby visit.

Pediatric health care provider diagnosis: after examining her, the doctor thought the colour changes were acrocyanosis and determined that Mala was normal and healthy. **Consequently,** as time passed, Mala's mother was concerned that Mala was not thriving and thought it was related to her breastfeeding. She began giving Mala progressively more formula made from powder mixed with tap water. When Mala was 2 months old, she developed progressive vomiting and diarrhoea. This prompted her mother to discontinue breastfeeding entirely and go to formula feeding exclusively, thinking she needs the additional calories. Mala's condition quickly deteriorated. At 2 and a half months old, Mala died.

What happened in this case? As mentioned on the previous slide, Mala and her family lived in a farming community.

What were some of the main risks to drinking water sources for Mala living in a farming community?

1. In this case, the family's drinking water was from a private well. **What are the potential risks of drinking water from private wells?** Private wells that are shallow and have permeable soils are at higher risk of chemical and microbial contamination, especially if they are located close to sources of chemical pollution or sewerage systems. Private wells may not undergo routine testing to ensure water quality

2. In this case, the well water was contaminated with artificial fertilizer run-off from local farms; a. Upon testing, the family's private well was found to have nitrate levels 15 times higher than the national standard

3. Mala was misdiagnosed with acrocyanosis. She died from methemoglobinaemia - a condition in which hemoglobin has decreased ability to transport oxygen to tissues

Why was Mala the only victim in her family to nitrate pollution in the drinking water?

Mala's case illustrates three ways that children are uniquely vulnerable to environmental exposures. The well water her mother was using to make formula had levels of nitrates 15 times higher than the national safety standard. Although the rest of her family were also drinking the same water, Mala was the only one who became ill. Many differences between infants and older children and adults contributed to this infant's special vulnerability and ultimate death.

In order to prevent similar circumstances, it's important to understand how nitrates are converted to nitrites in the body causing methaemoglobinemia.

1. Mala had a **unique exposure - a single food source**. Progressively, as her mother shifted from nursing to exclusive bottle feedings, Mala had only a single food source, the formula, and concurrently a single source of water. Her siblings and parents drank juices, sodas, bottled water, as well as water at work and outside the home. Combined with higher fluid intake per body weight typical of infants, and the result is a much higher exposure to the nitrates in the private well at home than the rest of her family.

2. Mala had **unique vulnerabilities - in the gastrointestinal tract**, nitrate is converted to nitrite by bacterial flora. In infants, there is a relative overgrowth of this flora related to a higher gastric pH. This results in more efficient conversion of nitrate to nitrite, which is then absorbed and causes methemoglobinaemia. Infants have a substantial proportion of fetal hemoglobin, which was more readily oxidized to methemoglobin with reduced oxygen carrying capacity. An infant's ability to convert methemoglobin back to normal hemoglobin is reduced as infants have only about half the methemoglobin reductase, compared to adults and older children, which completes this conversion. Mala also developed diarrhea and vomiting and consequently dehydration, which exacerbated methemoglobinaemia. Together, these factors cause unique vulnerability to nitrate in drinking water in infants less than four months old.

3. Mala was **dependent upon the adults in her life to keep her safe**. In this case, Mala's pediatrician misdiagnosed her condition as acrocyanosis, which led to her not receiving the life saving medical care and treatment that she needed. Additionally, her mother, with all good intentions and thinking her condition was related to it, decided to stop breastfeeding and switch exclusively to formula feeding, which she also thought would provide her with additional calories.

By understanding the effects that the environment can have on children's health and taking a pediatric environmental history, the pediatrician in this case study could have changed this scenario and prevented Mala's death.

Some methods of changing the scenario to prevent adverse health outcomes include

- **Primary prevention methods** may include conducting prenatal counselling to: Know your community and the local environmental hazards - Identify drinking water sources and advise regular private well testing, where relevant.
- **Prevent exposure to identified environmental risks by**: Educate expecting parents on the potential risks of contaminated water; advising the use of bottled water if relevant; suggesting a change in drinking water source if necessary; encourage exclusive breastfeeding for at least the first 6 months of life.
- **Primary prevention methods** may also include incorporating key environmental hazards as part of vital signs, in this case study by asking about drinking water sources.
- **Secondary prevention methods may include** Being curious and listening. Is the mother's concern disproportionate? Are there any red flags? Taking an environmental history and do not settle for idiopathic lightly.

Case study 3: Noise pollution

Patient's details: Zahid, a 5-year-old boy came to the pediatric outdoors with hearing problems for the last 6 months. On examination the attending physician suspected that he had conductive type of deafness in both ears. Pediatrician wanted to take environmental history and found out that their house was close to a bus stand. Consequently, Zahid was referred to ENT specialist. Hearing test shows a conductive type of deafness. This represents noise pollution, and the family was advised to shift the house.

Conclusion: All health care providers who are directly contact with the children, their families, and the wider community play a key role in detecting environmental threats to children's health. Health care providers have specific roles and responsibilities in recording environmental and health data and should be able to use the PEH tool.

Sample of Pediatrics Environmental History Record Keeping Form:

1. Demographics

Clinic Information	Patient Information	Environment
Visit date	Age of patient	Residence: Rural / Urban / Semiurban
Health care provider	Sex / Gender School grade Address / Mobile number Guardian's education Guardian's occupation	School type Work type

2. Exposure History[55]

a) Mothers and fathers' occupation

b) Housing status: Number of people per room:

c) Are there any pet animals in the house or surroundings? Which ones?

d) Are there vectors of disease? Which ones?

e) Are there any cattle sheds close proximity to house?

f) Source of drinking water, describe.

g) Sources of water which was used for washing dish/clothes, describe.

h) Has the child suffered traffic related injuries? Describe.

i) Has the child suffered fire related injuries? Describe.

j) Has the child been exposed to chemicals? Describe.

k) Has the child had poisoning due to chemicals / food poisoning? Describe.

l) Is there exposure to venomously poisoning animals?

m) Is there exposure to extreme temperature?

n) Does the mother/caregiver express concern about the environment? Which ones and why?

o) Are there any well-known environmental risk factors in the area? Which ones?

3. Environmental exposure rating

Grading of environmental conditions	Home	School	Recreation area	Workplace	Community
Built environment a. Excellent b. Average c. Precarious					
Geographical area a. Low risk b. Medium risk c. High risk					
Air (indoor) a. Clean b. Average c. Contaminated					

[55] Questions and answers: children's environmental health - the pediatric environmental history [website]. /questions-andanswers/item/q-a-the-pediatric-environmental-history, accessed 13 February 2023).

Grading of environmental conditions	Home	School	Recreation area	Workplace	Community
Air (outdoor) a. Clean b. Average c. Contaminated					
Water a. Potable b. Average c. Contaminated					
Soil floor a. Adequate b. Average c. Inadequate					
Sewage disposal a. Adequate b. Uncertain c. Inadequate					
Waste disposal a. Adequate b. Uncertain c. Inadequate					
Noise a. low, b medium, c high					
Chemical Exposure a. Low, b medium, c high					
Traffic a. Low b moderate c intense					

4. Public Services:

Public Services Available	Housing	School	Community
Electricity			
Communication(phone/radio)			
Waste collection			
Final waste Disposal			
Public transportation			
Public lighting			
Health care center			
Excrete treatment plant			
Sewage system			
Water supply			

Chapter 8: Pesticides and Children's Health

Pesticides represent a broad classification of chemical elements which are made to kill and control unwanted pests such as molds, plants, insects and rodents in agriculture, homes, yards, gardens, community areas and schools[56]. Bangladesh, being an agricultural country, these chemicals are widely used to protect crops. Due to their widespread use, pesticides are ubiquitous in our environment, including the air, soil, food and water.

All pesticides are inherently toxic and carry an increased risk of both acute and chronic health hazards including carcinogenicity and mutagenicity[57]. Children are more vulnerable to uptake and adverse effect of pesticides because of dietary, developmental and physiological factors[58].

Learning Objectives

At the end of the chapter, the learners will be able to-

a)	Mention the magnitude of child health problems due to pesticide use.
b)	List the major categories of pesticides and their use.
c)	Describe the ways of exposure to pesticides and the unique vulnerabilities of children.
d)	List the health hazards of pesticides on children.
e)	Identify actions to reduce and prevent pesticide exposure.

a. Magnitude of child health problems in Bangladesh due to pesticide use

A 2020 review estimated 385 million global cases and 11,000 deaths annually from unintentional acute pesticide poisoning, with southern Asia most affected. In Bangladesh, pesticide poisoning accounts for 39.1% of all poisoning cases[59], but data remains limited. A 2023 review found over 29% of 1,577 vegetable samples contaminated with pesticide residues—73% exceeding Maximum Residue Limits (MRLs). Common pesticides include organophosphorus, pyrethroids, and neonicotinoids. Bangladesh Agricultural University found high MRL exceedance in gourds (100%), beans (92%), tomatoes (78%), and eggplants (73%). Insecticides and fungicides make up 97% of pesticide use, totaling

56. Ingredients used in pesticide products: basic information about pesticide ingredients [website]. Washington (DC): United States Environmental Protection Agency; 2023 (https://www.epa.gov/ingredients-used-pesticide- products/basic-information-about-pesticide-ingredients, accessed 11 January 2024).

57. Exposure to highly hazardous pesticides: a major public health concern, Geneva: World Health Organization; 2019

58. Freeman NC,Jimenez M , Reed KJ et al, Quantitative analysis of children microactivity pattern: The Minesota Childrens Pesticide Exposure Study. J Expo Annal Environ Epidemiol.2001:11(6): 501-509

59. Gourab dewan, Analysis Of Recent situation Of Pesticide Poisoning in Bangladesh: Is There A Proper Estimate?: Asia Pacific Journal of Medical Toxicology,2014 :3(2): 76-83.

15,507 tons in 2021 (1.67 kg/hectare). Pesticides spread through air, water, and soil, contaminating distant regions and even polar ice. Groundwater contamination poses risks to drinking water. In Bangladesh, World Bank estimated that among different pesticides, insecticides and fungicides account 97% and rest are due to herbicides and rodenticides[60]. According to data from FAO in the year 2021 about 15507-ton pesticides being used in Bangladesh which is about 1.67kg/hectare agricultural land[61]. Pesticide pollution in groundwater can result in contamination of drinking water.

b. Classification of Pesticides

Chemical Class	Common use	Example
Organophosphorus compounds and Carbamates	Insecticides Rodenticides Herbicides	Chlorpyrifos Malathion Glyphosate DDT (dichloro-diphenyl-trichloroethane) Carbaryl
Pyrethroids	Insecticides	Permethrin Deltamethrin
Bipyridyl	Herbicides	Paraquat
Warfarin and related rodenticides	Rodenticides Herbicides	Lanirat Brodifacoum

c. Way of exposure to Children

Depending on the source and the context, children can have multiple routes of exposure to pesticides including inhalation, ingestion, dermal and transplacental[62]. Children have natural exploratory behaviors, such as high rates of hand-to-mouth and object-to-mouth behaviors. These behaviors may increase their exposure to pesticides that have settled on dust, soil or objects[63]. Children can also be exposed during working in agricultural industries. According to UNICEF and ILO, 160 million children are globally involved in child labor and 70% of them (112 million) are working in agriculture sector[64].

60. Meisner C. Report of Pesticide Hot Spots In Bangladesh. The World Bank: Infrastructure and environment department:2004

61. FAO Pesticide use. Available from: http://www.fao.org/faostat/en/#data/Rp

62. Reducing Pesticide Exposure. Available from: https://www.health.ny.gov/environmental/pests/reduce.htm#:~:text=Try%20using%20non%2Dchemical%20management,to%20reduce%20chemical%20use%20outdoors.

63. Etzel RA, editor. Pediatric environmental health, 4th edition. Itasca: American Academy of Pediatrics;2019

Pesticide lifecycle management. Available from: https://openknowledge.fao.org/server/api/core/bitstreams/77514648-d31c-427a-bf67-9aa99fb1b319/content

64. The worst form of child labour[website]. Geneva; International Labour Organization;2023(http://www.ilo.org/ipec/campaignandadvocacy/youthinaction/C182-Youth-oriented/worstforms/lang-en/index.htm.accessed 11 January 2024

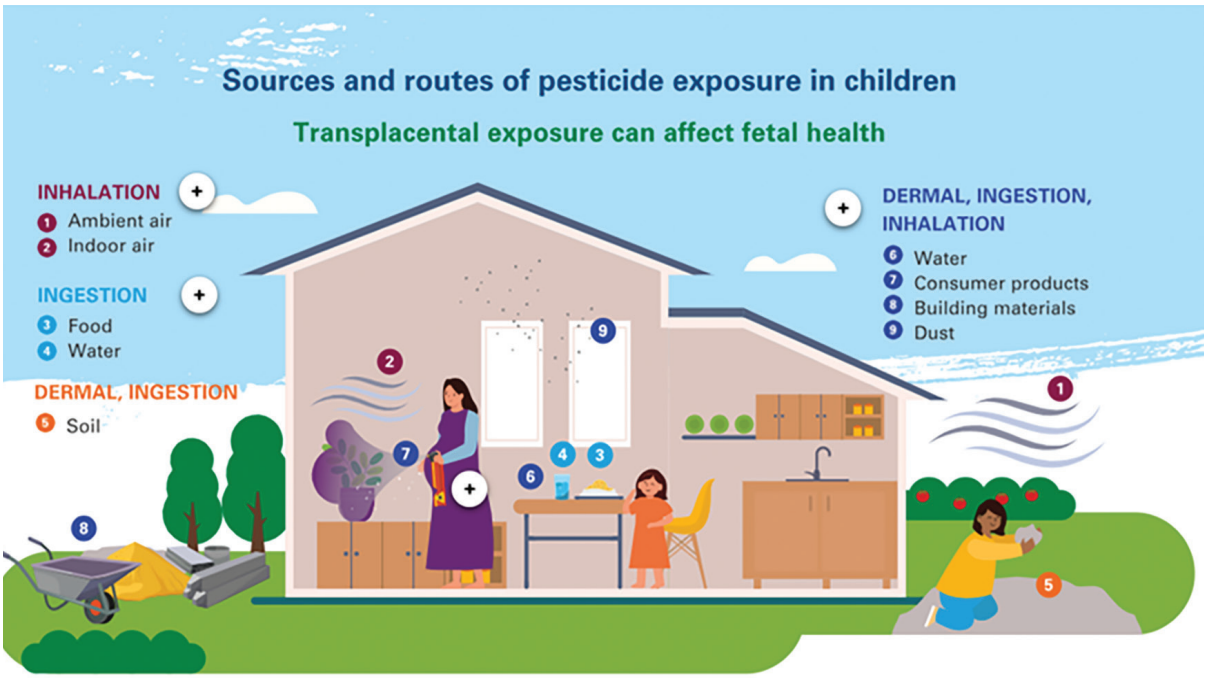


Fig 17: Source and routes of pesticide exposure in children

d. Health hazards

Children are at higher risk than adults from pesticide exposure. Exposure to pesticides and their metabolites starts in fetal period through the placenta[65]. Neonatal exposure to pesticides can lead to lifelong abnormalities and diseases. Pesticide exposure in children can be acute or chronic by unintentional and intentional poisoning.

Effects	Symptoms
Neurological effects	Poorer-cognition, motor function, behavioral and social development
Cancers	Leukemia, Lymphoma, Brain tumor
Respiratory effects	Asthma, Respiratory tract infection
Endocrine effects	Endocrine disrupting chemicals (EDCs) may negatively affect neurologic and sexual development, thyroid function
Other health effects	Dermal irritation, rash, Blisters, and allergic dermatitis

65. Casida JE. Pest toxicology: the primary mechanisms of pesticide action. Cheml Res Toxicol. 2009;22(4):609–19.

e. Measures to reduce exposure in the community

Individual Practice:

- Wear protective clothing while working so pesticides do not contaminate other clothes
- Remove all work clothing and shoes prior to entering the home and wash them to prevent pesticides being tracked through the house
- Always wash hands, face and any other body parts before entering the home and greeting others. If possible, shower before leaving work or as soon as possible
- Children and pregnant women should not work or play in fields that are being sprayed with pesticides, or have been recently sprayed
- Do not allow children to apply pesticides
- Keep children inside while pesticides are being applied outdoors
- Storing and disposing of pesticides properly
- Identify children at high risk of pesticide exposure, diagnose and treat as soon as possible

Community level:

- Ensure safe storge, packaging and clear labelling of pesticides used in public areas
- Ensure safe disposal of pesticide containers
- Prevent accumulation of waste in public areas
- Maintain public buildings
- Clear overgrown brush and grass in outdoor public spaces
- Do not allow stagnant water to accumulate in outdoor public spaces
- Avoid using pesticides if heavy rain is expected
- Ensure appropriate pesticide application
- Practice integrated pest and vector management principles
- Keep parents, teachers and child caregivers informed of local pesticide hazards

National policies:

- Identify and monitor high-risk populations and areas
- Prioritize development and access to lower-risk pesticides
- Institute measures to reduce the impacts of pesticides
- Address illegal pesticide sale and trade
- Minimize and eliminate the use of Highly Hazardous Pesticides
- Eliminate child labor

The health care providers can ask:

Health care providers can ask patients and their families key questions that can help in detecting and identifying children at risk of pesticide exposure. Key questions can help to build a pediatric environmental history, assess whether a child is suffering from symptoms related to pesticides and identify methods to reduce and prevent exposure. These questions must be context specific to each patient.

General Health and Symptoms

1. Has the child experienced sudden nausea, vomiting, or diarrhea?
2. Does the child have headaches, dizziness, or confusion?
3. Is the child experiencing excessive drooling or difficulty breathing?
4. Have there been any recent episodes of fainting or unconsciousness?
5. Is there any unusual sweating, muscle weakness, or tremors?
6. Has the child complained of blurred vision or eye irritation?
7. Has the child had any skin rashes, redness, or itching?

Exposure History

8. Has the child been in direct contact with pesticides, such as spraying or touching plants?
9. Does the child live near agricultural fields where pesticides are used?
10. Have there been any recent pesticide applications at home, school, or in nearby areas?
11. Has the child accidentally ingested or inhaled pesticides?
12. Were pesticides stored within the child's reach at home?

Behavioral and Neurological Symptoms

13. Has the child shown sudden behavioral changes, such as irritability or excessive crying?
14. Has the child experienced difficulty concentrating or memory problems?
15. Are there any signs of involuntary muscle movements or seizures?
16. Does the child have trouble coordinating movements (e.g., walking, grasping objects)?

Environmental and Dietary Factors

17. Has the child consumed food or water that may have been contaminated with pesticides?
18. Do family members or caregivers work in agriculture and bring home pesticide residues on clothing?
19. Are fruits and vegetables washed thoroughly before being given to the child?

Medical and Family History

20. Does the child have a history of asthma, allergies, or other respiratory conditions?
21. Has the child had previous episodes of similar symptoms?
22. Have other family members or neighbors experienced similar health issues recently?

Pesticide use poses risks to biodiversity, ecosystems, food chains, and human health—especially for children. It can disrupt natural pest control and harm surrounding habitats. While chemical control remains important, sustainable methods like Integrated Pest Management (IPM), along with physical, biological, and cultural strategies, can reduce pesticide reliance. Proper and rational pesticide use is essential to minimize environmental and health impacts.

Chapter 9: Water, Sanitation and Hygiene

Only 0.75% of Earth's water is fresh and accessible[66]. Safely managed drinking water—defined by WHO and UNICEF—must be accessible, available, and free from contamination. Climate change disrupts the water cycle, causing extreme floods and droughts; Bangladesh is a key example of flood vulnerability. Clean water, sanitation, and hygiene are vital for children's health, yet many rural and poor communities lack access. Cultural practices can also hinder proper hygiene adoption.

Learning Objectives

a)	List the sources of water
b)	Recognize the major categories of water pollutants and their sources
c)	Describe the magnitude of the problem of unsafe water, poor sanitation and hygiene
d)	Explain the concept of sanitation and hygiene
e)	Detect the effects of unsafe water and poor sanitation and hygiene on children's health
f)	Determine the actions to promote water safety and improving access to sanitation and hygiene

a. Source of water

Groundwater	**Surface water**
● Long residency time ● Long recharge time ● Protected from many polluting human activities ● Natural contaminants ● Subject to over harvest ● Engineering to acquire and maintain	● Short residency time ● Recharge with rain ● Highly susceptible to pollution from human activities ● Globally uneven geographic distribution ● Threatened by climate change, melting glaciers, drought

[66] Stephens GL, Sling JM, Rignot E, Reager JT, Hakuba MZ, Durack PJ, et al. Earth's water reservoirs in a changing climate. Proc Math Phys Eng. 2020;476(2236).

b. Major contaminants and their sources

Classification of contaminants:

Biological	Chemical	Physical
● Bacteria ● Viruses ● Parasites ● Toxins	● Inorganic ● Organic ● Disinfection by-products ● Pharmaceuticals	● Particles ● Radioisotopes

Sources of biological contaminants:

Pathogens:	Technology failure:
● Livestock and domestic animals ● Wild animals ● Untreated human sewage ● Insects and animal disease vectors	● Inadequate or overwhelmed water treatment facilities ● Inadequate distribution, storage, handling ● Poorly protected well heads

Sources of chemical contaminants[67]:

● Agricultural chemicals, such as pesticides and fertilizers ● Urban run-off from roadways and other hard surfaces ● Industrial discharges directly into rivers and lakes ● Deposition of chemicals from air pollution ● Human sewage treated or untreated discharged into rivers or lakes ● Effluent from drinking water treatment plants	● Leaching from landfills and dumps ● Ocean transportation ● Ocean dumping ● Plastic contaminants

[67] United Nations Environment Programme. FAQs on water quality [Internet]. Nairobi: United Nations Environment Programme; 2022 [cited 2024 Jul 15]. Available from: https://www.unep.org/exploretopics/water/what-we-do/improving-and-assessing-world-water-quality-partnership-effort/faqs

World Health Organization. International scheme to evaluate household water treatment technologies [Internet]. Geneva: WHO; 2022 [cited 2024 Jul 15]. Available from: https://www.who.int/tools/international-scheme-to-evaluate-household-water-treatmenttechnologies

c. Concept of sanitation and hygiene

The most important aspects of sanitation and hygiene are sanitation in households, hand hygiene and menstrual health

Five levels of sanitation services[68]

SERVICE LEVEL	DEFINITION
SAFELY MANAGED	Use of improved facilities that are not shared with other households and where excreta are safely disposed of in situ of removed and treated off-site
BASIC	Use of improved facilities that are not shared with other households
LIMITED	Use of improved facilities that are shared with other households
UNIMPROVED	Use of pit latrines without a slab or platform, hanging latrines or bucket latrines
OPEN DEFECATION	Disposal of human faeces in fields, forests, bushes, open bodies of water, beaches or other open places, or with solid waste

Table 4: WHO/UNICEF JMP sanitation service ladder and definitions

Hand hygiene services

The Joint Monitoring Programe for Water Supply, Sanitation and Hygiene (JMP) has defined three levels of hygiene service levels:

- **Basic**: the availability of facility at home for washing hands that has both soap and clean water available
- **Limited**: refers to households that have a handwashing facility but lack clean water and/or soap. In some settings, sand, ash or soil are used as handwashing agents. However, these are less effective than soap and are counted as limited services
- **No facility**: refers to households that have no handwashing facility[69]

Menstrual health

It is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity, in relation to the menstrual cycle[70].

[68] World Health Organization, United Nations Children's Fund. Progress on household drinking water, sanitation and hygiene 2000–2020: five years into the SDGs [Internet]. Geneva: WHO; 2021 [cited 2024 Jul 15]. Available from: https://apps.who.int/iris/handle/10665/345081

[69] World Health Organization, United Nations Children's Fund. Progress on household drinking water, sanitation and hygiene 2000–2020: five years into the SDGs [Internet]. Geneva: WHO; 2021 [cited 2024 Jul 15]. Available from: https://apps.who.int/iris/handle/10665/345081

[70] Hennegan J, Winkler IT, Bobel C, Keiser D, Hampton J, Larsson G, et al. Menstrual health: A definition for policy, practice and research. Sex Reprod Health Matters. 2021;29(1):31–8.

Key indicators of menstrual health:

- awareness of menstruation before menarche
- use of menstrual materials to capture and contain menstrual blood. This can include sanitary pads, cloth, tampons or cups
- access to a private place to wash and change at home
- participation in activities during menstruation, including school, work and social activities[71]

d. Magnitude of the problem

In 2020, it was estimated that 26% of the world's population lacked access to safe drinking water services at home and of these 1.2 billion had only basic services and 489 million were using unimproved sources or surface water.[72]

In 2020, UNICEF estimates found that 450 million children globally, live in areas of high or extremely-high water vulnerability. By 2030, under the current climate change scenario, 24–700 million people globally could be displaced due to water scarcity in some arid and semi-arid places[73]. By 2050, the number of people experiencing severe water scarcity during at least one month of the year could increase to 4.8–5.7 billion globally.[74] 3.6 billion people lacked safely managed sanitation services, 115 million people gained access to safe sanitation services at home and 2.3 billion people lacked basic hygiene services including soap and water at home.[75]

Access to and management of water at households	%
Sources of drinking water	
Shallow tube well/tara pump	51
Deep tube well/tara pump	30
Protected dug well/spring	1.1
Tap water inside dwelling	8.1
Tap water in outside	7.5
Unimproved sources	2.5
Sources of cooking water	
Shallow tube well/tara pump	48
Deep tube well/tara pump	23
Protected dug well/spring	0.4
Tap water inside dwelling	11
Tap water in outside	7.5
Unimproved sources	9.1

71. World Health Organization, United Nations Children's Fund. Progress on household drinking water, sanitation and hygiene 2000–2020: five years into the SDGs [Internet]. Geneva: WHO; 2021 [cited 2024 Jul 15]. Available from: https://apps.who.int/iris/handle/10665/345081

72. World Health Organization, United Nations Children's Fund. Progress on household drinking water, sanitation and hygiene 2000–2020: five years into the SDGs [Internet]. Geneva: WHO; 2021 [cited 2024 Jul 15]. Available from: https://apps.who.int/iris/handle/10665/345081

73. World Health Organization. International scheme to evaluate household water treatment technologies [Internet]. Geneva: WHO; 2022 [cited 2024 Jul 15]. Available from: https://www.who.int/tools/international-scheme-to-evaluate-household-water-treatmenttechnologies

74. World Health Organization. Guidelines on sanitation and health [Internet]. Geneva: WHO; 2018 [cited 2024 Jul 15]. Available from: https://apps.who.int/iris/handle/10665/274939

75. World Health Organization, United Nations Children's Fund. Progress on household drinking water, sanitation and hygiene 2000–2020: five years into the SDGs [Internet]. Geneva: WHO; 2021 [cited 2024 Jul 15]. Available from: https://apps.who.int/iris/handle/10665/345081

Access to and management of water at households	%
Households stored drinking water in containers	60
Households stored drinking water in covered containers	44
Treated source water at household after collection	14

In Bangladesh, almost all households (97%) had access to an improved water source, but after field team carried out spot-checks of the cleanliness of surroundings of improved household water sources to assess for presence of water logging, faeces and visible dirt, only 30% of the improved water sources appeared clean. Up to 95% of individual tube-wells were tested for arsenic contamination and 94% shared tube-wells were tested for arsenic contamination[76].

The overall status of the WASH services in health care facilities (HCFs) in Bangladesh is low. Only 1% of all HCFs have access to complete basic WASH services. Only 5% of HCFs have access to basic sanitation services, highlighting significant gaps in service quality. Rural HCFs are disproportionately affected, with access rates eight times lower than their urban counterparts. Overall Government HCFs are performing much lower (2%) compared to the non-government facilities, while the higher-level facilities are better off with Government Hospitals and Upazila Health Complexes at 29%[77].

e. Health hazards related to unsafe water

Disease Name	Cause	Transmission	Affected Population	Symptoms	Notes
Soil-transmitted helminth (STH)	Parasitic worms (Roundworm, Whipworm, Hookworm)	Contaminated soil	Pregnant women, preschool and school-aged children	Diarrhea, Anemia, Malnutrition, Slow weight gain, Impaired development	Low mortality but substantial morbidity; affects child development and pregnancy outcomes
Cutaneous anthrax	Anthrax spores	Entry through skin cuts	General population	Skin lesions	Occurs when spores enter through skin injuries
Leptospirosis	Leptospira bacteria	Contact with water or soil contaminated by animal urine	General population	Flu-like symptoms	Associated with contaminated environments
Trachoma	Bacterial infection	Contact with eye/nose discharge, contaminated hands, towels, bedding, flies	General population	Eye infection, blindness	Leading cause of preventable blindness globally
Poliomyelitis	Polio virus	Faecal contamination due to poor sanitation	Children under 5	Paralysis, respiratory failure	Highly infectious; preventable by vaccination

[76] Bangladesh Bureau of Statistics, National Hygiene Survey 2018, Dhaka, Available from: National Hygiene Survey 2018_Bangladesh.pdf
[77] WHO, UNICEF, WASH in health care facilities 2023 data update, Dhaka, Available from: WASH in health care facilities 2023 data update

Disease Name	Cause	Transmission	Affected Population	Symptoms	Notes
Hepatitis A	Hepatitis A virus	Contaminated water, poor sanitation	General population	Fever, Diarrhea, Jaundice	Preventable by vaccination
Respiratory infections	Various pathogens	Poor hygiene and sanitation	Children under 5	Acute lower respiratory infections	Major cause of child mortality; 744,000 deaths in 2019
Menstrual health issues	Poor sanitation and hygiene	Not applicable	Menstruating girls and women	Urinary and reproductive tract infections, mental health issues	Lack of facilities affects health and well-being

Also, children cannot be healthy without access to adequate sanitation and hygiene facilities. Human faeces can contain millions of pathogenic bacteria and viruses, and thousands of parasite cysts or worm eggs. Inadequate sanitation, including open defecation, may contaminate water sources and environments where children live, play and learn, and cause repeated infections which can hamper their nutritional status, growth and development. Inadequate sanitation and poor hygiene are related to:

Diarrhoeal	1. Acute watery diarrhea 2. Acute bloody diarrhea, also known as dysentery 3. Persistent diarrhea, lasting for 14 days or more. 4. Acute watery diarrhea 5. Acute bloody diarrhea, also known as dysentery 6. Persistent diarrhea, lasting for 14 days or more.	• Dehydration and its sequelae • Malnutrition • Stunting • Wasting • Micronutrient deficiency including Anemia

Actions needed to improve Water, Sanitation and Hygiene

Individual Practice:

- Universal access to safe toilets and safe sanitation systems
- Ensure adequate sanitation and hygiene facilities
- Home treatment: Rolling, boiling, filtration and chlorination
- Collection and storage: proper storage is critical to prevent recontamination. Ideally the water is stored in a covered container with a tap for drawing water
- Wash hands in a proper way

Fig 18: WHO Guidelines: hand hygiene and health care

[78] World Health Organization. Guidelines on sanitation and health [Internet]. Geneva: WHO; 2018 [cited 2024 Jul 15]. Available from: https://apps.who.int/iris/handle/10665/274939

Community level:

- Sanitation services included as part of local services fulfil core functions to ensure safe sanitation services and practices are protecting public health
- Share information and advocate for improved national access to sanitation and hygiene, and the health benefits it can bring
- Ensure that schools and health care facilities have access to adequate sanitation and hygiene services

National policies:

- Strengthening multisectoral collaborations to engage a greater number of communities and target multiple sanitation and hygiene issues
- Increase access to sanitation and hygiene facilities through strong intra-governmental department collaboration with Public Private Partnership (PPP)
- Establish effective surveillance systems to measure and prevent outbreaks of infectious diseases associated with inadequate sanitation and hygiene
- Industrial discharges from legal and illegal industry, contamination from mining operations, and run-off from farms and urban centers all contribute to water contamination.
- Point-source pollution from sewage treatment plants and industrial discharges can be controlled by appropriate technology, monitoring and enforcement of laws and regulations on drinking water quality.

Question can be asked from healthcare providers:

General Health and Gastrointestinal Symptoms

1. Has the child recently experienced frequent or severe diarrhea?
2. Has the child had nausea, vomiting, or abdominal cramps after drinking water or eating food?
3. Has the child shown signs of dehydration, such as dry mouth, no tears when crying, or reduced urination?

Skin and External Symptoms

4. Has the child developed any skin rashes, itching, or infections after bathing or playing in water?
5. Have you noticed any discoloration or hardening of the child's teeth or bones (possible sign of fluorosis)?

Exposure and Environmental History

6. What is the child's main source of drinking water (e.g., tap, well, bottled)?
7. Has there been any recent flooding, water contamination notice, or changes in water smell/taste?
8. Is the water used for drinking or cooking treated or boiled regularly?
9. Has the child had contact with stagnant or dirty water in the past month?

Parasitic and Infectious Risk

10. Has the child recently complained of stomach pain or had unexplained weight loss?
11. Has the child experienced recurring fever or fatigue with no clear cause?

Chemical and Toxic Exposure

12. Is the drinking water source in your area known to contain arsenic, nitrates, or other chemicals?
13. Does the family use a water filter or purification system?
14. Have any tests been conducted on your household water supply?

Family and Community History

15. Have other family members or neighbors shown similar symptoms recently?
16. Has the child had similar symptoms in the past, especially after consuming local water?

The United Nations General Assembly recognized access to safe drinking water and sanitation as a human right, "essential for the full enjoyment of life and all human rights". As the global population rises and climate change affects the global water cycle, protecting and conserving fresh water now is critical to the health and survival of future generations.

Sanitation is vital for health and the prevention of illness. It contributes to social development, as more children, particularly girls, are able to attend school and learn; safe sanitation reduces the vulnerability of women and children. Moreover, improved sanitation is a good economic investment, reducing the cost of illness and improving lost productivity.

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- Professor Dr. Ziaul Islam, Director, NIPSOM
- Professor Dr. Mohammad Shahadat Hossain, Principal, SSMC
- Professor Dr. Md Shafiqul Bari, Medicine, DMC
- Professor Dr. Iffat Ara Shamsad, Pediatrics, MMC
- Professor Dr. MD. Shahidul Basher, Community Medicine, Popular Medical College, Dhaka
- Professor Dr. Monowar Ahmed Tarafder, Community Medicine, Diabetic Association Medical College, Faridpur
- Professor Dr. Mala Banik, Gynecology and Obstetrics, JMC
- Professor Dr. Md. Humayun Kabir Talukder, Director, ICEHPER
- Professor Dr. Md. Belalul Islam, Medicine, STAMC
- Professor Dr. Md. Rafiqul Islam, Medicine, ShSMC
- Professor Dr. Md. Daharul Islam, Medicine, SSMC
- Professor Dr. Lutfunnesa, Pediatrics, DMC
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