Notes on this module:

- please add details of the date, time, place and sponsorship of the meeting for which you are using this presentation in the space indicated;

- this is a large set of slides from which the presenter should select the most relevant ones to use in a specific presentation. These slides cover many facets of the problem. Present only those slides that apply most directly to the local or regional situation. Adapt the information, statistics and photos within each slide to the particular context in which this module is being presented, where relevant. For instructions on how to use this module visit: https://www.who.int/publications/i/item/WHO-CED-PHE-EPE-19-12-02;

- **Children and chemicals** is one module from a larger training package focused on children’s environmental health. Consult these other modules where relevant. Throughout **Children and chemicals** a number of different modules are suggested that contain more relevant information. To see the full package visit: https://www.who.int/teams/environment-climate-change-and-health/settings-populations/children/capacity-building/training-modules;

- the World Health Organization (WHO) reference number for the module **Children and chemicals: training for health care providers, third edition** is WHO/HEP/ECH/CHE/23.02;

- for more information on WHO’s work on children’s environmental health, please visit: https://www.who.int/health-topics/children-environmental-health.
This presentation deals with children and chemicals – a topic of great concern for health care workers, parents, communities and policy-makers. Childhood exposure to chemicals has been the subject of a number of international recommendations.

This module is also an introduction to other more detailed modules on chemicals, including lead, mercury, pesticides and persistent organic pollutants (POPs).

Health care providers can play a key role in reducing children’s exposures to chemicals.

The learning objectives for this module are to:

- Learn about key chemical hazards and the risks they pose to children;
- Identify high-risk scenarios;
- Learn about diseases that may be associated with acute and chronic toxic chemical exposures in children;
- Understand methods to assess, prevent and manage children’s toxic chemical exposures.

Note: the WHO training package for the health sector contains the following additional modules which may contain extra information on specific chemicals of concern in your region or context. These modules are listed below:

- *Adverse health effects of heavy metals in children*
- *Children and radiation*
- *Lead*
- *Mercury*
- *Mycotoxins*
- *Persistent organic pollutants*
- *Pesticides.*

Photo:
- © WHO / Blink Media – Daiana Valencia. Karina and her son Gabriel, 7, read a book together at their home in Moreno, Argentina.
This training module includes the following sections:
- chemicals in the environment
- exposures
- health effects
- management and prevention

**Note:**
When selecting the slides to include in your presentation, please choose only those of relevance to the region and/or interests of your audience and adapt them as required.

**Photo:**
- © WHO/ G. Ritlewski. Two barefoot children play hoop rolling near a tent, South Sudan.
For the first section of this module, we will start with chemicals in the environment, including the magnitude of the problem.

**Photo:**
- © WHO/ G. Ritlewski. Two barefoot children play hoop rolling near a tent, South Sudan.
Chemicals are ubiquitous in everyday life. More than 160 million chemicals are known to humans, most of them manmade. Between 40,000 and 60,000 of these chemicals are found in commercial use; 6,000 of these make up 99% of the total volume of chemicals in commercial use. The toxicity to children of these 6,000 chemicals is unknown (1).

Children are exposed to many different chemicals everyday. Comprehensive data and research on the full range of acute, chronic, mixed exposures, high dose, low dose, fatal, non-fatal and transgenerational toxicity from chemicals to children exists for just a handful of chemicals such as lead, mercury, a few pesticides and some persistent organic pollutants (POPs) (2).

WHO estimated that 2 million deaths globally were attributed to select chemical exposures in 2019. Cardiovascular diseases, chronic obstructive pulmonary disease and cancers make up the largest proportions of deaths attributed to chemicals in 2019 (3, 4). Additionally, chemical exposure during pregnancy and childhood is a significant contributor to disability, potentially affecting a child for their life, and premature death (2, 3).

Note: For more detail, refer to modules on **Lead**, **Mercury**, **Persistent organic pollutants** and **Pesticides**.

References:
At the global level, the World Health Organization (WHO) has identified eight environmental threats to children’s health (1). All of these threats have either a strong chemical component or are related to the use, over-use or unsafe use of chemicals. Chemicals are often the specific component that confers health risks from the environment. For example, polluted indoor and outdoor air, inadequate or polluted water, and in the built environment. Chemicals, “old” and “new”, anthropogenic, or natural, are ubiquitous in the places where children live, learn, play, and work (2,3). Some examples of specific chemicals in specific media or environments include:

- **household and ambient (outdoor) air pollution.** Particulate matter and gases such as ozone (O3), sulfur dioxide (SO2), nitric oxides (NOx), polycyclic aromatic hydrocarbons (PAHs) and carbon monoxide (CO), are some of the typical air contaminants, by-products of polluting fuels combustion, whose effects on children’s morbidity and mortality have been clearly demonstrated (4);
- **tobacco smoke** is very rich in toxic chemicals particles and PAHs (5);
- **water**: although in low- and middle-income countries (LMICs) the main concern is microbiological contamination, a number of chemical pollutants in water have a tremendous impact on public health, in particular: arsenic, lead, fluoride and some pesticides (1); and
- **e-waste** and other dangerous industrial or agricultural residues may be responsible for an increasing number of contaminated urban and rural sites. Landfills can accumulate dangerous metals and persistent organic pollutants (POPs) and risk polluting the surrounding environments, including soil, dust, air and water (6).

References:

Figure:
Chemicals can enter the environment through multiple processes. Some of these processes occur naturally in the environment, while others are due to human activity (1). This slide uses an illustration of how mercury can enter the environment, polluting the air, soil, food, groundwater, bodies of water and fish.

Industrial processes, for example coal-fired power plants, chemical manufacturing and artisanal small-scale gold-mining, and sewerage systems can release chemicals into the environment where they may vaporize, contaminating the air. Air pollution can travel significant distances, where it may be deposited into soil, crops and water bodies through precipitation (2). Pollutants that are deposited into soil can also leach into the groundwater, which may contaminate important water supplies. Hazardous and poorly managed waste sites are at high risk of contaminating groundwater (1).

Human activities, such as industrial process, and natural process, such as rain can pollute bodies of water, including oceans and rivers. Fish can absorb chemicals in the water through consumption of food, water and sediments. Certain chemicals, including mercury, can bioaccumulate in fish and are an important source of exposure in children (3).

Environmental pollution can thus lead to the long-range transport of chemicals through air, water, soil and food contamination. Communities far away from sources of pollution are exposed through the food they eat, the water they drink and the air they breathe. It is important to note that this cycle differs between chemicals and health care workers should be aware of the main toxic chemicals in their local communities and how children are exposed to them.

References:

Figure:
Chemical substances provide important functionality in a wide range of products. Many chemicals can be used with a high degree of safety when best practices are followed. However, the unsafe use of toxic chemicals in common items is a growing concern for public health and the environment (1).

Children may be exposed during different stages of product lifecycle, for example during manufacturing, use or manipulation and discharge (1).

These images show some examples of common chemicals that may be present in places that children spend time, such as homes, schools or open places.

Some chemicals that are dangerous to children’s health are natural toxins from plants, venomous animals or marine food. These include bites and stings: envenoming by snakes, scorpions, spiders, bees. Other natural toxicants may be present naturally in the soil, air or water, for example fluoride, lead, arsenic or asbestos (1,2).

The below list gives some examples of consumer products, plants and materials that can be dangerous to children’s health if used improperly, overused, left within a child’s reach or used without carefully following product-specific instructions (1-3):

- toxicants found in household air pollution, for example carbon monoxide produced through indoor combustion
- pesticides, including insecticides, rodenticides, herbicides
- household products, including bleaches, cleaners, detergents, solvents, kerosene (paraffin)
- cosmetics, such as some perfumes, shampoo, nail products
- plants and mushrooms, for example some berries, seeds, leaves
- drugs of abuse, such as alcohol, illicit drugs of abuse, tobacco; and
- pharmaceuticals, for example sedatives, analgesics, contraceptives, syrups and pain medication.

Other materials may contain toxicants that remain from manufacturing. Some examples of these include:

- toys and children’s jewellery can contain lead in the form of paint and metal clasps, chains or charms. Lead is also used in some crayons and as a plastic stabilizer in some toys. Lead may leach out of these products when they are used by children and when discarded (4,5). Children’s toys may also contain batteries;
- electronic products and batteries: Many toxic materials are found in computers, phone and batteries, including lead, cadmium, mercury, beryllium, antimony, brominated flame retardants, perfluorinated compounds, and polyvinyl chloride plastic. Improper recycling methods can contaminate the environment and result in chronic exposure and poisonings in surrounding areas (6);
• **textiles**: Perfluoroalkyl and polyfluoroalkyl (PFAS) are commonly used as stain- and water-repellents in textile surfaces and are applied during the production of all-weather clothing and other textiles such as tents and tablecloths. Unbound PFAS chemicals on treated textiles may be released during wear, washing and disposal \(^7\). Thousands of different PFAS have been identified, but only a few such as perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) have been studied for their effects on health \(^8\). PFOA has been classified as potentially carcinogenic to humans. Industrial emissions of PFAS have been documented as contaminating water sources in a number of countries \(^9\); and

• **furniture**: The use of chemicals, such as fungicides and brominated flame retardants, in furniture can cause skin irritation, allergies and other health effect \(^2\).

**An example:**
Since the introduction of soluble liquid laundry capsules to consumer markets in 2010, poison centres have identified a rising trend in children suffering injuries and poisoning related to these products. Brightly coloured and soft, the capsules resemble soft toys or sweets and are highly appealing to young children. The capsules contain concentrated detergent that can cause corrosive injury to the oesophagus and eyes, as well as systemic effects such as drowsiness. These products should be clearly marked as hazardous and kept out of reach of children \(^2\).

**Note**: for more detail, refer to modules on *Adverse health effects of heavy meals in children, Lead* and *Mercury*.

**Note on terminology**: a *toxin* is a poison of natural origin and produced by a living organism, including animals, bacteria and plants. A *toxicant* is a substance harmful to human health that is produced by, or is a by-product of, human activity \(^10\).

**References**:

**Figure:**
Chemicals are used in everyday life – they bring numerous benefits, such as protecting human and animal health, promoting hygiene, protecting crops, controlling vectors of disease, treating diseases and helping in the creation of useful materials (1). However, chemicals may also pose risks to children’s health and the environment (2).

Exposures to chemicals in the micro- and macro-environments of children may cause functional and organic damage, especially during periods of developmental and physiological vulnerability (2). Chemicals may pollute the air that children breathe, the water they drink or bathe in, or the food they eat. Some chemicals can persist in the environment for a long time. Significant knowledge gaps remain on the toxicity and the potential adverse health effects of chemicals (4).

References:
Children may be exposed to chemicals through different media such as air, water, food, soil or dust. Exposure can happen during transport, use and disposal, or due to combustion or other process. Different chemicals of exposure include (1):

- naturally occurring metals, plant and animal toxins
- manufactured products, for example hydrocarbons, pesticides, pharmaceuticals, cleaning products and
- waste, combustion and other byproducts.

This detailed diagram shows how chemical exposures may be addressed by different prevention policies and programmes. These programmes are the key to promoting healthy environments for children and preventing chemical exposures. Programmes to manage chemical exposure and protect children from dangerous chemical exposure include (2):

- maintaining chemical safety measures when handling raw materials;
- ensuring that occupational, transport and chemical safety measures are upheld during manufacture and transport of products;
- establishing chemical and product safety for manufactured products and ensuring that safety instructions regarding children are provided with every chemical product;
- occupation, chemical, food and water safety refers to making sure that chemicals are used safely and do not pollute the environment, including food and water; and
- waste management activities should ensure that chemicals and any by-products are managed and disposed of safely to ensure that they do not pollute the environment.

Chemicals must be safely managed, used and disposed of from cradle to grave to ensure that they do not pollute the environment or pose a threat to human health (3).

References:

Figure:

This slide illustrates the primary pathways and routes of children’s exposure to chemicals.

**Air:** It is important to differentiate between indoor and outdoor pollutants. Indoor pollutants include particulate matter, gases, vapours as well as biological material and fibres. These contaminants are largely produced by tobacco smoke, stoves and construction materials. Pesticides and other chemicals for household use are present in the home, presenting a potential exposure risk. Outdoor pollutants vary according to density of traffic, extent of industrialization, time (of the year and of the day) and climate. The six main outdoor pollutants are: ozone ($O_3$), particulate matter ($PM_{10}$ and $PM_{2.5}$), lead, sulfur dioxide ($SO_2$), carbon monoxide ($CO$) and nitrogen dioxide ($NO_2$) (1,2).

**Water:** Used for drinking, cooking, preparation of infant formula, bathing and swimming. Groundwater or surface water may be contaminated by point sources of pollution, for example via industrial discharge, or non-point sources such as agricultural and rural run-off, soil contamination and atmospheric deposition. Some contaminants of concern are: arsenic, chromium, lead, mercury, nitrates, benzenes, pesticides, polychlorinated biphenyls (PCBs) and disinfectants such as chloramine and chlorine (2).

**Food:** Food may have a large range of contaminants, from additives, such as colourings, flavourings and preservatives, to pesticides, as residues or as contaminants, and mycotoxins, and other natural toxins in doses high enough to produce toxic effects, including some shellfish and fish toxins. Mercury and PCBs can contaminate fish, and mycotoxins can contaminate fruits, grains, and more. Special attention should be paid to the diets of breastfeeding women, infants and children in order to assess potential exposure to toxicants (2).

**Transplacental exposure:** Extensive evidence has linked prenatal exposure to some chemicals to a variety of derangements to fetal development and health effects in children later in life. During pregnancy, the fetus goes through critical windows of development that can be irreversibly deranged if disrupted. Pregnant women who are exposed to chemicals in food, water, air, dust and soil, as well as some pharmaceutical products, can expose the fetus to these chemicals via the placenta. Many chemicals including lead, ethanol and methymercury, and pharmaceuticals such as thalidomide and diethylstilbestrol (DES), can cross the placenta (1).

**Soil and dust:** Children may be exposed to soil contaminants by different pathways. Inhalation of dust aerosolized from contaminated soil and soil and dust ingestion. Soil may be the source of exposure particularly to persistent contaminants like metals and persistent organic pollutants (POPs). Dust may contain many other chemicals such as pesticides, plasticizers, flame retardants and polycyclic aromatic hydrocarbons (PAHs). Hand-to-mouth and object-
to-mouth behaviours (for example, contaminated toys) and living closer to the ground put children at greater exposure and risk compared to adults. The upper percentile of soil and dust ingestion for children under 6 years of age is 200 milligrams per day (3).

**Building materials:** Lead in paints, asbestos in construction materials and formaldehyde in some adhesive and wood products (1,2).

**Consumer products:** Toys, baby cots and other materials that come into close contact with children may have toxic components or contaminants, such as lead paint used on wooden toys. Plasticizers including phthalates and phenols, such as bisphenol A (BPA), may also be found in plastic toys. A number of products that may be applied to children may contain chemicals with toxic effects, for example mercury in some cosmetics (1).

**Note:** for each source of exposure, give examples that are pertinent to the area and/or your personal experience on the subject.

**Note:** for more details, refer to modules on *Adverse health effects of heavy metals in children, Lead, Mercury* and *Mycotoxins*.

**References:**
In 2010, the International Programme on Chemical Safety (IPCS) and the World Health Organization (WHO) presented specific reports for decision makers about the 10 chemicals or groups of chemicals that were prioritized according to major public health concern. These chemicals are considered to be hazardous to human health, including children (1).

The 10 chemicals of major public health concern are listed below in alphabetical order:

- air pollution
- arsenic
- asbestos
- benzene
- cadmium
- dioxin
- inadequate or excess fluoride
- hazardous pesticides
- lead
- mercury

These chemicals contribute to the burden of diseases and exposure is preventable through sound management and reduction of these chemicals in the environment.

**Note:** IPCS is a joint cooperative programme between the WHO, the International Labour Organization (ILO) and the United Nations Environment Programme (UNEP). It was established in 1980.

**Note:** for more details, refer to modules on *Ambient air pollution, Household air pollution, Lead, Mercury, Persistent organic pollutants* and *Pesticides*.

**References:**

**Figure:**
- Adapted from: 10 chemicals of public health concern [website]. Geneva: World Health Organization; 2021
Children have special vulnerabilities to chemical exposures. These include:

- **Different and unique exposures**: Some chemicals can cross the placenta and may harm the developing fetus. Breastfeeding infants and children may be exposed to chemicals that can be found in breastmilk. However, given that breastfeeding reduces child mortality and has health benefits that extend into adulthood, a specific assessment should be undertaken before mothers are advised to cease breastfeeding. The World Health Organization (WHO) and the United Nations Children’s Fund (UNICEF) recommend exclusively breastfeeding for the first 6 months of life with continued breastfeeding along with complementary foods while continuing to breastfeed for up to two years and beyond (1). Children also have exploratory behaviours and practice frequent hand-to-mouth and object-to-mouth behaviours, increasing their exposure to dust and soil which may contain hazardous substances. Children breathe more air, drink more water and consume more food than adults, relative to the size of their body. If air, water or food items are contaminated, children may receive more of the contaminant per kilogram of their body weight when compared with adults (2,3).

- **Dynamic developmental physiology**: Fetuses and children are going through rapid periods of development, including increased cellular division and differentiation. If these processes are disrupted by toxic chemicals, they may cause adverse health effects that affect a child for the rest of its life. Children have different metabolisms when compared to adults, which may modify the toxicity of the chemical compared with effects in adults. Children are going through **windows of susceptibility**. At particular ages, children’s development processes are susceptible to exposure to different chemicals. Exposure during these periods may affect a child for the rest of its life. Finally, children have a poorer understanding of risk and may engage in behaviours that increases their exposure to toxicants (4).

- **Longer life expectancy and latency period**: Children have a longer life expectancy than adults, meaning that there is a greater period over which a disease can develop. Children exposed to harmful substances at a young age may experience a long latency period between exposure and development of a disease or adverse health effects (2,3).

- **Dependent upon adults**: Children are unable remove chemical exposures, remove themselves from hazardous chemical environments, assess dangerous situations and young children cannot read labels warning them against chemical contents (4).

**Note**: for more detail, refer to the module *Children are not little adults*.

**References**:
   [https://www.who.int/en/news-room/fact-sheets/detail/infant-and-young-child-feeding], accessed 1
September 2022).


Children’s environmental health and chemical safety problems are often magnified in low- and middle-income countries (LMICs). These problems are often most severe in the poorest communities in LMICs.

- **Chemical production is growing** rapidly in LMICs due to factors including increased industrialization, intensified agricultural activities and gaps in regulatory control (1,2);
- many LMICs have **multiple burdens of disease**, including malnutrition, widespread infectious diseases and steady increases in noncommunicable diseases (NCDs) (3);
- in some LMICs, **increasing pollution, lack of appropriate regulatory measures and insufficient resources**, trained personnel, controls and surveillance, are barriers to effective implementation. These barriers can lead to widespread exposure in the population to some chemical. For example, as of 30 June 2022, of 194 World Health Organization (WHO) Member States, only 87 (or 45%) countries had legally binding controls on the production, import, sale and use of lead paints. Particular regulatory gaps on lead paint are found in the African and South-East Asia Regions (4);
- **chemical dumping on land, in water bodies or landfill, and poorly managed waste sites** adjacent to populated areas, especially in the poorest communities, may increase hazardous exposures to children. Some communities may rely on scavenging and waste picking activities, which children may participate in, as a significant source of income. These activities may increase children’s exposure to chemicals found in waste, or even the chemicals themselves, that have been dumped. High-income countries (HICs) export waste to LMICs, sometimes illegally. This may increase the burden on waste management in LMICs, which may not have the appropriate facilities, technologies, trained workers or regulations to safely dispose of hazardous chemicals found in some wastes (2,5);
- **child labour** is most prevalent in LMICs. In 2020, 160 million children were engaged in child labour. Nearly half of these children were engaged in hazardous labour, including agricultural work, scavenging and waste picking. These activities may bring children into direct contact with hazardous chemicals, for example pesticides (6); and
- poisoning is a significant global public health problem and there are **fewer poison centres** in LMICs. Poison centres advise on, and assist with, the prevention, diagnosis and management of poisoning. In 2023, only 47% of WHO Member States had a poison centre. Particular gaps in access to poison centres were found in the African, Eastern Mediterranean Regions and small island states of the Western Pacific Region (7–9).

**An example:**
LMICs account for the majority of childhood poisoning mortalities and disability-adjusted life years (DALYs). In many African countries kerosene, used for heating and lighting, ingestion is a major childhood poisoning risk. Kerosene ingestion is regularly associated with storing the product in old soft drink bottles. In South Africa, poison centres...
have reported that kerosene ingestion accounted for almost one quarter of all reported childhood poisonings in clinics (5,10,11).

**Note:** use the World Health Organization’s (WHO) world directory of poisons centres to identify your local or national poisons control centres here: https://www.who.int/data/gho/data/themes/topics/indicator-groups/poison-control-and-unintentional-poisoning.

**Note:** for more detail, refer to modules on *Electrical/electronic waste and children’s health*, *Lead, Mercury, Occupation risks and children’s health*, *Pesticides* and *Persistent organic pollutants*.

**References:**
Next we move to children’s exposure to chemicals, including types and circumstances of exposure.

**Photo:**
- © WHO/ G. Ritlewski. Two barefoot children play hoop rolling near a tent, South Sudan.
The potential circumstances of exposure to chemicals in children are listed here:

- **unintentional** – is the most common circumstance of exposure in small children who are "little explorers", ready to touch and taste everything at their ground-level microenvironment, for example colourful pills, berries, plants, mushrooms and plastic bottles (1,2);
- **environmental** – this includes children’s exposure to chemicals present as pollutants or contaminants in their environment. This is a growing cause of concern. Environmental chemicals may be from anthropogenic (influenced by human activity) or natural sources (4);
- **occupational** – young workers’ exposure to dangerous and/or unsafe chemicals in the workplace when engaged in child labour. Pregnant women can also expose their unborn children. Furthermore, parents and other household members may take chemicals home on their clothes, skin, shoes, or hair if they are inadequately protected from chemical exposures at work (4,5);
- **iatrogenic or therapeutic error** – occurring in the medical setting, such as when medications are wrongly administered or through the use of faulty or malfunctioning medical devices. For example unintentional overdose, medication error or leaching of plasticizers from intravenous (IV) bags (3);
- **intentional** – infrequently seen exposures caused by individuals close to children or children themselves. Intentional exposures include (6,7):
  - homicide – for example, children may receive fatal doses of pharmaceuticals or other poisons, such as carbon monoxide;
  - munchausen syndrome by proxy – simulation or induction of disease in children, in this case through the administration of pharmaceuticals or chemicals, usually by an individuals close to the child;
  - chemical battering – administration of pharmaceuticals and other substances, for example sedatives, sleeping pills, table salt or others, to children, with the intent of harming;
  - solvent abuse (“sniffing”) – a form of recreational drug use and abuse, seen in older children and adolescents;
  - suicide attempt – completed or attempted suicides, observed mainly in adolescents. Approximately 20% of global suicides in 2019 were due to pesticide self-poisoning (7,8);
  - abortifacient – use of abortion-inducing substances by female adolescents frightened by the consequences of unwanted pregnancy, and
  - warfare agents – exposure of children to chemicals used in the context of war.

**References:**


Photo:
- © WHO / SEARO/ Florian Lang. Boys working at a tannery factory in India. Many chemicals are used at tannery factories to produce leather items, including chromium.
Different types of exposure have unique effects on the physiological system of the developing child. Below are the different types of chemical exposure that children are most likely to experience and some chemical examples for each type of exposure.

**Acute chemical exposure occurs over a short period of time, for example 24 hours.** Acute poisonings include (1-3):
- single exposure: such as carbon monoxide
- repeated exposure: for example, aspirin overdose
- "hit and run": for example thalidomide during gestation leading to phocomelia; diethylstilboestrol exposure in utero leading to cervical cancer as an adult.

**Chronic or long-term exposures occur continuously or repeatedly for days, weeks or months.** Examples include (1):
- lead exposure, for example causing cognitive deficits or liver failure (4)
- arsenic exposure, for example causing skin or bladder cancer (5).

"Acute on chronic" is a single exposure against a background of chronic exposure to the same agent (6).

**The potency of a chemical is also relevant when assessing the type of exposure that a child has experienced:**
- potency is the power of a chemical to produce a particular effect in cells, tissues or organs. Some cells, tissues and organs are sensitive and may respond to low doses of particular chemicals. The potency of a particular chemical is one characteristic that may determine a clinical course of action in exposed children (7).

Effects of chemicals depend upon the type of exposure, dose, potency and timing; the characteristics of the chemical involved; and the clinical, nutritional and developmental status of the child. While acute poisonings may be easier and faster to identify, the other types of exposure can have similar impacts or be more severe, but may be difficult to diagnose. Chemical exposures of all types pose a special challenge for health workers.

**References:**


Child health effects depend on the type of chemical, the dose and timing of exposure.

In general:

- **High-dose exposures** tend to produce poisoning and the diagnosis is usually quite clear, for example a child is found with an empty bottle of medicine and presents drowsiness:
  - for example, a child with Pica behaviour who eats lead contaminated paint flakes may exhibit elevated blood lead levels and clinical symptoms (1,2).

- **Low-dose exposures** may produce undetected or subtle effects, which may be difficult to diagnose, for example chronic, low dose exposure to elemental mercury may result in nonspecific symptoms such as insomnia, forgetfulness, loss of appetite and mild tremor (1).

**Subtle effects do not equal minor effects.** A child exhibiting subtle effects associated with chemical exposure, such as the slight changes on intelligence quotient due to lead exposure, should be carefully observed and assessed by an appropriate medical professional. Even subtle effects can suggest or lead to permanent changes to a child’s development and may lead to lifelong adverse health effects (2).

**References:**

**Photo:**
Unintentional poisonings

According to poisons centres:
- Mortality varies by region
- Children under five years of age comprise one quarter of deaths from poisonings
- The number of poisoning cases is under-reported and under-recognized
- Cases of exposure are mostly acute

Unintentional refers to an exposure by any route (or incident) where there was no intention to cause harm (1). Unintentional poisonings are considered to include poisonings by chemicals or other noxious substances, including drugs and toxic vapours and gases (2).

Mortality varies by region. Almost all deaths from unintentional poisoning in 2019 occurred in low- and middle-income countries (LMICs) (3). Unintentional poisonings accounted for more than 18 600 deaths and more than 1.6 million disability-adjusted life years (DALYs) in children under the age of 5 years in 2019 (3,4). Children under the age of 5 years comprised nearly one quarter of all mortalities due to poisonings in 2019 (4). The number of poisoning cases is an under-reported and under-recognized public health concern (5).

Drugs, cosmetics, personal care products, household chemicals including pesticides, and in LMICs, kerosene, are among the common causes of unintentional childhood poisonings (6).

Cases of unintentional poisonings in children are usually acute and the majority are attributable to environmental exposures (2). Unintentional poisonings are monitored by Sustainable Development Goal (SDG) 3 which aims to, by 2030, “substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination (7).”

Note: search for statistical data of childhood poisoning in your country or region, or include information provided by local or national poison control centres.

References:
   Health Organization; 2017 (https://apps.who.int/iris/handle/10665/254678, accessed 1
   September 2022).
7. 3.9.3 mortality rate attributed to unintentional poisonings [website]. New York: United Nations;
   2019 (https://sdg.tracking-progress.org/indicator/3-9-3-mortality-rate-attributed-to-
   unintentional-poisonings/, accessed 1 September 2022).

Photo:
• © WHO Thailand / Suphalak Phupheng. A child plays on the ground, Thailand.
We will now look at health effects associated with chemical exposure studied in children.

Photo:
• © WHO/ G. Ritlewski. Two barefoot children play hoop rolling near a tent, South Sudan.
Chemical toxicokinetics and toxicodynamics

**Toxicokinetics** – all the processes and pathways that a substance goes through in the body

**Toxicodynamics** – the interaction between a substance and the body, resulting in toxic effects

*Toxicokinetics refers to what the body does to the toxicant, while toxicodynamics refers to what the toxicant does to the body*

The capacity of a substance to produce a toxic effect is influenced by many factors, including its absorption, distribution, site of activation or detoxification, excretion and site of action (1).

**Reference:**
Toxicokinetics describes the human body’s process of uptake of toxic substances, the transformations they undergo within the body, how they are distributed and spread throughout the body and, finally, how the body eliminates a substance and any metabolites (1).

Absorption, distribution, metabolism and elimination are the four key physiological processes in understanding toxicokinetics:

- **absorption** is the route by which chemicals enter the body. Absorption can occur by a variety of routes. The most common are ingestion, respiratory or through direct skin or eye contact. Fetuses may also be exposed to chemicals that can cross the placenta (2);
- **distribution** describes how a chemical moves from general circulation into the tissues or organs of the body. Distribution of a chemical is significantly affected by the age of the person and the particular substance being processed (1,2);
- **metabolism** is the method by which the body breaks down foreign chemical substances in tissues. Metabolism transforms chemicals into compounds and metabolites that can be more easily eliminated from the body. Metabolism may occur through enzymatic reactions or detoxification (2,3);
- **elimination** is the route by which chemicals and their metabolites leave the body. The kidney is an effective organ at eliminating substances from the body via urine. Other elimination routes include through skin glands, via sweating, and through the respiratory tract, via the lungs. The route of elimination depends upon the type of chemical (lipophilic, hydrophilic, and organic ions) and the age of the person (3).

The next slide discusses how these four processes are handled differently by children’s bodies.

References:
Children have a dynamic physiology due to growth demands. Children are in an anabolic state and require larger amounts of energy, water, oxygen and nutrients, relative to their size and weight, compared to adults. **Absorption** is frequently increased in children as they are anabolic and active, but this can differ depending upon the route of exposure. Some children may absorb nutrients very efficiently. For example, lead competes calcium, which is essential for skeletal and cellular growth, for the same locations in bone. A child may absorb up to 50% of a given ingested dose of lead, whereas a non-pregnant adult may absorb up to 10%. Nutritional deficiencies, particularly anaemia, which is common in rapidly growing children, will increase lead absorption (1,2).

**Distribution** is different in children from that in adults and varies with age (3). For example, the blood–brain barrier differs in the developing brain versus the adult brain, and consequently substances such as lead readily cross into the developing central nervous system.

Some chemicals are dangerous when ingested and must be detoxified by **metabolism**. Other are not immediately dangerous upon ingestion but may become so when metabolized, for example paracetamol overdose or ethanol. Either way, these processes are likely to be different in children, but unfortunately not in predictable ways. Particularly during fetal growth and in the first 6 to 12 months of life, important metabolic pathways such as cytochrome P450 systems and glutathione conjugation are significantly reduced in efficiency. Most known toxicants are detoxified in the body, so the immaturity of these systems in children can increase the duration and amount of any given internal dose (3-5).

The lifetime of the chemical in both children and adult’s blood or other tissues may vary from hours (for example hydrocarbon solvents), to days or weeks (for example some pesticides) to months or years (for example lead and persistent organic pollutants (POPs)) (3).

**Elimination** may be decreased in early postnatal life. For example the glomerular filtration rate of newborns is substantially less than that of adults, and premature infants will experience even lower rates (3).

**References:**


Toxicodynamics refers to the process of interaction between chemical substances with target sites, such as organs or systems in the body, and the subsequent reactions leading to adverse effects (1).

Effects may impact:
- **critical windows of exposure**: Every organ develops according to a strict "timetable" in which changes take place at specific times. There are periods during which an organ may be particularly sensitive to the adverse effect of exposure to some chemicals. These are called critical windows of exposure. Prenatal life is one critical window of exposure. Chemical exposure experienced by a pregnant woman may cross the placenta and expose the fetus. This may affect the normal development of the fetus (2);
- **central nervous system**: This is a precisely regulated system that entails numerous processes. Cells divide, multiply, migrate and differentiate; cell connections are continually formed; numerous biochemical changes take place; neurotransmitters, synapses and receptors are set up to enable the effective transmission of signals. The brain growth spurt, a period of rapid development, occurs in the fetus in the third trimester of pregnancy and continues into the first 2 years of life. The developing central nervous system is a potential target for neurotoxic substances (2);
- **immune system**: The immune system develops from pluripotent stem cells that migrate from the circulatory system into lymphoid organs and differentiate into a wide variety of cell types, including B- and T-lymphocytes, macrophages and granulocytes. The human immune system is not totally protective at birth. Important developments occur after birth, in the interaction with the environment that leads to acquisition of immunological memory. Toxicants, such as lead and polychlorinated biphenyls (PCBs) may alter pluripotent stem cells, T-lymphocytes and the thymus (1);
- **endocrine system**: Hormones are signalling molecules that enable cells, tissues and organs to interact with the environment and function in a harmonized manner. Hormones play a crucial role in sex differentiation: male sex hormones cause the embryo to develop as male at six weeks of gestation. Later in life, hormones control puberty, ovule maturation, spermatogenesis, gestation, birth and lactation (1). The thyroid produces hormones which are crucial for the correct development of organs, such as the brain and the gonads. Some chemicals have been proven to have an endocrine-disrupting capacity in wildlife. Human studies on the effects of some chemicals on thyroid function have found suggestive evidence of endocrine disruption. More research is required to confirm these findings. The effects may occur by mimicry. This means that some chemicals may behave like hormones, antagonising, preventing hormones from bonding, or disrupting production, conversion, transportation or excretion of hormones (3).

References:

Photo:
• © WHO / Ginny Stein. A preschool student at Aim Yee Kindy School, Vanuatu.
Chemicals cause disease by different and complex mechanisms of action that can be detected at multiple levels, including:
• systemic/target organ diseases
• cellular dysfunction, and
• molecular alterations (1).

Reference:
Clinical and subclinical effects

Clinical features observed depend upon:
- Agent
- Dose
- Timing and length of exposure

Effects may be:
- Asymptomatic
- Acute and evident: toxic syndromes ("toxidromes")
- Chronic and subtle: undefined symptoms
- Detected by experimental studies

The clinical effects observed in children depend upon the type of chemical or pollutant involved, the dose, timing and length of exposure (1). Typical examples include:
- acute poisoning by organophosphorus pesticides, with a characteristic syndrome: miosis, sweating, headache, bradycardia or convulsions (2);
- chronic lead exposure: the child may be asymptomatic for some time and later present with anaemia, abdominal pain, fatigue, behavioural changes and learning disabilities (2).

Some exposures may not produce obvious clinical effects, but may lead to disease after some time or in adulthood, for example air pollutants or arsenic in water (2,3).

In some instances, these exposures may be assessed through laboratory studies in individuals. Some effects may only be apparent through evaluation of large populations, for example intelligence quotient (IQ) testing and population level exposure to polychlorinated biphenyls (PCBs) or lead (4,5).

Note: toxic syndromes, or “toxidromes” are collections of signs and symptoms characteristic of the toxicity of a given chemical agent or family of agents (6).

Note: "subclinical" refers to a disease or health outcome that is not producing definite or observable signs or symptoms.

References:
Chronic exposure to some chemicals has been linked to certain noncommunicable diseases (NCDs). These include stroke and cardiovascular disease; congenital anomalies; neurological; mental and behavioural disorders; asthma and other respiratory disorders; and cancers. Some adverse birth outcomes have been linked to chronic exposure to some chemicals, and may impact a child's health and development for life. Some examples are listed below.

**Examples include:**

- Adverse pregnancy outcomes have been observed in mothers exposed to different environmental or occupational risk such as ambient air pollution, second-hand tobacco smoke and other household air pollutants. Prenatal exposure to certain chemicals has also been linked to adverse pregnancy outcomes, for example maternal exposure to some pesticides has been linked to reduced birth weight, lead exposure is associated with reduced fetal growth and preterm birth and polychlorinated biphenyls (PCBs) have been associated with decreases in birth weight, even at low levels (1,2).

- Endocrine disrupting chemicals, including persistent organic pollutants (POPs), some pesticides and some chemicals found in cosmetics, may be linked to low birth weight and premature birth (3).

- Chronic exposure to lead, mercury, some pesticides and plasticizers has been associated with neurodevelopmental disorders. It was estimated in 2016, 11% of the disease burden in disability-adjusted life-years (DALYs) from mental, behavioural and neurological disorders is related to environmental risks (4).

- Air pollution is associated with asthma and other respiratory diseases, such as chemical pneumonitis, in children (5). Asthma development and exacerbation is strongly linked with chemicals commonly found in both household and ambient air pollution, for example ozone and volatile organic compounds (VOCs) (1). Acute exposure to certain chemicals via inhalation can lead to pneumonia in children, for example cadmium and chromium (1).

- Second-hand tobacco smoke, pesticides and organic solvents are suspected to increase the risk of congenital anomalies, including heart malformations, limb reductions and cleft lip and palate defects (6).

- Many chemical components of household and ambient air pollution are associated with increased risk of cancers, such as lung and cervical cancers (7). Traffic-related air pollution is linked to an increased risk of childhood leukaemia. Associations between some organophosphate pesticides and cancer development, including childhood leukaemia, have also been posed (6,8).
Note: for more detail, refer to modules on Ambient air pollution, Childhood respiratory diseases linked to the environment, Endocrine disorders, Household air pollution and Pesticides.

References:

Photo:
• © WHO / Alasdair Bell. A nurse with his wife and child at the centre where he has been completing additional training, Trinidad and Tobago.
The final section of this module discusses management and prevention of children’s exposure to chemicals.

Photo:
• © WHO/G. Ritlewski. Two barefoot children play hoop rolling near a tent, South Sudan.
Health care professionals have a critical role to play in maintaining and stimulating changes that will protect children’s health from hazardous chemical exposures.

Staying informed about and understanding chemical influences on health and disease will allow us to create spaces that keep our children safe and healthy. Health care professionals are encouraged to look for ways in professional, political and personal lives to support environmental health. Everyone can do something.

At the one-to-one patient level, health care professionals can take an environmental history during each visit, include environmental etiologies in differential diagnoses and add environmental considerations to preventive advice. Health care professionals can be dissatisfied with the diagnosis of “idiopathic” and look hard for potential environmental causes of disease and disability. Health care professionals can stay informed about the specific environmental conditions and chemical risks faced by local and regional areas, helping to prioritize activities.

Health care professionals can identify and publish sentinel cases and develop and write up community-based interventions with a focus on children’s environmental health and hazardous chemical exposures.

Health care professionals must continue to educate themselves through courses, including e-learning, and stay up-to-date with new and updated information and research. Health care professionals can educate patients, families and communities by including environmental protections in our anticipatory guidance during each visit. Methods of continuing education include, formal presentations, continuing education programs, e-learning and developing case studies on children’s environmental health for colleagues and professional students.

Health care professionals can become vigorous advocates for the environmental health of children and future generations. It is not enough to be an informed citizen, write letters and articles, testify at hearings and approach our elected officials with educational and positive messages, avoiding “scares” and "alarmism”, but providing evidence for action and clear proposals for remedial and preventive activities.

And, health care professionals can recognize that as professionals with an understanding of health, the environment and chemical exposures, they are powerful role models. Choices will be noticed: they should be thoughtful and sustainable.

**Note:** if you have an example of a way in which health care providers play, or have played, a role in reducing children’s exposure to chemicals in your community, country or region, it can be used here.
Photo:

- © WHO/Yoshi Shimizu. A health worker provides counselling to a young family, Papua New Guinea.
Key questions: That health professionals can ask

- Do you know of any pollution problems in your neighbourhood?
- Do you use any pesticides in, or around, your home?
- Where and how do you store chemical products around the home (including medicines, cleaning products, pesticides, fuels for heating and lighting)?
- Do any household members work at home using chemicals or bring them home from work? If so, do you know which chemicals are used and how they are stored and disposed of?
- What technologies and fuels are used for cooking, heating and lighting in the home?

Detecting toxic chemical exposures in children’s environment may support diagnosis and treatment of disease (1).

Note: adapt these questions to the specific context of each patient and include the answers in a paediatric environmental history.

References:
   (https://www.who.int/publications/m/item/children-s-environmental-record--green-page, accessed 1
September 2022).
Prevention is the single most effective means of protecting children

Health care providers play a key role in:

• Identifying the problem
• Defining its determinants and characteristics
• Informing the community – and the children
• Educating colleagues and other professionals
• Raising the awareness of policy-makers
• Promoting the implementation of appropriate measures
• Evaluating the efficacy of preventive measures

Health care providers play a key role in many aspects of preventing children’s exposure to chemicals. These are:

• **Identifying the problem in your local community or area.** What are the main toxic chemical exposures in children? What are the main causes of acute poisonings? Are there any cases of chronic exposure to environmental pollutants? Is there a high incidence of disease or diseases that may be linked to chemicals in the environment? Paediatric hospitals and poisons centres may be able to provide statistical and epidemiological data on the subject (1,2);

• **What are the determinants and characteristics?** Are exposures in children acute or chronic? Where do they occur? When and how? Are there any predisposing factors? Which populations or groups are affected? Are they predominantly urban or rural (1,2)?

• **Informing the community – and the children.** A community whose children are exposed to chemicals and pollutants in the environment should be informed about the situation in a clear manner. Social workers and communications experts may provide valuable advice on how to communicate risks or potential threats to the community, and how its members may reduce or avoid them and protect their children (1);

• **Educating colleagues and other professionals.** It is especially important to educate those who should recognize and manage the effects of chemicals on children’s health, including nurses, paediatricians and primary health care workers. Those who will help in assessing environmental issues should also be educated (1,3);

• **Raising the awareness of policy-makers about the problems identified.** Policy-makers should be made aware of the chemical risks facing children, including poisonings and potential chronic exposures (1,3);

• **Promoting the implementation of appropriate actions.** The implementation of appropriate measures should be promoted in consultation with key partners including policy-makers, affected communities, doctors, nurses, teachers and parents (1); and

• **Evaluating the efficacy of preventive measures.** The efficacy of preventive measures should be evaluated and the community should be informed of the findings (4).

References:
1 September 2022).
Role of the laboratory

- Confirm exposure to toxicants
- Determine magnitude/severity
- Assess and measure effects
- Monitor the efficacy of treatment
- Follow clinical evolution

Unfortunately, only a minority of chemical exposures can be measured, understood and treated. Specific analyses may be not available in general hospitals. If chemical exposure is suspected or confirmed, follow available specific treatments and local guidance. It is important that children are removed from chemical exposures as soon as possible.

Laboratory studies are important in cases of childhood chemical exposure in order to:

- confirm exposure by detecting levels in biological fluids: blood, urine and hair
- determine the magnitude and severity of exposure; compare with reference or intervention levels
- assess and measure effects, for example levels of anaemia or cholinesterase inhibition
- monitor the efficacy of treatment, and
- follow the clinical evolution after treatment or environmental interventions.

Some examples:

- lead exposure – measuring is via blood lead levels
- exposure to organophosphorus pesticides – confirmation by measurement of cholinesterase in red blood cells or whole blood (1).

Reference:

Photo:
© WHO/ Lindsay Mackenzie. A mother brings her son for a blood test at a health facility for women and children in Abu Shouk IDP camp in North Darfur, Sudan.
The treatment of chemical exposures in children varies according to the type or level of exposure, clinical effects observed and results of laboratory tests (1).

Removing the chemical, or removing the child from the source of the chemical exposure.

Resuscitation includes intubation, ventilation, or other life-saving measures.

Decontamination may include ocular, dermal or gastrointestinal options. Gastrointestinal decontamination is only recommended in the most severe cases of poisoning. This must be done with the control of a poison centre (1,2).

Symptomatic treatment involves therapy that relieves the symptoms of a poisoning, for example the use of an intravenous (IV) line (2).

Antidotes or antagonists may also be administered depending on the chemical involved (1,2). For example, in some cases of acute lead poisoning the use of a chelating agent may be recommended, however this depends upon a number of factors including the age and blood lead level of the patient (3).

A specific example:
Organophosphorus pesticide:
- acute poisoning by an organophosphorus pesticide may require decontamination, such as washing of the skin, or possibly gastric lavage, under special circumstances, and the antidote atropine and the administration of enzyme reactivators, such as pralidoximes (1,2).

Call the poison centre (4-6):
- they can help you to identify, diagnose and treat exposures or poisoning
- in areas without poison centres, call local health services or local Children’s Environmental Health units (7).

Note: if relevant use the World Health Organization’s (WHO) world directory of poisons centres to identify your local or national poisons control centres here: https://www.who.int/data/gho/data/themes/topics/indicator-groups/poison-control-and-unintentional-poisoning.

References:
The treatment of toxic chemical exposures in children varies according to the chemical involved, type or level of exposure, clinical effects observed, and results of laboratory tests (1).

**Chronic/low-level exposure may require (1-3):**

- Removing the child from the source of exposure
- Symptomatic treatment
- Specific treatment: use of antidotes, if appropriate
- Follow-up treatment, nutritional interventions
- Remedial measures to the environment

Specialized paediatricians and medical toxicologists may help diagnose and treat children chronically exposed to toxic chemicals.

Children’s Environmental Health units and poison centres may have the knowledge and tools to assess and promote interventions (4).

A specific example:

**Lead:**

- chronic lead exposure requires removal of the child from the source of exposure (for example contaminated soil or water, paint chips in the home, stopping use of leaded ceramics) and personal and home hygiene measures. If blood lead levels are above 45 micrograms per decilitre (µg/dL), the use of a chelating agent, such as succimer, should be considered. If the child presents with lead encephalopathy, intensive care is required as well as the administration of chelating agents (3,5).

**References:**


Protecting children from chemical hazards requires the creation and enforcement of appropriate legislation and the promotion of safe chemical practices.

To protect children from dangerous chemical exposures (1):

- ensure safe storage, packaging and clear labelling of chemicals used in homes, gardens and schools;
- ensure regular cleaning in schools and safe storage of cleaning materials and any other chemicals used in school and play areas, including pesticides;
- never store chemicals in drinking bottles. All such liquids should be kept in clearly marked closed containers out of children’s sight and reach;
- promote the use of child-resistant packages for pharmaceuticals and for chemical products;
- inform parents, teachers and child-minders about the potential chemical hazards in the places where children spend their time (1);

(Continued on slide 36)

References:
Protecting children from chemical hazards

- Train healthcare providers on recognition, prevention and management of toxic chemical exposures, especially in children (1);
- Limit the use of unnecessary chemicals indoors;
- Train health care professionals on the use of the Paediatric Environmental History;
- Incorporate the teaching of chemical safety and health into school curricula;
- Advocate for legislation on the safe use and disposal of chemicals that protects children’s health;
- Advocate with relevant authorities to remedy pollution sites and hotspots and ensure child health is prioritized;
- Engage with local authorities to ensure homes, schools are not constructed near polluted areas and sites.

Note: for more detail, refer to module on the Paediatric environmental history.

References:
The World Health Organization (WHO) has a number of tools for healthcare providers that address issues on children's health and chemicals. These include:

- **Publications for all audiences** can be found at: [https://www.who.int/health-topics/children-environmental-health](https://www.who.int/health-topics/children-environmental-health);
- **Summary of Principles for Evaluating Health Risks in Children Associated with Exposure to Chemicals**,
  published in 2011 and providing a summary of the findings from Environmental Health Criteria 237 (2) and is intended for use by a wide audience;
- the WHO children’s environmental health training package for the health sector comprises approximately 30 individual modules. Additional modules that may be complementary to Children and Chemicals include Ambient air pollution, E-waste, Household air pollution, Lead and Mercury (3);
- **National profiles on children’s health and the environment** are assessments of the situation of children’s environmental health in a given country. This WHO publication is intended for use by a country, by its ministries and by all other stakeholders as a basis for identifying priorities and planning and coordinating interventions. Once strengths and weaknesses are identified, the profile serves as a basis for action and evaluation of progress made or lessons learned (4). WHO’s publication Making a difference, provides an introduction to children’s environmental health indicators (5). Case study examples of preventative actions that have been taken at national level to reduce children’s exposure to environmental hazards can be found in WHO’s Children’s health and the environment: a global perspective (6).
- **Paediatric environmental history** is a series of basic, concise questions to enable health professionals to identify children’s potential exposure to environmental factors. Some questions may be applicable throughout the world while others need to be tailored to particular contexts (7);
- **Toxicology in the classroom toolkit** for school children is a joint WHO and United Nations Environment Programme (UNEP) publication for teachers and students in late primary school and early high school. It aims to raise awareness among children of the potential adverse side effects of chemicals and safe ways of handling them (8).

References:


Various international commitments exist to reduce the use and control the movements of hazardous chemicals between continents and countries.

- **The Basel Convention** controls the transboundary movement of hazardous wastes and their disposal. It is a comprehensive environmental agreement in relation to tackling the issues surrounding e-waste and its management. In 2023, the Basel Convention had 190 parties, and 14 Basel Convention Regional and Coordinating Centres have been established for capacity building and technology transfer (1).

- **The Rotterdam Convention** promotes shared responsibility and cooperation between countries in the international trade of hazardous chemicals, including banned or controlled pesticides and industrial chemicals, in order to protect human health and the environment. As of 2023, there are 165 parties to, and 54 chemicals are covered under, the Rotterdam Convention (2).

- **The Stockholm Convention** requires parties to eliminate production, and restrict the import and export, of persistent organic pollutants. As of 2023, there are 186 parties to the Stockholm Convention and it eliminates, restricts or requires the reduction where possible of the use of 35 different persistent organic pollutants (3).

- **The Minamata Convention on Mercury** is a global treaty to protect human health and the environment from the adverse effects of mercury. It was agreed at the fifth session of the Intergovernmental Negotiating Committee on mercury in Geneva, Switzerland in January 2013, and adopted later that year in October at a Diplomatic Conference (Conference of Plenipotentiaries), held in Kumamoto, Japan. As of 2023, there are 139 parties to the Minamata Convention (4).

- **The Global Alliance to Eliminate Lead Paint** is a joint initiative between the World Health Organization (WHO) and the United Nations Environment Programme (UNEP). It aims to prevent childhood exposure to lead by promoting the phase-out of manufacture and sale of paints containing lead, eventually leading to the elimination of health risks posed by such paints (5).

- **The Strategic Approach to International Chemicals Management (SAICM)** is a policy framework created to foster multisectoral and multi-stakeholder engagement in the sound management of chemicals. It aims to ensure that chemicals are produced and used in ways that minimize significant adverse impacts on the environment and human health. This has included phasing out lead in paint, providing information on chemicals in products, as well as managing e-waste (6).
The Sixty-third World Health Assembly (WHA), convened in 2010, approved resolution 63.25 - *Improvement of health through safe and environmentally sound waste management*. This resolution urges Member States to assess health aspects and support greater awareness of, improve cooperation and increase capacity in, waste management (7).

WHA resolution 69.4, *The role of the health sector in the strategic approach to international chemicals management towards the 2020 goal and beyond*, is also relevant. It urges Member States to engage in actions to soundly manage chemicals and waste at national, regional and international levels, and to strengthen the role of the health sector in these actions (8).

**Note:** provide the commitments that are relevant to the setting of the course and participants, and mention those ratified and/or followed-up in the country or region.

**References:**
More information and recommended reading

For more information on children and chemicals see the WHO training modules:
- Air pollution package
- Electrical/ electronic waste and children’s health
- Endocrine disorders
- Lead
- Mercury
- Pesticides
- Persistent organic pollutants

Recommended reading on children and chemicals:
- Environmental Health Criteria 237
- The public health impact of chemicals: knowns and unknowns
- Evaluation and management of common childhood poisonings

For more information on children and chemical exposures see the World Health Organization (WHO) training package on children’s environmental health for the health care sector (1). The following modules may be of particular interest:
- Air pollution package – this includes Ambient air pollution, Children and respiratory diseases, Household air pollution, Indoor air pollution and Second-hand smoke
- Electrical/ electronic waste and children's health
- Endocrine disorders
- Lead
- Mercury
- Pesticides
- Persistent organic pollutants.

To read more on chemicals and children see the below references:
- Environmental health criteria 237: principles for evaluating health risks in children associated with exposure to chemicals (2) and its accompanying summary (3).
- The public health impact of chemicals: knowns and unknowns (4)
- Evaluation and management of common childhood poisonings (5).

References:
Acknowledgements for current version

Initial edits by: Julia Gorman (WHO consultant).

Working group for current version: Marie-Noël Bruné Drisse (WHO), Gloria Chen (USA), Julia F. Gorman (WHO consultant), Amalia Laborde (Uruguay), Katherine M. Shea (USA).

Reviewers: Maria Brown (UNICEF), Patrick Hicks (Canada), Carolyn Vickers (WHO).

Final review, technical and copy-editing: Julia Gorman (WHO consultant).

WHO CEH training project coordinator: Marie-Noël Bruné Drisse (WHO).

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First draft prepared by Jenny Pronczuk (WHO).

With the advice of the Working Group Members on the Training Package for the Health Sector:
Cristina Alonso (Uruguay); Iona Amitai (Israel); Stephan Boese-O’Reilly (Germany); Stephanie Borgo (ISDE, Italy); Irena Buka (Canada); Ernesto Burgio (ISDE, Italy); Lilian Corra (Argentina); Ruth A. Etzel (WHO); Ligia Fruchtengarten (Brazil); Amalia Labonde (Uruguay); Leda Nemer (WHO/EURO); Jenny Pronczuk (WHO); Roberto Romizi (ISDE, Italy); Christian Schweizer (WHO/EURO); Katherine M. Shea (USA).

Reviewers: Ligia Fruchtengarten (Brazil), Josef G. Thundiyil (USA), Renee Modica (USA), Huw Brunt (UK), Gary Coleman (UK), Raquiel Duarte-Davidson (UK), Elaine Lynch Farmery (UK), Alison M. Good (UK), Mark Griffiths (UK), John Thompson (UK), Laura Yates (UK), Atsuko Araki (Japan), Machiko Minatoya (Japan), Keiko Kishi (Japan), Lesley Brennan (Canada), Antonio Pascale (Uruguay), Halshka Graczyk and Lydia Tempesta.

WHO Project coordination: Ruth A. Etzel and Marie-Noël Bruné Drisse (WHO)

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