

Don't pollute my future! THE IMPACT OF THE ENVIRONMENT ON CHILDREN'S HEALTH



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Introduction

In 2015, 5.9 million children under age five died (1). The major causes of child deaths globally are pneumonia, prematurity, intrapartum-related complications, neonatal sepsis, congenital anomalies, diarrhoea, injuries and malaria (2). Most of these diseases and conditions are at least partially caused by the environment. It was estimated in 2012 that **26% of childhood deaths and 25% of the total disease burden in children under five could be prevented through the reduction of environmental risks** such as air pollution, unsafe water, sanitation and inadequate hygiene or chemicals¹ (3).

Children are especially vulnerable to environmental threats due to their developing organs and immune systems, smaller bodies and airways. Harmful exposures can start as early as in utero. Furthermore, breastfeeding can be an important source of exposure to certain chemicals in infants (4, 5); this should, however, not discourage breastfeeding which carries numerous positive health and developmental effects (4). Proportionate to their size, children ingest more food, drink more water and breathe more air than adults. Additionally, certain modes of behaviour, such as putting hands and objects into the mouth and playing outdoors can increase children's exposure to environmental contaminants (6).

¹ Estimates based on a combination of Comparative Risk Assessments, evidence syntheses, epidemiological calculations and expert evaluation.

Children's health impacts from the environment by disease group

The following sections focus on the impacts of the environment in children under five years, although older children are also considered. Full details of attributable disease by age group are provided in Table 2.

Methods to quantify health impacts in children

The population attributable fraction (PAF) is the proportional reduction in death or disease that would occur if exposure to a risk was removed or maximally reduced to an alternative level. To quantify health impacts from environmental exposures, a systematic literature review compiled estimates and summaries of environmental exposure and links between the respective exposure and disease or injury. The preferred source was global estimates of population impacts based on comparative risk assessment (CRA), followed by estimates based on more limited epidemiological data or knowledge of the disease transmission pathway or, finally, expert opinion (see (3) for details).

In this document, disease burden is presented in disability adjusted life years (DALYs) which is a weighted measure of deaths and disability or, if specifically mentioned, of premature mortality.

Figure 1. Total disease burden (in DALYs) in children under five years attributable to the environment, by disease, 2012



Respiratory infections

Lower respiratory infections are among the largest causes of mortality in children, accounting for 16.5% of deaths in children under five in 2012 and 15.5% of deaths in 2015 (2, 7, 8). The most important environmental risks are **household air pollution** from exposure to smoke from cookstoves, **ambient air pollution** and **second-hand tobacco smoke** (8, 9). Household air pollution from the use of solid fuels for cooking and ambient air pollution together cause more than 50% of lower respiratory infections in children under five years in low- and middle

income countries. In high-income countries, where the exposure to air pollution tends to be smaller, 13% of lower respiratory infections are attributable to those factors. Also, upper respiratory infections, such as pharyngitis, laryngitis, sinusitis or otitis media, can be caused by environmental risks such as air pollution, second-hand tobacco smoke and housing-related risks like exposure to mould and crowding (10–17).

Globally, close to 570 000 deaths in children under five in 2012 from respiratory infections and 57% (44–67%) of the disease burden (in DALYs) of lower respiratory infections in children under five are attributable to the environment.

Box 1. Air pollution and children's health

Children around the globe are exposed to hazardous effects of air pollution. 92% of the global population, including billions of children, live in areas with ambient air pollution levels that exceed WHO limits. Over three billion people are exposed to household air pollution from the use of solid fuels.. Air pollution causes approximately 600 000 deaths in children under five years annually and increases the risk for respiratory infections, asthma, adverse neonatal conditions and congenital anomalies. Air pollution accounts for over 50% of the overall disease burden of pneumonia which is among the leading causes of global child mortality. Growing evidence suggests that air pollution adversely affects cognitive development in children and early exposures might induce development of chronic disease in adulthood (*2*, *8*, *18*, *19*).

Diarrhoeal diseases

Diarrhoeal diseases are among the main contributors to global child mortality, causing about 10% of all deaths in children under five years (2). Children in sub-Saharan Africa and South East Asia are most affected by diarrhoea. A large proportion of diarrhoeal diseases are caused by faecal-oral pathogens and can be prevented through safe and adequate **drinking-water**, **sanitation** and **hygiene** and ending **open defaecation** (20, 21). WHO recently estimated that 361 000 diarrhoea deaths in children under five years, representing more than 5% of all deaths in this age group in low- and middle income countries, could have been prevented through reduction of exposure to inadequate drinking-water, sanitation and hygiene (22).

In total, it is estimated that around 57% (36-75%) of the disease burden (in DALYs) from diarrhoeal diseases in children under five years is attributable to the environment.

Malaria

Malaria, the most important vector-borne disease globally, is transmitted by the bites of infected *Anopheles* mosquitoes. It is estimated that malaria caused over 300 000 deaths in children under five years in 2015, which represents about 70% of all malaria deaths (23). The larval stages of malaria-transmitting mosquitoes mostly share a preference for clean, unpolluted, stagnant or slowly moving fresh water (24). Many malaria cases can therefore be prevented through the **management of those water bodies**.

It is estimated that 42% (28-55%) of the global malaria burden (in DALYs) in children under five years could be prevented by environmental management with considerable differences between locations, based on an expert survey.

Dengue

Dengue fever is the most rapidly spreading mosquito-borne viral disease in the world with half of the world's population being at risk (25). The severe form of dengue can be life-threatening, especially in children. There is no specific treatment though a vaccine has now been licensed for endemic settings (25). **Rapid urbanization**, unreliable drinking-water supply services, increased population mobility, global trade and **climate change** are important determinants of the resurgence of the disease (26, 27). The vector, a daytime biter, breeds in clean water collections close to human dwellings. Interventions to prevent dengue comprise a range of environmental management measures, the provision of reliable piped water, mosquito-proofing of water containers, solid waste management and well-enforced urban building design regulations.

The global mean fraction of the disease burden (in DALYs) in children under five years due to dengue fever attributable to modifiable environmental conditions is estimated to be 95% (89–100%), based on an expert survey.



(Intestinal nematode infections/soil-transmitted helminth infections

Ascariasis, trichuriasis and ancylostomiasis/necatoriasis (roundworm, whipworm and hookworm disease, respectively) affect hundreds of millions children around the world (28). Infections of heavy intensity affect the physical growth and cognitive development of children, and are a cause of micronutrient deficiencies including iron-deficiency anaemia. These worms are transmitted when faeces that are contaminated with eggs contaminate the environment in areas with **poor sanitation**.

The fraction of the disease burden in children due to soil-transmitted helminth infections attributable to manageable environmental conditions is estimated to be 100% (29).

Tuberculosis

About one million children became ill with tuberculosis (TB) and 169 000 children under 15 years of age died in 2015 (30). Environmental risks for TB transmission include **poor housing** (especially crowding) and potentially indoor smoke from **solid fuels** and second-hand tobacco smoke (31–33). Malnutrition, itself related to environmental factors, increases the risk of TB progression and worsens the prognosis (34, 35).

Globally, 15% (4–29%) of the TB disease burden (in DALYs) in children under five years is attributed to environmental factors, based on an expert survey.

Schistosomiasis

Schistosomiasis can lead to long-term, irreversible health effects when left untreated. Transmission occurs through direct human contact with water contaminated by excreta of infectious humans. In children, who are often infected due to a **lack of hygiene** and to contact with infested water, the disease can cause anaemia, stunting and reduced ability to learn (*36*). The main modifiable environmental risks are inadequate sanitation and hygiene (*37*).

The global mean fraction of the disease burden (in DALYs) in children under five years due to schistosomiasis attributable to environmental conditions that can be managed is estimated to be 82% (71–92%), based on an expert survey.

Leishmaniasis

Leishmaniasis was responsible for 23 000 deaths in children 0 to 14 years in 2012 (2). It is an infectious disease caused by protozoans transmitted by sandflies. Three forms exist: visceral, cutaneous and mucocutaneous; the first being fatal when left untreated (38). Leishmaniasis is associated with **poverty**, malnutrition, population displacement, poor housing, a weak immune system and has been linked to environmental factors such as **climate change**, **deforestation**, **building of dams**, irrigation schemes and urbanization (38). Sandflies often live in the peri-domestic environment (39–41) and leishmaniasis can often be prevented by housing improvement, eliminating soil and wall cracks, and removing organic material close to homes (42).

Globally, according to an expert survey, the mean fraction of the leishmaniasis burden (in DALYs) in children under five years attributable to environmental conditions that can be managed is estimated to be 27% (9–40%), based on an expert survey.

Neonatal conditions

Neonatal conditions include low birth weight, prematurity, intrauterine growth restriction, stillbirth, neonatal sepsis and infection, birth asphyxia and trauma. Around 15 million preterm births occur each year and the rate of preterm births ranges from 5–18% across countries while the majority occur in low-income countries (43). Preterm birth complications are the leading cause of deaths in children and were responsible for nearly one million deaths in 2015 (43). Furthermore, preterm birth is associated with disease and disability throughout life. Other neonatal conditions lead to more than one million child deaths annually (2). Higher rates of adverse pregnancy outcomes were observed for mothers exposed to different environmental or occupational risks, like ambient air pollution (44–48), household air pollution (49–51) and second-hand tobacco smoke (45, 52). Further risks for unborn children include **chemicals** (45, 53–57) and **inadequate water**, **sanitation** and **hygiene** (58).

It is estimated that environmental causes accounted for 6% (1–11%) of the total disease burden (in DALYs) of neonatal conditions in children under five years in high-income countries, and for 11% (2–27%) in low-income countries (where exposures to environmental risks were estimated to be higher), based on an expert survey.

Box 2. Endocrine disrupting chemicals

Endocrine disrupting chemicals are a class of chemicals that are confirmed or suspected to disrupt the normal functioning of human and/or animal endocrine systems. Approximately 800 chemicals have been classified as known or suspected endocrine disruptors *(59)*. They are common in everyday products, such as **metal** food cans, **pesticides**, **food** and **cosmetics**. Similar to many other environmental exposures, humans are most sensitive to endocrine disruption during periods of rapid development, including in utero, early childhood and puberty *(59)*.

Although it is debated, there is evidence of an association between some endocrine disrupting chemicals, **low birth weight** and premature birth (45, 53–57, 60), limited evidence of an association with attention deficit disorder and autism (59, 61), and a possible association with cryptorchidism and hypospadias (3, 54, 62).

Protein-energy malnutrition

Globally, 156 million children under five years old were stunted in 2015 and 50 million were wasted (58). About 45% of all child deaths are linked to malnutrition (63) and malnourished children show poorer motor and cognitive development and educational outcomes (64). Environmental risks for malnutrition or food insecurity include **poor water**, **sanitation** and

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