Inheriting a sustainable world?

Atlas on children's health and the environment

World Health Organization

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Contents

Acronyms and abbreviations

ASGM	artisanal and small-scale gold mining
BPA	bisphenol A
CEH	children's environmental health
CT	computed tomography
DALY	disability-adjusted life years
DDT	dichlorodiphenlytrichloroethane
DEHP	di(2-ethylhexyl)phthalate
FAO	Food and Agriculture Organization of the United Nations
FCTC	Framework Convention on Tobacco Control (WHO)
GAPPD	Global Action Plan for the Prevention and Control of Pneumonia and Diarrhoea
GDP	gross domestic product
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
GNI	gross national income
HAP	household air pollution
HCF	health-care facility
HFC	hydrofluorocarbon
HIC	high-income country
iCCM	integrated community case management
ILO	International Labour Organization
IQ	intelligence quotient
ITN	Insecticide-treated net
IRS	indoor residual spraying
LMICs	low- and middle-income countries
LPG	liquefied petroleum gas
MDG	Millennium Development Goal
MICS	Multiple Indicator Cluster Surveys
NCD	noncommunicable disease
PACE	Partnership for Action on Computing Equipment
PAH	polycyclic aromatic hydrocarbon
PBDE	polybrominated diphenyl ether
PCB	polychlorinated biphenyl
PFOA	perfluorooctanoic acid
POP	persistent organic pollutant
PPE	personal protective equipment
SAICM	Strategic Approach to International Chemicals Management
SBS	sick building syndrome
SDG	Sustainable Development Goal
SE4All	Sustainable Energy for All
SHTS	second-hand tobacco smoke
SIDS	sudden infant death syndrome
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund

UV	ultraviolet
VOC	volatile organic compound
WASH	water, sanitation and hygiene
WHO	World Health Organization
WHOPES	WHO Pesticide Evaluation Scheme

Regions of the World Health Organization

AFR	African Region
AMR	Region of the Americas
EMR	Eastern Mediterranean Region
EUR	European Region
SEAR	South-East Asia Region
WPR	Western Pacific Region

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Preface

Children are exposed to many different environments that have a profound influence on their growth and development. Environmental exposures, both adverse and health-promoting, do not work in isolation but interact with social and nutritional determinants of health to influence children's health and well-being. Whatever the natural resources and level of economic development, for all countries and all communities, children represent the future – to be nurtured and protected. And as governments discuss sustainability in the face of growing populations requiring food, water, housing and other basic needs, investing in the health of children by reducing exposure to environmental risks has to be an overriding priority. Only in healthy environments do children have the potential to become healthy adults, capable of meeting the challenges of the future.

The beginning of 2016 marked the start of the Sustainable Development Goals (SDGs); 17 standards that provide a broad framework for economic, social and environmental development. Though we have achieved a substantial decline in early childhood deaths and a reduction in communicable diseases, more investment and action is needed to tackle the major challenge represented by environmental exposures. The SDGs emphasize that health is inextricably linked to factors such as poverty, inequity, climate change and pollution; it is our duty to overcome the structural failures of the past and act to address such factors now. Much of the environmental burden of disease on children is completely preventable – for example, by reducing obesogenic environments, improving water and sanitation, limiting pollution and safely disposing of chemical waste.

More than a decade after WHO published *Inheriting the world: The atlas of children's health and the environment* in 2004, this new publication presents the continuing and emerging challenges to children's environmental health. This new edition is not simply an update but a more detailed review; we take into account changes in the major environmental hazards to children's health over the last 13 years, due to increasing urbanization, industrialization, globalization and climate change, as well as efforts in the health sector to reduce children's environmental exposures. *Inheriting a sustainable world? Atlas on children's health and the environment* aligns with the Global Strategy for Women's, Children's and Adolescents' Health, launched in 2015, in stressing that every child deserves the opportunity to thrive, in safe and healthy settings.

In publishing this book, we seek to promote the importance of creating sustainable environments and reducing the exposure of children to modifiable environmental hazards. The wide scope of the SDGs offers a framework within which to work and improve the lives of all children. To this end, we encourage further data collection and tracking of progress on the SDGs, to show the current range of global environmental hazards to children's health and identify necessary action to ensure that no one is left behind.

The findings, challenges identified and priority actions specified within *Inheriting a sustainable world? Atlas on children's health and the environment* are directed at a wide audience:

- The general public, who should be empowered with knowledge of what they can do as individuals and as advocates for children's environmental health.
- Community officials, who would benefit from knowing the most relevant environmental hazards in their region.
- National and international policy-makers, who often know about relevant environmental hazards but may lack the information to prioritize them for action.

Today's health landscape is very different from that of a decade ago, and much greater investment in the interconnected environmental determinants of health is required to protect our children from preventable harm. Overall, we hope this publication will increase interest in and efforts towards protecting our children from environmental hazards locally, regionally and globally.

Maria Neira
Director
Department of Public Heath, Environmental and Social Determinants of Health
World Health Organization

Executive summary

In 2015, 26% of the deaths of 5.9 million children who died before reaching their fifth birthday could have been prevented through addressing environmental risks – a shocking missed opportunity. The prenatal and early childhood period represents a window of particular vulnerability, where environmental hazards can lead to premature birth and other complications, and increase lifelong disease risk including for respiratory disorders, cardiovascular disease and cancers. The environment thus represents a major factor in children's health, as well as a major opportunity for improvement, with effects seen in every region of the world.

Children are at the heart of the Sustainable Development Goals, because it is children who will inherit the legacy of policies and actions taken, and not taken, by leaders today. The third SDG, to "ensure healthy lives and promote well-being for all at all ages," has its foundation in children's environmental health, and it is incumbent on us to provide a healthy start to our children's lives. This cannot be achieved, however, without multisectoral cooperation, as seen in the linkages between environmental health risks to children and the other SDGs. This publication is divided by target: SDGs 1, 2 and 10 address equity and nutrition; SDG 6 focuses on water, sanitation and hygiene (WASH); SDGs 7 and 13 call attention to energy, air pollution and climate change; SDGs 3, 6 and 12 look at chemical exposures; and SDGs 8, 9 and 11 study infrastructure and settings.

Known and emerging threats

The groupings highlight the problems – both "traditional" issues that have long plagued us, especially in developing regions, and "emerging" issues of growing concern, which are largely products of the industrialized world.

Traditional hazards include air pollution, water, sanitation and vector-borne diseases. Each year, household air pollution causes 531 000 deaths of children under five, as well as chronic respiratory infections, lung disease, cancer and other health effects. Children who must travel long distances to collect wood for cooking and heating are vulnerable to attack and injury, before returning to poorly ventilated homes polluted by inefficient burning of fuels.

In 2012, 361 000 child deaths due to diarrhoea could have been prevented by improved access to clean water, sanitation and hygiene. Ten per cent of the world lacks access to improved drinking-water, and one third are without improved sanitation facilities. Children who spend much of their time living and playing around unsafe water are at high risk of recurring intestinal diseases, which hinder growth and development.

Vector-borne diseases constitute another major cause of death for children under five – a child dies from malaria every two minutes, and 306 000 children died from the disease in 2015.

Another category of threat to children's health is emerging environmental hazards, including chemicals, electronic waste and climate change. The toxicity of many chemicals in common use is not well understood. The regulatory requirements for chemicals, where safety testing must be conducted by manufacturers and the results assessed by regulators, may be limited for some types and uses of chemicals. Chemicals from pesticides, plastics, and other manufactured goods, as well as from environmental contamination, eventually find their way into the food chain. These include arsenic, fluoride, lead, mercury, polybrominated diphenyl ethers, polychlorinated biphenyls and persistent organic pollutants, among others. Of particular concern are endocrine disrupting chemicals, which may leach into food from certain kinds of packaging and have been linked with liver, thyroid and neurodevelopmental effects. Their effects may be especially damaging to children, whose bodies are still developing.

Electronic waste, or e-waste, is another growing concern, as unsafely discarded e-waste that is handled by children exposes them to a myriad of chemicals and toxicants, many of which are associated with reduced intelligence, attention deficits, lung damage and cancer.

Climate change, caused by burning fossil fuels, is one of the greatest new threats to children's environmental health. Higher temperatures and higher levels of atmospheric carbon dioxide favouring pollen growth are associated with increased rates of asthma. Extension of disease vector ranges will increase children's risk of contracting infectious diseases. Disruption to fresh water supplies and food crop harvests will exacerbate malnutrition and stunting. More frequent heat waves will put children at risk of heat stress, renal disease and respiratory illness.

Time to act – reducing environmental risks to improve child health

The beginning of the SDG era is a great global opportunity for putting renewed focus on children's environmental health. Taking stock of both traditional and emerging environmental hazards to children's health, we can seize this chance to increase our efforts in the battles against air pollution and water issues, as well as take a precautionary approach to protecting children from the effects of chemicals, building healthy surroundings and curbing climate change. The SDG framework emphasizes the multifaceted nature of these challenges, and the intersectoral collaboration that will be required to address these preventable environmental risks, for the sake of our children's health.

The scope of environmental hazards is global, affecting the developing and developed world alike. However, unfortunately, much of the burden of disease falls on low- and middle-income countries (LMICs), which are subject to many traditional environmental hazards. Children in Africa, without access to healthy home energy, bear the brunt of air pollution-related illness. They are also the victims of more than 95% of the under-five deaths due to malaria. Likewise, regions with the least access to water, sanitation and hygiene include sub-Saharan Africa, where only 16% of people have access to piped water in their homes, and southern Asia, where more than 610 million people resort to open defecation (WHO, UNICEF, 2015). This division also runs along urban-rural lines, with 79% of the population without access to improved water sources, and around 70% of the population using unimproved sanitation facilities, living in rural areas (WHO, UNICEF, 2015)

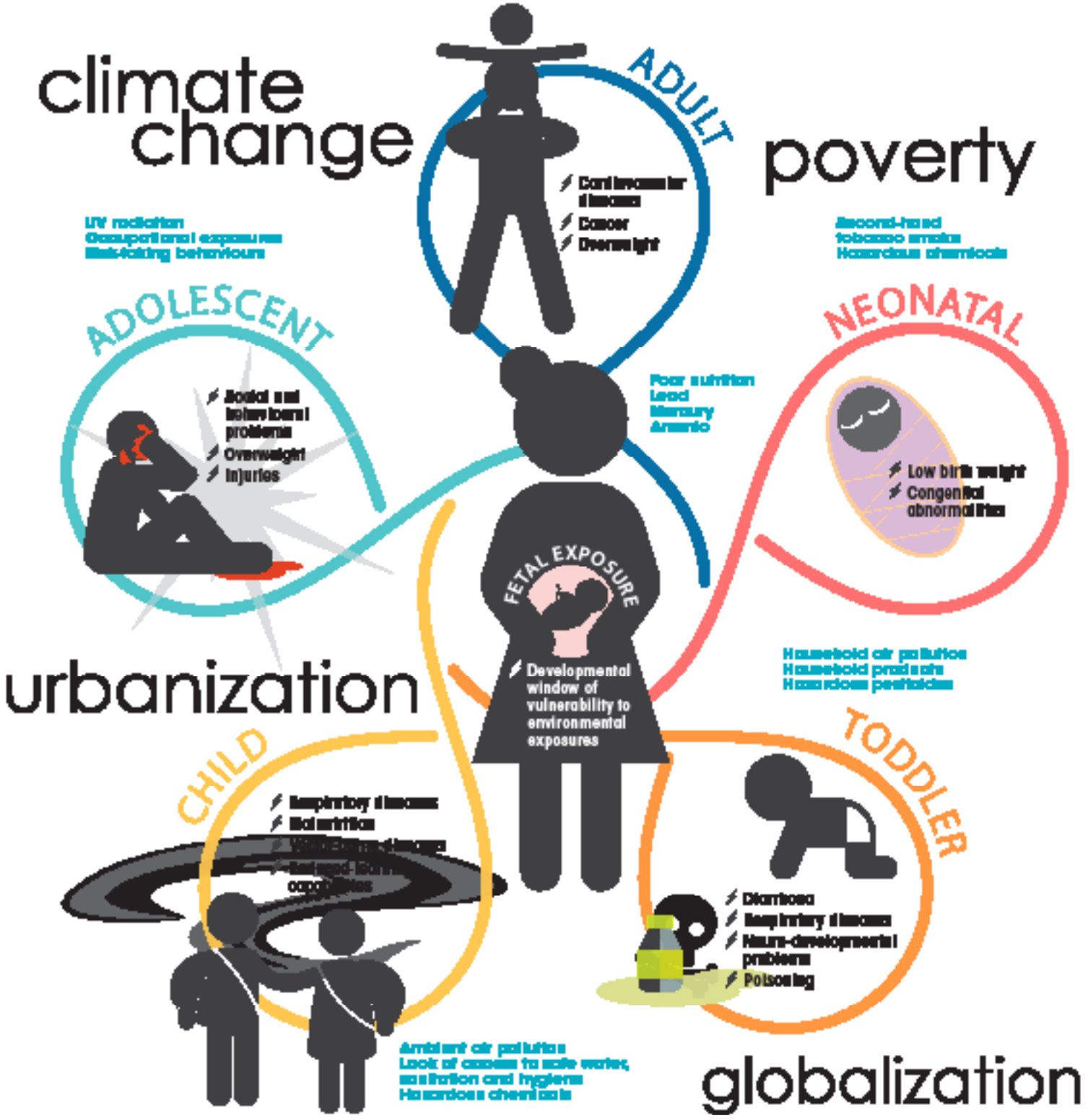
E-waste, coming largely from high-income countries, is often shipped to LMICs. Valuable parts are often extracted by burning and with acid – this is sometimes done by children, whose small hands can handle tiny parts. While the burden falls mostly on children in developing regions, this is a global issue for which the producers of e-waste across the world are responsible. Finally, children in every country are exposed to chemicals through food, water and household products, which may lead to lasting health effects later in life. Similarly, climate change is a global catastrophe. While children from low-income populations living in marginal areas are most susceptible to floods and drought, the effects of ambient air pollution, increased global temperatures, and changing disease vector ranges have the potential to affect everyone. By the time these repercussions are felt, damage to children's environmental health will already be widespread; it is imperative that preventive action be taken immediately to preclude these harms to our children.

Much needs to be done to successfully avoid the effects of environmental hazards on children's health. Progress has been made, as seen with the near universal elimination of lead in petrol, its phasing out in paint in many countries, the adoption of the Minamata Convention on Mercury restricting mercury and its devastating health effects, as well as major advances in water and sanitation access and reductions in child mortality. Still, there is much ground to cover.

Interventions that provide affordable, clean energy sources, such as liquefied petroleum gas, biogas and ethanol, are only feasible with intersectoral collaboration between the health, environment and energy sectors, among others. Multisectoral action between water management, hygiene education and the health sector can prevent major killers, including diarrhoea. Water and vegetation management, and modification of human habitation to reduce vector contact can reduce the risk of contracting malaria. Known, effective interventions for these traditional environmental hazards are low-hanging fruit – immediate investments that will result in major health benefits for children.

A life in health: The effects of environmental hazards

Children are exposed to a variety of hazards from the environments in which they live, learn, work and play. Children are especially vulnerable to these exposures because of their developing systems and behaviours. Environmental exposures in early life can have immediate effects or build over time to increase disease risk later in life. Exposure starts early – in the womb, and can have effects throughout life.



Reducing environmental risks could prevent a quarter of childhood deaths and disease

Source: Prüss-Ustün et al, 2016.

With respect to emerging issues, there is a precious opportunity to intervene today, to prevent future effects of improperly handled e-waste, unsafe chemical usage and increasing levels of ambient air pollution. Our failure to evaluate chemical effects and to curb climate change due to short-term economic interests directly harms our children's futures.

Now is the time to take action and become involved in healthy urban planning, avoiding harmful exposures at home. SDG 11, sustainable cities, is an opportunity to develop better urban design, and to reduce the exposure of children to environmental risk factors. SDG 12 highlights the action we can take to provide environmentally sound management of chemicals and waste, preventing them from reaching children. And SDG 13 urges us to take action to combat climate change, a chance to avert the catastrophic effects to children's health that environmental degradation will bring.

Since *Inheriting the world: The atlas of children's health and the environment, 2004*, and the Millennium Development Goal era …

Child mortality has been halved, from 12.7 million under five deaths in 1990 to 5.9 million in 2015.

The proportion of **underweight** children dropped from 25% in 1990 to 14% in 2015, but in 2015, 156 million children under five were stunted and 50 million wasted. At the same time, **obesity** is rising rapidly.

In 2015, 91% of the global population used an **improved drinking-water** source, compared with 76% in 1990. 2.6 billion people have gained access to improved water in this time.

Since 1990, 2.1 billion people have gained access to **improved sanitation**, and the proportion of people practising **open defecation** has been reduced almost by half. **Diarrhoeal disease-caused deaths** in children under five have fallen from 1.2 million in 2000 to 526 000 in 2015.

From 2000 to 2015, the number of **malaria deaths** in children under five has declined by 58%, both globally and in the WHO Africa Region. The proportion of children under five sleeping under **insecticide-treated nets** in sub-Saharan Africa has increased from 2% in 2000 to 68% in 2015.

Lead has been removed from most petrol, with the number of countries using leaded petrol for vehicles dropping from 82 in 2002 to only 3 in 2016. 62 countries have now begun to phase out lead in paint (as of June 2016).

The SDGs provide the stimulus and the opportunity to reshape our world and create a sustainable future for our children – one in which they can reach their fullest potential. With collaboration between multiple sectors, we have the ability to end preventable child deaths from environmental health risks. Here, as clearly evidenced in *Inheriting a sustainable world? Atlas on children's health and the environment,* there is a leading role for children's environmental health in championing interventions for both traditional and emerging issues to build a healthier world in which all of our children can survive, grow and thrive.

In 2013, a new convention addressing **mercury** exposures was signed (the Minamata Convention).

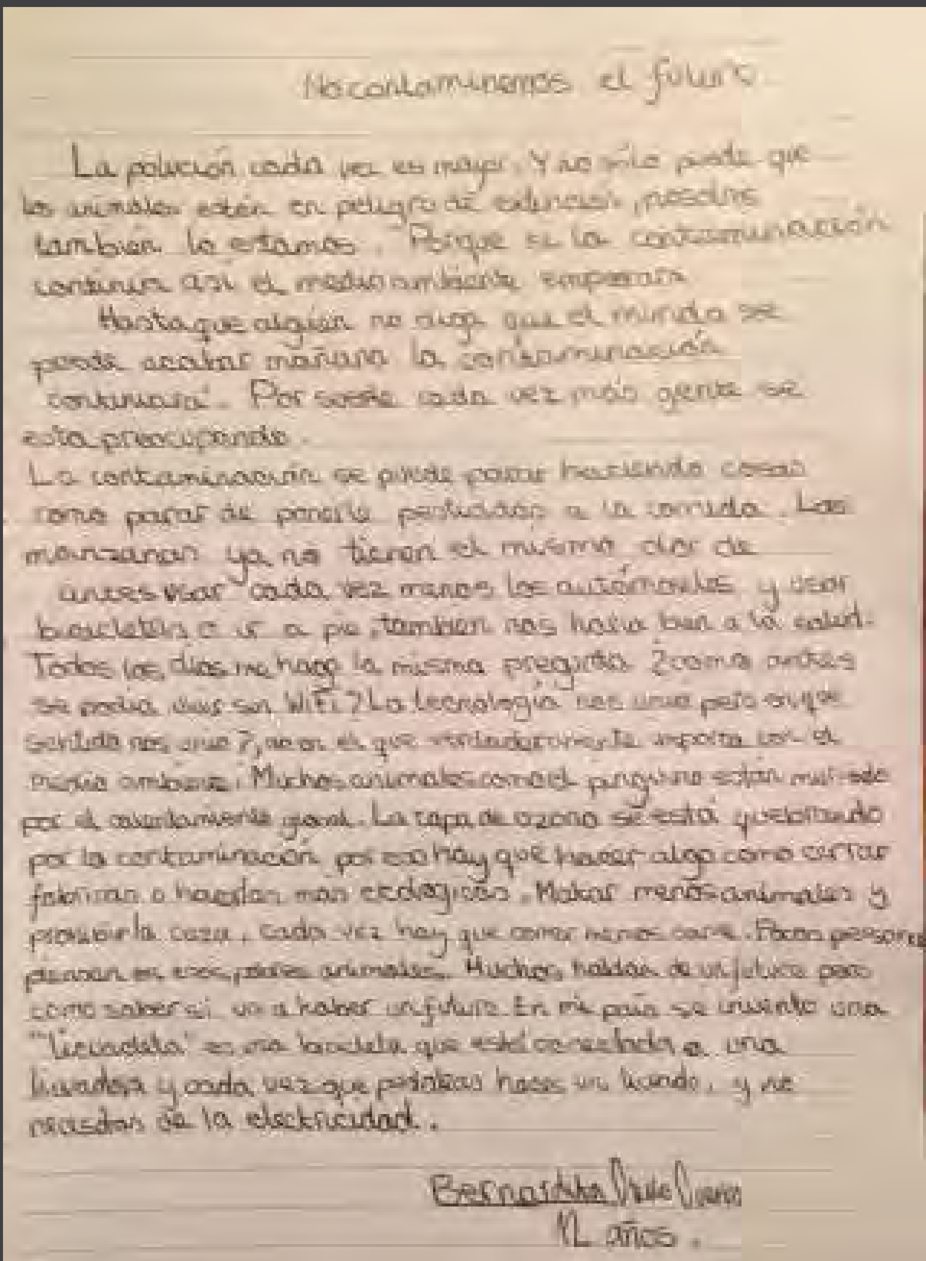
Some 40% of the world population is covered by at least one **tobacco control** measure.

E-waste is the fastest growing waste stream, expected to increase by 19% between 2014 and 2018.

There has been a decline in infectious disease, and a shift to **non-communicable diseases (NCDs)**. Environment-attributable child mortality in the communicable and neonatal categories has decreased, but high rates of NCDs attributable to the environment are found worldwide.

As many NCDs develop in later life this shift has been more obvious for adults and older people but exposures during gestation and early childhood have been linked to the development of NCDs including obesity, type 2 diabetes and thyroid disease in adulthood.

Don't pollute my future

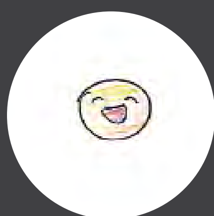

No contaminemos el futuro

La polución cada vez es mayor. Y no sólo puede que los animales estén en peligro de extinción, nosotros también lo estamos. Porque si la contaminación continúa así el medio ambiente empeorará.

Hasta que alguien no diga que el mundo se puede acabar mañana la contaminación continuará. Por suerte cada vez más gente se está preocupando.

La contaminación se puede parar haciendo cosas como parar de ponerle pesticidas a la comida. Las manzanas ya no tienen el mismo olor de antes. Usar cada vez menos los automóviles y usar bicicletas o ir a pie, también nos hace bien a la salud. Todos los días me hago la misma pregunta ¿cómo antes se podía vivir sin WiFi? La tecnología nos une pero ¿en qué sentido nos une?, no es lo que verdaderamente importa con el medio ambiente. Muchos animales como el pingüino están muriendo por el calentamiento global. La capa de ozono se está quebrando por la contaminación, por eso hay que hacer algo como cerrar fábricas o hacerlas más ecológicas. Matar menos animales y prohibir la caza, cada vez hay que comer menos carne. Pocas personas piensan en esos pobres animales. Muchos hablan de un futuro pero cómo saber si va a haber un futuro. En mi país se inventó una "licuadeta" es una bicicleta que está conectada a una licuadora y cada vez que pedaleas haces un licuado, y no necesitas de la electricidad.

Bernardita
12 años.



Don't pollute my future

The environment and child health — Improve one, improve the other: Steps towards SDGs 1, 2 and 10

Part 1

The environment and child health — Improve one, improve the other: Steps towards SDGs 1, 2 and 10

Child mortality:
Increasing a chance at life

The poor quality of health-care facilities (HCFs) is impacting lives in many countries – for those in the developed world it is inconceivable to imagine visiting health facilities that don't have basics such as electricity, safe water supplies and adequate sanitation. Yet this is the case in LMICs where many maternal and child deaths could be avoided if women and children had better access to good quality health services, particularly during pregnancy, childbirth and the first few months of life.

Preterm and newborn deaths

Despite improving statistics, each year 2.7 million babies still die in their first month of life and another 2.6 million are stillborn (UNICEF, WHO, World Bank, UN-DESA Population Division, 2015; Blencowe et al, 2016). Premature birth greatly increases the risk of infant mortality and can lead to long-term health problems (Prüss-Ustün et al, 2016). Occupational exposures, some chemicals and air pollution exposure are known to increase the risks of premature birth (Ferguson et al, 2013). Medical care by a skilled health-care worker before, during and after birth, access to high quality health-care facilities (HCFs) in case of health problems, hygiene education and exclusive breastfeeding are crucial for children to survive the first month of life (WHO, 2016b). Newborn and maternal mortality are closely linked, and interventions to improve the health of infants should also consider the health of their mothers (Were et al, 2015). Shockingly, but also promisingly, two thirds of these newborn deaths are preventable (WHO, 2016b).

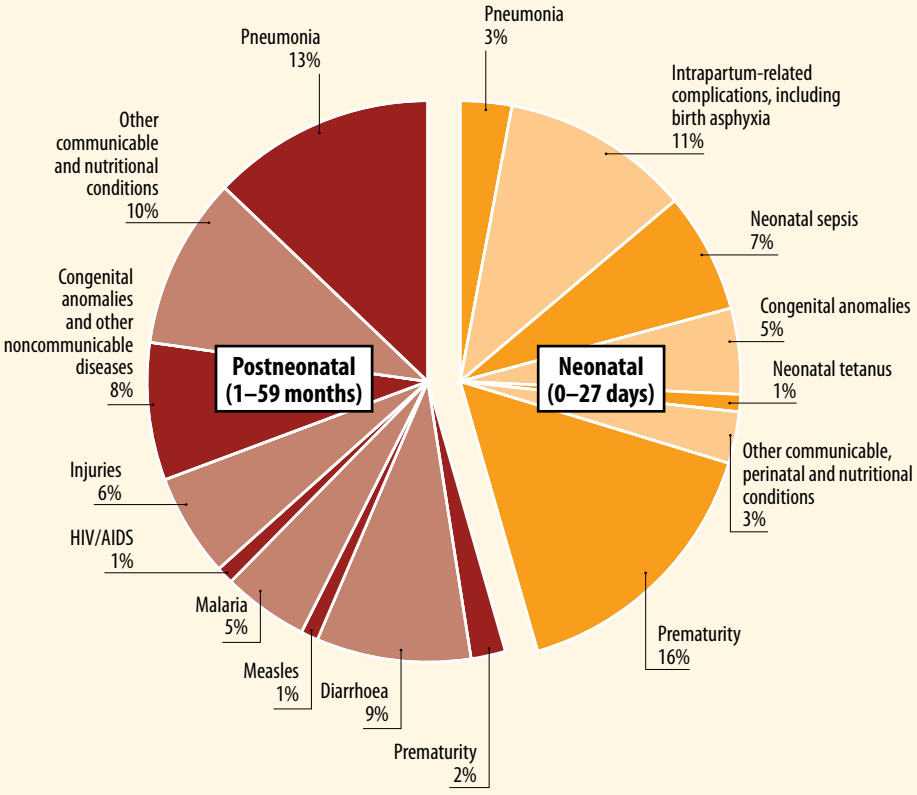
Key fact

An estimated 113 000 maternal deaths, 531 000 still births and 1.3 million neonatal deaths could be saved by 2020 if HCFs were improved (Bhutta et al, 2014).

Infant and child deaths

The largest contributors to under-five mortality are preterm birth complications, intrapartum-related complications, congenital anomalies, pneumonia, diarrhoea and malaria (WHO, 2015). Children in disadvantaged areas are particularly at risk because of: poor access to HCFs and to safe water, sanitation and hygiene; exposure to household air pollution; injuries; substandard housing; limited access to nutritious food, and many other factors. All these factors could be improved, resulting in far fewer deaths. Complicating the challenge of improving infant and child health is the shift occurring from

Causes of deaths among children under five years, 2015



communicable to non-communicable diseases as major causes of childhood morbidity. There is growing evidence that early life exposure to environmental hazards can lead to NCDs in adulthood (Barouki et al, 2012). As an example, arsenic exposure, especially during critical windows of vulnerability and development in early life may not develop into cancer or respiratory disease until adulthood (Smith et al, 2012).

SDGs and international initiatives

By virtue of their intersectoral and integrated approach, the Sustainable Development Goals (SDGs) provide an excellent opportunity to further reduce infant and child mortality. SDG Target 3.2, "by 2030, end preventable deaths of newborns and children under five years of age", means reducing child mortality to fewer than 25 deaths per 1000 children (UN, 2015). This is closely related to Target 3.1, "by 2030, reduce the global maternal mortality ratio to less than 70 per 100 000 live births", and Target 2.2, "by 2030, end malnutrition" (UN, 2015). Attention to SDGs outside of SDG 3 will also be required to address the major causes of child mortality: reducing diarrhoea depends on clean water, sanitation and hygiene (SDG 6); pneumonia and other respiratory illnesses must be addressed with reductions in air pollution and adoption of clean energy (SDG 7); road traffic injuries can be avoided with protective urban planning (SDG 11). Integrated action on determinants of children's environmental health will be crucial to reducing preventable child mortality.

To achieve these related targets, WHO and partners have launched a Global Strategy for Women's, Children's and Adolescents' Health (WHO, 2016c). The aim of this strategy is, by 2030, to achieve a world in which every woman, child and adolescent realizes their rights to physical and mental health and well-being, has social and economic opportunities, and is able to participate fully in shaping prosperous and sustainable societies. The markers of this vision will be:

- Surviving – ending preventable deaths
- Thriving – ensuring health and well-being
- Transforming – expanding enabling environments.

Other global initiatives to achieve SDG 3.2 include programmes to provide maternal and infant care by skilled health professionals, a Global Action Plan for the Prevention and Control of Pneumonia and Diarrhoea, a Comprehensive Implementation Plan on Maternal, Infant and Young Child Nutrition, a Global Technical Strategy for Malaria to reduce global malaria case incidence and mortality by 2030, and a Global Vaccine Action Plan (WHO, 2016a).

Policy action priorities

The unfinished agenda of the MDGs to eliminate preventable child mortality should remain a priority, with a focus on those countries and populations in greatest need. If they continue at their current rate, 47 countries will not achieve the SDG target to reduce child mortality to 25 deaths per 1000 live births by 2030 (UNICEF, WHO, World Bank, UN-DESA Population Division, 2015). Three quarters of these countries are in sub-Saharan Africa – Chad, Angola, Central African Republic, Sierra Leone and Somalia continue to have the highest rates of child mortality (UNICEF, WHO, World Bank, UN-DESA Population Division, 2015). At the same time, increased attention should be given to emerging child health priorities, in particular NCDs, congenital anomalies and child injuries. To work towards this, multisectorial action, as emphasized in the SDGs, will be key to ensuring the following policy action priorities:

- Providing universal access to safe, affordable and sustainable drinking-water.
- Investing in improved sanitation facilities and hygiene measures, including handwashing with soap, and implementation of sanitation safety plans.
- Reducing household air pollution through increased use of clean home energy fuels and technologies.
- Decreasing ambient air pollution with renewable power generation, energy-efficient construction, and lower emissions.
- Increasing access to electricity with new infrastructure development for energy access in communities with high mortality burden, including health facilities.
- Prioritizing measures to enhance food security for the family (or mother and child) in communities with high mortality burden.
- Improving maternal education.
- Including health education in schools (Were et al, 2015; Kumanan et al, 2015).

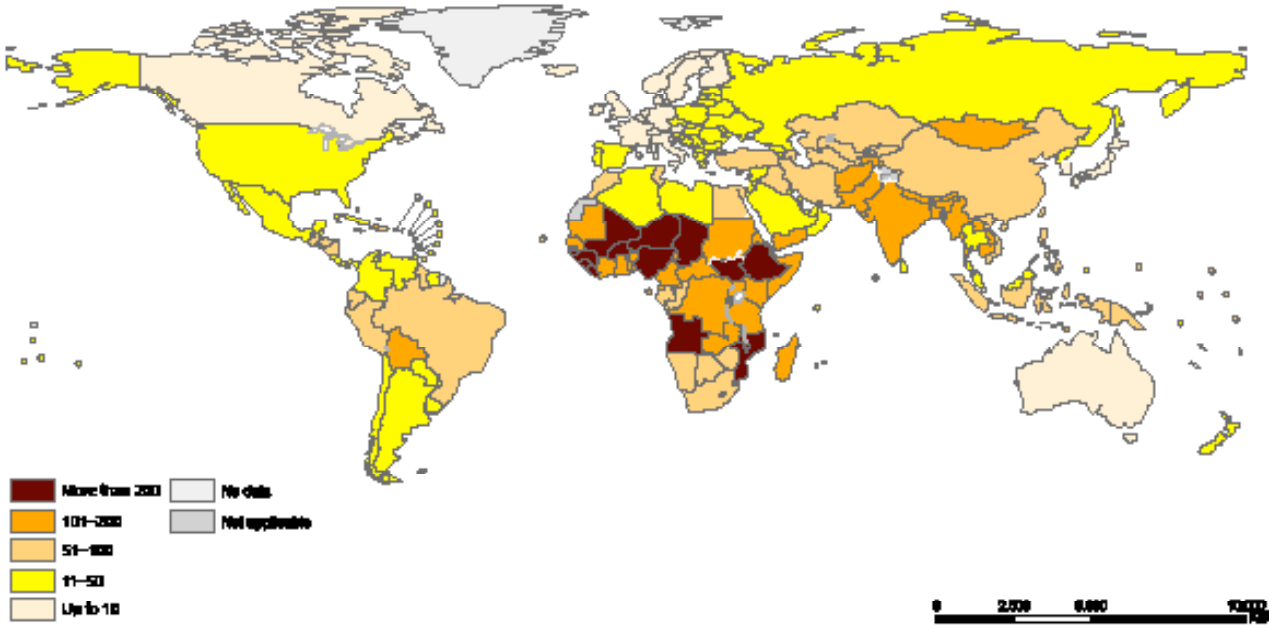
“Children are one third of our population and all of our future.”

Select Panel for the Promotion of Child Health, United States of America, 1981

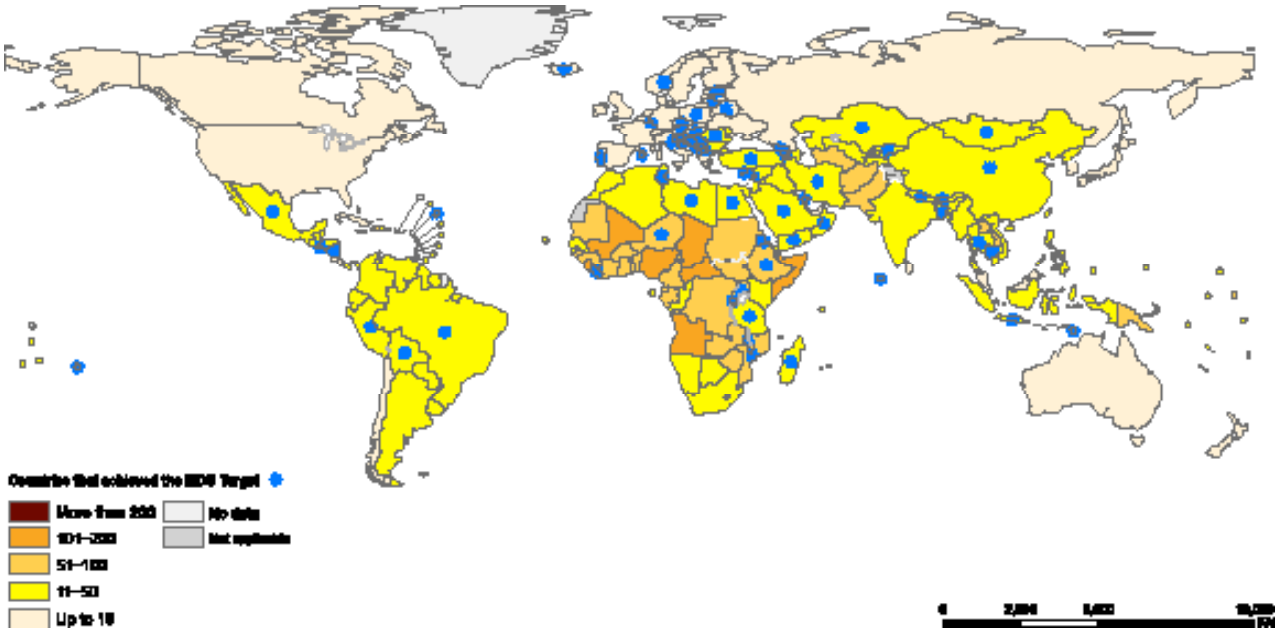
Community health workers help Ethiopia cut child mortality by two thirds

In 1990, Ethiopia’s under-five mortality was one of the world’s highest at 205 deaths per 1000 live births (UNICEF, WHO, World Bank, UN-DESA Population Division, 2015). By 2015, child mortality had been reduced to 59 deaths per 1000 live births, an impressive 71% decrease, led by the Ethiopian Government. Its Health Extension Programme has trained 38 000 mostly female health extension workers in integrated community case management (iCCM) to treat common childhood illnesses, and to provide immunization, latrine-making skills, family planning and coordination with health development armies made up of influential community members. Along with more than 3245 new health centres built between 2000 and 2014, with a total of 16 000 health posts in the country offering free preventive and primary care services with expanded iCCM services, increasing access to care has significantly improved the health of children across the country through better provision of treatment and prevention, especially in rural regions (Schmalzbach, 2014). Building on these improvements, the Ethiopian Government is continuing the fight against child mortality, most recently with the introduction of a national maternal, newborn and child heath score card, updated quarterly based on frequent monitoring and reporting, providing accountability and motivation for the effort to improve children’s health (UNICEF, 2014).

Under-five mortality rate (probability of dying by age 5 per 1000 live births), 1990



Under-five mortality rate (probability of dying by age 5 per 1000 live births), 2015

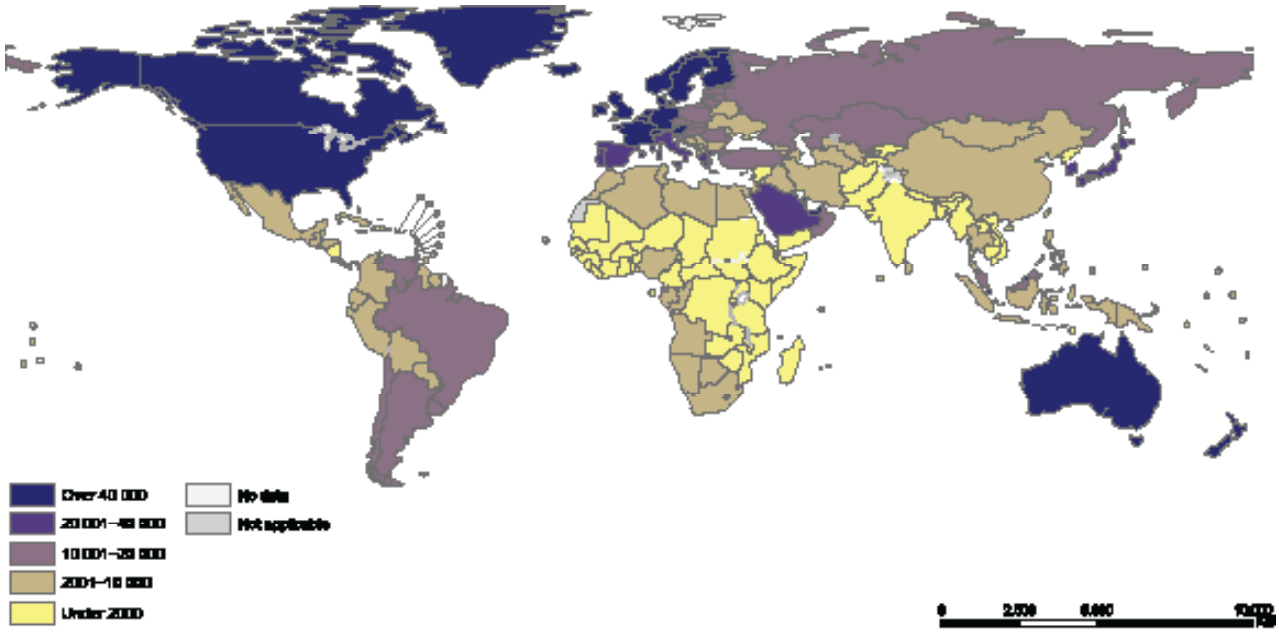


Inequity: Reducing the health divide

Few would deny that living on a very low income, such as less than US$ 2 a day, is a definition of poverty. However, financial deprivation is rarely experienced in isolation. It is often combined and associated with other forms of socioeconomic deprivation such as inequalities in access to good quality housing, adequate sanitation, clean and sufficient energy, and health services. Moreover, such social discrepancies in health are evident throughout the world – between countries, regions, and even neighbourhoods.

Similarly, environmental risks are not distributed equally, with the poorest communities often facing the biggest risks to their health from the environment. The consequences from such divides in socioeconomic and environmental health are often felt disproportionately by children. Targeted interventions to reduce poverty can increase learning ability and employment prospects, increase household savings, and lead to a better quality of life, thereby contributing not only to the fight against poverty but also to improvements in children's health.

Per capita gross national income (GNI) at current prices in US dollars, 2014



The social gradient in health

There is ample evidence to show that children living in poorer circumstances experience poorer health. A newborn's life expectancy in Japan (high-income country) is 84 years, whereas it is 46 years in Sierra Leone (low-income country) (WHO, 2015a). This 38-year gap demonstrates the dramatic and unfair inequalities in health outcomes between countries. Moreover, strong differences in children's health also exist within countries and even between neighbourhoods of the same city; a fact closely associated with the socioeconomic status of the family. The higher a family's social standing, the better the offspring's health (the "social gradient"). Children in the poorest 20% of urban households are at least twice as likely to die during childhood, compared with those in the richest 20% of urban households (WHO, 2015b).

However, children's health inequalities extend far beyond socioeconomic deprivation and relate to a number of overlapping deprivations – all suffered concurrently. If you are poor, you are more likely to live in sub-standard housing with limited or no access to clean electricity, sanitation, safe drinking-water, clean cooking and heating methods, and experience low education (UNDP, 2015).

Poverty, relative deprivation and social exclusion have a major impact on health and premature death, and the chances of living in poverty are loaded heavily against some social groups. At the highest risk are the unemployed,

homeless people and their children, refugees, many ethnic minority groups, guest workers and the disabled. People living on the streets suffer the highest rates of premature death (WHO EURO, 2003).

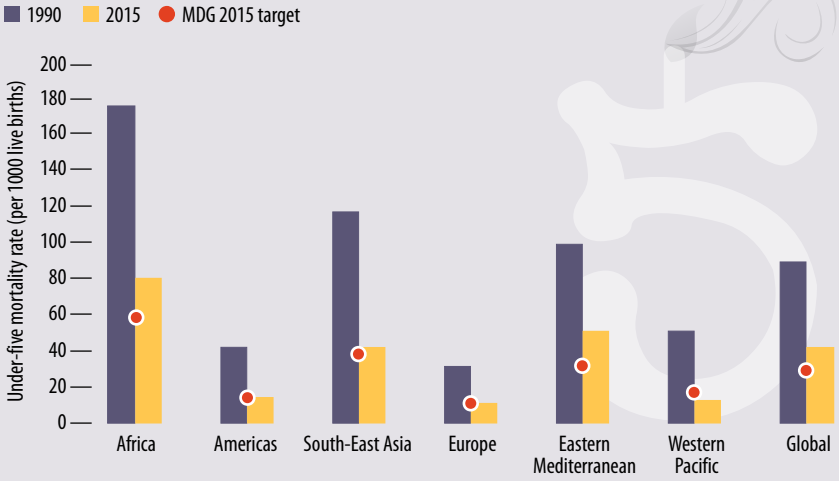
Persistent child health inequalities are also associated with poorer coverage of essential health services. In the regions and countries with the highest mortality rates, access to services is typically low. For instance, one million children developed tuberculosis in 2014, with the burden highest in countries with health systems least able to treat these children (WHO, 2015d), adding to the inequitable burden of child mortality. It is clear that tackling socioeconomic inequality and promoting environmental justice are crucial to reducing environmental risks for all children.

Environmental risks – unequally distributed

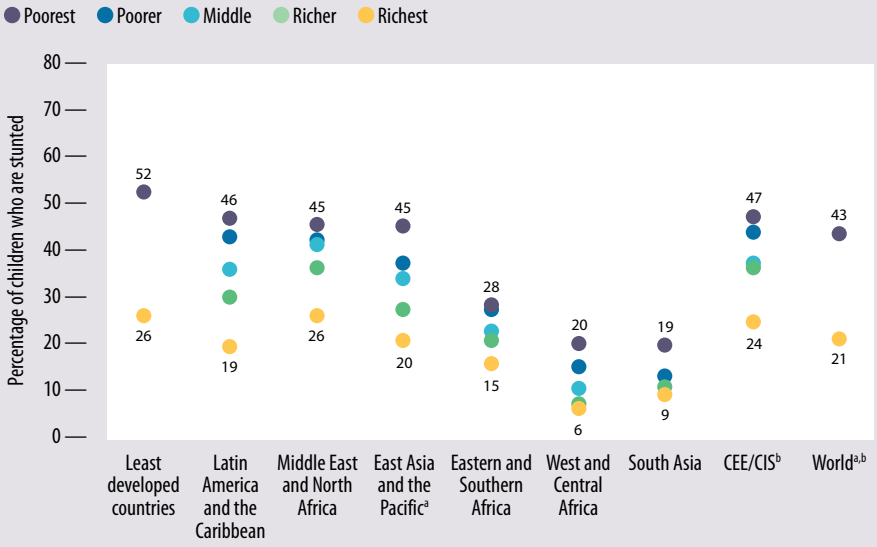
In LMICs, environmental risks are concentrated among the poorest settlements, where housing is inadequate, water and sanitation are lacking, rubbish collection is missing and smoke contaminates indoor air. Similarly, in high-income countries (HICs), socioeconomically deprived neighbourhoods are more commonly located near hazardous waste sites or polluting industries (National Research Council, 2001; Kohlhuber et al, 2006).

These social and environmental conditions increase the risks of both communicable and NCDs, particularly in children. For example, low water and sanitation standards directly impact infectious disease transmission, such as gastrointestinal diseases, whereas air pollution has an impact on respiratory diseases. Disparities within countries are evident, as for example, globally, 51% of rural populations have access to improved sanitation facilities versus 82% of urban inhabitants (UNICEF, WHO, 2015). Even within the same city, the urban poor face risks that may be very different from their wealthier peers.

Global and regional under-five mortality trends, 1990–2015, and gap in achieving the MDG 4 target

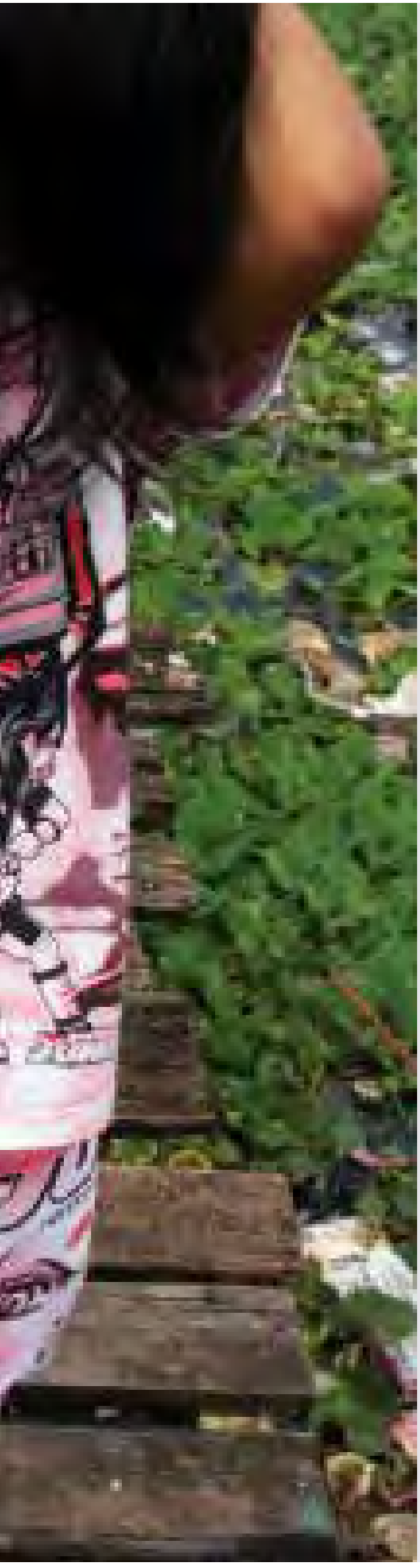


Percentage of children under five who are stunted, by wealth quintile and by region, 2015



Notes: [a]Excludes China; [b]Excludes Russian Federation. Analysis based on a subset of 87 countries with available data by wealth quintile groupings; regional estimates represent data from countries covering at least half of the regional population. Data are from 2008 to 2014, except for Brazil (2006). Note that these averages are not comparable to the "total" regional and global values generated through the Joint Malnutrition Estimates of UNICEF, WHO and the World Bank.

> "If you are poor, you are not likely to live long."
>
> Nelson Mandela



Policy action priorities

Improving child health requires health systems to be strengthened through long-term investment, such as the development of sustainable health facility infrastructure and quality health worker training programmes. But there is also a need to progress beyond developing health systems and relieving poverty, to take action on the social determinants of health to reduce inequalities in health across the world. Such actions both relieve poverty and improve the circumstances in which people live and work. They address not only the major infectious diseases linked with poverty but also NCDs.

The SDGs represent a major opportunity to address inequalities in children's health. Specifically, SDG 1 targets poverty, and SDG 10 is a call to reduce inequality within and among countries. Socioeconomic inequalities are major determinants of inequities in children's environmental health, and must be addressed in order to reduce environmental hazards to children. But addressing health inequalities means addressing health through all the SDGs, creating healthier living conditions based on sound economic development, social equity and environmental protection. Adopting a "Health in All Policies" approach provides an important opportunity for primary prevention and requires going beyond the goals of SDG 3.

Europe 2020

The coordinated, intersectoral approach championed by the SDGs is reflected in Europe 2020 – the European Union's 10-year economic growth strategy which emphasizes the importance of promoting a healthier EU. The project's fundamental aim is two-fold – poverty alleviation for 20 million people, and, crucially, an improvement in their social inclusion in terms of access to services. Five priority areas are focused on: employment, innovation, education, poverty reduction and climate/energy. National targets have been adopted by each member state in all five sectors. Concrete actions at EU and national levels underpin the strategy. The approach includes need-based welfare support, including antipoverty cash transfers, social insurance and facilities for emergency relief. Europe 2020 also includes interventions to reduce the exposure of poor children to environmental health risks and highlights intersectoral opportunities to address determinants of children's health inequalities (European Commission, 2016).

Oportunidades in Mexico

Oportunidades is an antipoverty programme that provides cash to low-income families in Mexico, which has considerably improved the physical and cognitive development of children. The project aids more than 5 million families. Around 70% of these families live in rural areas, 16% are in semi-urban areas, and the 14% live in urban areas. The programme has reduced inequalities in children's health and improved the health of the most vulnerable children (Fernald, 2008; Figueroa, 2014; World Bank, 2014).

Equity in European maternal and child health programmes

Lack of registration/ID cards, discrimination based on ethnicity, financial access barriers, limited service opening hours and insufficiency of local health personnel are a few of the difficulties faced by Roma and other marginalized populations seeking maternal and child health services. WHO is collaborating with multidisciplinary review teams from Albania, Kosovo, Romania, Slovakia and Ukraine to assess inequities faced by these groups and their sources, and to identify potential solutions. Focusing on the equity, social determinants, gender and human rights, they used a step-wise approach to close coverage gaps for marginalized populations through improved national maternal and child health programmes (WHO, 2015c).

Overweight and stunting: Getting the balance right

Astonishing as it may seem, nutritional problems leading to child stunting and overweight can exist side by side within the same country, the same community and even the same household. These two extremes of child height and weight are influenced by the quality of the environment. The causes of childhood stunting and wasting, and childhood overweight and obesity are complex and include maternal factors, nutrient intake, physical activity including safe and healthy environments, water, sanitation and hygiene, food safety and infectious diseases.

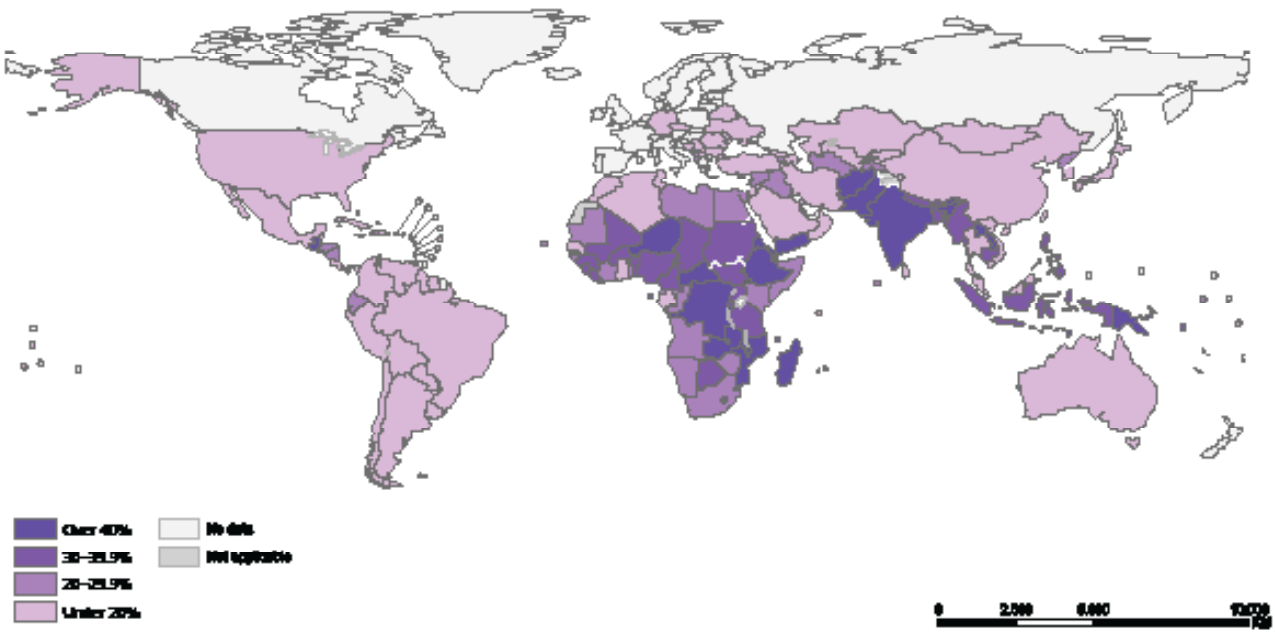
Key facts

- The proportion of underweight children under age five globally has dropped from 25% in 1990 to 14% in 2015; a rate close to the MDG target (WHO, 2015a). However, in 2015, 156 million children under five years of age were stunted, and 50 million children were-wasted (UNICEF, WHO, World Bank, 2016).
- 56% of children under five years of age who are stunted live in Asia, while 37% of stunted children under age five live in Africa (UNICEF, WHO, World Bank, 2016).

Stunting

A child who has a low height for their age is considered to be stunted, whereas a child with a low weight for their height is considered to be wasted (WHO, UNICEF, USAID, 2015). Stunted growth is primarily caused by prolonged insufficient caloric intake or other nutritional deficiencies, which may in turn be the result of poverty, poor agricultural productivity, environmental degradation or climate change (WHO, 2016a). Breastfeeding is of crucial importance in avoiding this health problem (see *Contaminated food: Getting the right start in life*). The first 1000 days of a child's life are critical. Maternal and childhood exposures can impact growth and even have intergenerational effects. Diarrhoeal diseases prevent absorption of nutrients, hindering weight gain, which in turn makes children even more susceptible to diarrhoeal diseases (WHO, 2015c). In addition to diarrhoeal diseases, water, sanitation and hygiene conditions can affect nutrition through intestinal parasitic infections and other common intestinal infections.

Percentage of children age 0–59 months who are stunted



Of all deaths in the under-five age group, 45% are linked to undernutrition (Black et al, 2013). Poor nutrition and stunting have both immediate and longer term effects on children's health and well-being. In addition to poor physical growth, children with stunted growth have an increased risk of neurodevelopmental effects and are more susceptible to infections (Stewart et al, 2013). Stunting can also impact intellectual development and learning capacity, affecting school and work performance. These children often remain shorter than their peers and have an increased risk of becoming overweight as they grow older (Black et al, 2013; Stewart et al, 2013). This in turn leads to an increased risk of nutrition-related chronic diseases such as diabetes and heart disease.

Mali WASHplus project – better hygiene and nutrition go hand in hand

In Mali, the WASHplus project is working with community members to build their own latrines, in conjunction with nutritional interventions designed to reduce diarrhoeal diseases and undernutrition in children. When sanitation methods are not in place, open defecation puts children at risk of diarrhoea, preventing them from eating adequately and absorbing nutrients from food. Primary prevention in the form of WASH and nutrition interventions in 180 Malian villages have reduced cases of diarrhoeal diseases and undernutrition in children, and the intersection of these health programmes has yielded results better than those seen with separate programmes (WHO, 2015c).

Multisectoral action in a Finnish city reduces childhood overweight and obesity

In 2009, nearly 20% of children under the age of five in the city of Seinäjoki, Finland were overweight or obese. Multisectoral action coordinated by the municipality's health department has involved childcare, education, nutrition, recreation and urban planning departments to create a healthier environment for children in the city. Nutrition worked with childcare and schools to eliminate sugary snacks and provide healthier lunches in schools. Recreation brought more physical activity to schools, with playgrounds improved by the urban planning department. The health department also introduced parent education on healthy eating. Through these integrated health in all policies, the proportion of overweight and obese children in Seinäjoki has been halved (WHO, 2015b).

Key interventions to reduce stunting and overweight/obesity

- Improve maternal nutrition and micronutrient status during pregnancy.
- Avoid exposure to alcohol, tobacco smoke and toxicants during pregnancy and keep the child's home free of smoke (WHO, 2016b).
- Encourage exclusive breastfeeding for the first six months of life, with complementary breastfeeding for up to two years (WHO, 2002).
- Children need foods rich in vitamins and minerals and should avoid highly processed foods and foods high in fat, sugar and salt.
- Encourage physical activity and a healthy life style. Children ages 5–17 should get at least 60 minutes of physical activity every day (WHO, 2016c).
- Ensure all family members wash their hands after contact with faeces and before contact with food.

Policy action priorities

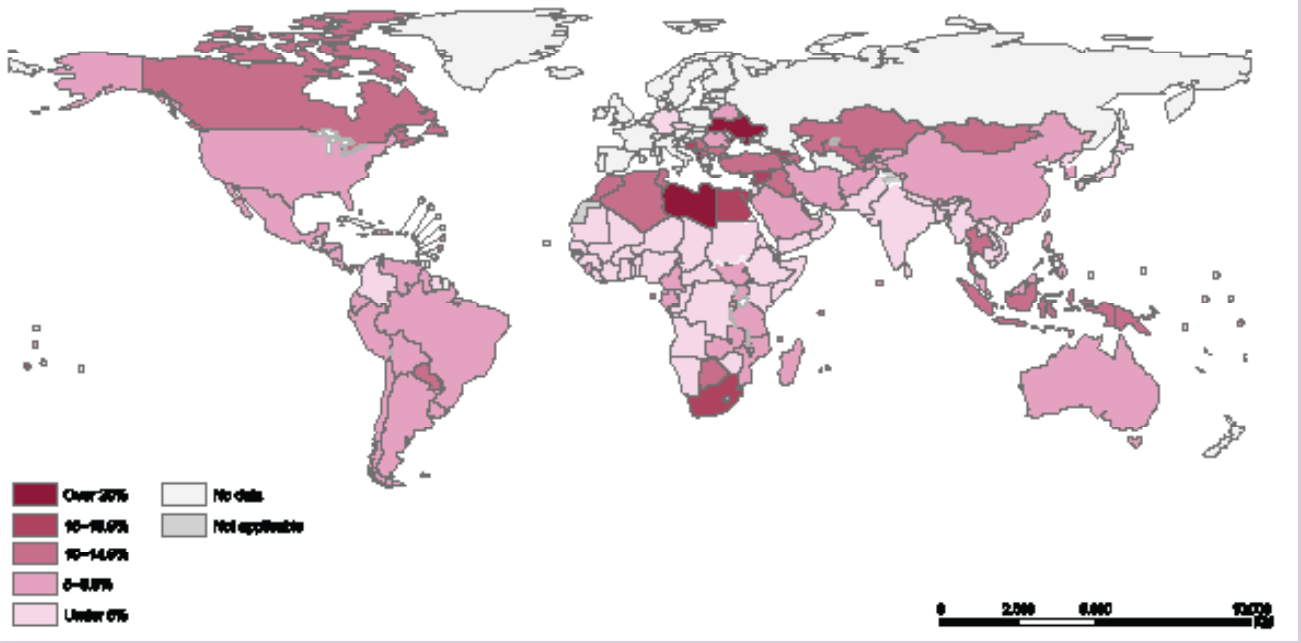
- Promote good nutrition and physical activity and the avoidance of tobacco, alcohol, drugs and other toxicants during and before pregnancy (WHO, 2016b).
- Strengthen community-based interventions, including providing access to safe drinking-water, sanitation and hygiene (WASH) services in homes and health-care facilities to prevent diarrhoeal disease, intestinal worms and mosquito-borne diseases (WHO, UNICEF, USAID, 2015).
- Provide multisectoral coordination and coherent public policies among relevant sectors, including health, agriculture, water, sanitation, hygiene, education, transport and urban planning.
- Create enabling environments that promote physical activity, such as safe parks, open spaces and facilities for safe walking and cycling.
- Provide fresh fruit and vegetables at affordable prices and ensure that families have access to information about healthy eating through national dietary guidelines and other sources.
- Facilitate use of public transport, which both promotes physical activity and decreased traffic-related air pollution (WHO, 2011).
- Ensure equitable coverage of interventions (WHO, 2016b).

Overweight

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health, with weight-for-height greater than two or three standard deviations, respectively, above WHO child growth standards median (WHO, 2015d). In practical terms, this means that overweight or obese children are too heavy for their height. Over 42 million children are now overweight or obese worldwide (UNICEF, WHO, World Bank, 2016). Once considered a problem only in developed countries, the prevalence of child overweight and obesity is now rising rapidly in developing countries and emerging economies, particularly in urban areas (WHO, 2015d). Children who are overweight are likely to remain overweight into adolescence and adulthood.

A high intake of energy-dense, high-fat foods and a low level of physical activity are the biggest contributors to childhood overweight (WHO, 2015d). However, many other factors may also contribute to childhood obesity risk, including maternal nutrition before and during pregnancy, maternal smoking

Percentage of children age 0–59 months who are overweight



Note: Latest national survey result is shown.

during pregnancy, and parental obesity (Behl et al, 2013; Oken at al, 2008; WHO, 2016b; Yu et al, 2013). There is some evidence that exposure to endocrine-disrupting chemicals during fetal development and in early life increases the risk of childhood obesity (WHO, UNEP, 2013).

Childhood overweight and obesity increase the risk of breathing problems, bone fractures, hypertension, early signs of cardiovascular disease, and insulin resistance. It can also have negative psychological effects, as well as long-term consequences such as musculoskeletal disorders, type 2 diabetes, cardiovascular disease, and breast, endometrial and colon cancer (WHO, 2015d).

SDGs and international initiatives

SDG Target 2.2 aims to "by 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under five years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons". Malnutrition includes not only undernutrition but also overweight and obesity. Furthermore, Target 3.4 aims "to reduce premature death from NCDs by one third". As obesity is a major risk factor for NCDs, preventing childhood obesity is critical to achieving this target. Also crucial to these targets is SDG 12, which aims to "ensure sustainable consumption and production patterns" by addressing food production, distribution and waste.

To achieve the SDGs, WHO has created global nutrition targets, by 2025, to:

- Reduce by 40% the number of children under five who are stunted.
- Reduce wasting in children under five to less than 5%.
- Increase the rate of exclusive breastfeeding for the first six months to 50%.
- Reduce low birth weight by 30%.
- Stop increases in childhood overweight (WHO, 2014).

"The world needs nutrition accountability. … Access to adequate nutritious food is a basic human right. … By investing in nutrition for all, we all win."

Akinwumi Adesina, President, African Development Bank

Environmental health risks: Reducing the impacts

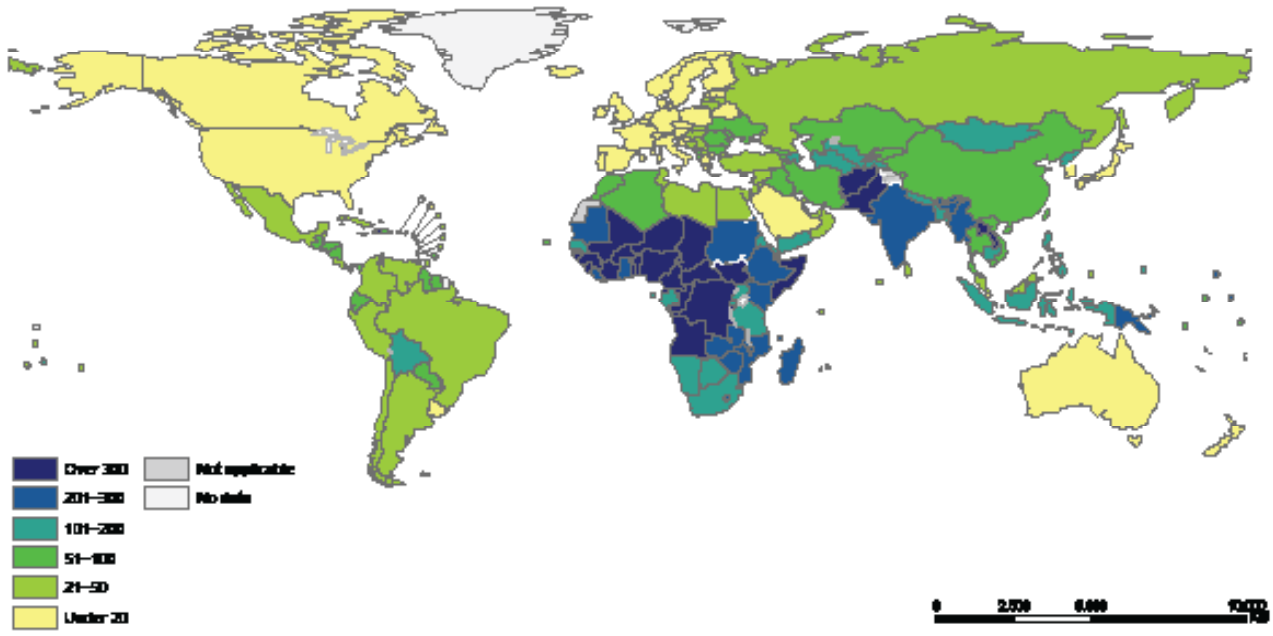
Substantial gains have been made in children's health over the past decade, notably a reduction in the under-five mortality rate, a fall in the proportion of underweight children and a decline in the incidence of malaria and other communicable diseases (WHO, 2015). However, progress has not been uniform. Nine-tenths of the world's population now have access to improved drinking-water, but almost one third are still without sanitation facilities (UNICEF, WHO, 2015). Leaded petrol has been phased out almost entirely, but lead is still widespread in paints (UNEP, 2013; UNEP, 2016; WHO, 2016c). Increasing urbanization, industrialization and globalization, unsustainable consumption patterns, global climate change and radiation are creating challenges that must be addressed in order to protect the health of the most vulnerable – children in particular.

The impact of environmental risks

Evidence-based assessment and expert opinion confirm that a staggering 23% of global deaths are attributable to modifiable or preventable environmental risk factors (Prüss-Ustün et al, 2016). The greatest disease burden is in LMICs and among the most vulnerable populations. Children under five years of age are one of the groups most affected; 26% of the 5.9 million deaths per year in that age group are attributable to the environment (Prüss-Ustün et al, 2016; WHO, 2016b). A large proportion of death and disease in children under five is still connected to living in households without access to basic services such as safe water and basic sanitation, or that have high indoor air pollution due to the use of unclean fuel and inefficient cooking and heating technologies.

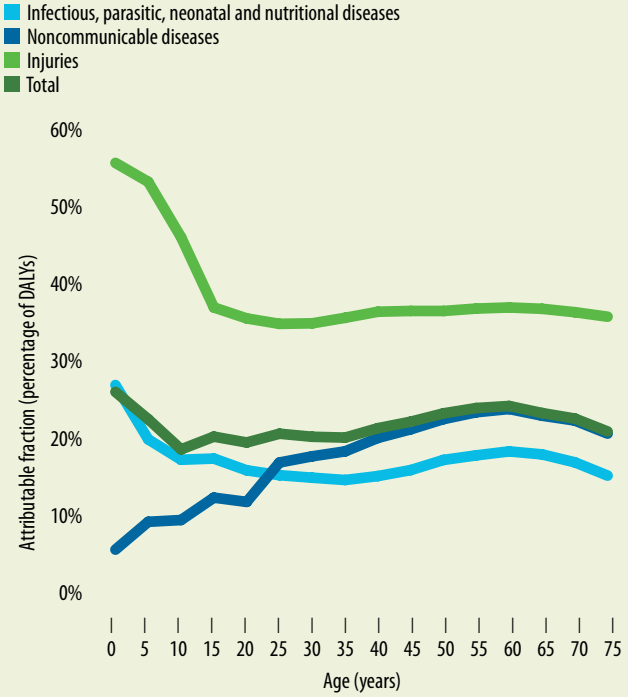
In children under five, the preventative potential for communicable diseases and injuries is greatest through environmental action. For early life respiratory infection prevention, for example, reducing exposure to polluted air is essential. Even if adults bear most of the NCD burden, these diseases may in many cases have an early life origin (WHO, UNEP, 2013). The risk of developing disease from early life exposures may be increased by later environmental exposures, and effects are often the result of combined exposures. For example, household and ambient air pollution and second-hand smoke prenatally and in the first years of life, can adversely affect systems and organs as they develop, the consequences of which may only be apparent later in life.

Deaths in children under five attributable to the environment (as a whole) per 100 000 people, 2012



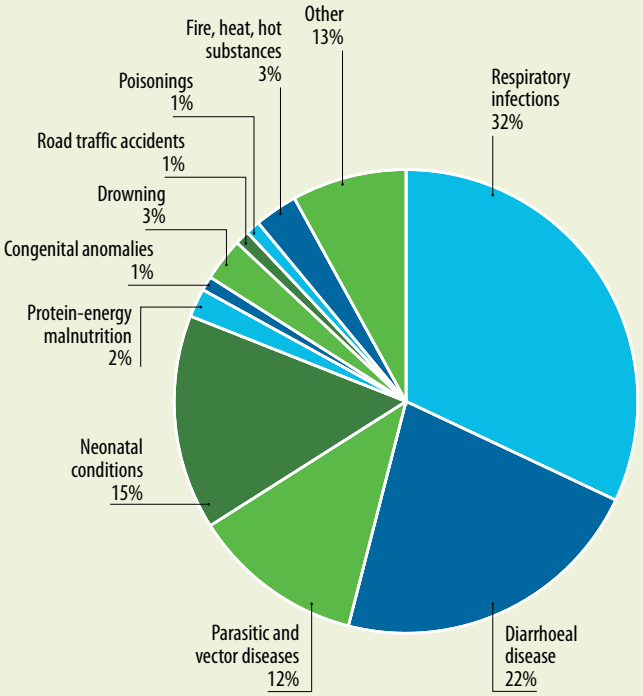
Note: Data from evidence-based assessment and expert opinion.

Environmental fraction of global burden of disease (in DALYs), by age and disease group, 2012



Note: Data from evidence-based assessment and expert opinion.

Main diseases contributing to the environmental burden of disease for children under five years, 2012



Diseases with the largest environmental contribution in children under five years of age include lower respiratory infections, diarrhoea, neonatal conditions, malaria and protein-energy malnutrition, as well as injuries.

Note: Data from evidence-based assessment and expert opinion.

"A clean environment is a human right like any other. It is therefore part of our responsibility towards others to ensure that the world we pass on is as healthy, if not healthier, than we found it."

The 14th Dalai Lama

Key facts

- There are now over 800 million more people on this planet than there were 10 years ago. Over half of the global population now live in cities and the figure is rising (UN, 2014). 92% of the world's population is exposed to unhealthy levels of ambient air pollution, caused primarily by road traffic, industrial emissions and domestic fuel burning (WHO, 2016e).
- The deaths of 169 250 children under five in 2012 were attributable to ambient air pollution (WHO, 2016e). An additional 531 190 deaths of children under five in 2012 resulted from lower respiratory infections caused by household air pollution (WHO, 2016a; WHO, 2016d).
- The neurodevelopmental effects of childhood lead exposure and lost productivity from exposure cost almost US$ 1 trillion every year in low- and middle-income countries (LMICs) (Attina & Trasande, 2013). This is seven times the total development aid given to developing countries each year (OECD, 2015). Despite successes in reducing lead exposure in high-income countries, it continues to cost about US$ 51 billion in the United States and US$ 55 billion in the European Union annually (Attina & Trasande, 2013).

Environmental interventions for improving child health

The main areas of environmental intervention for improving child health include ensuring clean air inside and outside households, adequate water, sanitation and hygiene (including in birth settings), protection of pregnant women from second-hand tobacco smoke, and safe built environments (at household and community levels).

Key environmental intervention areas for main childhood diseases and injuries

Diseases and injuries	Main environmental intervention areas
Respiratory infections	• Household and ambient air pollution, second-hand tobacco smoke • Housing
Diarrhoeal diseases	• Water, sanitation and hygiene • Climate change
Parasitic and vector diseases	• Environmental management and modification • Water, sanitation and hygiene • Housing
Neonatal and nutritional conditions	• Household air pollution • Maternal exposure to second-hand tobacco smoke • Water, sanitation and hygiene (including in birth settings)
Injuries (drowning, road traffic accidents, poisonings, burns)	• Road design, land-use planning • Safe handling, labelling and storage of chemicals • Safety of cooking, lighting and heating equipment, use of flammable materials in the home • Safety of water environments, public awareness, regulations
Cancers	• Household air pollution, exposure to second-hand tobacco smoke, ionizing and UV radiation, chemicals
Asthma	• Air pollution, second-hand tobacco smoke, indoor pollution from dampness and mould
Congenital anomalies	• Exposure of pregnant women to second-hand tobacco smoke, certain chemicals

Source: Adapted from Prüss-Ustün et al, 2016.

Emerging risks

In addition to traditional risks, emerging risks are frequently underestimated in disease burden estimates, particularly chemical risks. Children's health is at risk from exposures to new chemicals and new sources of toxic substances. Older pesticides which persist for a long time in the environment have largely been banned, but legacy effects can still persist. Newer pesticides are subject to more extensive regulatory oversight, but regulatory reviews are resource-intensive and take a long time to complete. Chemicals in our daily lives with endocrine-disrupting potential may affect reproductive function, thyroid function and neurodevelopment, and cause metabolic disorders, cancer and some immune diseases (WHO, UNEP, 2013). In addition, the global volume of electronic waste is growing at an alarming rate. Much of it is shipped illegally to developing countries where toxic components, such as lead, mercury, cadmium and arsenic, pose additional health risks, notably for children who scavenge on landfill sites.

Such emerging risks need to be closely monitored and appropriate solutions put into place. Climate change, for example, can affect health directly or indirectly in many ways, not all of which can yet be assessed adequately. Other health effects may arise from damaged or depleted ecosystems. Some health risks are also more difficult to measure, e.g. exposures due to child labour, as the conditions of working children have rarely been well assessed. Estimates of the health burden caused by the environment provide a useful view of the children most at risk from environmental exposures and estimates of how much disease burden can be prevented by reducing environmental risks. However, they do not provide a complete picture (Prüss-Ustün et al, 2016).

SDGs

Children's environmental health is intersectoral by nature, with links to every SDG. Issues with water, sanitation and hygiene take lives; clean energy and efforts to address climate change will reduce the burden of asthma and other respiratory illnesses in children; education and equity will give them opportunities to survive, thrive and lead healthy lives; cities and infrastructure will increasingly determine the environmental exposures with which children grow up. Children are the most vulnerable population affected by environmental health hazards, because their bodies are still in the process of developing. Their health depends on a multitude of factors, hence the importance of multiple sectors working together in the achievement of the SDGs.

Child injuries: Preventable tragedies

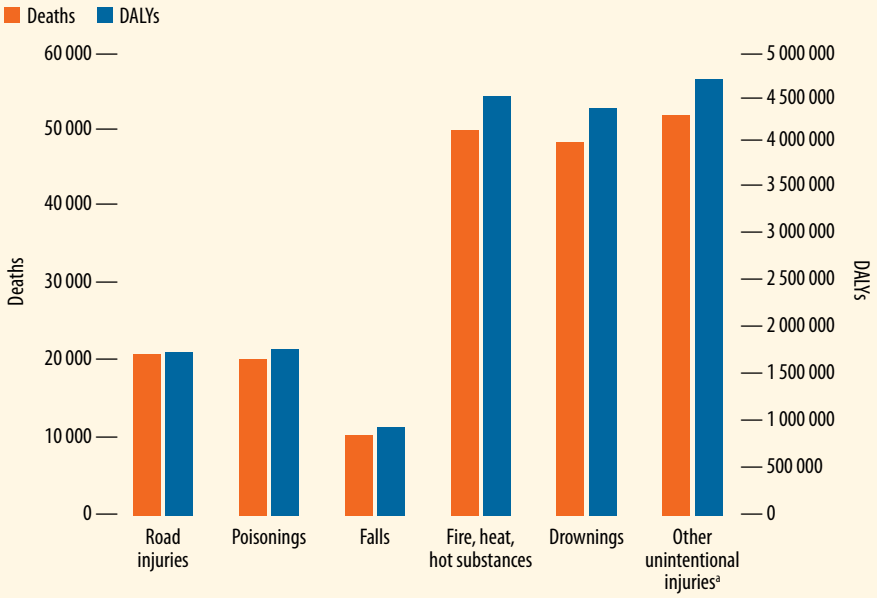
In 2012 391 000 children aged 0–14 years died from unintentional injuries, including road injuries, poisonings, falls, fire, exposure to heat and hot substances, drowning, exposure to forces of nature, and other unintentional injuries (WHO, 2014c). The impact of this terrible statistic is felt by the 2000 families every day who suffer the loss of a child (or children) from unintentional injury (WHO, 2012). In addition, tens of millions of children a year are injured or disabled, mostly through head injuries and fractured limbs and may go on to suffer emotional and physical consequences for life (WHO, UNICEF, 2008). Action is needed, and with active prevention measures and increased awareness the majority of these deaths and injuries could be prevented.

The causes of childhood injuries

Reducing environmental risk factors is very important for the prevention of child injuries. For example, in 2012 close to 50 000 under five deaths by drowning are attributable to modifiable environmental risks (Prüss-Ustün et al, 2016). Road traffic accidents are the leading cause of death among young people ages 15–29 and one of the leading causes of deaths due to injury among children under 18 (WHO, 2014b; WHO, 2014c). In many countries, children are at particular risk because roads are shared spaces for playing, working, walking, cycling and driving. In Latin America and Asia in particular, motorcycles are an important means of transport for many, and children are often carried on these motorcycles without any protection.

Drowning is among the major causes of death of people aged 1–24 in every region (WHO, 2014a). Peak rates of drowning occur among children between one to four years. Lack of supervision is a common risk factor. Children may drown anywhere there is water, including buckets, bathtubs, ponds and pools (WHO, 2014a). At least 5% of childhood non-fatal drownings that require hospitalization result in serious neurological damage, which can have major long-term impacts on families (WHO, UNICEF, 2008).

Burden of disease (deaths and DALYs) attributable to the environment globally – unintentional injuries in children ages 0–4 years, 2012



Notes: [a] This includes injuries from mechanical forces (tools, sports equipment, agricultural machinery), explosions, off-road transportation accidents, animal bites, venom, poisonous plants, ionizing radiation, electric currents, suffocation, natural forces (storms, extreme temperatures, earthquakes), and medical care complications.

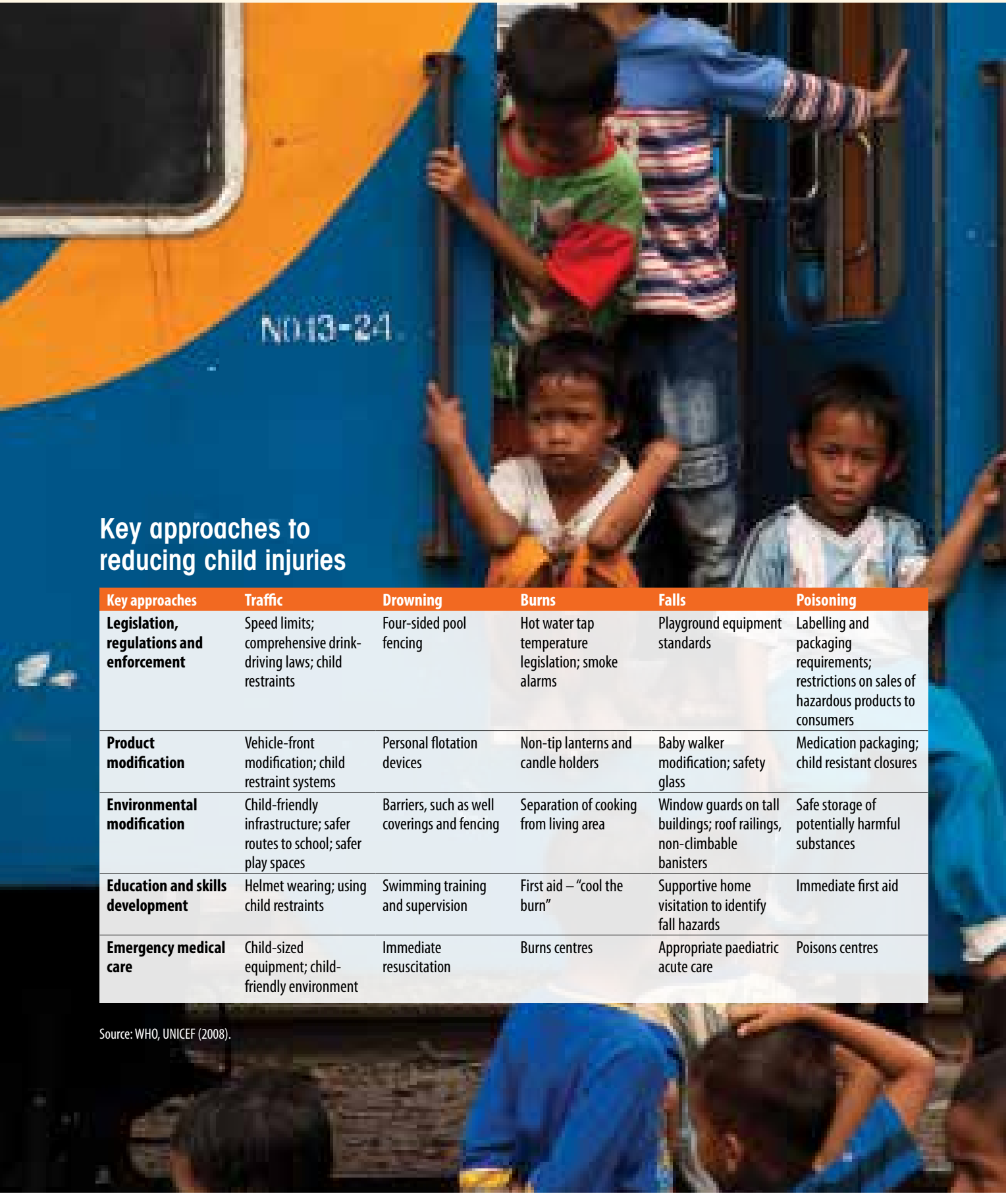
Preventing injury

To reduce road deaths and injuries among children, the use of seat belts and the wearing of helmets by cyclists and motorcyclists are essential. In the event of a car crash, seats and restraints appropriate for the age of the child can reduce child deaths by between 77% and 90% (WHO, 2015). Controlling drinking and driving, enforcing speed limits, checking vehicle roadworthiness and providing separation between drivers, cyclists and pedestrians are other vital measures. Well-designed cycle lanes shielded from vehicular traffic have the additional benefit of encouraging more children to cycle safely and help to combat the problem of child obesity due to physical inactivity (WHO, 2011).

Drowning among children can be prevented by:

- Installing barriers to control access to water.
- Teaching school-age children basic swimming, water safety and safe rescue skills.
- Training bystanders in safe rescue and resuscitation.
- At the policy level, setting and enforcing safe boating and ferry regulations, pool fencing regulations, better management of flood risks and developing a national water safety plan.

The 2004 tsunami that killed 230 000 people in Aceh, Indonesia, and other countries around the Indian Ocean was a preparedness wake-up call. Since then, much has been done by the countries concerned to establish tsunami warning systems and to plan evacuation routes. Climate change is likely to increase the frequency and intensity of natural disasters such as floods. Measures to adapt to and mitigate climate change are key to preventing injuries from natural disasters.

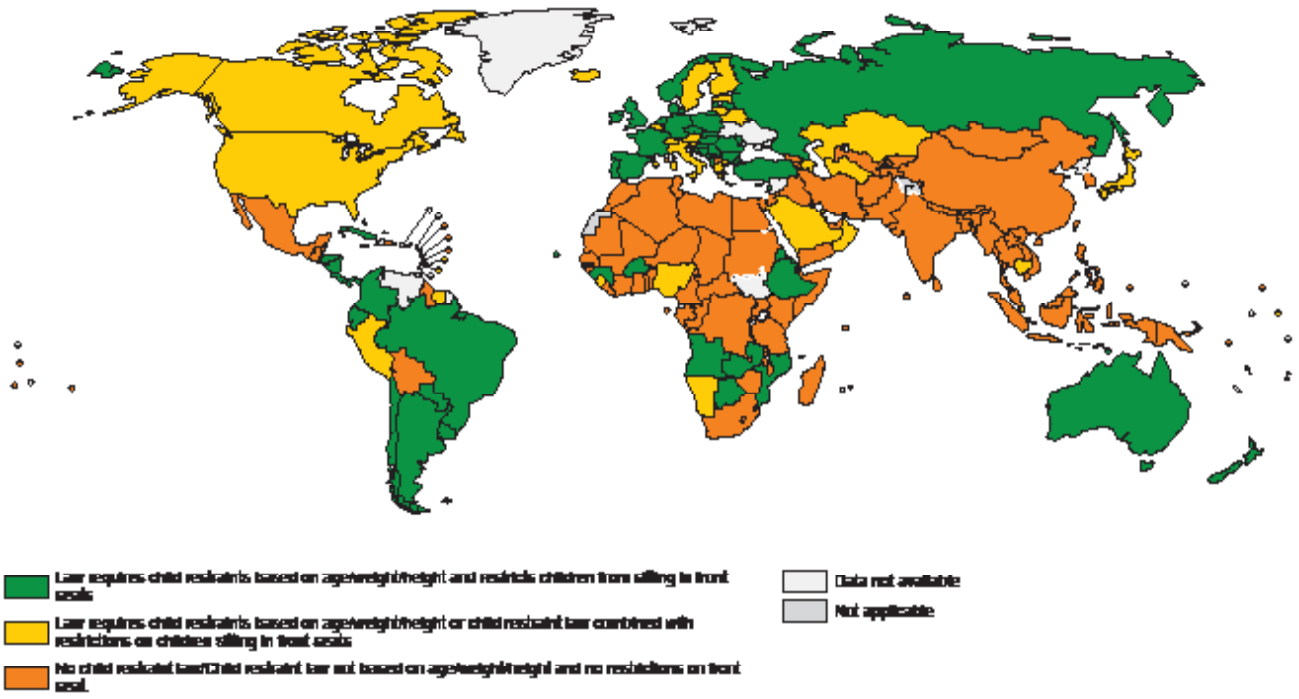


Key approaches to reducing child injuries

Key approaches	Traffic	Drowning	Burns	Falls	Poisoning
Legislation, regulations and enforcement	Speed limits; comprehensive drink-driving laws; child restraints	Four-sided pool fencing	Hot water tap temperature legislation; smoke alarms	Playground equipment standards	Labelling and packaging requirements; restrictions on sales of hazardous products to consumers
Product modification	Vehicle-front modification; child restraint systems	Personal flotation devices	Non-tip lanterns and candle holders	Baby walker modification; safety glass	Medication packaging; child resistant closures
Environmental modification	Child-friendly infrastructure; safer routes to school; safer play spaces	Barriers, such as well coverings and fencing	Separation of cooking from living area	Window guards on tall buildings; roof railings, non-climbable banisters	Safe storage of potentially harmful substances
Education and skills development	Helmet wearing; using child restraints	Swimming training and supervision	First aid – "cool the burn"	Supportive home visitation to identify fall hazards	Immediate first aid
Emergency medical care	Child-sized equipment; child-friendly environment	Immediate resuscitation	Burns centres	Appropriate paediatric acute care	Poisons centres

Source: WHO, UNICEF (2008).

Child restraint laws, by country/area



Burns, falls and poisonings – making homes baby and toddler safe

- A newborn's skin is particularly sensitive to scalding. Burns can occur from fire or hot liquids and are very common before two years of age.
- Newborn babies have bones in their heads that are still consolidating. Falls can lead to brain injury. Housing conditions can be adapted to prevent falls for babies and toddlers, as many household falls occur before three years of age.
- Infants and toddlers taste the world around them. Poisons are more toxic to children than adults, and unintentional poisoning is common. Household products, kerosene and medicines should be kept in child-safe packaging and out of the sight and reach of children.

Dramatic reduction in child drownings in Bangladesh

A prevention intervention in Bangladesh targeted the threat of drowning to children, which is the leading cause of death for children aged between one and four years in the country. For children aged between one and five years, collective supervision in child-care centres reduced the risk of death by drowning by more than 80%. For children aged between four and 12 years, swimming lessons, increased supervision, risk and water safety education, and safe rescue skills reduced the risk of death by drowning by more than 90%. Both approaches were deemed to be cost-effective (Rahman et al, 2012).

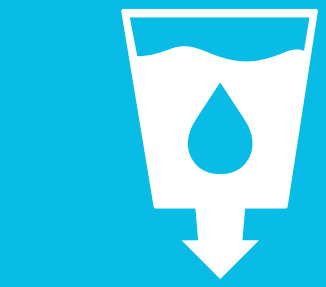
SDGs and international initiatives

Many SDGs relate to injury prevention. SDG 3.6 aims to "by 2020, halve the number of global deaths and injuries from road traffic accidents". Target 11.2 aims to "by 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons". Target 11.5 seeks to "by 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations". Target 13.1 refers to climate-related disasters noting the need to: "strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries".

Meeting basic needs for everyone: Steps towards SDG 6

Part 2

Meeting basic needs for everyone: Steps towards SDG 6



Safe water:
For all children everywhere

In 2010, MDG Target 7.C to improve access to drinking-water was reached five years ahead of schedule (UNICEF, WHO, 2012). This achievement reflected sustained global commitment and investment in drinking-water supply infrastructure, which resulted in 2.6 billion people gaining access to an improved source of water between 1990 and 2015, largely due to the installation of piped water. As a result, by 2015, the number of people without access to an improved source had fallen dramatically to 663 million people (UNICEF, WHO, 2015). This success is likely to have been a key contributor to the sizeable reduction in diarrhoeal deaths in children under age 5 years from 1.2 million in 2000 to 526 000 in 2015 (WHO, 2016a).

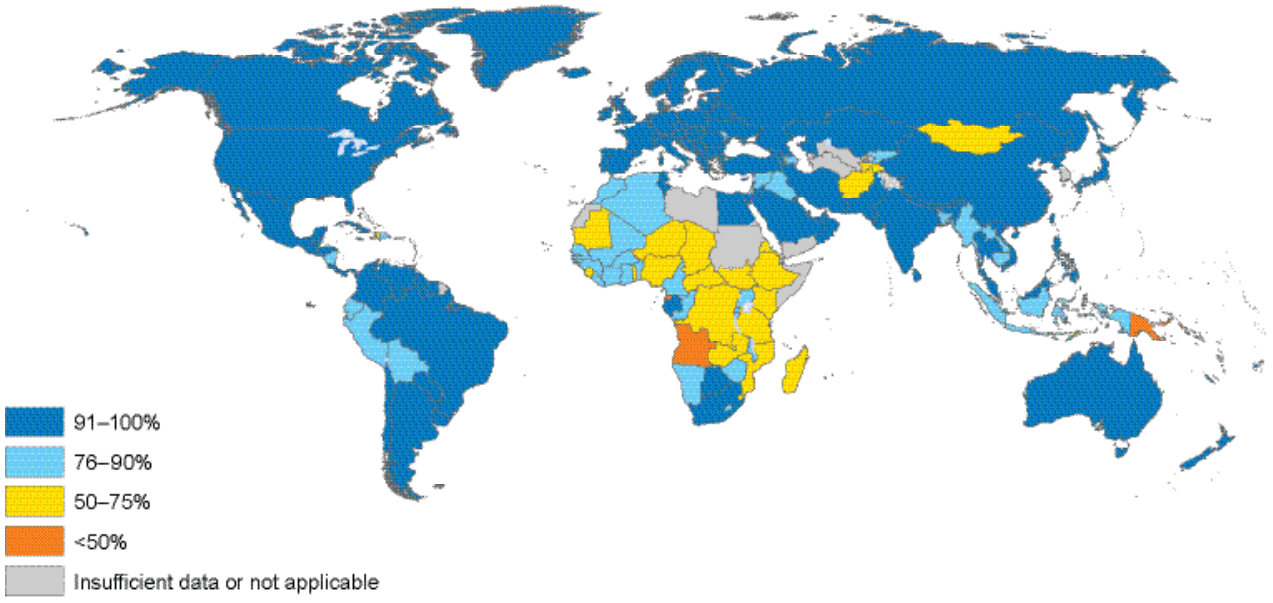
From water access to water quality

But behind the progress in access to improved supplies, recent surveys including direct measures of water quality suggest that many more people are at risk from contaminated water than previously thought. At least one in four people globally (1.8 billion people) drink water that is faecally contaminated (Bain et al, 2014). Even among those with access to improved drinking water sources 1.2 billion use water from sources that have serious sanitary risks (Onda et al, 2012). Consumption of water contaminated with human or animal faeces is the principal cause of a range of diseases including cholera, shigellosis, dysentery and typhoid. Health risks also arise as a result of long-term consumption of water that has been contaminated with naturally occurring or man-made chemicals such as arsenic, cyanide, lead, pesticides and radionuclides (see *Arsenic and fluoride: Poison in the well*) (WHO, 2011).

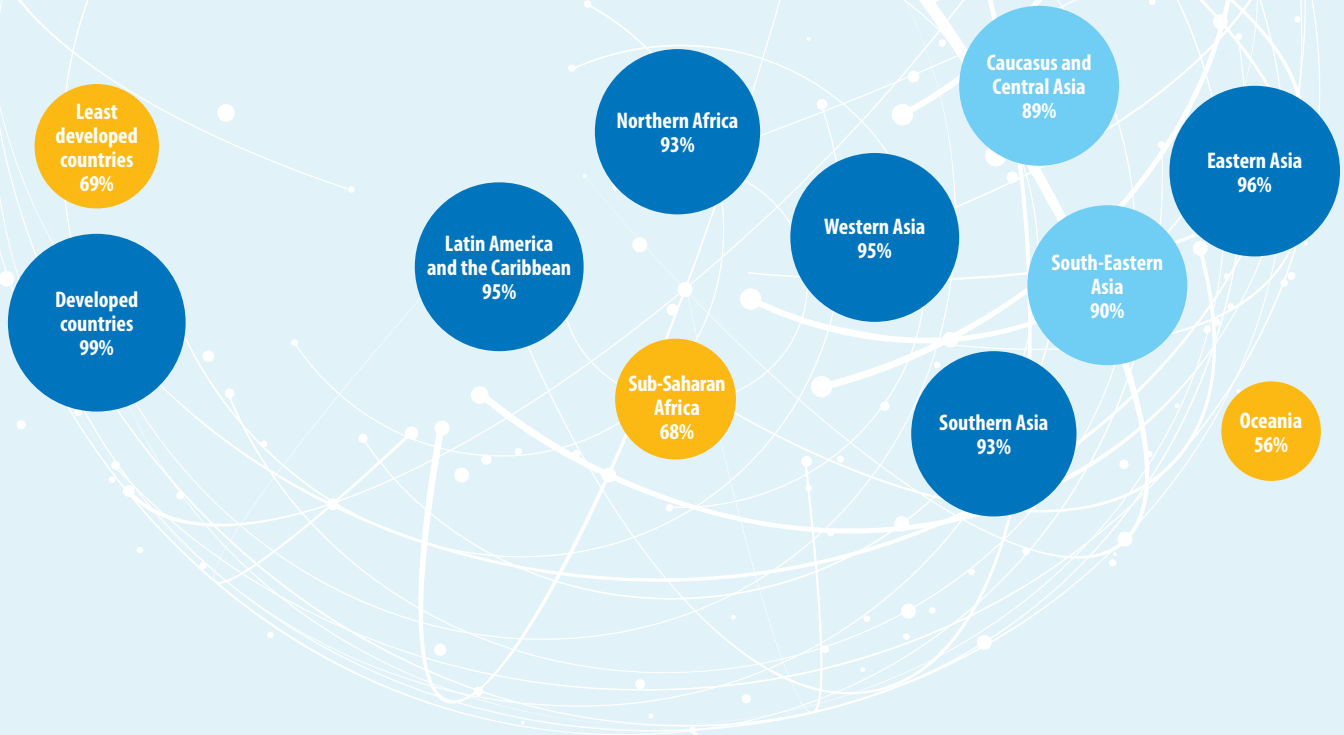
Contaminated drinking-water

Children under five years of age are the most vulnerable to the effects of unsafe water. Intestinal diseases, including diarrhoea, parasitic infections and environmental enteropathy (also called tropical enteropathy; a subclinical condition caused by repeated faecal-oral contamination resulting in blunting of intestinal villi and intestinal inflammation) impair the proper functioning of the gut and prevent the absorption of nutrients essential for a child's growth and development. Children who are malnourished or dehydrated are especially vulnerable because they are more susceptible to repeated diarrhoeal episodes. Children drink more water per unit body weight than adults and, because their metabolism is immature, they absorb a higher proportion of some waterborne chemicals. Moreover, children are not able to recognize and act upon risks related to water quality and safety. Unsafe drinking-water, sanitation and hygiene together caused 361 000 preventable child deaths, from diarrhoea alone, in 2012 (WHO, 2014a).

Proportion of the population using improved drinking-water sources, 2015



Access to improved drinking-water sources, by region, 2015



Waterborne diseases

Children spend many hours playing in environments or water bodies that are unclean and many wash in unsafe water. This puts them at increased risk of a range of neglected tropical diseases such as guinea-worm disease, schistosomiasis and trachoma. Stagnant water in containers, pools and marshes are places where some vectors that transmit disease breed.

- **Guinea-worm:** A crippling parasitic disease, transmitted exclusively through contaminated drinking-water. The number of cases has declined rapidly from 3.5 million in the mid-1980s to near-eradication, principally because of interventions to improve drinking-water quality (WHO, 2016b).
- **Schistosomiasis:** An acute and chronic disease caused by parasitic worms which causes about 20 000 deaths in 2012 (WHO, 2014b). It is most prevalent in tropical and subtropical areas and affects communities without access to safe drinking-water and adequate sanitation (WHO, 2016c).
- **Trachoma:** The single biggest cause of preventable blindness, responsible for blindness, or moderate to severe vision impairment in an estimated 1.8 million people worldwide (Bourne et al, 2013). When people do not have enough water to keep themselves clean, flies are attracted to dirty faces, especially to discharge around the eyes, spreading bacterial infection as they feed (WHO, 2015).

The water carriers

In sub-Saharan Africa, only one in six people have their own water supply on the premises (UNICEF, WHO, 2015). In many without household water supplies, boys and girls are responsible for collecting water (UNICEF, WHO, 2012). This reduces time that could be spent on education or other productive family tasks, thereby perpetuating poverty. Often, after the carried water is used for drinking, very little remains for hygiene purposes.

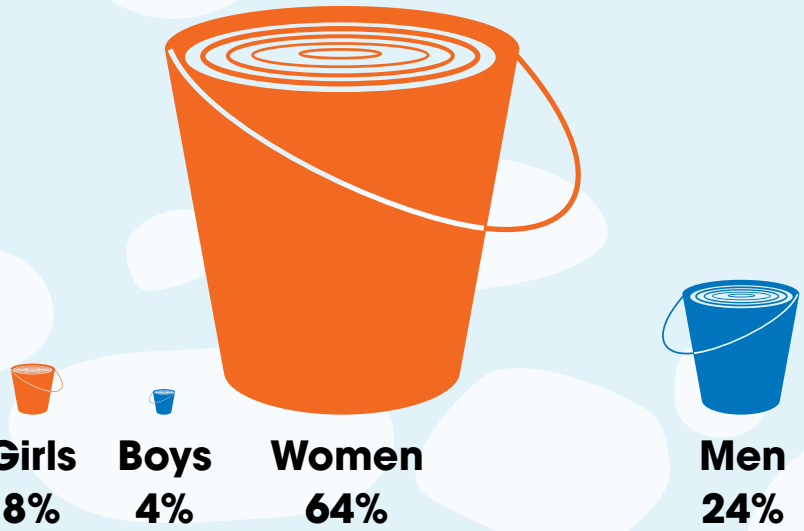
SDGs and international initiatives

In the MDG era, water and sanitation were addressed through one target within the goal of "ensuring environmental sustainability". The scope of water in the SDGs is much wider: there is a stand-alone goal on water and sanitation, with eight targets covering the whole water cycle and including completely new areas such as reducing water scarcity, improving water resources management, and protecting water-related ecosystems. Drinking-water safety also features more prominently in the SDGs, with Target 6.1, "by 2030, achieve universal and equitable access to safe and affordable drinking-water for all". The proposed indicator for this target – safely managed drinking-water services – will include measurement of microbial and chemical water quality.

Governments invested heavily in water supplies to meet the MDG target, but the SDG focus on water quality will pose new challenges. To prevent contamination of drinking-water supplies, utilities and governments are increasingly turning to risk-management approaches, such as the water safety planning approach introduced in the 2004 Guidelines for Drinking-water Quality (WHO, 2004). Since that time, policies and regulations on water safety plans have been formally approved in many countries and will play an important role in achieving the SDG targets.

Who fetches the water in households with no supply on tap?

Women and children shoulder a large burden in fetching water for households without their own water supply – children forego valuable schooling and playing time to carry out this mundane, and sometimes dangerous, task.



Key facts

- From 1990 to 2015, the number of people with improved drinking-water increased by 65%, from 4.0 to 6.6 billion (UNICEF, WHO, 2015).
- There are no universally agreed definitions of affordability, but it is assumed that spending more than 3–5% of household income on water, sanitation and hygiene is unaffordable. However, poor households in many low-income countries pay much more than this benchmark (WHO, 2011).

Testing drinking-water quality in the home

With advances in technology, water quality testing has become easier and cheaper. Water quality testing modules are being integrated into household surveys, such as the Multiple Indicator Cluster Surveys (MICS) supported by UNICEF. These surveys ask for "a glass of water you would give a child to drink", which is then tested for *Escherichia coli*, the recommended indicator of faecal contamination. Results from the first round of surveys show that household drinking-water is frequently contaminated, sometimes with heavy levels of *E. coli* (more than 100 colony-forming units in a 100-ml sample), whereas standards call for a level of zero (UNICEF, WHO, 2015; WHO, 2011).

Policy action priorities

The co-benefits of WASH interventions

The last UN Water/WHO global analysis and assessment of sanitation and drinking-water highlights the fact that investing in water and sanitation can bring numerous co-benefits. Water and sanitation interventions have prevented millions of child deaths from diarrhoea and malnutrition, saved children from having to collect and carry water, improved school attendance, provided safety and privacy for children using bathrooms, and reduced water and soil pollution. They have benefited economies by saving health-care costs, providing US$ 4.3 in benefit for every US$ 1 spent (UN Water, WHO, 2014; WHO, 2012).

"We forget that the water cycle and the life cycle are one."

Jacques Cousteau

Sanitation: Making safety a priority

The MDG target to reduce the proportion of the population without access to adequate sanitation was missed by nearly 700 million people (UNICEF, WHO, 2015). In 2015, nearly a billion people still used no toilet or latrine facility at all and resorted to open defecation and another 640 million people relied on shared or public toilets (UNICEF, WHO, 2015). Women and girls who do not have access to their own toilets have to make a choice between walking in the dark to shared facilities and risking assault or waiting until morning. Globally, one in three women lack access to private, improved sanitation facilities. However, in many dense urban environments, shared facilities are likely to be the only practical solution for years to come.

Safe sanitation and sewerage

One gram of human faeces can contain millions of pathogenic bacteria and viruses and thousands of parasite cysts or worm eggs, so safe management of faecal waste is essential. Basic improved toilets can reduce the number of pathogens to which a person or household is exposed, but unsafe management of faecal waste from the toilets – such as sewer pipes that drain directly into surface water – may just shift the problem to neighbouring communities. Inadequate sanitation in one small area can threaten a whole community by polluting water supplies and spreading intestinal worms, diarrhoea, cholera, dysentery, hepatitis A and polio.

Progress has been made in reducing diarrhoeal disease in recent years – deaths have fallen dramatically in the under-five age group from 1.2 million in 2000 to 526 000 in 2015, due in part to improvements in WASH, along with better case management (WHO, 2014; WHO, 2016a). But more remains to be done. In addition to diarrhoea, poor sanitation is the underlying cause of many neglected tropical diseases, including schistosomiasis and trachoma. Soil-transmitted helminths, a class of intestinal worms, are particularly common among children, and can cause malnutrition, slow weight gain and impaired mental development (WHO, 2016b).

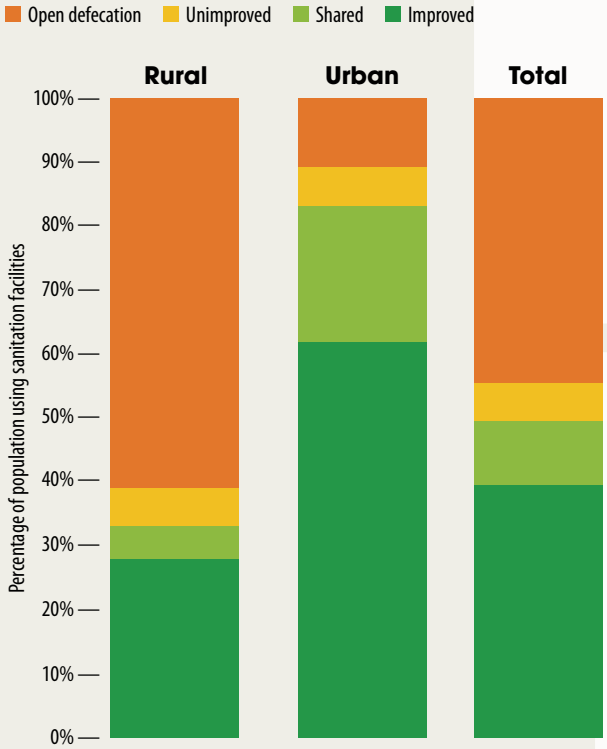
Public inconvenience – India's need to prioritize improved sanitation

Forty-four per cent of India's population of 1.3 billion people defecate and urinate in open areas (UNICEF, WHO, 2015). This carries great risks for children and women: infectious diseases, malnutrition and violence. Transforming both longstanding neglect to sanitation investment and entrenched cultural practices is a huge challenge, but the Government of India announced in 2014 the Swachh Bharat (Clean India) Mission to end open defecation by 2019. It aims to dramatically improve provision of toilets, including in schools where their lack deters girls in particular from attending school.

"Has it ever pained us that our mothers and sisters have to defecate in open? Poor womenfolk of the village wait for the night; until darkness descends, they can't go out to defecate. What bodily torture they must be feeling, how many diseases that act might engender. Can't we just make arrangements for toilets for the dignity of our mothers and sisters?"

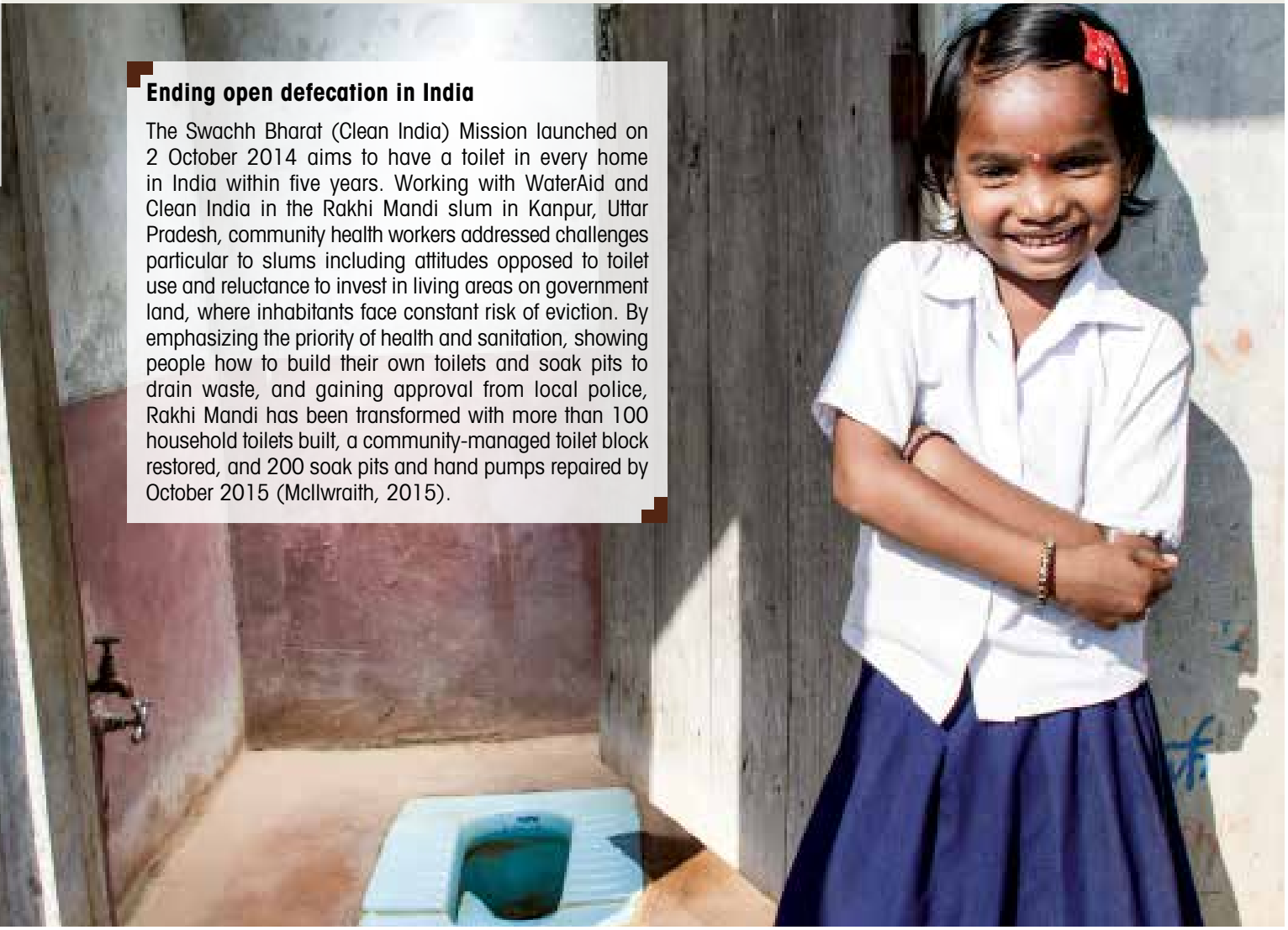
Narendra Modi, 2014

Use of sanitation facilities in India, 2015



Key facts

- Inadequate sanitation can hinder the effects of improved nutrition. Infections caused by poor sanitation can prevent children from absorbing nutrients and means that they use energy to fight infection instead of for growth, causing malnutrition, permanent stunting and intellectual deficits (Dangour et al, 2013; WHO, 2015b).
- In LMICs, more than 50% of faeces from young children are not disposed of safely. Children's faeces are often not considered harmful, and between 11% and 64% of households with improved toilets and latrines do not use them for child faeces. However, faeces from children actually contain more pathogens than adult faeces (IBRD, World Bank, UNICEF, 2015).
- From 1990 to 2015, the percentage of the global population using improved sanitation facilities increased from 54% to 68% (UNICEF, WHO, 2015).



Ending open defecation in India

The Swachh Bharat (Clean India) Mission launched on 2 October 2014 aims to have a toilet in every home in India within five years. Working with WaterAid and Clean India in the Rakhi Mandi slum in Kanpur, Uttar Pradesh, community health workers addressed challenges particular to slums including attitudes opposed to toilet use and reluctance to invest in living areas on government land, where inhabitants face constant risk of eviction. By emphasizing the priority of health and sanitation, showing people how to build their own toilets and soak pits to drain waste, and gaining approval from local police, Rakhi Mandi has been transformed with more than 100 household toilets built, a community-managed toilet block restored, and 200 soak pits and hand pumps repaired by October 2015 (McIlwraith, 2015).

Strong leadership in sanitation improvement in South-East and East Asia

A WaterAid (2016) study in Singapore, Republic of Korea, Malaysia and Thailand showed that active political leadership, strong institutions and finding the appropriate local solutions to improve sanitation and hygiene result in improved public health cleanliness. Approaches studied included well-coordinated, multisectoral action, capacity building and constant monitoring. In each of the countries studied, the government developed sanitation infrastructures at the same time as instigating changes to public health and hygiene policies. In Singapore, widespread sanitation access was achieved when the government made affordable housing with improved sanitation available to low-income families. This enabled many people to move out of *kampongs,* or slums, into apartments, and to transition from open defecation to private sanitation facilities (WaterAid, 2016).

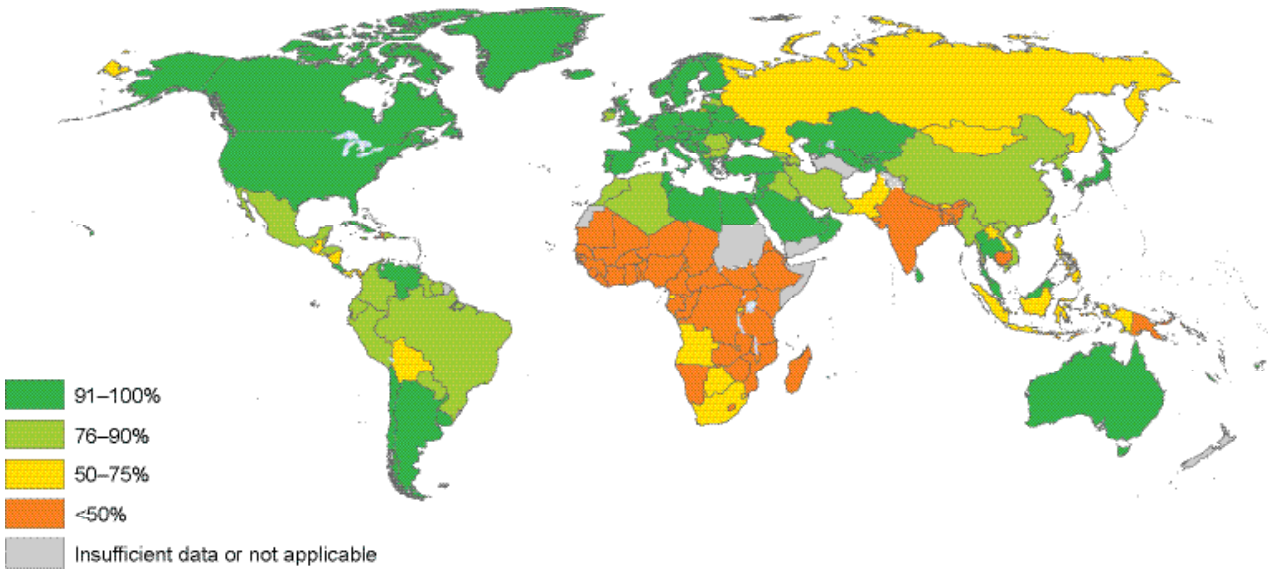
Integrated interventions to prevent schistosomiasis in China

Schistosomiasis is an infection caused by parasitic worms, contracted through exposure to contaminated water due to inadequate sanitation. Sanitation measures along with environmental management, vector control, provision of water supplies and education has halted transmission in most counties in China (Zhou et al, 2005a). This comprehensive control programme was more cost-beneficial than a health sector-only programme, with a benefit of US$ 6.20 in reduction of losses due to infection and disease for every US$ 1 spent (Zhou et al, 2005b). Such interventions prevent long-term, irreversible health effects such as liver and kidney damage, infertility and bladder cancer (WHO, 2016c).

"The health consequences of poor water, sanitation and hygiene services are enormous. I can think of no other environmental determinant that causes such profound, debilitating and dehumanizing misery."

Margaret Chan,
WHO Director-General, Budapest Water Summit,
9 October 2013

Proportion of the population using improved sanitation facilities, 2015



SDGs and international initiatives

The 2030 SDG agenda includes Target 6.2: "By 2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations." The indicator of "safely managed sanitation services" calls not only for access to improved facilities, but also for safe management of faecal wastes through on-site treatment and storage, or off-site-wastewater treatment plants. This is much more ambitious than the previous MDG indicator, and more likely to yield great reductions in disease.

Policy action priorities

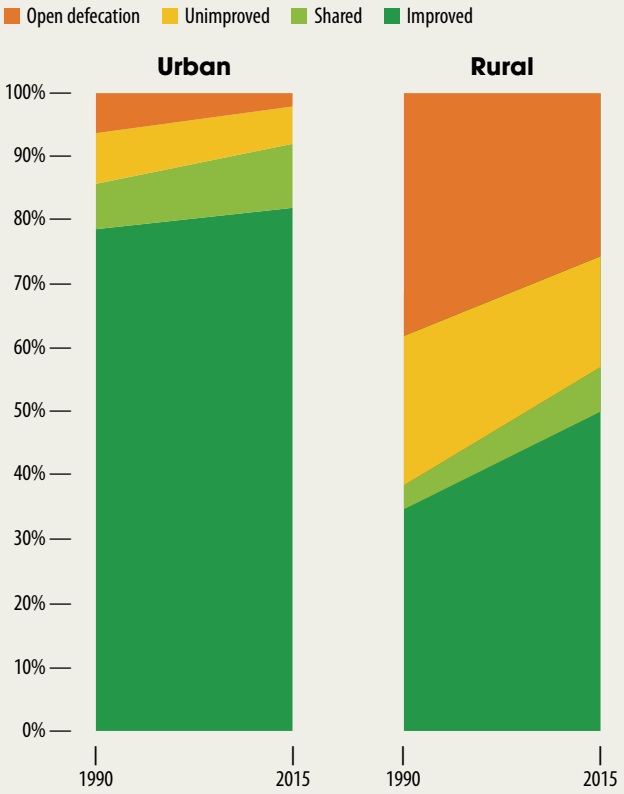
Integrated priority areas for WASH action

Although there is little debate about the priorities for international WASH action, achieving the SDGs will require a multi-level approach. National planning and coordination, effective national monitoring, human resources strategies and effective financing will be required.

The priority areas for action are:

- Renewed focus on health facilities
- Strengthened action in the crucial area of hygiene promotion
- Support for the operation and maintenance of existing infrastructure and services
- Expanded efforts in neglected rural areas where the need for improved services is the greatest
- Development of effective monitoring and evaluation to track progress and identify gaps (UN Water, WHO, 2014; WHO, 2015a).

Urban and rural trends in sanitation coverage (%), 1990–2015



Hygiene: Now WASH your hands!

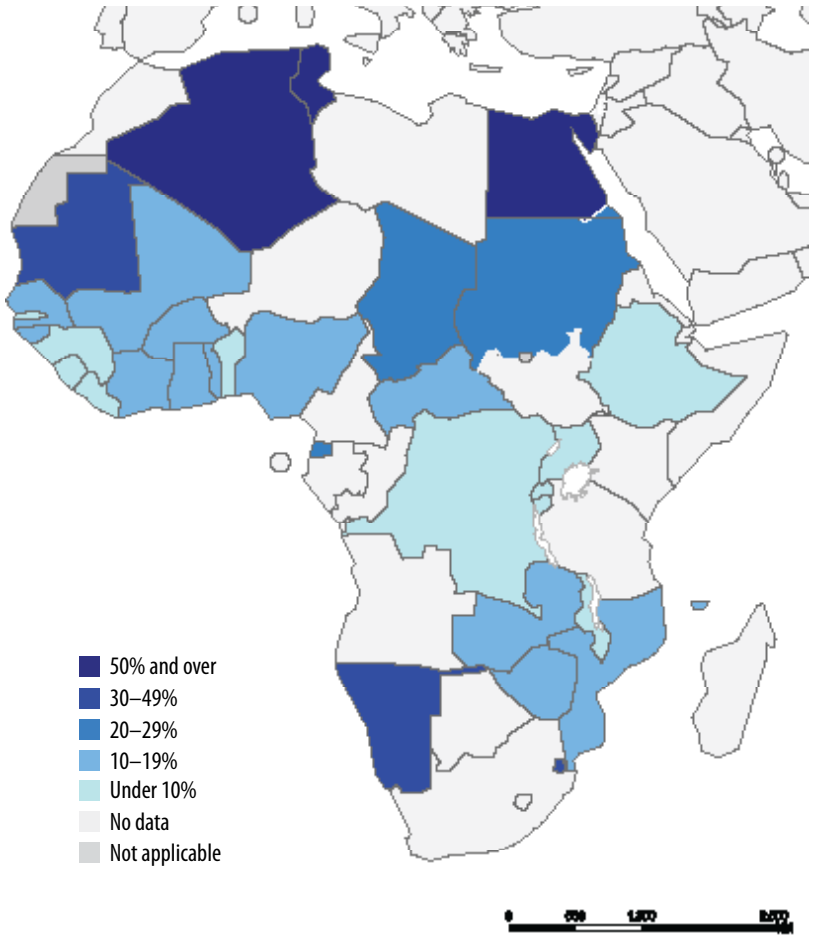
Without hygiene there is no health, but WASH projects have often given little or no attention to improving hygiene practices. Hygiene means different things to different people and can refer to practices associated with defecation, food preparation and storage, management of menstruation, oral cleanliness and contacts with professionals in schools and health-care settings, to name just a few.

Handwashing

The simple act of handwashing with soap can reduce the spread of viral infections, bacterial disease and chemical contamination. Despite variation in public health messages on the importance of handwashing around the world there is strong evidence that handwashing at two moments – after defecation and before preparing food – is key to reducing diarrhoeal disease (Freeman et al, 2014; Luby et al, 2011).

This is particularly important in reducing diarrhoea, trachoma and respiratory infections, to which children under five years of age are so vulnerable. It is estimated that handwashing with soap could reduce diarrhoeal disease risk by 23% and prevent 297 000 deaths per year from diarrhoea alone (WHO, 2014). Children should also wash their hands after playing with other children and after any contact with unclean water.

Proportion of the population with a handwashing facility at home with soap and water, 2010–2014



Hygiene in health-care settings

When health-care facilities have inadequate water, sanitation and hygiene, they can be sources of infection rather than places of safety. WHO's Global Patient Safety Challenge advocates reducing hospital infections through its annual SAVE LIVES: Clean Your Hands campaign. There are five situations for hand hygiene that are critical in health-care settings (WHO, 2009):

- Before patient contact
- Before an aseptic task
- After body fluid exposure risk
- After patient contact
- After contact with patient surroundings.

Clean birth and postnatal care practices, especially when births take place at home, can greatly reduce neonatal infections and deaths. Handwashing by the birth attendant, for example, is estimated to reduce neonatal mortality by 19%, cord infections by 30% and neonatal tetanus by 49% (Blencowe et al, 2011).

"Hygiene is two thirds of health."

Lebanese proverb

Key facts

- Only one in five people globally wash their hands with soap after contact with excreta (Freeman et al, 2014).
- The promotion of handwashing has led to an estimated 30% reduction of diarrhoea in childcare centres in developed countries and a 28% reduction in communities in developing countries (Ejemot-Nwadiaro et al, 2015).
- Trachoma, a bacterial infection of the eye, is the world's leading preventable cause of blindness. Infections are most common in children, as they are more likely to touch their eyes and have unclean faces. Improved hygiene is a key element of the SAFE strategy (surgery, antibiotics, facial cleanliness, and environmental improvement) promoted by the WHO Alliance for the Global Elimination of Trachoma by the year 2020 (GET 2020).

Source: WHO, SAVE LIVES: Clean Your Hands campaign.

Hygiene around food

Foodborne diseases caused 420 000 deaths in 2010, mostly from diarrhoeal disease in LMICs (WHO, 2015). Children under the age of five bore 40% of the foodborne disease burden, despite the fact that they made up only 9% of the global population (WHO, 2015). Improved food hygiene, both by food producers and by household members involved in food preparation, could prevent many of these deaths.

Five keys to safer food

The Five Keys to Safer Food programme has been used in over 100 countries. It is a set of simple guidelines to inform anyone who handles food of how to protect against foodborne disease.

1. Keep clean
2. Separate raw and cooked
3. Cook thoroughly
4. Keep food at safe temperatures
5. Use safe water and raw materials (WHO, 2006).

Menstruation and hygiene

While menstruation is a natural process, unhygienic management can lead to infections. Women and girls need access to: water and sanitation; private spaces to change sanitary cloths and pads and to wash their hands, bodies and reusable cloths; and appropriate places to dispose of used materials or dry reusable products. Girls without access to adequate toilets and facilities in schools are at risk of missing or dropping out of school (House et al, 2012; UNICEF, 2012). More research is needed on the health impacts of inadequate menstrual hygiene and which interventions will be most beneficial (House et al, 2012).

Progress on menstrual hygiene management at the national level – India

India is a particularly difficult place to be a menstruating teenage girl. Only 53% of government schools have separate toilets and hygiene facilities for girls and 132 million families do not have a useable toilet at home. But, in late 2015, the Government of India released the first National Guidelines on Menstrual Hygiene Management, a recognition of the widespread problem and its effects on the health and dignity of girls and women, and a call for action at many levels. The guidelines call for a multilevel approach involving the participation of state and district officials, public health officials, community workers, teachers and school staff, and men and boys. Although it is just a start, it explicitly recognizes that in order for girls to have dignity and remain in school they require awareness, information, affordable and hygienic menstrual absorbents, access to a separate toilet with private space for cleaning, washing facilities at home and at school, and infrastructure for disposal of used menstrual absorbents (Government of India, 2015).

Arsenic and fluoride: Poison in the well

It can take years of exposure before the damage from chemicals in drinking-water becomes apparent. Chemicals may be introduced from a variety of human activities, such as from fertilizers and pesticides, industrial effluent, through the process of water treatment or through corroded pipes. Arsenic and fluoride are among the chemical contaminants in drinking-water from natural geological sources with the greatest health impacts when in excess. High levels of both are especially harmful for children. High levels of arsenic and fluoride can occur naturally in water – especially groundwater (WHO, 2006; Winkel et al, 2008). Insidiously, neither arsenic or fluoride give taste or odour to the water, and they lead to a wide range of health impacts. Both can also contaminate foods or indoor air where coal is burned for domestic uses.

Arsenic

Arsenic is a known human carcinogen, which has been shown to cause skin, lung and bladder cancers, as well as serious diseases of the heart and lungs (JECFA, 2011; WHO, 2010). Prenatal exposure to arsenic can result in spontaneous abortion, stillbirth and preterm birth, as well as impaired mental development (Majumdar & Guha Mazumder, 2012; WHO, 2010). Those exposed to arsenic *in utero* and during childhood are at much greater risk of developing cancers and lung disease as adults (Smith et al, 2006). Arsenic can occur naturally in groundwater, as seen most frequently in Asia, including in China, India and Bangladesh (Ravenscroft, 2007).

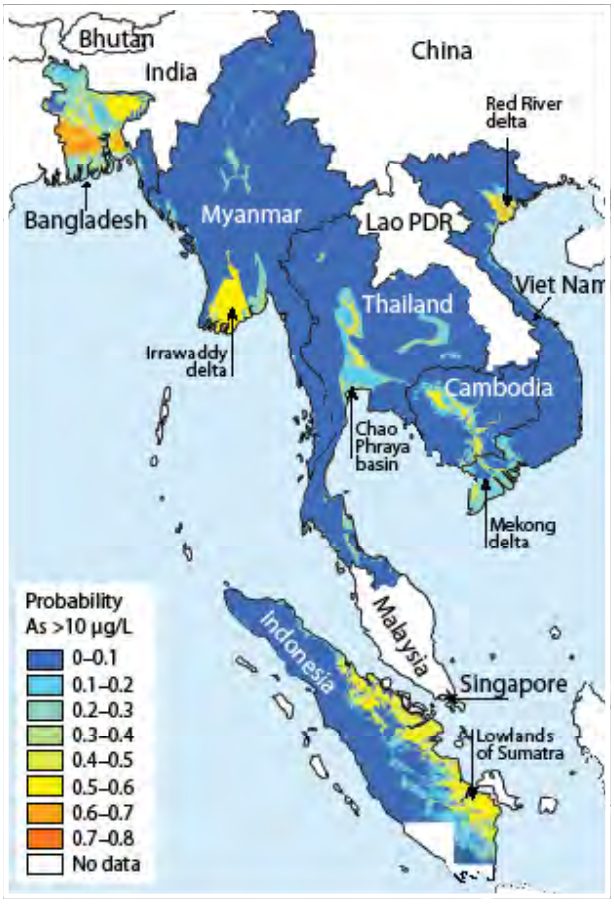
The health effects of arsenic may include:

- Skin pigmentation changes and skin thickening (hyperkeratosis) (WHO, 2016).
- Cancer of the skin, lungs, bladder and kidney (Straif et al, 2009; WHO, 2016).
- Cardiovascular disease (WHO, 2016).
- Lung diseases including bronchiectasis and chronic obstructive pulmonary disease (Smith et al, 2006).
- Reduced intellectual function (Majumdar & Guha Mazumder, 2012).

Critical to affected communities is taking action to prevent further exposure to arsenic by providing safe water supplies for drinking, food preparation and irrigation of food crops. There are a number of ways to reduce levels of arsenic in drinking-water by using rainwater and surface water treated with arsenic removal technology (WHO, 2016).

Modelled probability of arsenic in groundwater exceeding the WHO guidelines for drinking-water of 10 µg/dL in some Member States of the WHO South-East Asia Region

Estimated arsenic levels in groundwater in South-East Asia



Researching the health impacts of early arsenic exposure

From 1958 to 1971, water sources in the city of Antofagasta, Chile, were contaminated with arsenic (from geological sources and mining) until an arsenic-removal plant was installed. Studies on health impacts in adulthood following childhood exposure in Antofagasta during this time showed increases in mortality from lung, liver, larynx and bladder cancer, renal diseases and bronchiectasis, when exposures to contaminated drinking-water occurred in early life (childhood and/or *in utero*). When exposure occurred before birth and during childhood, bronchiectasis mortality rates were higher than for those whose exposure occurred only in childhood (Smith et al, 2006; Smith et al, 2012).

Fluoride

Unlike arsenic, fluoride does not cause cancer, but it does affect bone structure. Small amounts of fluoride strengthen bones and prevent dental caries, but large amounts make bone tissue brittle and subject to breaking or deformation. Fluoride exposure can occur through drinking-water, either from natural sources or artificial fluoridation. Excessive ingestion of toothpaste and mouth rinses can also lead to significant fluoride exposure. When children are exposed to excessive fluoride, developing teeth can be permanently damaged, leading to irreversible dental mottling and pitting of the enamel. Severe dental mottling due to water contamination is found in India, China and parts of Africa, but mild and moderate dental fluorosis is common throughout the world. The public health requirement is to maximize the beneficial effects of fluoride in drinking-water supplies for preventing tooth decay, while minimizing unwanted dental and potential general health effects (WHO, 2006).

The health effects of fluoride:

- Low levels prevent tooth decay (WHO, 2006).
- High levels cause tooth discolouration and pitting (WHO, 2006).
- Very high levels cause crippling skeletal damage (WHO, 2006).
- Exposures during childhood are suspected to reduce intelligence (Choi et al, 2012; Ding et al, 2011).

SDGs

Chemicals in water are addressed in both SDG Target 3.9, "by 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination", and Target 6.3, "by 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally". Close monitoring of both water quality and related health effects is necessary to reduce negative health effects of arsenic and fluoride.

Key facts

- In Bangladesh, 25% of households drink water contaminated with arsenic at levels above the WHO guideline value of 10 parts per billion (Pathey, 2015).
- Globally, 60–90% of schoolchildren have dental caries (Petersen, 2003). Fluoridation can increase the proportion of children without cavities by 14%–15% (Iheozor-Ejiofor et al, 2015).
- Between 1999 and 2004 in the USA, 3.6% of children ages 12–15 had moderate or severe dental fluorosis (Beltrán-Aguilar et al, 2010).

Policy action priorities

Monitoring and regulation are important – countries should review the occurrence of chemicals in drinking-water and monitor and regulate those that are relevant and of concern to health. Water safety plans, incorporating an assessment of local risks and implementation of mitigation options, should be developed, implemented and regularly verified through audits and compliance testing. Water sources should be protected to avoid contamination or designated as unsafe if contamination (e.g. arsenic) cannot be controlled.

Researching the health impacts of early arsenic exposure

A 12-year-old girl from the province of Buenos Aires, Argentina, presented with migraines and hypertension and was medicated for a year. She then went for specialized consultation to determine possible environmental factors behind her symptoms. During in-depth questioning, her mother mentioned that the girl's aunt and other neighbours had experienced problems due to arsenic present in the drinking-water in the area. After testing, high arsenic levels were found in the patient's urine. The girl was advised to drink bottled water and stop using well water. Her hypertension and arsenic levels dropped after three months, and anti-hypertensive medication was withdrawn, with blood tension remaining low. The local municipality has also intervened by delivering bottled water to the girl's house (M Gaioli, unpublished observations, 2016).

Vector-borne diseases: Environmental prevention

Over half of the world's population lives in regions, mostly tropical or subtropical, where diseases transmitted by mosquitoes, ticks, snails, flies and other small organisms are endemic. The parasites, bacteria and viruses transmitted to humans by these vectors account for one sixth of the global burden of illness and disability (WHO, 2014a). In such regions poverty is rife and access to health care limited, and children and pregnant women are affected disproportionately. Vector-borne diseases are very sensitive to changing climatic and environmental conditions. For example, through the movement of people, the Zika virus is thought to be capable of spreading to new regions and able, through climate change, to sustain its vector – mosquitoes (WHO, 2016a). The virus may cause microcephaly and other central nervous system malformations in infants when a pregnant mother is infected (WHO, 2016a). The environment, however, can also provide the key to the management and control of vector-borne diseases.

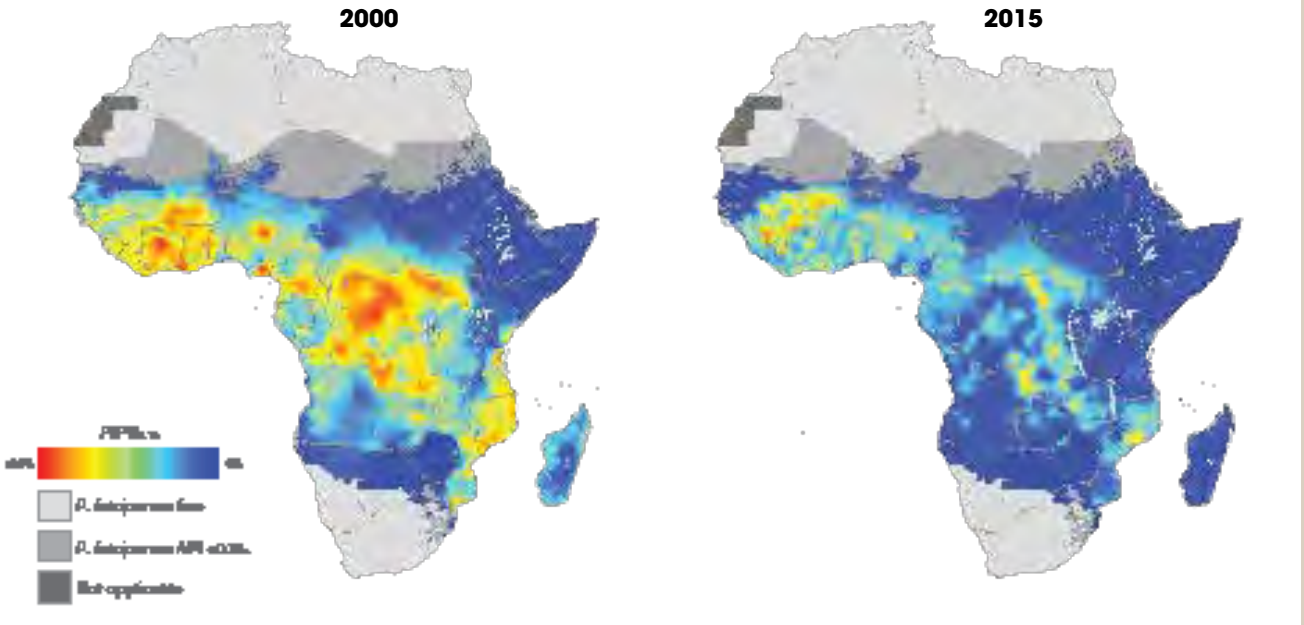
Malaria and dengue

Malaria causes the greatest burden of all vector-borne diseases, killing one child every two minutes. Globally, the disease caused an estimated 306 000 under-five deaths in 2015, of which 292 000 were in Africa. Encouragingly, between 2000 and 2015, the number of malaria deaths in the under-five age group declined by 58% globally and in the WHO Africa Region (WHO, 2016g). Nevertheless, in 2015 malaria still accounted for one in ten child deaths in sub-Saharan Africa (WHO, 2015a).

Case management for malaria involves prompt diagnosis and treatment of the disease with appropriate antimalarial medicines. In 2014, 78% of people presenting with suspected malaria in public health-care facilities had a diagnostic test (WHO, 2015a). It is estimated that fewer than 20% of children under five years of age with a *P. falciparum* malaria infection receive the recommended treatment, which is artemisinin-based combination therapy (WHO, 2015a).

In the past 50 years, dengue incidence has increased 30-fold and more than 3.9 billion people – over half of the world's population – are now at risk (Brady et al, 2012; WHO, 2015b). Severe dengue affects most Asian and Latin American countries and has become a leading cause of hospitalization and death among children in these regions. About 2.5% of those hospitalized with severe dengue die (WHO, 2015b), although mortality is considerably reduced with good medical care.

Estimated *P. falciparum* (malaria) infection in children age 2–10 years, 2000 and 2015



Environmental management – win-win solutions to reduce vector-borne disease

Environmental management is a nontoxic and sustainable approach to controlling the vectors that cause disease. It can involve:

- Permanent changes and infrastructure investments (e.g. water infrastructure design, building drains and wastewater management).
- Environmental modification (e.g. canal maintenance and removal of aquatic vegetation).
- Reduction of contact between the vector and humans (e.g. window screens).

Environmental management can be very effective and interventions should be adapted to local vector ecology (Utzinger et al, 2001; WHO, 1980). Water and vegetation management strategies can substantially reduce the risk of malaria by an impressive 88%; modification of human habitation to decrease contact with mosquitoes can also reduce the risk of malaria by 80% (Keiser et al, 2005). Rising global temperatures are already favouring the spread of disease-transmitting mosquitoes and the more rapid development of the malaria parasite. WASH improvements and interventions will be critical in the long-term control of malaria and neglected tropical diseases, particularly schistosomiasis and lymphatic filariasis (targeted for intensified control or elimination by 2020) (WHO, 2015c).

Examples of vector-borne diseases that cause death among children and related environmental interventions

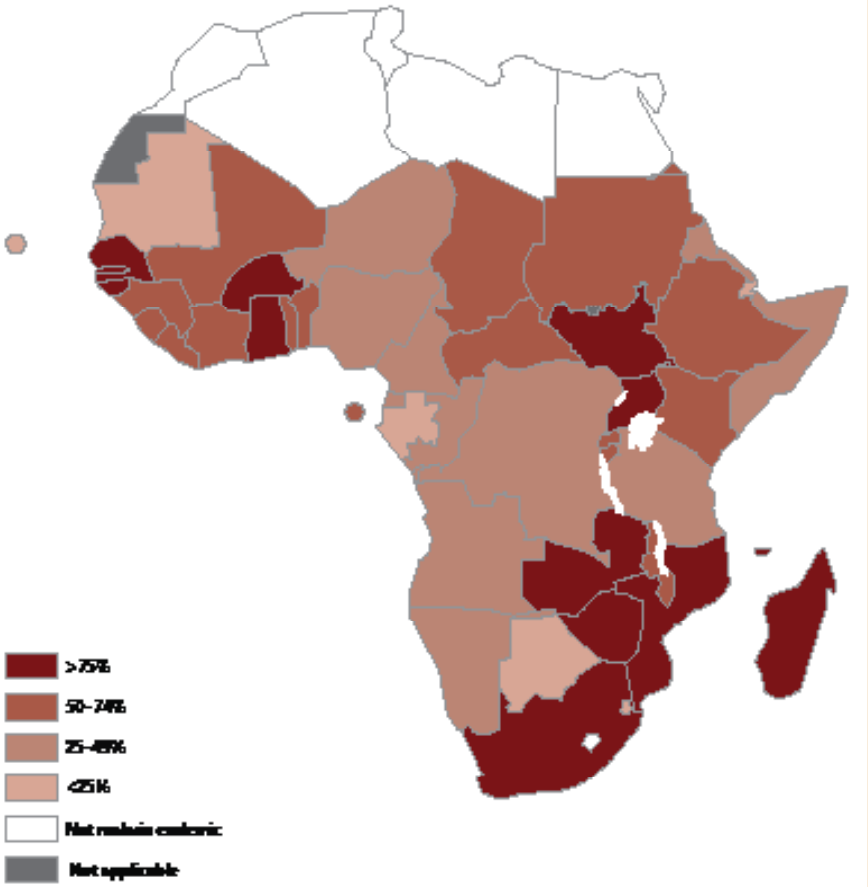
Disease	Vector	Environmental interventions
Malaria	Mosquitoes transmit the malaria-causing parasite, which triggers fever, chills and a flu-like illness at first. Around 70% of deaths are among children under five years of age.	Reduce vector breeding sites and contact with humans, e.g. through modifications to housing.
Dengue fever	Mosquitoes transmit the virus, producing a severe flu-like illness.	Remove stagnant water; management of water bodies and any other potential mosquito breeding sites around the house.
Schistosomiasis	Flat worms, whose life cycle takes place partly in freshwater snails, burrow through the skin. In children, this can cause anaemia, stunting and a reduced ability to learn, although the effects are usually reversible with treatment. 200 million people, many of them children, are currently infected.	Excreta management; safe water supply; safe agricultural practices; snail control; worker protection.
Lymphatic filariasis	Mosquitoes transmit worms that infect the lymphatic system, usually in childhood. Damage to the lymphatic system acquired over time becomes visible in adulthood with painful swelling of skin, limbs and genitals.	Modification of drainage and wastewater ponds; freshwater collection.
Japanese encephalitis	A viral disease transmitted by mosquitoes in Asia, which can cause the sudden onset of headache, high fever, coma, tremors and convulsions. 75% of cases occur in children under 15 years of age.	Management of irrigation areas and distribution of farm animals; personal protection (noting that the main intervention is based on vaccination).
Leishmaniasis	Transmitted by sandflies, this parasite causes skin lesions and damage to internal organs. It kills 20 000–30 000 people each year.	Housing, cleanliness of domestic environment.
Chikungunya	A viral tropical disease transmitted by mosquitoes that produces fever, skin rash and incapacitating joint pains.	Remove stagnant water; management of water bodies around the house.
Yellow fever	A viral haemorrhagic disease transmitted by mosquitoes, which causes fever, muscle pain, headache, shivers, loss of appetite and vomiting.	Reduce vector breeding sites in urban areas.
Chagas disease	The protozoan parasite is generally transmitted by triatomine bugs and can cause fever, headache, muscle pain and difficulty in breathing. The chronic phase may lead to cardiac, digestive and neurological disorders. Some 6 to 7 million people are infected globally.	House improvements; food hygiene and safe food storage.
Lyme disease	A bacterium that is transmitted by an infected deer tick causes fever, chills, headache, fatigue, and muscle and joint pain.	Home and garden improvements; personal protection.
Zika virus	A virus transmitted by mosquitoes that can cause fever, rash, conjunctivitis and Guillain-Barré syndrome in adults, and microcephaly and severe brain damage in some infants infected during gestation.	Remove stagnant water; management of water bodies and any other potential mosquito breeding sites around the house.

Sources: Based on Campbell et al, 2011; Pruss-Ustun et al, 2016; WHO, 2014a; WHO, 2014b; WHO, 2015a; WHO, 2016a; WHO, 2016b; WHO, 2016c; WHO, 2016e; WHO, 2016f.

Insecticide-treated nets and indoor residual spraying

The control of some species of mosquitoes that spread vector-borne diseases is strengthened by insecticide-treated nets (ITNs) and indoor residual spraying (IRS). In 2014, over half the population at risk of malaria in Africa had access to an ITN or were protected by IRS (see map). The proportion of children under five sleeping under an ITN has increased substantially in sub-Saharan Africa, from less than 2% in 2000 to an estimated 68% in 2015 (WHO, 2015a). Other species of mosquito, like the *Aedes aegypti* that transmits dengue fever, yellow fever, chikungunya and Zika virus, are active during the day and less affected by ITNs and IRS. For these vectors, alternative methods such as space spraying are needed to control their populations.

Percentage of population at risk protected by ITNs or IRS, 2014



SDGs and international initiatives

SDG Target 3.3 calls to "by 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases". This target also depends on Target 6.1, "by 2030, achieve universal and equitable access to safe and affordable drinking water for all" and Target 6.2, "by 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations".

Specific criteria to achieve Target 3.3 include:

- 90% reduction in the global malaria mortality rate and malaria case incidence by 2030 from the 2015 rate.
- Malaria elimination from at least 35 countries by 2030.
- 90% reduction in the number of people requiring interventions against neglected tropical diseases by 2030 from the 2015 level.
- Elimination of open defecation by 2025.
- Access to basic drinking-water supplies and handwashing facilities at home for all by 2030.
- Universal access to improved sanitation in the home by 2040 (WHO, 2015d; WHO, 2015e).

"Ensuring the continued reduction and elimination of malaria will generate benefits for entire economies, businesses, agriculture, education, health systems and households"

Ban Ki-moon, former Secretary-General of the United Nations

WHO Pesticide Evaluation Scheme

The WHO Pesticide Evaluation Scheme (WHOPES) makes recommendations on pesticides (including insecticides) and their use in public health. The use of insecticides for IRS, space spraying and larviciding (targeted at the larval stage of the insect) raises concerns over pesticide resistance and potential effects the chemicals may have on the health of vulnerable populations and the environment. WHO has developed specific guidance and risk assessment models for the various insecticide-based methods to ensure there are no unacceptable risks to vulnerable populations, including children (WHO, 2012).

Key fact

Malaria control activities are estimated to have saved about US$ 900 million in direct medical costs in sub-Saharan Africa through reducing the number of new malaria cases. However, the annual investment for malaria control and elimination needs to increase from US$ 2.5 billion in 2014 to US$ 6.4 billion per year by 2020 and to US$ 8.7 billion by 2030 in order to achieve the ambitious targets of the SDGs (WHO, 2015a).

Controlling vegetation reduces leishmaniasis in Tunisia

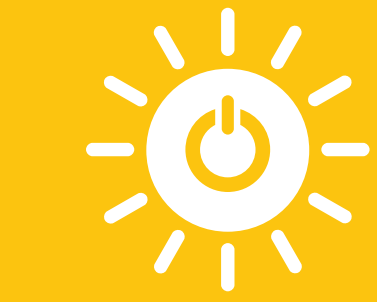
The vector-borne disease leishmaniasis is caused by a parasite carried by the fat sand rat, found in North Africa and the Middle East. A control strategy tailored to the Sidi Saad area of the Gafsa and El Guettar oases in central Tunisia successfully eliminated the rodents' habitat and food plants. As the fat sand rat population depends directly on Chenopodiaceae (goosefoot) vegetation, targeted control of this vegetation near flood areas and dams at the edge of communities can be undertaken to control fat sand rat populations. This environmental intervention is most cost-effective when used in compact settlements (Fichet-Calvet et al, 2000).

Families and communities can play their part by controlling vector breeding grounds. The simple intervention of covering water storage containers can reduce vector breeding and may also reduce faecal contamination of water at the household level.

A breath of fresh air: Steps towards SDGs 7 and 13

Part 3

A breath of fresh air: Steps towards SDGs 7 and 13



Climate change:
Building resilience together

Changing climate patterns worldwide are affecting our children's health. The accumulation of greenhouse gases in the atmosphere is raising temperatures and exposing populations to more severe and frequent extreme weather events and new ranges for vector-borne diseases. It also undermines many social and environmental determinants of health, such as safe drinking-water, clean air, adequate nutrition and secure shelter, all of which are critical for our children's well-being.

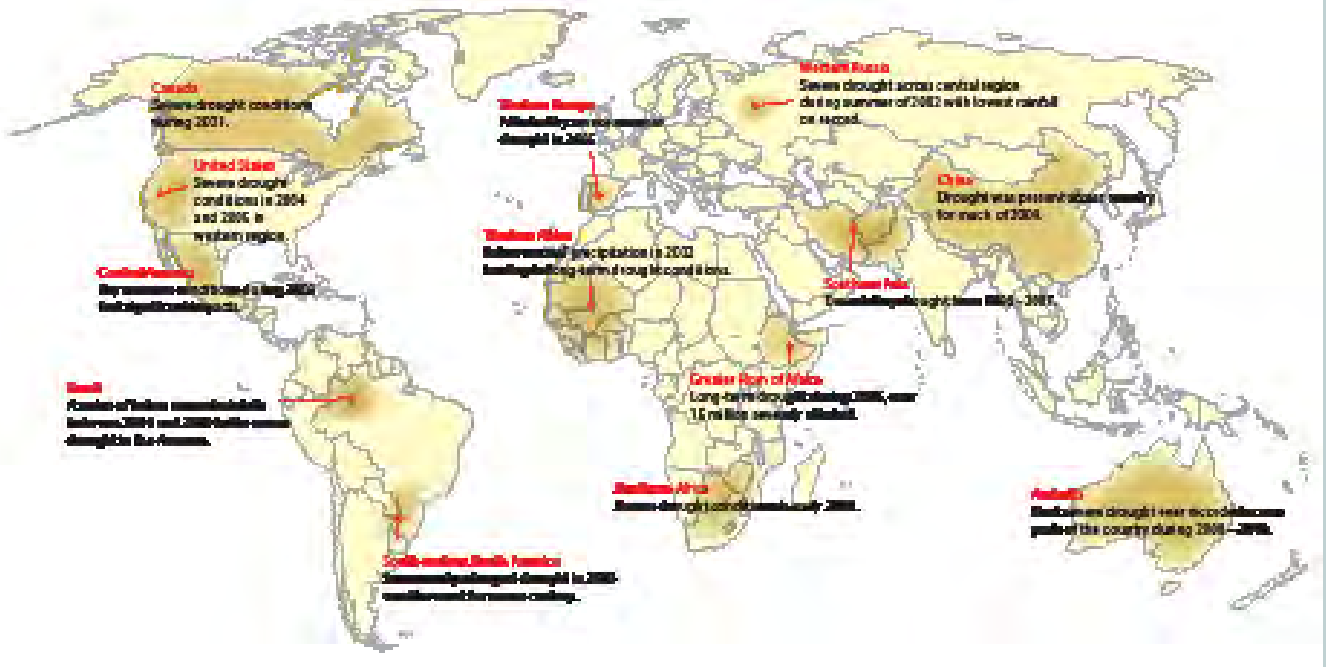
Changing patterns of disease

Climate change impacts the health risks people are exposed to, and it is children, particularly those from low-income populations living in marginal areas in developing countries subject to flooding and droughts, who are the most vulnerable (Perera, 2016). Climate change is, for example, expected to cause 95 000 additional deaths per year between 2030 and 2050 due to childhood undernutrition (WHO, 2014a). Variable rainfall patterns are likely to affect the supply of fresh water, raising the level of diarrhoeal disease, which killed approximately 526 000 children under five in 2015 (WHO, 2016a). The transmission season of some important vector-borne diseases is likely to increase and their geographic range change. Malaria, a climate-sensitive vector-borne disease, killed 438 000 people in 2015 – mainly African children under five years old (WHO, 2015a), and under climate change scenarios, malaria parasites and the mosquitoes that carry them will reproduce more quickly and live longer in many areas, increasing transmission. Temperature changes due to climate change have also caused increased frequency of deadly heat waves, putting children at risk of heat stress, renal disease and respiratory illness (Knowlton et al, 2009).

Flexible interventions in drought stricken areas

During a recent drought in Wajir, northeast Kenya, flexible funding allowed interventions to adjust to meet varying needs rather than providing only food supplementation. This included increasing trade prior to the drought, destocking support at the drought's peak, vaccination to halt a disease outbreak and then support for the livestock trade through the rest of the drought (Hedlund & Knox Clarke, 2011).

Major drought events from 2000–2010



Climate change and asthma

Asthma is a common chronic disease, with an estimated 250 million people worldwide experiencing symptomatic asthma in 2015 (GBD 2015 Disease and Injury Incidence and Prevalence Collaborators, 2016). Asthma can be caused or triggered by various factors, including poor air quality (from ground-level ozone to particulate pollution) and the presence of strong airborne allergens. Climate change can affect air quality through various pathways, from increasing ground-level ozone concentration to raising pollen levels caused by altered growing seasons. Changes in precipitation will favour mould growth; mould spores and particulate matter may not only cause respiratory disease but also worsen existing conditions both in children and adult populations susceptible to asthma, respiratory allergies and airway diseases (Portier et al, 2010). A warmer planet with progressively higher carbon dioxide concentrations will result in increasing levels of ground-level ozone, pollen and mould.

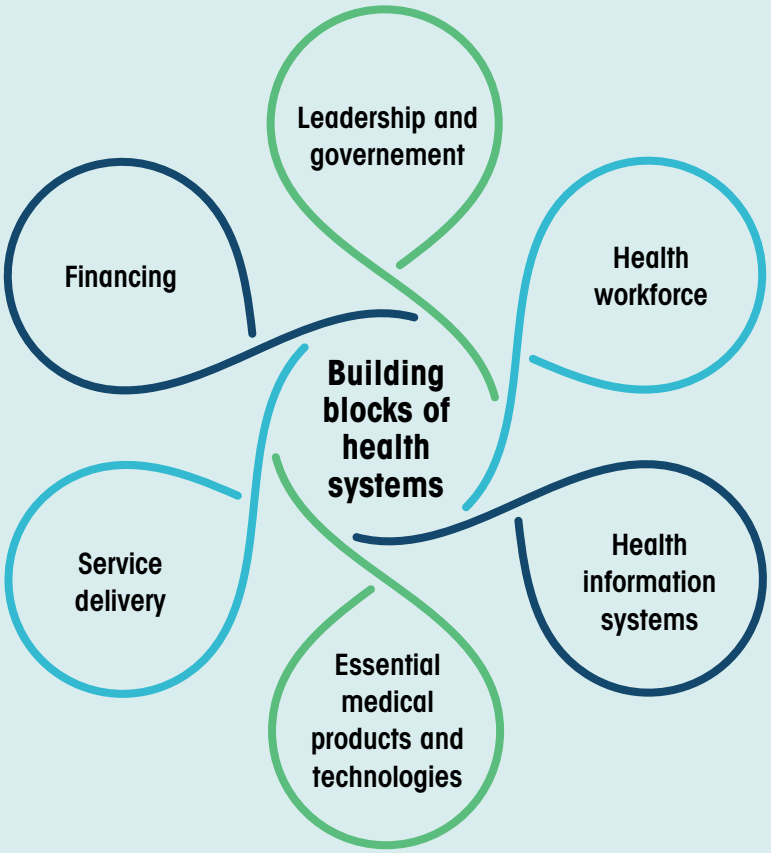
SDGs and international initiatives

SDG 13 aims to "take urgent action to combat climate change and its impact". Its targets focus on the integration of climate change measures into national policies and the improvement of education, awareness raising and institutional capacity on climate change mitigation, adaptation, impact reduction and early warnings.

In December 2015, the United Nations climate treaty was agreed upon by representatives of 195 countries in Paris, taking a major step in combating climate change. According to this agreement, possibly the most important public health agreement in recent history, countries are committed to lowering their greenhouse gas emissions with the target of holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the increase to 1.5°C. This aim requires joint mitigation efforts across sectors to be prioritized to support the shift from fossil fuels to sustainable and cleaner energy sources (UN, 2015).

In a comprehensive health response to climate change, WHO has proposed an operational framework for health systems in order to strengthen their public health functions and increase resilience to climate variability. In a changing climate, health decision-makers should consider a full range of functions that need to be strengthened to increase climate resilience, prepare adequately for health emergencies, control disease burdens, provide coverage of basic health-care and public health services, manage inequity, and use resources in a cost-effective way (WHO, 2015b).

WHO operational framework for building climate resilient health system



Short-lived climate pollutants

Carbon dioxide is not the only greenhouse gas that increases climate change. Short-lived climate pollutants methane, black carbon and hydrofluorocarbons (HFCs) remain in the atmosphere for shorter periods than carbon dioxide but can be much more potent. Black carbon in particular is one of the major components of indoor and outdoor air pollution, which kills millions each year. Reducing short-lived climate pollutants therefore presents an opportunity to significantly reduce global warming, and to cut deaths from air pollution. The Climate and Clean Air Coalition is a joint effort of governments, civil society and private companies to reduce the emissions of short-lived climate pollutants from multiple sectors. The coalition's action complements global efforts to reduce carbon dioxide emissions to improve air quality and prevent climate change. The coalition raises awareness, develops regional and national strategies to reduce emissions, promotes best practices and facilitates scientific research on these short-lived pollutants (Climate and Clean Air Coalition, 2016).

El Niño 2015–2016

Extreme climate events are expected to become more frequent with global climate change; the El Niño phenomenon provides a case for understanding the health consequences of such events. El Niño takes place every two to seven years when sea water temperatures on either side of the equator in the Pacific Ocean vary from the norm, changing rainfall patterns and temperatures. The 2015–2016 "super" El Niño was the most severe in recent decades, and globally, 2015 and 2016 were the hottest years on record (WHO, 2017). The effects of El Niño are most pronounced in the tropics, which experience extreme weather, including drought and temperature increases as well as flooding, unusually heavy rains and cyclones. For instance, severe flooding in Paraguay in December 2015 caused 100 000 people to be evacuated from their homes, while extreme drought has led to acute water shortage for 30 million people in southern Africa. Flooding increases the risk of vector-borne diseases, respiratory infections and damage to health facilities, as demonstrated by cholera outbreaks in Africa and the Americas and lasting damage to health infrastructure in Peru and Ecuador from the 1997–1998 El Niño. Drought, as well as poor water and sanitation conditions leading to diarrhoeal diseases and intestinal infections, can cause malnutrition in children. As demonstrated by the recent effects of El Niño, the climate resilience of health systems needs to be strengthened to prepare adequately and respond to emergencies that affect millions of vulnerable people, including children, especially in the Horn of Africa, southern and eastern Africa, South Pacific, Central America and South Asia (WHO, 2016b).

Policy action priorities

Cross-sector collaboration on climate change mitigation can result in major health benefits

Various sectors contribute to the energy and economic growth choices that drive climate change. Electricity, heat production, agriculture and land use, industry, transport and construction are all critical to strategies reducing greenhouse gas emissions. If policies in these sectors address air pollution and climate change together, this will simultaneously reduce health burdens (WHO, 2015c). In 2012, over 4 million deaths were attributable to household air pollution, largely from solid fuel combustion, and more than half a million of these deaths were from acute lower respiratory infections in children under five, making household air pollution the largest risk factor for childhood pneumonia (WHO, 2014c). Health protection through climate mitigation policies and actions will benefit the health of current and future generations and will support countries in their efforts to meet SDGs through:

- Sustainable public transport and urban planning policies that promote walking and cycling.
- Promotion of cleaner household energy for cooking, heating and lighting.
- Policies that moderate consumption of red and processed meat, to reduce methane emissions, and increase fruit and vegetable intake.

Ambient air pollution: The unseen threat outdoors

As children grow, develop and move beyond their homes to explore the wider world, there is an unseen threat around them. It can stunt their cognitive development, reduce lung function, trigger asthma and set the stage for problems later in life from cardiovascular disease, stroke, chronic respiratory illnesses and cancers. Outdoor air pollution is a largely invisible hazard, and worldwide its effects are increasing as levels rise in many regions. There have been improvements in air quality in high-income cities in North America, Europe and the Western Pacific Region. However, many cities in the Eastern Mediterranean and Western Pacific regions are experiencing declining air quality. And it is children, together with the elderly, who are most at risk from this invisible hazard.

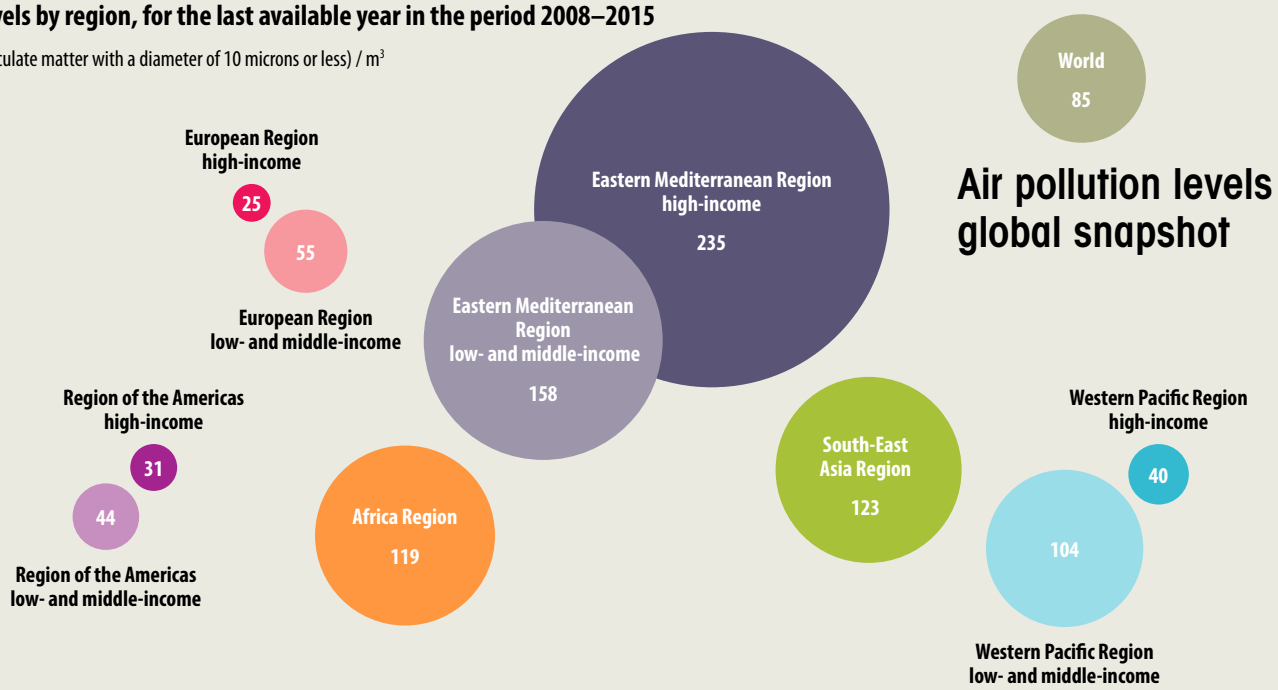
Sources and types

Both urban and rural areas contribute to outdoor air pollution. In cities, the main sources are emissions from vehicles, fossil fuel energy production, residential heating and cooking, and waste incineration (WHO, 2016e). Burning fossil fuels emits, among other pollutants, fine particulate matter, polycyclic aromatic hydrocarbons (PAHs), mercury, nitrogen dioxide, sulfur dioxide and carbon monoxide, which contribute to many damaging health effects (Perera, 2016). Poor urban planning, which leads to sprawl and overdependence on private vehicle transport, is a major factor in urban emissions (Hosking et al, 2011). In rural areas, the major sources of air pollution are the heavy use of agro-chemicals (e.g. fertilizers), burning of agricultural waste, deforestation, charcoal production, biomass burning, domestic heating, cooking and lighting, as well as naturally occurring forest fires and dust storms (Lelieveld et al, 2015; WHO, CCAC, Scovronick, 2015). Dust storms are a particular problem in arid regions, such as North Africa and the Eastern Mediterranean (WHO EURO, 2013a).

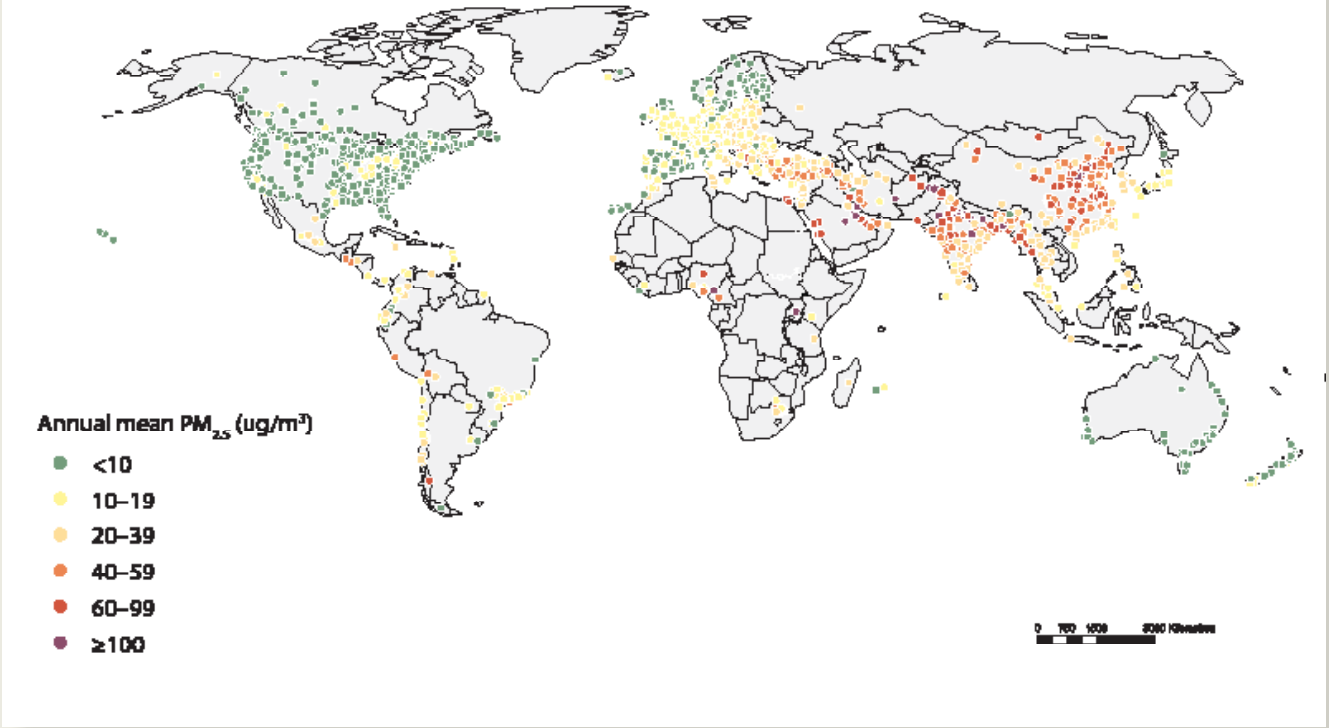
PM_{10}, or small particulate matter with a diameter of 10 microns or less, and its subset $PM_{2.5}$, or fine particles with a diameter of 2.5 microns or less, are widely used indicators for air pollution exposure (WHO, 2016e). These particles contain a toxic mixture of soot, heavy metals, nitrates, sulphates, black carbon and dust particles, which are capable of penetrating deep within lungs and the cardiovascular system (WHO, 2016e). The chemical cocktail of particulate matter and other pollutants varies from place to place. For example, although children in Aba, Nigeria, and Al Jahra, Kuwait, are exposed to similar average annual amounts of fine particulate matter, the mixtures of other pollutants they are exposed to can vary widely (WHO, 2016a).

PM_{10} levels by region, for the last available year in the period 2008–2015

PM_{10} (particulate matter with a diameter of 10 microns or less) / m^3



Concentration of $PM_{2.5}$ in around 3000 urban areas, 2008–2015



Note: Latest available annual mean data for each city in the period 2008–2015.

Monitoring air pollution

Most monitoring of ambient air pollution is currently undertaken in cities. This monitoring shows consistently high levels of air pollution in many urban areas, with a global increase of 8% between 2008 and 2013 (WHO, 2016b). In low-income countries, 98% of large cities have particulate air pollution above WHO guideline levels for $PM_{2.5}$. Many LMICs in WHO's Eastern Mediterranean and South-East Asia regions have annual mean $PM_{2.5}$ levels 5–10 times WHO guideline limits (WHO, 2016b). Almost every city in the Eastern Mediterranean included in the calculations annually exceeded the WHO Air Quality Guidelines on particulate matter between 2008 and 2013 (WHO, 2016c). Cities in North America, meanwhile, have the lowest air pollution levels – with only 20% exceeding WHO guidelines, while Europe is among the highest in high-income regions – with 60% of large cities exceeding guideline limits (WHO, 2016a).

Effects that can last a lifetime

The impacts of air pollution on children begin in the womb. Maternal exposure to air pollution is associated with increases in preterm birth, low birth weight and increased use of health care in the hospital after birth (Ferguson et al, 2013; Pedersen et al, 2013; Trasande et al, 2013). Air pollution is also associated with increased risk of infant mortality (Schwartz, 2004). As children grow, they continue to be at high risk from air pollution because their immune systems, lungs and brains are still developing. Because children spend a lot of time outdoors during peak times of air pollution in the day, their exposure levels are often higher than for adults (Schwartz, 2004).

Exposure to outdoor air pollution is a major asthma trigger, exacerbating attacks and the frequency of visits to doctors and hospitals (WHO EURO, 2013b). Over time, air pollution can lead to chronic deficits in lung function and reduced lung function growth in children and adolescents (Gauderman et al, 2004; Götschi et al, 2008). Ultrafine and fine particulate matter is capable of penetrating from the lungs into the central nervous system (Suglia et al, 2008). Air pollution is a suspected neurotoxin. Infants and children living near heavily trafficked areas are more likely to have cognitive delays and asthma (Gehring et al, 2010; Jerrett et al, 2008; Perera et al, 2009; Suglia et al, 2008; Sunyer et al, 2015).

Long-term exposure to ambient air pollution sets the stage for a number of adverse respiratory and cardiovascular health effects observed in adulthood, including from stroke, cardiovascular disease, chronic lung disease and cancer, and may be a risk factor for diabetes (Beelen et al, 2014; Crouse et al, 2015; Eze et al, 2015; US EPA, 2012). Ambient air pollution, including particulate matter and diesel exhaust, is recognized as causing cancer in adults (Benbrahim-Tallaa et al, 2012; Loomis et al, 2013).

"Pollution should never be the price of prosperity."

Al Gore, 45th Vice President of the United States of America

The need for long-term solutions

There has been growing attention to this children's health problem in recent years, both in the media and among experts. As short-term measures, official "red alerts" have become more common in large cities during pollution peak days, when schools close, traffic is curbed and children are advised to stay indoors (Burke, 2015). However, an urgent shift is needed, prioritizing sustainable and effective interventions for air pollution mitigation to better protect children's health and future development. Measures are available and affordable, but require the will to strengthen good government policies and shift transport, energy and other infrastructure investments to cleaner and greener technologies.

Policy action priorities

- Clean and efficient household energy for cooking, heating and lighting.
- Low emissions and renewable power generation.
- Rapid urban transit on dedicated rights of way, in combination with extensive investment in pedestrian and cycle networks.
- Planned energy-efficient housing, clustered in neighbourhoods with schools, shops and services nearby.
- Focus on creating urban parks, forests and lakes, rather than developing low-density urban sprawl and roads.
- Better waste and sewage management to reduce incineration, and reductions in burning agricultural waste and use of agro-chemicals close to urban areas.
- Improved land use management in rural areas to curb deforestation, agro-burning practices and charcoal production, and improved control of wildfires.
- Consumer-driven shift to healthier diets to reduce the pressure to expand energy-intensive livestock production – a major source of methane (an important greenhouse gas).

Success in southern California

Despite the challenges, there are success stories. Once one of the most polluted urban areas in the United States of America, southern California, has managed to dramatically reduce ambient air pollution over the past 20 years. Strict emissions controls of almost every source of ambient air pollution were introduced, with low emission vehicle programmes, emissions standards for heavy duty and diesel vehicles, emissions reduction standards for power plants and refineries, and programmes to reduce emissions from consumer products. Through these programmes, with more ambitious goals than those required by national legislation, the region has reduced concentrations of several individual air pollutants by between 15% and 65% (Lurmann et al, 2015). This reduction in pollution has been accompanied by significant improvements in the lung function of children in southern California (Gauderman et al, 2015).

Benefits of better air

Measures to combat air pollution will not only help in reducing the heavy toll pollutants take on children's health, but will also yield global benefits – notably, in mitigating climate change and creating healthier urban environments.

Reducing climate change

Air pollution contributes to climate change in both the short and long term. Biomass and diesel combustion, as well as livestock production, produce short-lived climate pollutants including methane and black carbon, which accelerate climate change in the short term (WHO, CCAC, Scovronick, 2015). It has been estimated that reducing these emissions by implementing a set of policy measures could reduce the pace of global warming by as much as 0.6ºC by 2050, as well as prevent millions of deaths per year from air pollution emissions (CCAC, 2016). Thus, the gains to children's health from these measures would be immediate and immense. At the same time, many of the same sources of air pollution also are heavy emitters of carbon dioxide, which contributes to long-term climate change patterns (WHO, CCAC, Scovronick, 2015).

Healthier urban environments

Many of the same strategies that reduce urban air pollution also contribute to healthier urban environments for children and adolescents in powerful ways. Improving urban transit goes hand in hand with better walking and cycling networks – these all allow children and adolescents to move around more safely and easily. In low-income cities, where 50% or more of traffic is on foot and traffic injury is a leading cause of death among children and adolescents, bike and pedestrian routes can reduce these risks. Safe walking, cycling and transit also improve children's independent access to schools, services and, in the case of adolescents, employment and recreation outlets.

Walking and cycling spaces can be integrated into urban parks and forests, stimulating physical activity, while also filtering air pollutants. "Arterial parks" for instance, are a strategy being adopted in many crowded residential cities – where walking or cycling networks are built along narrow green corridors, with play areas, exercise equipment and benches and tables for sitting and picnicking along the way. In addition to making walking and cycling much safer, this strategy also encourages physical activity.

SDGs and international initiatives

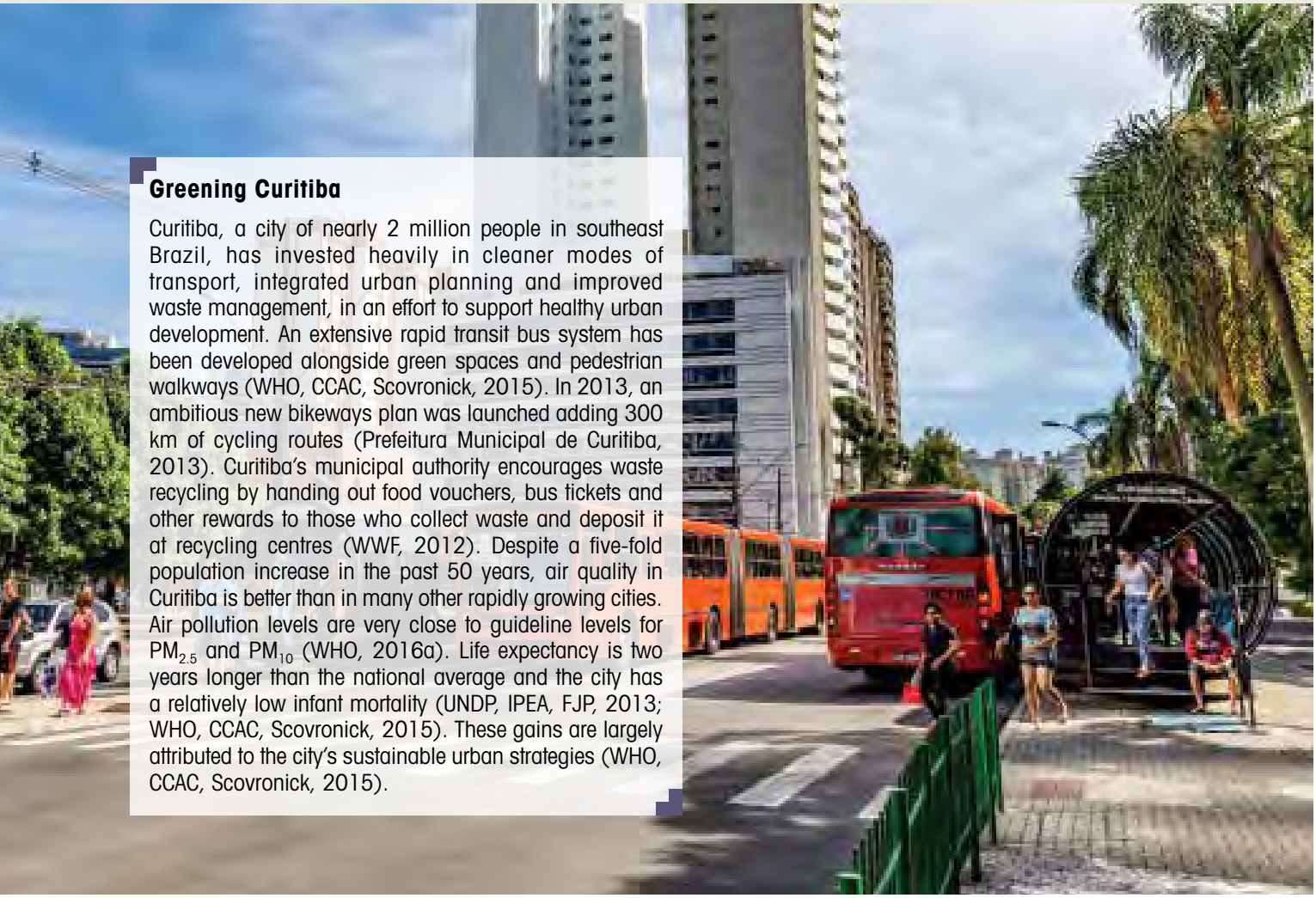
There are strong synergies between strategies that reduce air pollution and current SDG targets. Air pollution abatement efforts can help achieve SDG Target 3.9, which calls to "by 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination", as well as contribute to Target 11.2, which aims to "by 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons".

"Environmental pollution is a blight on people's quality of life and a trouble that weighs on their hearts."

Li Keqiang, Premier of the People's Republic of China

Key facts

- About half of the world's urban population lives in cities that exceed by 2.5 times or more the recommended levels of fine particulate matter ($PM_{2.5}$) set out by WHO air quality guidelines (WHO, 2014).
- Acute respiratory infections are the second largest cause of death in children under five, accounting for 15.5% of deaths (WHO, 2016d).



Greening Curitiba

Curitiba, a city of nearly 2 million people in southeast Brazil, has invested heavily in cleaner modes of transport, integrated urban planning and improved waste management, in an effort to support healthy urban development. An extensive rapid transit bus system has been developed alongside green spaces and pedestrian walkways (WHO, CCAC, Scovronick, 2015). In 2013, an ambitious new bikeways plan was launched adding 300 km of cycling routes (Prefeitura Municipal de Curitiba, 2013). Curitiba's municipal authority encourages waste recycling by handing out food vouchers, bus tickets and other rewards to those who collect waste and deposit it at recycling centres (WWF, 2012). Despite a five-fold population increase in the past 50 years, air quality in Curitiba is better than in many other rapidly growing cities. Air pollution levels are very close to guideline levels for $PM_{2.5}$ and PM_{10} (WHO, 2016a). Life expectancy is two years longer than the national average and the city has a relatively low infant mortality (UNDP, IPEA, FJP, 2013; WHO, CCAC, Scovronick, 2015). These gains are largely attributed to the city's sustainable urban strategies (WHO, CCAC, Scovronick, 2015).

Household air pollution: Switching to healthy home energy

More than a decade into the 21st century, hundreds of millions of children, mostly in LMICs, spend long hours each day in the dense, smoky, toxic haze arising from burning inefficient, polluting fuels for cooking and heating in their homes. Polluting fuels, such as wood, charcoal, coal, dung and crop waste, burned in simple stoves or over an open fire release health-damaging pollutants including fine particulate matter, carbon monoxide, volatile organic compounds and PAHs. These penetrate deep into the lungs leading to respiratory and cardiovascular disease (WHO, 2014). Switching to cleaner fuels and technologies is imperative to improving child health globally, and a number of international initiatives have been launched in recent years to move this issue up on the world's agenda.

Everyday use of polluting fuels

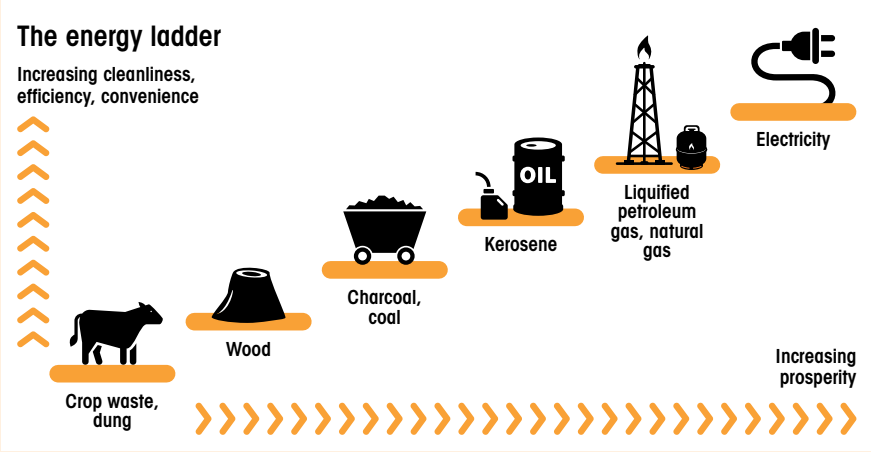
In 2014, WHO estimated that more than three billion people (43% of the world) still used polluting fuels for cooking, and that the resulting household air pollution (HAP) caused over 4 million deaths (WHO, 2016). The situation is particularly dire in South-East Asia, the Western Pacific and Africa, where most of these deaths occur (WHO, 2016). More than half a million of these deaths were from pneumonia in children under five years of age, making HAP the largest risk factor for childhood pneumonia (WHO, 2016).

It is not only cooking fires which can be dangerous for health, as the use of polluting fuels for warmth during cold months can also generate unhealthy levels of HAP. In areas without reliable electricity, children often rely on kerosene lanterns or candles to read or complete their school work at night. Kerosene, previously regarded as a cleaner fuel, emits noxious levels of fine particulate matter into the home, and also presents a number of other safety risks, particularly for children. Kerosene is a leading risk factor for childhood poisonings in the developing world, especially when it is stored in attractive containers such as old milk bottles or unused soda bottles (see *Poisons: Keep out of reach*). It is also a major source of fires and accidental burns in LMICs. Homes relying on unprocessed or "dirty" coal face additional health risks from airborne mercury, arsenic lead, selenium and fluorine emitted during its use (WHO, 2014).

Health effects of HAP on women and children

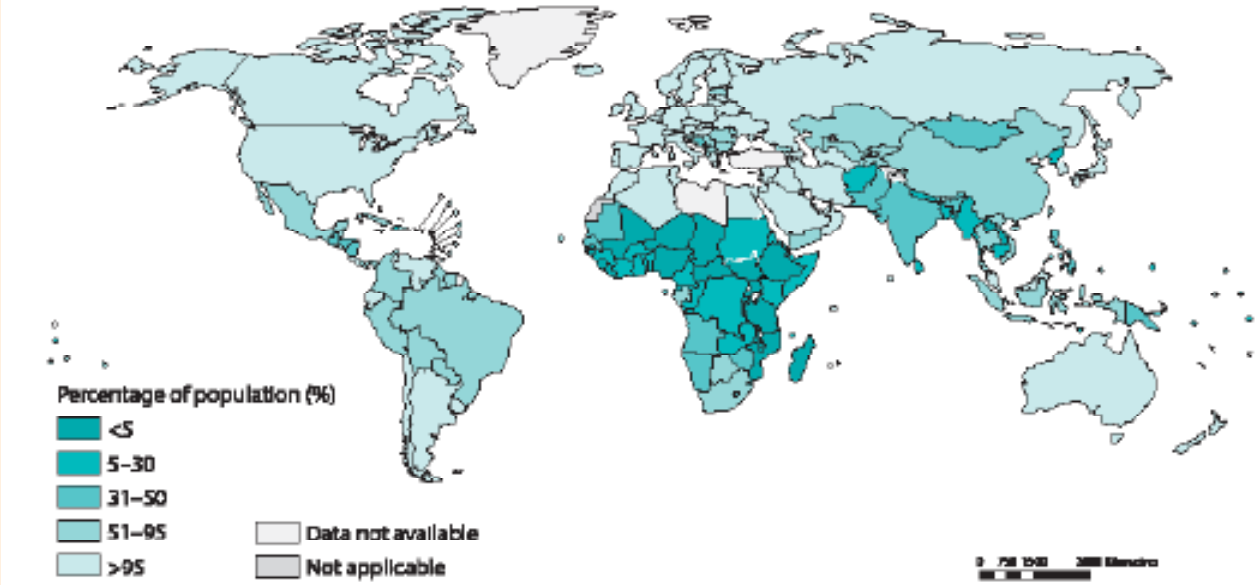
Among women chronically exposed to HAP during pregnancy, there is epidemiological evidence that links HAP exposure to an increased risk of stillbirth, as well as to preterm birth, low birth weight and stunting of their children (WHO, 2016). Emerging evidence has also shown that early life exposure to HAP leads to adverse effects on cognitive development (Dix-Cooper et al, 2012).

Owing to the long hours they spend at home and their close proximity to the hearth, women and children experience the highest rates of HAP exposure in regions dependent on polluting home fuels. In poorly ventilated dwellings, indoor smoke concentrations of fine particulates from the use of polluting fuels can be 100 times higher than acceptable levels (WHO, 2016). Infants are often kept close to their mother or carried on her back while she is cooking and therefore spend much of their early life, when their immune system is still immature, breathing these pollutants, which may lead to rhinitis, cough, wheezing and asthmatic conditions.

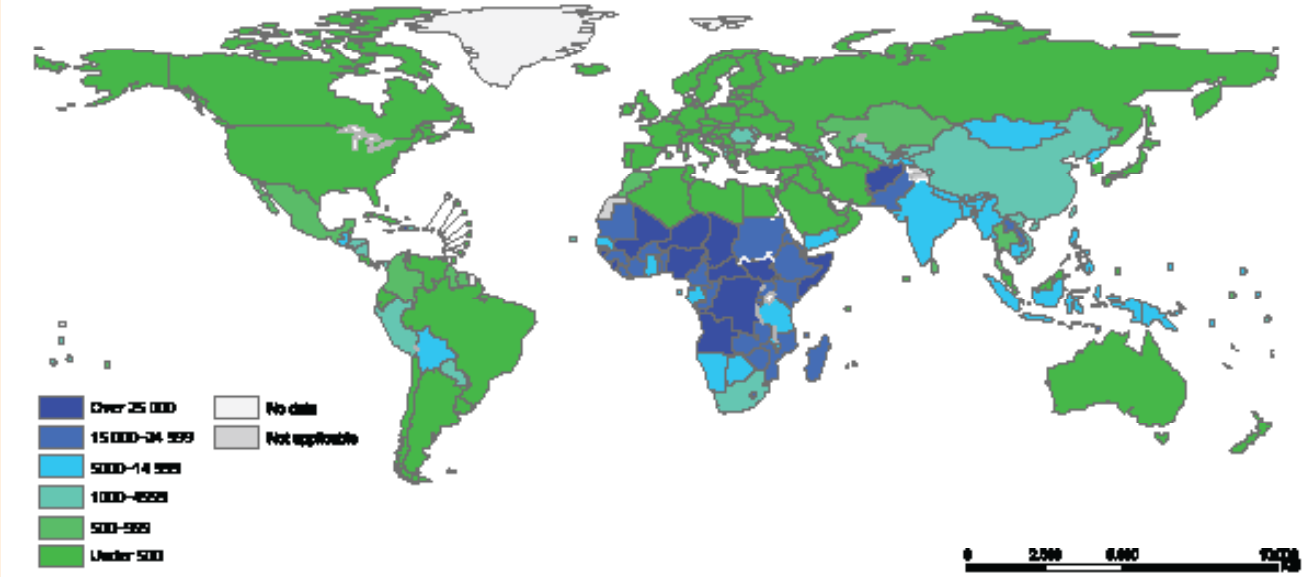


The health consequences of inefficient household energy extend far beyond disease alone. Children, often at the expense of their schooling or playtime, are given the task of cooking on inefficient stoves or gathering fuel. Fuel collection forces children to walk long distances with heavy loads. This work can lead to musculoskeletal disorders, and can put children, particularly girls, at higher risk of a violent attack, rape or injury (WHO, 2016).

Percentage of the population with primary reliance on clean fuels and technologies at the household level, 2014



Household air pollution attributable DALYs in children under five years of age, per 100 000 capita, 2012



Household air pollution is a major contributor to outdoor air pollution. In 2010, household air pollution "leaking" outdoors was responsible for almost half a million outdoor air pollution deaths (Lim et al, 2012).

Inefficient household energy use is a major source of climate-changing pollutants, thus contributing to the rising sea levels, droughts and food insecurity that affect those who can least afford it.

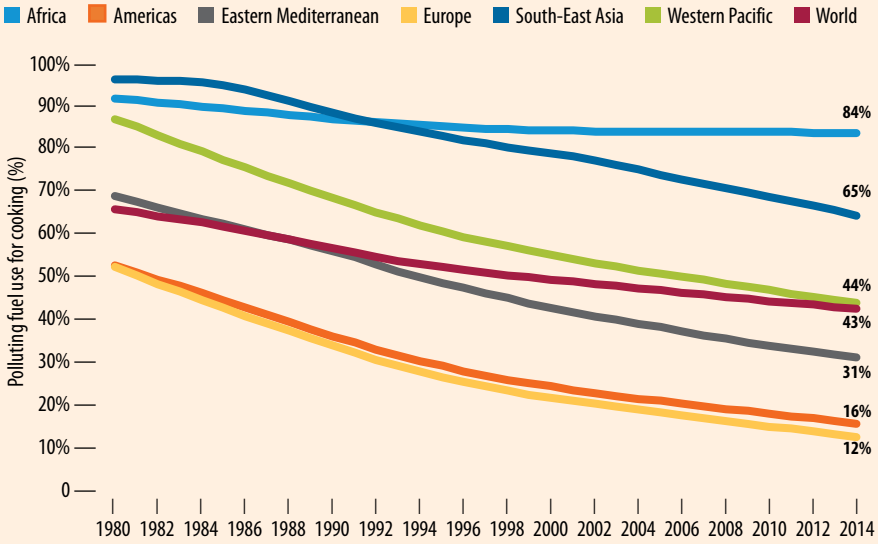
Solutions: Cleaner fuels, cleaner technologies

During the last decade, the percentage of the population using polluting fuels for cooking decreased in a number of countries. Over 100 million fewer people use polluting fuels in Brazil, India and Indonesia, and Algeria and Mauritius have almost completely transitioned to gas for cooking (WHO, 2016). This is partly due to the fact that cleaner burning fuels, such as liquefied petroleum gas (LPG), biogas and ethanol, along with cleaner technologies such as electricity and solar, have become more widely available and offer, in some cases, more affordable home energy options.

More advanced biomass stoves, using fans and/or secondary combustion (gasification) have shown substantial reductions in both fuel consumption and indoor air emissions and will play an important role in the transition to clean household energy, particularly in rural areas. Biogas stoves fuelled by anaerobic digesters of animal, human and crop waste are widely used in India, China and Nepal and some African countries for household cooking and lighting (Adair-Rohani & Bruce, 2011). If the digester is also linked to a latrine, the resulting improvement in sanitation can help prevent worm infestation, diarrhoeal disease and malnutrition (WHO, 2011).

Between 1980 and 2014 the percentage of the global population using polluting fuels for cooking declined from more than 65% to 43%.

WHO regional trends for percentage of the population mainly cooking with polluting fuels in LMICs, 1980–2014



A health professional's role in combating the dangers of HAP

In Uruguay, four-year-old Guillermo used to suffer from respiratory infections every winter. He had also been to the hospital twice for pneumonia. The family doctor noticed that his family was heating their home with a small stove without a chimney where they burned wood and vegetable and plant leftovers. The doctor taught the family about the dangers of breathing smoke, gas and particles from the stove, and now, a new stove with a chimney has been installed to replace the old one. Guillermo has since gone through a whole winter without respiratory symptoms (A Laborde, unpublished observations, 2016).

Sick building syndrome

Sick building syndrome (SBS) caused by deteriorating indoor air quality is characterized by nonspecific symptoms, including irritation of eyes, nose and throat, respiratory problems, headache and fatigue. It occurs in homes, offices, schools and other airtight buildings. The syndrome became common in the 1970s, and has been routinely reported to American school nurses (WHO, 2004). Young children breathe twice as much air in proportion to their body weight than adults, and therefore absorb more toxicants contained in air. In Japan, non-binding guideline values for 13 volatile organic compounds (VOCs) in indoor air were set by the Ministry of Health, Labour and Welfare. However, other unregulated chemicals have been used as replacements in building materials and indoor spaces, causing new types of SBS in recent years. Therefore, control of the total volume of indoor air chemicals is necessary. It has been proposed to limit the total sum of VOCs in indoor air to decrease the occurrence of SBS symptoms (Nakaoka et al, 2013; Saito et al, 2012).

WHO guidelines for indoor air quality: Household fuel combustion

The WHO guidelines for indoor air quality provide recommendations on the fuels and technologies that can be used cleanly and safely in the home (WHO, 2014), and include:

- Emission rate targets (for fine particulate matter and carbon monoxide) that all fuels and technologies used in the home should meet to protect health.
- Recommendations against the use of unprocessed coal and discouraging the use of kerosene in the home.
- Guidance for policy-makers planning to accelerate their transition to cleaner household energy, highlighting the need to prioritize intermediate interventions with the greatest health benefits.
- A good practice recommendation calling on governments and other agencies working with climate change mitigation policies related to household energy to carry out relevant assessments to maximize health and climate gains.

SDGs and international initiatives

SDG Target 3.9 aims to "by 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination" using adult and child mortality attributable to household and ambient air pollution as an indicator. SDG 7.1 specifies "by 2030, ensure universal access to affordable, reliable and modern energy services" in order to increase the primary use of clean home energy fuels and technologies (for cooking, heating and lighting).

The UN Secretary-General's Sustainable Energy for All (SE4All) vision includes three complementary objectives: ensuring universal access to modern energy services; doubling the global rate of improvement in energy efficiency; and doubling the share of renewable energy in the global energy mix. Realizing these three interlinked objectives by the target year of 2030 will drive economic growth, improve social equity and help protect the environment (SE4All, 2011).

The integrated Global Action Plan for the Prevention and Control of Pneumonia and Diarrhoea (GAPPD) proposes a cohesive approach to end, by 2025, preventable childhood deaths due to pneumonia and diarrhoea by bringing together critical services and interventions promoting good health practices, providing appropriate treatment and ensuring universal immunization coverage (WHO, UNICEF, 2013).

"Energy is the golden thread that connects economic growth, increased social equity, and an environment that allows the world to thrive."

Ban Ki-moon,
former Secretary-General
of the United Nations

Second-hand tobacco smoke: Protecting children from harm

At least 250 of the 4000 chemicals in tobacco smoke are known to be very damaging to health and more than 70 cause cancer (IARC, 2012; WHO, 2016). WHO recently estimated that 1.1 billion people age 15 and over currently smoke tobacco (WHO, 2015). However, the effects of tobacco, second-hand smoke and even third-hand smoke extend to those who do not smoke, including fetuses and children unable to take action to avoid exposure.

The effects of tobacco and second-hand tobacco smoke

Globally, about 5 million deaths each year are attributed to direct tobacco smoking. However, even those who choose not to smoke or are too young to understand or move away from smoke are at risk from second-hand tobacco smoke (SHTS). This is the smoke in indoor air that comes from cigarettes, pipes, water-pipes and bidi that non-smokers, including children, breathe. There is no safe level of SHTS exposure, which is estimated to have caused more than 600 000 deaths in 2004 (Oberg et al, 2011).

Infants and children can be severely harmed by exposure to tobacco and SHTS:

- Exposure during pregnancy significantly affects fetal lung development and increases the risk of congenital malformations, including heart, limb, kidney, urinary tract, cleft lip and palate defects, by as much as 13% (Leonardi-Bee et al, 2011; Wang & Pinkerton, 2008).
- Fetuses exposed to SHTS have an increased risk of low birth weight and stillbirth (Prüss-Ustün et al, 2016; WHO, 2016).

Some toxic chemicals in cigarette smoke

Source: DesignIsGood

- Infants exposed to tobacco smoke may be more likely to die from sudden infant death syndrome (SIDS), and in early childhood to have reduced lung function, more respiratory infections, asthma, behavioural problems and difficulty in learning at school (Hwang et al, 2012; Mitchell & Milerad, 1999).
- Exposure during childhood also increases the risk of developing chronic NCDs later in life (Hwang et al, 2012).

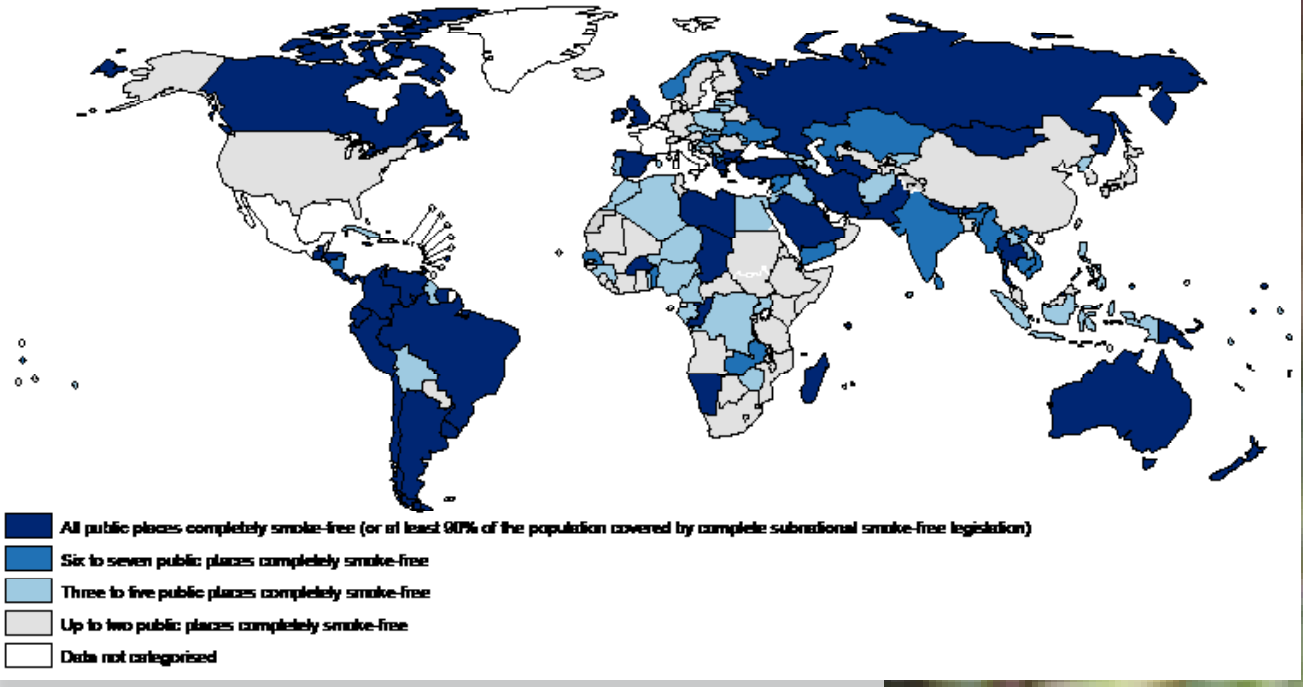
Third-hand smoke

Third-hand smoke consists of the chemicals from cigarette smoke that settle on surfaces and in dust. While playing on the floor, furniture or close to the ground, children can ingest or have skin contact with the chemicals concerned. These chemicals can also be re-volatized into the air and be inhaled, especially by children, who breathe air close to the ground. Third-hand smoke contains many of the same chemicals as first-hand tobacco smoke, but with some transformed into other hazardous substances whose effects are unknown. Tobacco smoke chemicals can remain on surfaces for months (Matt et al, 2011), which underlies the importance of smoke-free environment laws. Family members who smoke inside a house or car while a child is not present may still be exposing the child to hazardous chemicals.

Mixed progress in reducing the risks from tobacco

Although the percentage of people who smoke tobacco globally is slowly falling, the steady population increase means that the number of smokers will remain largely unchanged or even rise slightly to 1.15 billion people by 2025. As many as 81% of children between age 13 and 15 in Cyprus are exposed to SHTS in the home, while 89% of Russian children of the same age are exposed outside the home, in public areas (CDC, 2015). More than 80% of smokers live in LMICs. However, there was some progress between 2004 and 2015. Around 2.8 billion people (40% of the world's population) are covered by at least one tobacco control measure, including laws creating smoke-free environments, warning labels on cigarette packaging and bans on advertising tobacco products (WHO, 2015). Much more remains to be done, with only 18% of the world's population currently protected by comprehensive national smoke-free laws (WHO, 2015).

Smoke-free environments – best practice countries, 2014



SDGs and international initiatives

SDG 3 aims to "ensure healthy lives and promote well-being for all at all ages" specifically including Target 3.8: "Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all". It also acknowledges the underinvestment in the social circumstances and environmental factors affecting health and well-being. Undoubtedly, environmental exposure to tobacco undermines these goals.

Implementation of the WHO Framework Convention on Tobacco Control (FCTC) – a milestone in the promotion of public health – is the major tool for reducing the substantial health and social impacts of tobacco use. In 2008, to assist countries in implementing the WHO FCTC, WHO introduced a practical, cost-effective way to scale up implementation of selected demand-reduction measures included in the FCTC. Labelled under the acronym MPOWER, the six key measures are:

- **M**onitor tobacco use and prevention policies
- **P**rotect people from tobacco use
- **O**ffer help to quit tobacco use
- **W**arn about the dangers of tobacco
- **E**nforce bans on tobacco advertising, promotion and sponsorship
- **R**aise taxes on tobacco.

Key facts

- Prenatal and early life exposure to SHTS increases the risk for SIDS.
- Chemicals present in SHTS can alter child development.
- There are more than one billion smokers in the world.
- Exposure to tobacco smoke further exacerbates the effects of household and ambient air pollution on children's respiratory systems.

Policy action priorities

Legislation should ensure the exclusion of the tobacco industry from trade protections. Protecting public health should be prioritized, especially in view of the powerful legal challenges the tobacco industry mounts around the world to undermine the effects of anti-smoking legislation and fight the impact of branding and advertising regulations (Pattemore, 2013). Warnings against smoking should be mainstreamed in various fields of clinical medicine, such as paediatrics, notably paediatric pulmonology and gastroenterology, obstetrics and gynaecology, and neurology. Health care practitioners can actively support parents, educators and authorities in shaping tailored policies for protecting children from SHTS exposure.

Raising taxes and laws – effective ways to curb smoking

Among measures of particular significance are raising taxes on tobacco, implementing tobacco-free environment legislation and warning about the dangers of smoking. Significant progress is being made with legislation providing for public places where outdoor smoking is prohibited (e.g. on beaches and in parks), private places with indoor smoking prohibition in commonly used residential areas (e.g. halls, corridors), and prohibition within private vehicles. However, fetal exposure and smoking in the home can only be prevented by a drastic fall in the prevalence of adult smoking (Pattemore, 2013).

Belgium introduced indoor tobacco smoke-free legislation in phases, beginning with banning smoking in almost all public places and workplaces, then banning smoking in restaurants, and finally banning smoking in many bars in 2010. Each phase of the ban was accompanied by lowered risks of premature births among Belgian infants. Over five years, the preterm delivery rate decreased by six per 1000 deliveries (Cox et al, 2013).

Ultraviolet radiation: Be safe in the sun

Spending time outdoors is an essential part of an active and healthy lifestyle for children. It is also the best way for the body to obtain vitamin D, necessary for proper bone development. However, time in the sun without adequate sun protection can also lead to harmful ultraviolet (UV) exposure with the associated risks of skin and eye damage and skin cancer. This can occur from relatively short periods of unprotected time in the sun when UV intensity is high or from repeated exposure to sun or sunbeds over time.

Children and UV radiation

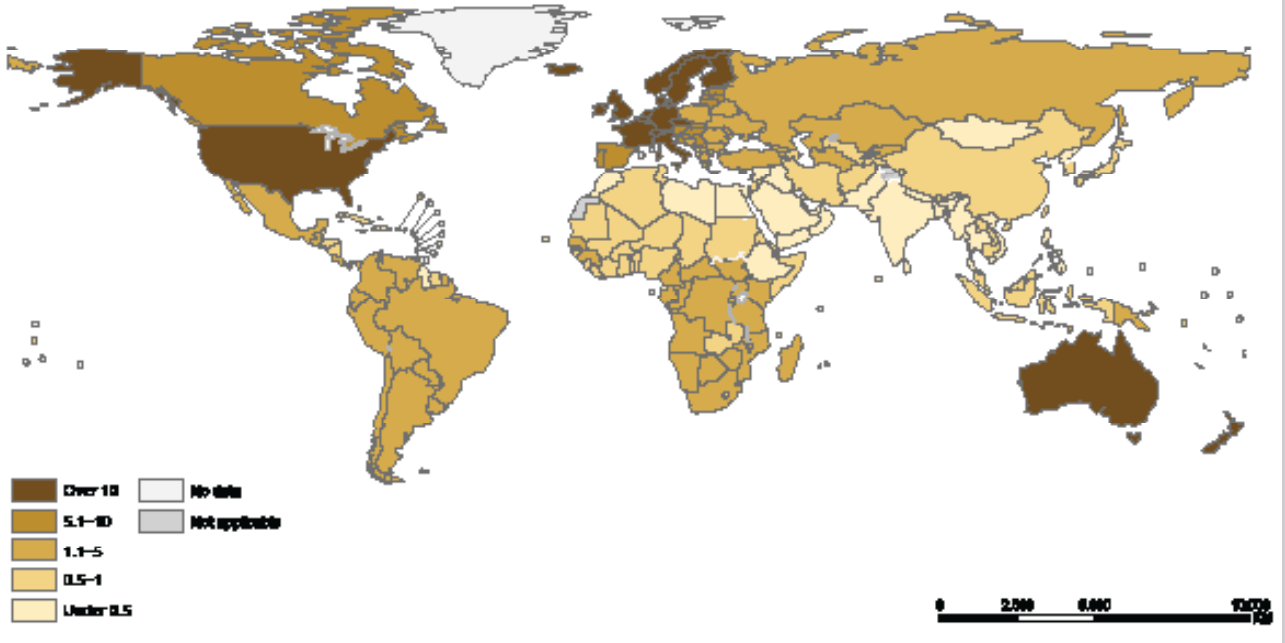
Children are often exposed to considerable UV radiation at a time in life when such exposure can have a significant impact on the likelihood of future harmful effects, including effects on the eyes and skin (Green et al, 2011). Frequent UV exposure and sunburns during childhood and adolescence are strong risk factors for skin cancer, particularly malignant melanoma (WHO, 2002). Although it is in adults that most skin cancers are detected, skin cancer can emerge in children and teenagers. UV exposure from a young age can also lead to cumulative chronic effects on the lens, which may result in cataracts, so protecting young eyes from UV exposure is important (Linetsky et al, 2014).

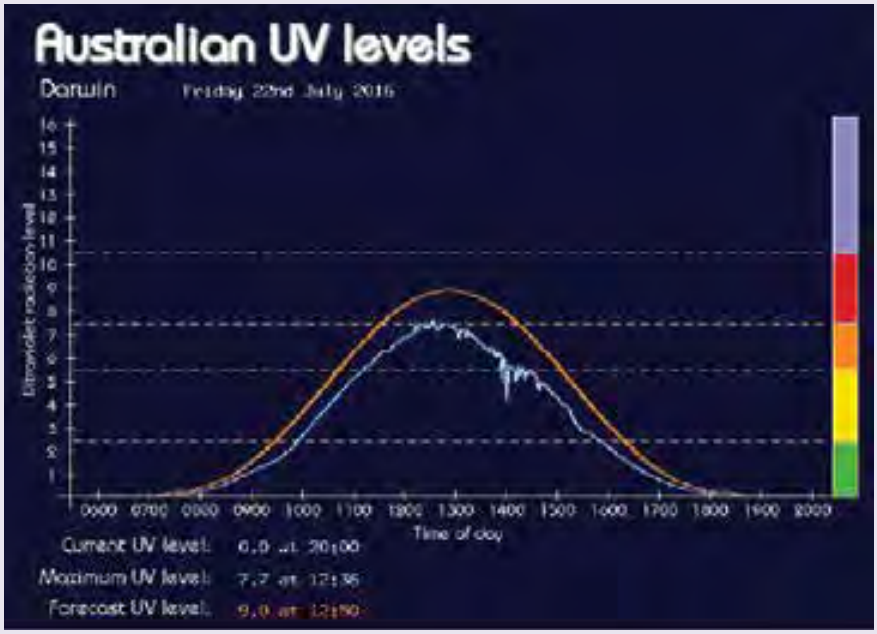
Since the 1920s, lifestyle and fashion trends among fair-skinned populations have driven the desire for a tan, especially in adolescents and young adults. Cheaper travel to sunny destinations, scanter clothing styles with more skin exposed, and the pursuit of a "fashionable" tan through deliberate sun exposure or the use of sunbeds have made significant contributions to increasing skin cancer rates in fair-skinned adults around the world (Chang et al, 2014). Sunbeds are now classified as carcinogenic (IARC, 2012) and their use should be avoided.

Measures to cut melanoma rates

Primary prevention programmes for children, adolescents and vulnerable populations in the form of education and public awareness campaigns on the hazards of UV exposure encourage better sun protection and reduce rates of melanoma. In a few countries, melanoma rates have been decreasing or levelling off, including for women in Iceland and both women and men in Australia (Erdmann et al, 2013). The most vulnerable are fair-skinned populations who live or spend time at low latitudes (e.g. a large proportion of Australians and New Zealanders), target groups for which primary prevention measures should be endorsed. Such measures are needed to curb the rising rates of the deadliest forms of skin cancer in eastern and southern Europe, among many other places (Erdmann et al, 2013).

Estimated incidence of melanoma, age-standardized rate, per 100 000, 2012





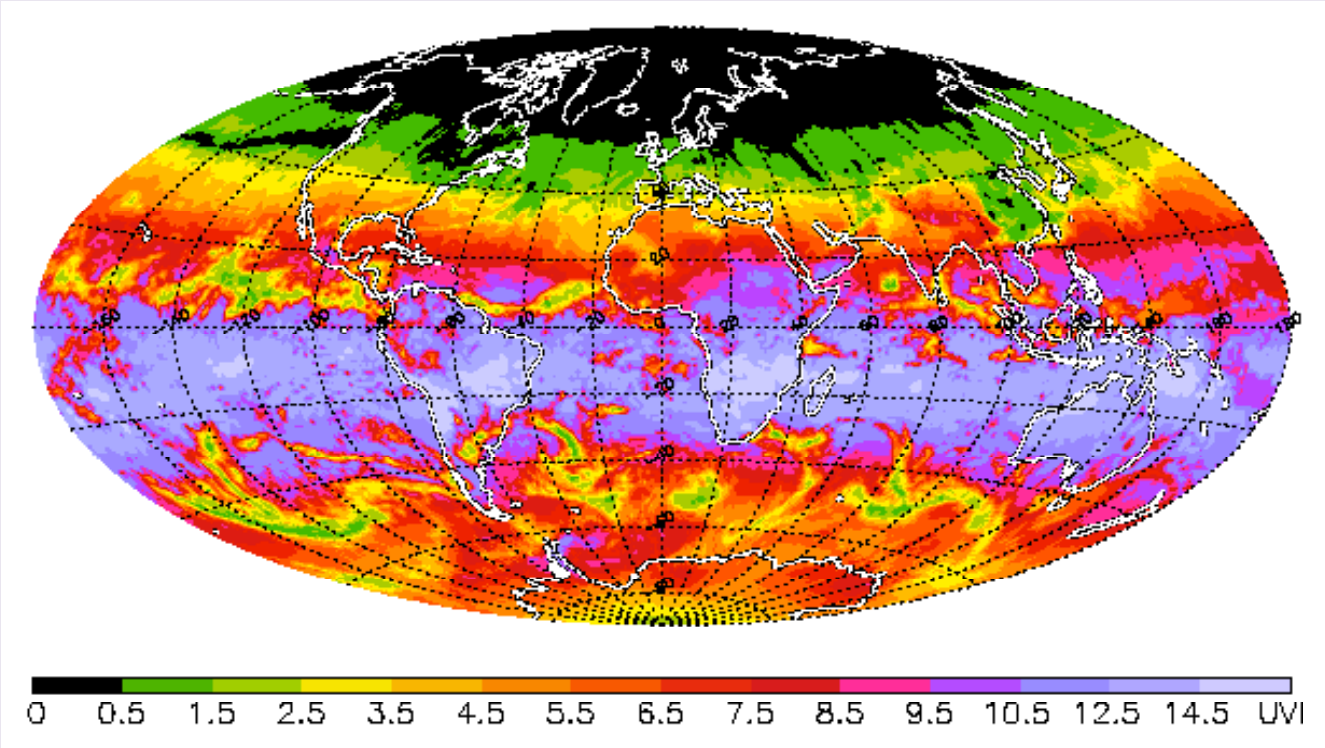
Industrial use of halogenated chemicals, such as chlorofluorocarbons, was found to reduce the protective ozone layer that absorbs much of UV radiation when ozone concentrations began falling in the 1980s (WHO, 2003). Since its establishment in 1987, the Montreal Protocol has effectively reduced the use of ozone-depleting chemicals. Recent evidence suggests the ozone layer is slowly healing, with near-complete recovery expected by the middle of the 21st century (Solomon et al, 2016; WHO, 2003). Reduced exposure to UV will have a beneficial effect of lowering related skin cancer and eye damage.

Recommendations regarding sun exposure

The UV index describes the level of solar UV radiation at the earth's surface. The values of the index range from 0 to over 20 – the higher the index value, the greater the potential for damage to the skin and eye, and the less time it takes for harm to occur. When the UV index is greater than 3, children and adults are advised to:

- ✔ Limit exposure during midday hours
- ✔ Seek shade
- ✔ Wear protective clothing, such as with long sleeves
- ✔ Wear a broad-brimmed hat to protect the eyes, face and neck
- ✔ Protect the eyes with wrap-around design sunglasses or sunglasses with side panels
- ✔ Use liberally and reapply a broad-spectrum sunscreen with a sun protection factor (SPF) of 15 or more
- ✔ Avoid tanning beds
- ✔ Protect babies and young children – this is particularly important
- ✔ Address UV health messages to parents, teachers and health professionals who are in contact with children (WHO, 2002)

Daily maximum of UV index under cloudy conditions 12 November 2015



"Perhaps the single most successful international agreement to date has been the Montreal Protocol."

Kofi Annan, former Secretary-General of the United Nations

The Australian Surf Lifesaving "Nippers" programme trains children on how to have fun safely at the beach. Zinc sunscreen, hats and long-sleeved shirts are three elements of Australian sun safety campaigns.

SDGs

With rates of skin cancer rising in many parts of the world, SDG Target 3.4 to "by 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being" is ever more salient. UV exposure to skin that occurs during childhood increases the risk for skin disease later in life, and with the goal of promoting well-being for all at all ages in mind, it is imperative that steps be taken to protect children from UV radiation. A prime example of the intersecting nature of SDGs and children's environmental health is how past industrial chemical usage with chlorofluorocarbons has put many people at increased risk of UV exposure by depleting the ozone layer. Subsequent international efforts with the Montreal Protocol have reduced the use of these chemicals and enabled recovery of much of the ozone layer. Every SDG has an impact on the environment and children's health, and not only SDG 3 which focuses on health, but also SDG 13: "take urgent action to combat climate change and its impacts" and measures such as the Montreal Protocol to preserve the ozone layer and the Paris Agreement on climate change in 2015, will contribute to saving the lives of the young.

Australia – SunSmart

Sun protective behaviour can be established most easily during childhood and early adulthood, so a wide range of sun safety educational resources has been developed (WHO, 2016). Children's education is a cost-effective primary prevention measure, as shown by recent data from Belgium and Australia. Studies of campaigns in New South Wales and Victoria, Australia, for example, indicate that each AUD$ 1 invested in prevention measures yields a benefit return of between AU$ 2.30 and AU$ 3.85 in reduced treatment and productivity costs of skin cancer (Doran et al, 2016; Shih et al, 2009).

The SunSmart Campaign of the Cancer Council of Victoria allows schools to become SunSmart accredited. Over 90% of primary schools in Victoria, Australia, are now recognized as "SunSmart Schools". To achieve this status, they must have a school policy that requires them to schedule outdoor classes in the early morning to avoid the highest UV levels, ensure that children apply and reapply sunscreen and wear broad-brimmed hats when outdoors, have places to play with shade, and educate children on the dangers of UV exposure and how to be sun safe. Although it is impossible to determine the exact effects of the 30-year-old SunSmart programme on skin cancer, rates of three major skin cancers are decreasing in Australians under age 40–45. The Victorian SunSmart Campaign estimates that it has prevented as many as 103 000 cases of skin cancer and saved more than 1000 lives (Harper, 2005; SunSmart Victoria, 2016).

Lessening the chemical load: Steps towards SDGs 6 and 12

Part 4

Lessening the chemical load: Steps towards SDGs 6 and 12

6 CLEAN WATER AND SANITATION

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Children and chemicals: Living in a chemical world

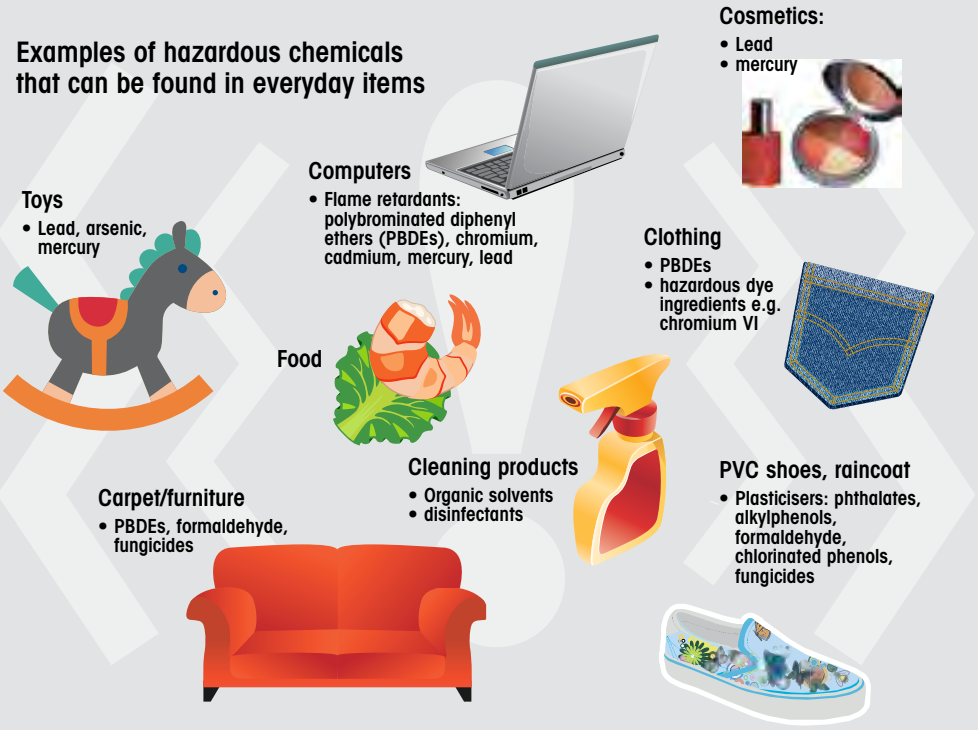
Chemicals are everywhere – in the air, our food and water, soil, homes, playgrounds and communities. They are a wide group of compounds necessary for our lives and health. In some cases, however, chemicals may also harm human health. These chemical hazards can arise naturally, as with arsenic in drinking-water, or be introduced into the environment through unsustainable patterns of production, consumption and industrialization, unsafe-waste disposal or intensive agriculture. Even at home they are common – in solvents, cleaning, bleaching and drain-unblocking agents, and medicines. These chemicals can be attractive to curious children and result in poisoning (*Poisons: Keep out of reach*). Despite chemicals being widespread in the environment, knowledge about their subtle long-term effects is limited. From asbestos to cigarette smoke to diesel exhaust, each decade brings new revelations about the damaging health effects of toxic substances. Though chemicals can support healthy development, they must be closely monitored for possible health effects.

The effects of chemicals on children

Growing children breathe more air, consume more food and drink more water than adults in proportion to their weight. Their nervous, digestive, reproductive and immune systems are still developing, so damage can result from early exposure to chemicals at critical developmental stages. Furthermore, their exposure patterns can differ markedly to those of adults, for example infants ("explorers") crawling and playing on the ground. For children, the stage of development when exposure occurs is just as critical as the dose. Exposures to the same chemical may result in different outcomes compared with adults, and the outcomes may not be immediately evident. Importantly, humans are rarely exposed to a single chemical but more often take in a mixture of substances released into the environment in various ways (IPCS, 2011).

POPs, pesticides and volatile products

Persistent organic pollutants (POPs) are synthetic chemicals, for the most part, that remain in the environment for many years, as their name suggests (WHO, 2010a). Transport by air currents and deposition into sediments in lakes, rivers and oceans allows POPs to disperse globally and enter food chains, where they can be stored in fatty tissues. Within the food chain, they biomagnify and persist over time, so that exposure to these chemicals can continue in some cases even after their use has stopped (WHO, 2010a). Many POPs have potential developmental and neurobehavioural effects, and some are recognized as endocrine disruptors, substances that alter one or more functions of the endocrine system and subsequently cause adverse health effects in organisms or their offspring (WHO, 2002). For example, polychlorinated biphenyls (PCBs), a type of POP formerly used in electrical equipment, have been linked with negative effects on brain development (UNEP, WHO, 2013). POPs are ubiquitous, and the highest exposure for most people is through eating fish, meat and dairy products (WHO, 2010a). However, even fruits, vegetables and grains can contain POPs, and children can also be exposed from before birth (WHO, 2010a). Thus, POPs exposure is truly a global issue, that requires worldwide action with measures such



as implementation of the Stockholm Convention (see box on *International instruments reducing exposures to hazardous chemicals*).

Pesticides are environmental hazards of growing concern because of their links to chronic disease in children. Children's exposures come from pesticides in agriculture, residues in food, and residential use, such as insecticide application within the home as well as in public spaces. Unsafe use of such chemicals may cause poisoning, and prolonged low-level exposure may induce chronic effects in children, including birth defects, asthma, cancer and neurological alterations (Bouchard et al, 2011; Eskenazi et al, 2014; Raanan et al, 2015; Raanan et al, 2016; Roberts & Karr, 2012). Volatile products, such as sprays, by-products of combustion, cleaning products and building materials, contribute to indoor air pollution and may lead to poisoning or aggravation of chronic respiratory or neurological conditions.

International instruments reducing exposures to hazardous chemicals

Over the past decades, significant progress has been made internationally in providing solutions to the growing problem of hazardous chemicals and waste, and in reducing exposure to toxic chemicals. A number of international instruments now cover several key aspects of the sound management of chemicals.

- The **Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal** (Basel Convention) was created to combat "toxic trade" in hazardous waste and entered into force in 1992. It is designed to reduce hazardous waste generation, promote the environmentally sound management of hazardous waste and restrict its movement between countries except in accordance with the principles of environmentally sound management. As of 2016, there are 184 countries party to the Convention (Basel Convention, 2016).
- The **Stockholm Convention on Persistent Organic Pollutants** (Stockholm Convention), which entered into force in 2004, introduced measures to reduce or eliminate the release of POPs into the environment. There are 180 countries party to the Convention (Stockholm Convention, 2016). With decreased production and release, several POPs have seen a corresponding decrease in their levels in breast milk (WHO, 2010a).
- The **Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade** (Rotterdam Convention), which also entered into force in 2004, concerns trade in hazardous pesticides and other chemicals. It promotes shared responsibility between importing and exporting countries to protect human health and the environment by enabling importing countries to decide whether they wish to receive future shipments of certain chemicals and ensuring compliance with these decisions by exporting countries. There are currently 155 countries party to the Convention, which covers 47 pesticides and industrial chemicals (UN, 2016).
- The **Strategic Approach to International Chemicals Management** (SAICM) is a policy framework to foster multisectoral and multistakeholder engagement in the sound management of chemicals. It aims to ensure that, by 2020, 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 (WHO, 2010b).
- The **Minamata Convention on Mercury** (see *Mercury: Protecting children's brains*).

Is your country party to these agreements and implementing the necessary measures?

Protecting children from chemical hazards

- Inform parents, teachers and child-care providers about the potential chemical hazards in the places where children spend their time and how to prevent exposure.
- Promote safe storage of chemicals at home. Poisons, medicines, bleach, acid and liquid fuels such as kerosene should never be stored in drinking bottles. All such liquids and poisons should be kept in clearly marked closed containers out of sight and reach of children (WHO, 2005).
- Require the use of child-resistant packages for pharmaceuticals and for hazardous chemical products.
- Ensure safe packaging and clear labelling of cleaners, fuels, solvents, pesticides and other chemicals used at home and in school (UN, 2011).
- Incorporate the teaching of chemical safety and health into school curricula.
- Train health-care providers on the recognition, prevention and management of toxic exposures, and on the use of the paediatric environmental history to investigate specific risks to which children are exposed.
- Avoid the construction of homes, schools and playgrounds near polluted areas and hazardous installations.
- Create and enforce legislation to promote the safe use and disposal of chemicals.
- Promote policies to reduce and remedy environmental pollution.

Policy action priorities

The health sector plays an important role in the sound management of chemicals, and is concerned with the impacts of chemicals on human health in all economic sectors (such as industry, agriculture, mining) and at all points in the life cycle of chemicals where exposure takes place (such as production, use, disposal). The health sector also contributes to sound chemicals management in its own health-care activities in order to prevent environmental, occupational and public health problems arising as a result of such activities. As a contribution to the achievement of the goal of the SAICM, the following health sector priorities have been developed:

- Devising better and standardized methods to determine impacts of chemicals on health, to set priorities for action and to evaluate the effectiveness of policies and progress of the strategic approach.
- Formulating strategies aimed at prevention of ill-health and disease caused throughout the life course by chemicals, including strategies directed specifically at the health of children and workers.
- Building capabilities of countries to deal with poisonings and chemical incidents and emergencies.
- Promoting alternatives to highly toxic and persistent chemicals.
- Filling of gaps in scientific knowledge.
- Elaborating globally harmonized methods for chemical risk assessment.
- Actions to improve ability to access, interpret and apply scientific knowledge, particularly in developing countries (WHO, 2015).

Dichlorodiphenyltrichloroethane (DDT)

Used as a pesticide since the Second World War, DDT was highlighted as a potential environmental hazard in 1962 by Rachel Carson in her book *Silent Spring*. From the 1970s, the application of DDT was banned in many countries. Today, the Stockholm Convention provides an exemption allowing DDT to be used for indoor residual spraying to prevent vector-borne diseases provided that the guidelines and recommendations of WHO and the Stockholm Convention are met. This will continue until locally appropriate and cost-effective alternatives are available for a sustainable transition from DDT where no alternatives currently exist. WHO seeks to eventually eliminate DDT use and supports the development of alternative effective, sustainable vector control methods.

Raising awareness among children about hazardous chemicals

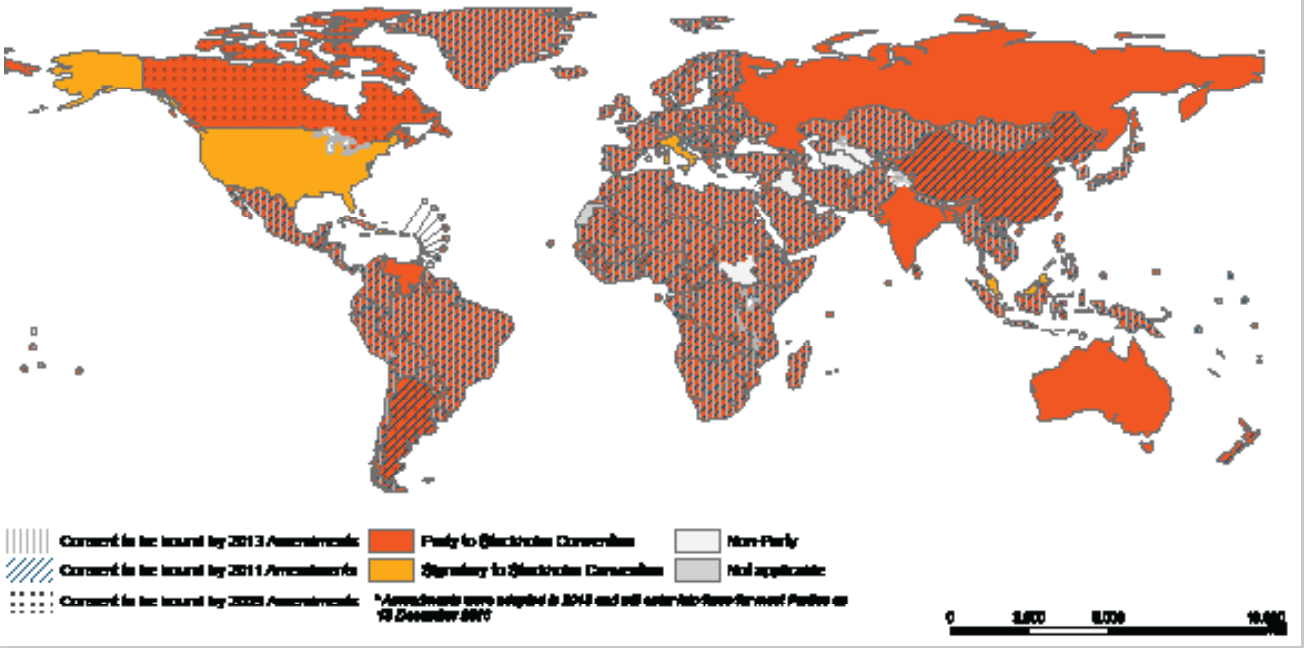
The development of educational materials that teach children about potential harmful effects of chemicals, hazard labelling and products in their daily life that may be toxic can avert poisoning and accidents. *Hanna's House of Hidden Hazards* is an example of an online teaching resource suited for students from 7–12 years. An interactive interface allows children to identify hazards in household situations and learn about the labelling system for hazardous chemicals used in the European Union (Norden, 2016). UNEP's Toxicology in the classroom is another interactive platform, aimed at youths from 9–15 years, with an emphasis on preventing careless use of pesticides (UNEP, WHO EURO, NPC-USM, 2010). Educating older children may also have a protective effect for younger siblings cared for by more independent adolescents.

SDGs and international initiatives

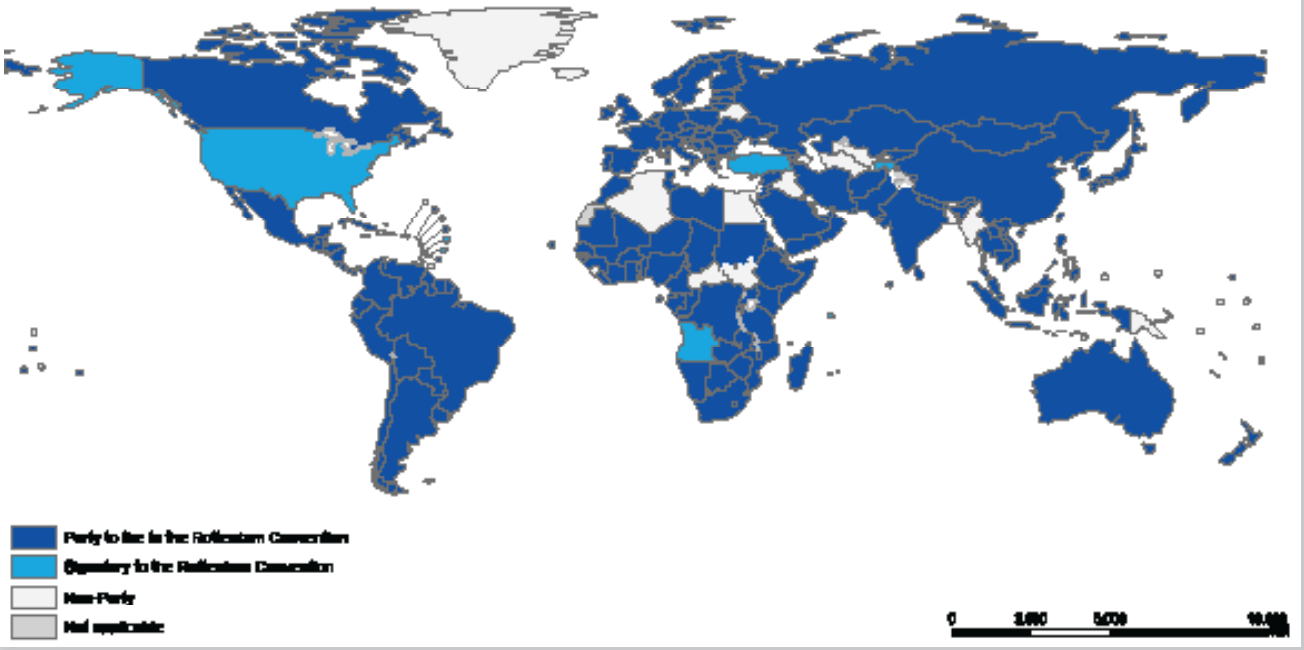
SDG Target 3.9 aims to "by 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination". Protecting children from chemicals is relevant to Target 12.4 to "by 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment", as well as Target 6.3, to "by 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally".

Launched in 2010, the United Nation's Safe Planet campaign, which includes the Basel, Rotterdam and Stockholm conventions, supports the lifecycle approach to chemicals and waste management and aims to promote responsibility for hazardous chemicals and waste to leave a safe and sustainable planet for our children's generation.

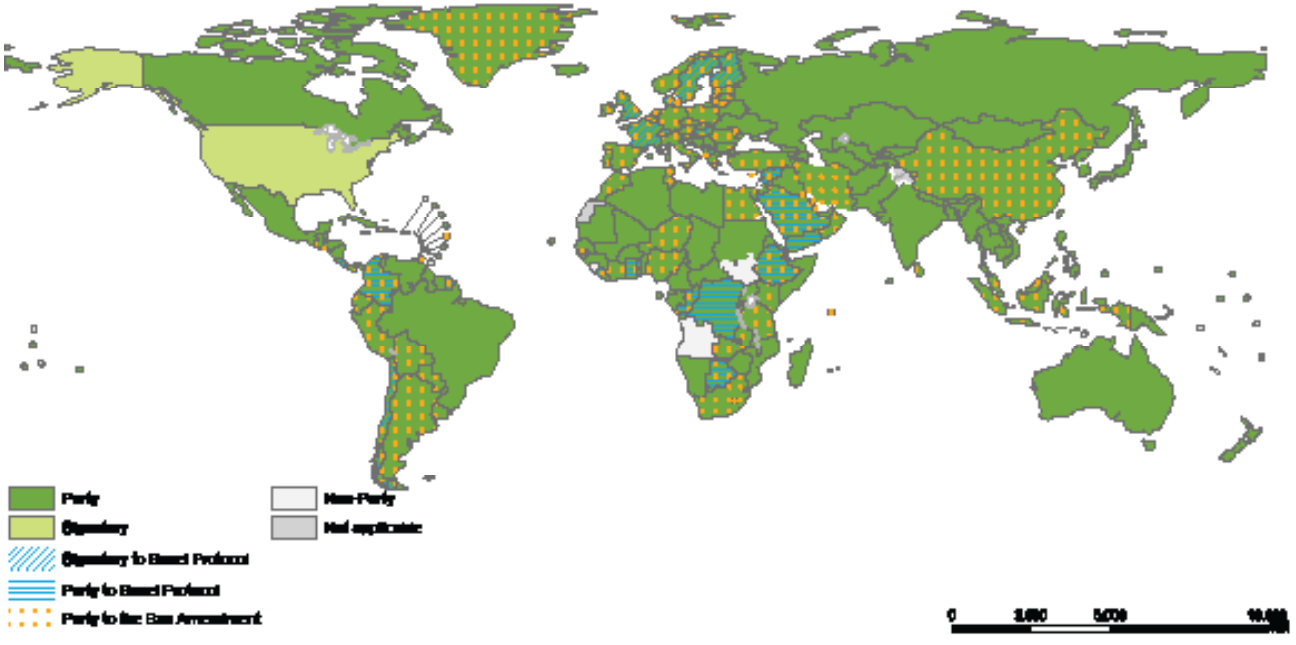
Parties to the Stockholm Convention, as of August 2016



Parties to the Rotterdam Convention, as of August 2016



Parties to the Basel Convention, as of August 2016



Kajal/kohl/surma

In many countries, such as Saudi Arabia, Iran (Islamic Republic of), Pakistan and India, use of *kajal* (*kohl, surma*) to line the eyes is common, including on children. Popular beliefs hold that it benefits the wearer by preventing eye diseases, improving vision, and strengthening, cooling and cleaning the eyes. Some also hold that *kajal* wards off the evil eye. However, *kajal* is produced from *kohl* stone (*galena*) containing lead. Children touching their eyes and then putting their fingers in their mouths can ingest lead, which can accumulate in the body and cause poisoning (see *Lead-free lives: Allowing children to thrive*). The presence of lead in *kajal* is not widely known; the use of this dangerous product should be avoided (Mohta, 2010).

Contaminated food: Getting the right start in life

Although the nutritional value of the food children eat is important, so is its safety. In addition to biological contaminants, food can contain a wide range of chemical contaminants such as methylmercury and other heavy metals, pesticides and POPs and newly recognized contaminants. Contamination can arise from various sources and actions:

- **Chemicals in breast milk**
- **Chemicals in soil or animal feeds**
- **Chemicals ingested by fish or animals**
- **Chemicals introduced through processing and packaging**
- **Pesticides**
- **Adulteration of food.**

Children and the poor are most at risk as a result of inadequate regulation, education and, in some cases, availability of good quality food. Even for chemicals to which humans are not particularly sensitive, the lower body weight of babies and young children can lead to exposures above safe levels.

Exposure risks early in life

Children have unique exposure pathways regarding chemicals in food. Babies can be exposed *in utero* to toxic agents in their mother's diet through the placenta and to pollutants that pass into breast milk. Neither of these routes of exposure occur in adults or older children. The benefits of breastfeeding infants are beyond question, and WHO recommends exclusive breastfeeding up to six months of age, with continued breastfeeding along with appropriate complementary foods up to two years of age or beyond (WHO, 2016). Yet, a nursing child can be exposed, for instance, to POPs in their mother's milk. POPs, such as PBDEs, are toxic chemicals that persist in the environment and build up in the food chain, particularly in the fatty tissues of animals.

Exposure to hazardous chemicals during vulnerable early life stages (fetus, infant and child) has been linked to an increased risk of a number of disorders, especially NCDs, throughout the life course. Changes in neurodevelopment, endocrine and immune system development, obesity, diabetes and other metabolic diseases have all been associated with pollutant exposure early in life (Grandjean et al, 2015). Early life exposure to certain pesticides may be associated with neurodegenerative diseases, such as Parkinson's disease in later life (Grandjean et al, 2015). The effects of some POPs include reproductive and developmental problems. Some chemicals can damage the immune system, interfere with hormones, affect neurological function or cause cancer (UNEP, WHO, 2013a; WHO, 2010b).

Note: Infant formula or the milk of other mammals, such as cows, may also be subject to environmental contamination. Safe water for formula should be available.

Mums and POPs

As part of the global monitoring plan under the Stockholm Convention, human milk surveys provide results that can indicate progress in eliminating certain POPs. As can be seen in the maps, this has provided valuable data on the levels of POPs in mothers' milk and the dose of chemicals to which their infants may be exposed through breastfeeding. However, few countries have evaluated trends concerning contamination of breast milk with POPs over time (Fång et al, 2015). In most cases where data are available, the trends show decreasing concentrations of POPs in breast milk, but this varies between countries and regions. The reduced risk of POPs exposure to children in countries where POPs have been eliminated shows that government actions to reduce exposures have been effective in reducing this environmental hazard. Long-term solutions include the implementation of the Stockholm Convention and the SAICM.

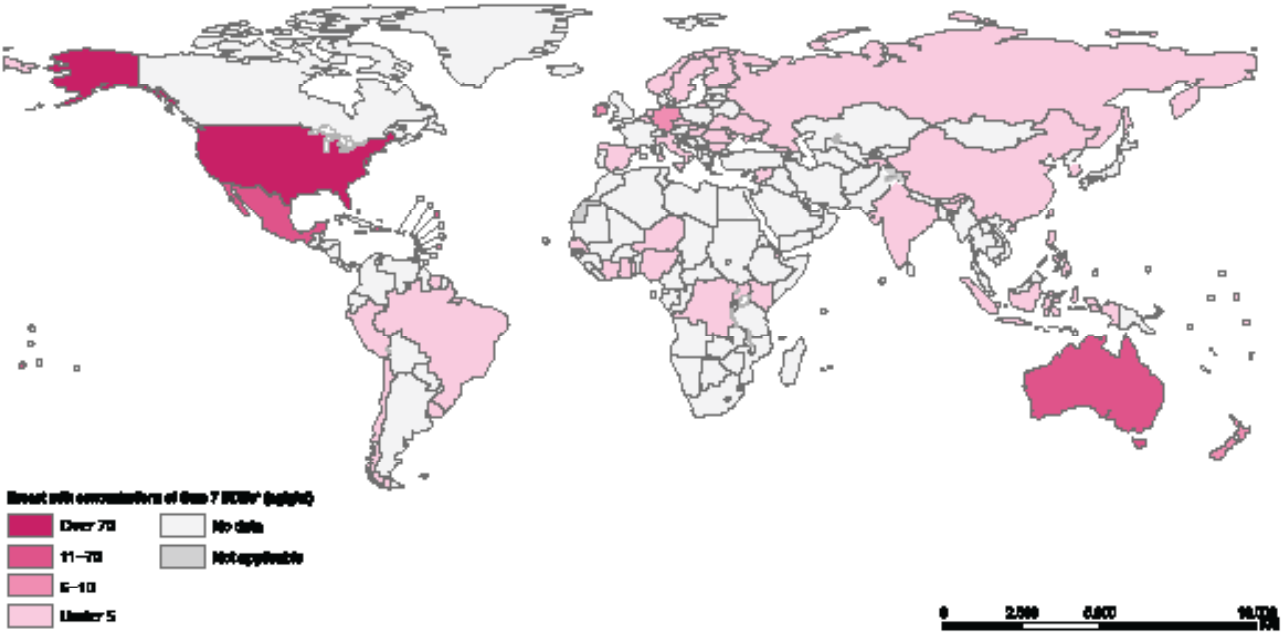
POPs contaminants in mothers' diets can affect the fetus with both early and long-term implications:

- Effects may have long latency periods.
- Infants are more sensitive to chemical pollutants than adults and older children.
- They may cause a variety of disorders at different life stages:
  - In childhood – asthma, cancer and neurological and behavioural effects
  - At puberty – alterations in normal development and impaired reproductive capacity
  - In adults – cancer, heart disease, and degenerative neurological and behavioural disorders.
- In some cases, "safe" levels can be difficult to determine.
- The effects of chemical mixtures are complex and mostly unknown.
- Use of safer alternatives, when available, is the most effective way to prevent exposure.

PBDEs

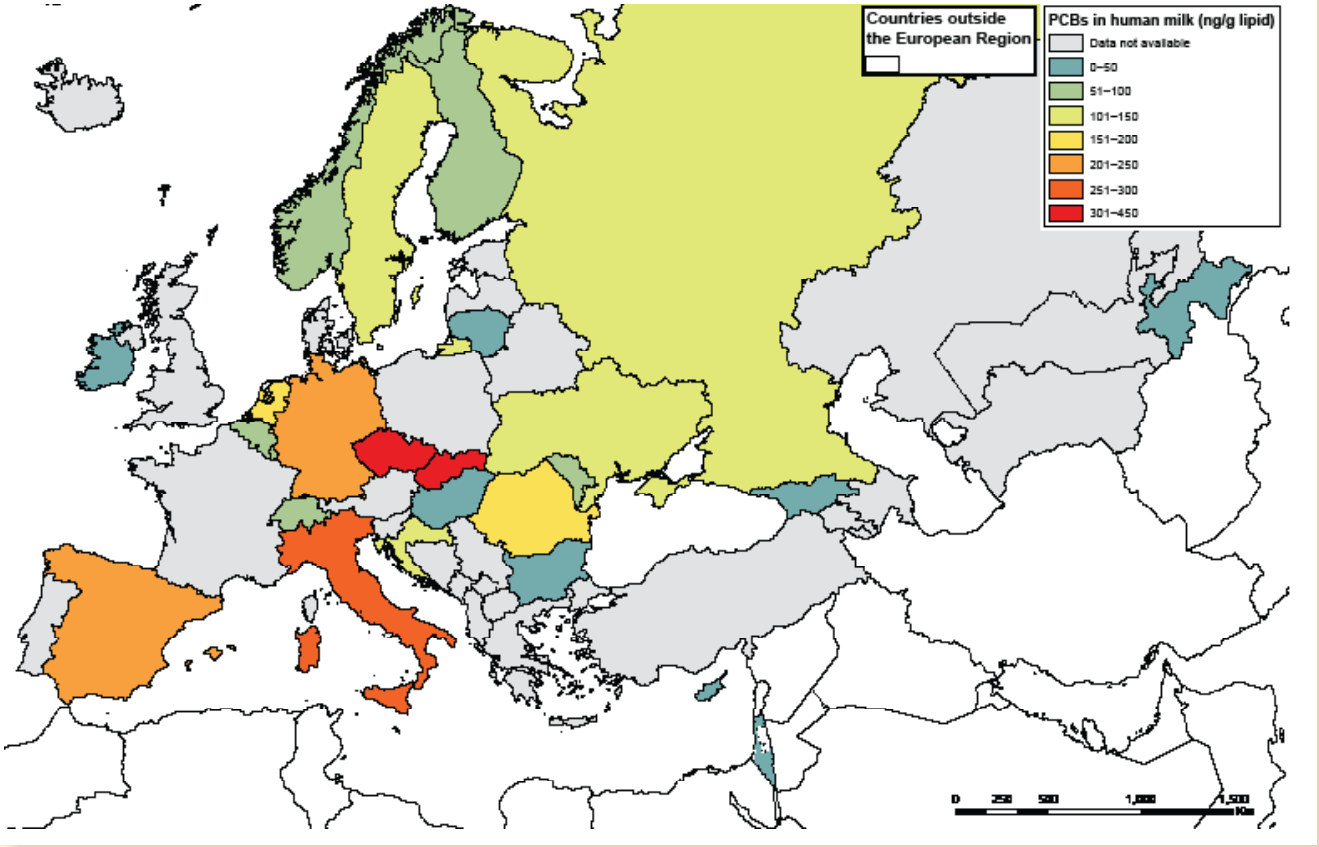
PBDEs are flame retardant chemicals that have been added to consumer products to lower their risk of catching fire. They have been added to products as diverse as furniture and carpets, to electronics and children's pyjamas. However, these chemicals can leach out of products into the environment and can be absorbed by animals and people. PBDEs build up in fatty tissue, particularly breast tissue, and can be passed to infants through breast milk. Some studies suggest PBDEs may interrupt the thyroid system and have effects on reproductive development (UNEP, WHO, 2013a). In recent years, these risks have led countries such as Canada to ban certain PBDEs and PBDE-containing products (Government of Canada, 2006).

Breast milk concentration of SUM 7 BDEs, 2014 or latest available data



*Note: Sum 7 includes congeners 17, 28, 47, 99, 100, 153 and 154.

Total non-dioxin-like PCBs in human milk, 2000–2012



PCBs

Non-dioxin-like polychlorinated biphenyls (PCBs) are a class of chemicals that were once widely produced and used in transformers, hydraulic fluids, paints and carbonless copy paper (NIOSH, 2000; US CDC, 2013). Like PBDEs, they can build up in fatty tissue and can be passed to children through breast milk and fatty foods such as meat, fish and dairy products (US CDC, 2013). Non-dioxin-like PCBs are suspected of affecting the immune system, the reproductive system, thyroid function and neurological function (UNEP, WHO, 2013a). Although it is debated, some children born to mothers who have been exposed to PCBs have been reported as having lower birth weight and cognitive delays (US CDC, 2013).

Pesticides

Pesticides are chemicals used for crop protection, to control certain disease vectors, such as mosquitoes, to remove unwanted vegetation in public places, and in pest control in homes. Some are potentially toxic to children and may cause adverse health effects to the immune, reproductive and nervous systems, as well as cancer. Pesticides should undergo a thorough assessment of their toxicity and the risks to human health of exposure, with particular attention to vulnerable groups such as infants and children. Countries should have in place an effective system for regulating the use of pesticides and for monitoring residues in foods. The Joint FAO/WHO Meeting on Pesticide Residues provides guidance on maximum residue limits and acceptable daily intakes (WHO, 2015).

Nature's contaminants

Not all food contaminants are artificial. Naturally occurring toxins, such as aflatoxins, may be present in common foods such as maize (corn) and other cereals. High levels of exposure to aflatoxins can cause life-threatening liver damage. Chronic exposure may impair growth and contribute to hepatocellular carcinoma by interacting with the hepatitis B virus or other risk factors. Interventions include food monitoring programmes in high-risk areas and instructions on the preparation of food using non-mouldy grains, as well as hepatitis vaccination programmes (IARC, 2015; Strosnider et al, 2006).

Emerging risks – the evolving list of contaminants

Of growing concern are newly recognized contaminants, such as phthalates (e.g. di(2-ethylhexyl) phthalate – DEHP) and bisphenol A (BPA), which are potential endocrine disruptors. These are widely used in the food industry and can leach into food from food packaging materials, e.g. canned food, milk formula, plastic babies' bottles and plastic food containers. Leaching can be exacerbated by placing hot food or liquid into plastic containers or heating food in plastics. Potential liver, thyroid

and neurodevelopmental toxicity of such chemicals has been reported and recent evidence suggests that endocrine disrupting chemicals may have additive effects even at low doses (UNEP, WHO, 2013a).

SDGs

The issue of chemicals in food is addressed in SDG 12: "Ensure sustainable consumption and production patterns". Guaranteeing food safety and preventing chemical contamination begins with environmentally sound management of food production and continues throughout the entire food course to consumers, including children.

Policy action priorities

- Pregnant women, the developing fetus, infants and young children all need special protection (INFOSAN, 2008). Policy-makers can foster multisectoral collaboration among public health, environmental and food safety authorities, as well as in agriculture and other sectors, for better communication and joint action on avoiding toxic exposures.
- Food safety authorities have a responsibility to work with nutritionists and maternal and child health professionals involved in pregnancy and infant feeding to ensure that pregnant mothers and caregivers are provided with food safety and nutritional advice that can help to prevent foodborne disease and exposures to chemicals, as well as improve nutritional status.
- Information provided to consumers should reflect the local situation and hazards of most concern to the country or region. This includes the need, in some cases, to balance health risks and nutritional benefits (INFOSAN, 2008).
- Much more research is needed to bridge existing knowledge gaps, and this will require internationally coordinated efforts in order to best protect children from contaminated food.

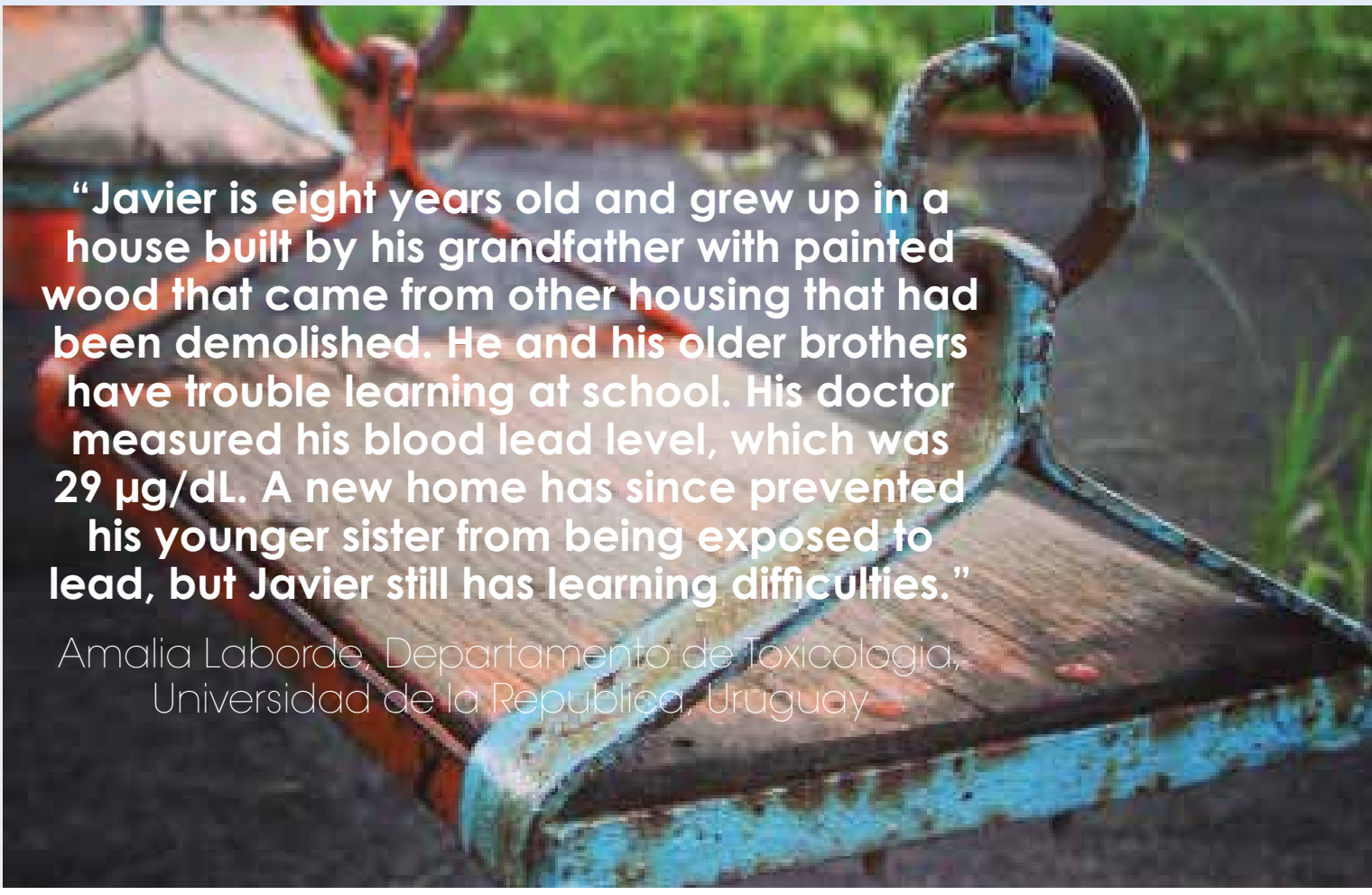
Lead-free lives:
Allowing children to thrive

Lead is one of the most harmful chemicals, especially to young children, because it can build up in the body over time and cause severe, long-term effects. Exposures once thought acceptable are now known to be harmful; no safe exposure level has been identified. The risks of lead poisoning are especially important for children because of their high susceptibility and because of the significant effects lead has on brain development and other organs. Blood lead concentrations as low as below 5 µg/dL may be associated with reduced intelligence quotient (IQ) in children (NTP, 2012). Preventing lead exposure is critically important and entirely possible, as recent measures, such as its elimination from petrol, have shown.

The effects and costs of lead exposure

Lead accumulates in the body and affects almost every organ system, resulting in a range of short- and long-term health impacts including, in severe cases, death. Young children are vulnerable as they have a high risk of exposure to lead and are more affected by its toxic effects. This is because young children spend relatively large amounts of time on the ground and frequently put their fingers and other objects in their mouths. As such, they may ingest lead from contaminated dust on their fingers and from objects containing lead. Children also absorb proportionately more lead than adults (WHO, 2010a). In addition, the central nervous system is still developing in early childhood and can be damaged by lead exposure. Childhood lead exposure can result in reduced cognitive abilities, dyslexia, behavioural disorders and hearing problems, and may also cause delayed puberty (NTP, 2012; WHO, 2010a).

Absorbed lead is stored in bone but can be mobilized back into blood during pregnancy, becoming a renewed source of exposure for the mother and the fetus. In lead-exposed women there is secretion of small amounts of lead into breast milk, further exposing infants (Ettinger et al, 2014). Formula-fed infants may also be exposed to lead if milk formula is contaminated or prepared with unsafe water. There is some evidence that calcium intake by the mother can reduce lead exposure to



"Javier is eight years old and grew up in a house built by his grandfather with painted wood that came from other housing that had been demolished. He and his older brothers have trouble learning at school. His doctor measured his blood lead level, which was 29 µg/dL. A new home has since prevented his younger sister from being exposed to lead, but Javier still has learning difficulties."

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the developing fetus and breast-feeding infant (Ettinger et al, 2007).

Lead exposure places a heavy cost on societies because of its effect on neurocognitive development and behavioural effects such as attention deficit disorder and antisocial behaviour. It is estimated that 12.4% of the global burden of idiopathic intellectual disability is attributable to lead exposure (IHME, 2016). In the United States, the estimated annual cost of lead poisoning due to lost economic productivity was US$ 50.9 billion in 2008 (Trasande & Liu, 2011). However, the economic burden due to childhood lead exposure is greatest in LMICs, accounting for an estimated $699.9 billion in Asia (1.88% of GDP), $134.7 billion in Africa (4.03% of GDP) and $142.3 billion in Latin America and the Caribbean (2.04% of GDP), expressed in international dollars (Attina & Trasande, 2013).

Lead exposure can be fatal:

- **Mass lead poisoning from environmental contamination:** In 2010 in Zamfara State, northwest Nigeria, over 400 children were estimated to have died from lead poisoning caused by environmental contamination with lead released during the processing of gold ore. The ore, which contained lead as well as gold, was processed by crushing and grinding. This dispersed lead-contaminated dust throughout the villages. An international response was needed to deal with this mass exposure; measures included environmental remediation, social mobilization and treatment with chelating agents (MSF, 2012).
- **Fatal lead poisoning from a lead charm:** A four-year-old boy in the United States developed fatal encephalopathy after swallowing a heart-shaped charm that had been provided as a free gift with the purchase of a branded sports shoe. The fact that the charm had been swallowed was not discovered until the child was already severely ill. The charm was found to consist of 67% lead by weight, and the child had a blood lead concentration of 180 µg/dL. The shoe manufacturer had to recall 300 000 charm bracelets (US CDC, 2006).

Sources of lead

Lead is a widely used chemical, creating numerous potential sources of exposure. It is used to make lead-acid batteries and can be found in some electronic goods, pigments and paints, ceramic glazes, toys, water distribution pipes, food-can solders, cosmetics and traditional medicines (WHO, 2010b). The use of lead as an additive in petrol has now been almost entirely phased out, though it is still used in some aviation fuels, especially for piston-engine aircraft (Miranda et al, 2011; UNEP, 2015a). In the USA, for example, leaded aviation fuel is now estimated to account for half of national lead emissions (US EPA, 2010). Environmental contamination can arise from the informal recycling of batteries and electronic waste, lead smelting and decaying lead paint in the home or in play areas (Clune et al, 2011; Ji et al, 2011; WHO AFRO, 2015). In some settings lead-containing cosmetics and traditional medicines are also an important source (WHO, 2010a).

Case study – Flint, Michigan USA – the dangers of lead pipes

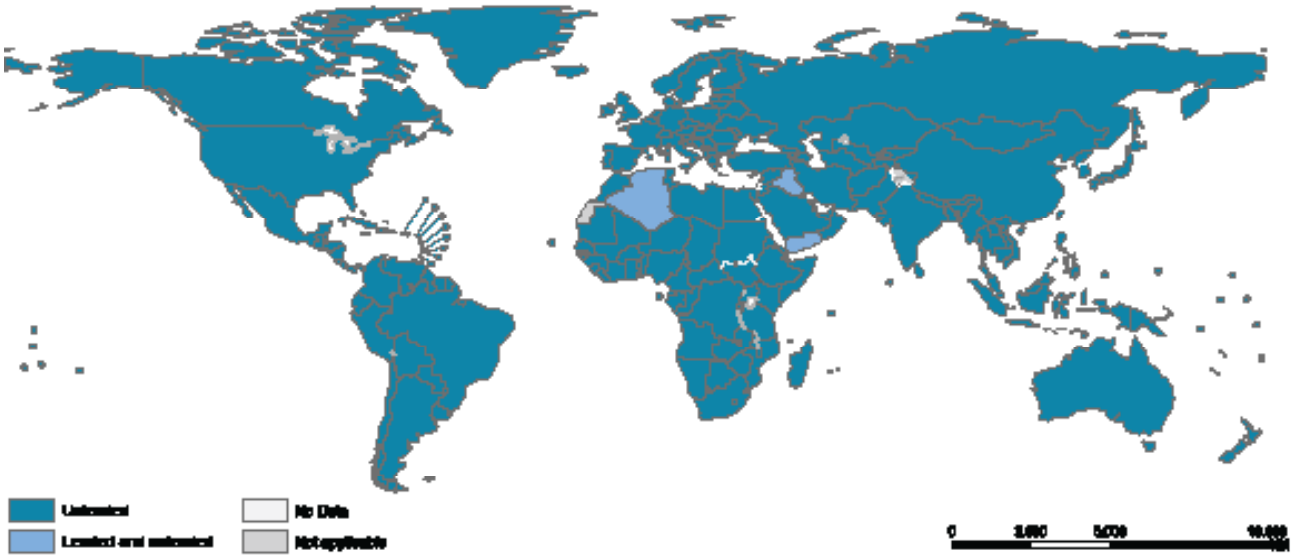
In 2016, Flint, Michigan, was declared to be in a federal state of emergency when lead leached into the city's drinking-water (The White House, 2016). The problem began in 2014 when the city switched its water supply to the Flint River. The water from the Flint River was not immediately treated to ensure that it did not corrode the old lead pipes carrying it. Later, when the water was found to contain *Escherichia coli* and total coliform bacteria, chlorine levels were increased, accelerating corrosion. In 2015, tests found high lead content in water in Flint homes, with the number of children exposed to lead estimated to be up to 15 000 (The White House, 2016). While Flint has now switched its water supply back to treated water, the pipes have sustained major corrosion and lead is still leaching into the water. The situation in Flint highlights how lead exposure through drinking water is still an issue for high-income countries; the impact from this disaster will be felt for years to come. A study found that prior to the water switch 2.4% of children under five years had elevated blood lead levels, compared with 4.9% after the switch (Hanna-Attisha et al, 2016).

Progress – lead-free petrol and paint

Preventing environmental contamination with lead is ultimately cheaper than the cost of environmental remediation and dealing with the economic and health impacts arising from lead exposure. Primary prevention measures in the form of laws and regulations to ban or restrict the use of lead in petrol, food cans, paints and toys, and to limit lead emissions, have been successful in reducing exposure in many countries. This has been clearly demonstrated by declining mean population blood lead concentrations (Rossi, 2008; WHO, 2010a). In the United States, the median blood level of children ages 1–5 dropped by more than 90%, from 15 µg/dL in 1976–1980 to 1.2 µg/dL in 2009–2010 (US EPA, 2013).

At the global level, the phasing out of leaded petrol has been achieved almost universally by concerted action over several decades, as demonstrated by the map, with only Algeria, Iraq and Yemen yet to do so. Progress to phase out lead in paint has been initiated as well, but many countries have yet to implement legally binding controls.

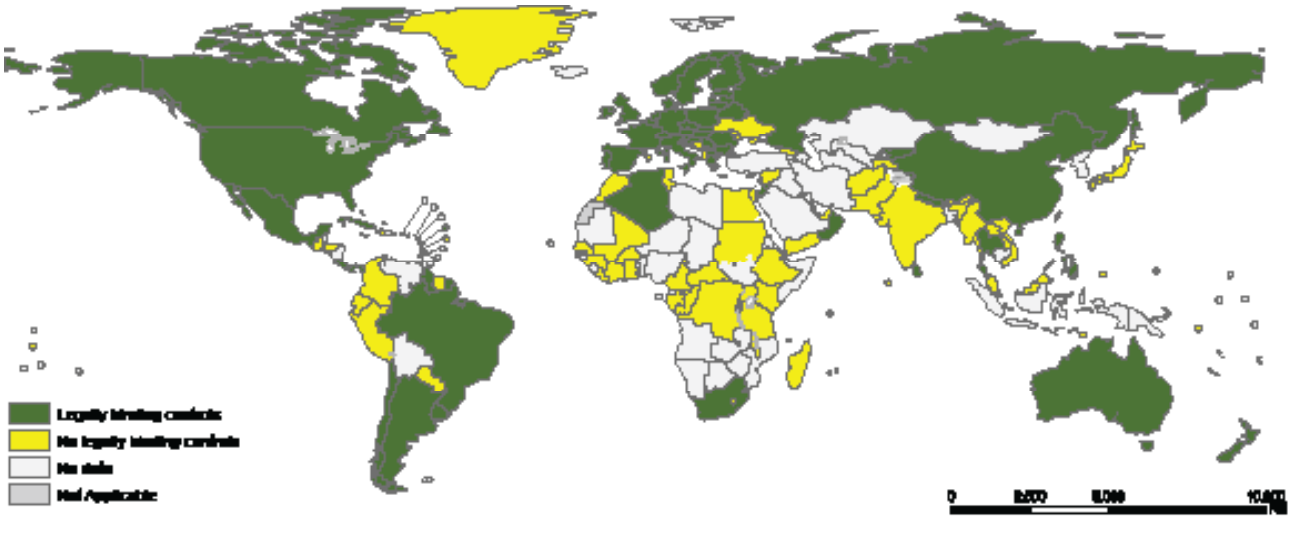
Leaded petrol phase-out, as of June 2016



Leaded petrol on the way out

Since 2002, the number of countries using leaded petrol for vehicles has dropped from 82 to three. This includes the phase-out of leaded petrol in 48 sub-Saharan African countries between 2002 and 2005 (UNEP, 2015a; UNEP, 2015b; UNEP, 2016).

Countries with legally binding controls on lead paint, as of 30 June 2016



Global Alliance to Eliminate Lead Paint

This international partnership of governments, NGOs, intergovernmental organizations, academics and industry, was formally established in 2011 to promote the phasing out of lead paint (i.e. paint to which lead has been added) (UNEP, 2012). In its business plan, the Alliance sets out a target that by 2020 all countries should have in place legally binding restrictions on lead paint (UNEP, 2012). This target supports the call by governments at the World Summit on Sustainable Development in 2002, reiterated at the second session of the International Conference on Chemicals Management, for lead paint to be phased out (SAICM, 2009). As of June 2016, 62 countries have the necessary legislation, but at least 70 countries have no legally binding controls (WHO, 2016). In some countries, domestic paints containing lead at very high concentrations of over 10 grams per kilogram – 10 000 parts per million (ppm) – are still for sale (UNEP, 2013). In countries with legal controls, the maximum permitted lead content typically ranges from 90–600 ppm in domestic paint (UNEP, 2013).

SDGs and international initiatives

Measures to prevent lead exposure will contribute to the achievement of a number of SDG targets: 3.9, "by 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination"; 6.3, "by 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and increasing recycling and safe reuse globally"; 12.4, and "by 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment". These targets are supported by SAICM, a policy framework to guide efforts to achieve the Johannesburg Plan of Implementation goal that, by 2020, chemicals will be produced and used in ways that minimize significant adverse impacts on human health and the environment, and which initiated the Global Alliance to Eliminate Lead Paint (see the box on *Global Alliance to Eliminate Lead Paint*)

Policy action priorities

Despite progress on reducing or removing lead in petrol and paint, there are still significant sources of environmental contamination in certain parts of the world, including informal recycling, industrial emissions and lead water pipes (Clune et al, 2011). Hence, more stringent actions are required to tackle this problem.

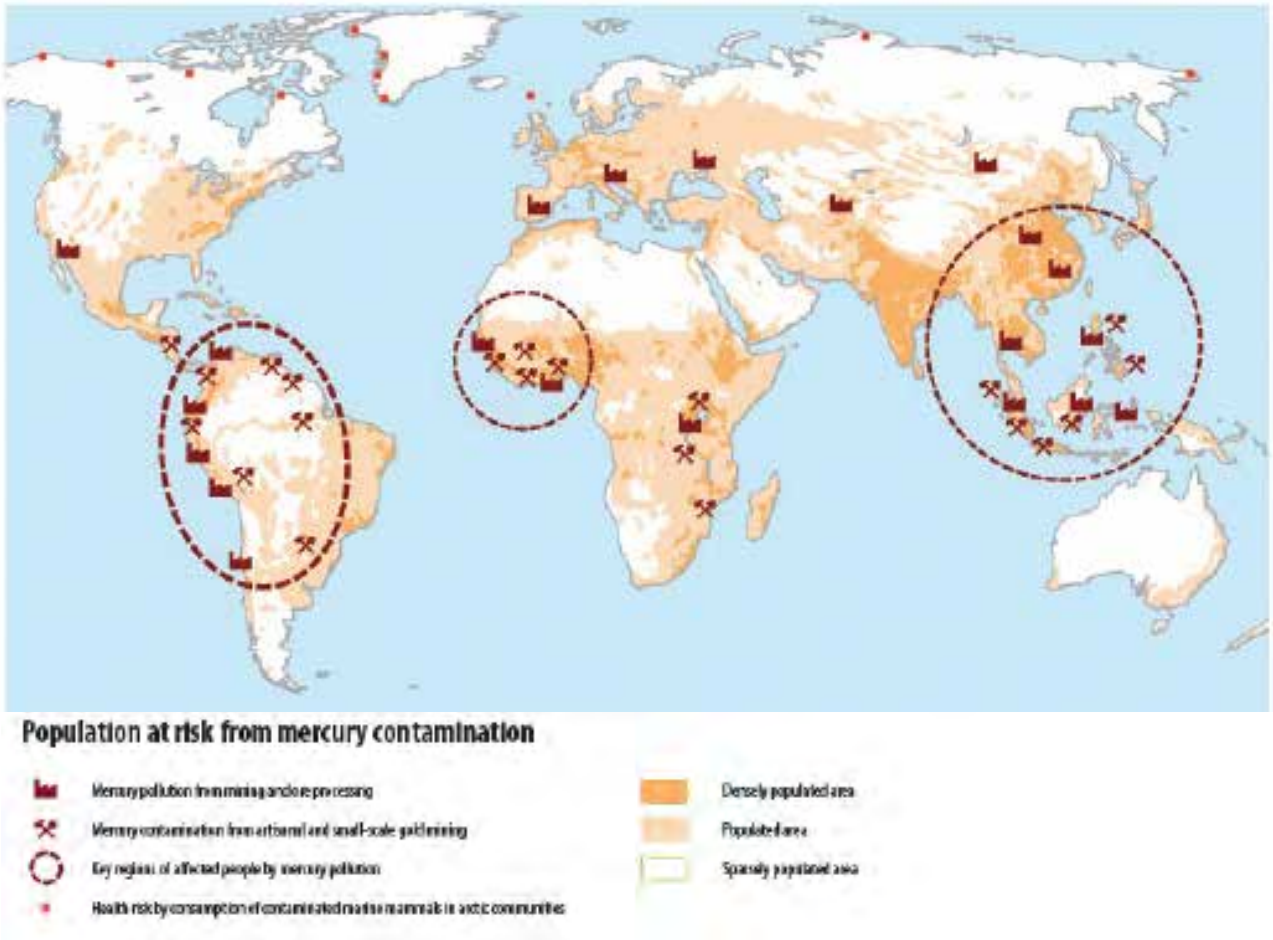
Mercury: Protecting children's brains

Since the world's most infamous mercury poisoning episode in Minamata, Japan in the 1950s and '60s, caused by eating seafood contaminated from industrial pollution, the toxic effects of this element have been increasingly studied and revealed. Exposure has been linked to a range of health effects, from rashes to a host of serious health problems including kidney, liver and brain damage at high doses. It is a particular threat to the brain development of fetuses and young children. While mercury is a natural element, occurring in different chemical and physical forms in water, air and soil, the majority of mercury in the environment that results in childhood exposures is due to human activities – as happened at Minamata, when a chemicals factory released contaminated wastewater into the nearby bay. Mercury bioaccumulates and biomagnifies in fish and shellfish, becoming a source of dietary exposure to humans. From involuntary intake through consuming fish to direct exposure through breathing mercury vapour near small scale gold mining activities and scavenging waste sites, children, particularly in the developing world, are exposed to this toxic element.

Sources of mercury

In the environment, metallic mercury can easily vaporize into the atmosphere, travelling long distances, undergoing chemical transformations and returning through precipitation to aquatic ecosystems. Here, biological activities produce methylmercury, which builds up within aquatic food chains. Large predatory fish species are more likely to have high concentrations of mercury than smaller size fish species that feed on plankton and bottom debris. Depending on the fish species and the amount that people eat, fish can be a major source of mercury exposure. However, fish is also an important source of beneficial nutrients, especially for children and pregnant women, including omega-3 fatty unsaturated acids, suspected to reduce the likelihood of premature birth (Grandjean, 2013; Nesheim & Yaktine, 2007; WHO, 2010).

Population at risk from mercury contamination, 2012



Encouraging awareness of the dangers of mercury

- **Mercury can be present in homes: in fluorescent light bulbs, some electrical equipment, some thermometers, barometers and batteries.**
- **Follow local recycling advice.**
- **Contact your relevant health or environment department or poisons centre in the event of a spill.**
- **Do not vacuum, pour down a drain, heat or burn spilled mercury!**
- **Liquid mercury is very attractive to children. Don't let children play with it.**
- **Consult local fish advisories to find which fish species you should avoid eating because of a risk of high mercury content (US EPA, 2016; US EPA, FDA, 2014).**

Some governments have developed local fish advisories to advise the public on which fish species to avoid because of high mercury levels. For instance, Australia and New Zealand have advised limited consumption of shark and swordfish by pregnant women and young children (Food Standards Australia New Zealand, 2011). The US EPA 2014 Draft Advice on Mercury in Fish and Shellfish recommends pregnant and breastfeeding women avoid consuming tilefish from the Gulf of Mexico, shark; swordfish; king mackerel; and more than six ounces of white (albacore) tuna a week (US EPA, FDA, 2014).

Current major human-made sources of mercury emissions include artisanal and small-scale gold mining (ASGM), fossil fuel combustion, waste incineration, and the metal and chlor-alkali industries. Fish consumption among communities in ecosystems affected by ASGM has been considered one of the most critical exposures to methyl mercury (Sheehan et al, 2014). These are often indigenous communities, who rely heavily on local fish consumption (Sheehan et al, 2014).

As indicated on the map, ASGM is found widely in South-East Asia, South America and West Africa. Mercury can also be found in skin-lightening products and other cosmetics. Some girls begin using these products in late childhood or adolescence, unaware of the risks of scarring, skin discoloration, infections, anxiety, depression and kidney damage they may cause. Even in countries where these products are banned, creams containing mercury can be easily obtained via the internet (WHO, 2011). Traditional practices such as *santeria* (Afro-Caribbean tradition), voodoo (Afro-Haitian), *palo mayombe* (Caribbean), *candomble* (Afro-Brazilian), *espiritismo* (Puerto Rican), *parad* (Hindu) and some forms of ayurvedic medicine use mercury (WHO, 2010). These practices are often employed to protect children from bad omens but may put children at risk. The extent of exposure through traditional practices and medicine is unknown.

Effects of mercury poisoning on children

Elemental and methyl mercury are toxic to the central nervous system, immune system, digestive system, lungs, skin and eyes (WHO, 2016). The most important effect of methylmercury is on the developing nervous system and brain. Exposure *in utero* and in early childhood can have lifelong consequences, including impairments

"I cannot put on my shoes."

Jitsuko Tanaka, aged two, last words before losing the ability to walk due to Minamata disease, 1956

in cognitive thinking, memory, attention, language, and fine motor and visual spatial skills (Bose O'Reilly et al, 2010; WHO, 2016). Children exposed to methylmercury may also be at increased risk of cardiovascular disease (Bose O'Reilly et al, 2010). Inorganic mercury exposure has been shown to cause kidney damage in children (Bose O'Reilly et al, 2010) and can also cause a skin rash called acrodynia (Boyd et al, 2000).

Mad as a hatter

The Mad Hatter character from *Alice's Adventures in Wonderland* (Lewis Carroll) has long been considered a representation of the effects of mercury exposure (from the felt-making process) on hat makers between the 17th and mid-20th centuries. Tremors, anxiety, depression, shyness, problems with speech and reduced cognitive function among hat makers with chronic mercury poisoning may have given rise to the terms "mad as a hatter" and the "hatter's shakes" (NIOSH, 2010; Waldrom, 1983).

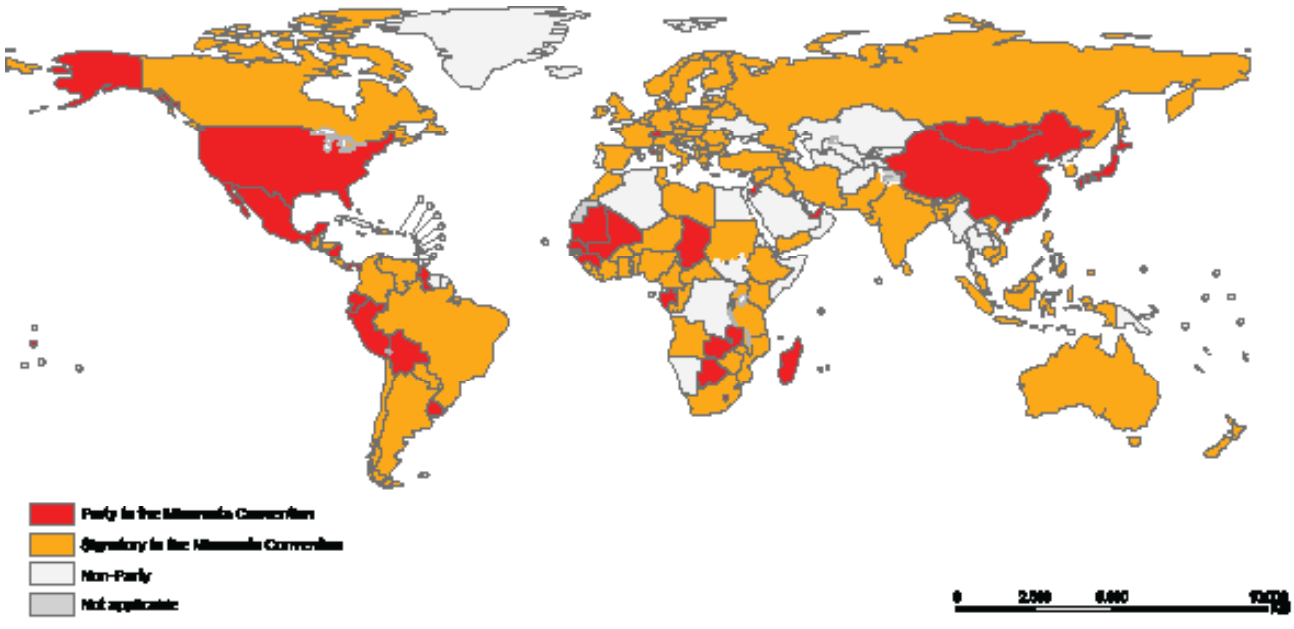
SDGs and international initiatives

The Minamata Convention on Mercury, an international treaty adopted by governments in 2013, aims to reduce mercury emissions and releases of mercury and mercury compounds in order to protect human health and the environment. ASGM is currently the largest source of human emissions of mercury into the atmosphere and therefore a major focus area of the convention (UNEP, 2013b). Implementation of the Minamata Convention will contribute to the achievement of SDG Targets 12.4, "by 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment"; 3.9 to "by 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination"; and 6.3 to "by 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally". The convention includes:

- A ban on the development of new mercury mines.
- Commitment to phase out existing mines.
- Measures to reduce ASGM.
- Measures to lower air emissions of mercury.
- Phasing out of the manufacture, import and export of many mercury-containing products.
- Measures for the safe disposal of mercury and mercury-containing products (UNEP, 2013a).

In support, the World Health Assembly adopted Resolution WHA67.11 on the roles of WHO and ministries of health in implementing the Minamata Convention in 2014 (WHO, 2014).

Signatories and Parties to the Minamata Convention on Mercury, as of 31 August 2016



Artisanal and small-scale gold mining

It is estimated that 10–15 million miners, including 1 million children, in 70 countries work in the ASGM sector (ILO, 2005; Telmer & Veiga, 2009; UNIDO, 2007). Mercury is commonly used in ASGM to extract gold. Miners, their families and communities living and working near to processing sites are at risk of exposure to mercury vapour released during the burning of the gold-mercury amalgam and to mercury contaminated foods (Gibb & O'Leary, 2014). Child labour is common in ASGM and has been reported in Niger, the Democratic Republic of the Congo and Burkina Faso, among others (Thorsen, 2012). The International Labour Organization (ILO) estimates nearly 1 million children 5–17 years old are engaged in ASGM and quarrying activities (ILO, 2005). Girls are often involved in wet and dry panning, extraction and amalgamation and domestic activities on site. Boys are more involved in extraction and processing (Thorsen, 2012). In addition to exposure to high doses of elemental mercury, adult and child miners are at risk of injuries (e.g. from falls or burns), musculoskeletal problems and respiratory problems.

The Minamata Convention provides an opportunity to strengthen action to prevent mercury exposure among children involved in or affected by ASGM. UNEP has developed advice on cost-effective alternatives to reduce the unsafe use of mercury in gold mining including the use of vortexes, magnets, shaking tables and centrifuges to concentrate ore (UNEP, 2012). Helping ASGM practices achieve more formal legal status will allow communities to benefit from mineral resources without negative health effects. This includes using improved mining techniques that reduce mercury use, practising safe-waste management and developing community based monitoring systems. ASGM has potential for regional development and poverty alleviation, and communities that adopt modern environmental standards can not only generate more wealth but also protect their health (UNEP, 2012).

Poisons: Keep out of reach

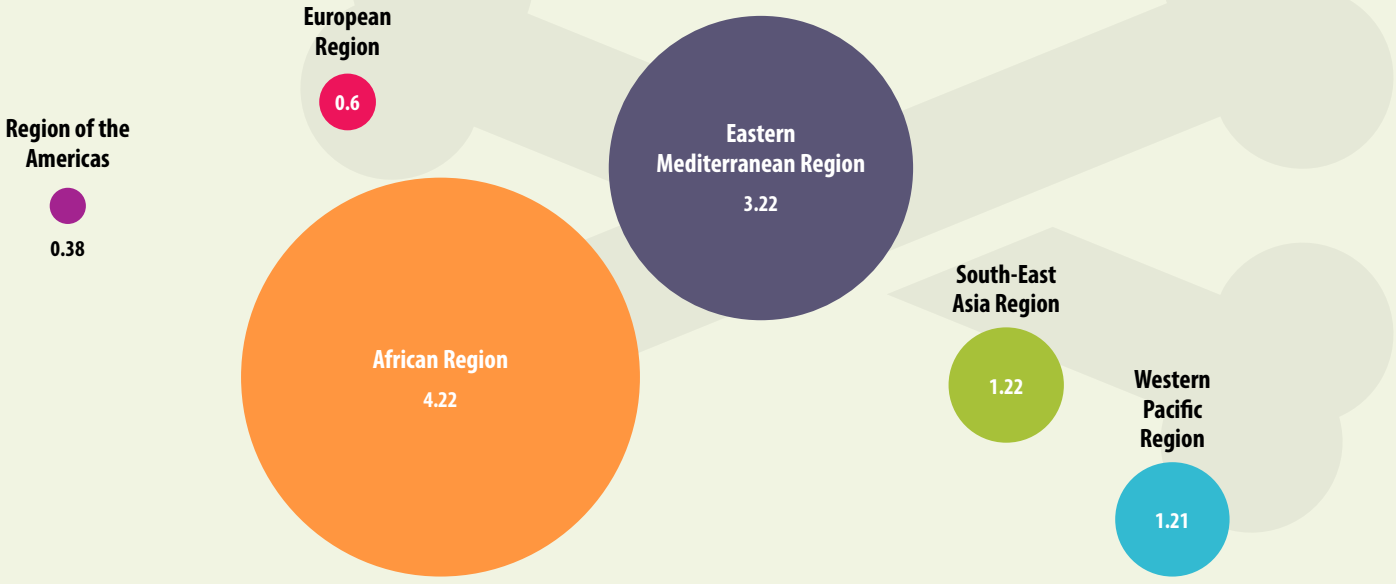
Most poisoning in young children is a consequence of normal exploratory behaviour, which involves touch and taste. However, where highly toxic substances are stored at home or used in work places where there is child labour, or where children intentionally take a chemical or drug, severe and life-threatening poisoning can occur. And it is not just the built environment that can present these dangers to children, as the natural world also harbours risks of poisoning in the form of snake and insect bites. Both age group and location influence the pattern of poisoning, and to some extent its severity.

Poisons all around us

In many cases the poisons children are exposed to do not result in serious harm as the quantity of toxic substance involved is small. However, more serious poisoning is a risk in settings where highly toxic chemicals can be found in the home (Contini et al, 2009). Intentional self-poisoning can be seen with older children, who may experiment with euphoriant chemicals, e.g. volatile solvents (Beckley & Woodward, 2013) or take a drug overdose for self-harm (Zakharov et al, 2013), and this can result in severe and possibly life-threatening poisoning. Some children may be exposed to toxic chemicals through work, for example in the leather tanning industry (Human Rights Watch, 2012) or from scavenging on waste sites. Contaminated work clothes being brought into the household are another potential source of exposure.

Common poisons

Mortality rate from unintentional poisonings per 100 000 children ages 0–14 years, by WHO region, 2012



Environmental contamination with chemicals such as lead (in some places causing severe mass poisoning) or mercury can also result in toxic exposure and both short- and long-term ill health (Hu et al, 2007) (see *Lead-free lives: Allowing children to thrive; Mercury: Protecting children's brains*).

Patterns of poisoning

The pattern of poisoning varies around the world. For example, in many parts of Africa kerosene is used for lighting and cooking and accidental poisoning is common. Typically, this occurs when kerosene is stored in the home in a soft-drinks bottle and mistaken for a drink by a young child (Schwebel et al, 2009). Upon swallowing, kerosene is easily aspirated into the lungs where it causes pneumonitis that may be fatal. It has been estimated that there are 40 000–60 000 cases of kerosene ingestion per year in South Africa alone (Matzopoulus & Carolissen, 2006). A South African poisons centre reported that kerosene ingestion accounted for 24% of enquiries about poisoning in children (Balme et al, 2012). In industrialized countries, where numerous household products and medicines are available in the home, these substances account for a large proportion of unintentional poisonings in children. For example, in the United States of America, poisons centres reported that the top three agents for poisoning in young children were cosmetics and personal care products (14.0%), household cleaners (11.0%) and analgesics (9.3%) (Mowry et al, 2015). In tropical countries snakebites are common and can cause death or lifelong disability. A study in India found that, while the peak age group for deaths from snakebite was 15–29 years, the relative risk of dying from snakebite compared with other causes was greater for the age range 5–14 years (Mohapatra et al, 2011).

Progress in prevention

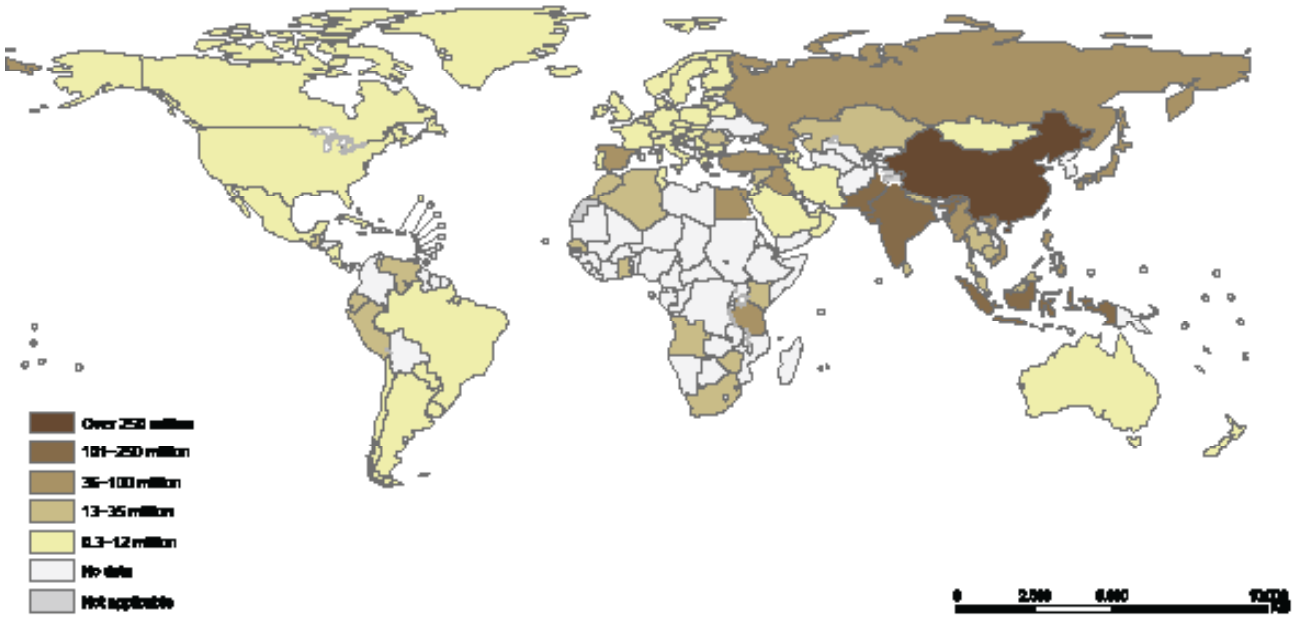
For the most part, poisoning in children is preventable, and recent years have seen the implementation of a number of measures that have had a positive impact on poisoning rates in children:

- Requirements to use child-resistant packaging on medicines and hazardous household products in a number of countries have reduced the incidence of accidental poisoning with those products (Rodgers, 1996; Rodgers, 2002; Sleet et al, 2003).
- Implementing legislation requiring hazard and safety information on product labels and safety data sheets contributes to reducing accidental poisonings by alerting the user to the need to keep hazardous products away from children and exercising caution when handling certain products.
- The replacement of hazardous chemicals with safer chemicals in products can reduce the severity of poisoning. An example is the reformulation of dishwasher detergents to replace corrosive metasilicates with less corrosive disilicates, resulting in a reduction in the incidence of severe mucosal injury following ingestion (Brockstedt et al, 2004).

Poisons centres – toxicovigilance in action

Poisons centres play an important role in advising on treatment and also in collecting information on poisoning cases and how they occur. By analysing enquiries, centres can identify the main types of poisoning in their community and spot new trends. Poisons centres use this information to alert regulatory authorities, manufacturers and the public, and to raise awareness of the need for poisoning prevention measures such as child-resistant packaging, better warning labels and safer storage. This activity is known as toxicovigilance (WHO, 2016a). Recently, poisons centres have raised alerts about children being poisoned by soluble liquid laundry capsules and by liquid nicotine refills for e-cigarettes (AAPCC, 2014; Davanzo et al, 2015). Through their toxicovigilance

Population served by each poisons centre, February 2016



As of June 2016, only 46% of countries had a poisons centre, with inadequate coverage for populations in much of Africa and Asia.

activities, poisons centres can make an important contribution to reducing the risk of poisoning children face.

SDGs and international initiatives

Work on characterizing, monitoring and preventing poisoning in children falls within SDG 3: "Ensure healthy lives and promote well-being for all at all ages" (Target 3.9: "by 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination"); and SDG 12: "Ensure sustainable consumption and production patterns" (Target 12.4: "by 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment").

The Globally Harmonized System of Classification and Labelling of Chemicals (GHS), launched in 1998, aims to ensure globally consistent classification and labelling of hazardous chemicals. It also seeks to standardize rules and regulations to ensure trade and use of chemicals does not harm health or the environment. Implementation of the GHS is under way in many countries (UNECE, 2016).

Policy action priorities

- The most effective programmes to prevent poisoning involve many actors: families, the health and education sectors, departments of trade and industry, consumer groups, the media, NGOs concerned with child safety, producers and retailers of pharmaceuticals, agrochemicals and other toxic substances, and industries that handle toxic substances and in which children are employed. Although legislation can compel companies to reduce the toxicity of products, consumer advocacy groups also play a role in pressuring producers to create less toxic products in some high-income countries (WHO, UNICEF, 2008).
- Poisons centres are a successful example of an intervention that protects children from poisoning. While there is no internationally accepted figure for the size of population that should be served by a single poisons centre, every country should have access to poisons centre services. As the map demonstrates, many countries still lack a poisons centre – a situation which requires urgent action.
- New products should go through effective testing before being introduced to the market. Post-marketing surveillance should also be conducted, in order to identify any unanticipated hazards as early as possible.

A toxicovigilance success story

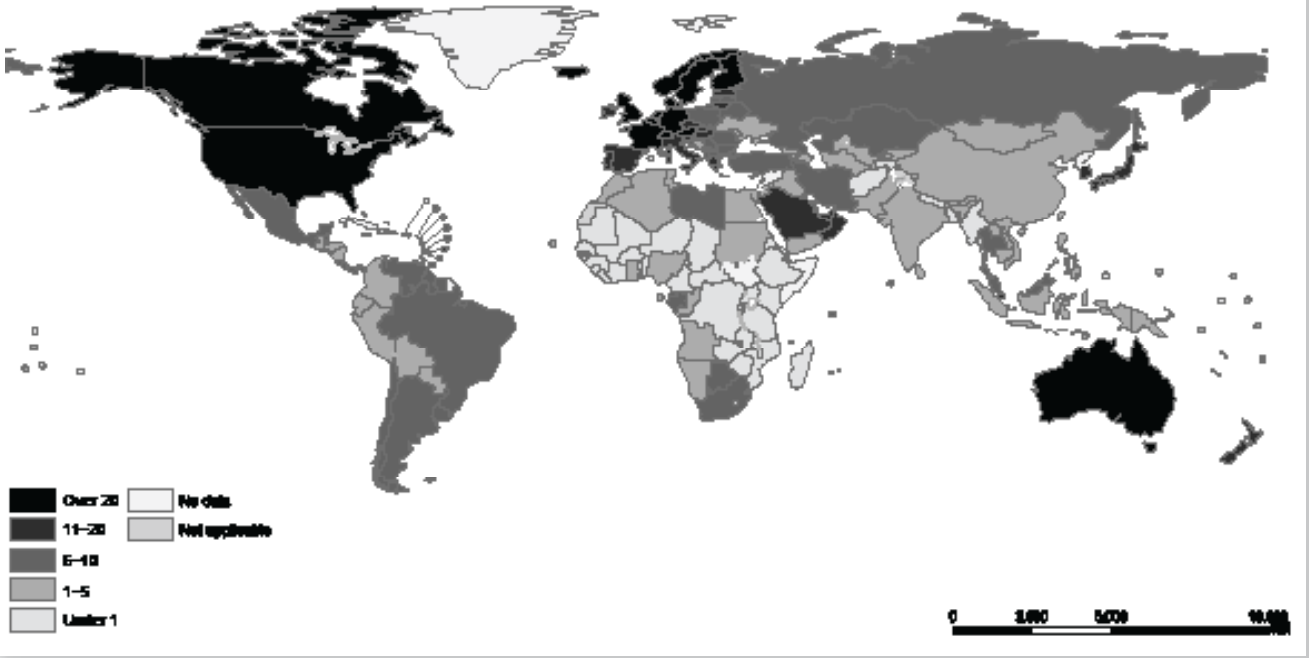
Since the introduction of soluble liquid laundry capsules to consumer markets in Europe and North America between 2010 and 2012, poisons centres have identified a rising trend in enquiries about children suffering injuries and poisoning related to these products. Brightly coloured and squidgy, the capsules resemble soft toys or sweets and are 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. Poisons centres in a number of countries have drawn attention to this newly emerging hazard, with the result that some manufacturers have changed the packaging of the capsules from transparent to opaque and have run public information campaigns to warn parents to keep the products out of reach of children. In Italy, a study by the National Institute of Health and the National Poison Control Centre in Milan, found that the introduction of opaque packaging was associated with a significant reduction in paediatric exposures to the affected brand of laundry capsules (Davanzo et al, 2015).

In 2015 the Organisation for Economic Co-operation and Development (OECD) developed a global awareness raising campaign to warn families about the poisoning risks of laundry detergent capsules, illustrated by this poster produced by the European Commission (OECD, 2015).

E-waste: Promoting responsible recycling

A laptop, a tablet, a mobile phone – it's hard to imagine life anywhere in the world without at least one of these. Technology has become essential to our modern lives and brought with it unprecedented consumption of new devices, which has resulted in a steady stream of electronic and electrical waste (e-waste). Increasing sales and shortening lifecycles of electrical and electronic equipment are leading to a rising tide of e-waste – expected to increase by 19% between 2014 and 2018 (UNU, 2014). Although e-waste can be safely recycled, much is not and is shipped from high-income to lower income countries, where it is either put in landfill or dismantled, often under hazardous conditions, exposing many workers, children and pregnant women to highly dangerous chemicals and serious injury (Lundgren, 2012).

Quantity of e-waste produced per inhabitant (kg), 2014



Children of the urban mines

Using primitive techniques, workers extract valuable metals from computers, large appliances, lights, televisions and batteries, often with little protective equipment (UNU, 2014). Children are often used because their small hands are ideal for handling and dismantling small parts. To separate valuable metal from computers, phones and other electronic devices, acid is poured on circuit boards and plastic-coated wires are burned, releasing lead, mercury, copper, cadmium, chromium, arsenic, PCBs, PBDEs and other flame retardants into the environment and directly exposing young workers to highly toxic substances which can produce adverse neurodevelopmental impacts even at low exposure levels (Grant et al, 2013). E-waste is also found in landfill and waste sites, where it is collected by children for dismantling and sale of the commercially valuable parts.

E-waste collection and recycling often happens in the informal sector and can be the only means of livelihood for workers. There are two different informal e-waste operation types commonly seen. In the first, entire towns in Africa, China and India have developed as e-waste recycling hotspots, where communities are built around e-waste recycling (Amoyaw-Osei et al, 2011; Ogungbuyi et al, 2012; Pradhan & Kumar, 2014; Wang et al, 2013). In contrast, in Latin America the informal recycling of e-waste is not concentrated in a specific location, but occurs throughout cities and towns (ITU et al, 2015). For instance, waste pickers may collect e-waste at waste sites or by door-to-door collection. This waste is then brought back and dismantled

with other waste in the recyclers' communities – an activity now termed "urban mining" (ITU et al, 2015).

In either scenario, children can be exposed in the community they live in or by going with their parents to the recycling sites. Informal e-waste dismantling often happens in the home in the context of "home workshops" where the whole family helps. Some children eat food grown in e-waste-polluted soil or drink from polluted rivers, many children play in contaminated areas or go to schools near informal recycling sites, and others are workers themselves. A systematic review by WHO and partners found that pregnant women in e-waste recycling towns are more likely to give birth to small infants, and that exposed children are also at risk of reduced IQ, attention deficits, lung damage, DNA damage and cancer (Grant et al, 2013).

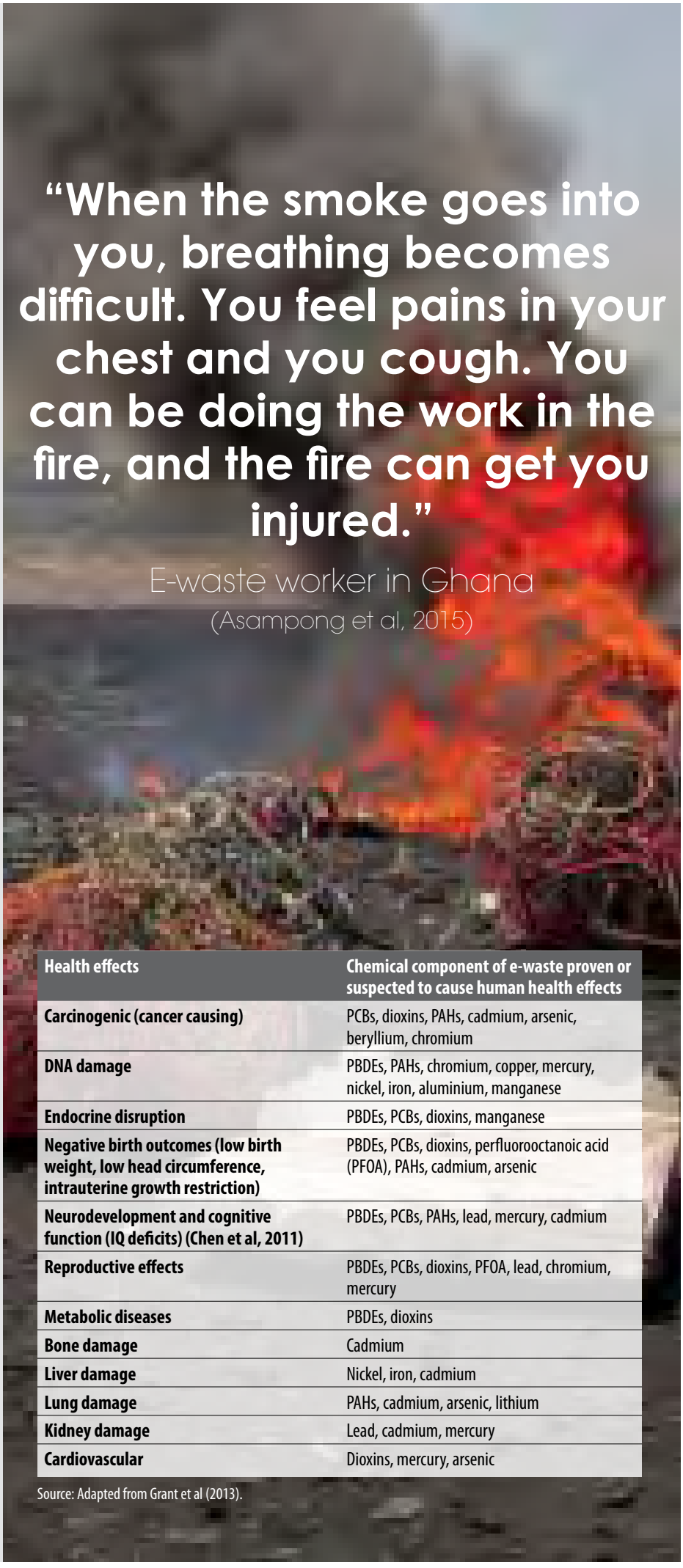
Even official e-waste collection does not guarantee safe recycling. For instance, containers of e-waste have been caught illegally leaving Australia, Europe, Japan and North America bound for China (Geeraerts et al, 2015; Rucevska et al, 2015).

Damaging health effects of e-waste

Although research into the health effects of e-waste exposure in children is limited, there is ample evidence of harmful health effects from the components of e-waste, which contain chemicals that affect almost every system in the human body.

Informal e-waste recycling and blood lead levels in children in Uruguay

Researchers from the University of the Republic in Montevideo, the Montevideo City Council and Pure Earth examined exposure to lead of children from low-income suburbs from cable burning and other sources of lead. High soil lead levels were found in areas where



Health effects	Chemical component of e-waste proven or suspected to cause human health effects
Carcinogenic (cancer causing)	PCBs, dioxins, PAHs, cadmium, arsenic, beryllium, chromium
DNA damage	PBDEs, PAHs, chromium, copper, mercury, nickel, iron, aluminium, manganese
Endocrine disruption	PBDEs, PCBs, dioxins, manganese
Negative birth outcomes (low birth weight, low head circumference, intrauterine growth restriction)	PBDEs, PCBs, dioxins, perfluorooctanoic acid (PFOA), PAHs, cadmium, arsenic
Neurodevelopment and cognitive function (IQ deficits) (Chen et al, 2011)	PBDEs, PCBs, PAHs, lead, mercury, cadmium
Reproductive effects	PBDEs, PCBs, dioxins, PFOA, lead, chromium, mercury
Metabolic diseases	PBDEs, dioxins
Bone damage	Cadmium
Liver damage	Nickel, iron, cadmium
Lung damage	PAHs, cadmium, arsenic, lithium
Kidney damage	Lead, cadmium, mercury
Cardiovascular	Dioxins, mercury, arsenic

Source: Adapted from Grant et al (2013).

cables had been burned. Burning cables and soil contamination inside or around the home were the sole sources of lead exposure in 28.9% of the sample population (Pascale et al, 2016). Children are particularly vulnerable to the neurotoxic effects of lead, and even relatively low levels of exposure can cause serious and in some cases irreversible neurological damage (WHO, 2010).

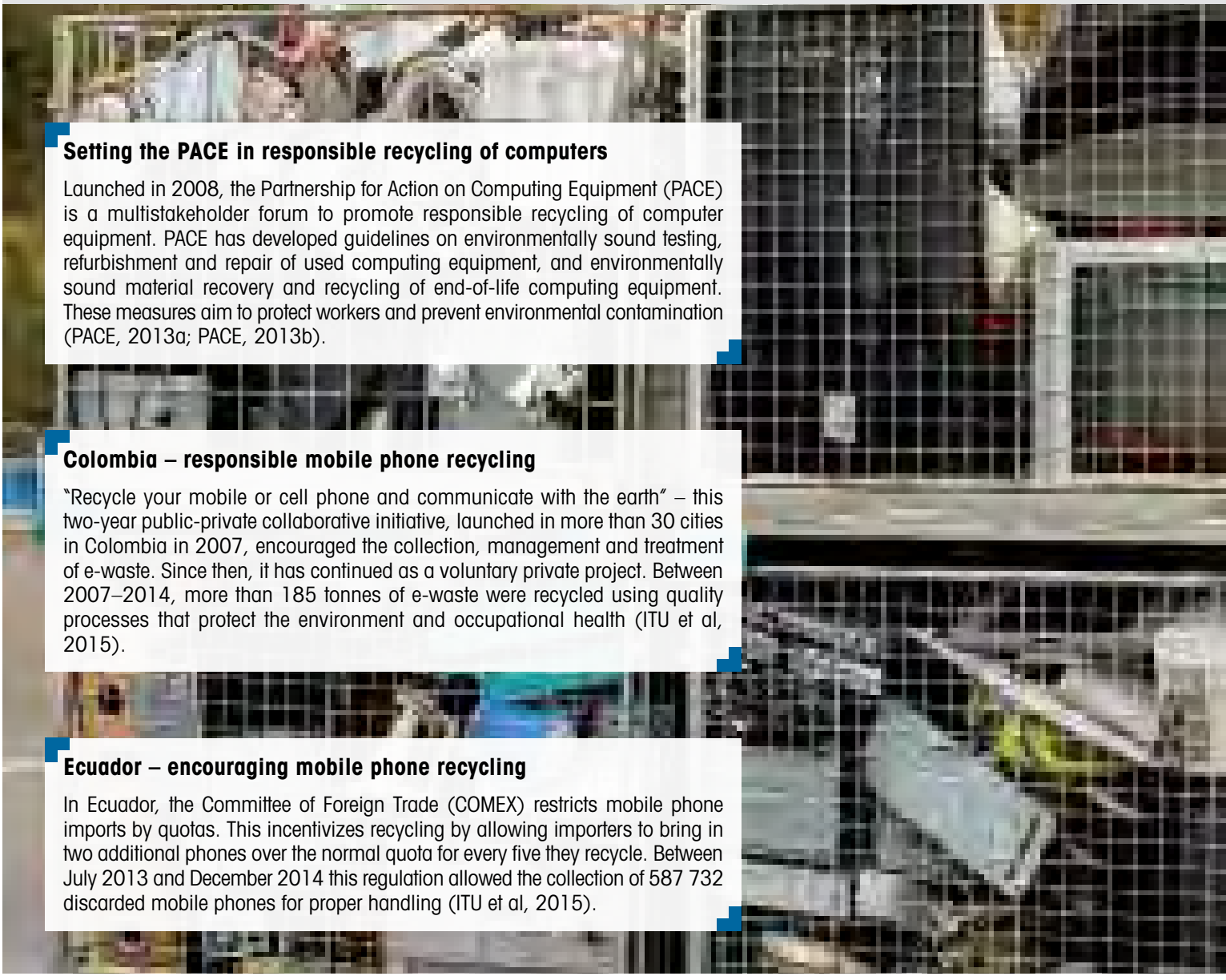
The benefits of responsible recycling

New alternatives are being tested for safe, even informal, e-waste recycling based on safe work practices (e.g. wire-stripping machines and tools) and worker training (Pure Earth/Blacksmith Institute, 2015). Risk-reduction strategies have been proposed, including reduction of working hours and use of personal protective equipment (PPE) (Nukpezah et al, 2014). Additional measures may be taken to reduce exposures from open dumping and burning, and to prevent direct or indirect exposures of children (e.g. separation of dismantling areas from houses, and clean-up of contaminated ground). The supervision of workers' use of PPE could be facilitated if the e-waste processing activities were formalized to minimize exposure (Akormedi et al, 2013). Pilot studies in China successfully combined manual dismantling of e-waste with high-tech processing of the most critical fractions (Wang et al, 2012).

The real financial opportunity in safe recycling of e-waste for its valuable materials should add impetus to initiatives to combat the health impacts that irresponsible e-waste recycling currently causes. The United Nations University estimated that in 2014 the value of global e-waste was €48 billion, much of which could have been retrieved from e-waste if all materials were properly recycled (UNU, 2014).

SDGs and international initiatives

A number of SDGs reflect the importance of tackling the debilitating impacts of e-waste on children around the world. SDG 3: "Ensure healthy lives and promote well-being for all at all ages" sets Target 3.9, "by 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination". SDG 11:



Setting the PACE in responsible recycling of computers

Launched in 2008, the Partnership for Action on Computing Equipment (PACE) is a multistakeholder forum to promote responsible recycling of computer equipment. PACE has developed guidelines on environmentally sound testing, refurbishment and repair of used computing equipment, and environmentally sound material recovery and recycling of end-of-life computing equipment. These measures aim to protect workers and prevent environmental contamination (PACE, 2013a; PACE, 2013b).

Colombia – responsible mobile phone recycling

"Recycle your mobile or cell phone and communicate with the earth" – this two-year public-private collaborative initiative, launched in more than 30 cities in Colombia in 2007, encouraged the collection, management and treatment of e-waste. Since then, it has continued as a voluntary private project. Between 2007–2014, more than 185 tonnes of e-waste were recycled using quality processes that protect the environment and occupational health (ITU et al, 2015).

Ecuador – encouraging mobile phone recycling

In Ecuador, the Committee of Foreign Trade (COMEX) restricts mobile phone imports by quotas. This incentivizes recycling by allowing importers to bring in two additional phones over the normal quota for every five they recycle. Between July 2013 and December 2014 this regulation allowed the collection of 587 732 discarded mobile phones for proper handling (ITU et al, 2015).

"Make cities inclusive, safe, resilient and sustainable" aims with Target 11.6 to, "by 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management". And finally, SDG 12: "Ensure sustainable consumption and production patterns", includes Target 12.4, "by 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment".

A number of United Nations agencies, including WHO, UNEP, United Nations University, ILO, International Telecommunications Union and United Nations Industrial Development Organization, and the Secretariat of the Basel Convention, are working together on different aspects of the e-waste problem. In part through PACE, Solving the E-waste Problem (StEP), and other international initiatives, these organizations promote and advocate for a combined approach involving:

- Improved product design
- Reduced consumption
- Official e-waste collection
- Safe recycling of e-waste
- Control of transboundary movements of e-waste.

What the health sector can do

Areas defined by WHO and collaborators for action in the health sector include: communicating and building capacity of the health sector to better protect children through exposure reduction; promoting monitoring of exposure to e-waste; and working with other sectors to implement policies and actions that reduce exposures. More specific research about e-waste and related health effects is necessary. Health professionals can play a key role at the local level, by identifying specific needs and working with communities through primary health-care to educate and empower key agents. These community leaders can then move the issue of e-waste forward and implement interventions to reduce exposures and improve the health of local children, workers and their families.

Environmentally unsound battery recycling poisons children

A study of children living close to a lead-acid battery recycling smelter in Haina, Dominican Republic, found very high blood lead concentrations, with a mean value of 71 µg/dL (range 9–234 µg/dL) (Kaul & Mukerjee, 1999). Shortly afterwards the government closed down the recycling plant. A follow-up study carried out six months later revealed that, while the mean blood lead concentrations had reduced to 32 µg/dL (range 6–130 µg/dL), they were still too high (Kaul et al, 1999). Only 9% of the children had blood lead concentrations below 10 µg/dL and 28% of the children had blood lead concentrations above 40 µg/dL. An environmental assessment found that although the smelter had shut down, scrap metal and other waste remained scattered around posing a continuing source of exposure. Thus, while closing the battery recycling facility had a positive impact on lead exposure, in the end, remediation was also needed.

Living and learning in healthy environments: Steps towards SDGs 8, 9 and 11

Part 5

Living and learning in healthy environments: Steps towards SDGs 8, 9 and 11

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

11 SUSTAINABLE CITIES AND COMMUNITIES

Health-care facilities: Investing in maternal and child survival

The poor quality of health-care facilities (HCFs) is impacting lives in many countries – for those in the developed world it is inconceivable to imagine visiting health facilities that don't have basics such as electricity, safe water supplies and adequate sanitation. Yet this is the case in LMICs where many maternal and child deaths could be avoided if women and children had better access to good quality health services, particularly during pregnancy, childbirth and the first few months of life. An estimated 113 000 maternal deaths, 531 000 still births and 1.3 million neonatal deaths could be saved by 2020 if HCFs were improved (Bhutta et al, 2014).

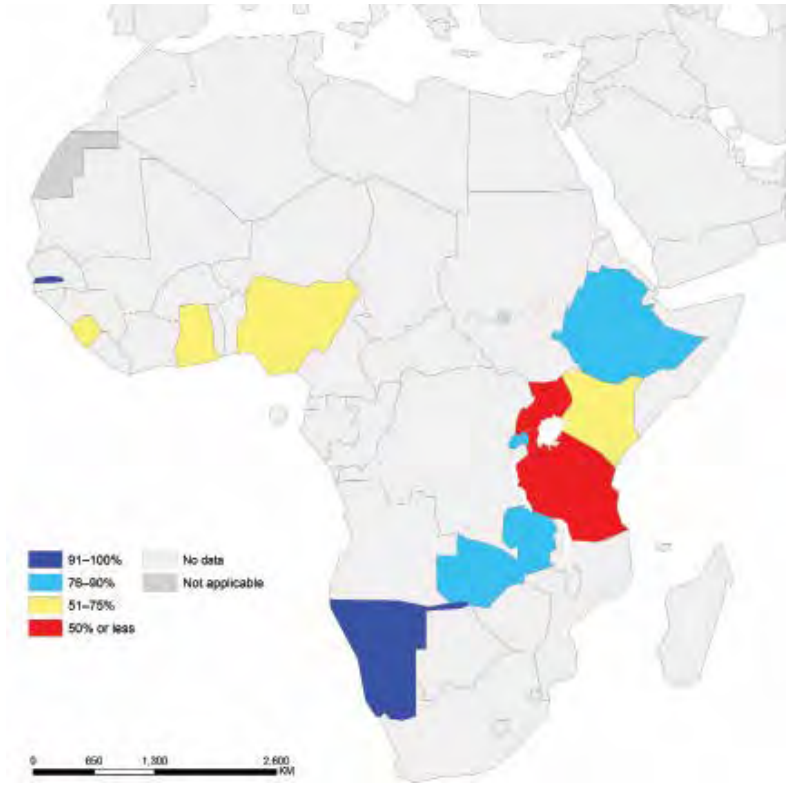
Electricity – powering health

Access to electricity in HCFs is vital for maternal and child health. Unlike many other medical procedures, childbirth cannot wait until morning. Reliable data on access to electricity in HCFs in developing countries is limited, however, a study of 11 sub-Saharan African countries revealed that 26% of facilities had no access to electricity. While many of the hospitals surveyed had access to electricity, only about one third had what could be considered "reliable" or "regular" access (no service outages greater than two hours in the previous seven days) (Adair-Rohani et al, 2013). However, there has been progress over the MDG era in some countries. For example, in Rwanda, the proportion of facilities with electricity access increased from 58% to 82% between 2001 and 2007, and in Kenya, from 65% to 74% between 2004 and 2010 (WHO, World Bank, 2014).

Without reliable power, many of the most basic life-saving interventions simply cannot be delivered safely (WHO, World Bank, 2014). Electricity is vital for:

- Operating essential medical devices, including emergency surgical, laboratory and diagnostic equipment.
- Lighting, refrigeration, ventilation, communications and computer systems.
- Infection control measures, such as the treatment of hazardous waste (e.g. autoclaves, incinerators).
- Water pumping and purification systems.

Percentage of health-care facilities in Africa with electricity, 2011 or latest available data



Policy action priorities

- At the policy level the health sector needs to work with the WASH and energy sectors to ensure that HCFs have adequate services (for example, in developing technical standards, facility-based policies and training). Health ministries will need guidance from the WASH and energy sectors on adopting appropriate technologies, service-delivery models and financing options.
- Securing reliable electricity supplies for resource-constrained rural HCFs.

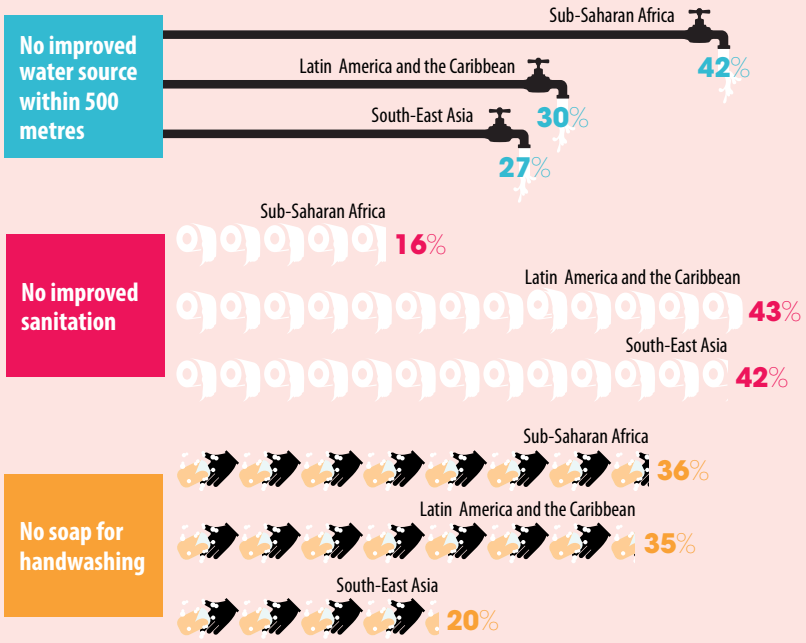
Water, sanitation and hygiene – essential for reducing infection

The situation with respect to water, sanitation and hygiene (WASH) in HCFs is equally alarming. Recent data from 54 LMICs show that 38% of HCFs lack access to an improved water supply, 19% lack sanitation and 35% do not have the soap and water needed for handwashing (WHO, UNICEF, 2015a). This situation has devastating consequences for health. One estimate suggests that, in developing countries, 13.5% of patients develop one or more infections during a hospital stay (Allegranzi et al, 2011). This burden of infections is especially high among neonates in low-resource settings where the risk of neonatal death from sepsis and other severe infections are estimated to be 34 times greater than in high-resource settings (Oza et al, 2015).

SDGs and international initiatives

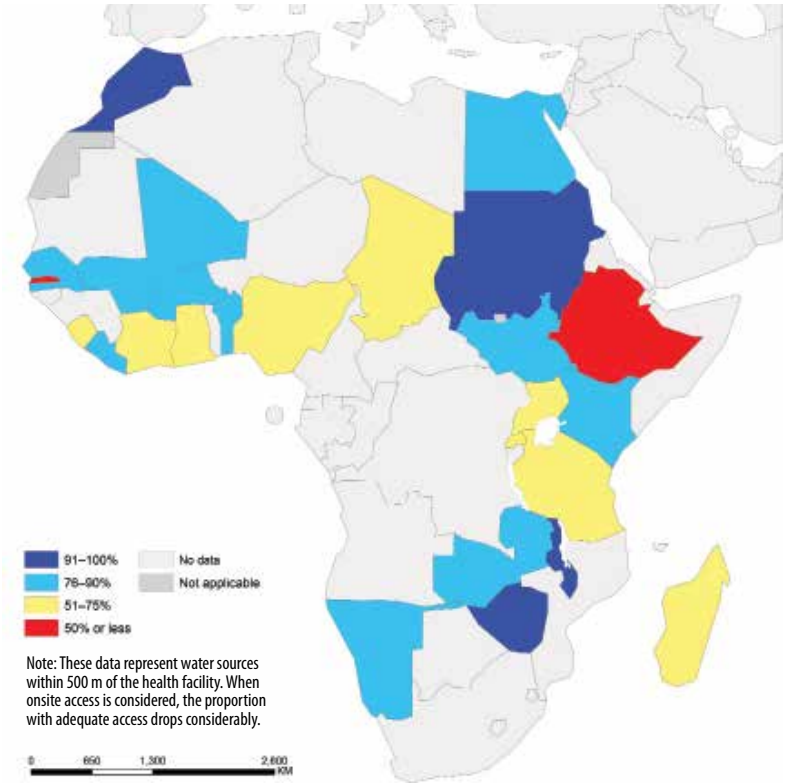
- Several SDGs and targets relate to HCF infrastructure: 3.1 (maternal mortality), 3.2 (child mortality), 3.8 (universal health coverage), 6 (water and sanitation) and 7 (sustainable energy). Indicators 6.1 (water) and 6.2 (sanitation and hygiene), which call for universal access to WASH, are being interpreted to include HCFs. The SDGs provide a useful framework to identify intersectoral engagement opportunities particularly where health, WASH and energy sector SDG goal interests can be aligned.
- Other global goals, such as those linked to the WHO/UNICEF Global Action Plan for the Prevention and Control of Pneumonia and Diarrhoea (GAPPD), also call for universal access to WASH in HCFs.
- Global initiatives, such as the UN Secretary-General's Sustainable Energy for All (SE4All), aim to integrate HCF energy needs into national and global processes in efforts to attain SDG 7.

Percentage of health-care facilities without basic water, sanitation and hygiene facilities, 2014 or latest available data



> "A labour ward without water is a danger to the life of newborn children."
>
> Mary Mwape, midwife, Zambia

Percentage of health-care facilities in Africa with water access, 2014 or latest available data



Reducing radiation risks in paediatric medical imaging

The use of ionizing radiation in paediatric radiology in medical and dental imaging has increased rapidly worldwide over the past 20 years, with procedures such as conventional radiography (screen-film, computed and digital radiography), computed tomography (CT) and fluoroscopy. Advanced imaging technology has opened new horizons for medical diagnostics and improved patient care. For instance, CT is a valuable clinical tool for assessing paediatric illness and injury, also used in paediatric dentistry, and fluoroscopy-guided procedures may replace more complex surgical options in children. However, both CT and fluoroscopy deliver relatively high radiation doses compared with conventional radiography, and have consequently triggered debate among scientists and public scrutiny concerning children's susceptibility to radiation and the potential for increased cancer risks from low-level exposures. Although individual radiation risks are, at most, quite small, radiation protection in paediatric imaging is a public health issue due to the large population exposed and the special vulnerability of children.

This environmental risk to children demands policies and actions that recognize and maximize the multiple health benefits of radiation use in paediatric imaging, and at the same time minimize potential health risks of radiation exposure to ensure that benefit outweighs harm. This can be achieved by applying the two principles of radiation protection in medicine: justification of procedures and optimization of protection. However, many health professionals have low awareness of radiation doses and associated risks in children. A substantial fraction of paediatric imaging procedures are unjustified and do not provide a net benefit. An area of special concern is the unnecessary use of radiation when clinical evaluation or other imaging modalities (e.g. ultrasound) could provide an accurate diagnosis. In the context of medical imaging, optimization means delivering the lowest possible dose necessary to acquire adequate diagnostic images. Paediatric imaging provides multiple opportunities for dose reduction while maintaining diagnostic benefit by tailoring the doses to a child's age and size. A stronger collaboration between radiation protection and paediatric health-care communities can enhance radiation safety culture in medical practice and reduce unnecessary radiation risks to children (IAEA, WHO, 2014; WHO, 2016).

Energy for Women's and Children's Health – a high-impact opportunity

Co-led by the UN Foundation, UN Women and WHO, the SE4All initiative seeks to improve the health and well-being of women and children by increasing access to reliable electricity in HCFs, using clean, modern, renewable energy solutions such as solar and wind power. It promotes engagement with energy and health sector stakeholders in governments, civil society and the development and private sectors to address structural, policy and market barriers limiting access to modern energy solutions. A key strategy is to ensure that HCF electrification needs are fully integrated within wider national sustainable energy sector planning processes, thus working towards SDG 7 targets, with a particular focus on electrification of rural HCFs in resource-constrained settings (UNF, UN Women, WHO, 2015). Hydroelectric power is proving a solution for some countries, including the Democratic Republic of the Congo, Rwanda and Uganda, where there are examples of hospitals tapping into this source of power either independently or in tandem with nearby communities.

Simple, low-cost water stations making the difference in Zambia

When Mary Mwape, a midwife, delivers babies at Lubwe Mission Hospital in Luapula Province, Zambia, there's often no water to wash her hands or clean the newborn. Yet, mothers from all over the region are referred to the hospital for delivery and related health-care activities. Zambia has made efforts to improve WASH services in HCFs. In 2010, the Ministry of Health, with support from the Tropical Disease Research Centre and other organizations, installed small water stations for safe drinking and handwashing in 150 HCFs, mostly in rural communities. The facilities were chosen because they reported high levels of diarrhoea and low access to clean water. As Mary Mwape says, "If a newborn child with a fresh umbilical cord is washed using water from shallow, open wells or unsafe water, the child is likely to be infected with diseases like neonatal tetanus or neonatal sepsis which may lead to death".

The project placed two locally produced water stations at key points in each health facility. One 60-litre water station provides chlorinated water that is safe for drinking. The second 70-litre water station is used for handwashing with soap. Depending on the health facility's water supply, the water stations are filled either by well, piped or delivered water. There are dedicated personnel to manage the stations in order to ensure proper operation and disinfection of water supplies. Besides making it possible for health workers to wash their hands, the water stations are increasing patients' satisfaction and promoting hygiene practices. Health workers are capitalizing on a "teachable moment" by encouraging patients to wash their hands and treat their drinking-water at home. Simple measures, like Zambia's water stations, can make an immediate difference, while realizing longer sustainable plans.

CEH units – Addressing environmental influences on child health

Children's environmental health (CEH) units provide services to identify and address environmental determinants of children's health. They advance training of health-care providers, and education of the public and other sectors concerned about CEH on the protection of children from environmental threats, management of children with known or suspected exposure to environmental stressors, and the diagnosis, management and treatment of children with illnesses that are derived from environmental stressors.

An example comes from Mexico where the CEH unit (a WHO collaborating centre) created a model for interventions for disadvantaged indigenous communities. The programme includes environmental interventions (toxic biomonitoring, installation of improved stoves); water security (rainwater harvest); nutrition (ethnobotanics, introduction of more nutritious food than in traditional diets, ecological agriculture, nutritional education and child nutritional evaluations); and disease prevention (development of participatory schemes for community interventions on environmental and social determinants). These interventions have proved successful thanks to active community participation, knowledge-based respectful dialogue, and constant support and monitoring from the CEH unit. Such initiatives demonstrate that child health can be the "glue" for a range of successful development projects working with vulnerable communities.

Urban spaces: Building well-being

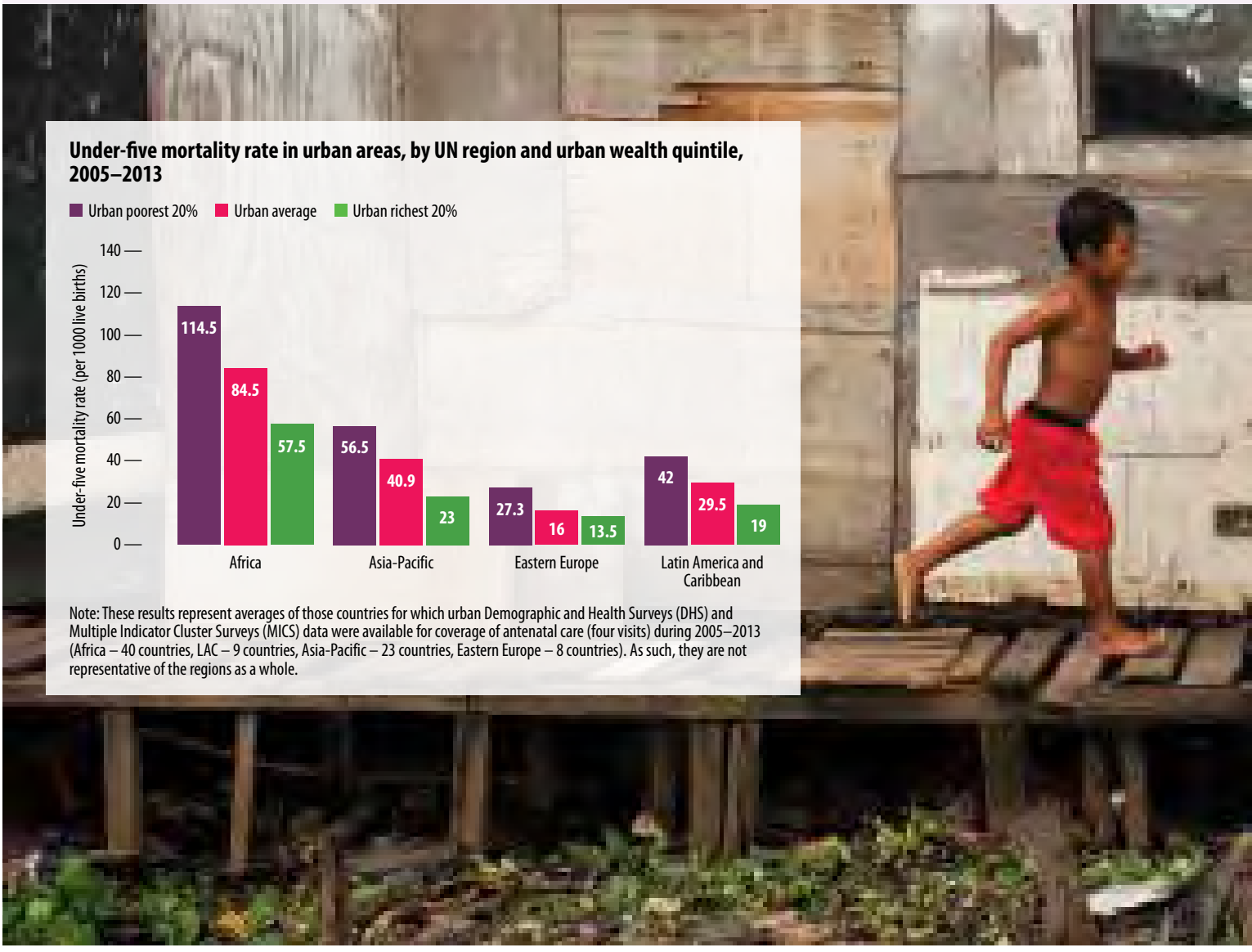
Over the past decades, urban populations around the world have grown exponentially, as urban rather than rural living becomes the norm and mega-cities housing more than 10 million people proliferate. As a result, an increasing number of children and young people live in cities – many of them in slums in Africa, Asia and Latin America. According to the United Nations, almost half of the world's urban population is under 30. In Africa 37% of the population is under 15, and 66% is under 30 (UN Population Division, 2014). With the growing number of people worldwide making the transition to urban living, there is considerable scope for improvement of the health and well-being of millions of children by building health promotion into city and infrastructure planning.

The health highs and lows of city living

Cities can be health-protective environments for all population groups, especially children, as city dwellers tend to benefit from greater access to better quality economic opportunities, social and educational programmes, food, infrastructure, transport and health care, compared with their rural neighbours. City children and their families gain from these advantages and the result is reduced morbidity and improved life expectancy. Yet, persistent and emerging environmental health risks, such as those from climate change, air pollution and inadequate water and sanitation infrastructure, threaten the well-being of many children in cities.

The health divide within cities

Where you live in a city can determine whether your health benefits from urban living. Good quality services and facilities, such as water and sanitation infrastructure, schools and health-care facilities, are distributed unequally across urban areas and are often absent in urban slums and



Under-five mortality rate in urban areas, by UN region and urban wealth quintile, 2005–2013

Note: These results represent averages of those countries for which urban Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) data were available for coverage of antenatal care (four visits) during 2005–2013 (Africa – 40 countries, LAC – 9 countries, Asia-Pacific – 23 countries, Eastern Europe – 8 countries). As such, they are not representative of the regions as a whole.

informal settlements. According to UN estimates, over 880 million people on the planet live in urban slums, shanty towns, on pavements, under bridges or along railway tracks (UN, 2015). Overcrowding, lack of water and sanitation, violence, discrimination and poverty combine to make slum children more vulnerable to disease and early death. Urban inequalities are disproportionately more harmful to children, who often go hungry and become malnourished, drop out of school to work at menial jobs and forego essential health care. Poverty and limited access to social services begin to put poor urban children at a disadvantage from an early age, which can have lifelong health impacts.

Each and every day, approximately 16 000 children under five die (WHO, 2016a); child mortality rates are particularly high in urban slums (Save the Children, 2015). In the slums of Nairobi, Kenya, the under-five child mortality rate has been reduced but is still much higher than the rate for other children living in Nairobi (APHRC, 2014). Childhood poverty, housing insecurity and lack of basic services help explain these unnecessary deaths. Yet, childhood poverty and health inequities are not limited to LMICs. Almost 30% of children in Los Angeles, United States of America, live in poverty (PPIC, 2016). On any given night in New York City, approximately 23 000 children are now in the homeless shelter system (Routher, 2016; NYC DHS, 2016). Urban poverty affects a child's physical, mental and emotional health and development, and makes accessing urban services and health care very difficult.

Women and children suffer the most from urban poverty. This is because urban economies are frequently cash-based and the work done by women and children, such as cleaning, cooking, fetching water and care work, is often unpaid. Urban economies may thus force children into unsafe, low-paid work in order to earn money. Women's unequal position in the urban labour market unnecessarily exposes them and their children to workplace environmental hazards and violence (Amnesty International, 2010).

Disease and the city

Sedentary lifestyles and predominance of unhealthy foods at low prices put children living in urban areas at increased risk of overweight and obesity (Ruel et al, 2010). Urban children living in poverty are more likely to be

exposed to elevated concentrations of air pollution, often because they live near congested roadways and industrial areas (Karner et al, 2010; McGranahan & Murray, 2003). This can lead to respiratory infections, asthma and elevated blood lead levels (UNICEF, 2012b). Likewise, lead exposure from contaminated soil and paint ingestion disproportionately plagues poor urban children (CMLCP, 1993). Impoverished urban children in low-income countries tend to live in informal settlements, and these young people often suffer from greater rates of malnutrition, stunting, diarrhoeal diseases and respiratory infections (Save the Children, 2015).

Urban built environments may have few safe play spaces and put children at risk of accidental injuries due to falls, drowning, electrocution, exposure to poisonous substances and road traffic injuries.

Urban violence

Urban violence is a particular problem for children. Children suffer from the direct health impacts of domestic abuse, gun violence and conflict. Inadequate sanitation, particularly unsafe toilets at night, can subject children to sexual violence (Save the Children, 2015). Rape can subject young girls to unwanted and unsafe pregnancies, and both girls and boys to sexually transmitted infections, social stigma and intense trauma. When left untreated and ignored, this combination of infections, injuries and mental health effects can contribute to lifelong health problems (WHO, 2016b).

Inadequate infrastructure

In low-income country cities, children suffer from inadequate life-supporting infrastructure, including unsafe streets, under-resourced schools, lack of clean, piped water, few safe toilets connected to a sewer and inconsistent electricity and/or power for lighting, cooking and heating (WHO, UN Habitat, 2010). Where no safe and reliable public transportation exists, children are in increased danger of road traffic injuries, such as from unprotected motorcycle usage. Sustainable mobility, including secure, accessible public transportation and improved paths for cycling and walking, can help to reduce traffic-related injuries, limit air pollution and promote healthy lifestyles for children.

Although there are often higher rates of skilled health professionals and health-care facilities in urban areas, this does not guarantee access to primary health care. Compounding the adverse health impacts of unsafe and inadequate built and social environments in cities are often unregulated, costly and ill-equipped health-care services (WHO, UN Habitat, 2010). Even where lifesaving care may be a stone's throw away, poor women and their children living in urban slums are often forced to rely on expensive and unregulated health care. The urban poor and migrants in particular may face language barriers, cultural barriers and discrimination when trying to access care and other life-supporting services (APHRC, 2014; Ndugwa & Zulu, 2008; WHO, UN Habitat, 2010).

The benefits of healthier cities

A healthy city is one that is continually improving the conditions for its communities to avoid health damaging hazards and support health-promoting living. Promoting healthier and more equitable cities could reduce childhood poverty, related cognitive decline and prevent a lifetime of health-care needs and expenditures. Pursuing healthy cities offers an approach to link normally disconnected child-centred interventions at a scale where young people are likely to benefit most – in their neighbourhood, district or school.

Safer streets, guaranteed educational opportunities, protection at work, industrial and transport pollution reduction, equitable distribution of quality infrastructure and land uses that promote play and creative spaces can all be encouraged through policies and legislation aimed at promoting child-healthy environments (Ståhl et al, 2006).

Urban land use planning can aid child health by co-locating services for multiple age groups, young and old, to promote social interactions. Planners can direct cultural, artistic and educational spaces towards public recreation areas to promote safe, physically and socially engaging urban environments.

Planning inclusive cities can promote children's health by ensuring that all groups and districts can benefit from the services and opportunities that cities offer, no matter their social status or location.

SDGs and international initiatives

SDG 11 aims to "make cities and human settlements inclusive, safe, resilient and sustainable". However, there are no specific targets for children's urban health within SDG 11, nor is community resilience defined in a way that recognizes the unique vulnerabilities children face in cities. Yet, SDG 11 does call for special attention to be paid to the most vulnerable in cities, including women and children, when planning for slum upgrading and when providing access to safe and affordable housing, water, sanitation, transport, public and green spaces.

WHO's Urban Health Equity Action Response Tool (HEART) encourages local and national officials to identify health inequities and plan actions to reduce them. Using evidence from WHO's Commission on Social Determinants of Health, Urban HEART encourages policy-makers to develop a holistic approach in tackling health equity (WHO, 2016c).

Youth and slum waste management in Mathare, Nairobi, Kenya

Waste has become a valuable commodity for slum dwellers in Nairobi's Mathare Valley. Youth in urban shanty towns are starting entrepreneurial waste management schemes, maintaining toilet facilities as well as collecting and recycling solid waste. In a market with few opportunities for youth employment, urban youths are finding self-employment opportunities in providing a desperately needed environmental health service by improving local sanitation. Young people in Mathare are participating in Community Cleaning Services, a micro-franchise business, which aids youth in launching shared toilet-cleaning businesses that present a source of income, improve community hygiene and contribute to overall health. In an area where unemployment was previously linked to gang violence, these youths have managed to improve community relations, in addition to asserting the rights of low-income urban residents politically (Thieme, 2010).

Youth violence reduction, Medellín, Colombia

The city of Medellín is now well recognized for its investments in improving safety and living conditions for the poor. A series of urban investments during the 2000s included constructing a metrocable and escalators to the poor hillside neighbourhoods, cultivating public spaces, building libraries and schools, and establishing social programmes to reduce violence and improve conditions for young people (UN Habitat, 2011). For example, in the Montecristo neighbourhood, youth working with the local community-based organization, Corporación Vida para Todos (Corporation Life for All) or CoVida, managed to avoid violence, gang membership and crime (Baird, 2012). Residents living in neighbourhoods with both physical and social improvement programmes reported increased trust in their neighbours to intervene to break up fights among children, and in asking the police for help (Cerdá et al, 2011). Moreover, the rate of homicide in Medellín was reduced from 185 per 100 000 people in 2002 (Cerdá et al, 2011) to a remarkable 26 per 100 000 people just five years later in 2007 (UN Habitat, 2011). The innovations in Medellín suggest that city development focused on bringing inclusive public transport to the urban poor can not only improve environmental conditions and residents' access to jobs, but also help reduce levels of youth violence and build increased collective trust among residents that can ultimately act to improve everyone's health.

Policy action priorities

To build healthy cities, local and national governments must work together to devise healthy city plans with a targeted focus on children's needs and health equity (WHO, UN Habitat, 2010). Urban and national policies focused on only one environmental or social hazard, behaviour or service at a time will not promote healthier environments for children and their families.

Housing: Raising standards, improving child health

Every child has the right to a standard of living adequate for their physical, mental, spiritual, moral and social development (UN, 1989). However, despite this laudable aim, in reality 30% of the urban population in developing regions live in slums, with very poor access to safe water, sanitation, durable housing and sufficient living space (UN Habitat, 2016). Huge variation in standards of living exist between and within countries globally. One stark statistic, for example, indicates that 95.6% of the urban population in South Sudan lives in slums (UN Habitat, 2016). Housing conditions are a key measure of social and environmental inequality, and poor housing can seriously affect the health and life chances of children.

Housing and health

Housing and the built environment have a profound impact on human health. Healthy, safe and energy-efficient housing can significantly decrease the risks of injuries and both communicable and noncommunicable disease, and are crucial for children's physical and mental development. Children are more vulnerable to indoor exposures due to their behaviour, the lower capacity of their immune systems, and the fact that they have, relative to their body weight, a much higher intake of pollutants than adults.

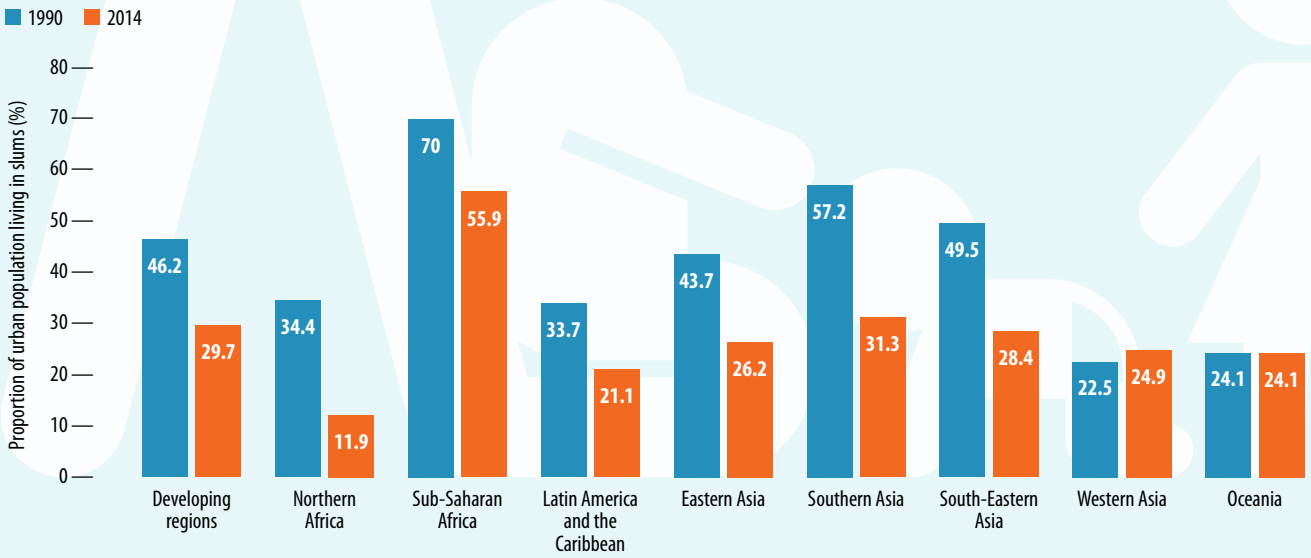
Inadequate basic services

Poor children can end up living in unsafe shelter without basic services, such as water, sanitation and waste management, and with higher risks of pest infestations. Low-income housing often lacks efficient energy for cooking, heating and lighting. Inefficient cooking fuels and technologies produce high levels of household air pollution with a range of toxic pollutants (see *Household air pollution: Switching to healthy home energy*). In poorly ventilated dwellings, indoor smoke can result in small particulate matter being 100 times higher than acceptable levels (WHO, 2016).

Overcrowding

Lower income families are more likely to live in dwellings where the number of inhabitants exceeds the capacity of the house to provide adequate shelter, space, privacy and facilities for occupants. Overcrowding is associated with more infectious disease, in particular tuberculosis, and children are particularly vulnerable to such diseases. Furthermore, overcrowding can increase the likelihood of suffering multiple exposures, compounding risks from housing. For instance, children in overcrowded households are more likely to be exposed to SHTS and are more likely to suffer home injuries (Office of the Deputy Prime Minister, 2004; Orton, 2014). In addition, overcrowding may be associated with poorer mental health in children, child maltreatment and limited educational attainment (Office of the Deputy Prime Minister, 2004; WHO, 2002). Limited educational attainment in turn is a major driver of health inequities over the life course.

Global urban population living in slums, 1990–2014



Note: Trends data are not available for Oceania. A constant figure does not mean there is no change.

Hazardous building materials

Poor housing construction may contain unhealthy materials such as asbestos, radon, lead in paint, and volatile organic compounds from paints, glues and resins. Exposure to lead paint, lead-contaminated house dust, soil and drinking-water, and lead in other housing-based sources has been well-correlated with blood lead levels and many adverse health effects. In children, neurological and behavioural problems linked to lead include reduced IQ, attention deficits, hyperactivity, and possibly links to violent or criminal behaviour in later life (Mielke & Zahran, 2012; Nevin, 2007; WHO, 2010).

Bringing work exposures home

Even in the apparent safety of their home, children can be at risk from work-related exposures. Before conception and during pregnancy, exposure of parents to toxic chemicals and psychological strain and injuries can impact the growth and development of fetuses. Children may be exposed to hazardous chemicals, such as heavy metals used in mining or agrochemicals used in agriculture, brought home on their parents' clothes, shoes and work tools. If parents work in the home, infants and children may be exposed to toxic materials such as solvents used in paints, or lead and cadmium from the recycling of car batteries. Simple measures such as changing clothes, washing clothes exposed to toxic materials separately, and washing before interacting with children can help to protect them at home.

Socioeconomic impacts of inadequate housing

In addition to the direct impact of housing on children's health, it is widely documented that a lack of affordable housing impacts most upon low socioeconomic groups and people in other vulnerable positions. Families lacking the means to pay for good quality housing may have to make frequent moves in search of appropriate accommodation ("transience").

Policy goals and the housing sector	
Sound construction: Dwellings provide adequate shelter from natural elements and hazardous substances.	Dwellings should be of sound construction, in a reasonable state of repair, weatherproof and adequately ventilated.
Safety and security: Housing ensures personal and household privacy, safety and security.	Housing should allow occupants to live without fear of intrusion, provide safety and allow safe entry and exit.
Adequate size: Dwellings provide space appropriate to household size and composition.	Dwellings should have space for individual and common purposes within accepted crowd ratios, and allow separation between uses.
Basic services available: Reasonable levels of basic services are available at the dwelling.	Clean water, sanitation, waste disposal, access infrastructure and power should be available.
Affordability: Housing costs are reasonable and affordable.	Accommodation costs should be within acceptable affordability limits to secure housing for all.
Accessibility: The location of dwellings allows access to social services, services and space for activities of daily life and economic opportunities.	Residential locations allow access to opportunities for education, purchasing or growing food, purchasing other necessities for daily living, recreation and employment.
Tenure: Tenure arrangements ensure reasonable continuity of occupation.	Terms of occupation provide stability for individuals, households, communities and areas or neighbourhoods.
Protection from climate change: Dwellings protect occupants from climate change.	Dwellings should protect people from extreme weather events and contribute to the reduction of greenhouse gas emissions.

Policy action priorities

- Ensuring everyone lives in healthy and safe dwellings has implications for central and local governments, which usually need to subsidize social housing, regulate the private rental market and work with community leaders in informal settlements. Local authorities, housing agencies and owners need to take responsibility for the quality of both the housing stock and the neighbourhoods.
- National governments play a major role by setting the overall standards and legal context for housing construction and renovation. Ideally a participatory, interdisciplinary framework should be used, which includes primary health care and community architects, as well as community architectural education in schools of architecture and urbanism.

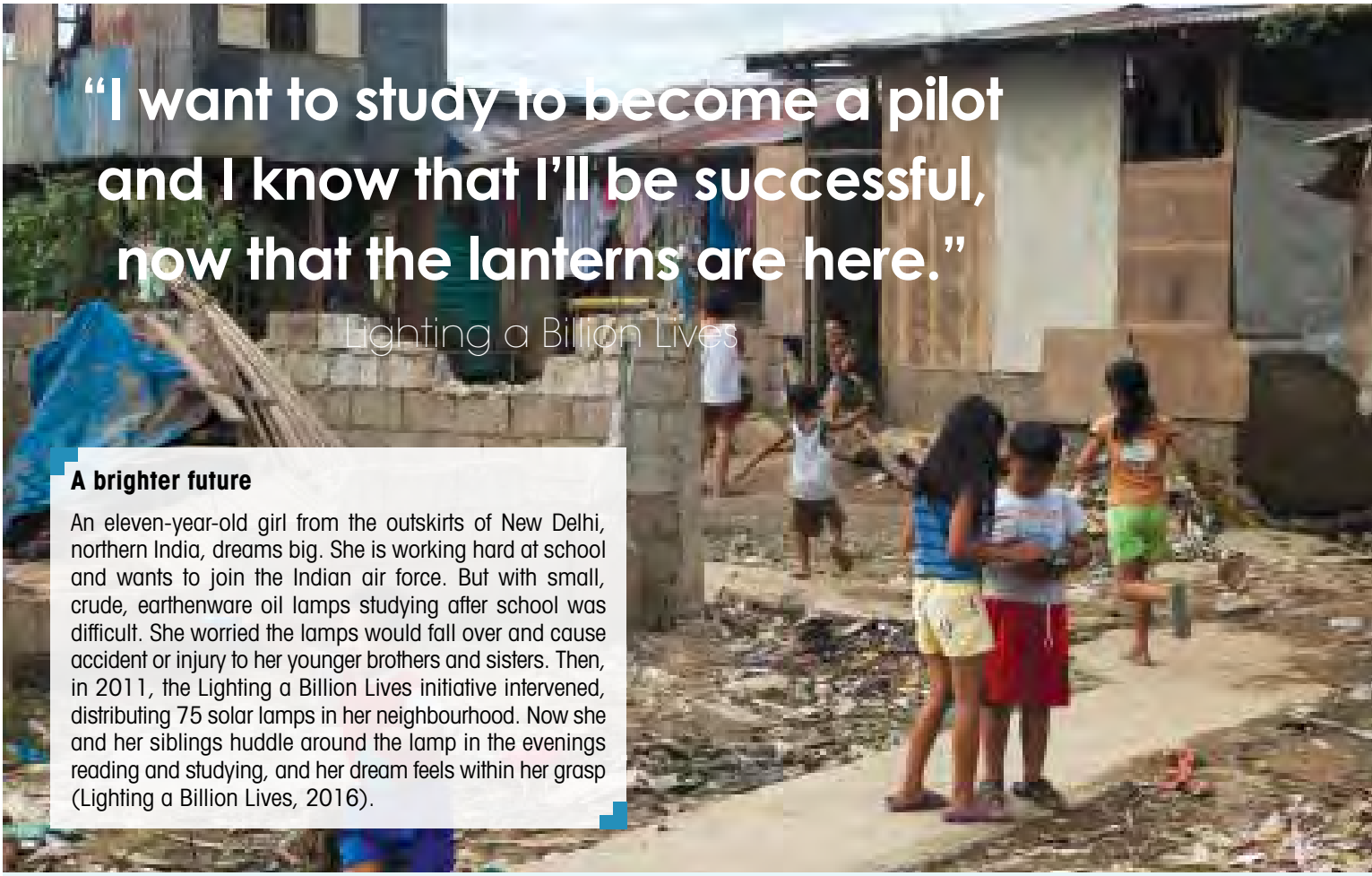
Affordable and stable housing creates a positive environment in which to raise children. Research suggests that children living in neighbourhoods with stable, long-term tenancies and occupation have a higher probability of completing secondary school (WHO, 2011).

Housing and policy

Proper urban planning and infrastructure development interventions have the potential not only to address traditional housing related hazards, preventing and avoiding adverse health effects, but also to play an important role in poverty reduction and economic growth for all household members. This includes increasing land value and strengthening economic and business development.

SDGs and international initiatives

Addressing housing for children's health and well-being goes well beyond health sector involvement. Housing is a cross-cutting issue across a number of SDGs relating to water and energy and is addressed specifically by SDG 11: "Make cities inclusive, safe, resilient and sustainable."



A brighter future

An eleven-year-old girl from the outskirts of New Delhi, northern India, dreams big. She is working hard at school and wants to join the Indian air force. But with small, crude, earthenware oil lamps studying after school was difficult. She worried the lamps would fall over and cause accident or injury to her younger brothers and sisters. Then, in 2011, the Lighting a Billion Lives initiative intervened, distributing 75 solar lamps in her neighbourhood. Now she and her siblings huddle around the lamp in the evenings reading and studying, and her dream feels within her grasp (Lighting a Billion Lives, 2016).

Sphere Project shelter standards: An example of humanitarian intervention

The Sphere Project, a voluntary initiative bringing humanitarian agencies together to improve the quality of humanitarian assistance, identifies minimum standards for humanitarian response in disaster-affected populations. Regarding shelter and settlement standards it highlights:

- **Strategic planning** to develop safe shelter response plans with local authorities and affected populations.
- **Settlement planning** to select and prepare locations for temporary, host or return housing.
- **Covered living space** with adequate separation between inhabitants, necessary for climate protection and privacy.
- **Construction** using local safe building practices and materials.
- **Environmental impact** to minimize adverse impacts on the environment (Sphere Project, 2011).

The importance of adhering to such standards for populations traumatized and uprooted by conflict and environmental disasters, particularly women and children, is obvious in the challenge of promoting their health and well-being in very difficult circumstances.

Kobe and Marmara – building standards save lives

The 7.2 Richter magnitude earthquake that hit Kobe, Japan, in 1995 and the 7.4 Richter scale one that hit Marmara, Turkey, in 1999 were of similar size. However, due to differences in building standards, the Marmara earthquake claimed nearly three times as many lives as the Kobe earthquake, with 18 000 deaths in Marmara and 6433 in Kobe. In Kobe, strong engineering standards saved lives, while in Marmara, poor construction and lack of regulation resulted in many modern buildings that were not resistant to earthquakes. Unsafe houses that do not adhere to earthquake codes are likely to become damaged and cause injury during a disaster (UN Habitat, 2007).

New Zealand's housing, insulation and health study

A New Zealand study on the benefits of retrofitting houses with insulation installed thermal envelopes to improve temperature and humidity and to reduce mould growth and energy consumption in 1350 low-income homes. Statistically significant positive effects were found in reduced numbers of respiratory hospitalizations, days off work and days off school. Furthermore, a 13% reduction in energy use was observed. In sum, the economic value of reported health gains from the efficiency measures supports the cost-effectiveness argument for retrofitting house insulation beyond direct energy savings and savings in carbon dioxide emissions (Chapman et al, 2009).

Safe as houses: Risks to children of inadequate housing

Healthy schools: Education for life

Healthy environments are crucial for effective learning and development. Healthy, attentive, secure and well-nourished children can fully participate in their classes and achieve their full potential. Children spend several hours a day at school, so making sure that these environments are safe and health-promoting is vital. The environmental challenges associated with schools are hugely varied from specific local issues, such as exposure to asbestos, to more general risks, for example, air pollution in cities.

Key fact

In some of the least developed countries, 49% of schools lack access to water and 53% lack access to sanitation facilities (UNICEF, WHO, 2015).

Range of risks

Far from being free from risk, schools for many children around the world can be the source of numerous potential health impacts. Examples include infectious diseases from unsafe water, unintentional injuries, air pollution from industry or traffic in urban areas, pesticides in rural areas, lead in paint, lead and arsenic in water, and mould in poorly maintained classrooms (Pronczuk-Garbino, 2005).

Some of these exposures may force children to be away from school or affect their ability to learn. Improvements in water, sanitation and hygiene conditions are crucial for reducing diarrhoea and malaria (two of the major killers of children under five), and foodborne and infectious diseases, such as helminth infections (Adams et al, 2009). Girls and boys are affected in different ways by inadequate water, sanitation and hygiene conditions in schools, especially when sanitary facilities are unavailable during menstruation (Adams et al, 2009).

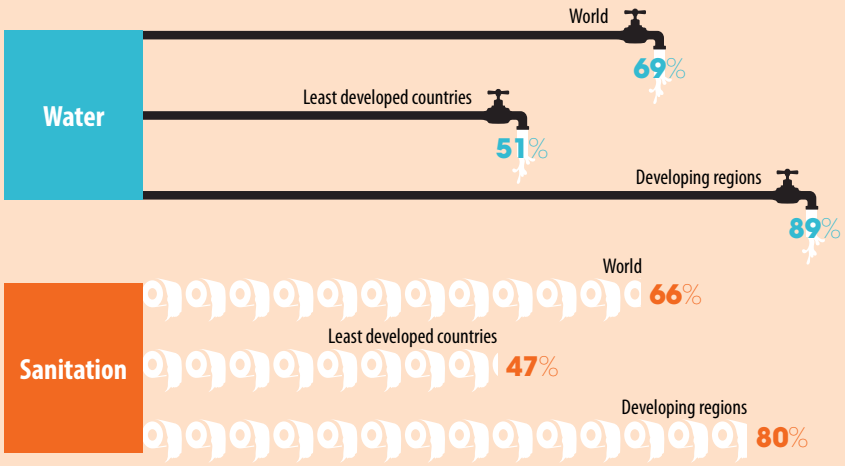
Poor environmental and infrastructure conditions in schools can make teaching and learning very challenging. Air pollution inside and outside the classroom can trigger or exacerbate respiratory diseases and infections. Radon may also be present in school buildings. Unshaded playgrounds expose children to ultraviolet radiation and related cancer risks. Poor construction can lead to unintentional injuries. Road safety conditions around schools are important to ensure children's safety (WHO, 2003).

Combined vulnerability conditions and exposures, such as undernutrition, parasites and exposure to toxic substances in the air or water, may affect development and learning abilities, which in turn translate into higher school absenteeism, slower learning and health problems. School absenteeism often affects parents' occupational situation, and adds to both the financial and psychological stresses on families.

SDGs and international initiatives

Safe and healthy schools are necessary to achieve SDG 4: "Ensure inclusive and equitable quality education and promote lifelong opportunities for all". Tied in to this goal is the need to, "ensure availability and sustainable management of water and sanitation for all", as in SDG 6, with universal access to basic drinking-water, sanitation and hygiene for households, schools and health facilities. WASH monitoring should move beyond access to include quality, with a particular focus on schools (UNICEF, WHO, 2015). SDG 7, which seeks to "ensure access to affordable, reliable, sustainable and modern energy for all", will also be important for schools, for clean and efficient heating, lighting and equipment usage. SDG Target 8.7, "take immediate and effective measures to eradicate forced labour, end modern slavery

Proportion of schools with access to adequate drinking water and sanitation, 2013



and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms", will allow children to continue their education. Planning healthy schools should go hand in hand with planning healthy cities; SDG 11: "Make cities and human settlements inclusive, safe, resilient and sustainable", will greatly impact school life in the areas surrounding school and routes that children travel.

Requirements for healthy schools

Ensuring children's health in school environments requires action at many levels. WHO encourages the development of health-promoting schools, which it defines as those that are "always strengthening their capacity as a healthy setting for living, learning and working". The physical environment is one of its pillars. Provision of shelter, safe water, decent sanitation – separate for boys and girls – are basic necessities, as are well-constructed and well-maintained buildings; protection from violence, noise, traffic and industry; and safe play areas. Ideally, a safe and healthy school environment should provide for basic necessities: shelter, warmth, water, food, light, ventilation, sanitary facilities and emergency medical care. It should also protect from biological threats: moulds, unsafe or insufficient water, unsafe food, vector-borne diseases, venomous animals, hazardous insects, rodents and other animals (e.g. dogs). A school should also protect from physical threats, such as traffic and transport, violence and crime, injuries, extreme heat and cold, radiation and chemical threats, air pollution, water pollution, pesticides, hazardous waste and materials, asbestos, toxic chemicals in paint and cleaning agents. A checklist for healthy schools is given to the right.

Low-cost policies and procedures: A checklist for healthy schools

Schools can implement low-cost policies and procedures to protect the health of students. Some examples include:

- Reducing the risk of vector-borne diseases by improving drainage to eliminate the formation of puddles where mosquitoes and other vectors breed.
- Adjusting behaviour to avoid risks. Scheduling outdoor activities during periods of the day when air pollution and sun exposure are lowest and insects are not feeding can reduce children's exposure to toxic air pollution, ultraviolet radiation and insects that transmit diseases.
- In areas where school children cross busy roads, crossing guards or older children can assist younger children and reduce the risk of accidents.
- Prohibiting the idling of school bus engines can minimize exposure to exhaust fumes. Buses should not idle in areas around schools where fumes could enter the school building.
- In schools, where children dip unwashed hands into shared drinking-water sources, a ladle may be used to fill cups or bowls providing a low-cost solution to cleaner water.
- Teaching young children the basic rules of food safety such as washing hands before eating.
- Establishing safety rules in the handling and preparation of foods.
- Planting shade trees around school grounds to reduce the risk of overexposure to the sun's UV rays.
- Creating a health committee with a mission to ensure that classroom facilities and grounds are safe and healthy for children.
- Sorting and recycling waste.
- Reducing respiratory health problems by using cleaner burning fuels and technologies and improving ventilation.
- Reducing pesticide exposure and poisonings by eliminating/minimizing the use of pesticides. Schools adjacent to locations where pesticides are routinely applied could learn about the timing of pesticide applications and keep children inside with windows and doors closed at those times (WHO, 2003).

Walking to school: For health and the environment

Walking or cycling to school is good for children's health and the environment. It facilitates increased physical activity, consumes less of the family income and is particularly beneficial among disadvantaged groups. Investing in walking and cycling infrastructure is also cost efficient for societies and has numerous co-benefits. By reducing the number of people travelling in vehicles, road deaths are reduced; air, noise and water pollution are improved; and emissions that contribute to climate change are decreased. However, it requires investment and careful land use planning to ensure children's safety while travelling near roads, crossing roads and travelling without supervision (see *Urban spaces: Building well-being*) (WHO, 2011a; WHO, 2011b; WHO, 2015a).

Rwanda: Rewards of school health interventions

In Musanze District, Rwanda, students afflicted by parasitic worms were facing health issues that made it difficult to study. Deworming campaigns in schools allow trained teachers and nurses to administer preventive medicine to children, reducing the rate of intestinal worm infection by close to 20%. Teachers have also begun school health clubs promoting hygiene; the health, school attendance and performance of children have shown dramatic improvement. More widespread deworming treatment rounds are now scheduled (WHO, 2015b).

Haiti: Health lessons for life from the school canteen

At a school in Palmiste Tampe, Haiti, children eat in a new canteen built by World Central Kitchen, which provides safely prepared food and education on food guidelines for rural areas. Children who learn the importance of hygiene, food safety and sanitation are health agents that bring healthy habits to the whole community. Such practices reduce the occurrence of food- and waterborne disease such as cholera beginning with healthy schools (WHO, 2015c).

Child labour: A dangerous phenomenon

Every day, some 168 million children around the world go to work instead of school (ILO, 2015a). In addition to denying them the joy and advantages of a normal childhood and education, much of the labour they undertake is dangerous and unhealthy. Child labour, despite being targeted for elimination, still occurs in many countries. Child labour and hazardous child labour can have devastating effects on children's physical and mental health both in the short term and throughout their lives. Many children enter into the labour market at very young ages due to family financial circumstances. However, empirical findings have shown that child labour can reduce lifetime earnings by 13–21% and increases the probability of being poor as an adult by 13–31% (Ilahi et al, 2005). Although there has been progress on this issue in recent years, reducing the number of children involved in child labour by 78 million between 2000 and 2012, much remains to be done to protect the 168 million children still involved in child labour, in particular the 85 million involved in hazardous child labour (ILO, IPEC, 2013).

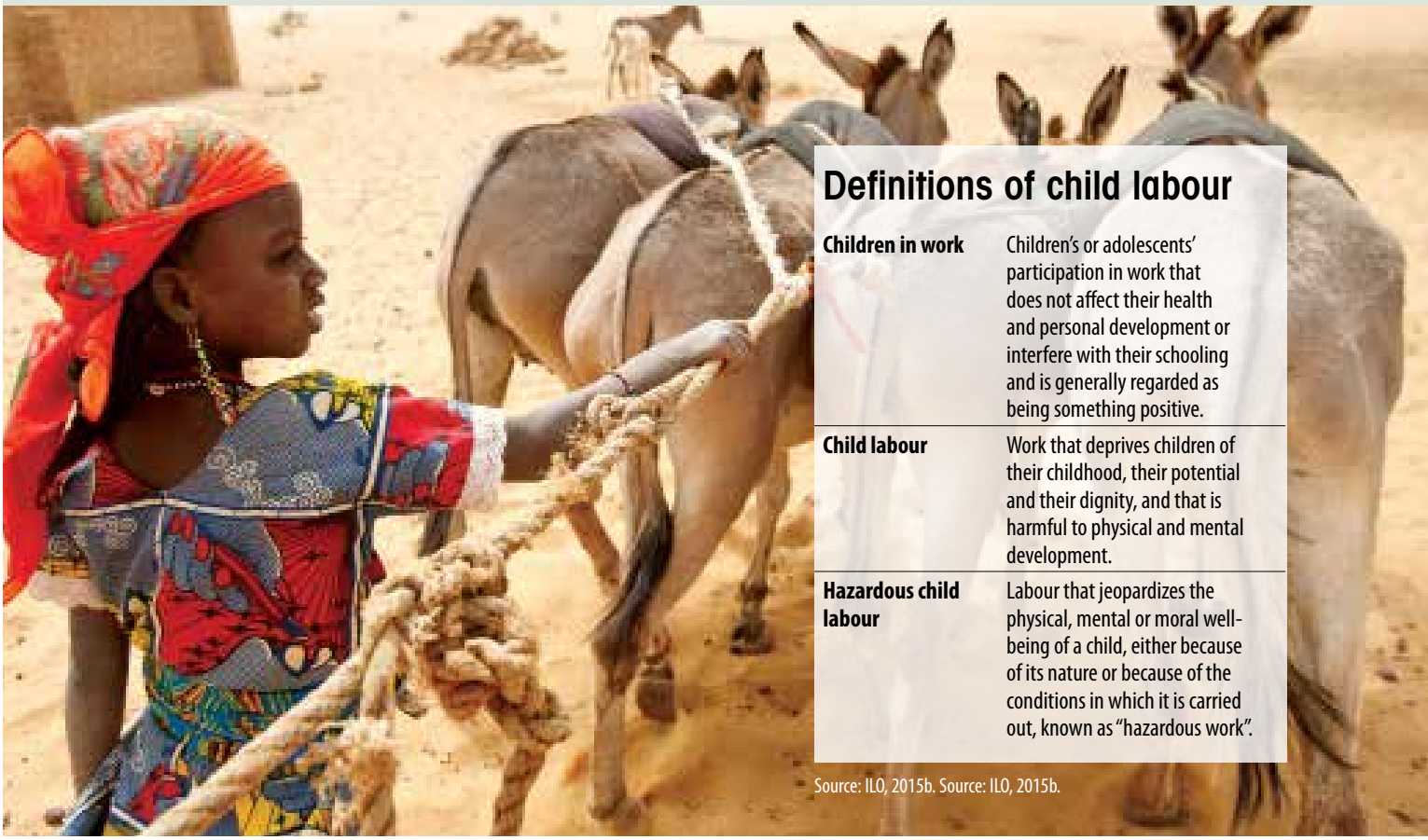
Child labour – types and trends

Not all children who work are involved in child labour. Whether work is considered child labour depends on a child's age, work hours and working conditions.

The worst forms of child labour include:

- Slavery, debt bondage and use of children in armed conflicts.
- Involvement of children in prostitution and pornography.
- Use of children for illicit activities, in particular for the production and trafficking of drugs.
- Work which, by its nature or the circumstances in which it is carried out, is likely to harm the health, safety or morals of children (ILO, 2015b).

These forms of child labour are prohibited according to ILO Convention 182 concerning the Prohibition and Immediate Action for the Elimination of the Worst Forms of Child Labour. To date, the convention has been ratified by 180 countries (ILO, 2015c), with the most notable exception of India, although the country is addressing child labour – making primary education free and compulsory and banning children under 14 years of age from being employed (MHRD 2016; PM India, 2015).



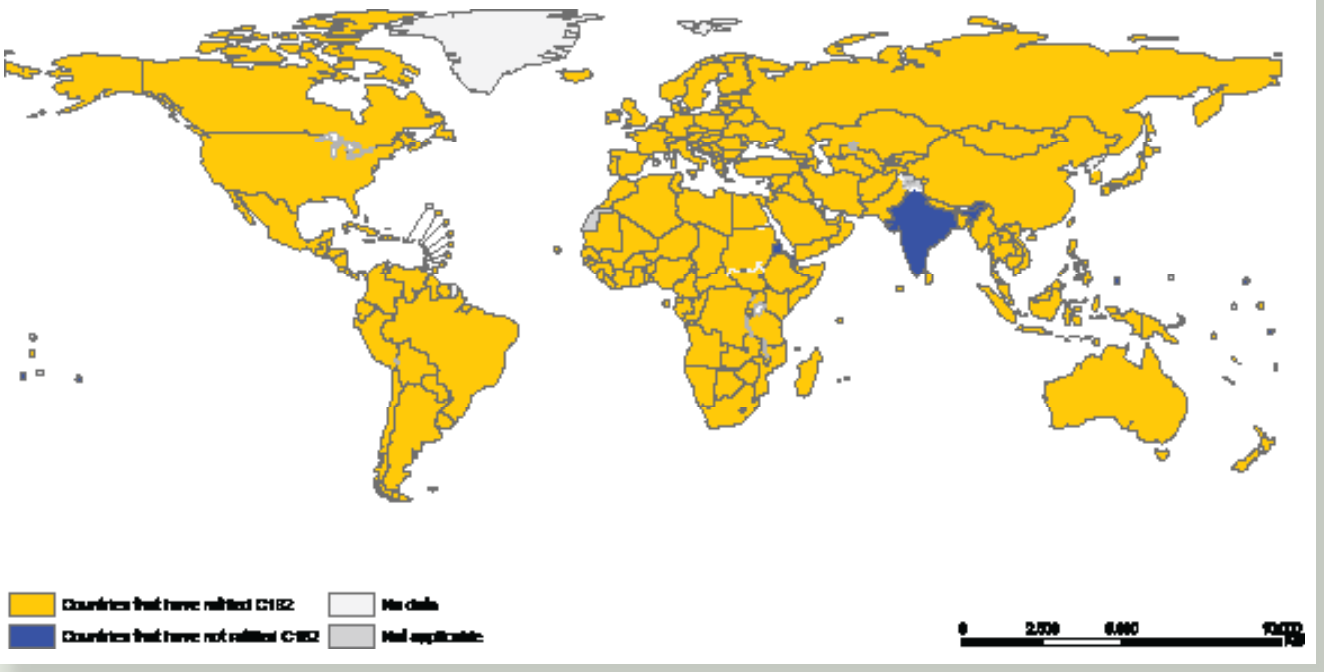
Definitions of child labour

Children in work	Children's or adolescents' participation in work that does not affect their health and personal development or interfere with their schooling and is generally regarded as being something positive.
Child labour	Work that deprives children of their childhood, their potential and their dignity, and that is harmful to physical and mental development.
Hazardous child labour	Labour that jeopardizes the physical, mental or moral well-being of a child, either because of its nature or because of the conditions in which it is carried out, known as "hazardous work".

Source: ILO, 2015b. Source: ILO, 2015b.

Despite ILO conventions, rates of hazardous child labour are still high in many countries. A majority of hazardous child labour is performed by adolescents ages 15–17, who are above the general minimum working age but are not yet adults, making this a worst form of child labour in violation of international labour standards. Close to one third of 15–17-year olds in Cambodia and Nicaragua, one in four in Honduras and the Lao People's Democratic Republic, and one in five in Guinea and Nepal are still involved in hazardous child labour (ILO, 2015a).

Countries that have ratified the Worst Forms of Child Labour Convention (No. 182)



Trends in child labour (ages 5–17) by sex, 2000–2012

According to the most recent ILO estimates, the trends are positive. Between 2000 and 2012, 40% fewer girls and 25% fewer boys were involved in child labour (ILO, IPEC, 2013). During this period, hazardous child labour declined by half (ILO, IPEC, 2013). But much remains to be done. Of the overall total (168 million) involved in child labour, the highest numbers of child labourers are found in middle-income countries, with 93.6 million child labourers, closely followed by 74.4 million in low-income countries (ILO, IPEC, 2013).

Number of children in child labour and hazardous work by sex, 5– 17 years, 2000– 2012

Percentage of children in child labour and hazardous work by sex, 5–17 years, 2000– 2012

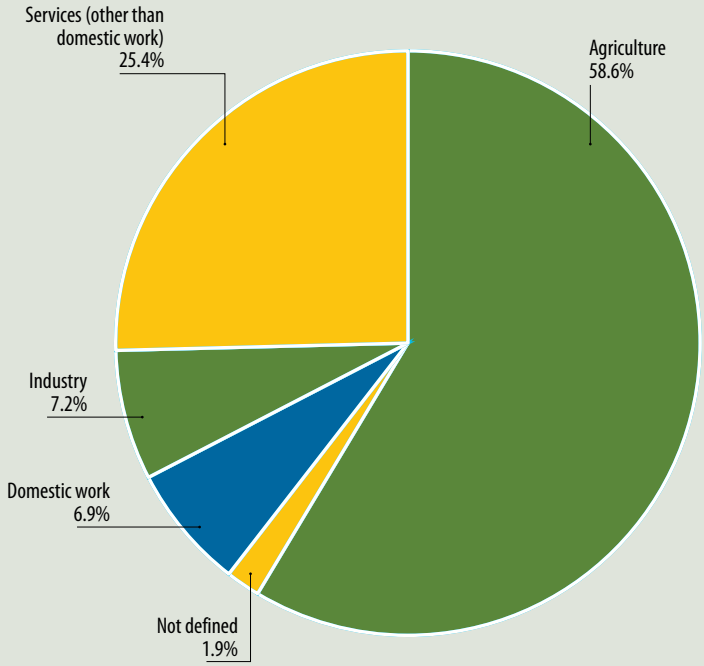
Child labour – health effects

Almost 60% of child labourers work in agriculture, operating dangerous machinery, carrying heavy items, spending long hours in the sun, being exposed to pesticides and risking insect and animal bites (ILO, 2015a; ILO, 2015d). Their small hands make them valuable workers in manufacturing, where they are exposed to injuries due to machinery use, indoor air pollution and long hours. Because of their height and size, they breathe air close to the ground, where some hazardous pollutants settle; productive equipment if available may be ill fitting. Children are obedient, easily manipulated and unlikely to demand their rights. As a result, they are often exploited and paid less than adult workers. Child labour can also be "hidden" with domestic labour, which can be difficult to observe. Isolation, exploitation and abuse are common in girls working as household labourers (WHO, 2004). Often, pregnancy leads to dismissal and social rejection.

Occupational hazards cause not only short-term health effects but also harm that can manifest later in life. These include cancer, infertility, chronic back pain, reduced intelligence and mental health issues (WHO, 2004). For instance, chemical exposures in children employed in manufacturing can cause respiratory effects and contribute to cancer development (Tennassee, 2005). Children who work in agriculture may be in contact with pesticides, which can lead to neurological disorders, reproductive health disorders and may lead to cancer later in life (ILO, 2011). Exposure to lead through child labour in recycling e-waste has the potential to result in impaired neurodevelopment and reduced IQ (Chen et al, 2011).

Child labour by sector

Sectoral distribution of children in child labour, 5–17 years age group, 2012



Banning children in camel racing

Since the 1970s, the Arabian sport of camel racing has grown in popularity, and as owners sought to increase the speed of their animals, they began to use small, light boys as riders. Children were trafficked from Oman, Sudan, Pakistan and other countries in North Africa and South Asia to become camel jockeys. Separated from their families and stranded in a foreign land, many were trained exclusively for dangerous racing, did not receive schooling and were underfed to maintain their small size. In May 2005, a meeting between UNICEF, the International Organization for Migration and several Gulf nations led to the banning of children in camel racing and the development of robot camel jockeys to use instead, notably in the United Arab Emirates, which have been a great success. Children rehabilitated from camel racing were given medical treatment before beginning the difficult journey of repatriation (UNICEF, 2006).

SDGs and international initiatives

The key international conventions drawn up to curb and ultimately eliminate child labour are:

- ILO Minimum Age Convention No. 138 (1973).
- ILO Worst Forms of Child Labour Convention No. 182 (1999).

SDG 8: "Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all" specifically targets the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers. The objective is to end child labour in all its forms by 2025 (UN, 2015).

"Few human rights abuses are so widely condemned, yet so widely practised."

Kofi Annan,
former Secretary-General of
the United Nations

Policy action priorities

- Health professionals are well-positioned to assess occupational health hazards to children, advise families on risk reduction and recommend action to policy-makers (WHO, 2004).
- Where possible reproductive risks are identified, guidance on assessing the risks and adapting workplace practices to reduce exposure to such risks should be given (WHO, 2006).
- International conventions exist, must be ratified and, crucially, acted upon.

Healthy environments for children: Key to achieving the Sustainable Development Goals

Every Sustainable Development Goal has the potential to impact the development of healthy environments for children.

Don't pollute my future

Conclusion

Increased recognition of the links between human health and the environment has been enshrined in the concept of sustainable development, which fundamentally demands intersectoral action. Unprecedented international consensus led to the adoption of two landmark agreements in 2015 – the Sustainable Development Goals and the Paris Agreement on climate change – both major public health opportunities. It is now up to each Member State to implement the policies and programmes necessary to achieve these ambitious targets, and leaders at every level will need to take action to reach these goals.

In this context, it is clear that protecting children's health from environmental hazards is a strong basis for lifelong health. There is irrefutable evidence that what children experience during the first five years of life lays the foundations for physical and mental health, affecting their capacity to adapt, learn and thrive later in life. Adverse environmental exposures in childhood can increase lifelong disease risk, as seen with ever more prominent noncommunicable diseases, including cardiovascular disease, obesity, diabetes and cancer. Measures to curb environmental degradation must take into account the special vulnerabilities of children during development in order to effectively protect them from harmful exposures with potentially irreversible consequences.

Much of the burden of disease falls on the shoulders of developing regions, which continue to suffer from traditional environmental hazards. The three most common postneonatal causes of death for children under five, diarrhoea, malaria and pneumonia, remain unchanged since the Millennium Development Goal era. While 2.6 billion people have gained access to clean water since 1990, 663 million people are still without, putting them at high risk of intestinal diseases. Household air pollution, a major risk for pneumonia, is most prevalent in the developing world where polluting fuels are used for cooking and heating. Successful interventions, such as those that have eradicated vector-borne diseases like malaria in developed regions, are opportunities to save the lives of children who so often bear the brunt of these preventable diseases.

Yet the environment is a key factor in every region of the world, and developed regions too are confronted with emerging hazards such as exposure to endocrine disrupting chemicals, climate change and e-waste. The burden of disease here will fall heavily on younger generations, who must deal with the consequences of the short-sighted inaction seen now in failing to protect children from chemical exposures and polluting the world with greenhouse gas emissions. Increased risk of UV damage is a result of ozone layer thinning, but progress is possible, as seen in the Montreal Protocol limiting the substances that result in ozone depletion. SDG 13, to "take urgent action to combat climate change" highlights the need to address these and other environmental threats to children's health.

From traditional environmental hazards, such as water and sanitation, vector-borne disease and household air pollution, to emerging hazards, including chemicals and climate change, challenges are coming from every direction. Only with multisectoral and multilevel collaboration can we work towards a healthier world for our children and the future. For example, inclusive urban policies, most effective in promoting child-healthy environments, tackle multiple issues together, with measures for cleaner air, safer streets, guaranteed educational opportunities and culturally rich public spaces accessible to all.

At the international level, action must continue in promoting healthier environments. At the country level, governments can implement international agreements such as chemical and climate change conventions to protect health, for instance addressing mercury emissions and releases in accordance with the Minamata Convention, eliminating lead paint, and lowering greenhouse gas emissions in accordance with the Paris Agreement on climate change. Each situation is unique, and the interventions presented in this publication may serve as starting points to explore what policies will be most effective in each region. At the municipal level, measures can be taken to design healthier schools and safer urban environments, favouring public transport and green spaces. Within communities, individuals empowered with knowledge of environmental health hazards can advocate on behalf of children and promote change, such as adopting clean home energy. In many ways the more local the scale of action, the more targeted its effects will be on the people who live and interact with their local environment.

With the SDGs comes a set of targets to guide interventions for children's environmental health. In addition to SDG 3, which aims at ensuring healthy lives and promoting well-being for all, the many SDGs linked to the environment provide a comprehensive multisectoral roadmap for the reduction of environmental health hazards: improving water, sanitation and hygiene with SDG 6, transitioning to clean energy with SDG 7, better infrastructure with SDG 9, building healthy cities with SDG 11 and reversing climate change with SDG 13.

By placing an emphasis on children, the overall benefit to society increases – a long-term investment. Commitment to the SDGs means taking responsibility for children's environmental health, given the potential it holds to improve the lives and futures of so many. The collaboration of children's environmental health champions across multiple sectors is essential to providing solutions to protect our children from environmental hazards that will affect their health for a lifetime.

World data table

Country	Total population in thousands, 2015	Under-five mortality rate per 1000 live births, 2015	Annual mean concentrations of fine particulate matter ($PM_{2.5}$) in urban areas, (µg/m3), 2014	Percentage of the population with primary reliance on clean fuels and technologies at the household level, 2014	Deaths in children under five attributable to the environment (as a whole) per 100 000 people, 2012
Afghanistan	32 527	91.1	64.11	17%	327.05
Albania	2 897	14	17.12	67%	79.51
Algeria	39 667	25.5	26.04	>95%	52.06
Andorra	70	2.8	10.55	>95%	5.85
Angola	25 022	156.9	42.83	48%	517.38
Antigua and Barbuda	92	8.1	15.00	>95%	27.19
Argentina	43 417	12.5	14.46	>95%	35.32
Armenia	3 018	14.1	25.09	>95%	51.63
Australia	23 969	3.8	5.83	>95%	10.54
Austria	8 545	3.5	17.20	>95%	9.95
Azerbaijan	9 754	31.7	26.39	>95%	146.97
Bahamas	388	12.1	21.96	>95%	41.90
Bahrain	1 377	6.2	60.10	>95%	23.38
Bangladesh	160 996	37.6	89.73	10%	179.00
Barbados	284	13	16.24	>95%	35.50
Belarus	9 496	4.6	18.07	>95%	19.38
Belgium	11 299	4.1	15.97	>95%	10.46
Belize	359	16.5	20.73	87%	39.07
Benin	10 880	99.5	27.91	7%	334.19
Bhutan	775	32.9	39.00	68%	204.52
Bolivia (Plurinational State of)	10 725	38.4	31.94	79%	122.71
Bosnia and Herzegovinia	3 810	5.4	55.96	40%	36.88
Botswana	2 262	43.6	19.27	63%	157.73
Brazil	207 848	16.4	11.88	93%	41.38
Brunei Darussalam	423	10.2	5.41	>95%	13.89
Bulgaria	7 150	10.4	30.52	79%	53.91
Burkina Faso	18 106	88.6	36.94	7%	372.08
Burundi	11 179	81.7	49.44	<5%	362.88
Cabo Verde	521	24.5		71%	67.68
Cambodia	15 578	28.7	25.00	13%	169.19
Cameroon	23 344	87.9	63.96	18%	337.12
Canada	35 940	4.9	7.26	>95%	12.38
Central African Republic	4 900	130.1	56.15	<5%	545.97
Chad	14 037	138.7	61.78	<5%	525.06
Chile	17 948	8.1	25.49	>95%	20.05
China	1 383 925	10.7	61.83	57%	89.72
Colombia	48 229	15.9	18.44	91%	45.46
Comoros	788	73.5	7.00	7%	260.38
Congo	4 620	45	57.60	18%	330.09
Costa Rica	4 808	9.7	19.21	>95%	21.20

Proportion of the population using improved drinking-water sources, 2015	Proportion of the population using improved sanitation facilities, 2015	Percentage of children aged 0–59 months who are overweight, latest national survey result	Percentage of children aged 0–59 months who are stunted, latest national survey result	Country
55%	32%	5.4%	40.9%	Afghanistan
95%	93%	23.4%	23.1%	Albania
84%	88%	12.4%	11.7%	Algeria
100%	100%			Andorra
49%	52%	1.6%	29.2%	Angola
98%				Antigua and Barbuda
99%	96%	9.9%	8.2%	Argentina
100%	89%	16.8%	20.8%	Armenia
100%	100%	7.7%	2%	Australia
100%	100%			Austria
87%	89%	13%	18%	Azerbaijan
98%	92%			Bahamas
100%	99%	7.5%	13.6%	Bahrain
87%	61%	1.4%	36.1%	Bangladesh
100%	96%	12.2%	7.7%	Barbados
100%	94%	9.7%	4.5%	Belarus
100%	99%			Belgium
100%	91%	7.9%	19.3%	Belize
78%	20%	1.7%	34%	Benin
100%	50%	7.6%	33.6%	Bhutan
90%	50%	8.7%	18.1%	Bolivia (Plurinational State of)
100%	95%	17.4%	8.9%	Bosnia and Herzegovinia
96%	63%	11.2%	31.4%	Botswana
98%	83%	7.3%	7.1%	Brazil
		8.3%	19.7%	Brunei Darussalam
99%	86%	13.6%	8.8%	Bulgaria
82%	20%	2.8%	32.9%	Burkina Faso
76%	48%	2.9%	57.5%	Burundi
92%	72%		21.4%	Cabo Verde
76%	42%	2%	32.4%	Cambodia
76%	46%	6.5%	32.6%	Cameroon
100%	100%	10.4%		Canada
68%	22%	1.8%	40.7%	Central African Republic
51%	12%	2.8%	38.7%	Chad
99%	99%	9.3%	1.8%	Chile
95%	76%	6.6%	9.4%	China
91%	81%	4.8%	12.7%	Colombia
90%	36%	10.9%	32.1%	Comoros
76%	15%	3.6%	25%	Congo
98%	95%	8.1%	5.6%	Costa Rica

Country	Total population in thousands, 2015	Under-five mortality rate per 1000 live births, 2015	Annual mean concentrations of fine particulate matter ($PM_{2.5}$) in urban areas, (µg/m3), 2014	Percentage of the population with primary reliance on clean fuels and technologies at the household level, 2014	Deaths in children under five attributable to the environment (as a whole) per 100 000 people, 2012
Côte d'Ivoire	22 702	92.6	19.29	18%	399.37
Croatia	4 240	4.3	20.46	94%	12.02
Cuba	11 390	5.5	16.47	87%	24.79
Cyprus	1 165	2.7	17.19	>95%	7.10
Czech Republic	10 543	3.4	20.90	>95%	9.69
Democratic People's Republic of Korea	25 155	24.9	31.58	7%	173.35
Democratic Republic of the Congo	77 267	98.3	63.22	6%	524.40
Denmark	5 669	3.5	10.52	>95%	7.94
Djibouti	888	65.3	46.00	10%	271.92
Dominica	73	21.2	16.27	92%	22.35
Dominican Republic	10 528	30.9	17.05	92%	75.18
Ecuador	16 144	21.6	13.54	>95%	59.78
Egypt	91 508	24	101.84	>95%	48.15
El Salvador	6 127	16.8	37.09	83%	47.48
Equatorial Guinea	845	94.1	32.00	22%	355.50
Eritrea	5 228	46.5	35.75	14%	164.24
Estonia	1 313	2.9	8.45	92%	13.42
Ethiopia	99 391	59.2	36.70	<5%	239.12
Fiji	892	22.4	11.43	37%	59.97
Finland	5 503	2.3	7.09	>95%	7.12
France	64 395	4.3	12.71	>95%	9.47
Gabon	1 725	50.8	35.85	73%	183.29
Gambia	1 991	68.9	43.04	<5%	215.60
Georgia	4 000	11.9	23.26	55%	78.29
Germany	80 689	3.7	14.46	>95%	13.00
Ghana	27 410	61.6	22.22	21%	266.99
Greece	10 955	4.6	12.70	>95%	11.86
Grenada	107	11.8	17.00	>95%	29.33
Guatemala	16 343	29.1	33.66	36%	89.15
Guinea	12 609	93.7	19.39	6%	380.34
Guinea-Bissau	1 844	92.5	28.90	<5%	486.40
Guyana	767	39.4	16.15	61%	94.62
Haiti	10 711	69	24.60	9%	338.95
Honduras	8 075	20.4	40.33	48%	52.94
Hungary	9 855	5.9	22.87	>95%	22.52
Iceland	329	2	7.72	>95%	2.71
India	1 311 051	47.7	73.63	34%	248.14
Indonesia	257 564	27.2	18.11	57%	117.27
Iran (Islamic Republic of)	79 109	15.5	41.13	>95%	57.70
Iraq	36 423	32	51.97	>95%	74.23
Ireland	4 688	3.6	9.96	>95%	7.47
Israel	8 064	4	19.35	>95%	5.70
Italy	59 798	3.5	18.64	>95%	9.68
Jamaica	2 793	15.7	17.23	93%	47.04
Japan	126 573	2.7	13.02	>95%	12.25
Jordan	7 595	17.9	38.34	>95%	39.97
Kazakhstan	17 625	14.1	21.93	92%	51.74

Proportion of the population using improved drinking-water sources, 2015	Proportion of the population using improved sanitation facilities, 2015	Percentage of children aged 0–59 months who are overweight, latest national survey result	Percentage of children aged 0–59 months who are stunted, latest national survey result	Country
82%	22%	3.2%	29.6%	Côte d'Ivoire
100%	97%			Croatia
95%	93%		7%	Cuba
100%	100%			Cyprus
100%	99%	4.4%	2.6%	Czech Republic
100%	82%	0%	27.9%	Democratic People's Republic of Korea
52%	29%	4.4%	42.6%	Democratic Republic of the Congo
100%	100%			Denmark
90%	47%	8.1%	33.5%	Djibouti
				Dominica
85%	84%	7.6%	7.1%	Dominican Republic
87%	85%	7.5%	25.2%	Ecuador
99%	95%	15.7%	22.3%	Egypt
94%	75%	6%	14%	El Salvador
48%	75%	9.7%	26.2%	Equatorial Guinea
58%	16%	1.9%	50.3%	Eritrea
100%	97%			Estonia
57%	28%	2.6%	40.4%	Ethiopia
96%	91%	5.1%	7.5%	Fiji
100%	98%			Finland
100%	99%			France
93%	42%	7.7%	17.5%	Gabon
90%	59%	2.7%	24.5%	Gambia
100%	86%	19.9%	11.3%	Georgia
100%	99%	3.5%	1.3%	Germany
89%	15%	2.6%	18.8%	Ghana
100%	99%			Greece
97%	98%			Grenada
93%	64%	4.9%	48%	Guatemala
77%	20%	3.8%	31.3%	Guinea
79%	21%	2.3%	27.6%	Guinea-Bissau
98%	84%	5.3%	12%	Guyana
58%	28%	3.6%	21.9%	Haiti
91%	83%	5.2%	22.7%	Honduras
100%	98%			Hungary
100%	99%			Iceland
94%	40%	1.9%	47.9%	India
87%	61%	11.5%	36.4%	Indonesia
96%	90%	6.9%	6.8%	Iran (Islamic Republic of)
87%	86%	11.8%	22.6%	Iraq
98%	90%			Ireland
100%	100%			Israel
100%	100%			Italy
94%	82%	7.8%	5.7%	Jamaica
100%	100%	1.5%	7.1%	Japan
97%	99%	4.7%	7.8%	Jordan
93%	98%	13.3%	13.1%	Kazakhstan

Country	Total population in thousands, 2015	Under-five mortality rate per 1000 live births, 2015	Annual mean concentrations of fine particulate matter ($PM_{2.5}$) in urban areas, (µg/m3), 2014	Percentage of the population with primary reliance on clean fuels and technologies at the household level, 2014	Deaths in children under five attributable to the environment (as a whole) per 100 000 people, 2012
Kenya	46 050	49.4	16.88	6%	237.02
Kiribati	112	55.9		<5%	240.79
Kuwait	3 892	8.6	78.79	>95%	22.00
Kyrgyzstan	5 940	21.3	15.68	76%	83.85
Lao People's Democratic Republic	6 802	66.7	33.60	<5%	373.19
Latvia	1 971	7.9	20.18	>95%	21.53
Lebanon	5 851	8.3	31.30	>95%	34.35
Lesotho	2 135	90.2	21.74	32%	226.76
Liberia	4 503	69.9	6.05	<5%	275.64
Libya	6 278	13.4	58.53		35.43
Lithuania	2 878	5.2	19.50	>95%	21.54
Luxembourg	567	1.9	16.60	>95%	7.30
Madagascar	24 235	49.6	32.40	<5%	208.80
Malawi	17 215	64	25.60	<5%	205.71
Malaysia	30 331	7	16.73	>95%	22.20
Maldives	364	8.6		>95%	20.77
Mali	17 600	114.7	34.78	<5%	421.79
Malta	419	6.4	14.48	>95%	13.04
Marshall Islands	53	36		41%	213.95
Mauritania	4 068	84.7	86.22	45%	297.06
Mauritius	1 273	13.5	14.34	>95%	54.96
Mexico	127 017	13.2	20.55	86%	41.85
Micronesia (Federated States of)	104	34.7	8.00	25%	105.87
Monaco	38	3.5	10.00	>95%	7.73
Mongolia	2 959	22.4	33.49	32%	124.77
Montenegro	626	4.7	24.34	74%	19.13
Morocco	34 378	27.6	19.31	>95%	94.97
Mozambique	27 978	78.5	22.45	<5%	289.02
Myanmar	53 897	50	56.74	9%	297.02
Namibia	2 459	45.4	18.76	46%	106.23
Nauru	10	35.4		>95%	82.23
Nepal	28 514	35.8	75.69	26%	159.98
Netherlands	16 925	3.8	14.88	>95%	8.88
New Zealand	4 529	5.7	5.35	>95%	14.71
Nicaragua	6 082	22.1	26.07	49%	71.54
Niger	19 899	95.5	51.80	<5%	379.78
Nigeria	182 202	108.8	38.89	<5%	429.35
Norway	5 211	2.6	9.13	>95%	5.12
Oman	4 491	11.6	47.43	>95%	21.90
Pakistan	188 925	81.1	68.68	45%	356.04
Palau	21	16.4		58%	40.16
Panama	3 929	17	12.84	86%	53.92
Papua New Guinea	7 619	57.3	12.05	31%	221.30
Paraguay	6 639	20.5	16.99	64%	52.96
Peru	31 377	16.9	37.00	68%	48.45
Philippines	100 699	28	27.64	45%	108.17
Poland	38 612	5.2	25.77	>95%	13.17

Proportion of the population using improved drinking-water sources, 2015	Proportion of the population using improved sanitation facilities, 2015	Percentage of children aged 0–59 months who are overweight, latest national survey result	Percentage of children aged 0–59 months who are stunted, latest national survey result	Country
63%	30%	4.1%	26%	Kenya
67%	40%			Kiribati
99%	100%	8.7%	5.8%	Kuwait
90%	93%	7%	12.9%	Kyrgyzstan
76%	71%	2%	43.8%	Lao People's Democratic Republic
99%	88%			Latvia
99%	81%	16.7%	16.5%	Lebanon
82%	30%	7.4%	33.2%	Lesotho
76%	17%	3.2%	32.1%	Liberia
	97%	22.4%	21%	Libya
97%	92%			Lithuania
100%	98%			Luxembourg
52%	12%	6.2%	49.2%	Madagascar
90%	41%	5.1%	42.4%	Malawi
98%	96%	5.5%	17.2%	Malaysia
99%	98%	6.5%	20.3%	Maldives
77%	25%	4.7%	38.5%	Mali
100%	100%			Malta
95%	77%			Marshall Islands
58%	40%	1.2%	22%	Mauritania
100%	93%	6.5%	13.6%	Mauritius
96%	85%	9%	13.6%	Mexico
89%	57%			Micronesia (Federated States of)
100%	100%			Monaco
64%	60%	10.5%	10.8%	Mongolia
100%	96%	22.3%	9.4%	Montenegro
85%	77%	10.7%	14.9%	Morocco
51%	21%	7.9%	43.1%	Mozambique
81%	80%	2.6%	35.1%	Myanmar
91%	34%	4.1%	23.1%	Namibia
97%	66%	2.8%	24%	Nauru
92%	46%	2.1%	37.4%	Nepal
100%	98%			Netherlands
100%				New Zealand
87%	68%	6.2%	23%	Nicaragua
58%	11%	3%	43%	Niger
69%	29%	1.8%	32.9%	Nigeria
100%	98%			Norway
93%	97%	1.7%	9.8%	Oman
91%	64%	4.8%	45%	Pakistan
	100%			Palau
95%	75%	6.2%	19.1%	Panama
40%	19%	13.8%	49.5%	Papua New Guinea
98%	89%	11.7%	10.9%	Paraguay
87%	76%	7.2%	17.5%	Peru
92%	74%	5%	30.3%	Philippines
98%	97%			Poland

Country	Total population in thousands, 2015	Under-five mortality rate per 1000 live births, 2015	Annual mean concentrations of fine particulate matter ($PM_{2.5}$) in urban areas, (µg/m3), 2014	Percentage of the population with primary reliance on clean fuels and technologies at the household level, 2014	Deaths in children under five attributable to the environment (as a whole) per 100 000 people, 2012
Portugal	10 350	3.6	9.61	>95%	11.15
Qatar	2 235	8	105.32	>95%	27.01
Republic of Korea	50 293	3.4	27.90	>95%	13.10
Republic of Moldova	4 069	15.8	17.09	93%	87.33
Romania	19 511	11.1	20.38	82%	77.64
Russian Federation	143 457	9.6	17.14	>95%	30.39
Rwanda	11 610	41.7	50.62	<5%	195.51
Saint Kitts and Nevis	56	10.5		>95%	17.59
Saint Lucia	185	14.3	18.24	>95%	32.15
Saint Vincent and the Grenadines	109	18.3		>95%	61.36
Samoa	193	17.5		27%	41.03
San Marino	32	2.9		>95%	14.04
Sao Tome and Principe	190	47.3		30%	134.74
Saudi Arabia	31 540	14.5	131.56	>95%	13.15
Senegal	15 129	47.2	43.68	36%	173.62
Serbia	8 851	6.7	21.50	71%	26.84
Seychelles	96	13.6	5.00	>95%	41.75
Sierra Leone	6 453	120.4	16.78	<5%	780.60
Singapore	5 604	2.7	17.00	>95%	9.41
Slovakia	5 426	7.3	20.26	>95%	20.56
Slovenia	2 068	2.6	19.44	>95%	7.79
Solomon Islands	584	28.1		9%	95.10
Somalia	10 787	136.8	16.93	9%	462.75
South Africa	54 490	40.5	32.59	82%	124.33
South Sudan	12 340	92.6	32.50	<5%	383.97
Spain	46 122	4.1	10.00	>95%	10.14
Sri Lanka	20 715	9.8	28.55	19%	26.80
Sudan	40 235	70.1	53.05	23%	256.97
Suriname	543	21.3	16.29	91%	51.13
Swaziland	1 287	60.7	19.88	35%	207.19
Sweden	9 779	3	5.89	>95%	5.93
Switzerland	8 299	3.9	12.57	>95%	11.73
Syrian Arab Republic	18 502	12.9	34.29	>95%	33.36
Tajikistan	8 482	44.8	51.21	72%	175.18
Thailand	67 959	12.3	27.54	76%	55.36
The former Yugoslav Republic of Macedonia	2 078	5.5	42.96	61%	27.32
Timor-Leste	1 185	52.6	15.00	<5%	168.35
Togo	7 305	78.4	25.89	6%	351.40
Tonga	106	16.7		63%	27.88
Trinidad and Tobago	1 360	20.4	13.18	>95%	39.88
Tunisia	11 254	14	36.43	>95%	44.17
Turkey	78 666	13.5	35.65		32.15
Turkmenistan	5 374	51.4	26.29	>95%	183.02
Tuvalu	10	27.1		30%	84.81
Uganda	39 032	54.6	80.29	<5%	196.01
Ukraine	44 824	9	16.98	>95%	51.64
United Arab Emirates	9 157	6.8	64.46	>95%	24.53

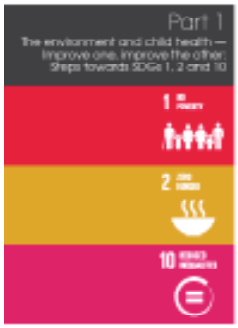
Proportion of the population using improved drinking-water sources, 2015	Proportion of the population using improved sanitation facilities, 2015	Percentage of children aged 0–59 months who are overweight, latest national survey result	Percentage of children aged 0–59 months who are stunted, latest national survey result	Country
100%	100%			Portugal
100%	98%	10.4%	11.6%	Qatar
	100%	7.3%	2.5%	Republic of Korea
88%	76%	4.9%	6.4%	Republic of Moldova
100%	79%	8.3%	12.8%	Romania
97%	72%			Russian Federation
76%	62%	7.7%	37.9%	Rwanda
98%				Saint Kitts and Nevis
96%	91%	6.3%	2.5%	Saint Lucia
95%				Saint Vincent and the Grenadines
99%	91%	6.2%	6.4%	Samoa
				San Marino
97%	35%	11.6%	31.6%	Sao Tome and Principe
97%	100%	6.1%	9.3%	Saudi Arabia
79%	48%	1.3%	19.4%	Senegal
99%	96%	13.9%	6%	Serbia
96%	98%	10.2%	7.9%	Seychelles
63%	13%	8.9%	37.9%	Sierra Leone
100%	100%	2.6%	4.4%	Singapore
100%	99%			Slovakia
100%	99%			Slovenia
81%	30%	2.5%	32.8%	Solomon Islands
		2.9%	25.9%	Somalia
93%	66%	19.2%	23.9%	South Africa
59%	7%	6%	31.1%	South Sudan
100%	100%			Spain
96%	95%	0.6%	14.7%	Sri Lanka
		3%	38.2%	Sudan
95%	79%	4%	8.8%	Suriname
74%	57%	9%	25.5%	Swaziland
100%	99%			Sweden
100%	100%			Switzerland
90%	96%	17.9%	27.5%	Syrian Arab Republic
74%	95%	6.6%	26.8%	Tajikistan
98%	93%	10.9%	16.3%	Thailand
99%	91%	12.4%	4.9%	The former Yugoslav Republic of Macedonia
72%	41%	5.8%	57.7%	Timor-Leste
63%	12%	2%	27.5%	Togo
100%	91%	17.3%	8.1%	Tonga
95%	92%	4.9%	5.3%	Trinidad and Tobago
98%	92%	14.3%	10.1%	Tunisia
100%	95%	10.9%	9.5%	Turkey
			28.1%	Turkmenistan
98%		6.3%	10%	Tuvalu
79%	19%	5.8%	34.2%	Uganda
96%	96%	26.5%	3.7%	Ukraine
100%	98%			United Arab Emirates

Country	Total population in thousands, 2015	Under-five mortality rate per 1000 live births, 2015	Annual mean concentrations of fine particulate matter ($PM_{2.5}$) in urban areas, (µg/m3), 2014	Percentage of the population with primary reliance on clean fuels and technologies at the household level, 2014	Deaths in children under five attributable to the environment (as a whole) per 100 000 people, 2012
United Kingdom	64 716	4.2	12.49	>95%	9.48
United Republic of Tanzania	53 470	48.7	24.15	<5%	159.42
United States of America	321 774	6.5	8.51	>95%	17.16
Uruguay	3 432	10.1	11.55	>95%	14.19
Uzbekistan	29 893	39.1	39.06	90%	140.93
Vanuatu	265	27.5	13.00	16%	43.80
Venezuela (Bolivarian Republic of)	31 108	14.9	24.26	>95%	43.21
Viet Nam	93 448	21.7	28.75	51%	88.13
Yemen	26 832	41.9	42.15	62%	190.51
Zambia	16 212	64	29.56	16%	269.84
Zimbabwe	15 603	70.7	24.07	31%	265.29
	Source: WHO (2016a).	Source: WHO (2016a).	Source: WHO (2016a).	Source: WHO (2016b).	Source: WHO (2016c).

Note: Please see original sources for information on indicators, data collection and data analysis.

Proportion of the population using improved drinking-water sources, 2015	Proportion of the population using improved sanitation facilities, 2015	Percentage of children aged 0–59 months who are overweight, latest national survey result	Percentage of children aged 0–59 months who are stunted, latest national survey result	Country
100%	99%			United Kingdom
56%	16%	5.2%	34.7%	United Republic of Tanzania
99%	100%	6%	2.1%	United States of America
100%	96%	7.2%	10.7%	Uruguay
	100%	12.8%	19.6%	Uzbekistan
94%	58%	4.6%	28.5%	Vanuatu
93%	94%	6.4%	13.4%	Venezuela (Bolivarian Republic of)
98%	78%	4.6%	19.4%	Viet Nam
		2%	46.5%	Yemen
65%	44%	6.2%	40%	Zambia
77%	37%	3.6%	27.6%	Zimbabwe
Source: UNICEF, WHO (2015).	Source: UNICEF, WHO (2015).	Source: UNICEF, WHO, The World Bank Group (2015).	Source: UNICEF, WHO, The World Bank Group (2015).	

References



1. The environment and child health — Improve one, improve the other: Steps towards SDGs 1, 2 and 10

Child mortality: Increasing a chance at life

Barouki R, Gluckman PD, Grandjean P, Hanson M, Heindel JJ (2012). Developmental origins of non-communicable disease: Implications for research and public health. Environ Health. 2012;11:42. doi: 10.1186/1476-069X-11-42.

Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M et al (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet. 2013;382(9890):427–51. doi: 10.1016/S0140-6736(13)60937-X.

Blencowe H, Cousens S, Jassir FB, Say L, Chou D, Mathers C et al (2016). National, regional, and worldwide estimates of stillbirth rates in 2015, with trends from 2000: a systematic analysis. Lancet Glob Health. 2016;4:e98–108. doi: 10.1016/S2214-109X(15)00275-2.

Bhutta ZA, Das JK, Bahl R (2014). Can available interventions end preventable deaths in mothers, newborn babies, and stillbirths, and at what cost? Lancet. 2014;384(9940):347–370. doi: (http://dx.doi.org/10.1016/S0140-6736(14)60792-3).

Ferguson KK, O'Neill MS, Meeker JD (2013). Environmental contaminant exposures and preterm birth: A comprehensive review. J Toxicol Environ Health B Crit Rev. 2013;16(2):69–113. doi: 10.1080/10937404.2013.775048.

Kumanan R, Damji N, Atsbeha T, Brune Drisse MN, Davis A, Dora C et al (2015). Ensuring multisectoral action on the determinants of reproductive, maternal, newborn, child, and adolescent health in the post-2015 era. BMJ. 2015;351:h4213. doi: 10.1136/bmj.h4213.

Prüss-Ustün A, Wolf J, Corvalán C, Bos R, Neira M (2016). Preventing disease through healthy environments: A global assessment of the burden of disease from environmental risks. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/204585/1/9789241565196_eng.pdf?ua=1 (accessed 20 June 2016).

Schmalzbach M (2014). Ethiopia Models Child Survival Success. Frontlines, USAID. May/June 2014. https://www.usaid.gov/news-information/frontlines/maternal-child-health/ethiopia-models-child-survival-success (accessed 20 June 2016).

Smith AH, Marshall G, Liaw J, Yuan Y, Ferreccio C, Steinmaus C (2012). Mortality in young adults following in utero and childhood exposure to arsenic in drinking water. Environ Health Perspect. 2012;120(11):1527–31. doi: 10.1289/ehp.1104867.

UN (2015). Sustainable Development Goals [website]. New York: United Nations. http://www.un.org/sustainabledevelopment/sustainable-development-goals (accessed 20 June 2016).

UNICEF (2014). Committing to child survival: A promise renewed. Progress report 2014. New York: United Nations Children's Fund. http://data.unicef.org/corecode/uploads/document6/uploaded_pdfs/corecode/APR-2014-17Oct14-web_194.pdf (accessed 20 June 2016).

UNICEF, WHO, World Bank, UN-DESA Population Division (2015). Levels and trends in child mortality. Report 2015. Estimates Developed by the UN Inter-agency Group for Child Mortality Estimation. New York: United Nations Children's Fund. http://www.childmortality.org/files_v20/download/IGME%20Report%202015_9_3%20LR%20Web.pdf (accessed 20 June 2016).

USAID (2011) All eyes on Ethiopia's National Health Extension Program [website]. USAID. https://www.usaid.gov/results-data/success-stories/all-eyes-ethiopia's-national-health-extension-program-0 (accessed 20 July 2016).

Were WM, Daelmans B, Bhutta Z, Duke T, Bahl R, Boschi-Pinto C et al (2015). Children's health priorities and interventions. BMJ. 2015;351:h4300. doi: 10.1136/bmj.h4300.

WHO (2015). Causes of child mortality [website]. Global Health Observatory (GHO) data. Geneva: World Health Organization. http://www.who.int/gho/child_health/mortality/causes/en/ (accessed 20 June 2016).

WHO (2016a). Children: reducing mortality [website]. Fact sheet no. 178. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs178/en/ (accessed 20 June 2016).

WHO (2016b). Newborns: reducing mortality [website]. Fact sheet no. 333. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs333/en/ (accessed 20 June 2016).

WHO (2016c). Global Strategy for Women's, Children's and Adolescents' Health 2016–2030. Geneva: World Health Organization. http://www.who.int/life-course/publications/global-strategy-2016-2030/en/ (accessed 27 September 2016).

Map: Under-five mortality rate (probability of dying by age 5 per 1000 live births), 1990
Data source: UNICEF, WHO, World Bank, UN-DESA Population Division (2015). Levels and trends in child mortality 2015. New York: United Nations Children's Fund (http://www.childmortality.org/files_v20/download/IGME%20report%202015%20child%20mortality%20final.pdf). Map production: amudhA Rathinam. Copyright: WHO.

Map: Under-five mortality rate (probability of dying by age 5 per 1000 live births), 2015Data source: UNICEF, WHO, World Bank, UN-DESA Population Division (2015). Levels and trends in child mortality 2015. New York: United Nations Children's Fund (http://www.childmortality.org/files_v20/download/IGME%20report%202015%20child%20mortality%20final.pdf). Map production: amudhA Rathinam. Copyright: WHO.

Map overlay: Countries that achieved the MGD target for under 5 mortalityData source: UNICEF, WHO, World Bank, UN-DESA Population Division (2015). Levels and trends in child mortality 2015. New York: United Nations Children's Fund (http://www.childmortality.org/files_v20/download/IGME%20report%202015%20child%20mortality%20final.pdf. Map production: amudhA Rathinam. Copyright: WHO.

Graph: Causes of deaths among children under five years, 2015
Data source: WHO (2016). WHO-MCEE methods and data sources for child causes of death 2000-2015 (Global Health Estimates Technical Paper WHO/HIS/IER/GHE/2016.1). Geneva: World Health Organization. (http://www.who.int/gho/child_health/mortality/causes/en/). Copyright: WHO.

Inequity: Reducing the health divide

European Commission (2016). Europe 2020 [website]. European Commission. http://ec.europa.eu/europe2020/index_en.htm (accessed 21 June 2016).

Fernald LC, Gertler PJ, Neufeld LM (2008). The importance of cash in conditional cash transfer programmes for child health, growth, and development: An analysis of Mexico's Oportunidades. Lancet. 2008;371(9615):828–37. doi: 10.1016/S0140-6736(08)60382-7.

Figueroa JL (2014). Distributional effects of Oportunidades on early child development. Social Soc Sci Med. 2014;113:42–49. doi: 10.1016/j.socscimed.2014.04.044.

Kohlhuber M, Mielck A, Weiland SK, Bolte G (2006). Social inequality in perceived environmental exposures in relation to housing conditions in Germany. Environ Res. 2006;101(2):246–255. doi: 10.1016/j.envres.2005.09.008.

National Research Council (2001). New horizons in health: an integrative approach. Committee on Future Directions for Behavioral and Social Sciences Research at the National Institutes of Health, Singer BH, Ryff CD, editors. Washington DC: National Academy Press. http://www.nap.edu/read/10002/chapter/1#ii (accessed 25 August 2016).

UNDP (2015). Multidimensional Poverty Index (MPI) [website]. United Nations Development Programme. http://hdr.undp.org/en/content/multidimensional-poverty-index-mpi (accessed 21 June 2016).

UNICEF (2012). Life in a day: Connecting Roma communities to health services (and more). United Nations Children's Fund, Serbia. http://www.unicef.org/serbia/reallives_18153.html (accessed 21 June 2016).

UNICEF, WHO (2015). Progress on sanitation and drinking water: 2015 update and MDG assessment. Geneva: World Health Organization. http://www.unicef.org/publications/files/Progress_on_Sanitation_and_Drinking_Water_2015_Update_.pdf (accessed 21 June 2016).

WHO (2015a). World health statistics 2015. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/170250/1/9789240694439_eng.pdf?ua=1&ua=1 (accessed 21 June 2016).

WHO (2015b). Global Health Observatory (GHO) data: Urban health [online database]. Geneva: World Health Organization. http://who.int/gho/urban_health/en/ (accessed 4 May 2016).

WHO (2015c). PHE e-News. Geneva: World Health Organization. http://www.who.int/phe/news/june-july2015/en/ (accessed 23 August 2016).

WHO (2015d). Global tuberculosis report 2015. Geneva: World Health Organization. http://www.who.int/tb/publications/global_report/gtbr15_main_text.pdf (accessed 25 August 2016).

WHO (2016). Under-five mortality [website]. Global Health Observatory (GHO) data. Geneva: World Health Organization. http://www.who.int/gho/urban_health/outcomes/under_five_mortality_text/en/ (accessed 21 June 2016).

WHO EURO (2003). Wilkinson R, Marmot M, editors. Social determinants of health: the solid facts. 2nd edition. Copenhagen: World Health Organization, Regional Office for Europe. http://www.euro.who.int/__data/assets/pdf_file/0005/98438/e81384.pdf (accessed 25 August 2016).

WHO EURO (2012). Environmental health inequalities in Europe: Assessment report. Copenhagen: World Health Organization. http://www.euro.who.int/en/publications/abstracts/environmental-health-inequalities-in-europe.-assessment-report (accessed 21 June 2016).

WHO, UN HABITAT (2010). Hidden cities: Unmasking and overcoming health inequalities in urban settings. Kobe: World Health Organization, United Nations Human Settlements Programme. http://www.who.int/kobe_centre/publications/hiddencities_media/who_un_habitat_hidden_cities_web.pdf?ua=1 (accessed 21 June 2016).

World Bank (2014). Implementation completion and results report on loans in the amount of US$1,503.76 million and US$1,250 million of additional financing to the United Mexican States for a support to Oportunidades project. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/07/03/000442464_20140703135110/Rendered/PDF/ICR29320P115060IC0disclosed07010140.pdf (accessed 21 June 2016).

Map: Per Capita Gross National Income (GNI) at current prices in US Dollars, 2014
Data source: UN (2015). National Accounts Main Aggregates Database. Per Capita GNI at current prices in US Dollars (all countries and regions). (http://unstats.un.org/unsd/snaama/dnlList.asp, accessed 22 January 2016). Map production: amudhA Rathinam. Reprinted with permission from the United Nations.

Graph: Global and regional under-five mortality trends, 1990–2015, and gap for achieving the MDG4 targetSource: WHO (2016). Global Health Observatory data repository [website]. Probability of dying per 1000 live births, data by WHO region. Geneva: World Health Organization (http://apps.who.int/gho/data/view.main.CM1300R?lang=en, accessed 11 August 2016). UNICEF, WHO, World Bank, UN-DESA Population Division (2015). Levels and trends in child mortality 2015. New York: United Nations Children's Fund. (http://www.childmortality.org/files_v20/download/IGME%20report%202015%20child%20mortality%20final.pdf, accessed 11 August 2016). Copyright: WHO.

Graph: Percentage of children under five who are stunted, by wealth quintile and by region, 2015Source: UNICEF (2015). UNICEF global database, 2015, based on Multiple Indicator Cluster Surveys (MICS), Demographic and Health Surveys (DHS) and other nationally representative surveys. Reprinted with permission from UNICEF.

Overweight and stunting: Getting the balance right

Behl M, Rao D, Aagaard K, Davidson TL, Levin ED, Slotkin TA et al (2013). Evaluation of the association between maternal smoking, childhood obesity, and metabolic disorders: A national toxicology program workshop review. Environ Health Perspect. 2012;121(2):171–80. doi:10.1289/ehp.1205404.

Black RE, Victoria CG, Walker SP, Bhutta ZA, Christian P, de Onis M et al (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet. 2013;382(9890):427–451.

Oken E, Levitan EB, Gillman MW (2008). Maternal smoking during pregnancy and child overweight: Systematic review and meta-analysis. Int J Obes (Lond). 2008;32:201–10. doi: 10.1038/sj.ijo.0803760.

Prüss-Ustün A, Wolf J, Corvalán C, Bos R, Neira M (2016). Preventing disease through healthy environments: A global assessment of the burden of disease from environmental risks. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/204585/1/9789241565196_eng.pdf?ua=1 (accessed 20 June 2016).

Stewart CP, Iannotti L, Dewey KG, Michaelsen KF, Onyango AW (2013). Contextualising complementary feeding in a broader framework for stunting prevention. Maternal and Child Nutrition. 2013;9(2):27–45. doi: 10.1111/mcn.12088.

UNICEF, WHO, World Bank (2016). Joint child malnutrition estimates - levels and trends (2016 edition). New York, Geneva, Washington DC: United Nations Children's Fund, World Health Organization, World Bank Group. http://www.who.int/nutgrowthdb/estimates2015/en/ (accessed 27 September 2016).

WHO (2002). Infant and young child nutrition: Global strategy on infant and young child feeding. Report by the Secretariat. Fifty-fifth World Health Assembly Provisional agenda item 13.10.

WHO (2011). Health in the green economy: co-benefits to health of climate change mitigation. Geneva: World Health Organization. http://extranet.who.int/iris/restricted/bitstream/10665/70913/1/9789241502917_eng.pdf (accessed 21 June 2016).

WHO (2014). Comprehensive implementation plan on maternal, infant and young child nutrition. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/113048/1/WHO_NMH_NHD_14.1_eng.pdf (accessed 21 June 2016).

WHO (2015a). Underweight in children [website]. Global Health Observatory (GHO) data. Geneva: World Health Organization. http://www.who.int/gho/mdg/poverty_hunger/underweight/en/ (accessed 15 August 2016).

WHO (2015b). Finland curbs childhood obesity by integrating health in all policies. Geneva: World Health Organization. http://www.who.int/features/2015/finland-health-in-all-policies/en/ (accessed 21 June 2016).

WHO (2015c). Building latrines and keeping water clean decreases diarrhoea and under-nutrition in Mali. Geneva: World Health Organization. http://www.who.int/features/2015/water-sanitation-mali/en/ (accessed 21 June 2016).

WHO (2015d). Obesity and overweight [website]. Fact sheet no. 311. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs311/en/ (accessed 21 June 2016).

WHO (2016a). The healthy growth project: Promoting healthy growth and preventing childhood stunting. Geneva: World Health Organization. http://www.who.int/nutrition/healthygrowthproj/en/index1.html (accessed 21 June 2016).

WHO (2016b). Report of the commission on ending childhood obesity. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/204176/1/9789241510066_eng.pdf?ua=1 (accessed 21 June 2016).

WHO (2016c). Physical activity and young people: Recommended levels of physical activity for children aged 5–17 years. Global strategy on diet, physical activity and health [website]. Geneva: World Health Organization. http://www.who.int/dietphysicalactivity/factsheet_young_people/en/ (accessed 21 June 2016).

WHO, UNEP (2013). Bergman Å, Heindel JJ, Jobling S, Kidd KA, Zoeller RT, editors. State of the science of endocrine disrupting chemicals - 2012. Geneva: World Health Organization. http://www.who.int/ceh/publications/endocrine/en/ (accessed 21 June 2016).

WHO, UNICEF, USAID (2015). Improving nutrition outcomes with better water, sanitation and hygiene: Practical solutions for policies and programmes. Geneva: World Health Organization. http://www.who.int/water_sanitation_health/publications/washandnutrition/en/ (accessed 21 June 2016).

Yu Z, Han S, Zhu J, Sun X, Ji C, Guo X (2013). Pre-pregnancy body mass index in relation to infant birth weight and offspring overweight/obesity: a systematic review and meta-analysis. PLoS One. 2013;8:e61627. doi: 10.1371/journal.pone.0061627.

Map: Percentage of children who are stunted (based on latest national estimates)

Data source: UNICEF, WHO, The World Bank Group (2015). UNICEF-WHO-The World Bank Group Joint Child Malnutrition Estimates - 2015 edition. New York, UNICEF; Geneva, WHO; Washington, DC, The World Bank Group (www.who.int/nutgrowthdb/estimates2014/). Map production: amudhA Rathinam. Copyright: WHO.

Map: Percentage of children who are overweight (based on latest national estimates)
Data source: UNICEF, WHO, The World Bank Group (2015). UNICEF-WHO-The World Bank Group Joint Child Malnutrition Estimates - 2015 edition. UNICEF, New York; WHO, Geneva; The World Bank Group, Washington, DC. (www.who.int/nutgrowthdb/estimates2014/). Map production: amudhA Rathinam. Copyright: WHO.

Environmental health risks: Reducing the impacts

Attina TM, Trasande L (2013). Economic costs of childhood lead exposure in low- and middle-income countries. Environmental Health Perspectives. 2013;121(9):1097–1102. doi: http://dx.doi.org/10.1289/ehp.1206424.

OECD (2015). Development aid stable in 2014 but flows to poorest countries still falling [website]. Organisation for Economic Co-operation and Development. http://www.oecd.org/dac/stats/development-aid-stable-in-2014-but-flows-to-poorest-countries-still-falling.htm (accessed 9 August 2016).

Prüss-Ustün A, Wolf J, Corvalán C, Bos R, Neira M (2016). Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/204585/1/9789241565196_eng.pdf?ua=1 (accessed 20 June 2016).

UN (2014). World urbanization prospects: The 2014 revision, highlights. New York: United Nations Department of Economic and Social Affairs, Population Division. http://esa.un.org/unpd/wup/Publications/Files/WUP2014-Highlights.pdf (accessed 21 June 2016).

UNEP (2013). Lead in enamel decorative paints. National paint testing results: A nine country study. United Nations Environment Programme. http://www.unep.org/chemicalsandwaste/Portals/9/Mercury/Documents/publications/Lead_in_Enamel_decorative_paints.pdf (accessed 21 June 2016).

UNEP (2016). Leaded petrol phase-out: global status as at June 2016 [website]. Nairobi: United Nations Environment Programme. http://www.unep.org/Transport/new/PCFV/pdf/Maps_Matrices/world/lead/MapWorldLead_June2016.pdf (accessed 8 July 2016).

UNICEF, WHO (2015). Progress on sanitation and drinking water: 2015 update and MDG assessment. Geneva: World Health Organization. http://www.unicef.org/publications/files/Progress_on_Sanitation_and_Drinking_Water_2015_Update_.pdf (accessed 21 June 2016).

WHO (2015). Millennium Development Goals (MDGs): Progress report on the health-related MDGs [website]. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs290/en/ (accessed 21 June 2016).

WHO (2016a). Burden of disease: Data by region. Global Health Observatory [website]. Geneva: World Health Organization. http://apps.who.int/gho/data/node.main.156?lang=en (accessed 21 June 2016).

WHO (2016b). Children: reducing mortality [website]. Fact sheet no. 178. http://www.who.int/mediacentre/factsheets/fs178/en/ (accessed 8 June 2016).

WHO (2016c). Countries with legally-binding controls on lead paint; status at 30 June 2016: Full country database. Global Health Observatory [website]. Geneva: World Health Organization. http://apps.who.int/gho/data/view.main.LEADCONTROLFULLv?lang=en (accessed 2 August 2016).

WHO (2016d). Household air pollution burden of disease by WHO Regions, 2012 All regions. Global Health Observatory [website]. Geneva: World Health Organization. http://apps.who.int/gho/data/node.main.HAPBYCAUSEBYREGIONANDWORLD?lang=en (accessed 21 June 2016).

WHO (2016e). Ambient air pollution: A global assessment of exposure and burden of disease. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/250141/1/9789241511353-eng.pdf?ua=1: (accessed 27 September 2016).

WHO, UNEP (2013). Bergman Å, Heindel JJ, Jobling S, Kidd KA, Zoeller RT, editors. State of the science of endocrine disrupting chemicals - 2012. Geneva: World Health Organization. http://www.who.int/ceh/publications/endocrine/en/ (accessed 21 June 2016).

Map: Deaths in children under five attributable to the environment (as a whole) per 100 000 people, 2012
Data source: WHO (2016). Unpublished data calculated for Prüss-Üstün A, Wolf J, Corvalán C, Bos R, Neira M (2016). Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks. Geneva: World Health Organization. (http://apps.who.int/iris/bitstream/10665/204585/1/9789241565196_eng.pdf?ua=1. Map production: amudhA Rathinam. Copyright: WHO.

Graph: Environmental fraction of global burden of disease (in DALYs), by age and disease group, 2012
Graph source: Prüss-Üstün A, Wolf J, Corvalán C, Bos R, Neira M (2016). Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks. Geneva: World Health Organization. (http://apps.who.int/iris/bitstream/10665/204585/1/9789241565196_eng.pdf?ua=1). Map production: amudhA Rathinam. Copyright: WHO.

Graph: Main diseases contributing to the environmental burden of disease for children under five years, 2012
Graph source: Prüss-Üstün A, Wolf J, Corvalán C, Bos R, Neira M (2016). Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks. Geneva: World Health Organization. (http://apps.who.int/iris/bitstream/10665/204585/1/9789241565196_eng.pdf?ua=1). Map production: amudhA Rathinam. Copyright: WHO.

Child injuries: Preventable tragedies

Prüss-Ustün A, Wolf J, Corvalán C, Bos R, Neira M (2016). Preventing disease through healthy environments: A global assessment of the burden of disease from environmental risks. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/204585/1/9789241565196_eng.pdf?ua=1 (accessed 20 June 2016).

Rahman F, Bose S, Linnan M, Rahman A, Mashreky S, Haaland B et al (2012). Cost-effectiveness of an injury and drowning prevention program in Bangladesh. Pediatrics. 130;(6):e1621–1628. doi: 10.1542/peds.2012-0757.

WHO (2011). Health in the green economy: Co-benefits to health of climate change mitigation. Geneva: World Health Organization. http://www.who.int/hia/examples/trspt_comms/hge_transport_factsheet_low-resdurban_30_11_2011.pdf (accessed 17 June 2016).

WHO (2012). Global Health Estimates. Geneva: World Health Organization. http://www.who.int/healthinfo/global_burden_disease/en/ (accessed 17 June 2016).

WHO (2014a). Global report on drowning: preventing a leading killer. Geneva: World Health Organization. http://www.who.int/violence_injury_prevention/publications/drowning_global_report/Final_report_full_web.pdf (accessed 17 June 2016).

WHO (2014b). Injuries and violence: the facts. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/149798/1/9789241508018_eng.pdf?ua=1&ua=1 (accessed 14 July 2016).

WHO (2014c). Global Health Estimates 2014 summary tables: Deaths by cause, age and sex, 2000–2012. Geneva: World Health Organization. http://www.who.int/healthinfo/global_burden_disease/estimates/en/index1.html (accessed 25 November 2016).

WHO (2015). Global status report on road safety 2015. Geneva: World Health Organization. http://www.who.int/violence_injury_prevention/road_safety_status/2015/en/ (accessed 17 June 2016).

WHO, UNICEF (2008). World report on child injury prevention. Geneva: World Health Organization. http://www.who.int/water_sanitation_health/diseases/report-on-child-injury-prevention/en/ (accessed 17 June 2016).

Map: Child restraint laws, by country/area
Data source: WHO (2015). Global status report on road safety, 2015. Geneva: World Health Organization; 2015 (http://www.who.int/violence_injury_prevention/road_safety_status/2015/en/). Map production: Health Statistics and Information Systems (HIS), WHO. Copyright: WHO.

Graph: Burden of disease (deaths and disability-adjusted life years) attributable to the environment globally – unintentional injuries in children age 0–4 years, 2012
Graph source: Prüss-Ustün A, Wolf J, Corvalán C, Bos R, Neira M (2016). Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks. Geneva: World Health Organization (http://apps.who.int/iris/bitstream/10665/204585/1/9789241565196_eng.pdf?ua=1). Copyright: WHO.

2. Meeting basic needs for everyone: Steps towards SDG 6

Safe water: For all children everywhere

Bain R, Cronk R, Hossain R, Bonjour S, Onda K, Wright J et al (2014). Global assessment of exposure to faecal contamination through drinking water based on a systematic review. Trop Med Int Health. 2014;19(8):917–27. doi: 10.1111/tmi.12334.

Bourne RRA, Stevens GA, White RA, Smith JL, Flaxman SR, Price H et al (2013). Cause of vision loss worldwide, 1990–2010: A systematic analysis. Lancet Glob Health. 2013;1:e339–349. doi: 10.1016/ S2214-109X(13)70113-X.

Onda K, LoBuglio J, Bartram J (2012). Global access to safe water: Accounting for water quality and the resulting impact on MDG progress. Int J Environ Res Public Health. 2012;9(3):880–94. doi: 10.3390/ijerph9030880.

UN (2015). Transforming our world: The 2030 Agenda for Sustainable Development. Resolution 70/1. New York: United Nations. https://sustainabledevelopment.un.org/post2015/transformingourworld (accessed 21 June 2016).

UN Water, WHO (2014). UN-water global analysis and assessment of sanitation and drinking-water (GLAAS) 2014 report. Investing in water and sanitation: Increasing access, reducing inequalities. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/139735/1/9789241508087_eng.pdf?ua=1 (accessed 21 July 2016).

UNICEF, WHO (2012). Progress on sanitation and drinking water: 2012 update. New York: United Nations Children's Fund, Geneva: World Health Organization. http://www.unicef.org/media/files/JMPreport2012.pdf (accessed 22 June 2016).

UNICEF, WHO (2015). Progress on sanitation and drinking water: 2015 update and MDG assessment. Geneva: World Health Organization. http://files.unicef.org/publications/files/Progress_on_Sanitation_and_Drinking_Water_2015_Update_.pdf (accessed 21 June 2016).

WHO (2004). Guidelines for drinking-water quality, 3rd edition. Geneva: World Health Organization. http://www.who.int/water_sanitation_health/dwq/GDWQ2004web.pdf (accessed 17 August 2016).

WHO (2011). Guidelines for drinking-water quality, 4th edition. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/44584/1/9789241548151_eng.pdf (accessed 21 June 2016).

WHO (2012). Global costs and benefits of drinking-water supply and sanitation interventions to reach the MDG target and universal coverage. Geneva: World Health Organization. http://www.who.int/water_sanitation_health/publications/2012/globalcosts.pdf (accessed 21 July 21).

WHO (2014a). Preventing diarrhoea through better water, sanitation and hygiene: Exposures and impacts in low- and middle-income countries. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/150112/1/9789241564823_eng.pdf (accessed 22 June 2016).

WHO (2014b). Global Health Estimates 2014 summary tables: Deaths by cause, age and sex, 2000–2012. Geneva: World Health Organization. http://www.who.int/healthinfo/global_burden_disease/estimates/en/index1.html (accessed 25 November 2016).

WHO (2015). Trachoma [website]. Fact sheet no. 382. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs382/en/ (accessed 21 June 2016).

WHO (2016a). WHO-MCEE estimates for child causes of death, 2000–2015. Updated 5 February 2016. Geneva: World Health Organization. http://www.who.int/healthinfo/global_burden_disease/estimates_child_cod_2015/en/ (accessed 23 November 2016).

WHO (2016b). Dracunculiasis (guinea-worm disease) [website]. Fact sheet no. 359. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs359/en/ (accessed 21 June 2016).

WHO (2016c). Schistosomiasis [website]. Fact sheet no. 115. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs115/en/ (accessed 21 June 2016).

Map: Proportion of the population using improved drinking water sources, 2015
Data source: UNICEF, WHO (2015). Progress on sanitation and drinking water – 2015 update and MDG Assessment. New York: United Nations Children's Fund and World Health Organization (http://files.unicef.org/publications/files/Progress_on_Sanitation_and_Drinking_Water_2015_Update_.pdf). Map production: Health Statistics and Information Systems (HIS), WHO. Copyright: WHO.

Graph: Access to improved drinking water sources, by region, 2015
Data source: UNICEF, WHO (2015). Progress on sanitation and drinking water – 2015 update and MDG Assessment. New York: United Nations Children's Fund and World Health Organization (http://files.unicef.org/publications/files/Progress_on_Sanitation_and_Drinking_Water_2015_Update_.pdf). Copyright: WHO.

Graph: Gender and age distribution of individuals who usually collect drinking water within households without access to drinking water on the premises
Data source: MICS and DHS surveys from 45 developing countries, 2005-2008. WHO, UNICEF (2010). Progress on sanitation and drinking-water: 2010 update. Geneva: World Health Organization and United Nations Children's Fund (http://www.unicef.org/eapro/JMP-2010Final.pdf). Copyright: WHO.

Sanitation: Making safety a priority

Dangour AD, Watson L, Cumming O, Boisson S, Che Y, Velleman Y et al (2013). Interventions to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children. Cochrane Database of Syst Rev. 2013;8:CD009382. doi: 10.1002/14651858.CD009382.pub2.

IBRD, World Bank, UNICEF (2015). Water and Sanitation Program Research Brief: Management of Child Feces: Current Disposal Practices. International Bank for Reconstruction and Development, World Bank, UNICEF. https://www.wsp.org/sites/wsp.org/files/publications/WSP-CFD-Summary-Brief.pdf (accessed 14 July 2016).

McIlwraith B (2015). Steps towards Clean India [website]. London: WaterAid. http://www.cleanindia.wateraid.org/ (accessed 24 Jun 2016).

UN Water, WHO (2014). Investing in water and sanitation: Increasing access, reducing inequalities. UN Water Global Analysis and Assessment of Sanitation and Drinking-Water. Geneva: World Health Organization. http://www.who.int/water_sanitation_health/glaas/2013/14063_SWA_GLAAS_Highlights.pdf (accessed 3 June 2016).

UNICEF, WHO (2015). Progress on sanitation and drinking water: 2015 update and MDG assessment. Geneva: World Health Organization. http://www.unicef.org/publications/files/Progress_on_Sanitation_and_Drinking_Water_2015_Update_.pdf (accessed 21 June 2016).

WaterAid (2016). Achieving total sanitation and hygiene coverage within a generation – lessons from East Asia. WaterAid. http://www.wateraid.org/what-we-do/our-approach/research-and-publications/view-publication?id=85d7a0ca-181b-4d81-931b-d5b97a9456a3 (accessed 14 July 2016).

WHO (2014). Preventing diarrhoea through better water, sanitation and hygiene: Exposures and impacts in low- and middle-income countries. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/150112/1/9789241564823_eng.pdf (accessed 24 June 2016).

WHO (2015a). Health in 2015: From MDGs to SDGs. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/200009/1/9789241565110_eng.pdf (accessed 23 June 2016.

WHO (2015b). Building latrines and keeping water clean decreases diarrhoea and under-nutrition in Mali. Geneva: World Health Organization. http://www.who.int/features/2015/water-sanitation-mali/en/ (accessed 21 June 2016).

WHO (2016a). WHO-MCEE estimates for child causes of death, 2000–2015. Updated 5 February 2016. Geneva: World Health Organization. http://www.who.int/healthinfo/global_burden_disease/estimates_child_cod_2015/en/ (accessed 23 November 2016).

WHO (2016b). Soil-transmitted helminth infections [website]. Fact sheet. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs366/en/ (accessed 24 June 2016).

WHO (2016c). Schistosomiasis [website]. Fact sheet no. 115. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs115/en/ (accessed 14 July 2016).

Zhou XN, Wang LY, Chen MG, Wu XH, Jiang QW, Chen XY et al (2005a). The public health significance and control of schistosomiasis in China – then and now. Acta Tropica. 2005;96(2–3):97–105. doi: 10.1016/j. actatropica.2005.07.005.

Zhou XN, Wang LY, Chen MG, Wang TP, Guo JG, Wu XH et al (2005b). An economic evaluation of the national schistosomiasis control programme in China from 1992 to 2000. Acta Tropica. 2005;96(2–3):255–265. doi: 10.1016/j.actatropica.2005.07.026.

Map: Proportion of the population using improved sanitation facilities, 2015
Data source: UNICEF, WHO (2015). Progress on sanitation and drinking water – 2015 update and MDG Assessment. New York: United Nations Children's Fund and World Health Organization (http://files.unicef.org/publications/files/Progress_on_Sanitation_and_Drinking_Water_2015_Update_.pdf). Map production: Health Statistics and Information Systems (HIS), WHO. Copyright: WHO.

Graph: Urban and rural trends in sanitation coverage (%), 1990–2015
Data source: UNICEF, WHO (2015). Progress on sanitation and drinking water – 2015 update and MDG Assessment. New York: United Nations Children's Fund and World Health Organization (http://files.unicef.org/publications/files/Progress_on_Sanitation_and_Drinking_Water_2015_Update_.pdf). Copyright: WHO.

Graph: Use of sanitation facilities in India, 2015
Data source: UNICEF, WHO (2015). Progress on sanitation and drinking water – 2015 update and MDG Assessment. New York: United Nations Children's Fund and World Health Organization (http://files.unicef.org/publications/files/Progress_on_Sanitation_and_Drinking_Water_2015_Update_.pdf). Copyright: WHO.

Hygiene: Now WASH your hands!

Blencowe H, Cousens S, Mullany LC, Lee AC, Kerber K, Wall S et al (2011). Clean birth and postnatal care practices to reduce neonatal deaths from sepsis and tetanus: A systematic review and Delphi estimation of mortality effect. BMC Public Health. 2011;11 Suppl 3:S11. doi: 10.1186/1471-2458-11-S3-S11.

Ejemot-Nwadiaro RI, Ehiri JE, Meremikwu MM, Critchey JA (2015). Hand washing promotion for preventing diarrhoea. Cochrane Database Syst Rev. 2015;(9):1–95. doi: 10.1002/14651858.CD004265.pub3.

Freeman MC, Stocks ME, Cumming O, Jeandron A, Higgins JP, Wolf J et al (2014). Hygiene and health: Systematic review of handwashing practices worldwide and update of health effects. Trop Med Int Health. 2014;19(8):906–916. doi: 10.1111/tmi.12339.

Government of India (2015). Menstrual hygiene management: national guidelines. New Delhi: Ministry of Drinking Water and Sanitation, Government of India. http://www.mdws.gov.in/sites/default/files/Menstrual%20Hygiene%20Management%20-%20Guidelines.pdf (accessed 21 July 2016).

House S, Mahon T, Cavill S (2012). Menstrual hygiene matters. London: WaterAid. http://www.wateraid.org/what-we-do/our-approach/research-and-publications/view-publication?id=02309d73-8e41-4d04-b2ef-6641f6616a4f (accessed 24 June 2016).

Luby SP, Halder AK, Huda T, Unicomb L, Johnston RB (2011). The effect of handwashing at recommended times with water alone and with soap on child diarrhea in rural Bangladesh: An observational study. PLoS Med. 2011;8(6):e1001052. doi: 10.1371/journal.pmed.1001052.

UNICEF (2012). Water, sanitation and hygiene (WASH) in schools: A companion to the Child Friendly Schools Manual. New York: United Nations Children's Fund. http://www.unicef.org/publications/files/CFS_WASH_E_web.pdf (accessed 24 June 2016).

WHO (2006). Five keys to safer food manual. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/43546/1/9789241594639_eng.pdf?ua=1 (accessed 24 June 2016).

WHO (2009). WHO guidelines on hand hygiene in health care. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/44102/1/9789241597906_eng.pdf (accessed 24 June 2016).

WHO (2014). Preventing diarrhoea through better water, sanitation and hygiene: Exposures and impacts in low- and middle-income countries. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/150112/1/9789241564823_eng.pdf (accessed 24 June 2016).

WHO (2015) Estimates of the global burden of foodborne diseases: Foodborne disease burden epidemiology reference group 2007–2015. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/199350/1/9789241565165_eng.pdf (accessed 24 June 2016).

Map: Proportion of the population with handwashing facilities with soap and water, 2010–2014
Data source: Demographic and Health Surveys and Multiple Indicator Cluster Surveys. 2010-2014. Proportion of population having handwashing facilities with soap and water. Map production: amudhA Rathinam. Copyright: WHO.

Arsenic and fluoride: Poison in the well

Beltrán-Aguilar ED, Barker L, Dye BA (2010). Prevalence and severity of dental fluorosis in the United States, 1999–2004. NCHS Data Brief. 2010;(53):1–8.

Choi AL, Sun G, ZhangY, Grandjean P (2012). Developmental fluoride neurotoxicity: A systematic review and meta-analysis. Environ Health Perspect. 2012;120(10):1362–1368. doi: 10.1289/ehp.1104912.

Ding Y, Gao Y, Sun H, Han H, Wang W, Ji X et al (2011). The relationships between low levels of urine fluoride on children's intelligence, dental fluorosis in endemic fluorosis areas in Hulunbuir, Inner Mongolia, China. J Hazard Mater. 2011;186(2–3):1942-6. doi: 10.1016/j.jhazmat.2010.12.097.

Iheozor-Ejiofor Z, Worthington HV, Walsh T, O'Malley L, Clarkson JE, Macey R et al (2015). Water fluoridation for the prevention of dental caries. Cochrane Database Syst Rev. 2015;(6):CD010856. doi: 10.1002/14651858.CD010856.pub2.

JECFA (2011). Evaluation of certain contaminants in food: seventy-second report of the Joint FAO/WHO Expert Committe on Food Additives. Rome: FAO, Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/44514/1/WHO_TRS_959_eng.pdf (accessed 24 June 2016).

Majumdar KK, Guha Mazumder DN (2012). Effect of drinking arsenic-contaminated water in children. Indian J Public Health. 2012;56(3):223–6. doi: 10.4103/0019-557X.104250.

Pathey P (2015). Bangladesh: Multiple Indicator Cluster Survey 2012–3: Final report. Dhaka: Bangladesh Bureau of Statistics (BBS), United Nations Children's Fund. http://www.unicef.org/bangladesh/MICS_Final_21062015_Low.pdf (accessed 24 June 2016).

Petersen PE (2003). The World Oral Health Report 2003: Continuous improvement of oral health in the 21st century – the approach of the WHO Global Oral Health Programme. Geneva: World Health Organization. Community Dent Oral Epidemiol. 2003;31 Suppl 1:3–23. http://www.who.int/oral_health/media/en/orh_report03_en.pdf (accessed 24 June 2016).

Ravenscroft P (2007). Predicting the global extent of arsenic pollution of groundwater and its potential impact on human health. New York: United Nations Children's Fund. http://users.physics.harvard.edu/~wilson/arsenic/references/Ravenscroft_Prediction.pdf (accessed 24 June 2016).

Smith AH, Marshall G, Yuan Y, Ferreccio C, Liaw J, von Ehrenstein O et al (2006). Increased mortality from lung cancer and bronchiectasis in young adults after exposure to arsenic in utero and in early childhood. Environ Health Perspect. 2006;114(8):1293–1296. doi: 10.1289/ehp.8832.

Smith AH, Marshall G, Liaw J, Yuan Y, Ferreccio C, Steinmaus C (2012). Mortality in young adults following in utero and childhood exposure to arsenic in drinking water. Environ Health Perspect. 2012;120(11):1527–31. doi: 10.1289/ehp.1104867.

Straif K, Benbrahim-Tallaa L, Baan R, Grosse Y, Secretan B, El Ghissassi F et al (2009). A review of human carcinogens – Part C: Metals, arsenic, dusts, and fibres. Lancet Oncol. 2009;10(5):453–4. doi: 10.1016/S1470-2045(09)70134-2.

WHO (2006). Fluoride in drinking-water. London: IWA Publishing. http://www.who.int/water_sanitation_health/publications/fluoride_drinking_water_full.pdf?ua=1 (accessed 24 June 2016).

WHO (2010). Exposure to arsenic: A major public health concern. Geneva: World Health Organization. http://www.who.int/ipcs/features/arsenic.pdf (accessed 24 June 2016).

WHO (2016). Arsenic [website]. Fact sheet no. 372. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs372/en/ (accessed 21 July 2016).

Winkel L, Berg M, Amini M, Hug SJ, Johnson CA (2008). Predicting groundwater arsenic contamination in Southeast Asia from surface parameters. Nat Geosci. 2008;1(8):536–542. doi: 10.1038/ngeo254.

Map: Modelled probability of arsenic in groundwater exceeding the WHO guidelines for drinking water of 10 µg/dL in some Member States of the WHO South-East Asia Region
Map source: Adapted from Winkel L, Berg M, Amini M, Hug SJ, Johnson CA (2008). Predicting groundwater arsenic contamination in Southeast Asia from surface parameters. Nature Geoscience. 1: 536-542. Map production: Swiss Federal Institute of Aquatic Science and Technology (EAWAG).

Vector-borne diseases: Environmental prevention

Brady OJ, Gething PW, Bhatt S, Messina JP, Brownstein JS, Hoen AG et al (2012). Refining the global spatial limits of dengue virus transmission by evidence-based consensus. PLoS Negl Trop Dis. 2012;6:e1760. doi:10.1371/journal.pntd.0001760

Campbell GL, Hills SL, Fischer M, Jacobson JA, Hoke CH, Hombach JM et al (2011). Estimated global incidence of Japanese encephalitis: A systematic review. Bull World Health Organ. 2011;89:766–774E. doi: 10.2471/BLT.10.085233.

Fichet-Calvet E, Jomâa I, Zaafouri B, Ashford RW, Ben-Ismail R, Delattre P (2000). The spatio-temporal distribution of a rodent reservoir host of cutaneous leishmaniasis. J App Ecol. 2000;37(4):603–615. doi: 10.1046/j.1365-2664.2000.00522.x.

Keiser J, Singer BH, Utzinger J (2005). Reducing the burden of malaria in different eco-epidemiological settings with environmental management: A systematic review. Lancet Infectious Diseases. 2005;5(11),695–708. doi: 10.1016/S1473-3099(05)70268-1.

Prüss-Ustün A, Wolf J, Corvalán C, Bos R, Neira M (2016). Preventing disease through healthy environments: A global assessment of the burden of disease from environmental risks. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/204585/1/9789241565196_eng.pdf?ua=1 (accessed 20 June 2016).

Utzinger J, Tozan Y, Singer BH (2001). Efficacy and cost-effectiveness of environmental management for malaria control. Trop Med Int Health. 2001;6(9):677–687.

WHO (1980). Environmental management for vector control. Fourth report of the WHO Expert Committee on Vector Biology and Control. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/41404/1/WHO_TRS_649.pdf (accessed 27 June 2016).

WHO (2012). Handbook for integrated vector management. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/44768/1/9789241502801_eng.pdf?ua=1 (accessed 27 June 2016).

WHO (2014a). A global brief on vector-borne diseases. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/111008/1/WHO_DCO_WHD_2014.1_eng.pdf (accessed 27 June 2016).

WHO (2014b). Vector-borne diseases [website]. Fact sheet no. 387. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs387/en/ (accessed 27 June 2016).

WHO (2015a). World Malaria Report 2015. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/200018/1/9789241565158_eng.pdf?ua=1 (accessed 27 June 2016).

WHO (2015b). Dengue and severe dengue [website]. Fact sheet no. 117. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs117/en/ (accessed 27 June 2016).

WHO (2015c). Water sanitation and hygiene for accelerating and sustaining progress on neglected tropical diseases: A global strategy 2015–2020. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/182735/1/WHO_FWC_WSH_15.12_eng.pdf?ua=1 (accessed 27 June 2016).

WHO (2015d). Global technical strategy for malaria 2016–2030. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/176712/1/9789241564991_eng.pdf (accessed 27 June 2016).

WHO (2015e). Health in 2015: From MDGs to SDGs. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/200009/1/9789241565110_eng.pdf?ua=1 (accessed 27 June 2016).

WHO (2016a). Zika virus [website]. Fact sheet. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/zika/en/ (accessed 2 August 2016).

WHO (2016b). Chagas disease (American trypanosomiasis) [website]. Fact sheet no. 340. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs340/en/ (accessed 27 June 2016).

WHO (2016c). Leishmaniasis [website]. Fact sheet no. 375. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs375/en/ (accessed 27 June 2016).

WHO (2016d). Lymphatic filariasis [website]. Fact sheet no. 102. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs102/en/ (accessed 27 July 2016).

WHO (2016e). Schistosomiasis [website]. Fact sheet no. 115. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs115/en/ (accessed 2 August 2016).

WHO (2016f). Yellow fever [website]. Fact sheet no. 100. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs100/en/ (accessed 2 August 2016).

WHO (2016g). WHO-MCEE estimates for child causes of death, 2000–2015. Updated 5 February 2016. Geneva: World Health Organization. http://www.who.int/healthinfo/global_burden_disease/estimates_child_cod_2015/en/ (accessed 23 November 2016).

Map: Estimated P. falciparum (malaria) infection prevalence among children ages 2-10 years, 2000 and 2015
Map source: Malaria Atlas Project. Adapted from: Keating J, Miller JM, Bennett A, Moonga HB, Eisele TP (2009). Plasmodium falciparum parasite infection prevalence from a household survey in Zambia using microscopy and a rapid diagnostic test: implications for monitoring and evaluation. Acta Trop. 2009;112(3):277–82. Map production: Malaria Atlas Project. Reprinted with permission from Malaria Atlas Project.

Map: Percentage of population at risk protected by IRS or ITNs, 2014
Data source: WHO (2015). World Malaria report 2015. Geneva: World Health Organization. (http://apps.who.int/iris/bitstream/10665/200018/1/9789241565158_eng.pdf). Map production: Health Statistics and Information Systems (HIS), WHO. Copyright: WHO.

3. A breath of fresh air: Steps towards SDGs 7 and 13

Climate change: Building resilience together

Climate and Clean Air Coalition (2016). About us [website]. Climate and Clean Air Coalition. http://www.ccacoalition.org/en/content/about-us (accessed 26 June 2016).

GBD 2015 Disease and Injury Incidence and Prevalence Collaborators (2016). Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990–2015: A systematic analysis for the Global Burden of Disease Study 2015. Lancet. 388:1545–602. doi: http://dx.doi.org/10.1016/S0140-6736(16)31678-6.

Hedlund K, Knox Clarke P (2011). ALNAP Lessons Paper: Humanitarian action in drought-related emergencies. ALNAP. http://www.alnap.org/resource/6156.aspx (accessed 16 June 2016).

Knowlton K, Rotkin-Ellman M, King G, Margolis HG, Smith D, Solomon G et al (2009). The 2006 california heat wave: Impacts on hospitalizations and emergency department visits. Environ Health Perspect 117(1):61–67. doi: 10.1289/ehp.11594.

Perera FP (2016). Multiple threats to child health from fossil fuel combustion: Impacts of air pollution and climate change. Environ Health Perspect. doi: 10.1289/EHP299.

Portier CJ, Thigpen TK, Carter SR, Dilworth CH, Grambsch AE, Gohlke J et al (2010). A human health perspective on climate change: A report outlining the research needs on the human health effects of climate change. Research Triangle Park (NC): Environ Health Perspect, National Institute of Environmental Health Sciences. https://www.niehs.nih.gov/health/materials/a_human_health_perspective_on_climate_change_full_report_508.pdf (accessed 30 May 2016).

UN (2015). Paris Agreement. New York: United Nations. http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf (accessed 15 July 2015).

WHO (2014a). Quantitative risk assessment of the effects of climate change on selected causes of death, 2030s and 2050s. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/134014/1/9789241507691_eng.pdf (accessed 15 July 2016).

WHO (2014b). Preventing diarrhoea through better water, sanitation and hygiene: Exposures and impacts in low- and middle-income countries. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/150112/1/9789241564823_eng.pdf (accessed 27 June 2016).

WHO (2014c). Mortality from household air pollution for 2012 [website]. Global Health Observatory data. Geneva: World Health Organization. http://www.who.int/gho/phe/indoor_air_pollution/en/ (accessed 30 May 2016).

WHO (2015a). World Malaria Report 2015. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/200018/1/9789241565158_eng.pdf?ua=1 (accessed 30 May 2016).

WHO (2015b). Operational framework for building climate resilient health systems. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/189951/1/9789241565073_eng.pdf?ua=1 (accessed 30 May 2016).

WHO (2015c). The climate and health country profiles: A global overview [website]. Geneva: World Health Organization. http://www.who.int/globalchange/resources/countries/en/ (accessed 15 July 2016).

WHO (2016a). WHO-MCEE estimates for child causes of death, 2000–2015. Updated 5 February 2016. Geneva: World Health Organization. http://www.who.int/healthinfo/global_burden_disease/estimates_child_cod_2015/en/ (accessed 23 November 2016).

WHO (2016b). El Niño and health: Global overview – January 2016. Geneva: World Health Organization. http://www.who.int/hac/crises/el-nino/who_el_nino_and_health_global_report_21jan2016.pdf?ua=10 (accessed 30 May 2016).

WMO (2017). WMO confirms 2016 as hottest year on record, about 1.1°C above pre-industrial era [website]. Geneva: World Meteorological Organization. https://public.wmo.int/en/media/press-release/wmo-confirms-2016-hottest-year-record-about-11%C2%B0c-above-pre-industrial-era (accessed 16 February 2017).

Map: A number of major drought events from 2000–2010
Map source: WHO, WMO (2012). Atlas of health and climate. Geneva: World Health Organization, World Meteorological Organization (http://www.who.int/globalchange/publications/atlas/report/en/). Data source: National Oceanic and Atmospheric Administration (NOAA). Map production and copyright: WHO, WMO.

Ambient air pollution: The unseen threat outdoors

Beelen R, Raaschou-Nielson O, Stafoggia M, Andersen ZJ, Weinmayr G, Hoffmann B et al (2014). Effects of long-term exposure to air pollution on natural-cause mortality: An analysis of 22 European cohorts within the multicentre ESCAPE project. Lancet. 2014;383(9919):785–795. doi:10.1016/S0140-6736(13)62158-3.

Benbrahim-Tallaa L, Baan RA, Grosse Y, Lauby-Secretan B, El Ghissassi F, Bouvard V et al (2012). Carcinogenicity of diesel-engine and gasoline-engine exhausts and some nitroarenes. Lancet Oncol. 2012;13(7):663–664. doi:10.1016/S1470-2045(12)70280-2.

Burke J (2015). Delhi considers shutting schools as toxic smog continues. Guardian. http://www.theguardian.com/environment/2015/dec/11/delhi-considers-shutting-schools-as-toxic-smog-continues (accessed 4 June 2016).

CCAC (2016). Short-lived climate pollutants [website]. Climate and Clean Air Coalition. http://www.ccacoalition.org/en/science-resources (accessed 28 July 2016).

Crouse DL, Peter PA, Hystad P, Brook JR, van Donkelaar A, Martin RV et al (2015). Ambient $PM_{2.5}$, 03, and NO2 exposures and associations with mortality over 16 years of follow-up in the Canadian Census Health and Environment Cohort (CanCHEC). Environ Health Perspect. 2015;123(11):1180–6. doi: 10.1289/ehp.1409276.

Eze IC, Hemkens LG, Bucher HC, Hoffmann B, Schindler C, Künzli N et al (2015). Association between ambient air pollution and diabetes mellitus in Europe and North America: Systematic review and meta-analysis. Environ Health Perspect. 2015;123(5):381–389. doi: 10.1289/ehp.1307823.

Ferguson KK, O'Neill MS, Meeker JD (2013). Environmental contaminant exposures and preterm birth: A comprehensive review. J Toxicol Environ Health B Crit Rev. 2013;16(2):69–113. doi: 10.1080/10937404.2013.775048.

Gauderman WJ, Avol E, Gilliland F, Vora H, Thomas D, Berhane K et al (2004). The effect of air pollution on lung development from 10 to 18 years of age. N Engl J Med. 2004;351(11):1057–67. doi: 10.1056/NEJMoa040610.

Gauderman WJ, Urman R, Avol E, Berhane K, McConnell R, Rappaport E et al (2015). Association of improved air quality with lung development in children. N Engl J Med. 2015; 372(10):905–913. doi: 10.1056/NEJMoa1414123.

Gehring U, Wijga Ah, Brauer M, Fischer P, de Jongste JC, Kerkhof M et al (2010). Traffic-related air pollution and the development of asthma and allergies during the first 8 years of life. Am J Respir Crit Care Med. 2010;181(6):596–603. doi: 10.1164/rccm.200906-0858OC.

Götschi T, Heinrich J, Sunyer J, Künzli N (2008). Long-term effects of ambient air pollution on lung function: A review. Epidemiology. 2008;19(5):690–701. doi: 10.1097/EDE.0b013e318181650f.

Hosking J, Mudu P, Dora C (2011). Health in the green economy: Health co-benefits of climate change mitigation – transport sector. Geneva: World Health Organization. http://extranet.who.int/iris/restricted/bitstream/10665/70913/1/9789241502917_eng.pdf?ua=1 (accessed 17 May 2016).

Jerrett M, Shankardass K, Berhane K, Gauderman WJ, Künzi N, Avol E et al (2008). Traffic-related air pollution and asthma onset in children: A prospective cohort study with individual exposure measurement. Environ Health Perspect. 2008;116(10):1433–1438. doi: 10.1289/ehp.1096.

Lelieveld J et al (2015). The contribution of outdoor air pollution sources to premature mortality on a global scale. Nature. 2015;525(7569):367–371. doi:10.1038/nature15371.

Loomis D, Grosse Y, Lauby-Secretan B, El Ghissassi F, Bouvard V, Benbrahim-Tallaa L et al (2013). The carcinogenicity of outdoor air pollution. Lancet Oncol. 2013;14(13):1262–1263. doi:10.1016/S1470-2045(13)70487-X.

Lurmann F, Avol E, Gilliland F (2015). Emissions reduction policies and recent trends in southern California's ambient air quality. J Air Waste Manag Assoc. 2015;65(3):324–35. doi: 10.1080/10962247.2014.991856.

Pedersen M, Giorgis-Allemand L, Bernard C, Aguilera I, Andersen AM, Ballester F et al (2013). Ambient air pollution and low birthweight: A European cohort study (ESCAPE). Lancet Respir Med. 2013;1(9):695–704. doi:10.1016/S2213-2600(13)70192-9.

Perera FP (2016). Multiple threats to child health from fossil fuel combustion: Impacts of air pollution and climate change. Environ Health Perspect. doi: 10.1289/EHP299.

Perera FP, Li Z, Whyatt R, Hoepner L, Wang S, Camann D et al (2009). Prenatal airborne polycyclic aromatic hydrocarbon exposure and child IQ at age 5 years. Pediatrics. 2009;124(2):e195–202. doi: 10.1542/peds.2008-350.

Prefeitura Municipal de Curitiba (2013). Curitiba terá mais 300 km de vias cicláveis e investimento de R$ 90 milhões para consolidar novo modal [website]. http://www.pam.curitiba.pr.gov.br/geral/noticia.aspx?idf=30592 (accessed 2 August 2016).

Prüss-Ustün A, Wolf J, Corvalán C, Bos R, Neira M (2016). Preventing disease through healthy environments: A global assessment of the burden of disease from environmental risks. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/204585/1/9789241565196_eng.pdf?ua=1 (accessed 20 June 2016).

Schwartz J (2004). Air pollution and children's health. Pediatrics. 2004;113(4 Suppl):1037–43. PMID: 15060197.

Suglia SF, Gryparis A, Wright RO, Schwartz J, Wright RJ (2008). Association of black carbon with cognition among children in a prospective birth cohort study. Am J Epidemiol. 2008;167(3):280–6. doi: 10.1093/aje/kwm308.

Sunyer J, Esnaola M, Alvarez-Pederol M, Forns J, Rivas I, López-Vicente M et al (2015). Association between traffic-related air pollution in schools and cognitive development in primary school children: A prospective cohort study. PLoS Med. 2015;12(3):e1001792. doi:10.1371/journal.pmed.1001792.

Trasande L, Wong K, Roy A, Savitz DA, Thurston G (2013). Exploring prenatal outdoor air pollution, birth outcomes and neonatal health care utilization in a nationally representative sample. J Expo Sci Environ Epidemiol. 2013;23(3):315–21. doi:10.1038/jes.2012.124.

UNDP, IPEA, FJP (2013). Curitiba, PR: Longevidade, mortalidade e fecundidade [website]. Atlas do desenvolvimento humano no brasil 2013. United Nations Development Programme, Instituto de Pesquisa Econômica Aplicada, Fundação João Pinheiro. http://www.atlasbrasil.org.br/2013/pt/perfil_m/curitiba_pr (accessed 2 August 2016).

US EPA (2012). Provisional assessment of recent studies on health effects of particulate matter exposure, Washington (DC): US Environmental Protection Agency. https://www3.epa.gov/ttn/naaqs/standards/pm/data/20121213psa.pdf (accessed 15 July 2016).

WHO (2014). Frequently asked questions – Ambient (outdoor) air pollution database update 2014. Geneva: World Health Organization. http://www.who.int/phe/health_topics/outdoorair/databases/faq-ambient-air-pollution-database-2014.pdf?ua=1 (accessed 4 June 2016).

WHO (2016a). WHO global urban ambient air pollution database (update 2016) [website]. Geneva: World Health Organziation. http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/ (accessed 22 June 2016).

WHO (2016b). Air pollution levels rising in many of the world's poorest cities. Press release. 2016. Geneva: World Health Organization. http://www.who.int/mediacentre/news/releases/2016/air-pollution-rising/en/ (accessed 16 May 2016).

WHO (2016c). WHO urban ambient air pollution database (update 2016) [website]. Data summary. World Health Organization. http://www.who.int/phe/health_topics/outdoorair/databases/AAP_database_summary_results_2016_v02.pdf?ua=1 (accessed 28 July 2016).

WHO (2016d). WHO-MCEE estimates for child causes of death, 2000–2015. Updated 5 February 2016. Geneva: World Health Organization. http://www.who.int/healthinfo/global_burden_disease/estimates_child_cod_2015/en/ (accessed 23 November 2016).

WHO (2016e). Ambient (outdoor) air quality and health. Fact sheet. http://www.who.int/mediacentre/factsheets/fs313/en/ (accessed 22 December 2016).

WHO, CCAC, Scovronick N (2015). Reducing global health risks through mitigation of short-lived climate pollutants. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/189524/1/9789241565080_eng.pdf?ua=1 (accessed 16 May 2016).

WHO EURO (2013a). Health effects of particulate matter. Copenhagen: World Health Organization, Regional Office for Europe. http://www.euro.who.int/__data/assets/pdf_file/0006/189051/Health-effects-of-particulate-matter-final-Eng.pdf?ua=1 (accessed 18 May 2016).

WHO EURO (2013b). Review of evidence on health aspects of air pollution – REVIHAAP Project. Copenhagen: World Health Organization, Regional Office for Europe. http://www.euro.who.int/__data/assets/pdf_file/0004/193108/REVIHAAP-Final-technical-report-final-version.pdf?ua= (accessed 25 August 2016).

WWF (2012). Curitiba waste as resource. World Wide Fund For Nature. http://wwf.panda.org/wwf_news/?204414/Curitiba-waste-as-resource (accessed 4 June 2016).

Map: Concentration of particulate matter with an aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$) in nearly 3000 urban areas, 2008-2015
Data source: WHO (2016). Annual mean concentrations of fine particulate matter ($PM_{2.5}$) in urban areas. Global Health Observatory (GHO) data. Geneva: World Health Organization (http://apps.who.int/gho/indicatorregistry/App_Main/view_indicator.aspx?iid=4674). Map production: Health Statistics and Information Systems (HIS), WHO. Copyright: WHO.

Graph: PM10 levels by region, for the last available year in the period 2008-2015
Data source: WHO (2016). WHO global urban ambient air pollution database (update 2016) [website]. Geneva: World Health Organization (http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/, accessed 22 June 2016). Copyright: WHO.

Household air pollution: Switching to healthy home energy

Adair-Rohani H, Bruce N (2011). Health in the green economy: Co-benefits to health of climate change mitigation: Household energy sector in developing countries. Geneva: World Health Organization. http://www.who.int/hia/green_economy/en/index.html (accessed 22 July 2016).

Dix-Cooper L, Eskenazi B, Romero C, Balmes J, Smith KR (2012). Neurodevelopmental performance among school age children in rural Guatemala is associated with prenatal and postnatal exposure to carbon monoxide, a marker for exposure to wood smoke. Neurotoxicology. 2012;33(2):246–54. doi: 10.1016/j.neuro.2011.09.004.

Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: A systematic analysis for the Global Burden of Disease Study 2010. Lancet. 2012; 380(9859):2224–2260

Nakaoka H, Todaka E, Seto H, Saito I, Hanazato M, Watanabe M et al (2013). Correlating the symptoms of sick-building syndrome to indoor VOCs concentration levels and odour. Indoor Built Environ. 23(6):804–813. doi: 10.1177/1420326X13500975.

Saito I, Onuki A, Todaka E, Nakaoka H, Mori C, Hosaka M et al (2012). Recent trends in indoor air pollution: Health risks from unregulated chemicals. Japanese Journal of Risk Analysis. 2011;21(2):91–100. doi: 10.11447/sraj.21.91.

SE4All (2011). Our objectives. Sustainable Energy for All [website]. United Nations, World Bank. http://www.se4all.org/our-vision_our-objectives (accessed 20 May 2016).

WHO (2004). The physical school environment – An essential component of a health-promoting school. http://www.who.int/ceh/publications/cehphysical/en/ (accessed 28 June 2016).

WHO (2011). Co-benefits to health of climate change mitigation: The household energy sector in developing countries. Geneva: World Health Organization. http://www.who.int/hia/green_economy/housing_report/en/ (accessed 28 June 2016).

WHO (2014). WHO indoor air quality guidelines: Household fuel combustion. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/141496/1/9789241548885_eng.pdf (accessed 20 May 2016).

WHO (2016). Burning opportunity: Clean household energy for health, sustainable development, and wellbeing of women and children. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/204717/1/9789241565233_eng.pdf (accessed 20 May 2016).

WHO, UNICEF (2013). End preventable deaths: Global Action Plan for Prevention and Control of Pneumonia and Diarrhoea. Geneva: World Health Organization, United Nations Children's Fund. http://apps.who.int/iris/bitstream/10665/79200/1/9789241505239_eng.pdf?ua=1 (accessed 20 May 2016).

Map: Percentage of the population with primary reliance on clean fuels and technologies at the household level

Data source: WHO (2016). Population with primary reliance on clean fuels. Global Health Observatory (GHO) data. Geneva: World Health Organization. (http://apps.who.int/gho/data/node.main.SDGFUELS712?lang=en). Map production: Health Statistics and Information Systems (HIS), WHO. Copyright: WHO.

Map: Household air pollution attributable DALYs in children under five years of age, per 100 000 capita, 2012
Data source: WHO. World Health Organization Global Health Observatory Data Repository [website]. Household air pollution attributable DALYs in children under 5 yrs, 2012. Geneva: World Health Organization (http://apps.who.int/gho/data/node.main.HAPBYCAUSEBYCOUNTRY?lang=en, accessed 21 October 2015). Map production: amudhA Rathinam. Copyright: WHO.

Graph: Regional trends for percentage of the population mainly cooking with polluting fuels in LMICs, 1980–2014

Data source: WHO Household energy database 2016. WHO (2016). Burning opportunity: clean household energy for health, sustainable development, and wellbeing of women and children. Geneva: World Health Organization; 2016 (http://apps.who.int/iris/bitstream/10665/204717/1/9789241565233_eng.pdf, accessed 20 May 2016). Copyright: WHO

Second-hand tobacco smoke: Protecting children from harm

CDC (2015). Global Youth Tobacco Survey (GYTS). Atlanta (GA): Centers for Disease Control and Prevention. http://www.cdc.gov/tobacco/global/ (accessed 23 August 2016).

Cox B, Martens E, Nemery B, Vangronsveld J, Nawrot TS (2013). Impact of a stepwise introduction of smoke-free legislation on the rate of preterm births: Analysis of routinely collected birth data. BMJ. 2013;346:441. doi: 10.1136/bmj.f441.

Hwang SH, Hwang JH, Moon JS, Lee DH (2012). Environmental tobacco smoke and children's health. Korean J Pediatr. 2012;55(2):35–41. doi: 10.3345/kjp.2012.55.2.35 (accessed 27 May 2016).

IARC (2012). Personal habits and indoor combustions. IARC Monographs. Volume 100E. Lyon: International Agency for Research on Cancer. http://monographs.iarc.fr/ENG/Monographs/vol100E/mono100E.pdf (accessed 27 May 2016).

Leonardi-Bee J, Britton J, Venn A (2011). Secondhand smoke and adverse fetal outcomes in nonsmoking pregnant women: A meta-analysis. Pediatrics. 2011;127(4):734–741. doi: 10.1542/peds.2010-3041.

Matt GE, Quintana PJE, Destaillats H, Gundel LA, Sleiman M, Singer BC et al (2011). Third-hand tobacco smoke: Emerging evidence and arguments for a multidisciplinary research agenda. Environ Health Perspect. 2011;119:1218–1226. doi: 10.1289/ehp.1103500.

Mitchell EA, Milerad J (1999). Smoking and sudden infant death syndrome. In: International consultation on environmental tobacco smoke (ETS) and child health. Geneva: World Health Organization. http://www.who.int/tobacco/media/en/mitchell.pdf (accessed 27 July 2016).

Oberg M, Jaakkola MS, Woodward A, Peruga A, Prüss-Ustün A (2011). Worldwide burden of disease from exposure to second-hand smoke: A retrospective analysis of data from 192 countries. Lancet. 8;377(9760):139–46. doi: 10.1016/S0140-6736(10)61388-8.

Pattemore PK (2013). Tobacco or healthy children: The two cannot co-exist. Front Pediatr. 2013;1:20. doi: 10.3389/fped.2013.00020.

Prüss-Ustün A, Wolf J, Corvalán C, Bas R, Neira M (2016). Preventing disease through healthy environments: A global assessment of the burden of disease from environmental risks. Geneva: World Health Organization. http://www.who.int/quantifying_ehimpacts/publications/preventing-disease/en/ (accessed 27 May 2016).

Wang L, Pinkerton KE (2008). Detrimental effects of tobacco smoke exposure during development on postnatal lung function and asthma. Birth Defects Res C Embryo Today. 2008;84(1):54–60. doi: 10.1002/bdrc.20114.

WHO (2008). WHO report on the global tobacco epidemic, 2008: The MPOWER package. Geneva: World Health Organization. http://www.who.int/tobacco/mpower/2008/en/ (accessed 27 May 2016).

WHO (2014). A guide for users to quit. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/112833/1/9789241506939_eng.pdf?ua=1 (accessed 27 May 2016).

WHO (2015). WHO report on the global tobacco epidemic, 2015: Raising taxes on tobacco. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/178574/1/9789240694606_eng.pdf?ua=1 (accessed 27 May 2016).

WHO (2016). Tobacco [website]. Fact sheet no. 339. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs339/en/ (accessed 27 May 2016).

Map: Smoke-free environments – best practice countries, 2014
Data source: WHO (2015). WHO Report on the Global Tobacco Epidemic, 2015: Raising taxes on tobacco. Geneva: World Health Organization, (http://apps.who.int/iris/bitstream/10665/178574/1/9789240694606_eng.pdf?ua=1). Map production: Health Statistics and Information Systems (HIS), WHO. Copyright: WHO.

Ultraviolet radiation: Be safe in the sun

Chang C, Murzaku EC, Penn L, Abbasi NR, Davis PD, Berwick M et al (2014). More skin, more sun, more tan, more melanoma. Am J Public Health. 2014;104(11):e92-e99. doi: 10.2105/AJPH.2014.302185.

Doran CM, Ling R, Byrnes J, Crane M, Shakeshaft AP, Searles A et al (2016). Benefit cost analysis of three skin cancer public education mass-media campaigns implemented in New South Wales, Australia. PLoS One. 2016;11(1):e0147665. doi: 10.1371/journal.pone.0147665.

Erdmann F, Lortet-Tieulent J, Schüz J, Zeeb H, Greinert R, Breitbart EW, Bray (2013). International trends in the incidence of malignant melanoma 1953–2008: Are recent generations at higher or lower risk? Int J Cancer. 2013;132:385–400. doi: 10.1002/ijc.27616.

Green AC, Wallingford SC, McBride P (2011). Childhood exposure to ultraviolet radiation and harmful skin effects: Epidemiological evidence. Prog Biophys Mol Biol. 2011;107(3):349–355. doi: 10.1016/j.pbiomolbio.2011.08.010.

Harper S (2005). Protection against the sun in schools. In: Pronczuk de Garbino J, editor. Children's health and the environment: A global perspective. Geneva: World Health Organization. 2005;283–286. http://apps.who.int/iris/bitstream/10665/43162/1/9241562927_eng.pdf (accessed 15 July 2016).

IARC (2012). IARC Monographs on the evaluation of carcinogenic risks to humans, Radiation, Volume 100D; 2012. http://monographs.iarc.fr/ENG/Monographs/vol100D/index.php (accessed 14 January 2016).

Linetsky M, Raghavan CT, Johar K, Monnier VM, Fan X, Vasavada AR et al (2014). UVA light-excited kynurenines oxidize ascorbate and modify lens proteins through the formation of advanced glycation end products: Implications for human lens aging and cataract formation. J Biol Chem. 2014;289(24):17111–17123. doi: 10.1074/jbc.M114.554410.

Shih S, Carter R, Sinclair C, Mihalopoulos C, Vos T (2009). Economic evaluation of a skin cancer prevention program in Australia: Achievements of the past and prospects for the future. Prev Med. 2009;49(5):449–453. doi: 10.1016/j.ypmed.2009.09.008.

Solomon S, Ivy DJ, Kinnison D, Mills MJ, Neely RR, Schmidt A (2016). Emergence of healing in the Antarctic ozone layer. Science. 2016;353(6296):269-274. doi: 10.1126/science.aae0061.

SunSmart Victoria (2016). History [webpage]. http://www.sunsmart.com.au/about/history (accessed 29 June 2016).

WHO (2002). Global Solar UV Index: A practical guide. A joint recommendation of the World Health Organization, World Meteorological Organization, United Nations Environment Programme and the International Commission on Non-Ionizing Radiation Protection. Geneva: World Health Organization. http://www.who.int/uv/publications/en/UVIGuide.pdf (accessed 29 May 2016).

WHO (2003). Climate change and human health: Risks and responses. Geneva: World Health Organization. http://www.who.int/globalchange/publications/climchange.pdf?ua=1 (accessed 11 August 2016).

WHO (2016). Educational programmes for children sites. Ultraviolet radiation and the INTERSUN Programme [website]. Geneva: World Health Organization. http://www.who.int/uv/resources/link/edulinks/en/ (accessed 4 May 2016).

Map: Estimated incidence of melanoma, age-standardized rate, per 100 000, 2012
Data source: Ferlay J, Soerjomataram I, Ervik M, Dikshit R, Eser S, Mathers C, et al (2013). GLOBOCAN 2012 v1.0, Cancer Incidence and Mortality Worldwide: IARC CancerBase No. 11 [website]. Lyon: International Agency for Research on Cancer, (http://globocan.iarc.fr, accessed 16 October 2016). Map production: amudhA Rathinam. Copyright: WHO.

Map: Daily maximum of UV index cloudy 12/11/2015
Deutscher Wetterdienst, http://www.dwd.de. Map production and copyright: Deutscher Wetterdienst.

4. Lessening the chemical load: Steps towards SDGs 6 and 12

Children and chemicals: Living in a chemical world

Basel Convention (2016). Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal [website]. http://www.basel.int/Countries/StatusofRatifications/PartiesSignatories/tabid/4499/Default.aspx#enote1 (accessed 26 July 2016).

Bouchard MF, Chevrier J, Harley KG, Kogut K, Vedar M, Calderon N et al (2011). Prenatal exposure to organophosphate pesticides and IQ in 7-year-old children. Environ Health Perspect. 2011;119(8):1189–95. doi: 10.1289/ehp.1003185.

Eskenazi B, Kogut K, Huen K, Harley KG, Bouchard M, Bradman A et al (2014). Organophosphate pesticide exposure, PON1, and neurodevelopment in school-age children from the CHAMACOS study. Environ Res. 2014;134:149–157. doi: 10.1016/j.envres.2014.07.001.

IPCS (2011). Environmental Health Criteria 237: Summary of principles for evaluating health risks in children associated with exposure to chemicals. International Programme on Chemical Safety. Geneva: World Health Organization. http://www.who.int/ceh/health_risk_children.pdf (accessed 31 May 2016).

Mohta A (2010). Kajal (kohl) – a dangerous cosmetic. Oman J Ophthalmol. 2010;3(2):100–101. doi: 10.4103/0974-620X.64242.

Norden (2016). Hanna's house of hidden hazards [website]. The Nordic Council. http://english.hannashus.dk/ (accessed 11 August 2016).

Raanan R, Harley KG, Balmes JR, Bradman A, Lipsett M, Eskenazi B (2015). Early-life exposure to organophosphate pesticides and pediatric respiratory symptoms in the CHAMACOS cohort. Environ Health Perspect. 2015;123(2):179–85. doi: 10.1289/ehp.1408235.

Raanan R, Balmes JR, Harley KG, Gunier RB, Magzamen S, Bradaman A et al (2016). Decreased lung function in 7-year-old children with early-life organophosphate exposure. Thorax. 2016;71(2):148–153. doi: 10.1136/thoraxjnl-2014-206622.

Roberts JR, Karr CJ (2012). Pesticide exposure in children. Pediatrics. 2012;130(6):1765–1788. doi: 10.1542/peds.2012-2758.

Stockholm Convention (2016). Status of ratification [website]. http://chm.pops.int/Countries/StatusofRatifications/PartiesandSignatoires/tabid/4500/Default.aspx (accessed 7 July 2016).

UN (2011). Globally Harmonized System of Classification and Labelling of Chemicals. New York: United Nations. https://www.unece.org/fileadmin/DAM/trans/danger/publi/ghs/ghs_rev04/English/ST-SG-AC10-30-Rev4e.pdf (accessed 31 May 2016).

UN (2016). Rotterdam Convention [website]. New York: United Nations. https://sustainabledevelopment.un.org/index.php?page=view&type=30022&nr=132&menu=3170 (accessed 1 July 2016).

UNEP, WHO (2013). Bergman A, Heindel JJ, Jobling S, Zoeller RT, editors. State of the science of endocrine disrupting chemicals – 2012. Geneva: United Nations Environment Programme, World Health Organization. http://www.who.int/ceh/publications/endocrine/en/ (accessed 2 June 2016).

UNEP, WHO EURO, NPC-USM (2010). Toxicology in the classroom [website]. United Nations Environmental Programme, World Health Organization Regional Office for Europe, National Poison Centre of Universiti Sains Malaysia. http://www.prn.usm.my/toxicology_english/ (accessed 11 August 2016).

WHO (2002). Damstra T, Barlow S, Bergman A, Kavlock R, Van Der Kraak G, editors. Global assessment of the state-of-the-science of endocrine disruptors. Geneva: World Health Organization. http://www.who.int/ipcs/publications/new_issues/endocrine_disruptors/en/ (accessed 9 August 2016).

WHO (2005). Children's health and the environment: A global perspective. Pronczuk de Garbino J, editor. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/43162/1/9241562927_eng.pdf (accessed 23 August 2016).

WHO (2010a). Persistent organic pollutants: Impact on child health. Geneva: World Health Organization. http://www.who.int/ceh/publications/persistent_organic_pollutant/en/ (accessed 31 May 2016).

WHO (2010b). Strategic Approach to International Chemicals Management: Report by the secretariat. Geneva: World Health Organization. http://apps.who.int/gb/ebwha/pdf_files/WHA63/A63_21-en.pdf?ua=1 (accessed 1 July 2016).

WHO (2015). SAICM health sector input to implementation of the strategic approach, and the overall orientation and guidance, for the period 2015 to 2020. Geneva: World Health Organization. http://www.who.int/ipcs/section_v_onlinesurvey.pdf?ua=1 (accessed 10 August 2016).

Map: Signatories and parties to the Stockholm Convention
Data source: Secretariat of the Stockholm Convention (2016). Stockholm Convention, Status of Ratifications. (http://chm.pops.int/Countries/StatusofRatifications/PartiesandSignatories/tabid/252/Default.aspx#a-note-5, accessed 11 August 2016). Map production: amudhA Rathinam. Reprinted with permission from UNEP.

Map: Signatories and parties to the Rotterdam Convention
Data source: Secretariat of the Rotterdam Convention (2016). Rotterdam Convention, Status of Ratifications. (http://www.pic.int/Countries/Statusofratifications/tabid/1072/language/en-US/Default.aspx, accessed 11 August 2016). Map production: amudhA Rathinam. Reprinted with permission from UNEP.

Map: Signatories and parties to the Basel Convention
Data source: Secretariat of the Basel Convention (2016). Basel Convention, Status of Ratifications. (http://www.basel.int/Countries/StatusofRatifications/PartiesSignatories/tabid/4499/Default.aspx, accessed 11 August 2016). Map production: amudhA Rathinam. Reprinted with permission from UNEP.

Contaminated food: Getting the right start in life

Fång J, Nyberg E, Winnberg U, Bignert A, Bergman Å (2015). Spatial and temporal trends of the Stockholm Convention POPs in mothers' milk – a global review. Environ Sci Pollut Res Int. 2015;22(12):8989–9041. doi: 10.1007/s11356-015-4080-z.

Government of Canada (2006). Polybrominated Diphenyl Ethers Regulations (SOR/2008-218) [website]. Government of Canada. http://laws-lois.justice.gc.ca/eng/regulations/SOR-2008-218/index.html (accessed 30 June 2016).

Grandjean P, Barouki R, Bellinger DC, Casteleyn L, Chadwick LH, Cordier S et al (2015). Life-long implications of developmental exposure to environmental stressors. Endocrinology. 2015;156(10):3408–3415. doi: 10.1210/EN.2015-1350.

IARC (2015). Wild CP, Miller JD, Groopman JD, editors. Mycotoxin control in low- and middle-income countries. Lyon: International Agency for Research on Cancer. www.iarc.fr/en/publications/pdfs-online/wrk/wrk9/IARC_publicationWGR9_full.pdf (accessed 25 July 2016).

INFOSAN (2008). Food safety and nutrition during pregnancy and infant feeding. INFOSAN Information note no. 3/2008. International Food Safety Authorities Network: World Health Organization, Food and Agriculture Organization. http://www.who.int/foodsafety/fs_management/No_03_nutrition_Apr08_en.pdf?ua=1 (accessed 2 June 2016).

NIOSH (2000). NIOSH hazard review: Carbonless copy paper. Atlanta: National Institute for Occupational Safety and Health. https://www.cdc.gov/niosh/docs/2001-107/pdfs/2001-107.pdf (accessed 28 July 2016).

Strosnider H, Azziz-Baumgartner E, Banziger M, Bhat RV, Breiman R, Brune MN et al (2006). Workgroup report: Public health strategies for reducing aflatoxin exposure in developing countries. Environ Health Perspect. 2006;114(12):1898–1903. doi: 10.1289/ehp.9302.

UNEP, WHO (2013a). Bergman A, Heindel JJ, Jobling S, Zoeller RT, editors. State of the science of endocrine disrupting chemicals – 2012. Geneva: United Nations Environment Programme, World Health Organization. http://www.who.int/ceh/publications/endocrine/en/ (accessed 2 June 2016).

US CDC (2013). Biomonitoring summary: Non-dioxin-like polychlorinated biphenyls [website]. United States. Centers for Disease Control and Prevention. https://www.cdc.gov/biomonitoring/NDL-PCBs_BiomonitoringSummary.html (accessed 30 June 2016).

WHO (2010a). Children's exposure to mercury compounds. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/44445/1/9789241500456_eng.pdf (accessed 2 June 2016).

WHO (2010b). Persistent organic pollutants: Impact on child health. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/44525/1/9789241501101_eng.pdf (accessed 2 June 2016).

WHO (2015). Pesticide residues in food: Guidance document for WHO monographers and reviewers. Geneva: World Health Organization. http://www.who.int/foodsafety/areas_work/chemical-risks/jmpr_Guidance_Document_FINAL.pdf (accessed 2 June 2016).

WHO (2016). Infant and young child feeding [website]. Fact sheet no. 342. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs342/en/ (accessed 17 August 2016).

Map: Breast milk concentration of SUM 7 BDEs, 2014 or latest available data
Data source: UNEP, WHO (2015). The Global Monitoring Plan for POPs under the Stockholm Convention Data Warehouse (UNEP/WHO Human Milk Survey). Geneva: United Nations Environment Programme, World Health Organization (http://www.pops-gmp.org/, accessed 09 July 2015). Map production: amudhA Rathinam. Copyright: WHO.

Map: Total non-dioxin-like PCBs in human milk, 2000-2012
Data source: WHO EURO (2015). Human biomonitoring: facts and figures. Copenhagen: World Health Organization Regional Office for Europe (http://www.euro.who.int/__data/assets/pdf_file/0020/276311/Human-biomonitoring-facts-figures-en.pdf). Map production: Pierpaolo Mudu. Copyright: WHO.

Lead-free lives: Allowing children to thrive

Attina TM, Trasande L (2013). Economic costs of childhood lead exposure in low- and middle-income countries. Environ Health Perspect. 2013;121(9):1097–1102. doi: 10.1289/ehp.1206424.

Clune AL, Falk H, Riederer AM (2011). Mapping global environmental lead poisoning in children. J Health and Pollution. 2011;(2):14–23.

Ettinger AS, Hu H, Hernández-Avila M (2007). Dietary calcium supplementation to lower blood lead levels in pregnancy and lactation. J Nutr Biochem. 2007;18(3):172–8. doi: 10.1016/j.jnutbio.2006.12.007.

Ettinger AS, Roy A, Amarasiriwardena CJ, Smith D, Lupoli N, Mercado-García A et al (2014). Maternal blood, plasma, and breast milk lead: Lactational transfer and contribution to infant exposure. Environ Health Perspect. 2014;122(1):87–92. doi: 10.1289/ehp.1307187.

Hanna-Attisha M, LaChance J, Sadler RC, Champney Schnepp A (2016). Elevated blood lead levels in children associated with the Flint drinking water crisis: A spatial analysis of risk and public health response. Am J Public Health. 2016;106(2):283-290. doi: 10.2105/AJPH.2015.303003.

IHME (2016). GBD Compare Data Visualization. Seattle (WA): Institute for Health Metrics and Evaluation, University of Washington. http://vizhub.healthdata.org/gbd-compare (accessed 19 October 2016)

Ji A, Wang F, Luo W, Yang R, Chen J, Cai T (2011). Lead poisoning in China: A nightmare from industrialisation. Lancet. 2011;377:1474–5. doi: http://dx.doi.org/10.1016/S0140-6736(10)60623-X.

Miranda ML, Anthopolos R, Hastings D (2011). A geospatial analysis of the effects of aviation gasoline on childhood blood lead levels. Environ Health Perspect. 2011;119(10):1513–1516. doi: 10.1289/ehp.1003231.

MSF (2012). Lead poisoning crisis in Zamfara State northern Nigeria. MSF briefing paper. Amsterdam: Médecins Sans Frontières. http://www.msf.org/sites/msf.org/files/old-cms/fms/article-documents/MSF-Nigeria-Lead.pdf (accessed 12 January 2016).

NTP (2012). Monograph on health effects of low-level lead. Research Triangle Park NC: National Toxicology Program. http://ntp.niehs.nih.gov/pubhealth/hat/noms/lead/index.html (accessed 29 October 2015).

Rossi E (2008). Low level environmental lead exposure – a continuing challenge. Clin Biochem Rev. 2008;29(2):63–70.

SAICM (2009) Resolution III/4/B. In: Report of the second session of the International Conference on Chemicals Management, Geneva, 11–15 May 2009. Nairobi: United Nations Environment Programme. http://www.saicm.org/images/saicm_documents/iccm/ICCM2/ICCM2%20Report/ICCM2%2015%20FINAL%20REPORT%20E.pdf (accessed 27 July 2016).

Trasande L, Liu Y (2011). Reducing the staggering costs of environmental disease in children, estimated at $76.6 billion in 2008. Health Aff (Millwood). 2011;30(5):863–870. doi: 10.1377/hlthaff.2010.1239.

UNEP (2012). Global Alliance to Eliminate Lead Paint: Business plan. Geneva: United Nations Environment Programme. http://www.unep.org/chemicalsandwaste/Portals/9/Lead_Cadmium/docs/GAELP/GAELP%20Documents/GAELP_businessPlan-FULL-131017_web.pdf (accessed 26 July 2016).

UNEP (2013). Lead in enamel decorative paints. National paint testing results: A nine country study. Geneva: United Nations Environment Programme. http://www.unep.org/chemicalsandwaste/Portals/9/Mercury/Documents/publications/Lead_in_Enamel_decorative_paints.pdf (accessed 29 October 2015).

UNEP (2015a). UNEP 15 annual report. Nairobi: United Nations Environment Programme. http://www.unep.org/annualreport/2015/en/in-focus-chemicals-and-waste.html (accessed 25 July 2016).

UNEP (2015b). Status of fuel quality and vehicle emission standards: Sub-Saharan Africa. Nairobi: United Nations Environment Programme. http://www.unep.org/Transport/new/PCFV/pdf/Maps_Matrices/Africa/matrix/SSAFuels_Veh_matrix_June2015.pdf (accessed 30 June 2016).

UNEP (2016). Leaded petrol phase-out: Global status as at June 2016 [website]. Nairobi: United Nations Environment Programme. http://www.unep.org/Transport/new/PCFV/pdf/Maps_Matrices/world/lead/MapWorldLead_June2016.pdf (accessed 8 July 2016).

US CDC (2006). Death of a child after ingestion of a metallic charm – Minnesota, 2006. MMWR. 2006;55(12):340–341. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5512a4.htm (accessed 6 June 2016).

US EPA (2010). Advance notice of proposed rulemaking on lead emissions from piston-engine aircraft using leaded aviation gasoline; proposed rule. US Environmental Protection Agency. Federal Register. 2010;75(81):22439–22468. https://www.gpo.gov/fdsys/pkg/FR-2010-04-28/pdf/2010-9603.pdf (accessed 5 January 2016).

US EPA (2013). America's children and the environment, third edition. Washington (DC): United States Environmental Protection Agency. https://www.epa.gov/sites/production/files/2015-06/documents/ace3_2013.pdf (accessed 7 June 2016).

U.S. News and World Report (2016). Flint: The big cost of small government. http://www.usnews.com/opinion/economic-intelligence/articles/2016-01-28/lead-in-flint-michigans-water-shows-the-cost-of-undermining-regulations (accessed 30 June 2016).

The White House (2016). Fact sheet: Federal support for the Flint water crisis response and recovery. https://www.whitehouse.gov/the-press-office/2016/05/03/fact-sheet-federal-support-flint-water-crisis-response-and-recovery (accessed 30 June 2016).

WHO (2010a). Childhood lead poisoning. Geneva: World Health Organization. http://www.who.int/ceh/publications/childhoodpoisoning/en/ (accessed 29 October 2015).

WHO (2010b). Exposure to lead: A major public health concern. Geneva: World Health Organization. http://www.who.int/ipcs/features/lead..pdf?ua=1 (accessed 29 October 2015).

WHO (2016). Countries with legally-binding controls on lead paint; status at 30 June 2016; full country database. In: Global Health Observatory. Geneva: World Health Organization. http://apps.who.int/gho/data/view.main.LEADCONTROLFULLv?lang=en (accessed 26 July 2016).

WHO AFRO (2015). Lead exposure in African children: Contemporary sources and concerns. Brazzaville: World Health Organization, Regional Office for Africa. http://apps.who.int/iris/bitstream/10665/200168/1/9780869707876.pdf (accessed 5 June 2016).

Map: Leaded petrol phase-out, status at June 2016
Map source: UNEP (2016). Leaded petrol phase-out: global status as at June 2016 [website]. Nairobi: United Nations Environment Programme (http://www.unep.org/Transport/new/PCFV/pdf/Maps_Matrices/world/lead/MapWorldLead_June2016.pdf, accessed 8 July 2016). Map production: amudhA Rathinam. Reprinted with permission from UNEP.

Map: Countries with legally binding controls on lead paint, as of 30 June 2016
Data source: Survey of national focal points for the Strategic Approach to International Chemicals Management (SAICM) carried out between July 2014 to March 2016 by the World Health Organization and the United Nations Environment Programme on behalf of the Global Alliance to Eliminate Lead Paint. Map production: amudhA Rathinam. Copyright: WHO.

Mercury: Protecting children's brains

Bose-O'Reilly S, McCarty KM, Steckling N, Lettmeier B (2010). Mercury exposure and children's health. Curr Probl Pediatr Adolesc Health Care. 40(8):186–215. doi: 10.1016/j.cppeds.2010.07.002.

Boyd AS, Seger D, Vannucci S, Langley M, Abraham JL, King LE (2000). Mercury exposure and cutaneous disease. J American Academy of Dermatology. 43(1):81–90. doi: 10.1067/mjd.2000.106360.

Food Standards Australia New Zealand (2011). Mercury in fish: advice on fish consumption [website]. Food Standards Australia New Zealand. http://www.foodstandards.gov.au/consumer/chemicals/mercury/Pages/default.aspx (accessed 6 June 2016).

Gibb H, O'Leary G (2014). Mercury exposure and health impacts among individuals in the artisanal and small-scale gold mining community: A comprehensive review. Environ Health Perspect. 122(7): 667–672. doi: 10.1289/ehp.1307864

Grandjean P (2013). Only one chance: how environmental pollution impairs brain development and how to protect the brains of the next generation. Environmental Ethics and Science Policy Series. New York: Oxford University Press.

ILO (2005). The burden of gold: child labour in small-scale mines and quarries. In: World of work. 54: 16–20. Geneva: International Labour Organization. http://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/dwcms_080601.pdf (accessed 18 July 2016).

Nesheim MC, Yaktine AL, editors (2007). Seafood choices: balancing benefits and risks. Washington (DC): National Academies Press.

NIOSH (2010). NIOSH Backgrounder: Alice's Mad Hatter and work-related illness [website]. The National Institute for Occupational Safety and Health. http://www.cdc.gov/niosh/updates/upd-03-04-10.html (accessed 28 January 2016).

Sheehan MC, Burke TA, Navas-Acien A, Breysse PN, McGready J, Fox MA (2014). Global methylmercury exposure from seafood consumption and risk of developmental neurotoxicity: a systematic review. Bull World Health Organ. 2014;92(4):254–69. doi: 10.2471/BLT.12.116152.

Telmer KH, Veiga MM (2009). World emissions of mercury from artisanal and small scale gold mining. In: Pirrone M, Mason R, editors. Mercury fate and transport in the global atmosphere. New York (NY): Springer. http://www.unep.org/chemicalsandwaste/Portals/9/Mercury/Documents/Full_Report.pdf (accessed 18 July 2016).

Thorsen D (2012). Children working in mines and quarries: evidence from West and Central Africa. Briefing Paper 4. Dakar-Yoff, Senegal: UNICEF West and Central Africa Regional Office. http://www.unicef.org/wcaro/english/Briefing_paper_No_4_-_children_working_in_mines_and_quarries.pdf (accessed 18 July 2016).

UNEP (2012). A practical guide: reducing mercury use in artisanal and small-scale gold mining. Geneva: United Nations Environment Programme. http://www.unep.org/chemicalsandwaste/Portals/9/Mercury/Documents/ASGM/Techdoc/UNEP%20Tech%20Doc%20APRIL%20 2012_120619%20with%20links_web.pdf (accessed 21 June 2016).

UNEP (2013a). Minamata Convention on Mercury. United Nations Environment Programme. http://www.mercuryconvention.org/Convention (accessed 6 June 2016).

UNEP (2013b). Global mercury assessment 2013: sources, emissions, releases and environmental transport. Geneva: United Nations Environment Programme. http://www.unep.org/PDF/PressReleases/GlobalMercuryAssessment2013.pdf (accessed 18 July 2016).

UNEP, WHO (2008). Guidance for identifying populations at risk from mercury exposure. Geneva: United Nations Environment Programme, World Health Organization. http://www.who.int/foodsafety/publications/chem/mercuryexposure.pdf?ua=1 (accessed 4 August 2016).

UNIDO (2007). Global mercury project: global impacts of mercury supply and demand in small-scale gold mining. Report to the United Nations Environment Programme Governing Council, Nairobi, Kenya, 2007. Vienna: United Nations Industrial Development Organization. http://iwlearn.net/iw-projects/1223/reports/global-impacts-of-mercury-supply-and-demand-in-small-scale-gold-mining (accessed 6 June 2016).

US EPA (2016). Mercury in your environment [website]. US Environmental Protection Agency. https://www.epa.gov/mercury (18 July 2016).

US EPA, FDA (2014). EPA-FDA advisory on mercury in fish and shellfish. United States Environmental Protection Agency, United States Food and Drug Administration. http://www.epa.gov/fish-tech/epa-fda-advisory-mercury-fish-and-shellfish (accessed 15 February 2016).

Waldrom HA (1983). Did the Mad Hatter have mercury poisoning? Br Med J (Clin Res Ed). 287(6409):1961.

WHO (2010). Children's exposure to mercury compounds. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/44445/1/9789241500456_eng.pdf (accessed 6 June 2016).

WHO (2011). Mercury in skin-lightening products. Geneva: World Health Organization. http://www.who.int/ipcs/assessment/public_health/mercury_flyer.pdf?ua=1 (accessed 6 June 2016).

WHO (2014). World Health Assembly. Resolution WHA67.11: Agenda item 14.5. Sixty-seventh World Health Assembly, 24 May 2014. Public health impacts of exposure to mercury and mercury compounds: the role of WHO and ministries of public health in the implementation of the Minamata Convention. Geneva: World Health Organization. http://apps.who.int/gb/ebwha/pdf_files/WHA67-REC1/A67_2014_REC1-en.pdf#page=1 (accessed 10 August 2016).

WHO (2016). Mercury and health [website]. Fact sheet no. 361. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs361/en/ (accessed 6 June 2016).

Map: Population at risk from mercury contamination
Map source: UNEP (2013). Mercury: time to act. Geneva: United Nations Environment Program. Geneva: United Nations Environment Programme (http://www.unep.org/PDF/PressReleases/Mercury_TimeToAct_hires.pdf). Data source: Adapted from Blacksmith Institute (2012). Arctic Monitoring and Assessment Programme (AMAP) (www.amap.no). Map production: Zoï Environment Network, GRID-Arendal. Reprinted with permission from UNEP.

Map: Signatories and Parties to the Minamata Convention on Mercury, as of 31 August 2016
Data source: Interim Secretariat of the Minamata Convention on Mercury (2016). Countries: List of signatories and future parties [website]. Geneva: United Nations Environment Programme (http://www.mercuryconvention.org/Countries/tabid/3428/Default.aspx, accessed 31 August 2016). Map production: amudhA Rathinam. Reprinted with permission from UNEP.

Poisons: Keep out of reach

AAPCC (2014). New e-cigarette poisoning data reinforce need for immediate government action to protect children. Washington (DC): American Association of Poison Control Centers http://www.aapcc.org/press/36/ (accessed 9 June 2016).

Balme, K, Roberts JC, Glasstone M, Curling L, Mann MD (2012). The changing trends of childhood poisoning at a tertiary children's hospital in South Africa. S Afr Med J. 2012;102(3 Pt 1):142–146.

Beckley JT, Woodward JJ (2013). Volatile solvents as drugs of abuse: Focus on the cortico-mesolimbic circuitry. Neuropsychopharmacology. 2013;38:2555–2567. doi: 10.1038/npp.2013.206.

Brockstedt M, Gregorszewsky D, Dilger I (2004). Substituting metasilicates in machine dishwashing agents prevents childhood corrosive injuries. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz. 2004;47(1):2–6.

Contini S, Swarray-Deen A, Scarpignato C (2009). Oesophageal corrosive injuries in children: A forgotten social and health challenge in developing countries. Bull World Health Organ. 2009;87:950–954. doi: 10.2471/BLT.08.058065.

Davanzo F, Settimi L, Milanesi G, Giordan F, Sesana FM, Celentano A et al (2015). Surveillance of hazardous exposures to liquid laundry detergent capsules in Italy: A preliminary evaluation of the impact of preventive measures (Abstract). In: XXXV International Congress of the European Association of Poisons Centres and Clinical Toxicologists (EAPCCT) St Julian's, Malta. Clin Toxicol (Phila). 2015;53(4):233–403. doi: 10.3109/15563650.2015.1024953.

Hu H, Shine J, Wright RO (2007). The challenge posed to children's health by mixtures of toxic waste: The Tar Creek Superfund Site as a case-study. Pediatric Clinics of North America. 2007;54(1):155–175. doi: 10.1016/j.pcl.2006.11.009.

Human Rights Watch (2012). Toxic tanneries: the health repercussions of Bangladesh's Hazaribagh leather. Human Rights Watch. https://www.hrw.org/report/2012/10/08/toxic-tanneries/health-repercussions-bangladeshs-hazaribagh-leather (accessed 12 January 2016).

Matzopoulus R, Carolissen G (2006). Estimating the incidence of paraffin ingestion. African safety promotion: A Journal of Injury and Violence Prevention. 2006;3:4–14.

Mohapatra B, Warrell DA, Suraweera W, Bhatia P, Dhingra N, Jotkar RM et al (2011). Snakebite mortality in India: A nationally representative mortality survey. PLoS Negl Trop Dis. 2011;5(4):e1018. doi: 10.1371/journal.pntd.0001018.

Mowry JB, Spyker DA, Brooks DE, McMillan N, Schauben JL (2015). 2014 Annual report of the American Association of Poison Control Centers' National Poison Data System (NPDS): 32nd annual report. Clin Toxicol (Phila). 2015;53(10):962–1147. doi: 10.3109/15563650.2015.1102927.

OECD (2015). Laundry detergent capsules and packets [website]. Paris: Organisation for Economic Co-operation and Development. http://www.oecd.org/sti/consumer/Laundry-Detergent-Awareness.htm (28 June 2016).

Rodgers GB (1996). The safety effects of child-resistant packaging for oral prescription drugs. Two decades of experience. JAMA. 1996;275(21):1661–5.

Rodgers GB (2002). The effectiveness of child-resistant packaging for aspirin. Arch of Pediatr and Adolesc Med. 2002;156(9):929–33. doi: 10.1001/archpedi.156.9.929.

Schwebel DC, Swart D, Azor Hui SK, Simpson J, Hobe P (2009). Paraffin-related injury in low-income South African communities: knowledge, practice and perceived risk. Bull World Health Organ. 2009;87(9):700–706. doi: 10.2471/BLT.08.057505.

Sleet DA, Schieber RA, Gilchrist J (2003). Health promotion policy and politics: Lessons from childhood injury prevention. Health Promot Pract. 2003;4(2):103–8.

UNECE (2016). About the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) [website]. Geneva: United Nations Economic Commission for Europe (UNECE). http://www.unece.org/trans/danger/publi/ghs/ghs_welcome_e.html (accessed 10 June 2016).

WHO (2016a). Toxicovigilance. International Programme on Chemical Safety [website]. Geneva: World Health Organization. http://www.who.int/ipcs/poisons/centre/toxicovigilance/en/ (accessed 10 June 2016).

WHO (2016b). World health statistics 2016: Monitoring health for the SDGs. Geneva: World Health Organization. http://www.who.int/gho/publications/world_health_statistics/2016/en/ (23 June 2016).

WHO, UNICEF (2008). Peden M, Oyegbite K, Joan Ozanne-Smith J et al, editors (2008). World report on child injury prevention. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/43851/1/9789241563574_eng.pdf (accessed 28 June 2016).

Zakharov S, Navratil T, Pelclova D (2013). Suicide attempts by deliberate self-poisoning in children and adolescents. Psychiatry Res. 2013;210(1):302–307. doi: 10.1016/j.psychres.2013.03.037.

Map: Population served by each poison centre, 2016
Data source: WHO (2016). World Directory of Poison Centres [website]. Geneva: World Health Organization (http://apps.who.int/poisoncentres/, accessed 29 February 2016).
Additional calculations were made to determine population served by each poison centre. Map production: amudhA Rathinam. Copyright: WHO.

Graph: Mortality rate from unintentional poisonings per 100,000 children ages 0-14 years, 2012
Data source: WHO (2014). Global health estimates 2014 summary tables: deaths by cause, age and sex, by WHO region, 2000-2012. Geneva: World Health Organization (http://www.who.int/healthinfo/global_burden_disease/estimates/en/index1.html, accessed 22 July 2016). Copyright: WHO.

E-waste: Promoting responsible recycling

Akormedi M, Asampong E, Fobil JN (2013). Working conditions and environmental exposures among electronic waste workers in Ghana. Int J Occup Environ Health. 2013;19(4):278–86. doi: 10.1179/2049396713Y.0000000034.

Amoyaw-Osei Y, Agyekum OO, Pwamang JA, Mueller E, Fasko R, Schluep M (2011). Ghana ewaste country assessment: SBC ewaste Africa Project. Geneva: Secretariat of the Basel Convention. http://www.basel.int/Portals/4/Basel%20Convention/docs/eWaste/E-wasteAssessmentGhana.pdf (accessed 8 June 2016).

Asampong E, Dwuma-Badu K, Stephens J, Srigboh R, Neitzel R, Basu N, Fobil JN. Health seeking behaviours among electronic waste workers in Ghana. BMC Public Health. 2015;15:1065. doi: 10.1186/s12889-015-2376-z.

Chen A, Dietrich KN, Huo X, Ho SM (2011). Developmental neurotoxicants in ewaste: An emerging health concern. Environ Health Perspect. 2011;119:431–438. doi: 10.1289/ehp.1002452.

Geeraerts K, Illes A, Schweizer J-P (2015). Illegal shipment of ewaste from the EU: A case study on illegal ewaste export from the EU to China. A study compiled as part of the EFFACE project. London: Institute for European Environmental Policy (IEEP). http://efface.eu/sites/default/files/EFFACE_Illegal%20shipment%20of%20e%20waste%20from%20the%20EU.pdf (accessed 18 July 2016).

Grant K, Goldizen FC, Sly PD, Brune MN, Neira M, van den Berg M et al (2013). Health consequences of exposure to ewaste: A systematic review. Lancet Glob Health. 2013;1(6): e350–e36. doi: 10.1016/S2214-109X(13)70101-3.

ITU, Basel Convention, CRBAS, UNESCO, UNIDO, WHO et al (2015). Sustainable management of waste electrical and electronic equipment in Latin America. Geneva: International Telecommunications Union. http://www.who.int/ceh/publications/ewaste_latinamerica/en/ (accessed 8 June 2016).

Lundgren K (2012). The global impact of ewaste: addressing the challenge. Geneva: International Labour Organization. http://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/publication/wcms_196105.pdf (accessed 5 July 2016).

Kaul, B, Mukerjee, H (1999). Elevated blood lead and erythrocyte protoporphyrin levels of children near a battery-recycling plant in Haina, Dominican Republic. Int J Occup Environ Health. 1999;5(4):307–312. doi: 10.1179/oeh.1999.5.4.307.

Kaul B, Sandhu RS, Depratt C, Reyes F (1999). Follow-up screening of lead-poisoned children near an auto battery recycling plant, Haina, Dominican Republic. Environ Health Perspect. 1999;107(11):917–920.

Nukpezah D, Okine HA, Oteng-Ababio M, Ofori BD (2014). Electronic waste risk assessment and management in Ghana. Proceedings of the 28th EnviroInfo 2014 Conference, Oldenburg, Germany. http://enviroinfo.eu/sites/default/files/pdfs/vol8514/0205.pdf (accessed 8 June 2016).

Ogungbuyi O, Nnorom IC, Osibanjo O, Schluep M (2012). Ewaste country assessment Nigeria: Ewaste Africa Project. Geneva: Secretariat of the Basel Convention. http://www.basel.int/Portals/4/Basel%20Convention/docs/eWaste/EwasteAfrica_Nigeria-Assessment.pdf (accessed 8 June 2016).

PACE (2013a). Guideline on environmentally sound testing, refurbishment and repair of used computing equipment. Geneva: Partnership for Action of Computing Equipment. http://www.basel.int/Implementation/TechnicalAssistance/Partnerships/PACE/PACEGuidelinesandGlossaryofTerms/tabid/3247/Default.aspx (accessed 8 June 2016).

PACE (2013b). Guideline on environmentally sound material recovery and recycling of end-of-life computing equipment. Geneva: Partnership for Action of Computing Equipment. http://www.basel.int/Implementation/TechnicalAssistance/Partnerships/PACE/PACEGuidelinesandGlossaryofTerms/tabid/3247/Default.aspx (accessed 8 June 2016).

Pascale A, Sosa A, Bares C, Battocletti A, Moll MJ, Pose D et al (2016). E-waste informal recycling: An emerging source of lead exposure in South America. Ann Glob Health. 2016;82(1):197–201. doi: 10.1016/j.aogh.2016.01.016.

Pradhan JK, Kumar S (2014). Informal ewaste recycling: Environmental risk assessment of heavy metal contamination in Mandoli industrial area. Environ Sci Pollut Res Int. 2014;21(13):7913–28. doi: 10.1007/s11356-014-2713-2.

Pure Earth/Blacksmith Institute (2015). Project completion report: Making electronic waste recycling in Ghana safer through alternative technology. Accra: Pure Earth-Blacksmith Institute. http://www.pureearth.org/wp-content/uploads/2014/01/Ghana-Pilot-PCR-2015.pdf (accessed 8 June 2016).

Rucevska I, Nellemann C, Isarin N, Yang W, Liu N, Yu K et al (2015). Waste crime – waste risks: Gaps in meeting the global waste challenge. A UNEP Rapid Response Assessment. Nairobi and Arendal: United Nations Environment Programme and GRID-Arendal. http://www.unep.org/delc/Portals/119/publications/rra-wastecrime.pdf (accessed 18 July 2016).

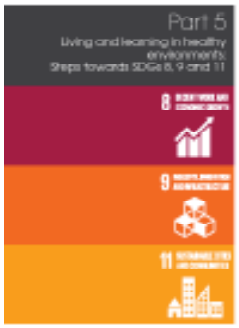
UNU (2014). The global ewaste monitor 2014: Quantities, flows and resources. Bonn: United Nations University. http://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf (accessed 8 June 2016).

Wang F, Huisman J, Meskers CEM, Schluep M, Stevels A, Hagelüken C (2012). The Best-of-2-Worlds philosophy: Developing local dismantling and global infrastructure network for sustainable ewaste treatment in emerging economies. Waste Manag. 2012;32(11):2134–2146. doi: 10.1016/j.wasman.2012.03.029.

Wang F, Kuehr R, Ahlquist D, Li J. Ewaste in China: A country report (2013). Bonn: United Nations University, Solving the Ewaste Problem (StEP) Initiative. http://ewasteguide.info/files/Wang_2013_StEP.pdf (accessed 8 June 2016).

WHO (2010). Childhood lead poisoning. Geneva: World Health Organization. http://www.who.int/ceh/publications/leadguidance.pdf (accessed 8 June 2016).

Map: Quantity of e-waste produced per inhabitant (kg), 2014
Data source: UNU (2014). The global e-waste monitor – 2014: Quantities, flows and resources. Bonn: United Nations University, (http://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf). Map production: amudhA Rathinam. Reprinted with permission from United Nations University (UNU).



5. Living and learning in healthy environments: Steps towards SDGs 8, 9 and 11

Health-care facilities: Investing in maternal and child survival

Adair-Rohani H, Zukor K, Bonjour S, Wilburn S, Kuesel AC, Hebert R et al (2013). Limited electricity access in health facilities of sub-Saharan Africa: A systematic review of data on electricity access, sources, and reliability. Global Health: Science and Practice. 2013;1(2):249–261. doi: 10.9745/GHSP-D-13-00037.

Allegranzi B, Bagheri Nejad S, Combecure C, Graafmans W, Attar H, Donaldson L et al (2011). Burden of endemic health-care-associated infection in developing countries: Systematic review and meta-analysis. Lancet. 2011;15;377(9761):228–41. doi: 10.1016/S0140-6736(10)61458-4.

Bhutta ZA, Das JK, Bahl R (2014). Can available interventions end preventable deaths in mothers, newborn babies, and stillbirths, and at what cost? Lancet. 2014;384(9940):347–370. doi: (http://dx.doi.org/10.1016/S0140-6736(14)60792-3).

IAEA, WHO (2014). Bonn Call for Action – 10 Actions to improve radiation protection in medicine in the next decade. Bonn: International Atomic Energy Agency, World Health Organization. http://www.who.int/ionizing_radiation/medical_radiation_exposure/BonnCallforAction2014.pdf?ua=1 (accessed 25 August 2016).

Oza S, Lawn JE, Hogan DR, Mathers C, Cousens SN (2015). Neonatal cause-of-death estimates for the early and late neonatal periods for 194 countries: 2000–2013. Bull World Health Organ. 2015;93:19–28. doi: http://dx.doi.org/10.2471/BLT.14.139790.

UNF, WHO, UN Women (2015). Energy for women's and children's health: A high-impact opportunity of the Sustainable Energy for All Initiative Five-year Strategic Plan (2014–2019). Unpublished report. Washington (DC): United Nations Foundation.

WHO (2016). Communicating radiation risk in paediatric imaging. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/205033/1/9789241510349_eng.pdf?ua=1 (accessed 25 August 2016).

WHO, World Bank (2014). Access to modern energy services for health facilities in resource-constrained settings: A review of status, significance, challenges and measurement. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/156847/1/9789241507646_eng.pdf (accessed 26 May 2016).

WHO, UNICEF (2015a). Progress on sanitation and drinking water: 2015 update and MDG assessment. Geneva: World Health Organization. http://files.unicef.org/publications/files/Progress_on_Sanitation_and_Drinking_Water_2015_Update_.pdf (accessed 21 June 2016).

WHO, UNICEF (2015b). Water, sanitation and hygiene in health care facilities: Status in low- and middle-income countries and way forward. Geneva: World Health Organization and United Nations Children's Fund. http://apps.who.int/iris/bitstream/10665/154588/1/9789241508476_eng.pdf?ua=1 (accessed 26 May 2016).

Map: Percentage of health-care facilities in Africa with water access, 2014 or latest available data
Data source: WHO, UNICEF (2015). Water, sanitation and hygiene in health care facilities: Status in low- and middle-income countries and way forward. Geneva: World Health Organization (http://apps.who.int/iris/bitstream/10665/154588/1/9789241508476_eng.pdf). Map production: amudhA Rathinam. Copyright: WHO.

Map: Percentage of health-care facilities in Africa with electricity, 2011 or latest available data
Data source: Adair-Rohan, Zukor K, Bonjour S, Wilburn S, Kuesel AC, Hebert R et al (2013). Limited electricity access in health facilities of sub-Saharan Africa: a systematic review of data on electricity access, sources, and reliability. Global Health: Science and Practice. 1(2):249–261. Map production: amudhA Rathinam.

Graph: Proportion of health-care facilities without basic water, sanitation and hygiene facilities
Data source: UNICEF, WHO (2015). Progress on sanitation and drinking water – 2015 update and MDG Assessment. New York: United Nations Children's Fund and World Health Organization (http://files.unicef.org/publications/files/Progress_on_Sanitation_and_Drinking_Water_2015_Update_.pdf). Copyright: WHO.

Urban spaces: Building well-being

Amnesty International (2010). Insecurity and indignity: Women's experiences in the slums of Nairobi, Kenya. London: Amnesty International. https://www.amnesty.org/en/documents/AFR32/002/2010/en/ (accessed 10 June 2016).

APHRC (2014). Population and health dynamics in Nairobi's informal settlements: Report of the Nairobi cross-sectional slums survey (NCSS) 2012. Nairobi: African Population and Health Research Center. http://aphrc.org/wp-content/uploads/2014/08/NCSS2-FINAL-Report.pdf (accessed 4 May 2016).

Baird A (2012). Negotiating pathways to manhood: Rejecting gangs and violence in Medellín's periphery. Journal of Conflictology. 2012;3(1):30–41.

Butala NM, VanRooyen MJ, Patel RB (2010). Improved health outcomes in urban slums through infrastructure upgrading. Soc Sci Med. 2010;71(5):935–40. doi: 10.1016/j.socscimed.2010.05.037.

Cerdá M, Morenoff JD, Hansen BB, Tessari Hicks KJ, Duque LF, Restrepo A et al (2011). Reducing violence by transforming neighborhoods: A natural experiment in Medellín, Colombia. Am J Epidemiol. 2012;175(10):1045–53. doi: 10.1093/aje/kwr428.

CMLCP (1993). Measuring lead exposure in infants, children and other sensitive populations. Committee on Measuring Lead in Critical Populations. Washington (DC): National Academy Press.

Karner AA, Eisinger DS, Niemeier DA (2010). Near roadway air quality: Synthesizing the findings from real world data. Environ Sci Technol. 2010;44(14):5334–5344. doi: 10.1021/es100008x.

McGranahan G, Murray F, editors (2003). Air pollution and health in rapidly developing countries. Stockholm: Stockholm Environment Institute.

Ndugwa RP, Zulu EM (2008). Child morbidity and care-seeking in Nairobi slum settlements: The role of environmental and socio-economic factors. J Child Health Care. 2008;12(4):314–28. doi: 10.1177/1367493508096206.

NYC DHS (2016). Daily DHS shelter census. New York: NYC Department of Homeless Services. http://www1.nyc.gov/site/dhs/index.page (accessed 28 July 2016).

PPIC (2016). Just the facts: Child poverty in California [website]. Public Policy Institute of California. http://www.ppic.org/main/publication_show.asp?i=721 (accessed 15 June 2016).

Routher G (2016). State of the homeless 2016: Beyond the rhetoric: What will turn the tide? New York: Coalition for the Homeless. http://www.coalitionforthehomeless.org/wp-content/uploads/2016/04/SOTH-2016.pdf (accessed 20 July 2016).

Ruel MT, Garrett JL, Hawkes C, Cohen MJ (2010). The food, fuel, and financial crises affect the urban and rural poor disproportionately: a review of the evidence. J Nutr. 2010;140(1):170S–176S. doi: 10.3945/jn.109.110791.

Save the Children (2015). State of the world's mothers 2015: The urban disadvantage. Fairfield (CT): Save the Children. http://www.savethechildren.org/atf/cf/%7B9def2ebe-10ae-432c-9bd0-df91d2eba74a%7D/SOWM_2015.PDF (accessed 4 May 2016).

Ståhl T, Wismar M, Ollila E, Lahtinen E, Leppo K, editors (2006). Health in all policies: Prospects and potentials. Finland: Finnish Ministry of Social Affairs and Health and the European Observatory on Health Systems and Policies. http://www.euro.who.int/__data/assets/pdf_file/0003/109146/E89260.pdf?ua=1 (accessed 4 May 2016).

Thieme T (2010). Youth, waste and work in Mathare: Whose business and whose politics? Environ Urban. 2010;22(2):333–352. doi: 10.1177/0956247810379946.

UN (2015). Millennium Development Goals Report 2015. New York: United Nations. http://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf (accessed 8 November 2016).

UN Habitat (2011). Building urban safety through slum upgrading. Nairobi: United Nations Human Settlements Programme. http://mirror.unhabitat.org/pmss/listItemDetails.aspx?publicationID=3222 (accessed 4 May 2016).

UN Population Division (2014). Urban and rural population by age and sex, 1980–2015. New York: United Nations Department of Economic and Social Affairs Population Division. http://www.un.org/en/development/desa/population/publications/dataset/urban/urbanAndRuralPopulationByAgeAndSex.shtml (accessed 19 July 2016).

UNICEF (2012b). The state of the world's children 2012: Children in an urban world. New York: United Nations. http://www.unicef.org/sowc2012 (accessed 4 May 2016).

Victora CG, Smith PG, Vaughan JP, Nobre LC, Lombardi C, Teixeira AM et al (1988). Water supply, sanitation and housing in relation to the risk of infant mortality from diarrhoea. Int J Epidemiol. 1988;17(3):651–4. doi: 10.1093/ije/17.3.651.

WHO (2015). Global Health Observatory (GHO) data: Urban health [online database]. Geneva: World Health Organization. http://who.int/gho/urban_health/en/ (accessed 4 May 2016).

WHO (2016a). Children: Reducing mortality [website]. Fact sheet no. 178. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs178/en/ (accessed 20 July 2016)

WHO (2016b). Violence against women [website]. Fact sheet no. 239. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs239/en/ (16 May 2016).

WHO (2016c). Urban health equity assessment and response tool (urban HEART) [website]. Kobe, Japan: World Health Organization Centre for Health Development. http://www.who.int/kobe_centre/measuring/urbanheart/en/ (accessed 4 May 2016).

WHO, UN Habitat (2010). Hidden cities: Unmasking and overcoming health inequities in urban settings. Geneva: World Health Organization, United Nations Human Settlements Programme. http://www.who.int/kobe_centre/publications/hidden_cities2010/en/ (accessed 4 May 2016).

Graph: Under-five mortality rate in urban areas, by region and urban wealth quintile, 2005-2013
Data source: WHO calculations based on data from DHS and MICS, 2005–2013.
WHO (2016). Under-five mortality. Global Health Observatory (GHO) data [website]. Geneva: World Health Organization (http://www.who.int/gho/urban_health/outcomes/under_five_mortality/en/, accessed 23 Dec 2016). Copyright: WHO.

Housing: Raising standards, improving child health

Chapman R, Howden-Chapman P, Viggers H, O'Dea D, Kennedy M (2009). Retrofitting houses with insulation: A cost-benefit analysis of a randomised community trial. J of Epidemiol Community Health. 2009;63(4):271–277. doi: 10.1136/jech.2007.070037.

Lighting a Billion Lives (2016). Young children with big dreams [website]. http://labl.teriin.org/young_children_with_big_dreams.php (accessed 16 June 2016).

Mielke HW, Zahran S (2012). The urban rise and fall of air lead (Pb) and the latent surge and retreat of societal violence. Environment International. 43:48–55. doi: 10.1016/j.envint.2012.03.005.

Nevin R (2007). Understanding international crime trends: The legacy of preschool lead exposure. Environmental Research. 104:315–336.

OECD (2011). How's life? Measuring well-being. OECD Publishing. http://dx.doi.org/10.1787/9789264121164-en (accessed 6 July 2016).

Office of the Deputy Prime Minister (2004). The impact of overcrowding on health and education: A review of the evidence and literature. London: Office of the Deputy Prime Minister. http://dera.ioe.ac.uk/5073/1/138631.pdf (accessed 30 November 2016).

Orton S, Jones LL, Cooper S, Lewis S, Coleman T (2014) Predictors of children's secondhand smoke exposure at home: A systematic review and narrative synthesis of the evidence. PLoS One. 9(11):e112690. doi: 10.1371/journal.pone.0112690.

Sphere Project (2011). Shelter and settlement. In: The sphere handbook, third edition. Rugby: Practical Action Publishing. http://www.spherehandbook.org/en/1-shelter-and-settlement/ (accessed 6 July 2016).

UN (1989). Convention on the Rights of the Child. New York: United Nations General Assembly. https://www.nesri.org/sites/default/files/Convention_on_the_Rights_of_the_Child.pdf (accessed 16 June 2016).

UN Habitat (2007). Enhancing urban safety and security: Global report on human settlements 2007 (part IV). New York: UN Habitat. http://unhabitat.org/wp-content/uploads/2008/07/GRHS.2007.4.pdf (accessed 6 July 2016).

UN Habitat (2016). Urbanization and development: Emerging futures. World cities report 2016. New York: UN Habitat http://wcr.unhabitat.org/wp-content/uploads/sites/16/2016/05/WCR-%20Full-Report-2016.pdf (accessed 1 July 2016).

WHO (2002). Krug EG, Dahlberg LL, Mercy JA, Zwi AB, Lozano R, editors. World report on violence and health. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/42495/1/9241545615_eng.pdf (accessed 30 November 2016).

WHO (2010). Childhood lead poisoning. Geneva: World Health Organization. http://www.who.int/ceh/publications/childhoodpoisoning/en/ (accessed 29 October 2015).

WHO (2011). Housing: Shared interests in health and development. Social determinants of health sectoral briefing series 1. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/44705/1/9789241502290_eng.pdf (accessed 16 June 2016).

WHO (2016). Household air pollution and health [website]. Fact sheet no. 292. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs292/en/ (accessed 16 June 2016).

Graph: Global urban population living in slums, 1990–2014
Data source: UN-Habitat, Global Urban Observatory, 2016. Reprinted with permission from UN-Habitat.

Healthy schools: Education for life

Adams J, Bartram J, Chartier Y, Sims J, editors (2009). Water, sanitation and hygiene standards for schools in low-cost settings. Geneva: World Health Organization. http://www.who.int/water_sanitation_health/publications/wash_standards_school.pdf (accessed 4 May 2016).

Pronczuk-Garbino J, editor (2005). Children's health and the environment: A global perspective. A resource manual for the health sector. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/43162/1/9241562927_eng.pdf (accessed 4 May 2016).

UNICEF, WHO (2015). Progress on sanitation and drinking water – 2015 update and MDG assessment. Geneva: UNICEF and World Health Organization. http://www.wssinfo.org/fileadmin/user_upload/resources/JMP-Update-report-2015_English.pdf (accessed 4 May 2016).

WHO (2003). The physical school environment: An essential component of a health-promoting school. WHO Information series on school health; document 2. Geneva: World Health Organization. http://www.who.int/school_youth_health/media/en/physical_sch_environment.pdf?ua=1 (accessed 4 May 2016).

WHO (2011a). Health in the green economy report: Health co-benefits of climate change mitigation – housing sector. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/10665/44609/1/9789241501712_eng.pdf (accessed 4 May 2016).

WHO (2011b). Health in the green economy report: Health co-benefits of climate change mitigation – transport sector. Geneva: World Health Organization. http://www.who.int/hia/examples/trspt_comms/hge_transport_lowresdurban_30_11_2011.pdf (accessed 30 June 2016).

WHO (2015a). Global status report on road safety 2015. Geneva: World Health Organization. http://www.who.int/violence_injury_prevention/road_safety_status/2015/en/ (accessed 4 May 2016).

WHO (2015b). Deworming campaign improves child health, school attendance in Rwanda [website]. Features 2015. World Health Organization.

http://who.int/features/2015/rwanda-deworming-campaign/en/ (accessed 29 May 2016).

WHO (2015c). Haiti: safe food in rural schools [website]. Features 2015. World Health Organization. http://who.int/features/2015/haiti-food-safety/en/ (accessed 29 May 2016).

Graph: Proportion of schools with access to adequate drinking water and sanitation, 2013
Data source: UNICEF, WHO (2015). Progress on sanitation and drinking water: 2015 update and MDG assessment. Geneva: United Nations Children's Emergency Fund, World Health Organization (http://www.unicef.org/publications/files/Progress_on_Sanitation_and_Drinking_Water_2015_Update_.pdf). Copyright: WHO.

Child labour: A dangerous phenomenon

Chen A, Dietrich KN, Huo X, Ho SM (2011). Developmental neurotoxicants in ewaste: An emerging health concern. Environ Health Perspect. 2011;119(4):431–438. doi: 10.1289/ehp.1002452.

Ilahi N, Orazem PF, Sedlacek G (2005). How does working as a child affect wage, income and poverty as an adult? Washington (DC): World Bank. http://siteresources.worldbank.org/SOCIALPROTECTION/Resources/0514.pdf (accessed 5 July 2016).

ILO (2011). Hazardous work of children and regulation of hazardous chemicals. Geneva: International Labour Organization. http://www.ilo.org/wcmsp5/groups/public/---arabstates/---ro-beirut/documents/genericdocument/wcms_210582.pdf (accessed 25 July 2016).

ILO (2015a). World report on child labour 2015: Paving the way to decent work for young people. Geneva: International Labour Organization. http://www.ilo.org/ipec/Informationresources/WCMS_358969/lang--en/index.htm (accessed 17 June 2016).

ILO (2015b). What is child labour [website]. Geneva: International Labour Organization. http://www.ilo.org/ipec/facts/lang--en/index.htm (accessed 17 June 2016).

ILO (2015c). Ratifications of C182: Worst Forms of Child Labour Convention, 1999 (No. 182) [website]. Geneva: International Labour Organization. http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:11300:0::NO::P11300_INSTRUMENT_ID:312327 (accessed 17 June 2016).

ILO (2015d). Farming. Child labour in agriculture [website]. Geneva: International Labour Organization. http://www.ilo.org/ipec/areas/Agriculture/WCMS_172416/lang--en/index.htm (accessed 17 June 2016).

ILO, IPEC (2013). Marking progress against child labour – global estimates and trends 2000–2012. International Programme on the Elimination of Child Labour (IPEC). Geneva: International Labour Organization. http://www.ilo.org/ipec/Informationresources/WCMS_221513/lang--en/index.htm (accessed 17 June 2016).

MHRD (2016). Right to education [website]. Department of School Education & Literacy, Ministry of Human Resource Development, Government of India. http://mhrd.gov.in/rte (accessed 28 July 2016).

PM India (2015). Approval to move official amendments to the Child Labour (Prohibition & Regulation) Amendment Bill, 2012 [website]. Prime Minister's Office. http://www.pmindia.gov.in/en/news_updates/approval-to-move-official-amendments-to-the-child-labour-prohibition-regulation-amendment-bill-2012/ (accessed 28 July 2016).

Tennassee M (2005). In: Pronczuk-Garbino J, editor. Children's health and the environment: A global perspective. http://apps.who.int/iris/bitstream/10665/43162/1/9241562927_eng.pdf (accessed 18 July 2016).

UN (2015). Sustainable Development Goals [website]. New York: United Nations. http://www.un.org/sustainabledevelopment/sustainable-development-goals (accessed 8 July 2016).

UNICEF (2006). Starting over: Children return home from camel racing. Riyadh: United Nations Children's Fund Gulf Area Office. http://www.unicef.org/infobycountry/files/StartingOver.pdf (accessed 5 July 2016).

WHO (2004). Hazardous child labour [website]. World Health Organization. http://www.who.int/occupational_health/topics/childlabour/en/ (accessed 5 July 2016).

WHO (2006). Gender equality, work and health: A review of the evidence. Geneva: World Health Organization. http://www.who.int/gender/documents/Genderworkhealth.pdf (accessed 17 June 2016).

Map: Countries that have ratified the Worst Forms of Child Labour Convention (C182)
Data source: ILO (2016). C182 - Worst Forms of Child Labour Convention, 1999 (No. 182) [website]. Geneva: International Labour Organization (http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:11310:0::NO:11310:P11310_INSTRUMENT_ID:312327:NO, accessed 9 February 2016). Map production: amudhA Rathinam. Reprinted with permission from ILO.

Graph: Trends in child labour (ages 5–17) by sex, 2000–2012
Data source: ILO (2013). Marking progress against child labour: Global estimates and trends 2000-2012. Geneva: International Labour Organization (http://www.ilo.org/wcmsp5/groups/public/---ed_norm/---ipec/documents/publication/wcms_221513.pdf, accessed 26 August 2016). Reprinted with permission from ILO.

Graph: Sectoral distribution of children in child labour, 5-17 years age group, 2012
Data source: ILO (2013). Marking progress against child labour: Global estimates and trends 2000-2012. Geneva: International Labour Organization (http://www.ilo.org/wcmsp5/groups/public/---ed_norm/---ipec/documents/publication/wcms_221513.pdf, accessed 26 August 2016). Reprinted with permission from ILO.

World data table

UNICEF, WHO (2015). Progress on sanitation and drinking water: 2015 update and MDG assessment. New York: United Nations Children's Fund and World Health Organization. http://files.unicef.org/publications/files/Progress_on_Sanitation_and_Drinking_Water_2015_Update_.pdf (accessed 25 August 2016).

UNICEF, WHO, The World Bank Group (2015). UNICEF-WHO-The World Bank Group Joint Child Malnutrition Estimates, 2015 edition. New York: UNICEF; Geneva: WHO; Washington (DC): The World Bank Group. www.who.int/nutgrowthdb/estimates2014/ (accessed 25 August 2016).

WHO (2016a). World health statistics 2016: Monitoring health for the SDGs. Geneva: World Health Organization. http://www.who.int/gho/publications/world_health_statistics/2016/EN_WHS2016_TOC.pdf?ua=1 (accessed 25 August 2016).

WHO (2016b). Population with primary reliance on clean fuels. Global Health Observatory (GHO) data. Geneva: World Health Organization. http://apps.who.int/gho/data/node.main.SDGFUELS712?lang=en (accessed 25 August 2016).

WHO (2016). Unpublished data calculated for Prüss-Üstün A, Wolf J, Corvalán C, Bos R, Neira M (2016). Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks. Geneva: World Health Organization. (http://apps.who.int/iris/bitstream/10665/204585/1/9789241565196_eng.pdf?ua=1).

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