







THE PUBLIC HEALTH IMPACT OF CHEMICALS: KNOWNS AND UNKNOWNS

International Programme on Chemical Safety

World Health Organization

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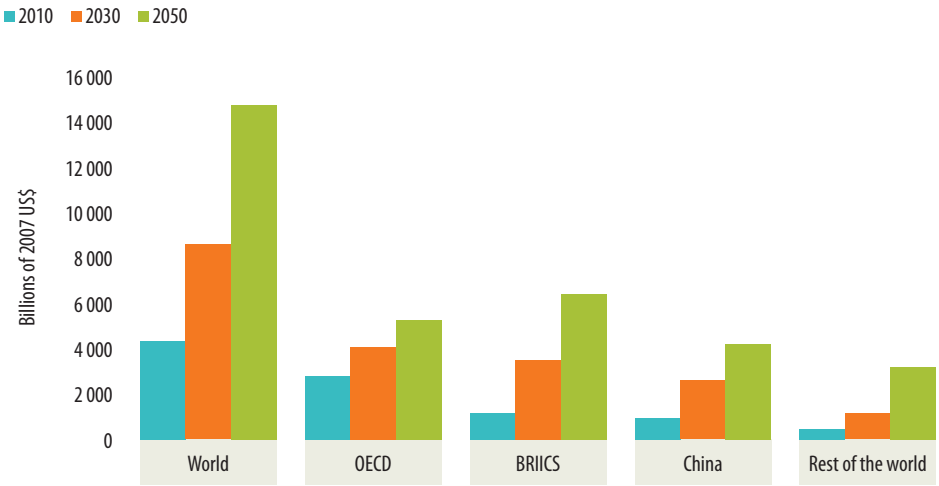
Removing the most toxic pesticides from agricultural practice and reducing access to pesticides would prevent many poisonings.

INTRODUCTION

Exposure to various chemicals occurs every day and through multiple routes such as ingestion, inhalation, skin contact and via the umbilical cord to the unborn child. Many chemicals are harmless or even beneficial; others are a threat to our health and to the environment. Chemicals production continues to increase and, with it, the potential for chemical exposure. As shown in Figure 1 the fastest growth in chemical production is projected to be in non-OECD countries. The chemicals explored in this publication are hazardous to human health and exposure could potentially be reduced or removed through environmental management. They include pesticides, asbestos, various other household and occupational chemicals, ambient and household air pollution, second-hand tobacco smoke, lead and arsenic. Estimates of health impacts are presented for a selection of chemicals with sufficient evidence for global quantification.

Figure 1. Projected chemicals production (sales) by region, "Baseline" scenario, 2010–2050



Source: *OECD Environmental Outlook to 2050: The Consequences of Inaction*, (Chapter 6: Health and Environment) (OECD, 2012, doi: http://dx.doi.org/10.1787/9789264122246-en).

METHODS TO QUANTIFY POPULATION HEALTH IMPACTS

The population attributable fraction (PAF) is the proportional reduction in death or disease that would occur if exposure to a risk were removed or maximally reduced to an alternative level. To quantify population health impacts from exposure to chemicals, a systematic literature review compiled estimates and summaries of chemical exposure and links between the respective chemicals and disease or injury. The preferred source was global estimates of population impacts for selected chemicals based on comparative risk assessment (CRA), followed by estimates based on more limited epidemiological data or, finally, expert opinion (see Prüss-Ustün et al, 2016[1] for details on methods).

CHEMICALS AND THE SUSTAINABLE DEVELOPMENT GOALS

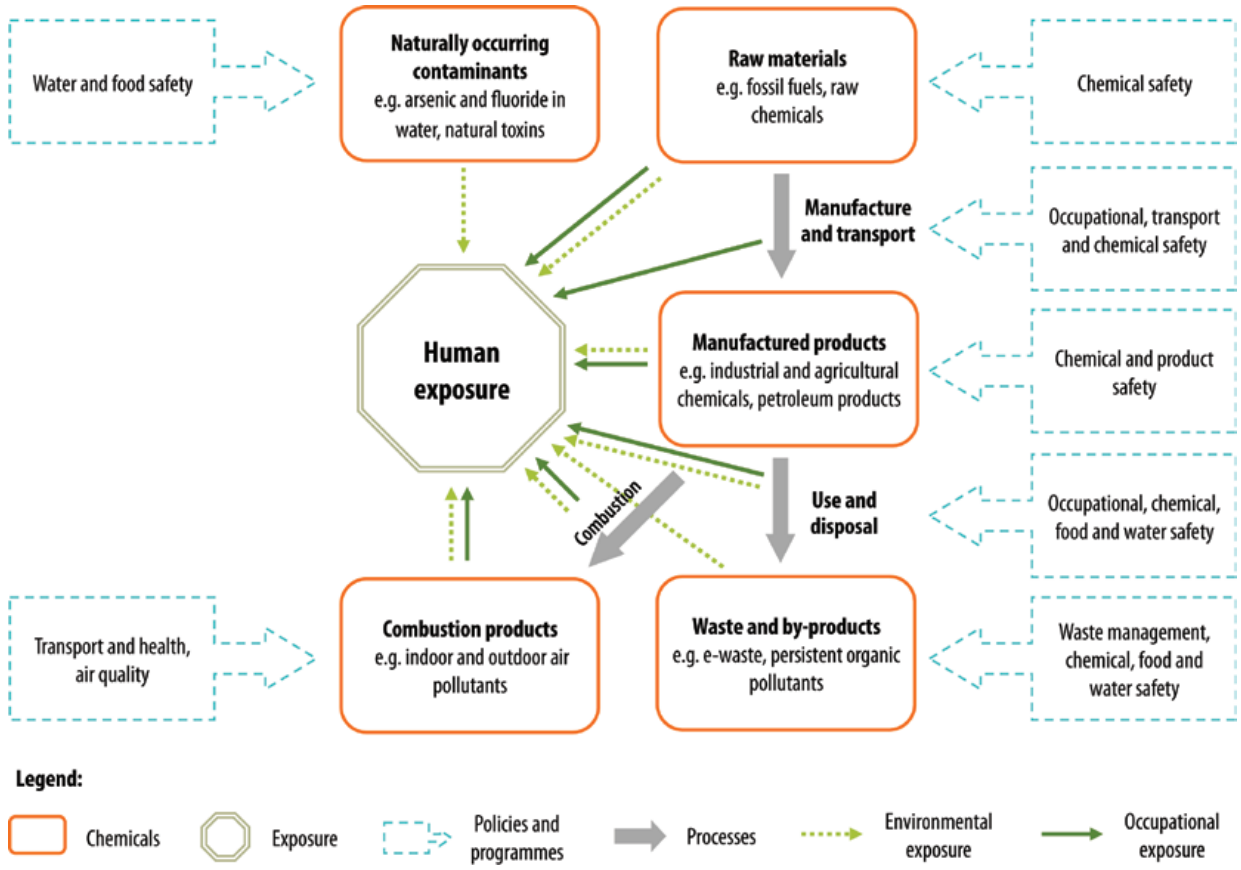
Reducing exposure to hazardous chemicals is essential to achieving the Sustainable Development Goals (SDGs), which aim:

By 2020, to 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 (Target 12.4).

By 2030, to substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination (Target 3.9).

By 2030, to 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 (Target 6.3).

Figure 2. Human exposure to chemicals throughout their life cycle and selected programmes relevant to their prevention



Source: Knowns and unknowns on burden of disease due to chemicals: A systematic review, Prüss-Ustün et al (2011).

Coal-fired power stations contribute to ambient air pollution and are a major source of mercury emissions.

POPULATION HEALTH IMPACTS FROM THE ENVIRONMENT BY DISEASE GROUP

Just over one third (35%) of **ischaemic heart disease**, the leading cause of deaths and disability worldwide, and about 42% of **stroke**, the second largest contributor to global mortality, could be prevented by reducing or removing exposure to chemicals such as from ambient air pollution, household air pollution, second-hand smoke and lead.[1]

Chemicals such as heavy metals, pesticides, solvents, paints, detergents, kerosene, carbon monoxide and drugs lead to **unintentional poisonings** at home and in the workplace. Unintentional poisonings are estimated to cause 193 000 deaths annually with the major part being from preventable chemical exposures.[1,2]

The list of chemicals classified as human carcinogens with sufficient or limited evidence is long.[3] Occupational carcinogens are estimated to cause between 2% and 8% of all **cancers**.[4] For the general population it is estimated that 14% of lung cancers are attributable to ambient air pollution, 17% to household air pollution, 2% to second-hand smoke and 7% to occupational carcinogens.[1,2,5]

A centuries' old scene – a worker washes leather before it is dyed (Fez, Morocco). Many chemicals used in the leather tanning industry have been linked to various forms of cancer.

Exposure to certain chemicals, such as lead, is associated with reduced neurodevelopment in children and increases the risk for attention deficit disorders and intellectual disability. Parkinson's disease has been associated with exposure to pesticides. Other links between **mental, behavioural and neurological disorders** are suspected; evidence, however, is more limited.[1]

Air pollution and second-hand smoke are risk factors for **adverse pregnancy outcomes** like low birth weight, prematurity and stillbirths. Antenatal exposure to second-hand smoke for example was estimated to increase the overall risk for stillbirths by 23% and for congenital malformations by 13%.[6] There are, furthermore, potential links between various chemicals and adverse pregnancy outcomes or congenital malformations, though evidence is limited.[1]

Cataracts, the most important cause of blindness worldwide, can develop from exposure to household air pollution. Exposure to cookstove smoke was estimated to be responsible for 35% of cataract disease burden in women and 24% of the overall cataract disease burden.[2,7]

Second-hand smoke and air pollution are also responsible for 35% of **acute lower respiratory infections**, including pneumonia, bronchitis and bronchiolitis, the most important cause of mortality in children, and are also linked to upper respiratory infections and otitis media.[1,2,5]

More than a third (35%) of overall chronic obstructive pulmonary disease **(COPD)** burden is caused by exposure to chemicals in second-hand smoke, air pollution or occupational gases, fumes and dusts.[2,5] Second-hand smoke and air pollution can induce reduced lung function and a predisposition for pulmonary disease in unborn and young children.[1]

Second-hand smoke and air pollution can lead to the development of, and increased morbidity from, **asthma**. Air pollution additionally provokes asthma exacerbations and increases related hospital admissions. Asthma from occupational asthmagens is among the most frequent diseases related to the workplace.[1]

Over 800 000 individuals die from **suicides** every year.[2] About 20% of suicides could be prevented through restricting access to poisons (estimate based on expert survey and limited epidemiological data). Self-poisoning with pesticides is the main means of suicide in India, China and some central American countries.[1,2,8,9,10]

Chemicals and air pollution

Air pollutants from ambient and household sources are a mixture of many components including, for example, carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NO_x) and particulate matter, the last containing substances such as acids, organic chemicals, metals, soil and dust particles.[11] The way chemicals are managed can directly contribute to air pollution. One example is the use of pesticides in agriculture, which can volatilize and suspend into the air when sprayed.[12] Phasing out leaded gasoline has reduced the amount of airborne lead. However, the largest sources of air pollution are combustion and other processes from energy generation, industry and transport.[13] Nevertheless, because of the chemical composition of air pollution which can vary to a large extent depending on prevailing pollution sources, the assessment of health hazards from these chemicals remains important.

Table 1. Overview of the disease burden preventable through sound management and reduction of chemicals in the environment (2012)

Chemicals/groups of chemicals	Disease outcomes considered (population attributable fraction of DALYs)	Deaths (% total deaths)	DALYs (% total DALYs)	Method
Chemicals in acute poisonings				
Chemicals involved in preventable, unintentional acute poisonings (methanol, diethylene glycol, kerosene, pesticides etc.)	Unintentional poisonings (73%)	137 300	7 825 000	Expert survey[c]
Chemicals involved in unintentional occupational poisonings (already included in the above poisonings)	Unintentional poisonings (occupational) (14%)	27 100	1 505 000	CRA[d]
Pesticides involved in self-inflicted injuries	Self-inflicted injuries (20%)	156 200	7 714 000	Limited epidemiological data[c]
Single chemicals with mostly longer term effects				
Lead[a]	Idiopathic intellectual disability (9.8%); IHD (4%); stroke (4.6%)	674 000	13 936 000	CRA[d]
Chemicals in occupational exposures (longer term effects)				
Occupational lung carcinogens (arsenic, asbestos, beryllium, cadmium, chromium, diesel exhaust, nickel, silica)	Trachea, bronchus, lung cancer (6.6%)	99 100	2 546 000	CRA[d]
Occupational leukaemogens (benzene, ethylene oxide, ionizing radiation)	Leukaemia (1.1%)	3 000	118 000	CRA[d]
Occupational particulates – causing COPD (dusts, fumes/gas)	COPD (12%)	233 500	10 970 000	CRA[d]
Air pollutant mixtures				
Ambient air pollutants (particulate matter, sulfur dioxide, nitrogen oxides, benzo[a]pyrene, benzene, others)	ALRI (7.9%); COPD (9.4%); IHD (24%); lung cancer (14%); stroke (25%)	3 732 500	100 125 000	CRA[c]
Household air pollutants from solid fuel combustion (carbon monoxide, nitrogen oxides, sulfur oxides, benzene, formaldehyde, polyaromatic compounds, particulates, others)	ALRI (33%); cataracts (24%); COPD (24%); IHD (18%); lung cancer (17%); stroke (26%)	4 261 500	144 789 000	CRA[c]
Second-hand smoke (nicotine, formaldehyde, carbon monoxide, phenols, nitrogen oxides, naphthalenes, tar, nitrosamine, PAHs, vinyl chloride, various metals, hydrogen cyanide, ammonia, others)	ALRI (9.3%); IHD (3.6%); lung cancer (1.8%); otitis (2.3%); stroke (4%)	601 900	19 931 000	CRA[d]
Subtotal chemicals without air pollution	Considered diseases: poisonings, leukaemia, lung cancer,	1 303 100 (2.3%)	43 109 000 (1.6%)	