



A Swedish Environmental Health Report with focus on Children

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Background

On behalf of the government and the National Board of Health and Welfare, The Institute of Environmental Medicine at the Karolinska Institute, together with the Work and Environmental Medicine Unit at Stockholm County Council has prepared an Environmental Health Report with focus on children that was published in February, 2005. The report describes present knowledge about environmental risk factors and the impact on children's health in Sweden.

Aim

The aim of the Environmental Health Report 2005 has been to develop a better understanding of children's exposure to various priority environmental factors, describe the health risks associated with these environmental factors and, if possible, try to estimate to what extent health effects in children are due to environmental factors. The report provides an important basis for evaluations of health aspects in environmental protection work and supervision by national, regional and local authorities.

Methods

Many experts participated in the preparation of the report. Each chapter is a literature-based up-to-date summary of scientific data. An important part of the background information is provided by results from a national survey of environment-related health aimed at about 40,000 children aged 8 months, 4 years and 12 years old. (Sweden has a population of about 9 million inhabitants and 1.5 million children up to the age of 14). The questionnaire contained questions about health status, family and building conditions, transportation, pets, parental smoking, asthmatic symptoms and other symptoms from the airways, food

allergy, skin allergy, hearing and exposure to noise from different sources, annoyance to smell and exhausts, sun protection and some dietary habits. In all there were about 100 questions that were answered by the parents. The overall response rate was 71 %.

Introduction

There are certain important physiological and biological differences between children and adults. Children and unborn children are in certain respects especially vulnerable to environmental effects. It is not only the dose that is important in determining whether harm will arise but also the development stage when the exposure occurs. Organ systems that develop and mature over a long period are considered to be particularly vulnerable. Examples of such organ systems are the brain, the hormone system, the reproductive organs and the immune system. Children have greater nutritional needs than adults, which means a higher intake of food and drink calculated per kilogram of body weight. As a result they have a higher intake of environmental pollutants.

People are exposed to environmental pollutants chiefly via food and water or inhalation. Children's exposure differs from adults' in some cases. While being breastfed, a child can be exposed to substances to which its mother has been exposed and which are excreted in breast milk, primarily fat-soluble substances. A natural form of behaviour exhibited by infants involves them sticking their fingers and objects in their mouths. This can lead to them being exposed to substances that can be dissolved from objects (e.g. plasticisers in plastics), or that have stuck to their hands and objects. Infants are therefore also at greater risk of exposure to toxic substances in soil and dust



when playing, both indoors and outdoors. Air pollutants, smoke, allergens, moulds, poor ventilation, noise and radiation are examples of things to which children can be exposed at home, in nursery and other schools, and outdoors. Exposure to undesirable substances also occurs in environments intended for leisure activities and sport.

Children's health and diseases

From an international perspective, children's health is very good in Sweden. Vaccination programmes have led to a number of serious infectious diseases being more or less stamped out. Sweden is one of the countries with the lowest infant mortality in the world. Children's health has also been improved by conditions such as malnutrition and vitamin deficiency having been virtually eliminated. On the other hand, obesity and the medical conditions that it induces is a significant problem. In infancy, children face a number of infections of the airways and gastrointestinal tract. Certain relatively severe and sometimes chronic diseases are also major problems.

Effects on the unborn child, nervous system and hormonal system

Foetal effects, effects on the nervous system and the hormonal system, cancer in children and allergic diseases in particular have been observed as environment-related effects on health.

Foetal development and the subsequent health of children depend on genetic factors as well as the environment prior to birth. About 2 per cent of all newborn children have some kind of chromosomal change or congenital malformation that is important for health. In most cases, the cause is unknown. Among environmental factors, only ionising radiation has definitely been shown to give rise to malformations in humans.

The central nervous system is formed by a series of

processes in which each stage is dependent on the previous one. This means that the time of exposure is crucial in determining the neurological consequences of a potentially neurotoxic substance. During its developmental phase, the brain is extra vulnerable to many foreign substances. The commonest conditions related to disturbances in the development of the nervous system include motor problems, mental retardation, learning difficulties, hyperactivity, impulsiveness and attention deficit. The causes of these conditions are often unclear and both heredity and environment are probably involved. That chemicals and environmental pollutants can affect brain development has been clearly shown in animal experiments. Environmental pollutants such as lead, methyl mercury, dioxins and PCBs have also been associated with low IQ, adverse effects on motor coordination, memory, language development, etc. in children. The risks of Swedish children being affected by serious harm to the nervous system as a result of environmental pollutants are, however, considered to be low.

Over the last decade, the *hormone-disrupting properties* of certain chemicals have been a matter of discussion, as have the effects on health that these might induce. Animal experiments clearly show that a number of environmental pollutants can, in relatively low doses, interact with the hormonal system and affect the early development of, in particular, the reproductive organs and their function, and the central nervous system. Studies of possible effects on humans are largely lacking. Understanding of how much humans are exposed to substances that disrupt hormones is also inadequate. As a result, it is not currently possible to assess possible health risks from substances that disrupt hormones, whether for children or adults.

Cancer

Cancer is uncommon in children under the age of 15



(in Sweden, about 270 children contract cancer each year), but is one of the commonest causes of death. The commonest types of cancer in children are leukaemia and brain tumours. The causes of cancer in children are largely unknown. Genetic factors are important, but can explain only a small proportion of the cases that occur. With regard to exposure to various environmental factors, it is largely only ionising radiation that is definitely known to increase the risk of cancer in children. Examples of other factors suspected of affecting this risk include extremely low-frequency (ELF) magnetic fields, pesticides, infections and certain forms of work-related exposure suffered by parents prior to conception and during pregnancy.

Allergic diseases

Over the last few decades, the number of children with allergies has more than doubled in Sweden, as in the rest of Europe. Most children with allergic diseases fall ill in the first 4-5 years of their lives. According to the questionnaire, roughly one in every four 4-year-olds and 12-year-olds has eczema, asthma, hay fever, food allergy or other symptoms due to allergy to common substances. Among 4-year-olds, 12 per cent indicated an allergy to inhalation or food allergens. The corresponding figure for 12-year-olds was 19 per cent. Allergy to pollen was commonest, followed by allergy to fur-bearing animals. Contact allergy to nickel was reported by 9 per cent of 12-year-old girls and by 2 per cent of boys in the same age. Asthma and reported allergy to fur-bearing animals was commoner in the north of the country than in the south.

The hypothesis most frequently put forward nowadays to explain why allergic diseases are increasing is that the body's immune system is no longer experiencing the necessary stimulant early on in life, while children's environmental exposure has changed. Differences in the occurrence of allergies between regions and between groups provide clear indications that lifestyle and environmental factors are important

for the contracting of disease. It is not possible to quantify how large a proportion of the increased number of allergies can be attributed to individual environmental factors as a range of such factors probably interact. It has been demonstrated, however, that exposure to maternal smoking during pregnancy, breastfeeding periods of less than 4 months and a damp home during the first few years of life increase the risk of the onset of asthma up to the age of 4.

For individuals who have already developed an allergic disease, their lives become more difficult in everyday situations entailing exposures that induce symptoms. Among 12-year-olds with asthma, 22 per cent report breathing difficulties over the past month from various air pollutants, smells and odours that are common in the environments inhabited by children. In addition, children with asthma are exposed to tobacco smoke in the home roughly just as much as children without asthma, despite the fact that children who are regularly exposed to other people's tobacco smoke are at risk of developing more severe asthma disease.

Thirty-four per cent of 12-year-olds with asthma reported experiencing asthma symptoms from contact with fur-bearing animals over the past year. The corresponding figure for this age group with allergic rhinitis was 75 per cent. For individuals with clinical symptoms of allergy to fur-bearing animals, frequent contact with fur-bearing animals, though also indirect contact, means a significant risk of exacerbation of the allergic disease. Nevertheless, slightly more than 19 per cent of children who are allergic to fur-bearing animals have a cat, dog or rodent at home.

Children's exposure to environmental factors

Indoor environment

Non-specific health problems related to the indoor environment are reported from many countries. In general, the most commonly reported symptoms are



eye, skin and airway complaints and diffuse problems such as fatigue, concentration problems, susceptibility to infection, etc. For children, the most commonly studied effects are lower airway symptoms such as persistent cough and repeated episodes of wheezing (asthma symptom). Small children are regarded as a particularly vulnerable group, and the child's home environment as a particularly important environment.

Damp and mould damage is common in homes and there is evidence to suggest that such damage may induce chemical and microbial processes that give rise to the release of toxic substances. People living in dwellings with damp problems have been linked with an increased incidence of lower airway symptoms in children. These studies have been conducted in various parts of the world, and only a relatively small proportion in regions with a Scandinavian climate. In the questionnaire, 19 per cent of parents reported the existence of visible damp damage, visible mould (excluding growth on surfaces in wet rooms) and/or a smell of mould in the home. In a Swedish study, corresponding exposure has been associated with a roughly 50 per cent increased risk of repeated lower airway symptoms (infant asthma). With an incidence of infant asthma of 11 per cent up to the age of 4, this corresponds to more than 1,000 cases a year that can be linked to damp problems in the home.

With regard to the importance of *ventilation* for children's health, it is harder to make risk assessments, but studies conducted in the school environment confirm how important it is that these establishments meet the requirements imposed on airflow in the school environment.

An important exposure factor for children in the indoor environment is *adult smoking*. In Sweden, children's exposure to tobacco smoke has declined considerably in recent years. Fewer parents smoke during pregnancy (less than 10 per cent) and about 5 per cent

of children are exposed daily to tobacco smoke in the home according to the questionnaire. The risk of acute lower airway disease in children up to 4 years of age, particularly infant asthma, has, based on a large number of studies, been calculated to correspond to more than 500 cases a year caused by parents smoking. A total risk increase for ear inflammation in children up to 2 years of age has been calculated on the basis of a number of studies and shows an increased risk equivalent to just over 500 cases caused by parents smoking.

Air pollutants

Owing to their faster metabolism, children breathe more than adults in relation to their weight, and are often more active outdoors. Children also have relatively extensive transport needs, which means that they spend time in traffic environments with higher levels of air pollutants than in other environments. All this contributes to them possibly being more exposed to air pollutants than adults. According to the questionnaire, nearly 40 per cent of children travel more than 5 km a day to get to and from kindergarten/school and other activities.

Air pollutants affect children's airways. They inhibit development of the lungs so that someone growing up in polluted areas is at increased risk of poorer pulmonary function as an adult. The scale of the problem in Sweden is difficult to estimate, but if studies from other countries are translated to the Swedish situation, Swedish inner-city children might be at a twofold risk of reduced pulmonary function. Air pollutants may also give rise to various symptoms in the airways of children, both in the upper and lower airways, probably partly in combination with infections. It is likely that these effects occur in Swedish children despite the air pollution situation having partially improved. Based on current knowledge, it is not, however, possible to comment on the scale of the problem. Children with asthma are a



particularly vulnerable group for effects on the airways. It is, however, uncertain whether air pollutants are contributing to previously healthy children developing asthma.

Air quality in built-up areas in Sweden has in some respects (SO₂, soot) improved substantially over the last few decades as a result of reduced emissions from heating and energy production. At the same time, road traffic has grown strongly. For many places, local small-scale wood burning plays a major role in determining concentrations of particulates and carcinogens. A major contribution to poorer air quality in Sweden also comes from other countries, particularly ozone and particulates (PM_{2,5}).

Metals and organic environmental pollutants

Environmental pollutants in the form of metals and persistent organic substances accumulate in the environment and reach humans chiefly via food.

In the environment, inorganic mercury, which largely comes from old emissions, is converted to *methyl mercury*. The highest concentrations in Sweden are found in lake fish such as pike, perch, burbot and zander. The National Food Administration has issued dietary recommendations for such fish species. In the questionnaire, 77 per cent of women reported that they knew about these recommendations. Methyl mercury crosses the placenta and can harm the central nervous system, which is why unborn and small children are especially vulnerable. Pregnant Swedish women usually have a lower level of exposure than what is associated with effects in children. The margins are, however, small, and so it is important that the exposure situation in the country be continuously monitored.

Although *cadmium* has been banned for many applications, it is found in the environment. Cadmium is readily taken up by plants. The highest intake is from cereal products and vegetables. Cadmium

accumulates in the kidneys and important effects after long-term exposure are exerted on the kidneys and skeleton. Cadmium accumulates in the placenta and a relatively small proportion reaches the foetus. There is a lack of information on the effects of cadmium in children. In general, cadmium exposure should be reduced so as to lower the risks of effects in adulthood.

Arsenic is an element that occurs naturally in rock, from where it can dissolve out into groundwater. Globally, millions of people use drinking water with such a high arsenic level that there is a risk of serious effects on health. The EU limit value for arsenic in drinking water, 10 µg/l, is based on the risk of cancer. Most Swedish drinking water catchments are below the limit value. However, it is desirable to limit arsenic intake as far as possible. This is particularly the case with children as studies indicate that unborn and small children are more vulnerable than adults.

Copper is an essential (vital) trace element needed for many of the body's functions to operate normally. It has been a matter of discussion whether copper in drinking water from copper pipes may cause infant diarrhoea when the water is used to prepare, for example, milk substitutes or gruel. It is unclear at what levels these symptoms start to appear, but their onset has not been demonstrated at copper levels below the EU limit value for copper in drinking water of 2 mg/l.

Measures to reduce the spread of *lead* into the environment, particularly the phasing-out of lead in petrol, have been successful. They have resulted in substantially reduced lead concentrations in air, food and human blood over the last 20 years. Lead crosses the placenta and the unborn child has roughly the same blood levels of lead at birth as the mother. Very low levels are present in breast milk. The critical effect of lead is damage to the central nervous system, especially during the development of the brain. The margin between blood levels of lead recorded in



pregnant women and children of preschool age in Sweden and the levels at which effects on health begin to occur is relatively small (a factor of 2–5), and so it is important that exposure is not allowed to increase.

The organic environmental pollutants described in the report have been chosen as they are considered to pose a health risk, or a possible health risk, for children. *Dioxins* and *PCBs* are present in our food. The highest levels are found in fatty fish from the Baltic, although other fish, dairy products and meat also contribute to humans in Sweden being exposed to these substances. Infants are exposed a great deal to dioxins and PCBs via breast milk. Dioxin and PCB levels in breast milk have, however, fallen sharply in Sweden since the early 1970s. The critical effects for these substances, which have primarily been observed in animal experiments, are impaired development of reproductive organs, effects on behaviour, impaired immune defence and cancer. Unborn children are particularly vulnerable. The general population in Sweden is exposed to levels close to those considered to give rise to subtle effects on health, chiefly on foetal development. Levels of dioxins, PCBs and the brominated flame retardant PBDE in breast milk are so high that the nursing infant is subjected to the highest exposure of all the groups. With regard to all the well-known benefits that breastfeeding offers the infant, it is, however, agreed that breastfeeding should be encouraged. Both the WHO and EU consider that the benefits outweigh any effects that can be caused by dioxins and PCBs.

In the case of the *brominated flame retardants*, *phthalates* and *alkyl phenols*, there are big gaps in the toxicology data and/or a lack of information on how and how much people are exposed. Effects in animal experiments on early development of the brain and reproductive organs have, however, prompted the EU to ban certain brominated flame retardants. In addition, bans on the use of certain phthalates in toys and

children's products are also being proposed.

Noise

Community noise is a widespread environmental problem in Sweden and is the form of disturbance that affects the highest number of people, both children and adults. Based on the findings from the questionnaire, an estimated 162,000 Swedish children aged 0-14 years old have their bedroom windows facing roads used by traffic, railways or industrial facilities. Twelve-year-olds are disturbed by the same noise sources as adults, but the noise sources that produce discomfort in most children in this age group are noise from other children and loud music. One in every seven 12-year-olds is discomforted by noise in or near the home (nearly 17,000 children in this age group) and one in four is discomforted by noise in or near the school/day centre (about 30,000 children in this age group).

One of the most serious effects of community noise is sleep disturbance. Undisturbed sleep is essential for children and adults to function well, both physiologically and mentally. For about 19,000 twelve-year-olds, noise disturbances mean that they have trouble sleeping; for just over about 3,000 of these children, this happens several times a week.

Particularly worrying is the fact that children and young people are exposed to hearing-impairing noise to an extent that does not seem to have happened in the past. At the age of 4, about 2,000 children are reported as having impaired hearing, with the corresponding figure at the age of 12 being about 4,000 children. However, we do not know how many of these cases of hearing impairment are caused by exposure to high noise levels. Nor do we know for certain whether hearing damage has become more common among children and young people.

One in every four children in Sweden sometimes



listens to loud music through earphones, while one in every hundred children does this virtually daily. One in every five 12-year-olds in Sweden report that, after listening to loud music or other loud noise, they experience ringing, squeaking, howling or buzzing in their ears, with this being slightly more frequent among boys than girls. Just over one in ten report that their hearing is sometimes worse afterwards (17,000 children). About 4,000 children in this age group report that they often or always have buzzing in their ears (tinnitus).

In kindergartens and schools, such high noise levels have been measured that they sometimes exceed the limit for when ear defenders must be worn according to legislation governing health and safety at work.

For the adult population, there are a number of studies indicating that, in highly exposed individuals in the general population, there can be an increased risk of high blood pressure caused by community noise. Indications that an impact on blood pressure can arise in schoolchildren as well are provided by some studies, but the findings should be interpreted carefully and are unproven.

After long-term exposure to aircraft noise near airports, schoolchildren have been shown to perform worse in proofreading, completing jigsaw puzzles and reading comprehension and to have poorer memory and motivation. Particularly the effects on children's ability to read and on learning have been confirmed in a number of studies. The longer and stronger the exposure, the greater the harmful effect seems to be. These results indicate that kindergartens and schools should not be located near strong noise sources such as thoroughfares, airports and noisy industrial facilities.

Ionising and non-ionising radiation

Radon is the single biggest source of ionising radiation in Sweden. About 200,000 children are estimated to

live in homes with radon levels above the current Swedish guideline value (200 Bq/m³). Radon increases the risk of lung cancer, although this form of cancer scarcely occurs at all in children, and it is unclear how radon exposure in childhood affects the risk of subsequently developing lung cancer.

It is calculated that a total of about 80-90 per cent of all skin cancer in Sweden is caused by *UV radiation from sunlight*. The serious form of skin cancer, malignant melanoma, has over a 20-year period increased by an average of 2 per cent per annum. One reason for this increase is thought to be outdoor activities involving exposure to UV radiation, both in Sweden and other countries. Individuals with certain constitutional factors such as pale skin, red or blond hair and blue/green/grey eyes are at increased risk of malignant melanoma. The skin of small children is especially vulnerable to UV radiation.

Electrical and magnetic fields occur wherever electric current is present. In the general environment, power lines are the most visible source of magnetic fields. Epidemiological data indicate that exposure to power frequency magnetic fields might increase the risk of leukaemia in children. In recent meta-analyses of these studies, a doubled risk of leukaemia in children has been shown for exposures above about 0.4 μ T. In the general environment, magnetic fields exceeding 0.4 μ T for lengthy periods are uncommon. Estimates indicate that they are present in considerably less than 1 per cent of homes in Sweden. This means that a very small proportion (< 0.5 per cent) of cases of leukaemia in children could be explained by this exposure.

Radio frequency electromagnetic fields are used for information transfer by radio and TV and by mobile telephony. They are also used in many other areas, e.g. surveillance. Their occurrence has increased very sharply in recent years and this increase may very well continue. During calls, mobile telephones give rise to



exposure near the antenna, i.e. as a rule in the vicinity of the user's head. Levels vary sharply during a call depending on the automatic upward and downward control of the signal strength. The fields from the base stations with which the telephones communicate have also been discussed as a potential health risk. Exposure to these fields is, however, 1000 times weaker than exposure from telephones. At the present time, support for the hypothesis that exposure to radio frequency fields below the current exposure guideline values could be associated with certain health risks is very limited. As extensive use of mobile telephones has been going on only for a few years, the effects of long-term exposure are hard to assess.