Umwelt Bundes Amt

Für Mensch und Umwelt

HOW POLLUTANTS AND NOISE AFFECT OUR CHILDREN'S HEALTH

First results from the German Environmental Survey for Children (GerES IV)

Is exposure to pollutants present in the environment also harmful for human beings? And is this exposure increasing? Are bans on the manufacture or use of certain substances sufficient to protect us against such exposure? Environmental health monitoring provides answers to these questions. It generates information for policymakers and the public on how pollutants, noise, dust and allergens adversely affect human health. It seeks to evaluate the complex relationships between the environment and health in order to propose adequate precautionary and hazard prevention measure. How is the German Federal Environment Agency (Umweltbundesamt, or UBA) addressing this task?

A basis for environmental health monitoring is human biomonitoring. These are measurents of pollutant concentrations in the human body, mainly in blood and urine. Individual interviews about participants' living environment, consumption habits, and diet may round off these investigations and may provide information about exposure pathways and sources. In the past 20 years, the German Environmental Surveys carried out by the UBA have produced reliable data on the exposure of Germany's population.

The term "survey" means, firstly, the act of measuring: to delineate the form, extent, and position of something; it also means a broad investigation of a subject by data collection, inspection or exploration, as well as a statistically exploitable poll. In our context, "survey" means a systematic cross-sectional study of a statistically representative sample of Germany's general population. The **German Environmental Survey** carried out by the UBA since 1985 (GerES for short) serves to collect and update representative data on human exposure to pollutants and on their sources. GerES required considerable resources and was therefore carried out only every four to six years.

1 Why an environmental survey especially for children?

Children require special care, since their bodies are still developing and may react more sensitively to environmental chemicals. Some of these developmental processes, such as sexual and cognitive, are particularly vulnerable. Children's exposure to pollutants is higher than adults' relative to body weight.

The UBA carried out its first environmental survey especially for children (GerES IV) from 2003 to 2006. A pilot study was conducted in 2001/2002. The UBA is currently evaluating the data in detail. Cooperation with the Robert Koch Institute's Health Interview and Examination Survey for Children and Adolescents (German acronym: KiGGS) enables it to compare the extensive data on children's health status from that survey with the data on pollutant concentrations generated in its own survey. These data are particularly important for taking targeted decisions on environmental policies and measures. The report on pollutant concentrations in blood and urine (human biomonitoring) has already been published. Two further reports, dealing with pollutant concentrations in house dust and in drinking water in Germany, will be available shortly. Since the group of children participating in the survey has a representative composition, the results of the study are applicable not only to them, but to all children in Germany.

2 Who and what was surveyed?

1,790 children 3 to 14 years of age participated in GerES IV. They were a sub-group from the Health Interview and Examination Survey for Children and Adolescents (KiGGS) and representative for children in Germany. As part of the field work, urine, blood and drinking water samples were taken. Furthermore, the field workers took house dust and indoor air samples in the homes of nearly 600 of the children. In subsequent analysis, the UBA and commissioned laboratories found many environmental pollutants in the samples. To investigate exposure to environmental tobacco smoke, the UBA not only used information on smoking habits provided by the children or their parents, but also evaluated the concentrations of cotinine, a nicotine metabolite, in the children's urine. Separate programmes to evaluate the children's sensitisation by indoor allergens (for example, mould, animal hair, mites) and noise exposure, and its effects were also included.

3 The basic report on human biomonitoring is now available

A study such as the GerES IV has many objectives. One important objective is to obtain reference values that allow a better categorisation of levels measured in individual children. The representative values obtained from GerES IV can be used to evaluate whether such levels – determined, for example, as part of medical investigations into health complaints or after an accident – correspond to the average exposure of children in Germany or are higher than normal.

The basic report on GerES IV was published in summer of 2007. It is now available in English. The report presents data on concentrations of pollutants in blood and urine of children in Germany in clear, tabular form. It also includes tables listing pollutant levels for important sub-groups, such as boys and girls and different age groups. Environmental health practitioners or epidemiologists interested in reference values may thus draw on the values that fit their specific cases. The report "Concentrations of pollutants in blood and urine of children in Germany" is available in the Internet.

4 Which results are currently available?

The measurement and monitoring of environmental influences on health is one of UBA's priorities. In-depth evaluations are carried out on an ongoing basis to identify exposure sources and look into potential exposure risk groups, which are defined by a range of factors including socioeconomic status (parents' income, education and professional status). The data are also used to justify new exposure control measures and to evaluate whether political measures taken have been successful or need to be adapted.

For example, the results of GerES II of 1990/92 and of the GerES for Children between 2003 and 2006 show a decrease in the exposure of children in Germany to various heavy metals, to pentachlorophenol (PCP), which was used in wood preservatives, and to polycyclic aromatic hydrocarbons (PAHs), which are formed during combustion processes. This is an indication that measures to improve air quality and the quality of drinking water as well as bans and restrictions on the use of certain substances have been successful. Other new results are presented on the following pages.

4.1 Persistent and accumulative substances

Persistent and accumulative substances are substances that accumulate in the human body and in the environment and do not degrade at all or only very slowly. A European Commission working group is currently looking into the question whether 120 of these substances should be specifically regulated. Most of these substances have not been detectable in the human body to date, due to the absence of appropriate analytical methods. This is why as examples and representatives of the group of persistent and accumulative substances, in GerES for children the UBA investigated children's exposure to a number of toxic organochlorine compounds that are persistent in the environment and the human body, such as DDT (dichlorodiphenyl trichloroethane[1]), which is used for malaria control, PCBs (polychlorinated biphenyls[2]) or HCB (hexachlorobenzene[3]).

Environmental concentrations and human body burdens of these substances have decreased since their use was banned in the 1970s and 1980s, but the substances are still stored in human fatty tissue. Despite the fact that all children investigated were born after these substances had been banned completely, their exposure can be allocated to distinct sources: Children who were breastfed have markedly higher body levels of persistent substances than children who were not, levels increasing with the nursing period and the age of the mother **(Figure 1)**. This difference between breastfed and non-breastfed children was clearly evident even in the oldest group investigated (14 year-olds).

[1] Chronic toxicity: neuro- and hepatotoxic, endocrine disruptor, classified into Group 2B: possible human carcinogen; human biomonitoring: the metabolite DDE has a longer half-life in blood than DDT; use: prohibited since 1972 (used until 1989 in former East Germany).

[2] Chronic toxicity: neuro-, immuno- and reprotoxic effects, classified into Group 2A: probable human carcinogen; human biomonitoring: indicator congeners (PCB 138, 153, 180) detected in blood; use: use in open systems prohibited since 1978, total ban since 1989, many uses before that time).

[3] Chronic toxicity: changes to liver, skin and CNS, effects on the thyroid gland, classified into Group 2B: possible human carcinogen; use: prohibited since 1977 (used until 1984 in former East Germany).

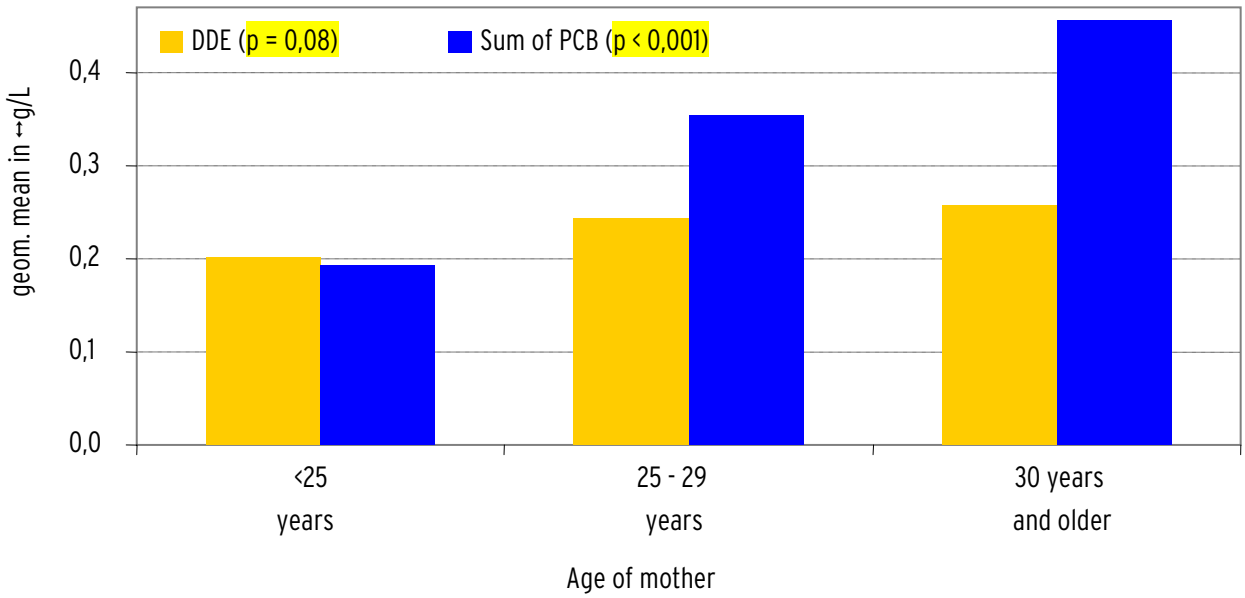

Figure 1: Sum of PCBs and DDE – a degradation product of DDT – in children's blood, by age of mother at birth (only covers children 7 to 14 years of age who do not have older siblings who had been breastfed by mother; GerES IV)

Breastfeeding is important for a child's emotional and health development. The majority of experts agree that mothers should continue to be advised to breastfeed. It is not acceptable, however, that mothers should feel bad about passing pollutants on to their children in the first days and months of their lives. That children are exposed to persistent substances via breast milk argues strongly in favour of taking precautionary action and restricting the release of such substances.

In the light of REACH, the new EU chemicals legislation, the analyses carried out for DDT, PCBs and HCB can in fact serve as a model. It may be assumed that as well as to these persistent substances, children are exposed in the same way to substances with similar properties for which however suitable analytical methods do not yet exist. REACH, the new chemicals legislation, allows such substances to be used only in exceptional cases.

4.2 Environmental protection and justice – Are children from poorer families more affected?

Although all children are affected by environmental pollution today, there are socioeconomic status-specific differences in type and amount. For example, whilst children of families with a low socioeconomic status are more exposed to environmental tobacco smoke or lead **(Fig. 2)**, exposure to persistent organochlorine compounds (DDT, for example) is higher for children from families with a higher socioeconomic status **(Fig. 3)**. Terpenes too have an irritating effect on the eye and mucous membranes and may cause respiratory complaints at high concentrations. Terpenes are substances that outgas from wood, for example. They are found more in homes of families with a higher socioeconomic status.

Children that have a migration background have a DDT exposure twice as high as the average exposure across all children. This shows that environmental pollution is not just a problem for disadvantaged children, but a problem for all children in Germany. Therefore, parents from all status groups need differentiated and targeted advice on what they can do to reduce their

children's exposure to pollutants[4]. Children should only be exposed to such pollution as is unavoidable, irrespective of their parents' origins and socio-economic status.

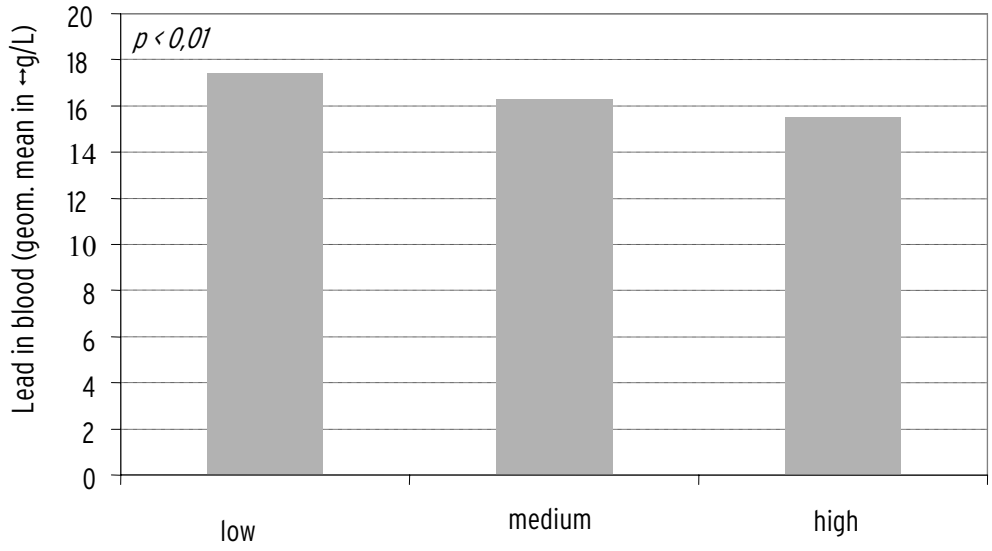

Fig. 2: Blood lead levels and socioeconomic status of children in Germany (GerES IV)

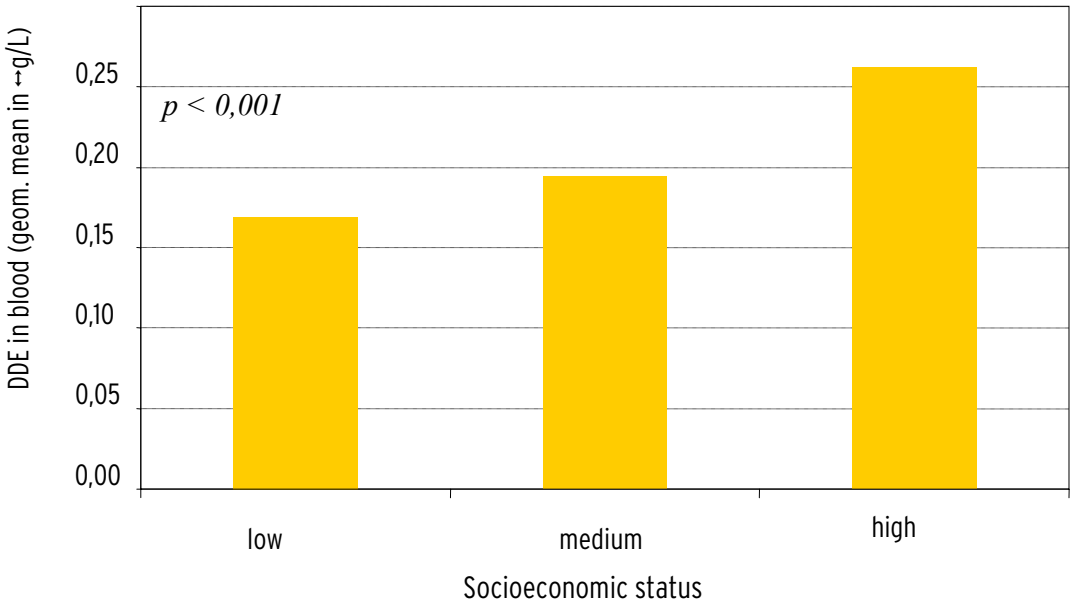

Fig. 3: DDE, a DDT metabolite, in blood and socioeconomic status of children in Germany (only children 7-14 years of age) (GerES IV)

[4] Breastfeeding is a good prophylaxis against allergies. However, when done for a very long time, breastfeeding can lead to high transfers of pollutants from mother to child.

4.3 Results for newly measured substances – what are the problems?

The UBA also evaluates whether the body burdens measured pose a health risk to the children. It has therefore compared the levels measured in blood and urine with toxicologically- and epidemiologically-based assessment values. Experts believe that the successful limitation of exposure (see box) to heavy metals has decisively reduced the risk of children in Germany suffering adverse health effects from heavy metals. However, for many environmental pollutants, standards to assess the health risk they pose do not yet exist.

In risk assessment, **exposure** means being subject to environmental influences. For example, a miner is exposed to rock dust and a passive smoker to tobacco smoke. Exposure need not necessarily lead to illness, but if the substance in question is toxic or ecotoxic, effect and exposure may combine to result in a risk to human health and the environment.

Findings from GerES IV show that drinking half a glass of fruit juice or more per day markedly increases the body levels of metabolites of organophosphate-pesticides[5]. Hence, children might be exposed to considerable amounts of organophosphate via consumption of fruit juice **(Fig. 4)**.

It is not yet known, however, whether it is mainly the organophosphates themselves or their degradation products that are contained in fruit juice. This means that further investigation is required as regards concentrations of organophosphates[6] in fruit juices.

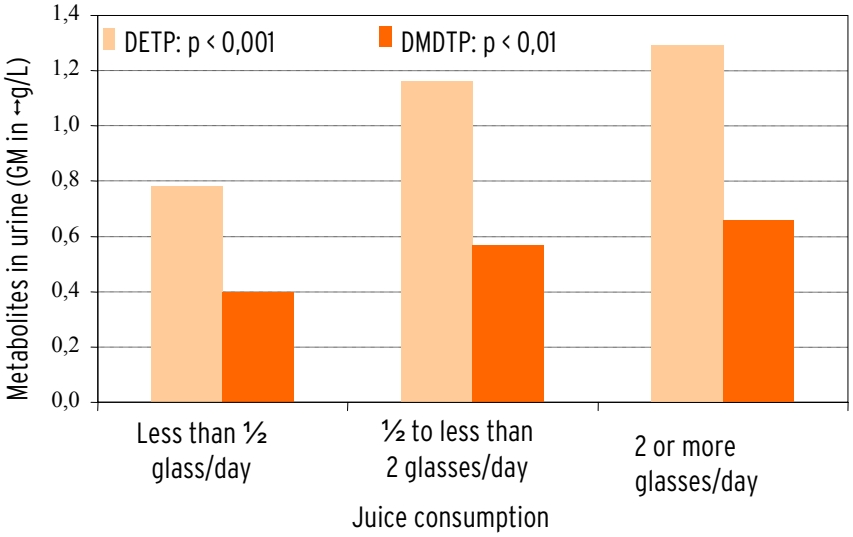

Fig. 4: Metabolites of organophosphate pesticides in urine of children in Germany and consumption of fruit or vegetable juice (source: GerES IV). The metabolites shown are DEPT diethyl thiophosphate and DMDTP = dimethyl dithiophosphate. Both are dialkyl phosphates and 2 of 6 easy-to-measure main organophosphate metabolites.

[5] These are neutoxins: effects on the central nervous system similar to those of muscarine and nicotine, such as increased glandular secretion, arrhythmia, muscular weakness, respiratory paralysis, confusion, respiratory and circulatory depression; chronic effect: similar to the above but weaker, nerve damage/neuropathic disorders.

[6] Body levels of organophosphates themselves cannot be measured as these compounds are immediately metabolised. Hence, the metabolites which the UBA has measured either may have formed in the children's bodies or come from bacteria on the fruit, for example. This suggests that the fruit from which the relevant juice was produced must have been treated with organophosphates.

Another problematic group of pollutants are the so-called phthalates, which are mainly used as plasticisers in PVC products. UBA's data show that phthalates were detected in the urine of all children participating in the survey. Currently, about 2 percent of children take in more DEHP (diethylhexyl phthalate) and between 12 and 37 percent of children take in more DnBP (di-n-butyl phthalate) than can be regarded as safe from a health perspective. Children take in DEHP mainly via food (rich in fats) – it is contained, for example, in soft plastics or in the sealing of twist-off lids – whereas indoor air and house dust make no significant contribution. Their intake of DnBP most likely occurs via food, house dust and indoor air. The results on body levels of phthalates in children are alarming, since they exceed the acceptable daily intake (ADI). The UBA is working to identify the exact sources and to thus pave the way for a reduction of this exposure of children in Germany.

4.4 The importance of the indoor environment for children's exposure to environmental pollutants

In its study, the UBA also looked into the pollution to which children are exposed in their domestic environment. After all, children spend almost 15 hours per day in their parents' homes, as the study was able to show for the first time. Children, therefore, are exposed to pollutants in indoor air and their toxic effects for long periods of time. Many of these substances come from furniture, carpets, and household and building products. The UBA has been working to limit emissions of "volatile organic compounds" (VOCs) from such products for quite some time. To do so, it is of course important to know the composition of these VOCs as well as current trends in their use so as to be able to counteract unfavourable product developments and to evaluate them from a toxicological and health perspective and in a properly targeted manner.

Two examples are presented below:

Tobacco smoke: Environmental tobacco smoke (ETS) must still be regarded as the main source of indoor air pollution. About half of the children are exposed to tobacco smoke in their homes and this has not improved in the last 15 years. Whilst in West Germany exposure levels have remained almost unchanged since 1990/92, the situation of children in East Germany has even deteriorated, because more and more mothers there smoke and thus add to the children's exposure. The data from GerES IV show this clearly **(Fig. 5)**.[7]

Children's exposure to environmental tobacco smoke adversely affects their health and quality of life. The pilot study of GerES IV already showed that exposure to environmental tobacco smoke increases the incidence of inflammations of the middle ear and of infections in children. The main study now also demonstrates that environmental tobacco smoke also markedly increases levels of carcinogenic substances such as benzene and polycyclic aromatic hydrocarbons (PAHs) in indoor air; in the case of benzene concentrations the European Commission considers not to be harmful to health can be exceeded.

Mould: GerES also showed that six percent of children are sensitised to indoor mould and that some of them are sensitised even exclusively to these fungi, which are specific to indoor spaces.

[7] Krause, C., W. Babisch, K. Becker, W. Bernigau, K. Hoffmann, P. Nöllke, C. Schulz, R. Schwabe, M. Seiwert and W. Thefeld: Umweltsurvey 1990/92, Band I a: Studienbeschreibung und Human-Biomonitoring: Deskription der Spurenelemente in Blut und Urin der Bevölkerung der Bundesrepublik Deutschland. WaBoLu-Heft 1/96. Institut für Wasser-, Boden- und Lufthygiene des Umweltbundesamtes, Berlin, 1996.

As the allergy tests currently available do not cover indoor mould fungi, the UBA had special blood tests developed. These tests should become an integral part of commercial allergy tests. To this end, a dialogue between manufacturers, associations of allergy sufferers, and scientists would be useful. It was not previously known that exclusive sensitisation to indoor mould fungi exists and that some individual species cause sensitisation at all. These new findings might help clarify allergenic conditions that could not as yet be explained, and to find remedies.

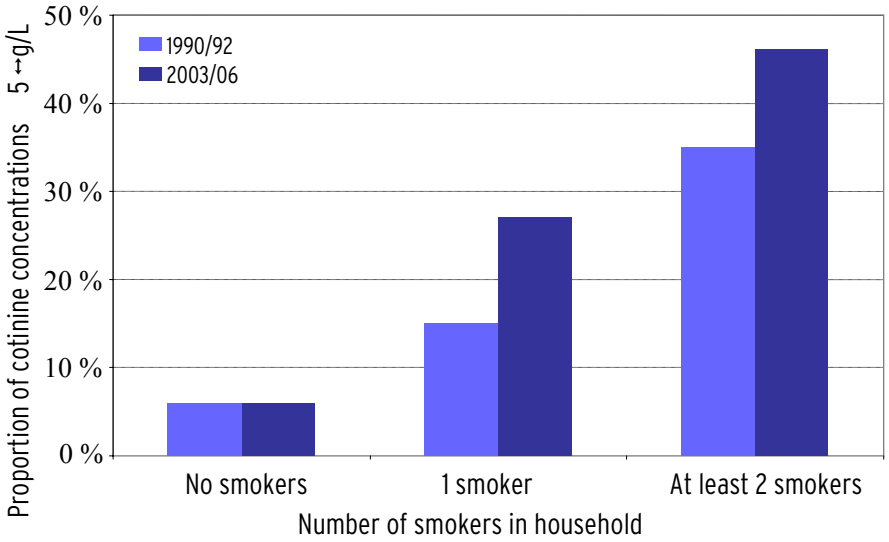

Fig. 5: Exposure of children to environmental tobacco smoke by number of smokers in household (only non-smoking children; source: GerES IV)

4.5 Noise and children's hearing

Not only chemical substances affect our children's health. It is also impaired by noise, because noise may cause disease. The UBA therefore carried out investigations on noise exposure and the effects of noise. Just how important it is to include this area is evident from the fact that about three percent of the children 8 to 14 years of age were found to suffer initial hearing loss and that around 14 percent showed a slight hearing impairment. 6 percent of the children felt disturbed by road traffic noise, according to their parents, and 5.5 percent by aircraft noise. The UBA expects to generate further findings from the GerES IV data, for example on the contribution which noise from leisure activities makes to total exposure and on the extent of health impairments.

5 Summary and Outlook

The German Environmental Survey for Children (GerES IV) is the first of its kind in Europe. It provides important information on children's exposure to environmental pollutants, on future challenges in the evaluation of health-relevant environmental factors and in ensuring fair access to a clean environment for all children living in Germany. The UBA will continue to evaluate the data and continually present the results to the scientific community and the general public.