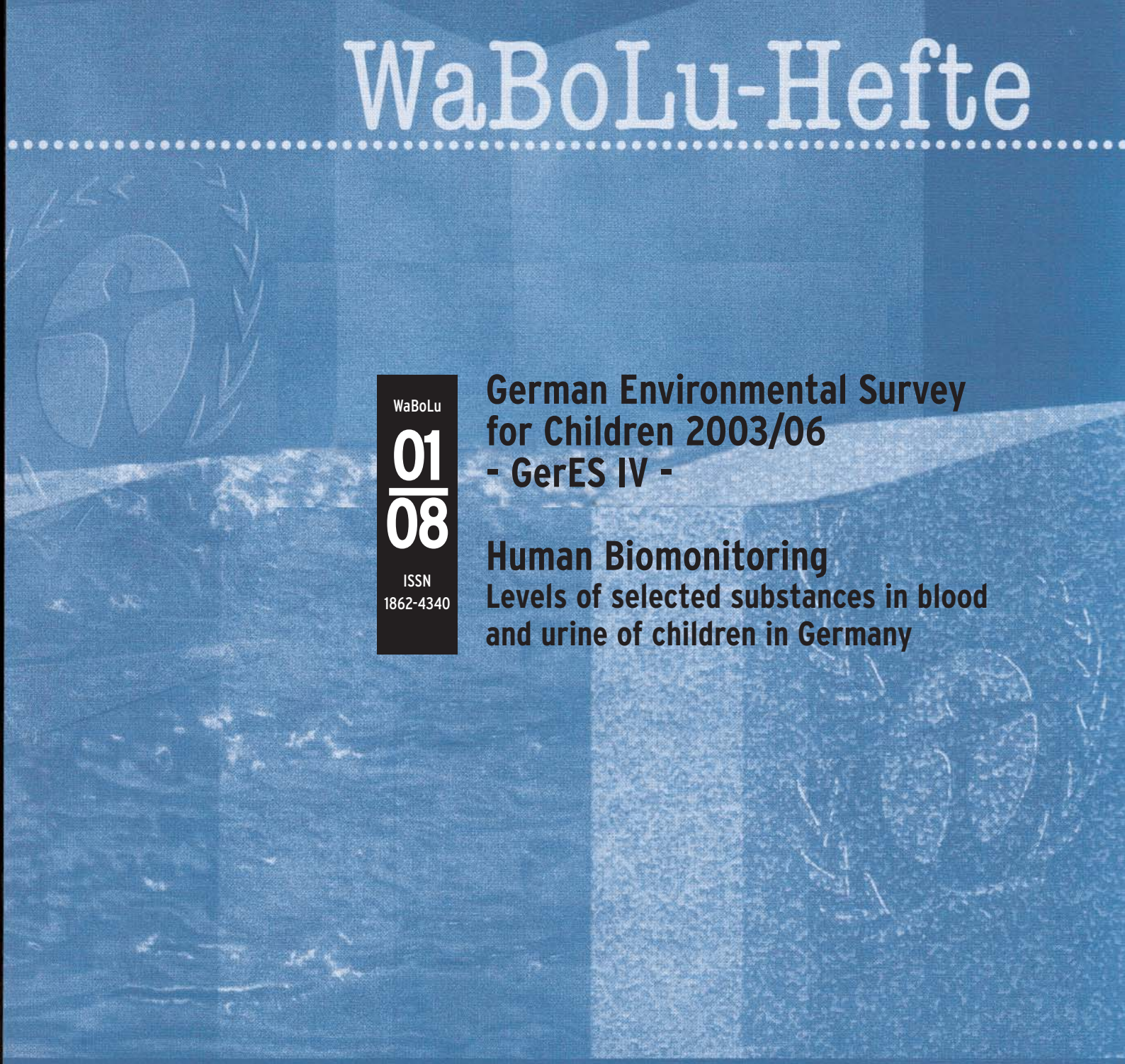
WaBoLu-Hefte



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ISSN
1862-4340

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Levels of selected substances in blood and urine of children in Germany

Umwelt Bundes Amt
Für Mensch und Umwelt

ENVIRONMENTAL RESEARCH OF THE
FEDERAL MINISTRY OF THE ENVIRONMENT,
NATURE CONSERVATION AND NUCLEAR SAFETY
Research Report 202 62 219
UBA-FB 001026

WaBoLu
01
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by

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On behalf of the Federal Environment Agency

This publication is only available at
http:/www.umweltbundesamt.de

Conducted by:	Federal Environment Agency (UBA), Dessau-Roßlau Robert Koch Institute (RKI), Berlin
Commissioned by:	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and German Aerospace Center, project contractor of the Federal Ministry of Education and Research
Project management:	M. Kolossa-Gehring / C. Schulz
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Translation from German by:	Andrea Bartel, Berlin

Acknowledgement: The authors wish to thank all parties involved in this study, particularly the citizens who took part in the time-consuming examinations, as well as the staff of the local health and environmental departments, hospitals, and other local government bodies, who supported this project.

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Section II 1.2
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Dessau-Roßlau, January 2008

Preface

In the period of May 2003 - May 2006, the fourth German Environmental Survey (GerES IV) was conducted. It was the first environmental survey referring exclusively to the examination of children and their environmental exposure. The study included a representative cross-sectional random sample of children aged 3 to 14 years in Germany. The survey was based on the examination of both blood and urine specimens sampled from the children as well as house dust and drinking water samples from the corresponding households. In order to complete the measured data, an inquiry by means of questionnaires was carried out in parallel to identify exposure-related behaviour patterns and conditions in the households and in the residential environment.

The basic evaluation of the rather comprehensive data material is presented in the form of separate reports. In the present volume entitled „Human Biomonitoring“, the basic description of the levels of a variety of substances in the blood and urine of children in Germany is given. These substances include arsenic, lead, cadmium, nickel, mercury, HCH, HCB, DDE, PCB, nicotine, cotinine, PCP and other chlorophenols, as well as metabolites of organophosphate pesticides, of PAH and of pyrethroids.

Also in the future, the results of such basic evaluation will be presented in the series, WaBoLu-Hefte. These will include the results of the analysis of element levels in drinking water, levels of organochlorine compounds in house dust, and of VOCs in indoor air of the homes where the children covered by the study lived, and the results of examinations referring to the complex of noise and noise effects. The basic description of the results in the report volumes is completed by publications on their detailed evaluation in national and international scientific journals.

For updated information on the publications related to GerES IV see
http://www.umweltbundesamt.de/survey/.

Summary

The German Environmental Survey (GerES) is a representative population study carried out in order to determine the exposure to pollutants of the general population in Germany. The study has been conducted by the Federal Environment Agency since the mid-1980s. GerES IV is the first environmental survey to determine, on a representative basis, the body burden of pollutants in children in Germany and the exposure to pollutants in their homes. It is a module of the German Health Interview and Examination Survey for Children and Adolescents (German acronym: KiGGS) and was carried out in close cooperation with the Robert Koch Institute (RKI). In a randomly selected sub-sample of the KiGGS population consisting of 1 790 children aged 3 to 14 years and living in 150 different sampling locations, also the body burden of environmental pollutants was examined.

The present report provides the basic information on the human biomonitoring part of the survey. It starts with a description of the study design and the methods used for chemical analysis and statistical evaluation, as far as such information is necessary to understand the report. The description of results is presented by specimen types (whole blood, morning urine) and within each type, by substances or groups of substances detected. A brief description is given of the substances or groups of substances considered and of the tables listing the statistical parameters for the distribution of these pollutants.

Blood specimens were analyzed for lead, cadmium, mercury, polychlorinated biphenyls (PCB), dichlorodiphenyldichloroethylene (DDE), hexachlorobenzene (HCB) and hexachlorocyclo-hexane (HCH). In urine specimens, the levels of arsenic, cadmium, mercury, nickel, nicotine and cotinine, pentachlorophenol (PCP) and other chlorophenols as well as the metabolites of polycyclic aromatic hydrocarbons (PAHs), organophosphates and pyrethroids were determined. **Table S1** summarizes the distribution data of the pollutant levels detected, stating a number of percentiles and mean values.

The report also presents the parameters characteristic of pollutant level distributions also for sub-groups of the children examined. This stratification always refers to the potential influencing variables (predictors), sex and age, social and migrant status, place of residence and community size. For some substances or groups of substances, there are additional substance-specific predictors known to be particularly important, such as breastfeeding for blood levels of organochlorine compounds.

The present report describes the body burden situation in children aged 3 to 14 in Germany during the 2003 – 2006 period and provides the scientific community interested in the subject with a contemporary review of the results of human biomonitoring (HBM). In additional publications by the Federal Environment Agency which are to follow, these HBM data will be evaluated with regard to their health relevance and compared with the results of earlier GerES. By late 2008, the data of GerES IV will be made available to interested scientists as a public use file.

Table S1: Elements and compounds in blood and urine of children in Germany

	LOQ	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Heavy metals in the blood (µg/L) of children (3 to 14 years)													
Lead	2.1	1560	4	100	9.1	16.9	29.7	33.8	42.4	100	18.2	**16.3**	15.9 - 16.7
Cadmium	0.12	1560	874	44	<LOQ	<LOQ	0.23	0.33	0.80	3.36	0.152	**<LOQ**	
Mercury	0.2	1552	637	59	<LOQ	0.2	0.7	1.0	1.3	6.3	0.33	**0.23**	0.22 - 0.24
Heavy metals and arsenic in the urine (µg/L) of children (3 to 14 years)													
Arsenic	0.6	1734	30	98	1.9	4.5	11.0	14.0	20.0	190	5.94	**4.40**	4.24 - 4.56
Cadmium	0.05	1734	519	70	<LOQ	0.08	0.17	0.22	0.28	0.97	0.090	**0.068**	0.065 - 0.070
Nickel	0.5	1567	137	91	0.51	1.30	3.15	4.50	6.50	15.0	1.68	**1.26**	1.21 - 1.31
Mercury	0.1	1734	952	45	<LOQ	<LOQ	0.3	0.5	1.0	52.0	0.19	**<LOQ**	
Organochlorine compounds in the blood (µg/L) of children (7 to 14 years)													
HCB	0.043	1079	31	97	0.06	0.10	0.17	0.21	0.27	0.74	0.110	**0.098**	0.096 - 0.101
α-HCH	0.016	1063	1063	0									
β-HCH	0.004	1063	256	76	<LOQ	0.01	0.04	0.10	0.26	1.87	0.029	**0.011**	0.010 - 0.012
γ-HCH	0.076	1063	1062	0	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	1.75	<LOQ	**<LOQ**	
DDE	0.005	1079	2	100	0.08	0.18	0.63	0.91	1.55	5.05	0.304	**0.206**	0.196 - 0.217
PCB 138	0.023	1079	30	97	0.04	0.09	0.22	0.28	0.38	0.92	0.114	**0.089**	0.085 - 0.093
PCB 153	0.013	1079	2	100	0.05	0.12	0.33	0.43	0.59	1.28	0.167	**0.129**	0.123 - 0.135
PCB 180	0.006	1079	12	99	0.02	0.06	0.21	0.28	0.38	0.81	0.096	**0.065**	0.062 - 0.069
Total PCB 38,153,180)		1079			0.11	0.28	0.76	0.98	1.35	3.00	0.377	**0.286**	0.273 - 0.299
Nicotine and cotinine in the urine (µg/L) of children (3 to 14 years)													
Nicotine	1	1723	969	44	<LOQ	<LOQ	9	23	130	3300	13.7	**1.3**	1.2 - 1.4
Cotinine	2	1723	841	51	<LOQ	2	12	28	476	2390	31.6	**2.5**	2.4 - 2.7
Organophosphate metabolites (µg/L) in the urine of children (3 to 14 years)													
DMP	0.1	599	0	100	4.9	15.2	57.8	86.2	115	908	25.6	**15.8**	14.6 - 17.1
DMTP	0.1	599	0	100	4.1	15.9	71.8	112	211	1560	33.2	**16.8**	15.4 - 18.4
DMDTP	0.1	599	47	92	0.1	0.5	3.9	8.4	16.3	253	2.31	**0.56**	0.50 - 0.63
DEP	0.1	599	0	100	1.6	6.0	20.6	29.1	38.1	526	10.7	**5.92**	5.46 - 6.43
DETP	0.1	599	2	100	0.2	1.0	6.4	9.9	23.1	83.2	2.68	**1.09**	0.98 - 1.21
DEDTP	0.01	599	204	66	<LOQ	0.02	0.16	0.34	0.72	1.71	0.079	**0.023**	0.020 - 0.026

Notes: LOQ = limit of quantification; N = sample size; n<LOQ = number of values below (LOQ); % ≥ LOQ = percentage of values above LOQ; P10, P50, P90, P95, P98 = percentiles MAX = maximum value; AM = arithmetic mean; GM = geometric mean; CI GM = approximate 95% confidence interval for GM; values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM and/or lower limit of the CI is below LOQ

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table S1c: Elements and compounds in blood and urine of children in Germany

	LOQ	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
PCP and other chlorophenols in the urine (µg/L) of children (3 to 14 years)													
2-MCP	0.1	599	13	98	0.75	1.70	4.70	6.78	9.93	41.5	2.42	**1.72**	1.60 - 1.84
4-MCP	0.1	599	6	99	1.97	4.58	9.97	15.3	25.8	102	6.45	**4.49**	4.20 - 4.81
2,4-DCP	0.1	599	69	89	<LOQ	0.33	1.14	2.52	5.16	19.3	0.713	**0.332**	0.303 - 0.363
2,5-DCP	0.1	599	12	98	0.26	0.71	3.95	7.49	23.8	517	3.45	**0.853**	0.773 - 0.942
2,6-DCP	0.1	599	457	24	<LOQ	<LOQ	0.17	0.25	0.33	1.93	<LOQ	**<LOQ**	
2,3,4-TCP	0.1	599	583	3	<LOQ	<LOQ	<LOQ	<LOQ	0.11	0.37	<LOQ	**<LOQ**	
2,4,5-TCP	0.1	599	186	69	<LOQ	0.15	0.41	0.56	0.85	4.55	0.207	**0.141**	0.131 - 0.151
2,4,6-TCP	0.1	598	114	81	<LOQ	0.22	0.57	0.82	1.43	13.7	0.327	**0.208**	0.193 - 0.224
2,3,4,6-TeCP	0.3	599	539	10	<LOQ	<LOQ	0.30	0.43	0.69	3.83	<LOQ	**<LOQ**	
PCP	0.6	599	306	49	<LOQ	<LOQ	1.32	1.64	3.13	9.71	0.718	**<LOQ**	
PAH metabolites (µg/L) in the urine of children (3 to 14 years)													
1-OH pyrene	0.012	599	4	99	0.052	0.129	0.367	0.465	0.673	4.03	0.178	**0.129**	0.121 - 0.138
1-OH phen.	0.016	599	2	100	0.077	0.187	0.454	0.595	0.901	2.42	0.240	**0.185**	0.175 - 0.196
2,9-OH phen.	0.004	599	1	100	0.053	0.119	0.253	0.367	0.571	2.00	0.153	**0.119**	0.113 - 0.126
3-OH phen.	0.005	599	0	100	0.065	0.165	0.385	0.531	0.749	2.43	0.208	**0.162**	0.153 - 0.172
4-OH-phen.	0.008	599	107	82	<LOQ	0.023	0.117	0.233	0.548	1.55	0.059	**0.024**	0.022 - 0.027
Pyrethroid metabolites (µg/L) in the urine of children (3 to 14 years)													
cis-Cl_2CA	0.1	598	241	60	<LOQ	0.12	0.52	1.00	2.38	10.8	0.314	**0.136**	0.124 - 0.148
trans-Cl_2CA	0.1	598	85	86	<LOQ	0.25	1.18	2.46	5.93	30.8	0.733	**0.280**	0.255 - 0.308
Br_2CA	0.1	598	327	45	<LOQ	<LOQ	0.52	0.91	1.69	21.9	0.293	**0.110**	0.101 - 0.120
F-PBA	0.1	598	484	19	<LOQ	<LOQ	0.21	0.43	0.81	5.04	0.125	**<LOQ**	
3-PBA	0.1	598	15	98	0.16	0.43	1.67	3.80	6.80	15.7	0.908	**0.486**	0.447 - 0.527

Notes: LOQ = limit of quantification; N = sample size; n<LOQ = number of values below LOQ; % ≥ LOQ = percentage of values above LOQ; P10, P50, P90, P95, P98 = percentiles; MAX = maximum value; AM = arithmetic mean; GM = geometric mean; CI GM = approximate 95% confidence interval for GM; values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM and/or lower limit of the CI is below LOQ

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

1 Introduction

Preventive health care and the scientific analysis of problems concerning the relationship between environmental influences and health impairment require continuous monitoring of the exposure of the population to environmental pollutants. To this aim, representative population studies are needed, which form an important pillar of health-related environmental monitoring.

This is why environmental surveys have been conducted by the Federal Environment Agency since the mid-1980s. The German Environmental Survey (GerES) is a representative study of the German population conducted from the angle of environmental epidemiology, which is based on randomly selected cross-sectional samples.

Already at the planning stage of the second German Environmental Survey in 1990/92 (GerES II), the Federal Environment Agency had identified the need to also include children in these examinations because children have to be regarded as a group with a high risk for health impairment caused by environmental exposure. Reasons for this include children's exposure-prone behaviour (hand-to-mouth contact, crawling, playing on the floor, digging in sand and uptake of dirt during dust-producing outdoor games), their special physiological conditions (elevated ventilation and absorption rates) and the resulting higher exposure to pollutants as compared to adults. A particular health risk also results from the intake of high quantities of pollutants as related to the child's body weight because the ratio of height to body surface is clearly different from that of adults. Since in addition, a child's body is a developing one, children are particularly susceptible to certain influences at different growth stages, e.g. to neurotoxic substances (lead) in the prenatal stage, or to substances having effects similar to those of (sex) hormones in puberty.

Against this background, a study on the environmental exposure of children in Germany (German Environmental Survey for Children, GerES IV) was conducted by the Federal Environment Agency (UBA) in the 2003 to 2006 period, in cooperation with and as a module of the German Health Interview and Examination Survey for Children and Adolescents (KiGGS) carried out by the Robert Koch Institute (RKI). Using GerES IV, it has become possible for the first time to make available and update representative data on the body burden of environmental pollutants in children and adolescents for the purposes of environmental health monitoring and reporting on the national level.

GerES IV was supported by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and by the Federal Ministry of Education and Research. The Ethics Committee of the Charité University Hospital of the Humboldt University of Berlin, and the Federal and Länder Commissioners for Data Protection have approved of the joint project. The field work was performed by the Robert Koch Institute, Berlin.

2 Objectives of the Environmental Survey for Children

Essential objectives of GerES IV include the recording, provision, updating and evaluation of representative data for the purposes of a health-related environmental monitoring and reporting on a national level. By linking these with the data on children aged 6 to 14 years recorded under the Environmental Survey 1990/1992 (GerES II), also temporal trends can be identified and thus be used for reviewing whether environmental policy measures taken have been successful or not. In addition, the representative data obtained shall serve

- as a basis for establishing reference values for the exposure of children to environmental pollutants and noise, which enable a uniform assessment on the German national level;
- the description of temporal trends and of regional differences in exposure levels;
- the identification and quantification of exposure pathways;
- the identification of risk groups;
- the statistical examination of possible influences of certain environmental factors on the health situation of children;
- the development and examination of prevention, intervention and reduction strategies in the framework of health and environmental policy measures.

3 Material and methods

3.1 Study design

Below, the study design and the parameters examined in GerES IV are presented in a condensed form, and a description is given of how the chemical analyses in the context of human biomonitoring were performed.

3.1.1 Sampling

GerES IV was conducted in a sub-sample randomly selected from participants of the KiGGS carried out by the RKI (Kurth et al., 2002, Kamtsiuris et al. 2007).

The target population of KiGGS consisted of children and adolescents aged between 0 and 17 years who were registered in the residents' register as having their main place of residence in the Federal Republic of Germany and living there. Children and adolescents living in institutions such as hospitals or nursing homes were excluded from participation. In order to obtain a representative study population, the RKI, in cooperation with the Centre for Survey Research and Methodology (ZUMA) in Mannheim, used a stratified multi-stage probability sample, which was selected in two steps: Selection of study locations and selection of target persons. It was intended to establish separate representative accounts for both East and West Germany with comparable precision. Therefore, disproportionate to population figures, 112 study locations in West Germany, 50 study locations in East Germany and 5 study locations in Berlin were randomly selected for KiGGS (East/West oversampling). In the third and last year of the field stage, 17 communities were selected in addition to the 150 study locations originally envisaged,

using the same algorithm (again by RKI in cooperation with ZUMA Mannheim), and included in the study so that the total number of locations had increased to 167 when the study was completed. The increase in samples, which had been approved by the scientific advisory board of the study, was necessary because (despite a high participation rate but due to participants missing appointments made for examinations) the number of KiGGS participants was slightly too low to reach the intended total number of almost 18 000 participants (Kamtsiuris et al., 2007). For GerES IV, such increase in samples was not necessary because the number of participants (1 800) could almost be reached on the basis of 150 study locations, even under conditions of a low responding rate.

Due to the considerably limited financial resources of GerES IV it was impossible to examine in its context the entire KiGGS sample comprising 18 000 children and adolescents. Therefore, a sub-sample was randomly selected for GerES IV, which was to consist of 1 800 children of the age group of 3 to 14 years living in 150 of the 167 study locations. Children whose birthday was within the two weeks of the examination date planned at the respective study location were excluded from the study. At each study location, the first three children of each one-year age group were envisaged to take part in GerES IV. These children were selected from the sampling frame of children and adolescents taking part in KiGGS according to a previously generated random number and randomly assigned rank numbers from 1 to 3. In the subsequent recruitment of subjects, this ranking determined the priority of an initial telephone or personal contact for invitation to participate in GerES IV. Initial contacts were resumed either two working days before the start of examinations at the respective location or even later, through the coordinating centre for field work at the RKI, or, in the field, by trained environmental interviewers responsible for visits to homes for the special environmental examinations. If children of the first three ranks were not prepared to take part in GerES IV, the sample for the corresponding age group was extended.

The participation rate achieved in GerES IV was 77.3 %. If referred to the KiGGS response rate of the subjects aged 3 to 14 years (67.7 %), the response rate of GerES IV was 52.6 %. When evaluating the response rate it has to be taken into account that in GerES IV only those children of the respective age group were examined who had also participated in KiGGS, so that altogether, the response rate achieved in GerES IV was lower. Altogether, 1 790 children (907 girls and 883 boys) aged 3 to 14 years and living in 150 communities or study locations, respectively, took part in GerES IV. Of these children, 232 (12.9 %) had a migration background (Schenk et al., 2007).

For reasons of economy, some analytes in urine specimens were examined in a sub-sample of GerES IV only. These include PCP and other chlorophenols as well as metabolites of PAH, organophosphates and pyrethroids. 600 urine samples were selected on a random basis from all samples characterized by a sufficiently large volume, an existing dust and blood sample (only children aged 7 years and above), which was the case for the majority of children taking part in GerES IV. Due to this selection it was possible to establish associations between house dust contamination and a number of pollutants and their metabolites in blood or urine.

3.1.2 Study programme

In GerES IV, main emphasis was laid on the analysis of biological material (human biomonitoring). The study programme was completed by additional sampling and measurements performed in private homes, and by inquiries into personal behaviour relevant in terms of environment and health, on the standard of homes and the residential environment (cf. Schulz et al., 2004). Based on the experience gained in the pilot study (Schulz et al., 2002, Wolf et al., 2004), children aged 3 years and above were examined.

The study programme of human biomonitoring encompassed the following components:

Whole blood
Blood specimens were collected in the framework of KiGGS, with only one puncture being permitted. For the GerES IV analyses, an additional tube (Blaukopf vacutainer) was filled with blood whose quantity depended on the child's age.
The quantities of whole blood collected were 2 mL from children aged 3 to 6 years and max. 7 mL from children aged 7 to 14 years. In addition, 200 µL of serum specimens obtained under the KiGGS were available for the GerES IV analyses.

Parameters examined

- In children aged 3 to 6 years: lead, cadmium, mercury;
- In children aged 7 to 14 years: lead, cadmium, mercury and organochlorine compounds such as PCB, DDE HCB and HCH;
- In all children: five fungus-specific IgE (*Penicillium (notatum) chrysogenum*, *Aspergillus versicolor, Alternaria alternata, Wallemia sebi* and *Eurotium spp*) in 200 µL serum.

Morning urine (total quantity excreted)
No morning urine specimens were taken from children still wearing diapers at night because collection of a standardized urine specimen largely free from external contamination was impossible under such conditions. Morning urine was collected as follows:

- From children aged 3 to 4 years who did no longer wear diapers at night (from girls up to 6 years of age if required or after consultation with their parents), in 750 mL toilet seat inserts;
- and from children aged 5 years and above (girls aged 7 and above, if required) in 1 L polyethylene wide-neck flasks.

Parameters of analysis

- In all children: creatinine, arsenic, cadmium, mercury, nickel, uranium, thallium, antimony, nicotine, cotinine;
- from children aged 8 years and above, also: cortisol, adrenaline and noradrenaline.
- in a randomly selected subgroup (n = 600) also:
  pentachlorophenol (PCP) and other chlorophenols, metabolites of pyrethroids, PAH and organophosphates.

Reports on the evaluation of serum IgE levels as well as of stress hormones, uranium, thallium and antimony in urine will be published at a later date.

Questionnaires
In GerES IV, the parents and also the children aged 8 years and above, were asked, by means of standardized interview-based questionnaires, about factors having an influence on the exposure, such as smoking habits, number of teeth with amalgam fillings or consumption of selected food (Schulz et al., 2004). Using a standardized questionnaire on the residential environment, the environmental interviewers assessed the residential environment of the subjects. Sampling and measurements carried out in the context of GerES IV were documented in a separate and also standardized questionnaire (sampling documentation form) (cf. Annex 7.2).

In KiGGS, parents and children aged 11 years and older were asked to complete self-administered questionnaires. One of the questions to be answered in the parental questionnaire referred to a breastfeeding history of the child. Examinations conducted in KiGGS such as blood pressure measurements and body measurements were documented in a medical measurement record sheet. The records in this sheet also included the processing of early morning urine specimens (including weighing and determination of pH values) from the GerES IV subjects as well as the date of the last fish consumption prior to blood collection (cf. Annex 7.2).

3.1.3 Field work

The field work of GerES IV (interviews, sampling, measurements) took place in the period from 19 May 2003 to 6 May 2006 and was conducted jointly with the field work of KiGGS at 150 study locations (Hölling et al., 2007). Examinations were conducted on the spot by three RKI study teams headed by physicians. Each of the study teams consisted of six members: a paediatrician, an examiner, a centre interviewer, a medical technical assistant, an environmental interviewer and a staff member performing preparatory field visits. The predominant share of GerES IV field work was done by the environmental interviewer of the respective KiGGS team (Schulz et al., 2004, Wolf et al., 2004).

An essential component of the examinations of GerES IV consisted in a visit to the homes of the subjects to be made by the environmental interviewers. The interviewers tasks during such visits included reception of the early morning urine specimens and interviews of the parents and children involved in the study. All examinations, measurements, interviews etc. conducted in KiGGS and GerES IV have been documented in an operations manual that had been developed jointly by RKI and UBA. The manual also includes descriptions of the entire project management, the tasks of team members, the procedures of field work and the measures of quality assurance taken.

At the study locations, the RKI set up study centres for a period of about two weeks. Where possible, the centres were accommodated in rooms of the public health service. The entire

examination programme of KiGGS was carried out and GerES IV specimens were processed and stored at these centres.

On the day of the KiGGS examinations, blood was collected by a paediatrician at the study centre (cf. Chapter 3.2.1). Collection and processing of specimens as well as the data on the last fish meal eaten by the child prior to blood collection were documented in the KiGGS medical measurement record sheet (Hölling et al., 2007). For morning urine specimens, the entire quantity of morning urine was collected in the morning of the visit to the home, as a rule, and received by the environmental interviewer in the course of the day, who ensured immediate storage in a refrigerated container.

The specimens collected and compiled (whole blood and morning urine) were processed at the study centre without delay and prepared for transport. The specimens were stored and transported in a deep-frozen state at -20°C. The laboratory specimens were transported from the study centre to Berlin once a week and stored at the UBA in a deep-frozen state (at -20°C) until analysis.

Quality assurance
The quality of field work was ensured by internal and external controls and by the implementation of proposals for field work optimisation resulting from the controlling activities (Wolf et al., 2004). Internal quality assurance (QA) was ensured by RKI and UBA staff, and external QA, by a staff member of the GFS National Research Centre for Environment and Health (GSF) in Neuherberg. Quality controls in the field and during visits to homes were conducted according to uniform criteria, which had been harmonized between all three institutions and laid down in checklists (operations manual). For quality assurance of field work, the study teams also attended courses of additional and refresher training.

3.2 Analytical methods

The chemical analyses for human biomonitoring were performed at the UBA and a number of contract laboratories.

External laboratories were commissioned to perform analyses for the substances listed in Chapter 4, except for lead, cadmium and mercury in blood. A synoptic view of the analytical methods used and the laboratories involved in the analyses is given in the Table in Chapter 7.1 of the Annex.

Quality assurance

The analyses had to be conducted at the highest possible level of precision and accuracy. For the placing of orders, it was therefore required to pay particular attention to corresponding measures of quality assurance.

The validity of the analytical methods used was ensured by internal and external quality controls and by successful participation in interlaboratory studies, as far as these were available for the

respective substance groups examined. The accuracy of measuring results was determined by analysis of controls. In addition, comparability of analytical results with the results of previous surveys was ensured. To this aim, additional samples (ca. 5 % of genuine samples) which had already been analyzed in previous surveys were “mixed in”. These specimens were provided by the Federal Environment Agency from the stock of samples from previous GerES.

3.3 Statistical methods

In the following, the statistical methods and parameters applied, the selection of variables used for the definition of sub-samples (stratification) and weighting are described. In order to be able to make representative statements on the children in Germany, weighting has been performed in all evaluations. The main purpose of weighting is to adapt the age structure of the GerES IV sample to the general population and to make up for the disproportionately higher number of subjects selected in East Germany.

3.3.1 Weighting

The GerES IV sample is a representative random sample of subjects selected according to the variables of age, gender, East and West Germany and community size. Due to the presence of non-responders, the sample selected and the study population differ with regard to the proportional distribution of the sampling variables age, gender and community size. In addition, East Germany is considerably over-represented in the sample as compared to West Germany for reasons of research strategy. In order to restore the proportions for the population of Germany as a whole, the sample was weighted on the basis of population data established by the German Federal Statistical Office as of 31 December 2004. These data represent the best characterization of the population structure over the entire study period (May 2003 – May 2006). Calculation of the weighting variable was done at the RKI (Schaffrath-Rosario, 2007).

3.3.2 Parameters describing distribution

To describe the distributions of levels of substances in the media, the following statistical parameters are stated in the tables: Sample size (N), number of values below the respective analytical limit of quantification (n<LOQ), percentage of values exceeding the LOQ (%≥LOQ), percentiles (P10, P50, P90, P95, P98), maximum value (MAX), arithmetic mean (AM), geometric mean (GM) and the 95 % confidence interval for the geometric mean (CI GM).

Percentiles and maximum values serve to describe the distribution of samples. The percentiles of the upper measuring range were emphasized for reasons of environmental and health policy because on the one hand, these percentiles are used to derive reference values and on the other, populations with a higher exposure (higher body burdens) are of particular interest with

regard to preventive health care. The distributions of substance levels are, as a rule, highly asymmetrical and approximately lognormal.

For a description of the average location of data, the arithmetic mean and the geometric mean are stated in addition to the median (50^{th} percentile). Of the three measures of location (measures of central tendency), the GM is the preferred one because in contrast to the median, it takes into account all values measured and represents the “ideal” measure of central tendency in the event of logarithmic normal distribution. For asymmetrical distributions, the AM is unfavourable as a measure of central tendency. The difference between AM and GM or median can be regarded as an indicator of skewness.

In calculations of AM, GM and CI GM, the values below the limit of quantification were taken into account as LOQ/2. This is a procedure commonly used which, however, is arbitrary to a certain extent. The calculated parameters become more problematic with a rising number of values measured below the LOQ. In order to illustrate this fact, AMs and GMs, respectively that are below the LOQ are not stated in numerical form, and no confidence interval is given.

The figures given in the tables are rounded, as a rule. This also refers to the tabulated sub-sample sizes which are calculated as a sum of weighting factors. Due to the arising rounding inaccuracies, the sum of the sub-sample sizes may not exactly correspond to the total sample size. However, the minor deviations arising from rounding are negligible. The differences between the sum of sub-sample sizes and the total sample size arise if a number of subjects failed to answer to the respective question.

3.3.3 Definition of sub-samples

The levels of substances are described not only for the total sample of 3- to 14-year-old children but also for selected sub-groups. The definition of these sub-groups is based on stratification variables. For all substances, the following standard stratification variables have been used: Gender, age, socioeconomic status, migrant status, place of residence (East and West Germany) and community size. On the one hand, these variables were chosen because of their potential importance. On the other hand, the sampling procedure was based on place of residence (East and West Germany), community size, gender and age. Beyond this, the importance of socioeconomic status and migrant status has increasingly become a subject of political discussion. In addition, the main influencing variable (predictor) for each substance has been chosen as a substance-specific stratification variable. All tabulated stratification variables have been explained in Chapter 7.2 (wording of questions and answer categories, calculation rules for the formation of indices, substantiation of interval formation of measuring variables).

For each variable selected for stratification, it was tested whether significant differences existed between the body burdens found in the groups of persons defined by the respective variable or, in other words, whether a significant association existed between the variable and the pollutant levels detected.

As a rule, it was examined whether the geometric means of the different groups of persons differed significantly. For this purpose, t-tests (for two groups to be compared) or one-way analyses of variance (for more than two groups to be compared) were performed using the levels of substances in logarithmic form.

For pollutants with a high percentage of measured values below the limit of quantification, the significance tests were based on dichotomized values (below vs. above LOQ). By means of the x^2 test for contingency tables, it has been examined whether the percentage of values below LOQ differed significantly between the different groups of persons or, in other words, whether a significant association existed between the dichotomized levels of pollutants and the variable defining the group of persons.

If a stratification variable has not been marked with an asterisk (*), it has to be assumed that possible differences between the groups of persons are coincidental and cannot be generalized for the population.

Statistical calculations were performed with the statistics software SPSS for Windows, Version 14. The version of the GerES IV database of January 2007 was used.

4 Results

In the following sections, a description is given of the measuring results for a number of substances in the blood and urine of 3- to 14-year-old children in Germany.

It has been the purpose of evaluation to describe the body burden found in 3- to 14-year-old children in Germany, on the one hand, and on the other that found in a great number of sub-samples. As a result of this evaluation, bivariate relationships are revealed between the target variable (pollutant levels) and the structuring variables. The data serve as a basis to establish and update, respectively, reference values in children.

The approach chosen in this volume is different from that used in previous surveys. It has been the objective of the present report to provide a quick overview of the results of GerES IV so that the scientific community and other interested parties can have a rapid access to data. Therefore, a comprehensive description, temporal comparison of values, description of substance levels exceeding human biomonitoring levels and international comparison of measurements have been omitted. These results and those of further evaluations will be communicated in future publications.

The description of the levels of pollutants detected in 3- to 14-year-old children in Germany has been structured by type of specimens (blood, urine) and pollutants measured. It contains a short text part for each substance group and the substance-specific tables stating the levels of the parameters for the parent population and for defined subgroups.

In the text part, a short information is given on the importance of the individual pollutants, their relevance in terms of environmental health and their toxicological classification. This is followed by a description of the parameters measured.

For each target variable (pollutant), the same statistical parameters were calculated and presented in tables with uniform headings. In each table, one particularly meaningful parameter is highlighted in bold type and by a coloured background, which represents the geometric mean, as a rule. Only for pollutants with a high number of measurements below the limit of quantification (LOQ), the percentage of measurements above the LOQ has been highlighted.

In the tables, the results of tests for significant differences of mean values of the GM between the sub-populations marked with an asterisk represent the significance level. The different significance levels are not discussed in the text to ensure its conciseness.

4.1 Heavy metals (Pb, Cd, Ni, Hg) and arsenic in blood and urine

The elements, lead, cadmium, mercury and arsenic are environmental pollutants of particular relevance in toxicology. Although their ubiquitous distribution in the environment has decreased in recent years, these substances are counted among those whose presence in the environment has to be furthermore reduced. This applies in particular to lead because recent findings have suggested that even low concentrations of lead may have neurotoxic effects on the development of children (WHO, 1995; Kommission Human-Biomonitoring, 2002). In addition, lead is probably carcinogenic to humans, according to recent studies (Group 2A of the IARC list). Sufficient data are available providing evidence of carcinogenic effects of the substance in animal studies (WHO, IARC, 2006).

Carcinogenic effects in humans of arsenic, cadmium and nickel compounds (except for metallic nickel, which has been classified as “reasonably anticipated to be a human carcinogen”) have been known for a relatively long time. Due to their confirmed carcinogenic effects in humans, these substances have been assigned to Group 1 of the IARC list (2006). In addition, chronic exposure to metals may cause a great number of toxicological effects, e.g. nephrotoxic effects (cadmium) and neurological effects (lead).

Some of the target elements of analysis (As, Pb, Cd, Ni, Hg) may cross the placental barrier or pass into breast milk (Cd, Hg, Ni, Pb) so that a body burden of heavy metals may be found already in foetuses and infants (Böse-O’Reilly et al. 1999, Wilhelm 1999, Wünschmann et al., 2004). Body burdens of heavy metals and arsenic in childhood mainly result from dietary intake (food or drinking water) and intake of soil particles and dust. Airborne exposure to heavy metals has decreased in recent years and is of importance only in the vicinity of emitters.

The tables below show numerical values for the statistical parameters describing the distribution of heavy metals and arsenic in blood and urine of the 3- to 14-year-old children in Germany. The distributions stated have also been stratified by essential structuring variables (cf. Chapter 3.3.3).

Levels of the heavy metals, lead, mercury, cadmium and arsenic in blood and urine of children were also determined in the German Environmental Survey 1990/92 (GerES II). Hence, the essential exposure pathways and predictors such as fish consumption for arsenic in urine and mercury in blood, smoking for cadmium in blood and urine, or the number of teeth with amalgam fillings for mercury in urine have been known and discussed (Krause et al., 1996). They have been included in the standard description.

The mean level of arsenic in urine was 4.4 µg/L (Table 4.1.1). It was significantly higher in boys than in girls and was found to decrease with age. The mean levels (GM) detected in migrants, children from the West Germany and children from large communities were higher than those in children from the respective control group. As expected, an association with fish consumption within 48 hours prior to sampling was observed.

The mean lead level in blood was 16.3 µg/L. It was found to decrease with increasing age and was higher in boys than in girls (Table 4.1.2). Significantly higher mean lead levels were found in the blood of children from the East Germany. Lower mean lead levels were found in children of migrants. The comparatively highest mean levels in blood were found in children with a low socioeconomic status.

For cadmium in blood, the majority of levels measured was below the LOQ (Table 4.1.3). The percentage of levels above the LOQ was found to increase with age. It was higher in migrants than in non-migrants and markedly higher in smoking children than in non-smoking children. An age effect was also seen for cadmium in urine, with mean levels increasing with age (Table 4.1.4). Smoking was found to cause a marked increase in cadmium levels. Table 4.1.4 shows the results for cadmium in urine. Also the mean level (GM) in urine was found to increase with age. This result is plausible since also the percentage of active smokers among the children was found to increase with age.

Table 4.1.5 describes the results for of nickel in urine. The mean nickel level was found to decrease with increasing age. Comparatively lower nickel levels in urine were found in children with a high socioeconomic status and in non-migrants.

Age, socioeconomic status, migrant status, size of the community and frequency of fish consumption were found to be significant predictors of mean levels of mercury in blood (Table 4.1.6). The of percentage quantifiable mercury levels in urine was found to increase with an increasing number of teeth with amalgam fillings (Table 4.1.7). Quantifiable levels of mercury in urine were more often detected in boys and migrants than in girls and non-migrants, respectively.

Table 4.1.1: Arsenic (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.6 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1734	30	98	1.9	4.5	11.0	14.0	20.0	190	5.94	**4.40**	4.24 - 4.56
Gender ***												
Boys	877	7	99	2.1	4.7	12.0	15.0	19.5	190	6.45	**4.76**	4.54 - 5.00
Girls	857	22	97	1.7	4.3	9.6	13.0	20.0	82.0	5.41	**4.07**	3.86 - 4.30
Age ***												
3 to 5 years	380	4	99	2.3	4.9	11.0	15.0	18.0	97.0	6.14	**4.86**	4.53 - 5.22
6 to 8 years	432	5	99	2.1	4.7	11.0	15.4	22.1	75.0	6.32	**4.71**	4.39 - 5.06
9 to 11 years	434	9	98	1.7	4.3	9.9	13.0	19.4	65.0	5.53	**4.08**	3.78 - 4.40
12 to 14 years	488	12	98	1.8	4.2	9.8	14.0	21.0	190	5.80	**4.11**	3.83 - 4.41
Socioeconomic status												
Low	411	9	98	2.0	4.5	9.6	12.0	23.5	190	6.29	**4.25**	3.93 - 4.60
Intermediate	795	12	99	1.8	4.5	11.0	15.0	19.0	75.0	5.80	**4.38**	4.15 - 4.62
High	509	9	98	2.0	4.7	11.0	14.0	20.0	82.0	5.92	**4.61**	4.32 - 4.92
Migrant status **												
Migrant	225	1	99	2.3	5.2	12.7	15.0	20.5	190	7.35	**5.05**	4.58 - 5.57
Non-migrant	1506	28	98	1.9	4.4	11.0	14.0	20.0	97.0	5.72	**4.31**	4.14 - 4.48
Place of residence **												
East Germany	230	5	98	1.6	3.8	9.4	13.5	23.1	97.0	5.39	**3.85**	3.47 - 4.27
West Germany	1504	25	98	1.9	4.7	11.0	14.0	19.0	190	6.02	**4.50**	4.33 - 4.68
Community size (inhabitants) **												
< 100 000	812	11	99	1.8	4.3	9.6	13.0	17.9	82.0	5.54	**4.19**	3.98 - 4.41
≥ 100 000	922	19	98	2.0	4.8	11.0	15.0	21.0	190	6.29	**4.61**	4.38 - 4.85
Fish consumption within the last 48 hours prior to urine sampling ***												
No	1487	26	98	1.8	4.3	9.7	12.4	16.0	82.0	5.27	**4.16**	4.01 - 4.32
Yes	231	3	99	2.6	6.2	18.0	32.0	59.0	190	10.3	**6.49**	5.78 - 7.28

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.1.2: Lead (µg/L) in the blood of children (3 to 14 years) in Germany

[Limit of quantification: 2.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1560	4	100	9.1	16.9	29.7	33.8	42.4	100	18.2	**16.3**	15.9 - 16.7
Gender ***												
Boys	813	1	100	9.9	18.2	30.9	37.0	44.1	100	19.4	**17.5**	16.9 - 18.1
Girls	747	2	100	8.3	15.4	26.2	31.9	39.4	90.1	16.9	**15.1**	14.6 - 15.6
Age ***												
3 to 5 years	315	1	100	10.1	19.6	34.2	39.9	46.0	90.1	21.4	**19.1**	18.1 - 20.2
6 to 8 years	377	0	100	10.1	17.9	30.5	33.4	43.5	61.0	19.0	**17.3**	16.5 - 18.1
9 to 11 years	407	2	100	8.7	15.6	27.0	31.4	41.3	68.8	17.4	**15.6**	14.9 - 16.4
12 to 14 years	460	1	100	7.6	14.6	25.1	30.5	39.1	100	16.1	**14.5**	13.9 - 15.2
Socioeconomic status **												
Low	357	0	100	10.1	17.1	30.4	37.1	48.4	61.0	19.3	**17.4**	16.6 - 18.2
Intermediate	721	0	100	9.1	16.9	30.4	33.2	41.3	100	18.3	**16.3**	15.7 - 16.9
High	469	4	99	8.5	16.5	26.5	31.1	43.3	71.8	17.4	**15.5**	14.8 - 16.3
Migrant status *												
Migrant	187	0	100	8.3	15.6	25.7	32.7	39.1	46.1	16.6	**15.1**	14.1 - 16.2
Non-migrant	1370	4	100	9.2	17.1	29.9	34.4	43.0	100	18.4	**16.5**	16.1 - 16.9
Place of residence												
East Germany	206	0	100	9.3	17.6	32.1	39.0	49.6	100	19.5	**17.2**	16.1 - 18.4
West Germany	1354	4	100	9.0	16.8	29.2	32.8	41.3	61.0	18.0	**16.2**	15.8 - 16.6
Community size (inhabitants)												
< 100 000	738	2	100	9.6	16.8	30.0	34.7	44.5	100	18.4	**16.5**	15.9 - 17.1
≥ 100 000	822	2	100	8.7	17.0	28.6	33.7	40.6	90.1	18.1	**16.2**	15.7 - 16.8

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.1.3: Cadmium (µg/L) in the blood of children (3 to 14 years) in Germany

[Limit of quantification: 0.12 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1560	874	**44**	<0.12	<0.12	0.23	0.33	0.80	3.36	0.152	<0.12	
Gender												
Boys	813	458	**44**	<0.12	<0.12	0.23	0.31	0.60	2.80	0.138	<0.12	
Girls	747	416	**44**	<0.12	<0.12	0.25	0.39	1.52	3.36	0.167	<0.12	
Age ***												
3 to 5 years	315	212	**33**	<0.12	<0.12	0.18	0.25	0.32	0.85	<0.12	<0.12	
6 to 8 years	377	224	**41**	<0.12	<0.12	0.20	0.26	0.40	0.83	<0.12	<0.12	
9 to 11 years	407	243	**40**	<0.12	<0.12	0.21	0.25	0.31	1.05	<0.12	<0.12	
12 to 14 years	460	195	**58**	<0.12	0.13	0.47	1.25	2.25	3.36	0.256	0.136	0.125 - 0.148
Socioeconomic status												
Low	357	207	**42**	<0.12	<0.12	0.26	0.58	2.25	3.36	0.198	<0.12	
Intermediate	721	414	**43**	<0.12	<0.12	0.22	0.30	0.58	2.13	0.129	<0.12	
High	469	248	**47**	<0.12	<0.12	0.25	0.39	0.74	2.34	0.151	<0.12	
Migrant status **												
Migrant	187	86	**54**	<0.12	0.12	0.25	0.33	0.67	1.90	0.151	<0.12	
Non-migrant	1370	785	**43**	<0.12	<0.12	0.23	0.34	0.82	3.36	0.152	<0.12	
Place of residence												
East Germany	206	116	**44**	<0.12	<0.12	0.22	0.34	1.26	2.13	0.145	<0.12	
West Germany	1354	759	**44**	<0.12	<0.12	0.24	0.34	0.77	3.36	0.153	<0.12	
Community size (inhabitants)												
< 100 000	738	415	**44**	<0.12	<0.12	0.23	0.38	0.89	3.36	0.155	<0.12	
≥ 100 000	822	459	**44**	<0.12	<0.12	0.24	0.32	0.70	2.85	0.150	<0.12	
Smoking status ***												
Non-smoker	1498	868	**42**	<0.12	<0.12	0.22	0.27	0.39	2.14	<0.12	<0.12	
Smoker	62	6	**90**	<0.12	0.56	2.57	2.83	3.36	3.36	0.963	0.506	0.367 - 0.697

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM < LOQ Significance test: chi-square test of independence (comparison of measured values below and above LOQ)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.1.4: Cadmium (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.05 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1734	519	70	<0.05	0.08	0.17	0.22	0.28	0.97	0.090	**0.068**	0.065 - 0.070
Gender												
Boys	877	251	71	<0.05	0.07	0.18	0.21	0.27	0.96	0.090	**0.069**	0.065 - 0.072
Girls	857	268	69	<0.05	0.08	0.17	0.22	0.28	0.97	0.089	**0.066**	0.063 - 0.070
Age ***												
3 to 5 years	380	157	59	<0.05	0.06	0.15	0.20	0.26	0.97	0.077	**0.056**	0.052 - 0.061
6 to 8 years	432	130	70	<0.05	0.07	0.16	0.19	0.23	0.34	0.081	**0.064**	0.060 - 0.068
9 to 11 years	434	116	73	<0.05	0.08	0.19	0.23	0.29	0.59	0.092	**0.070**	0.065 - 0.075
12 to 14 years	488	115	76	<0.05	0.09	0.19	0.25	0.32	0.96	0.106	**0.080**	0.074 - 0.085
Socioeconomic status												
Low	411	130	68	<0.05	0.07	0.18	0.24	0.29	0.59	0.088	**0.065**	0.060 - 0.070
Intermediate	795	226	72	<0.05	0.08	0.17	0.21	0.27	0.97	0.091	**0.069**	0.066 - 0.073
High	519	153	70	<0.05	0.08	0.17	0.22	0.26	0.96	0.089	**0.067**	0.063 - 0.072
Migrant status												
Migrant	225	63	72	<0.05	0.08	0.19	0.26	0.42	0.59	0.097	**0.071**	0.064 - 0.079
Non-migrant	1506	453	70	<0.05	0.08	0.17	0.22	0.27	0.97	0.089	**0.067**	0.065 - 0.070
Place of residence												
East Germany	230	73	68	<0.05	0.07	0.17	0.23	0.34	0.52	0.089	**0.066**	0.060 - 0.073
West Germany	1504	446	70	<0.05	0.08	0.18	0.22	0.27	0.97	0.090	**0.068**	0.065 - 0.070
Community size (inhabitants)												
< 100 000	812	243	70	<0.05	0.07	0.17	0.22	0.27	0.47	0.086	**0.066**	0.063 - 0.070
≥ 100 000	922	275	70	<0.05	0.08	0.18	0.23	0.29	0.97	0.093	**0.069**	0.065 - 0.072
Smoking status **												
Non-smoker	1667	506	70	<0.05	0.07	0.17	0.21	0.27	0.97	0.089	**0.067**	0.064 - 0.069
Smoker	66	13	81	<0.05	0.10	0.25	0.35	0.42	0.42	0.120	**0.090**	0.074 - 0.110

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.1.5: Nickel (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.5 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1567	137	91	0.51	1.30	3.15	4.50	6.50	15.0	1.68	**1.26**	1.21 - 1.31
Gender												
Boys	814	65	92	0.54	1.30	3.10	4.00	5.10	9.10	1.62	**1.27**	1.21 - 1.34
Girls	753	71	91	0.51	1.30	3.40	5.10	7.50	15.0	1.75	**1.26**	1.19 - 1.34
Age **												
3 to 5 years	311	25	92	0.57	1.50	3.50	5.07	9.73	15.0	1.90	**1.40**	1.28 - 1.53
6 to 8 years	390	38	90	<0.5	1.40	3.87	4.90	6.67	13.0	1.82	**1.34**	1.23 - 1.46
9 to 11 years	402	38	90	0.50	1.20	2.90	3.78	5.00	9.00	1.47	**1.14**	1.06 - 1.23
12 to 14 years	464	35	93	0.52	1.20	3.10	3.97	6.50	11.0	1.61	**1.23**	1.15 - 1.32
Socioeconomic status ***												
Low	364	20	95	0.58	1.36	3.40	4.59	6.30	15.0	1.73	**1.33**	1.23 - 1.43
Intermediate	723	59	92	0.51	1.40	3.50	5.00	7.33	12.0	1.80	**1.33**	1.25 - 1.41
High	463	57	88	<0.5	1.20	2.70	3.45	4.75	11.0	1.46	**1.11**	1.03 - 1.19
Migrant status *												
Migrant	195	7	96	0.61	1.40	3.16	5.50	7.77	13.0	1.85	**1.42**	1.28 - 1.57
Non-migrant	1370	129	91	0.50	1.30	3.20	4.36	6.50	15.0	1.66	**1.24**	1.19 - 1.29
Place of residence												
East Germany	210	25	88	<0.5	1.20	3.20	4.72	6.50	15.0	1.63	**1.17**	1.04 - 1.31
West Germany	1357	112	92	0.53	1.30	3.12	4.41	6.50	12.0	1.69	**1.28**	1.23 - 1.33
Community size (inhabitants)												
< 100 000	730	61	92	0.54	1.30	3.20	4.70	6.50	15.0	1.73	**1.29**	1.22 - 1.37
≥ 100 000	837	75	91	0.51	1.30	3.10	4.30	6.20	13.0	1.65	**1.24**	1.18 - 1.31

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.1.6: Mercury (µg/L) in the blood of children (3 to 14 years) in Germany

[Limit of quantification: 0.2 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1552	637	59	<0.2	0.2	0.7	1.0	1.3	6.3	0.33	**0.23**	0.22 - 0.24
Gender												
Boys	811	331	59	<0.2	0.2	0.8	1.0	1.4	6.3	0.35	**0.24**	0.22 - 0.25
Girls	741	307	59	<0.2	0.2	0.7	0.9	1.3	2.4	0.31	**0.23**	0.21 - 0.24
Age *												
3 to 5 years	311	140	55	<0.2	0.2	0.7	0.9	1.2	1.9	0.30	**0.21**	0.20 - 0.23
6 to 8 years	377	162	57	<0.2	0.2	0.7	0.9	1.5	6.3	0.34	**0.23**	0.21 - 0.25
9 to 11 years	407	177	57	<0.2	0.2	0.7	0.9	1.3	2.4	0.31	**0.22**	0.21 - 0.24
12 to 14 years	456	158	65	<0.2	0.3	0.8	1.0	1.4	2.2	0.36	**0.26**	0.24 - 0.28
Socioeconomic status * **												
Low	354	134	62	<0.2	0.2	0.7	1.0	1.4	6.3	0.35	**0.24**	0.22 - 0.26
Intermediate	720	331	54	<0.2	0.2	0.7	0.9	1.2	2.2	0.30	**0.21**	0.20 - 0.23
High	465	168	64	<0.2	0.3	0.8	1.1	1.5	2.4	0.36	**0.25**	0.23 - 0.27
Migrant status *												
Migrant	185	67	64	<0.2	0.3	0.9	1.2	1.9	6.3	0.42	**0.27**	0.24 - 0.31
Non-migrant	1363	568	58	<0.2	0.2	0.7	0.9	1.3	2.4	0.32	**0.23**	0.22 - 0.24
Place of residence												
East Germany	205	86	58	<0.2	0.3	0.6	0.9	1.3	2.4	0.30	**0.22**	0.20 - 0.25
West Germany	1347	551	59	<0.2	0.2	0.7	1.0	1.3	6.3	0.34	**0.23**	0.22 - 0.24
Community size(inhabitants) *												
< 100.000	737	317	57	<0.2	0.2	0.7	0.9	1.2	2.2	0.31	**0.22**	0.21 - 0.23
≥ 100.000	814	320	61	<0.2	0.3	0.8	1.0	1.4	6.3	0.35	**0.24**	0.23 - 0.26
Frequency of fish consumption per month * **												
Up to three times	891	446	50	<0.2	<0.2	0.6	0.8	1.0	6.3	0.27	**<0.2**	
More than three times	660	190	71	<0.2	0.3	0.9	1.2	1.4	2.4	0.41	**0.29**	0.27 - 0.31

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.1.7: Mercury in the urine (µg/L) of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1734	952	**45**	<0.1	<0.1	0.3	0.5	1.0	52.0	0.19	<0.1	
Gender *												
Boys	877	456	**48**	<0.1	<0.1	0.4	0.5	1.0	4.3	0.18	0.10	0.10 - 0.11
Girls	857	496	**42**	<0.1	<0.1	0.3	0.5	0.9	52.0	0.21	<0.1	
Age												
3 to 5 years	380	221	**42**	<0.1	<0.1	0.3	0.4	0.8	52.0	0.26	<0.1	
6 to 8 years	432	238	**45**	<0.1	<0.1	0.3	0.4	0.7	2.3	0.15	<0.1	
9 to 11 years	434	243	**44**	<0.1	<0.1	0.3	0.5	0.8	7.3	0.16	<0.1	
12 to 14 years	488	250	**49**	<0.1	<0.1	0.4	0.7	1.4	4.7	0.20	0.11	0.10 - 0.12
Socioeconomic status												
Low	411	214	**48**	<0.1	<0.1	0.4	0.7	1.3	2.2	0.18	0.11	0.10 - 0.12
Intermediate	795	444	**44**	<0.1	<0.1	0.3	0.5	0.9	7.3	0.17	<0.1	
High	509	286	**44**	<0.1	<0.1	0.3	0.5	0.8	1.7	0.15	<0.1	
Migrant status *												
Migrant	225	109	**52**	<0.1	0.1	0.4	0.7	1.7	52.0	0.39	0.11	0.10 - 0.13
Non-migrant	1506	841	**44**	<0.1	<0.1	0.3	0.5	0.9	7.3	0.16	<0.1	
Place of residence												
East Germany	230	122	**47**	<0.1	<0.1	0.4	0.6	1.6	7.3	0.19	0.10	<0.1 - 0.12
West Germany	1504	830	**45**	<0.1	<0.1	0.3	0.5	0.9	52.0	0.19	<0.1	
Community size (inhabitants)												
< 100 000	812	455	**44**	<0.1	<0.1	0.3	0.5	0.9	7.3	0.16	<0.1	
≥ 100 000	922	497	**46**	<0.1	<0.1	0.4	0.5	1.0	52.0	0.22	0.10	0.10 - 0.11
Amalgam fillings * **												
None	1612	909	**44**	<0.1	<0.1	0.3	0.5	0.7	52.0	0.18	<0.1	
1 to 2 teeth	68	26	**62**	<0.1	0.1	1.2	1.5	2.2	4.7	0.35	0.16	0.12 - 0.21
More than 2 teeth	39	13	**67**	<0.1	0.2	1.7	3.1		3.4	0.51	0.21	0.14 - 0.32

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM < LOQ Significance test: x^2 test of independence (comparison of measured values below and above LOQ) * (p≤0,05), ** (p≤0,01), *** (p≤0,001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

4.2 Organochlorine compounds in blood

The particular relevance of organochlorine compounds as environmental pollutants is based on their toxicity and on the fact that they accumulate in the food chain and in human body fat due to their lipophilic character. Production, trade in and use of these substances have been banned or, in the case of lindane, made subject to legal limitations. In GerES IV, blood was examined for HCB (hexachlorobenzene), isomers of hexachlorocyclohexane (α-, β- and γ-HCH), DDE (dichlorodiphenyldichloroethylene) as a metabolite of DDT, and six congeners of polychlorinated biphenyls (PCB 28, PCB 52, PCB 101, PCB 138, PCB 153, PCB 180). These substances are examples of a great number of organochlorine compounds present in the environment.

Organochlorine compounds may cause immunotoxic, neurological and endocrine effects. PCB have been classified as probably carcinogenic to humans (Group 2A, IARC list, 2006) and DDT, HCB and HCH, as possibly carcinogenic to humans (Group 2B, IARC list, 2006).

For the population not exposed at the workplace, the essential exposure pathway is through food consumption, particularly that of foods rich in fat of animal origin. In children, a history of breastfeeding is an essential exposure pathway, of which evidence can be found also in later years of life (Nawrot et al. 2002, Karmaus et al. 2001). In the process of breastfeeding, substances accumulated in the fatty tissue of the mother are released and passed on to the child with the breast milk (Lackmann et al., 2005). Also, if energy reserves are mobilized during pregnancy, the substances may be transmitted by the transplacental route. Particular attention should be paid to the fact that effects of the intake of pollutants in early stages of development may become evident only after years or decades (Böse-O'Reilly 1999).

Although it could be demonstrated in a number of studies that the concentration of organochlorine compounds in breast milk has been largely on the decrease (Schade und Heinzow 1998, Doering et al. 1999, Vieth et al. 1996), breastfeeding could nevertheless be identified as a significant predictor of HCB and PCB levels in the blood of 9- to 11-year-old children, for example in the context of the project "Beobachtungsgesundheitsämter" (surveillance by public health departments) in the federal Land of Baden-Württemberg (LGA 2002). This is why the breastfeeding status of children has been included in the standard description given below.

The distribution of levels of organochlorine compounds found in the blood of 7- to 14-year-old children in Germany is shown in Tables 4.2.1 to 4.2.11. The levels of lower chlorinated PCB (PCB 28, PCB 52, PCB 101) were mostly below the limit of quantification (Tables 4.2.2 to 4.2.4). The geometric means of the highly chlorinated PCB in blood were 0.089 µg/L for PCB 138, 0.129 µg/L for PCB 153, 0.065 µg/L for PCB 180 and 0.286 µg/L for the total PCB (138+153+180) (Tables 4.2.5 to 4.2.8).

PCB levels found in boys were higher than those found in girls (for PCB 138, however, the significance level required was not reached). The mean levels were found to decrease with increasing age. Comparatively higher mean levels were calculated for children from households

with a high socioeconomic status and for non-migrants. Children living in West Germany showed higher mean PCB levels than those living in East Germany.

The mean DDE level in the blood of the children was 0.206 µg/L. Also, mean DDE levels were found to decrease with increasing age. Analogous to PCB, the GM found in children with a high socioeconomic status was higher than that in children with a lower socioeconomic status. However, unlike PCB levels mean DDE levels detected in migrants were higher than those in non-migrants. In East Germany and in large communities, the mean level was higher than in West Germany (Table 4.2.9).

The predictors for HCB were the same as for PCB, with the exception of gender, which was of no relevance for HCB levels (Table 4.2.10). The predictors relevant for β-HCH were identical with those for DDE (Table 4.2.11).

The breastfeeding status had a clear influence on the mean levels of all organochlorine compounds examined. For all substances described, significantly higher GMs were found in children who had been breastfed as compared to children who had not been breastfed.

Table 4.2.1: α- and γ-HCH in the blood of children (7 to 14 years) in Germany

	LOQ	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM
α-HCH	0.016	1063	1063	0								
γ-HCH	0.076	1063	1062	0	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	1.75	<LOQ	**<LOQ**

Notes: LOQ = limit of quantification (µg/l); N = sample size; n<LOQ = number of values below the limit of quantification (LOQ); % ≥ LOQ = percentage of values above the limit of quantification; P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM and/or lower limit of the CI is below LOQ

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.2.2: PCB 28 (µg/L) in the blood of children (7 to 14 years) in Germany

[Limit of quantification: 0.001 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM
Total	1079	867	**20**	<0.001	<0.001	0.004	0.008	0.012	1.14	0.003	<0.001
Gender											
Boys	561	459	**18**	<0.001	<0.001	0.004	0.009	0.013	1.14	0.004	<0.001
Girls	518	408	**21**	<0.001	<0.001	0.004	0.007	0.011	0.042	0.002	<0.001
Age											
7 to 8 years	244	186	**24**	<0.001	<0.001	0.005	0.011	0.013	0.042	0.002	<0.001
9 to 11 years	393	314	**20**	<0.001	<0.001	0.005	0.008	0.012	0.028	0.002	<0.001
12 to 14 years	442	367	**17**	<0.001	<0.001	0.003	0.007	0.012	1.14	0.005	<0.001
Socioeconomic status											
Low	252	204	**19**	<0.001	<0.001	0.003	0.008	0.012	0.023	0.001	<0.001
Intermediate	501	402	**20**	<0.001	<0.001	0.004	0.007	0.013	1.14	0.004	<0.001
High	318	254	**20**	<0.001	<0.001	0.005	0.009	0.012	0.042	0.002	<0.001
Migrant status											
Migrant	134	106	**21**	<0.001	<0.001	0.006	0.009	0.014	0.028	0.002	<0.001
Non-migrant	945	761	**19**	<0.001	<0.001	0.004	0.008	0.012	1.14	0.003	<0.001
Place of residence *											
East Germany	137	120	**12**	<0.001	<0.001	0.001	0.004	0.006	0.028	<0.001	<0.001
West Germany	942	747	**21**	<0.001	<0.001	0.004	0.009	0.012	1.14	0.003	<0.001
Community size (inhabitants)											
< 100 000	519	423	**19**	<0.001	<0.001	0.003	0.008	0.013	1.14	0.004	<0.001
≥ 100 000	560	444	**21**	<0.001	<0.001	0.004	0.008	0.012	0.042	0.002	<0.001
Breastfed											
Yes	824	667	**19**	<0.001	<0.001	0.004	0.008	0.012	1.14	0.003	<0.001
No	236	186	**21**	<0.001	<0.001	0.004	0.008	0.015	0.028	0.002	<0.001

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM < LOQ Significance test: x^2 test of independence (comparison of measured values below and above LOQ) * (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.2.3: PCB 52 (µg/L) in the blood of children (7 to 14 years) in Germany

[Limit of quantification: 0.001 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM
Total	1079	931	**14**	<0.001	<0.001	0.001	0.003	0.005	0.049	<0.001	<0.001
Gender											
Boys	561	493	**12**	<0.001	<0.001	0.001	0.003	0.005	0.049	<0.001	<0.001
Girls	518	438	**15**	<0.001	<0.001	0.001	0.003	0.005	0.007	<0.001	<0.001
Age											
7 to 8 years	244	213	**12**	<0.001	<0.001	0.001	0.002	0.004	0.010	<0.001	<0.001
9 to 11 years	393	342	**13**	<0.001	<0.001	0.001	0.003	0.005	0.021	<0.001	<0.001
12 to 14 years	442	375	**15**	<0.001	<0.001	0.002	0.003	0.006	0.049	<0.001	<0.001
Socioeconomic status											
Low	252	218	**13**	<0.001	<0.001	0.001	0.003	0.004	0.007	<0.001	<0.001
Intermediate	501	431	**14**	<0.001	<0.001	0.002	0.003	0.006	0.049	<0.001	<0.001
High	318	274	**14**	<0.001	<0.001	0.001	0.003	0.005	0.011	<0.001	<0.001
Migrant status											
Migrant	134	118	**12**	<0.001	<0.001	0.001	0.002	0.004	0.015	<0.001	<0.001
Non-migrant	945	813	**14**	<0.001	<0.001	0.001	0.003	0.005	0.049	<0.001	<0.001
Place of residence											
East Germany	137	123	**10**	<0.001	<0.001	<0.001	0.003	0.004	0.015	<0.001	<0.001
West Germany	942	808	**14**	<0.001	<0.001	0.001	0.003	0.005	0.049	<0.001	<0.001
Community size (inhabitants)											
< 100 000	519	458	**12**	<0.001	<0.001	0.001	0.003	0.005	0.049	<0.001	<0.001
≥ 100 000	560	473	**16**	<0.001	<0.001	0.001	0.003	0.005	0.015	<0.001	<0.001
Breastfed *											
Yes	877	771	**12**	<0.001	<0.001	0.001	0.003	0.004	0.049	<0.001	<0.001
No	240	198	**16**	<0.001	<0.001	0.001	0.004	0.007	0.021	<0.001	<0.001

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM < LOQ. Significance test: x^2 test of independence (comparison of measured values below and above LOQ) * (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.2.4: PCB 101 (µg/L) in the blood of children (7 to 14 years) in Germany

[Limit of quantification: 0.001 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM
Total	1079	858	**20**	<0.001	<0.001	0.002	0.005	0.007	0.018	0.001	<0.001
Gender											
Boys	561	446	**21**	<0.001	<0.001	0.003	0.004	0.006	0.015	0.001	<0.001
Girls	518	413	**20**	<0.001	<0.001	0.002	0.005	0.008	0.018	0.001	<0.001
Age											
7 to 8 years	244	185	**24**	<0.001	<0.001	0.002	0.004	0.006	0.012	0.001	<0.001
9 to 11 years	393	309	**21**	<0.001	<0.001	0.003	0.005	0.008	0.018	0.001	<0.001
12 to 14 years	442	364	**18**	<0.001	<0.001	0.003	0.005	0.007	0.014	0.001	<0.001
Socioeconomic status											
Low	252	206	**18**	<0.001	<0.001	0.003	0.005	0.009	0.018	0.001	<0.001
Intermediate	501	401	**20**	<0.001	<0.001	0.002	0.004	0.006	0.014	<0.001	<0.001
High	318	245	**23**	<0.001	<0.001	0.003	0.005	0.008	0.013	0.001	<0.001
Migrant status											
Migrant	134	104	**23**	<0.001	<0.001	0.002	0.004	0.005	0.013	<0.001	<0.001
Non-migrant	945	755	**20**	<0.001	<0.001	0.003	0.005	0.008	0.018	0.001	<0.001
Place of residence ***											
East Germany	137	126	**8**	<0.001	<0.001	<0.001	0.002	0.005	0.006	<0.001	<0.001
West Germany	942	732	**22**	<0.001	<0.001	0.003	0.005	0.008	0.018	0.001	<0.001
Community size (inhabitants) *											
< 100 000	519	427	**18**	<0.001	<0.001	0.002	0.004	0.005	0.012	<0.001	<0.001
≥ 100 000	560	431	**23**	<0.001	<0.001	0.003	0.005	0.008	0.018	0.001	<0.001
Breastfed											
Yes	877	697	**21**	<0.001	<0.001	0.002	0.005	0.007	0.024	0.001	<0.001
No	240	193	**20**	<0.001	<0.001	0.003	0.005	0.014	0.018	0.001	<0.001

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM < LOQ Significance test: x^2 test of independence (comparison of measured values below and above LOQ)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.2.5: PCB 138 (µg/L) in the blood of children (7 to 14 years) in Germany

[Limit of quantification: 0.023 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1079	30	97	0.04	0.09	0.22	0.28	0.38	0.92	0.114	**0.089**	0.085 - 0.093
Gender												
Boys	561	17	97	0.04	0.09	0.22	0.27	0.38	0.56	0.118	**0.092**	0.086 - 0.098
Girls	518	12	98	0.04	0.08	0.22	0.28	0.40	0.92	0.111	**0.085**	0.080 - 0.091
Age ***												
7 to 8 years	244	8	97	0.04	0.11	0.27	0.36	0.47	0.55	0.138	**0.103**	0.092 - 0.114
9 to 11 years	393	12	97	0.04	0.09	0.21	0.27	0.37	0.60	0.113	**0.088**	0.082 - 0.095
12 to 14 years	442	9	98	0.04	0.08	0.19	0.24	0.31	0.92	0.103	**0.082**	0.077 - 0.088
Socioeconomic status ***												
Low	252	11	96	0.03	0.07	0.17	0.22	0.29	0.55	0.090	**0.071**	0.065 - 0.078
Intermediate	501	14	97	0.04	0.08	0.21	0.24	0.34	0.60	0.105	**0.082**	0.077 - 0.088
High	318	4	99	0.05	0.13	0.27	0.37	0.45	0.92	0.149	**0.120**	0.111 - 0.129
Migrant status ***												
Migrant	134	3	97	0.03	0.07	0.13	0.17	0.22	0.40	0.076	**0.064**	0.058 - 0.071
Non-migrant	945	26	97	0.04	0.09	0.23	0.29	0.40	0.92	0.120	**0.093**	0.088 - 0.097
Place of residence ***												
East Germany	137	8	94	0.03	0.07	0.17	0.24	0.30	0.50	0.088	**0.068**	0.060 - 0.078
West Germany	942	22	98	0.04	0.09	0.22	0.29	0.40	0.92	0.118	**0.092**	0.088 - 0.097
Community size (inhabitants)												
< 100 000	519	12	98	0.04	0.09	0.21	0.27	0.38	0.56	0.113	**0.089**	0.083 - 0.094
≥ 100 000	560	18	97	0.04	0.09	0.23	0.29	0.40	0.92	0.116	**0.089**	0.083 - 0.095
Breastfed ***												
Yes	824	23	97	0.04	0.10	0.24	0.30	0.41	0.92	0.127	**0.099**	0.094 - 0.104
No	236	6	97	0.03	0.07	0.13	0.16	0.18	0.40	0.074	**0.063**	0.058 - 0.067

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.2.6: PCB 153 (µg/L) in the blood of children (7 to 14 years) in Germany

[Limit of quantification: 0.013 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1079	2	100	0.05	0.12	0.33	0.43	0.59	1.28	0.167	**0.129**	0.123 - 0.135
Gender *												
Boys	561	2	100	0.06	0.14	0.34	0.43	0.60	0.86	0.175	**0.136**	0.128 - 0.144
Girls	518	0	100	0.05	0.11	0.32	0.39	0.59	1.28	0.158	**0.122**	0.114 - 0.130
Age **												
7 to 8 years	244	2	99	0.05	0.15	0.40	0.57	0.68	0.80	0.199	**0.145**	0.129 - 0.161
9 to 11 years	393	0	100	0.06	0.13	0.32	0.44	0.55	0.86	0.166	**0.130**	0.121 - 0.139
12 to 14 years	442	1	100	0.05	0.12	0.29	0.36	0.50	1.28	0.150	**0.120**	0.113 - 0.128
Socioeconomic status *												
Low	252	0	100	0.05	0.10	0.24	0.32	0.41	0.73	0.127	**0.101**	0.092 - 0.110
Intermediate	501	2	100	0.05	0.11	0.30	0.39	0.54	0.86	0.154	**0.120**	0.113 - 0.128
High	318	0	100	0.07	0.18	0.43	0.53	0.66	1.28	0.221	**0.177**	0.164 - 0.191
Migrant status *												
Migrant	134	0	100	0.05	0.09	0.18	0.25	0.40	0.43	0.105	**0.089**	0.081 - 0.099
Non-migrant	945	2	100	0.05	0.13	0.33	0.45	0.60	1.28	0.176	**0.136**	0.129 - 0.142
Place of residence *												
East Germany	137	1	99	0.04	0.10	0.25	0.33	0.44	0.80	0.128	**0.101**	0.089 - 0.113
West Germany	942	2	100	0.06	0.13	0.33	0.44	0.60	1.28	0.173	**0.134**	0.127 - 0.140
Community size (inhabitants)												
< 100 000	519	2	100	0.05	0.12	0.31	0.41	0.58	0.86	0.164	**0.128**	0.120 - 0.136
≥ 100 000	560	1	100	0.05	0.13	0.34	0.47	0.59	1.28	0.170	**0.130**	0.122 - 0.138
Breastfed *												
Yes	824	2	100	0.06	0.15	0.36	0.47	0.63	1.28	0.188	**0.145**	0.138 - 0.153
No	236	0	100	0.05	0.09	0.16	0.21	0.26	0.43	0.099	**0.087**	0.082 - 0.093

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.2.7: PCB 180 (µg/L) in the blood of children (7 to 14 years) in Germany

[Limit of quantification: 0.006 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1079	12	99	0.022	0.064	0.21	0.278	0.38	0.81	0.096	**0.065**	0.062 - 0.069
Gender *												
Boys	561	10	98	0.023	0.07	0.219	0.288	0.38	0.65	0.102	**0.069**	0.064 - 0.075
Girls	518	2	100	0.021	0.058	0.199	0.271	0.39	0.81	0.09	**0.061**	0.057 - 0.066
Age												
7 to 8 years	244	7	97	0.017	0.08	0.263	0.338	0.4	0.58	0.114	**0.072**	0.062 - 0.082
9 to 11 years	393	3	99	0.023	0.065	0.203	0.269	0.39	0.65	0.096	**0.067**	0.061 - 0.073
12 to 14 years	442	2	100	0.023	0.056	0.189	0.249	0.33	0.81	0.086	**0.061**	0.056 - 0.066
Socioeconomic status * **												
Low	252	5	98	0.017	0.048	0.149	0.186	0.27	0.48	0.069	**0.048**	0.043 - 0.054
Intermediate	501	7	99	0.022	0.057	0.19	0.256	0.33	0.65	0.086	**0.059**	0.055 - 0.064
High	318	0	100	0.034	0.106	0.268	0.364	0.43	0.81	0.134	**0.097**	0.089 - 0.107
Migrant status * **												
Migrant	134	5	96	0.017	0.04	0.103	0.163	0.27	0.31	0.054	**0.039**	0.034 - 0.045
Non-migrant	945	6	99	0.024	0.07	0.216	0.292	0.39	0.81	0.102	**0.07**	0.066 - 0.074
Place of residence * **												
East Germany	137	1	99	0.017	0.048	0.15	0.204	0.31	0.58	0.068	**0.048**	0.041 - 0.055
West Germany	942	11	99	0.023	0.067	0.216	0.289	0.39	0.81	0.1	**0.068**	0.064 - 0.072
Community size (inhabitants)												
< 100 000	519	3	99	0.023	0.067	0.208	0.265	0.35	0.65	0.094	**0.066**	0.061 - 0.071
≥ 100 000	560	8	99	0.022	0.062	0.219	0.299	0.4	0.81	0.097	**0.065**	0.060 - 0.070
Breastfed * **												
Yes	824	10	99	0.025	0.077	0.235	0.303	0.4	0.81	0.11	**0.076**	0.071 - 0.081
No	236	1	99	0.017	0.043	0.086	0.124	0.19	0.28	0.049	**0.039**	0.030 - 0.043

Notes:
N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.2.8: Total PCB (138, 153, 180) (µg/L) in the blood of children (7 to 14 years) in Germany

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1079			0.11	0.28	0.76	0.98	1.35	3.00	0.377	**0.286**	0.273 - 0.299
Gender *												
Boys	561			0.12	0.30	0.78	1.02	1.40	2.02	0.394	**0.301**	0.282 - 0.321
Girls	518			0.11	0.25	0.73	0.95	1.32	3.00	0.359	**0.271**	0.254 - 0.289
Age **												
7 to 8 years	244			0.100	0.34	0.95	1.29	1.49	1.88	0.452	**0.323**	0.289 - 0.362
9 to 11 years	393			0.117	0.28	0.72	0.96	1.32	2.02	0.375	**0.288**	0.268 - 0.310
12 to 14 years	442			0.11	0.25	0.66	0.82	1.12	3.00	0.338	**0.266**	0.249 - 0.283
Socioeconomic status ***												
Low	252			0.10	0.23	0.55	0.73	1.02	1.76	0.286	**0.222**	0.203 - 0.243
Intermediate	501			0.11	0.25	0.69	0.88	1.22	2.02	0.345	**0.265**	0.249 - 0.283
High	318			0.15	0.42	0.95	1.25	1.47	3.00	0.504	**0.397**	0.367 - 0.431
Migrant status ***												
Migrant	134			0.10	0.19	0.39	0.52	0.87	1.10	0.235	**0.196**	0.176 - 0.217
Non-migrant	945			0.11	0.30	0.77	1.02	1.40	3.00	0.398	**0.302**	0.288 - 0.317
Place of residence ***												
East Germany	137			0.09	0.21	0.55	0.75	1.01	1.88	0.284	**0.220**	0.195 - 0.248
West Germany	942			0.12	0.29	0.77	1.02	1.39	3.00	0.391	**0.297**	0.283 - 0.312
Community size (inhabitants)												
< 100 000	519			0.11	0.28	0.72	0.93	1.33	2.02	0.371	**0.285**	0.267 - 0.304
≥ 100 000	560			0.11	0.27	0.77	1.06	1.39	3.00	0.384	**0.287**	0.269 - 0.306
Breastfed ***												
Yes	824			0.12	0.33	0.82	1.08	1.42	3.00	0.425	**0.324**	0.307 - 0.342
No	236			0.10	0.19	0.39	0.50	0.57	1.10	0.222	**0.192**	0.179 - 0.205

Notes: N = sample size; P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.2.9: DDE (µg/L) in the blood of children (7 to 14 years) in Germany

[Limit of quantification: 0.005 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1079	2	100	0.08	0.18	0.63	0.91	1.55	5.05	0.304	**0.206**	0.196 - 0.216
Gender												
Boys	561	2	100	0.08	0.19	0.65	0.91	1.69	3.78	0.307	**0.209**	0.195 - 0.224
Girls	518	0	100	0.08	0.17	0.59	0.95	1.51	5.05	0.302	**0.202**	0.188 - 0.217
Age ***												
7 to 8 years	244	2	99	0.09	0.23	0.95	1.47	2.77	5.05	0.408	**0.247**	0.219 - 0.279
9 to 11 years	393	0	100	0.08	0.18	0.59	0.84	1.48	3.78	0.287	**0.201**	0.185 - 0.217
12 to 14 years	442	1	100	0.08	0.18	0.53	0.68	1.29	2.30	0.262	**0.190**	0.177 - 0.204
Socioeconomic status ***												
Low	252	0	100	0.07	0.16	0.47	0.67	1.84	2.40	0.246	**0.169**	0.153 - 0.186
Intermediate	501	2	100	0.08	0.18	0.63	0.90	1.46	5.05	0.289	**0.194**	0.180 - 0.210
High	318	0	100	0.11	0.24	0.76	1.20	2.01	3.26	0.376	**0.262**	0.241 - 0.286
Migrant status ***												
Migrant	134	0	100	0.13	0.24	1.42	1.96	2.83	5.05	0.510	**0.319**	0.273 - 0.372
Non-migrant	945	2	100	0.08	0.18	0.57	0.83	1.36	3.78	0.275	**0.193**	0.183 - 0.203
Place of residence ***												
East Germany	137	1	99	0.17	0.40	1.11	1.47	2.07	5.05	0.556	**0.415**	0.361 - 0.477
West Germany	942	2	100	0.08	0.17	0.52	0.78	1.48	3.49	0.268	**0.186**	0.177 - 0.195
Community size (inhabitants) ***												
< 100 000	519	2	100	0.08	0.17	0.59	0.84	1.43	3.78	0.271	**0.187**	0.174 - 0.201
≥ 100 000	560	1	100	0.09	0.21	0.64	1.00	2.01	5.05	0.335	**0.224**	0.209 - 0.240
Breastfed ***												
Yes	824	2	100	0.09	0.21	0.70	1.10	1.82	3.49	0.339	**0.230**	0.217 - 0.244
No	236	0	100	0.07	0.13	0.30	0.47	0.71	5.05	0.181	**0.139**	0.128 - 0.150

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.2.10: HCB (µg/L) in the blood of children (7 to 14 years) in Germany

[Limit of quantification: 0.043 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1079	31	97	0.06	0.10	0.17	0.21	0.27	0.74	0.110	**0.098**	0.096 - 0.101
Gender												
Boys	561	20	96	0.06	0.10	0.17	0.20	0.27	0.73	0.111	**0.099**	0.095 - 0.104
Girls	518	11	98	0.06	0.10	0.17	0.21	0.27	0.74	0.109	**0.097**	0.094 - 0.102
Age ***												
7 to 8 years	244	6	98	0.06	0.12	0.20	0.27	0.36	0.74	0.127	**0.111**	0.104 - 0.119
9 to 11 years	393	6	99	0.06	0.10	0.16	0.21	0.26	0.73	0.110	**0.101**	0.096 - 0.105
12 to 14 years	442	19	96	0.06	0.09	0.16	0.19	0.24	0.63	0.101	**0.091**	0.086 - 0.095
Socioeconomic status ***												
Low	252	11	96	0.05	0.09	0.15	0.17	0.30	0.73	0.098	**0.087**	0.082 - 0.092
Intermediate	501	16	97	0.06	0.10	0.17	0.20	0.26	0.50	0.108	**0.097**	0.093 - 0.101
High	318	3	99	0.07	0.11	0.19	0.23	0.28	0.74	0.124	**0.113**	0.107 - 0.118
Migrant status ***												
Migrant	134	9	93	0.05	0.09	0.14	0.26	0.41	0.74	0.103	**0.087**	0.079 - 0.096
Non-migrant	945	22	98	0.06	0.10	0.17	0.21	0.27	0.73	0.111	**0.100**	0.097 - 0.103
Place of residence												
East Germany	137	5	97	0.06	0.10	0.18	0.21	0.26	0.73	0.113	**0.100**	0.092 - 0.109
West Germany	942	26	97	0.06	0.10	0.17	0.21	0.27	0.74	0.110	**0.098**	0.095 - 0.101
Community size (inhabitants)												
< 100 000	519	16	97	0.06	0.10	0.17	0.21	0.26	0.73	0.110	**0.100**	0.096 - 0.104
≥ 100 000	560	15	97	0.06	0.10	0.18	0.20	0.27	0.74	0.110	**0.098**	0.094 - 0.102
Breastfed ***												
Yes	824	18	98	0.06	0.11	0.18	0.22	0.28	0.74	0.116	**0.104**	0.101 - 0.108
No	236	11	95	0.05	0.08	0.13	0.15	0.20	0.73	0.090	**0.082**	0.078 - 0.087

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.2.11: β-HCH (µg/L) in the blood of children (7 to 14 years) in Germany

[Limit of quantification: 0.004 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1063	256	76	<0.004	0.01	0.04	0.10	0.26	1.87	0.029	**0.011**	0.010 - 0.012
Gender												
Boys	550	129	77	<0.004	0.01	0.06	0.11	0.26	1.87	0.032	**0.011**	0.010 - 0.013
Girls	512	127	75	<0.004	0.01	0.04	0.10	0.27	0.77	0.026	**0.010**	0.009 - 0.011
Age ***												
7 to 8 years	239	44	81	<0.004	0.02	0.07	0.12	0.29	0.57	0.034	**0.015**	0.012 - 0.017
9 to 11 years	389	96	75	<0.004	0.01	0.04	0.08	0.26	0.77	0.027	**0.011**	0.009 - 0.012
12 to 14 years	435	115	74	<0.004	0.01	0.04	0.09	0.22	1.87	0.028	**0.009**	0.008 - 0.011
Socioeconomic status **												
Low	245	69	72	<0.004	0.01	0.04	0.12	0.29	0.74	0.028	**0.010**	0.008 - 0.011
Intermediate	497	117	76	<0.004	0.01	0.04	0.08	0.26	1.87	0.028	**0.010**	0.009 - 0.011
High	314	68	78	<0.004	0.02	0.06	0.10	0.18	0.77	0.031	**0.013**	0.011 - 0.015
Migrant status ***												
Migrant	130	20	85	<0.004	0.03	0.32	0.63	0.82	1.87	0.121	**0.035**	0.026 - 0.047
Non-migrant	933	236	75	<0.004	0.01	0.03	0.05	0.07	0.35	0.016	**0.009**	0.009 - 0.010
Place of residence *												
East Germany	135	22	84	<0.004	0.01	0.05	0.14	0.41	1.87	0.038	**0.014**	0.011 - 0.017
West Germany	928	234	75	<0.004	0.01	0.04	0.10	0.26	0.97	0.028	**0.010**	0.010 - 0.011
Community size (inhabitants)												
< 100 000	511	123	76	<0.004	0.01	0.04	0.07	0.20	0.97	0.025	**0.010**	0.009 - 0.011
≥ 100 000	551	132	76	<0.004	0.01	0.06	0.12	0.27	1.87	0.033	**0.012**	0.010 - 0.013
Breastfed ***												
Yes	813	173	79	<0.004	0.01	0.06	0.11	0.27	1.87	0.033	**0.013**	0.011 - 0.014
No	233	80	66	<0.004	0.01	0.02	0.03	0.06	0.52	0.013	**0.006**	0.006 - 0.007

Notes:
N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

4.3 Nicotine and cotinine in urine

Tobacco smoke constitutes a frequent source of exposure of the general population and poses an essential health risk. The exposure level can be determined by means of the detection of nicotine or of cotinine, a metabolic product of nicotine. The determination of nicotine and cotinine levels in urine allows a differentiation not only between smokers and non-smokers but also between non-smokers not exposed to tobacco smoke and those passively exposed to tobacco smoke. Thus, not only subjective data from questionnaires but also objective criteria are available to assess the exposure to tobacco smoke.

Due to their toxicity and confirmed carcinogenic effects in humans (WHO, IARC, 2002), active and passive smoking have been assigned to Group 1 of the IARC list (2006).

The statistical parameters describing the distributions of nicotine and cotinine levels found in 3- to 14-year-old children in Germany are shown in Tables 4.3.1 and 4.3.2. With the limits of quantification reached (1 and 2 µg/L for nicotine and cotinine, respectively), nicotine could be detected by analysis in 44 % and cotinine, in 51 % of the children.

There were a number of smokers (n=67) among the 3- to 14-year-old children examined. The mean nicotine level in urine was 1.3 µg/L and the mean level of cotinine, 2.5 µg/L.

The geometric mean values were found to increase significantly with increasing age. Significantly higher mean levels were found in migrants and children with a low socioeconomic status. As expected, the smoking status has shown a significant and very clear association with nicotine and cotinine levels.

In addition, a significant correlation was found to exist between nicotine and cotinine levels in the urine of children and the number of smokers living in the household. The nicotine and cotinine levels in non-smoking children increased with an increasing number of smokers living in the household. Thus, nicotine and cotinine levels in urine provide evidence of the children's ETS exposure.

Table 4.3.1: Nicotine (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1723	969	44	<1	<1	9	23	130	3300	13.7	**1.3**	1.2 - 1.4
Gender												
Boys	872	487	44	<1	<1	9	23	93	1040	10.7	**1.2**	1.1 - 1.4
Girls	851	481	43	<1	<1	9	28	214	3300	16.7	**1.3**	1.2 - 1.4
Age ***												
3 to 5 years	373	226	39	<1	<1	5	13	29	105	3.0	**1.0**	<1 - 1.1
6 to 8 years	431	271	37	<1	<1	6	12	27	161	3.1	**1.0**	<1 - 1.1
9 to 11 years	432	241	44	<1	<1	9	18	46	184	4.3	**1.2**	1.1 - 1.3
12 to 14 years	488	232	52	<1	1	24	218	691	3300	39.5	**1.9**	1.6 - 2.3
Socioeconomic status ***												
Low	405	140	65	<1	2	22	101	516	3300	29.8	**2.4**	2.0 - 2.8
Intermediate	793	449	43	<1	<1	8	20	80	690	9.0	**1.2**	1.1 - 1.3
High	507	372	27	<1	<1	3	7	32	1040	8.5	**<1**	
Migrant status **												
Migrant	223	92	59	<1	1	11	32	673	1050	21.7	**1.6**	1.3 - 2.0
Non-migrant	1497	875	42	<1	<1	9	22	119	3300	12.5	**1.2**	1.1 - 1.3
Place of residence												
East Germany	228	130	43	<1	<1	11	33	169	3300	16.4	**1.3**	1.1 - 1.6
West Germany	1495	839	44	<1	<1	9	20	128	1170	13.2	**1.3**	1.2 - 1.4
Community size (inhabitants)												
< 100 000	808	469	42	<1	<1	9	33	203	3300	15.8	**1.2**	1.1 - 1.4
≥ 100 000	915	500	45	<1	<1	9	18	93	1170	11.7	**1.3**	1.2 - 1.4
Smoking status ***												
No	1656	968	42	<1	<1	6	12	28	161	3.0	**1.1**	1.0 - 1.1
Yes	66	1	98	4	128	738	1050	1590	3300	279	**75.8**	46.2 - 124
Number of smokers in the household / only non-smokers ***												
No smokers	884	660	25	<1	<1	2	3	5	105	1.1	**<1**	
One smoker	500	237	53	<1	1	9	14	20	100	3.2	**1.4**	1.2 - 1.5
More than one smoker	271	69	74	<1	3	28	44	76	161	9.2	**2.9**	2.4 - 3.4

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM < LOQ Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.3.2: Cotinine (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 2 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	1723	841	51	<2	2	12	28	476	2390	31.6	**2.5**	2.4 - 2.7
Gender												
Boys	872	413	53	<2	2	12	27	282	2390	23.8	**2.5**	2.3 - 2.7
Girls	851	428	50	<2	<2	14	29	810	1920	39.5	**2.6**	2.3 - 2.9
Age ***												
3 to 5 years	373	190	49	<2	<2	9	23	33	42	4.2	**2.2**	1.9 - 2.4
6 to 8 years	431	237	45	<2	<2	7	10	21	61	3.2	**<2**	
9 to 11 years	432	216	50	<2	<2	12	18	32	725	7.0	**2.2**	2.0 - 2.5
12 to 14 years	488	197	60	<2	2	98	915	1630	2390	99.3	**4.1**	3.5 - 5.0
Socioeconomic status ***												
Low	405	116	71	<2	3	27	298	997	1630	55.3	**4.5**	3.8 - 5.3
Intermediate	793	384	52	<2	2	11	23	235	1900	21.8	**2.4**	2.2 - 2.6
High	507	338	33	<2	<2	5	10	56	2390	28.3	**<2**	
Migrant status *												
Migrant	223	73	67	<2	2	15	31	933	1630	30.5	**3.1**	2.6 - 3.7
Non-migrant	1497	766	49	<2	<2	12	28	476	2390	31.8	**2.5**	2.3 - 2.6
Place of residence												
East Germany	228	116	49	<2	<2	19	89	786	1620	35.4	**2.7**	2.2 - 3.4
West Germany	1495	725	52	<2	2	12	25	460	2390	31.0	**2.5**	2.3 - 2.7
Community size (inhabitants)												
< 100 000	808	423	48	<2	<2	11	34	725	2390	37.9	**2.5**	2.2 - 2.7
≥ 100 000	915	418	54	<2	2	14	25	179	1920	26.0	**2.6**	2.4 - 2.8
Smoking status ***												
No	1656	840	49	<2	<2	9	16	27	74	3.8	**2.1**	2.0 - 2.2
Yes	66	1	98	8	478	1830	1920	2390	2390	724	**269**	165 - 439
Number of smokers in the household / only non-smokers ***												
No smokers	884	599	32	<2	<2	3	5	9	25	<2	**<2**	
One smoker	500	188	62	<2	2	11	17	23	38	4.4	**2.6**	2.4 - 2.9
More than one smoker	271	51	81	<2	5	27	33	39	74	9.0	**4.8**	4.2 - 5.6

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM < LOQ Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

4.4 Organophosphate metabolites in urine

Organophosphates are counted among the pesticides used most frequently in agriculture. They are organic esters of phosphoric acid, thiophosphoric acid and dithiophosphoric acid and are characterized by a short-term pesticidal activity. They have no pronounced tendency to accumulate through the food chain or in the environment.

Carcinogenicity of organophosphate pesticides to humans has not been confirmed. However, their neurotoxic effects have been known for a long time (Kamanyire et al., 2004; Wessels et al., 2003).

The main pathway of organophosphate intake is through their residues remaining on or in foods. In official examinations, however, foods are exclusively tested for the parent substances, which means that these analyses do not account for products of hydrolysis or metabolites that may have formed. Another exposure pathway may result from indoor use of products containing organophosphates. Due to the contact with house dust, a particular risk is possibly involved for children playing on the floor (Kommission Human-Biomonitoring, 2003b). However, no association could be observed so far between organophosphate levels in house dust and metabolite concentrations in the urine of children having played on the floor of the respective home (Heudorf und Angerer 2001b). Organophosphate pesticides have a short half-life in the human body and are excreted mainly by the urinary route (Kommission Human-Biomonitoring 2003).

The morning urine of 600 representatively selected children aged 3 to 14 years who took part in GerES IV (cf. Chapter 3.1.1) was examined for the following dialkyl phosphates: dimethyl phosphate (DMP), dimethyl thiophosphate (DMTP), dimethyl dithiophosphate (DMDTP), diethyl phosphate (DEP), diethyl thiophosphate (DETP) and diethyl dithiophosphate (DEDTP). These metabolites are formed in the human body from almost all organophosphates such as chlorpyrifos, diazinon, malathion or parathion. This is why the organophosphates analyzed represent group-specific metabolites.

In initial studies conducted in Germany, children aged 3 to 6 years were found to show higher metabolite levels in their urine than adults examined simultaneously (Heudorf und Angerer 2001b). In addition, conspicuously high body burden levels were found in adults in single cases (Heudorf 2000), where an elevated dietary intake was assumed to be the cause.

Tables 4.4.1 to 4.4.6 show the parameters for the distribution of organophosphate metabolites determined in the urine of 3- to 14-year-old children.

The relatively highest mean metabolite levels in urine were found for the dimethyl phosphates, DMP and DMTP. They amounted to 15.8 µg/L for DMP and 16.8 µg/L for DMTP. The mean DMDTP level was 0.56 µg/L.

The mean levels found of the diethyl phosphates, DEP, DETP and DEDTP were 5.92 µg/L, 1.09 µg/L and 0.02 µg/L.

The DEDTP levels detected were within a comparatively narrow range of values: DETP was not detectable in ca. 40 % of the samples, and no dependency on the descriptive variables was found.

Although correlations for the other phosphates showed similar tendencies they did not always reach the statistical significance level required. The mean levels decreased with increasing age, and the mean levels for girls were higher than those for boys (significant only for DMTP). Significantly higher mean levels of DMP, DMTP, DMDTP and DETP were found in children with a high socioeconomic status.

Table 4.4.1: DMP (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	599	0	100	4.9	15.2	57.8	86.2	115	908	25.6	**15.8**	14.6 - 17.1
Gender												
Boys	310	0	100	4.4	14.8	58.6	86.9	118	908	25.5	**14.9**	13.3 - 16.7
Girls	289	0	100	5.5	15.7	58.2	83.9	124	161	25.6	**16.7**	15.0 - 18.7
Age *												
3 to 5 years	138	0	100	6.3	19.0	80.2	110	135	908	33.5	**20.0**	16.8 - 23.6
6 to 8 years	145	0	100	4.4	15.7	51.8	69.2	97.7	123	22.8	**15.2**	13.0 - 17.7
9 to 11 years	148	0	100	4.5	15.5	59.5	78.7	95.7	126	22.6	**14.7**	12.6 - 17.2
12 to 14 years	168	0	100	4.5	13.5	53.6	87.0	145	625	24.1	**14.3**	12.4 - 16.6
Socioeconomic status *												
Low	128	0	100	4.1	13.0	51.7	71.3	101	625	21.8	**13.1**	11.1 - 15.5
Intermediate	284	0	100	4.7	16.4	64.4	91.9	126	158	25.6	**16.3**	14.6 - 18.3
High	183	0	100	5.9	16.1	66.2	84.6	120	908	28.5	**17.6**	15.3 - 20.1
Migrant status												
Migrant	45	0	100	3.6	12.7	58.7	85.9		96.5	20.9	**13.1**	9.87 - 17.5
Non-migrant	555	0	100	4.9	15.6	58.2	86.3	121	908	25.9	**16.0**	14.7 - 17.4
Place of residence												
East Germany	77	0	100	4.1	14.9	58.7	91.3	525	908	31.0	**15.1**	11.8 - 19.2
West Germany	522	0	100	4.9	15.3	58.5	86.3	113	205	24.7	**15.9**	14.6 - 17.2
Community size (inhabitants)												
< 100 000	281	0	100	4.9	15.6	45.6	71.2	125	908	25.1	**15.4**	13.7 - 17.2
≥ 100 000	318	0	100	4.6	15.0	73.7	91.0	114	205	26.0	**16.1**	14.4 - 18.0

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.4.2: DMTP (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	599	0	100	4.1	15.9	71.8	112	211	1560	33.2	**16.8**	15.4 - 18.4
Gender*												
Boys	310	0	100	3.4	15.0	62.3	98.1	213	1560	30.4	**15.3**	13.5 - 17.3
Girls	289	0	100	4.2	17.4	79.2	117	228	697	36.3	**18.7**	16.4 - 21.3
Age * **												
3 to 5 years	138	0	100	5.2	19.0	112	181	310	1560	49.0	**22.1**	18.1 - 27.0
6 to 8 years	145	0	100	5.0	16.5	75.8	112	298	384	32.9	**17.5**	14.6 - 21.0
9 to 11 years	148	0	100	3.9	16.6	72.6	120	216	404	32.1	**17.1**	14.3 - 20.5
12 to 14 years	168	0	100	3.1	12.2	51.4	69.9	91.6	248	21.7	**12.8**	10.9 - 15.1
Socioeconomic status *												
Low	128	0	100	3.0	12.1	62.6	99.7	147	384	25.1	**13.2**	10.8 - 16.2
Intermediate	284	0	100	5.2	17.3	69.5	102	204	697	32.3	**17.9**	15.8 - 20.3
High	183	0	100	4.2	16.2	83.5	176	249	1560	40.8	**18.7**	15.7 - 22.2
Migrant status												
Migrant	45	0	100	3.0	13.9	68.0	72.5		404	27.4	**14.4**	10.4 - 19.8
Non-migrant	555	0	100	4.1	16.0	72.1	113	212	1560	33.7	**17.1**	15.5 - 18.8
Place of residence												
East Germany	77	0	100	4.5	16.2	89.4	159	361	1560	43.9	**18.5**	14.1 - 24.2
West Germany	522	0	100	4.1	15.8	70.9	112	209	697	31.7	**16.6**	15.1 - 18.3
Community size (inhabitants)												
< 100 000	281	0	100	4.1	15.9	70.7	114	177	1560	32.7	**16.3**	14.3 - 18.6
≥ 100 000	318	0	100	4.0	15.7	72.4	111	247	404	33.7	**17.3**	15.2 - 19.6

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification; P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.4.3: DMDTP (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	599	47	92	0.1	0.5	3.9	8.4	16.3	253	2.31	**0.56**	0.50 - 0.63
Gender												
Boys	310	30	90	0.1	0.5	3.1	5.9	14.0	253	1.90	**0.51**	0.43 - 0.59
Girls	289	17	94	0.1	0.5	5.2	12.2	27.1	84.4	2.76	**0.62**	0.52 - 0.75
Age **												
3 to 5 years	138	12	91	0.1	0.6	7.1	13.1	22.2	253	3.35	**0.70**	0.54 - 0.92
6 to 8 years	145	13	91	0.1	0.5	4.9	13.5	59.7	74.1	3.19	**0.65**	0.50 - 0.84
9 to 11 years	148	10	93	0.1	0.5	5.3	10.5	18.8	50.5	2.06	**0.56**	0.44 - 0.72
12 to 14 years	168	13	92	0.1	0.4	1.9	4.3	7.8	13.4	0.94	**0.41**	0.34 - 0.49
Socioeconomic status ***												
Low	128	12	91	<0.1	0.3	2.6	4.7	10.9	29.0	1.14	**0.36**	0.29 - 0.46
Intermediate	284	17	94	0.1	0.5	4.5	10.8	14.6	84.4	2.48	**0.63**	0.53 - 0.75
High	183	17	91	0.1	0.5	5.0	11.3	24.8	253	2.89	**0.63**	0.51 - 0.79
Migrant status												
Migrant	45	3	93	0.1	0.4	4.5	5.2		50.5	1.71	**0.46**	0.30 - 0.69
Non-migrant	555	45	92	0.1	0.5	3.9	9.4	16.9	253	2.36	**0.57**	0.50 - 0.65
Place of residence												
East Germany	77	6	93	0.1	0.5	9.6	14.0	27.6	253	3.94	**0.67**	0.46 - 0.98
West Germany	522	42	92	0.1	0.5	3.7	7.1	14.9	84.4	2.07	**0.54**	0.48 - 0.62
Community size (inhabitants)												
< 100 000	281	20	93	0.1	0.4	3.8	5.8	12.3	253	2.09	**0.54**	0.46 - 0.64
≥ 100 000	318	27	91	0.1	0.5	5.1	11.9	22.5	74.1	2.51	**0.58**	0.48 - 0.68

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.4.4: DEP in the urine (µg/L) of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	599	0	100	1.6	6.0	20.6	29.1	38.1	526	10.7	**5.92**	5.46 - 6.43
Gender												
Boys	310	0	100	1.6	6.0	19.2	27.4	39.3	526	11.2	**5.80**	5.17 - 6.50
Girls	289	0	100	1.6	6.0	22.3	30.9	38.1	181	10.1	**6.06**	5.38 - 6.83
Age ***												
3 to 5 years	138	0	100	2.6	7.5	24.8	34.5	91.3	526	16.5	**8.10**	6.87 - 9.56
6 to 8 years	145	0	100	1.5	5.8	19.9	30.9	36.0	43.6	8.50	**5.34**	4.52 - 6.32
9 to 11 years	148	0	100	1.5	5.7	18.7	22.7	33.9	69.6	8.11	**5.53**	4.77 - 6.41
12 to 14 years	168	0	100	1.5	5.7	20.7	29.7	57.1	181	10.0	**5.32**	4.51 - 6.29
Socioeconomic status												
Low	128	0	100	1.2	5.6	22.8	36.3	63.0	526	13.9	**5.24**	4.25 - 6.46
Intermediate	284	0	100	1.8	6.0	22.6	31.4	38.0	270	10.5	**6.04**	5.36 - 6.81
High	183	0	100	2.0	6.7	19.4	23.4	30.6	93.9	8.92	**6.36**	5.61 - 7.22
Migrant status												
Migrant	45	0	100	1.1	6.4	21.4	41.7		526	23.0	**5.93**	4.07 - 8.65
Non-migrant	555	0	100	1.7	6.0	20.6	28.9	36.5	270	9.69	**5.92**	5.45 - 6.44
Place of residence												
East Germany	77	0	100	1.7	5.8	25.2	31.7	89.8	270	11.4	**6.11**	4.79 - 7.78
West Germany	522	0	100	1.6	6.1	19.9	28.8	37.8	526	10.6	**5.90**	5.40 - 6.44
Community size (inhabitants)												
< 100 000	281	0	100	1.7	5.7	16.8	22.6	35.5	526	10.3	**5.56**	4.97 - 6.23
≥ 100 000	318	0	100	1.6	6.6	23.1	31.1	39.3	270	11.0	**6.26**	5.56 - 7.05

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.4.5: DETP (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	599	2	100	0.2	1.0	6.4	9.9	23.1	83.2	2.68	**1.09**	0.98 - 1.21
Gender												
Boys	310	0	100	0.2	1.0	5.6	8.1	23.6	83.2	2.50	**1.05**	0.92 - 1.22
Girls	289	2	99	0.2	1.1	6.9	13.2	21.6	40.1	2.87	**1.13**	0.97 - 1.32
Age **												
3 to 5 years	138	0	100	0.3	1.3	8.4	16.7	20.7	83.2	3.39	**1.44**	1.16 - 1.78
6 to 8 years	145	1	99	0.2	1.1	5.8	8.6	24.1	32.5	2.54	**1.13**	0.92 - 1.38
9 to 11 years	148	1	99	0.2	1.0	6.7	10.4	21.9	40.1	2.75	**1.09**	0.87 - 1.37
12 to 14 years	168	0	100	0.2	0.8	4.1	7.5	25.0	33.4	2.15	**0.84**	0.69 - 1.02
Socioeconomic status *												
Low	128	0	100	0.1	0.8	6.2	7.8	19.1	24.0	2.00	**0.87**	0.70 - 1.09
Intermediate	284	2	99	0.2	1.0	6.4	11.8	25.2	40.1	2.80	**1.11**	0.95 - 1.29
High	183	0	100	0.3	1.1	6.7	13.5	23.5	83.2	2.98	**1.26**	1.05 - 1.52
Migrant status												
Migrant	45	0	100	0.3	1.0	4.3	6.4		24.0	2.05	**1.10**	0.79 - 1.54
Non-migrant	555	2	100	0.2	1.0	6.5	10.5	23.3	83.2	2.73	**1.09**	0.98 - 1.22
Place of residence												
East Germany	77	0	100	0.2	0.9	8.4	20.3	32.2	83.2	3.47	**1.16**	0.84 - 1.59
West Germany	522	2	100	0.2	1.0	6.3	9.0	20.1	40.1	2.56	**1.08**	0.97 - 1.21
Community size (inhabitants)												
< 100 000	281	2	99	0.2	1.0	6.8	8.3	17.6	83.2	2.54	**1.09**	0.93 - 1.26
≥ 100 000	318	0	100	0.2	1.0	6.3	15.9	24.4	40.1	2.79	**1.09**	0.95 - 1.26

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.4.6: DEDTP (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.01 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	599	204	66	<0.01	0.02	0.16	0.34	0.72	1.71	0.079	**0.023**	0.020 - 0.026
Gender												
Boys	310	104	66	<0.01	0.02	0.21	0.48	0.87	1.71	0.095	**0.025**	0.021 - 0.030
Girls	289	100	65	<0.01	0.02	0.12	0.25	0.64	1.32	0.062	**0.021**	0.017 - 0.024
Age												
3 to 5 years	138	53	61	<0.01	0.01	0.15	0.28	1.45	1.66	0.076	**0.019**	0.015 - 0.025
6 to 8 years	145	44	70	<0.01	0.02	0.16	0.48	0.63	1.71	0.079	**0.024**	0.019 - 0.031
9 to 11 years	148	55	63	<0.01	0.02	0.16	0.37	0.91	1.06	0.077	**0.023**	0.018 - 0.029
12 to 14 years	168	53	69	<0.01	0.02	0.19	0.56	0.79	1.32	0.083	**0.025**	0.020 - 0.031
Socioeconomic status												
Low	128	47	63	<0.01	0.02	0.24	0.45	0.87	0.98	0.082	**0.023**	0.018 - 0.030
Intermediate	284	94	67	<0.01	0.02	0.15	0.47	1.10	1.71	0.088	**0.024**	0.020 - 0.028
High	183	62	66	<0.01	0.02	0.16	0.28	0.51	1.06	0.064	**0.022**	0.018 - 0.027
Migrant status												
Migrant	45	15	67	<0.01	0.02	0.15	0.24		0.29	0.044	**0.020**	0.014 - 0.029
Non-migrant	555	189	66	<0.01	0.02	0.16	0.40	0.78	1.71	0.082	**0.023**	0.020 - 0.026
Place of residence												
East Germany	77	32	59	<0.01	0.01	0.25	0.62	1.66	1.66	0.114	**0.023**	0.016 - 0.033
West Germany	522	173	67	<0.01	0.02	0.15	0.32	0.65	1.71	0.074	**0.023**	0.020 - 0.026
Community size (inhabitants)												
< 100 000	281	93	67	<0.01	0.02	0.16	0.27	0.62	1.71	0.075	**0.023**	0.020 - 0.028
≥ 100 000	318	112	65	<0.01	0.02	0.17	0.47	0.80	1.66	0.082	**0.022**	0.019 - 0.026

Notes:
N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

4.5 PCP and other chlorophenols in urine

Pentachlorophenol (PCP) is a biocide with a broad-spectrum activity, which was used mainly as a fungicide. Due to its toxicity, its contamination with dioxin and its wide distribution, PCP has been counted among the important environmental chemicals. In recent years, the contamination of the environment and the background exposure of the general population have become reduced owing to the ban on PCP in the Federal Republic of Germany effective since 1989. The other chlorophenols (2,4-dichlorophenol, 2,5-dichlorophenol, 2,6-dichlorophenol, 2,3,4-trichlorophenol, 2,3,4,6-tetrachlorophenol, 4-monochlorophenol) have good fungicidal, algicidal and bactericidal properties and are therefore used in disinfectants and preservatives.

Due to their toxicity, some chlorophenols (2,4-dichlorophenol, 2,4,5-trichlorophenol, 2,4,6-trichlorophenol, 2,3,4,6-tetrachlorophenol and pentachlorophenol) have been classified as possibly carcinogenic to humans (Group 2B, IARC list, 2006).

The current environmental health concern has resulted from the use of these substances in wood and building preservation in the past and particularly, its uncontrolled use by non-professionals, which still today may lead to indoor exposure. Furthermore, indoor air contamination may result from imported products such as leather goods, textiles or carpets containing PCP. It is noteworthy that in households contaminated with PCP, higher urine levels were found in young children than in adults (Cline at al. 1989, Schulz et al. 1998).

The first representative data for 6- to 14-year-old German children were compiled in GerES II, 1990/92 (Schulz et al. 1998). In GerES IV, it has now become possible to determine the exposure of 3- to 14-year-old children to PCP over the entire age range. The study was conducted using urine specimens from 600 children randomly selected from the total sample (cf. Chapter 3.1.1).

The urine specimens from children aged 3-14 years were examined for the chorophenols, 2-monochlorophenol (2-MCP), 4-monochlorophenol (4-MCP), 2,4-dichlorophenol (2,4-DCP), 2,5-dichlorophenol (2,5-DCP), 2,6-dichlorophenol (2,6-DCP), 2,3,4-trichlorophenol (2,3,4-TCP), 2,4,5-trichlorophenol (2,4,5-TCP), 2,4,6-trichlorophenol (2,4,6-TCP), 2,3,4,6-tetrachlorophenol (2,3,4,6-TeCP) and pentachlorophenol (PCP). Tables 4.5.1 to 4.5.10 show the statistical parameters describing the distribution of chlorophenol levels in children in Germany.

PCP was detectable in 49 % of samples only so that the value of the limit of quantification (0.6 µg/L) was stated as the mean level. None of the variables was seen to have had a significant influence on the percentage of values representing quantifiable PCP levels. For the other chlorophenols, single significant effects were found which, however, could not be generalized for the entire group.

Table 4.5.1: 2-Monochlorophenol (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	599	13	98	0.75	1.70	4.70	6.78	9.93	41.5	2.42	**1.72**	1.60 - 1.84
Gender												
Boys	310	6	98	0.73	1.71	4.71	7.35	9.79	16.4	2.37	**1.71**	1.55 - 1.89
Girls	289	7	98	0.81	1.67	4.76	6.56	11.2	41.5	2.47	**1.72**	1.55 - 1.91
Age *												
3 to 5 years	138	1	100	0.89	1.78	4.71	8.00	12.8	18.1	2.63	**1.95**	1.72 - 2.21
6 to 8 years	145	4	97	0.90	1.95	6.06	8.72	15.9	41.5	2.86	**1.93**	1.65 - 2.25
9 to 11 years	148	5	96	0.73	1.64	4.60	6.38	7.65	11.1	2.13	**1.57**	1.36 - 1.82
12 to 14 years	168	4	98	0.60	1.50	4.55	5.82	7.68	22.6	2.13	**1.51**	1.32 - 1.73
Socioeconomic status												
Low	128	1	99	0.64	1.74	4.68	6.89	11.2	18.1	2.42	**1.72**	1.49 - 1.99
Intermediate	284	8	97	0.71	1.66	4.72	6.89	8.63	41.5	2.35	**1.66**	1.49 - 1.84
High	183	4	98	0.89	1.77	4.78	7.19	14.1	16.4	2.53	**1.80**	1.59 - 2.05
Migrant status												
Migrant	45	1	97	0.58	1.56	3.78	5.20		5.71	1.79	**1.37**	1.06 - 1.76
Non-migrant	555	12	98	0.75	1.71	4.78	7.19	10.5	41.5	2.47	**1.75**	1.62 - 1.88
Place of residence												
East Germany	77	3	96	0.66	1.67	4.46	7.68	17.7	41.5	2.45	**1.58**	1.25 - 1.98
West Germany	522	10	98	0.75	1.70	4.75	6.72	10.0	18.1	2.42	**1.74**	1.61 - 1.87
Community size (inhabitants)												
< 100 000	281	4	98	0.69	1.70	4.61	6.29	8.64	41.5	2.38	**1.72**	1.56 - 1.90
≥ 100 000	318	9	97	0.80	1.66	4.79	7.66	11.2	22.6	2.46	**1.71**	1.54 - 1.89

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.5.2: 4-Monochlorophenol (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	599	6	99	1.97	4.58	9.97	15.3	25.8	102	6.45	**4.49**	4.20 - 4.81
Gender												
Boys	310	2	99	1.99	4.51	9.48	12.6	19.7	102	5.70	**4.37**	4.03 - 4.75
Girls	289	4	99	1.92	4.70	10.3	20.8	59.1	87.0	7.25	**4.63**	4.15 - 5.16
Age												
3 to 5 years	138	0	100	2.38	4.48	9.78	11.7	21.0	24.6	5.51	**4.68**	4.25 - 5.14
6 to 8 years	145	2	98	1.65	5.01	10.8	20.2	57.0	102	7.26	**4.48**	3.81 - 5.27
9 to 11 years	148	0	100	2.20	4.28	9.15	12.4	71.9	83.5	6.40	**4.44**	3.97 - 4.97
12 to 14 years	168	4	98	1.85	4.80	10.7	17.2	27.2	87.0	6.56	**4.41**	3.78 - 5.14
Socioeconomic status												
Low	128	1	99	2.07	4.16	10.3	16.7	20.6	83.5	6.18	**4.40**	3.81 - 5.09
Intermediate	284	5	98	1.97	4.69	9.47	12.6	25.8	78.3	5.95	**4.31**	3.89 - 4.79
High	183	0	100	1.92	4.76	10.7	16.2	72.0	102	7.44	**4.88**	4.36 - 5.45
Migrant status												
Migrant	45	0	100	1.95	4.74	16.0	18.8		20.2	6.06	**4.57**	3.63 - 5.75
Non-migrant	555	6	99	1.97	4.57	9.87	14.3	26.1	102	6.48	**4.49**	4.18 - 4.82
Place of residence												
East Germany	77	1	98	1.95	4.55	10.00	16.2	33.8	50.4	5.99	**4.44**	3.64 - 5.41
West Germany	522	5	99	1.97	4.59	9.97	15.6	26.1	102	6.52	**4.50**	4.19 - 4.84
Community size (inhabitants)												
<100 000	281	4	99	1.96	4.71	9.29	12.8	16.6	83.5	5.70	**4.31**	3.91 - 4.75
≥100 000	318	2	99	1.97	4.50	10.3	20.6	52.2	102	7.10	**4.66**	4.25 - 5.12

Notes: N = sample size; n<LOQ= number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.5.3: 2,4-Dichlorophenol (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	599	69	89	<0.10	0.33	1.14	2.52	5.16	19.3	0.713	**0.332**	0.303 - 0.363
Gender												
Boys	310	32	90	<0.10	0.34	1.28	2.58	7.32	19.3	0.791	**0.345**	0.304 - 0.391
Girls	289	37	87	<0.10	0.33	1.09	2.26	4.68	15.6	0.629	**0.318**	0.280 - 0.362
Age												
3 to 5 years	138	19	86	<0.10	0.38	0.85	1.64	4.62	19.3	0.643	**0.329**	0.276 - 0.392
6 to 8 years	145	17	88	<0.10	0.36	1.75	2.55	7.90	18.5	0.821	**0.369**	0.305 - 0.447
9 to 11 years	148	13	91	0.11	0.29	2.50	5.07	8.22	14.0	0.954	**0.368**	0.300 - 0.451
12 to 14 years	168	20	88	<0.10	0.28	0.87	1.32	2.56	6.81	0.464	**0.278**	0.240 - 0.323
Socioeconomic status												
Low	128	21	84	<0.10	0.31	1.01	2.16	10.9	15.6	0.696	**0.284**	0.231 - 0.349
Intermediate	284	29	90	<0.10	0.36	1.12	2.53	5.28	16.7	0.700	**0.350**	0.308 - 0.398
High	183	19	90	<0.10	0.34	1.49	3.30	6.40	19.3	0.753	**0.344**	0.292 - 0.405
Migrant status *												
Migrant	45	1	97	0.12	0.35	2.32	8.73		14.0	1.21	**0.457**	0.314 - 0.664
Non-migrant	555	67	88	<0.10	0.33	1.04	2.47	4.95	19.3	0.673	**0.323**	0.295 - 0.355
Place of residence												
East Germany	77	10	87	<0.10	0.36	1.39	2.71	15.8	19.3	0.766	**0.331**	0.256 - 0.428
West Germany	522	59	89	<0.10	0.33	1.13	2.52	5.16	16.7	0.705	**0.332**	0.302 - 0.365
Community size (inhabitants)												
< 100 000	281	30	89	<0.10	0.31	1.09	2.19	5.16	18.5	0.647	**0.325**	0.286 - 0.370
≥ 100 000	318	39	88	<0.10	0.35	1.30	2.54	7.36	19.3	0.771	**0.338**	0.298 - 0.383

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.5.4: 2,5-Dichlorophenol (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	599	12	98	0.26	0.71	3.95	7.49	23.8	517	3.45	**0.853**	0.773 - 0.942
Gender												
Boys	310	3	99	0.28	0.70	5.26	10.00	55.6	517	4.93	**0.920**	0.795 - 1.060
Girls	289	9	97	0.23	0.72	3.16	5.45	11.7	78.5	1.86	**0.787**	0.689 - 0.898
Age **												
3 to 5 years	138	5	96	0.27	0.63	3.08	4.96	10.8	32.4	1.45	**0.706**	0.591 - 0.843
6 to 8 years	145	1	99	0.30	0.83	8.23	18.1	48.0	517	6.01	**1.100**	0.878 - 1.380
9 to 11 years	148	1	99	0.28	0.73	5.34	7.34	87.5	182	4.45	**0.956**	0.777 - 1.180
12 to 14 years	168	5	97	0.20	0.71	2.51	4.41	16.8	108	1.98	**0.724**	0.610 - 0.860
Socioeconomic status												
Low	128	2	99	0.27	0.73	4.92	9.40	31.1	109	2.88	**0.876**	0.708 - 1.080
Intermediate	284	8	97	0.23	0.77	4.42	9.58	55.9	441	4.23	**0.895**	0.766 - 1.050
High	183	3	99	0.29	0.65	3.06	6.71	16.8	517	2.68	**0.786**	0.674 - 0.917
Migrant status												
Migrant	45	3	94	0.19	1.01	19.5	47.0		109	7.09	**1.270**	0.760 - 2.130
Non-migrant	555	10	98	0.27	0.70	3.34	7.34	18.2	517	3.15	**0.826**	0.749 - 0.912
Place of residence												
East Germany	77	3	96	0.24	0.74	3.81	7.96	319	517	6.76	**0.857**	0.639 - 1.150
West Germany	522	10	98	0.27	0.71	3.96	7.51	27.2	182	2.96	**0.853**	0.768 - 0.947
Community size (inhabitants)												
< 100 000	281	5	98	0.22	0.72	3.68	6.21	32.4	517	4.43	**0.831**	0.716 - 0.965
≥ 100 000	318	8	98	0.29	0.70	4.03	8.76	18.6	109	2.58	**0.873**	0.765 - 0.996

Notes:
N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.5.5: 2,6-Dichlorophenol (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM
Total	599	457	**24**	<0.10	<0.10	0.17	0.25	0.33	1.93	<0.10	<0.10
Gender *											
Boys	310	226	**27**	<0.10	<0.10	0.19	0.26	0.46	1.34	<0.10	<0.10
Girls	289	231	**20**	<0.10	<0.10	0.15	0.21	0.31	1.93	<0.10	<0.10
Age											
3 to 5 years	138	114	**17**	<0.10	<0.10	0.16	0.17	0.24	0.50	<0.10	<0.10
6 to 8 years	145	111	**24**	<0.10	<0.10	0.16	0.24	0.38	0.86	<0.10	<0.10
9 to 11 years	148	112	**24**	<0.10	<0.10	0.22	0.28	0.31	1.34	<0.10	<0.10
12 to 14 years	168	120	**29**	<0.10	<0.10	0.20	0.30	0.67	1.93	0.109	<0.10
Socioeconomic status											
Low	128	89	**30**	<0.10	<0.10	0.21	0.30	0.69	1.93	0.117	<0.10
Intermediate	284	219	**23**	<0.10	<0.10	0.16	0.27	0.37	1.34	<0.10	<0.10
High	183	146	**20**	<0.10	<0.10	0.17	0.22	0.28	0.86	<0.10	<0.10
Migrant status											
Migrant	45	38	**16**	<0.10	<0.10	0.26	0.29		0.30	<0.10	<0.10
Non-migrant	555	420	**24**	<0.10	<0.10	0.17	0.25	0.37	1.93	<0.10	<0.10
Place of residence											
East Germany	77	61	**21**	<0.10	<0.10	0.15	0.27	0.86	1.13	<0.10	<0.10
West Germany	522	396	**24**	<0.10	<0.10	0.18	0.25	0.32	1.93	<0.10	<0.10
Community size (inhabitants)											
< 100 000	281	219	**22**	<0.10	<0.10	0.16	0.24	0.50	1.93	<0.10	<0.10
≥ 100 000	318	238	**25**	<0.10	<0.10	0.19	0.28	0.33	1.34	<0.10	<0.10

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM < LOQ Significance test: x^2 test of independence (comparison of measured values below and above LOQ)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.5.6: 2,3,4-Trichlorophenol (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM
Total	599	583	**3**	<0.10	<0.10	<0.10	<0.10	0.11	0.37	<0.10	<0.10
Gender											
Boys	310	303	**2**	<0.10	<0.10	<0.10	<0.10	0.12	0.29	<0.10	<0.10
Girls	289	280	**3**	<0.10	<0.10	<0.10	<0.10	0.11	0.37	<0.10	<0.10
Age											
3 to 5 years	138	133	**3**	<0.10	<0.10	<0.10	<0.10	0.15	0.15	<0.10	<0.10
6 to 8 years	145	141	**3**	<0.10	<0.10	<0.10	<0.10	0.14	0.29	<0.10	<0.10
9 to 11 years	148	148	**1**	<0.10	<0.10	<0.10	<0.10	<0.10	0.37	<0.10	<0.10
12 to 14 years	168	162	**4**	<0.10	<0.10	<0.10	<0.10	0.13	0.18	<0.10	<0.10
Socioeconomic status											
Low	128	123	**3**	<0.10	<0.10	<0.10	<0.10	0.18	0.29	<0.10	<0.10
Intermediate	284	276	**3**	<0.10	<0.10	<0.10	<0.10	0.11	0.37	<0.10	<0.10
High	183	181	**1**	<0.10	<0.10	<0.10	<0.10	<0.10	0.15	<0.10	<0.10
Migrant status											
Migrant	45	45	**0**								
Non-migrant	555	539	**3**	<0.10	<0.10	<0.10	<0.10	0.12	0.37	<0.10	<0.10
Place of residence											
East Germany	77	74	**3**	<0.10	<0.10	<0.10	<0.10	0.16	0.37	<0.10	<0.10
West Germany	522	509	**3**	<0.10	<0.10	<0.10	<0.10	0.11	0.29	<0.10	<0.10
Community size (inhabitants)											
< 100 000	281	273	**3**	<0.10	<0.10	<0.10	<0.10	0.11	0.18	<0.10	<0.10
≥ 100 000	318	311	**2**	<0.10	<0.10	<0.10	<0.10	0.12	0.37	<0.10	<0.10

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM < LOQ Significance test: x^2 test of independence (comparison of measured values below and above LOQ)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.5.7: 2,4,5-Trichlorophenol (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	599	186	69	<0.10	0.15	0.41	0.56	0.85	4.55	0.207	**0.141**	0.131 - 0.151
Gender												
Boys	310	102	67	<0.10	0.14	0.39	0.55	0.83	4.55	0.200	**0.134**	0.122 - 0.147
Girls	289	83	71	<0.10	0.17	0.41	0.56	0.85	2.99	0.214	**0.148**	0.134 - 0.164
Age												
3 to 5 years	138	38	73	<0.10	0.17	0.43	0.62	0.91	1.60	0.213	**0.153**	0.132 - 0.176
6 to 8 years	145	40	72	<0.10	0.17	0.45	0.56	1.38	1.93	0.222	**0.152**	0.132 - 0.175
9 to 11 years	148	44	70	<0.10	0.15	0.39	0.68	0.83	4.55	0.224	**0.143**	0.125 - 0.165
12 to 14 years	168	64	62	<0.10	0.13	0.38	0.42	0.85	2.99	0.174	**0.122**	0.107 - 0.138
Socioeconomic status												
Low	128	44	66	<0.10	0.13	0.52	0.80	0.95	1.60	0.215	**0.140**	0.119 - 0.165
Intermediate	284	90	68	<0.10	0.15	0.38	0.56	1.09	4.55	0.217	**0.141**	0.127 - 0.156
High	183	49	73	<0.10	0.17	0.37	0.46	0.66	0.74	0.186	**0.142**	0.127 - 0.159
Migrant status												
Migrant	45	19	58	<0.10	0.16	0.44	0.70		0.85	0.195	**0.130**	0.099 - 0.171
Non-migrant	555	167	70	<0.10	0.15	0.39	0.55	0.83	4.55	0.208	**0.142**	0.132 - 0.152
Place of residence												
East Germany	77	24	69	<0.10	0.17	0.47	0.70	1.64	2.99	0.238	**0.154**	0.125 - 0.189
West Germany	522	162	69	<0.10	0.15	0.39	0.52	0.80	4.55	0.202	**0.139**	0.129 - 0.149
Community size (inhabitants)												
< 100 000	281	83	70	<0.10	0.16	0.42	0.56	0.87	1.93	0.213	**0.147**	0.133 - 0.163
≥ 100 000	318	102	68	<0.10	0.14	0.37	0.47	0.74	4.55	0.202	**0.135**	0.123 - 0.149

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification; P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.5.8: 2,4,6-Trichlorophenol (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	598	114	81	<0.10	0.22	0.57	0.82	1.43	13.7	0.327	**0.208**	0.193 - 0.224
Gender ***												
Boys	310	72	77	<0.10	0.20	0.47	0.65	0.93	2.76	0.257	**0.180**	0.163 - 0.199
Girls	287	41	86	<0.10	0.26	0.71	1.11	1.59	13.7	0.402	**0.242**	0.217 - 0.270
Age												
3 to 5 years	136	23	83	<0.10	0.25	0.53	0.71	1.52	13.7	0.382	**0.220**	0.189 - 0.256
6 to 8 years	145	19	87	<0.10	0.24	0.69	0.87	1.55	2.74	0.335	**0.234**	0.203 - 0.270
9 to 11 years	148	42	72	<0.10	0.20	0.77	1.22	1.58	2.76	0.316	**0.185**	0.156 - 0.218
12 to 14 years	168	30	82	<0.10	0.20	0.50	0.65	1.02	4.14	0.285	**0.199**	0.175 - 0.226
Socioeconomic status												
Low	126	24	81	<0.10	0.21	0.51	0.69	1.08	1.59	0.280	**0.203**	0.175 - 0.236
Intermediate	284	48	83	<0.10	0.24	0.61	1.02	1.49	4.14	0.330	**0.219**	0.197 - 0.244
High	183	40	78	<0.10	0.21	0.57	0.82	2.25	13.7	0.359	**0.197**	0.171 - 0.226
Migrant status												
Migrant	45	9	79	<0.10	0.20	0.65	1.00		1.59	0.291	**0.194**	0.147 - 0.255
Non-migrant	553	104	81	<0.10	0.23	0.57	0.81	1.42	13.7	0.330	**0.209**	0.193 - 0.225
Place of residence												
East Germany	77	14	82	<0.10	0.22	0.49	0.63	1.69	2.58	0.277	**0.197**	0.163 - 0.238
West Germany	521	100	81	<0.10	0.22	0.59	0.84	1.42	13.7	0.334	**0.209**	0.193 - 0.227
Community size (inhabitants)												
< 100 000	281	51	82	<0.10	0.21	0.58	0.81	1.39	13.7	0.347	**0.210**	0.188 - 0.234
≥ 100 000	317	63	80	<0.10	0.23	0.58	0.83	1.50	4.14	0.309	**0.206**	0.186 - 0.227

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.5.9: 2,3,4,6-tetrachlorophenol (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.3 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM
Total	599	539	**10**	<0.30	<0.30	0.30	0.43	0.69	3.83	<0.30	<0.30
Gender											
Boys	310	284	**8**	<0.30	<0.30	<0.30	0.38	0.61	1.21	<0.30	<0.30
Girls	289	255	**12**	<0.30	<0.30	0.36	0.52	0.77	3.83	<0.30	<0.30
Age											
3 to 5 years	138	125	**9**	<0.30	<0.30	<0.30	0.46	0.67	1.21	<0.30	<0.30
6 to 8 years	145	132	**9**	<0.30	<0.30	<0.30	0.46	0.78	3.40	<0.30	<0.30
9 to 11 years	148	139	**7**	<0.30	<0.30	<0.30	0.33	0.95	3.83	<0.30	<0.30
12 to 14 years	168	143	**15**	<0.30	<0.30	0.38	0.53	0.78	2.01	<0.30	<0.30
Socioeconomic status											
Low	128	116	**10**	<0.30	<0.30	<0.30	0.52	0.89	3.83	<0.30	<0.30
Intermediate	284	250	**12**	<0.30	<0.30	0.35	0.54	1.19	3.40	<0.30	<0.30
High	183	171	**7**	<0.30	<0.30	<0.30	0.38	0.45	0.54	<0.30	<0.30
Migrant status											
Migrant	45	42	**6**	<0.30	<0.30	<0.30	0.37		0.41	<0.30	<0.30
Non-migrant	555	498	**10**	<0.30	<0.30	0.32	0.44	0.74	3.83	<0.30	<0.30
Place of residence											
East Germany	77	70	**9**	<0.30	<0.30	<0.30	0.54	2.74	3.83	<0.30	<0.30
West Germany	522	469	**10**	<0.30	<0.30	0.32	0.43	0.66	1.76	<0.30	<0.30
Community size (inhabitants)											
< 100 000	281	249	**11**	<0.30	<0.30	0.35	0.44	0.87	3.83	<0.30	<0.30
≥ 100 000	318	290	**9**	<0.30	<0.30	<0.30	0.41	0.61	2.01	<0.30	<0.30

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM < LOQ Significance test: x^2 test of independence (comparison of measured values below and above LOQ) * (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.5.10: Pentachlorophenol (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.6 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM
Total	599	306	**49**	<0.60	<0.60	1.32	1.64	3.13	9.71	0.718	<0.60
Gender											
Boys	310	152	**51**	<0.60	0.62	1.37	1.85	3.54	4.97	0.744	<0.60
Girls	289	154	**47**	<0.60	<0.60	1.27	1.60	2.17	9.71	0.691	<0.60
Age											
3 to 5 years	138	61	**56**	<0.60	0.65	1.44	1.87	4.95	8.12	0.802	<0.60
6 to 8 years	145	67	**54**	<0.60	0.63	1.31	1.64	3.41	6.05	0.745	<0.60
9 to 11 years	148	80	**46**	<0.60	<0.60	1.26	1.58	2.54	9.71	0.669	<0.60
12 to 14 years	168	98	**42**	<0.60	<0.60	1.39	1.96	3.40	4.53	0.670	<0.60
Socioeconomic status											
Low	128	77	**40**	<0.60	<0.60	1.38	1.75	3.77	9.71	0.678	<0.60
Intermediate	284	137	**52**	<0.60	0.61	1.26	1.82	3.41	6.05	0.730	<0.60
High	183	89	**52**	<0.60	0.64	1.42	1.72	2.12	8.12	0.736	<0.60
Migrant status											
Migrant	45	25	**43**	<0.60	<0.60	1.38	1.56		3.50	0.659	<0.60
Non-migrant	555	281	**49**	<0.60	<0.60	1.29	1.78	3.08	9.71	0.723	<0.60
Place of residence											
East Germany	77	43	**45**	<0.60	<0.60	1.40	1.94	4.14	9.71	0.703	<0.60
West Germany	522	264	**50**	<0.60	<0.60	1.32	1.63	3.20	8.12	0.720	<0.60
Community size (inhabitants)											
< 100 000	281	142	**49**	<0.60	<0.60	1.28	1.98	3.52	9.71	0.735	<0.60
≥ 100 000	318	164	**49**	<0.60	<0.60	1.38	1.61	2.14	8.12	0.704	<0.60

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM < LOQ Significance test: x^2 test of independence (comparison of measured values below and above LOQ) * (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

4.6 PAH metabolites in urine

Polycyclic aromatic hydrocarbons (PAHs) are formed as products of incomplete combustion of organic material. In addition, they are contained in liquid and solid products formed as a result of heating of organic material in the absence of oxygen, such as in tar, crude oil distillates, used motor oil and soot. In the environment or at the workplace, PAHs are always present as mixtures that may contain up to several hundred single substances.

Many PAHs have shown carcinogenic effects in animal studies and are carcinogenic to humans. They act as indirect carcinogens, which means that they must have been metabolized in the body to develop their mutagenic and carcinogenic properties (Kommission Human-Biomonitoring, 2005b). Depending on their chemical structure, however, the PAHs classified as carcinogenic differ with regard to their carcinogenic potential. Toxicological assessments and classifications of PAHs as single substances range from “not classifiable as to carcinogenicity to humans” (Group 3, IARC list, 2007) e.g. for anthracene, fluoranthene, phenanthrene, pyrene, “possibly carcinogenic to humans” (Group 2B, IARC list, 2007) for benz(a)anthracene, chrysene, naphthalene, and “probably carcinogenic to humans” (Group 2A, IARC list, 2007), e.g. for dibenz(a,h)anthracene, dibenz(a,l)pyrene; to “carcinogenic to humans” (Group 1, IARC list, 2007) e.g. for benzo(a)pyrene.

There have been indications of a higher sensitivity to PAHs in children and of carcinogenesis depending on age (Schneider 1999). Against this background, it is of particular interest to determine PAH exposure of children in Germany.

In the German Environmental Survey 1998 (GerES III), urine specimens from a sample of adults and archived specimens from 6- to 14-year-old children who participated in the Environmental Survey 1990/92 (GerES II) were examined for levels of PAH metabolites. In these analyses, hydroxypyrene levels found in the urine specimens from children were higher than those found in the urine specimens from adults examined simultaneously (Seiwert et al. 2000).

Food has been regarded as an essential source of PAH exposure of humans. Intensively heated foods (grilled or smoked), but also cereal products contribute essentially to exposure. Hence, food constitutes the main exposure pathway for the general population and obviously, also for children (Fiala et al. 2001). However, this does not apply to smokers, who are essentially exposed through the inhalation of tobacco smoke. For children, passive smoking could be demonstrated to be a pathway of exposure to PAHs (Chuang et al. 1999, Siwinska et al. 1998, van Wijnen et al. 1996, Seiwert et al., 2005). In addition, PAHs are ubiquitous air pollutants.

When absorbed, PAHs undergo a complex metabolic process resulting in their transformation to hydroxylated compounds. They are preferentially excreted with bile in the faeces, and only to a minor extent, in the urine. Urinary excretion of measurable quantities mainly includes PAH metabolites with a low molecular weight, such as naphthalene, phenanthrene and pyrene. The concentrations of non-metabolized PAHs in the blood are so low that they escape detection by

the methods of instrumental analysis currently available (Kommission Human-Biomonitoring, 2005b).

In GerES IV, early morning urine specimens from 600 children aged 3 to 14 years constituting a representative sub-sample selected from the total sample (cf. Chapter 3.1.1) were examined for the following PAH metabolites: 1-hydroxypyrene, 1-hydroxyphenanthrene, 2/9-hydroxyphenanthrene, 3-hydroxyphenanthrene and 4-hydroxyphenanthrene. Tables 4.6.1 to 4.6.6 contain the statistical data describing the frequency distribution of PAH metabolites found in the urine of 3- to 14-year-old children in Germany.

The geometric means are: 0.13 µg/L for 1-hydroxypyrene, 0.19 µg/L for 1-hydroxyphenanthrene, 0.12 µg/L for 2/9-hydroxyphenanthrene, 0.16 µg/L for 3-hydroxyphenanthrene, and 0.02 µg/L for 4-hydroxyphenanthrene. The geometric mean for the total of hydroxylphenanthrenes analyzed is 0.52 µg/L.

The results have shown excretion of 1-hydroxypyrene in smoking children to be clearly higher than in non-smoking children. Also for hydroxyphenanthrenes, the mean level reflects the smoking habits. However, no significance of the levels detected was reached for 1- and 4-hydroxyphenanthrenes. For all PAH metabolites except 4-hydroxyphenanthrene, the mean level in the urine of children living in East Germany was higher than that in children living in West Germany.

Table 4.6.1: 1-Hydroxypyrene (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.012 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	599	4	99	0.052	0.129	0.367	0.465	0.673	4.03	0.178	**0.129**	0.121 - 0.138
Gender												
Boys	310	3	99	0.051	0.122	0.364	0.432	0.665	2.02	0.166	**0.124**	0.113 - 0.135
Girls	289	1	100	0.054	0.131	0.380	0.480	0.705	4.03	0.191	**0.136**	0.123 - 0.149
Age												
3 to 5 years	138	1	99	0.056	0.131	0.364	0.423	0.661	0.775	0.172	**0.133**	0.117 - 0.151
6 to 8 years	145	1	99	0.046	0.124	0.312	0.403	0.516	0.542	0.154	**0.118**	0.103 - 0.134
9 to 11 years	148	0	100	0.050	0.116	0.307	0.455	1.11	1.36	0.168	**0.122**	0.108 - 0.137
12 to 14 years	168	1	99	0.061	0.143	0.432	0.523	0.727	4.03	0.211	**0.145**	0.127 - 0.165
Socioeconomic status												
Low	128	0	100	0.052	0.142	0.405	0.473	0.527	0.865	0.177	**0.136**	0.120 - 0.155
Intermediate	284	1	100	0.055	0.134	0.374	0.516	0.826	4.03	0.193	**0.134**	0.122 - 0.148
High	183	1	99	0.051	0.116	0.351	0.379	0.483	0.663	0.156	**0.120**	0.108 - 0.134
Migrant status												
Migrant	45	0	100	0.063	0.142	0.294	0.403		0.432	0.157	**0.136**	0.115 - 0.160
Non-migrant	555	4	99	0.051	0.128	0.372	0.476	0.691	4.03	0.179	**0.129**	0.120 - 0.138
Place of residence *												
East Germany	77	0	100	0.054	0.159	0.430	0.614	2.02	4.03	0.240	**0.160**	0.132 - 0.193
West Germany	522	4	99	0.051	0.124	0.364	0.456	0.663	1.36	0.168	**0.125**	0.117 - 0.134
Community size (inhabitants)												
< 100 000	281	3	99	0.049	0.131	0.375	0.483	0.683	4.03	0.182	**0.129**	0.117 - 0.142
≥ 100 000	318	1	100	0.055	0.128	0.365	0.453	0.683	1.36	0.174	**0.129**	0.119 - 0.141
Smoking status * **												
Non-smoker	571	4	99	0.052	0.124	0.347	0.432	0.684	4.03	0.172	**0.126**	0.118 - 0.134
Smoker	28	0	100	0.106	0.290	0.486	0.569		0.580	0.293	**0.237**	0.178 - 0.316

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.6.2: 1-Hydroxyphenanthrene (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.016 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	599	2	100	0.077	0.187	0.454	0.595	0.901	2.42	0.240	**0.185**	0.175 - 0.196
Gender												
Boys	310	0	100	0.077	0.179	0.417	0.536	0.964	2.42	0.229	**0.180**	0.166 - 0.194
Girls	289	2	99	0.077	0.201	0.480	0.638	0.897	2.30	0.252	**0.191**	0.175 - 0.209
Age												
3 to 5 years	138	0	100	0.081	0.198	0.474	0.646	0.732	1.07	0.245	**0.197**	0.176 - 0.221
6 to 8 years	145	0	100	0.070	0.195	0.406	0.533	0.712	1.21	0.223	**0.178**	0.158 - 0.199
9 to 11 years	148	0	100	0.075	0.170	0.419	0.535	0.857	1.02	0.215	**0.171**	0.153 - 0.191
12 to 14 years	168	2	99	0.079	0.204	0.532	0.884	1.05	2.42	0.273	**0.196**	0.172 - 0.222
Socioeconomic status												
Low	128	0	100	0.078	0.175	0.444	0.581	0.960	2.42	0.229	**0.176**	0.155 - 0.199
Intermediate	284	2	99	0.083	0.204	0.471	0.583	0.734	2.30	0.243	**0.192**	0.176 - 0.209
High	183	0	100	0.071	0.186	0.449	0.662	1.02	1.57	0.246	**0.185**	0.166 - 0.206
Migrant status												
Migrant	45	0	100	0.081	0.179	0.398	0.572		1.02	0.219	**0.176**	0.146 - 0.214
Non-migrant	555	2	100	0.077	0.189	0.462	0.601	0.897	2.42	0.242	**0.186**	0.175 - 0.198
Place of residence ***												
East Germany	77	0	100	0.110	0.263	0.637	0.905	1.78	2.42	0.337	**0.262**	0.223 - 0.308
West Germany	522	2	100	0.075	0.178	0.416	0.548	0.885	1.57	0.226	**0.176**	0.165 - 0.187
Community size (inhabitants)												
< 100 000	281	0	100	0.075	0.183	0.426	0.519	0.870	2.42	0.225	**0.174**	0.160 - 0.190
≥ 100 000	318	2	99	0.081	0.190	0.474	0.674	0.997	1.57	0.253	**0.195**	0.180 - 0.212
Smoking status												
Non-smoker	571	2	100	0.076	0.183	0.455	0.593	0.921	2.42	0.237	**0.183**	0.172 - 0.194
Smoker	28	0	100	0.082	0.307	0.451	0.884		0.884	0.300	**0.239**	0.178 - 0.320

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.6.3: 2/9-Hydroxyphenanthrene (µg/L) in the urine of Children (3 to 14 years) in Germany

[Limit of quantification: 0.004 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	599	1	100	0.053	0.119	0.253	0.367	0.571	2.00	0.153	**0.119**	0.113 - 0.126
Gender												
Boys	310	0	100	0.053	0.115	0.240	0.361	0.485	2.00	0.146	**0.117**	0.109 - 0.125
Girls	289	1	100	0.055	0.126	0.275	0.378	0.734	1.64	0.160	**0.121**	0.111 - 0.132
Age **												
3 to 5 years	138	1	99	0.053	0.110	0.236	0.412	0.520	1.64	0.147	**0.114**	0.102 - 0.128
6 to 8 years	145	0	100	0.053	0.122	0.199	0.251	0.663	0.995	0.134	**0.111**	0.101 - 0.122
9 to 11 years	148	0	100	0.049	0.106	0.226	0.326	0.466	0.705	0.133	**0.109**	0.098 - 0.121
12 to 14 years	168	0	100	0.063	0.139	0.363	0.464	1.10	2.00	0.190	**0.141**	0.126 - 0.158
Socioeconomic status												
Low	128	0	100	0.059	0.110	0.277	0.404	0.617	2.00	0.158	**0.121**	0.107 - 0.135
Intermediate	284	1	100	0.057	0.128	0.274	0.368	0.669	1.60	0.162	**0.124**	0.114 - 0.135
High	183	0	100	0.053	0.118	0.209	0.341	0.571	0.745	0.137	**0.112**	0.103 - 0.123
Migrant status												
Migrant	45	0	100	0.065	0.110	0.242	0.279		0.705	0.145	**0.122**	0.103 - 0.144
Non-migrant	555	1	100	0.053	0.120	0.264	0.368	0.571	2.00	0.153	**0.119**	0.112 - 0.126
Place of residence **												
East Germany	77	0	100	0.060	0.141	0.382	0.484	0.964	2.00	0.194	**0.149**	0.127 - 0.175
West Germany	522	1	100	0.053	0.117	0.234	0.340	0.566	1.64	0.147	**0.115**	0.109 - 0.122
Community size (inhabitants)												
< 100 000	281	0	100	0.053	0.113	0.254	0.366	0.503	2.00	0.149	**0.116**	0.107 - 0.126
≥ 100 000	318	1	100	0.056	0.129	0.262	0.380	0.661	1.64	0.156	**0.122**	0.113 - 0.131
Smoking status **												
Non-smoker	571	1	100	0.054	0.117	0.245	0.367	0.575	2.00	0.150	**0.117**	0.111 - 0.124
Smoker	28	0	100	0.040	0.196	0.362	0.571		0.571	0.207	**0.165**	0.123 - 0.222

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.6.4: 3-Hydroxyphenanthrene (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.005 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM	
Total	599	0	100	0.065	0.165	0.385	0.531	0.749	2.43	0.208	**0.162**	0.153	0.172
Gender													
Boys	310	0	100	0.071	0.158	0.360	0.498	0.684	2.43	0.201	**0.161**	0.150	0.174
Girls	289	0	100	0.063	0.174	0.397	0.546	0.846	1.53	0.215	**0.164**	0.150	0.179
Age **													
3 to 5 years	138	0	100	0.079	0.160	0.451	0.640	0.731	1.29	0.215	**0.171**	0.152	0.191
6 to 8 years	145	0	100	0.054	0.173	0.372	0.433	0.666	1.21	0.196	**0.157**	0.140	0.175
9 to 11 years	148	0	100	0.063	0.150	0.354	0.404	0.593	0.713	0.185	**0.152**	0.136	0.168
12 to 14 years	168	0	100	0.072	0.169	0.471	0.747	0.934	2.43	0.232	**0.171**	0.152	0.193
Socioeconomic status													
Low	128	0	100	0.066	0.145	0.394	0.602	0.771	2.43	0.205	**0.155**	0.137	0.176
Intermediate	284	0	100	0.075	0.179	0.395	0.537	0.736	1.53	0.217	**0.174**	0.160	0.188
High	183	0	100	0.055	0.153	0.355	0.459	0.853	1.21	0.197	**0.153**	0.138	0.170
Migrant status													
Migrant	45	0	100	0.074	0.150	0.349	0.404		0.798	0.180	**0.154**	0.130	0.182
Non-migrant	555	0	100	0.064	0.166	0.386	0.535	0.754	2.43	0.210	**0.163**	0.154	0.173
Place of residence ***													
East Germany	77	0	100	0.090	0.217	0.640	0.780	1.43	2.43	0.298	**0.224**	0.189	0.266
West Germany	522	0	100	0.064	0.154	0.356	0.478	0.697	1.21	0.194	**0.155**	0.146	0.164
Community size (inhabitants)													
< 100 000	281	0	100	0.059	0.151	0.392	0.542	0.738	2.43	0.208	**0.160**	0.147	0.174
≥ 100 000	318	0	100	0.067	0.172	0.379	0.519	0.754	1.21	0.208	**0.165**	0.153	0.177
Smoking status **													
Non-smoker	571	0	100	0.065	0.160	0.377	0.530	0.720	2.43	0.203	**0.159**	0.151	0.169
Smoker	28	0	100	0.088	0.309	0.509	0.954		0.954	0.306	**0.238**	0.176	0.323

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.6.5: 4-OH-phenanthrene (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.008 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	599	107	82	<0.008	0.023	0.117	0.233	0.548	1.55	0.059	**0.024**	0.022 - 0.027
Gender *												
Boys	310	62	80	<0.008	0.021	0.103	0.178	0.353	1.35	0.050	**0.022**	0.019 - 0.025
Girls	289	45	84	<0.008	0.025	0.156	0.312	0.590	1.55	0.069	**0.027**	0.023 - 0.031
Age *												
3 to 5 years	138	21	84	<0.008	0.027	0.147	0.276	0.669	0.776	0.065	**0.028**	0.023 - 0.035
6 to 8 years	145	16	89	<0.008	0.024	0.177	0.323	0.615	1.55	0.076	**0.028**	0.023 - 0.034
9 to 11 years	148	34	77	<0.008	0.022	0.095	0.124	0.458	0.848	0.044	**0.020**	0.017 - 0.024
12 to 14 years	168	36	79	<0.008	0.022	0.114	0.280	0.536	0.747	0.053	**0.021**	0.018 - 0.026
Socioeconomic status *												
Low	128	27	79	<0.008	0.019	0.099	0.178	0.363	0.776	0.042	**0.019**	0.015 - 0.023
Intermediate	284	52	82	<0.008	0.024	0.124	0.308	0.563	0.848	0.061	**0.025**	0.022 - 0.030
High	183	29	84	<0.008	0.024	0.122	0.242	0.578	1.55	0.067	**0.026**	0.022 - 0.031
Migrant status												
Migrant	45	9	80	<0.008	0.019	0.101	0.102		0.547	0.041	**0.019**	0.014 - 0.026
Non-migrant	555	98	82	<0.008	0.023	0.120	0.248	0.555	1.55	0.060	**0.024**	0.022 - 0.027
Place of residence												
New Länder	77	13	83	<0.008	0.028	0.199	0.525	0.814	1.35	0.083	**0.030**	0.022 - 0.042
Old Länder	522	94	82	<0.008	0.023	0.114	0.215	0.519	1.55	0.055	**0.023**	0.021 - 0.026
Community size (inhabitants) * **												
< 100 000	281	63	77	<0.008	0.022	0.093	0.178	0.260	0.776	0.041	**0.020**	0.017 - 0.023
≥ 100 000	318	44	86	<0.008	0.025	0.128	0.325	0.615	1.55	0.074	**0.028**	0.024 - 0.033
Smoking status												
Non-smoker	571	105	82	<0.008	0.023	0.118	0.249	0.548	1.55	0.060	**0.024**	0.021 - 0.026
Smoker	28	2	94	0.008	0.026	0.085	0.115		0.848	0.047	**0.028**	0.020 - 0.039

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.6.6: Total OH-phenanthrene (1, 2/9, 3, 4) (µg/L) in the urine of children (3 to 14 years) in Germany

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM	
Total	599			0.227	0.527	1.23	1.55	2.22	7.26	0.659	**0.524**	0.496	0.553
Gender													
Boys	310			0.235	0.511	1.06	1.49	1.97	7.26	0.625	**0.510**	0.475	0.547
Girls	289			0.223	0.560	1.33	1.82	2.52	5.14	0.696	**0.539**	0.496	0.587
Age													
3 to 5 years	138			0.257	0.529	1.38	1.51	2.16	3.63	0.671	**0.549**	0.492	0.611
6 to 8 years	145			0.206	0.553	1.14	1.33	1.64	4.72	0.629	**0.512**	0.461	0.568
9 to 11 years	148			0.206	0.501	1.05	1.37	1.95	2.67	0.577	**0.473**	0.426	0.525
12 to 14 years	168			0.246	0.546	1.60	2.07	2.74	7.26	0.748	**0.563**	0.502	0.632
Socioeconomic status													
Low	128			0.226	0.486	1.24	1.60	2.40	7.26	0.635	**0.494**	0.438	0.558
Intermediate	284			0.260	0.553	1.31	1.64	2.06	5.14	0.683	**0.555**	0.514	0.600
High	183			0.199	0.527	1.05	1.57	2.68	4.72	0.648	**0.508**	0.460	0.561
Migrant status													
Migrant	45			0.232	0.482	0.991	1.63		2.67	0.586	**0.486**	0.408	0.579
Non-migrant	555			0.226	0.528	1.24	1.57	2.16	7.26	0.665	**0.527**	0.498	0.558
Place of residence ***													
East Germany	77			0.317	0.712	1.62	2.12	4.47	7.26	0.912	**0.711**	0.606	0.833
West Germany	522			0.224	0.506	1.13	1.49	2.07	4.72	0.622	**0.501**	0.473	0.530
Community size (inhabitants)*													
< 100 000	281			0.206	0.500	1.13	1.53	1.95	7.26	0.623	**0.495**	0.456	0.536
≥ 100 000	318			0.241	0.552	1.33	1.67	2.52	4.72	0.691	**0.551**	0.512	0.593
Smoking status *													
Non-smoker	571			0.226	0.523	1.24	1.54	2.10	7.26	0.649	**0.517**	0.489	0.546
Smoker	28			0.250	0.867	1.43	2.52		2.52	0.861	**0.684**	0.511	0.917

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

4.7 Pyrethroid metabolites in urine

In recent years, more and more attention has been paid to pyrethroids because of their increasing use in indoor environments. Pyrethroids are neurotoxins, and a great number of manifestations of pyrethroid poisoning have been described and controversially discussed (Mersch-Sundermann 1999, Butte et al. 1998).

In animal studies, pyrethroids were found not to be carcinogenic (Miyamoto et al., 1995). Neurotoxic and endocrine-like effects have been reported repeatedly (e.g. Shafer et al., 2005; Kim et al., 2005).

In general, it has been assumed that the main pathways of exposure to pyrethroids were through residues in foods and their indoor use. No data have been published so far on dietary exposure. Contamination of indoor environments with these substances is preferentially examined by means of analysis of house dust samples (Kommission Human-Biomonitoring, 2005a).

Pyrethroids have a short half-life in the human body and are excreted by the urinary route (Kommission Human-Biomonitoring, 2005a). Cis- and trans-Cl_2CA are the specific metabolites of permethrin, cypermethrin and cyfluthrin. Br_2CA is the specific metabolite of deltamethrin. Most pyrethroids, except cyfluthrin, also form 3-PBA.

The early morning urine specimens from the representative sub-sample of 600 children taking part in GerES IV (cf. Chapter 3.1.1) were examined for the following pyrethroid metabolites: cis-Cl_2CA, trans- Cl_2CA (cis- and trans-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid), Br_2CA (3-(2,2-dibromovinyl)-2,2-dimethylcyclopropane-1-carboxylic acid), 3-PBA (3-phenoxybenzoic acid) and F-PBA (4-fluoro-3-phenoxybenzoic acid). The data are presented in Tables 4.7.1 to 4.7.5.

The geometric means of the pyrethroid metabolites are: 0.136 µg/L for cis-Cl_2CA, 0.280 µg/L for trans-Cl_2CA and 0.486 µg/L for 3-PBA. With a limit of quantification of 0.1 µg/L, F-PBA could be detected by analysis in 19 %, and Br_2CA, in 45 % of the children examined.

In girls, the mean levels of cis- and trans-Cl_2CA as well as of 3-PBA were significantly higher than in boys. Age was seen to be a significant variable for three of the metabolites examined. However, a clear tendency towards mean levels increasing with increasing age was only found for Br_2CA.

Table 4.7.1: Cis-Cl_2CA in the urine (µg/L) of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	598	241	60	<0.10	0.12	0.52	1.00	2.38	10.8	0.314	**0.136**	0.124 - 0.148
Gender ***												
Boys	310	139	55	<0.10	0.11	0.38	0.62	1.50	10.8	0.233	**0.115**	0.103 - 0.128
Girls	288	102	64	<0.10	0.15	0.76	1.98	4.34	7.78	0.401	**0.162**	0.141 - 0.186
Age												
3 to 5 years	138	58	58	<0.10	0.12	1.24	2.25	4.00	7.78	0.411	**0.149**	0.121 - 0.184
6 to 8 years	144	63	56	<0.10	0.11	0.38	0.69	3.97	5.79	0.265	**0.117**	0.099 - 0.138
9 to 11 years	148	51	66	<0.10	0.16	0.65	0.85	1.39	2.36	0.246	**0.150**	0.128 - 0.175
12 to 14 years	168	70	59	<0.10	0.13	0.45	0.73	4.29	10.8	0.335	**0.130**	0.111 - 0.154
Socioeconomic status												
Low	128	51	60	<0.10	0.12	0.45	1.45	2.38	3.70	0.276	**0.135**	0.112 - 0.163
Intermediate	283	110	61	<0.10	0.13	0.54	1.26	2.38	4.96	0.288	**0.138**	0.122 - 0.156
High	183	78	57	<0.10	0.11	0.55	0.90	5.78	10.8	0.383	**0.133**	0.113 - 0.157
Migrant status												
Migrant	45	20	55	<0.10	0.12	0.40	0.94		2.55	0.237	**0.125**	0.092 - 0.169
Non-migrant	553	221	60	<0.10	0.12	0.52	1.09	2.37	10.8	0.320	**0.136**	0.125 - 0.149
Place of residence												
East Germany	77	32	59	<0.10	0.13	0.60	1.26	3.62	3.71	0.257	**0.129**	0.102 - 0.163
West Germany	521	210	60	<0.10	0.12	0.52	1.01	2.45	10.8	0.322	**0.136**	0.124 - 0.150
Community size (inhabitants)												
< 100 000	280	108	62	<0.10	0.13	0.52	1.32	3.61	10.8	0.336	**0.139**	0.122 - 0.158
≥ 100 000	318	134	58	<0.10	0.12	0.52	0.97	2.32	7.78	0.294	**0.132**	0.118 - 0.149

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.7.2: Trans-Cl_2CA in the urine (µg/L) of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	598	85	86	<0.10	0.25	1.18	2.46	5.93	30.8	0.733	**0.280**	0.255 - 0.308
Gender* **												
Boys	310	44	86	<0.10	0.22	0.83	1.40	3.38	30.8	0.556	**0.241**	0.214 - 0.271
Girls	288	41	86	<0.10	0.30	1.40	3.81	9.71	22.1	0.923	**0.330**	0.284 - 0.384
Age *												
3 to 5 years	138	16	89	<0.10	0.26	2.42	3.93	9.34	22.1	0.951	**0.327**	0.263 - 0.407
6 to 8 years	144	17	88	<0.10	0.25	0.81	1.41	13.4	19.4	0.678	**0.267**	0.224 - 0.320
9 to 11 years	148	16	89	<0.10	0.28	1.31	2.39	4.30	10.9	0.606	**0.318**	0.266 - 0.380
12 to 14 years	168	36	79	<0.10	0.20	0.93	1.61	7.68	30.8	0.713	**0.231**	0.192 - 0.277
Socioeconomic status												
Low	128	16	88	<0.10	0.25	1.06	2.86	5.66	19.4	0.599	**0.264**	0.217 - 0.321
Intermediate	283	45	84	<0.10	0.27	1.20	2.59	5.84	15.6	0.647	**0.280**	0.244 - 0.322
High	183	22	88	<0.10	0.25	1.35	2.45	13.1	30.8	0.970	**0.299**	0.251 - 0.358
Migrant status												
Migrant	45	6	86	<0.10	0.21	0.78	1.17		4.53	0.338	**0.220**	0.168 - 0.288
Non-migrant	553	79	86	<0.10	0.26	1.23	2.70	6.34	30.8	0.764	**0.286**	0.259 - 0.316
Place of residence												
East Germany	77	7	90	<0.10	0.26	1.60	3.08	13.9	19.4	0.781	**0.306**	0.235 - 0.398
West Germany	521	77	85	<0.10	0.25	1.14	2.36	5.91	30.8	0.725	**0.277**	0.250 - 0.307
Community size (inhabitants)												
< 100 000	280	47	83	<0.10	0.26	1.23	2.82	8.75	30.8	0.792	**0.279**	0.241 - 0.322
≥ 100 000	318	38	88	<0.10	0.24	1.14	1.95	5.92	22.1	0.680	**0.282**	0.249 - 0.320

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.7.3: Br_2CA (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	598	327	**45**	<0.10	<0.10	0.52	0.91	1.69	21.9	0.293	0.110	0.101 - 0.120
Gender												
Boys	310	173	**44**	<0.10	<0.10	0.48	0.92	1.44	12.5	0.249	0.105	<0.10 - 0.118
Girls	288	154	**46**	<0.10	<0.10	0.55	1.24	2.22	21.9	0.340	0.115	0.101 - 0.131
Age *												
3 to 5 years	138	88	**36**	<0.10	<0.10	0.44	1.36	1.75	21.9	0.410	<0.10	
6 to 8 years	144	77	**47**	<0.10	<0.10	0.54	1.43	2.23	12.5	0.321	0.113	<0.10 - 0.135
9 to 11 years	148	81	**45**	<0.10	<0.10	0.45	0.57	0.68	2.99	0.160	<0.10	
12 to 14 years	168	81	**52**	<0.10	0.10	0.86	1.02	2.92	4.85	0.290	0.129	0.108 - 0.153
Socioeconomic status												
Low	128	79	**38**	<0.10	<0.10	0.54	0.90	1.07	2.99	0.195	0.101	<0.10 - 0.120
Intermediate	283	149	**47**	<0.10	<0.10	0.56	1.25	1.96	21.9	0.347	0.115	0.100 - 0.131
High	183	96	**48**	<0.10	<0.10	0.45	0.92	2.18	10.3	0.281	0.111	<0.10 - 0.129
Migrant status												
Migrant	45	24	**46**	<0.10	<0.10	0.76	1.44		1.59	0.235	0.113	<0.10 - 0.157
Non-migrant	553	303	**45**	<0.10	<0.10	0.52	0.90	1.71	21.9	0.297	0.110	0.100 - 0.120
Place of residence												
East Germany	77	49	**37**	<0.10	<0.10	0.38	1.32	7.31	12.5	0.291	<0.10	
West Germany	521	279	**46**	<0.10	<0.10	0.54	0.92	1.70	21.9	0.293	0.112	0.102 - 0.123
Community size (inhabitants)												
< 100 000	280	154	**45**	<0.10	<0.10	0.52	0.89	1.63	21.9	0.356	0.110	<0.10 - 0.125
≥ 100 000	318	174	**45**	<0.10	<0.10	0.53	0.95	1.75	4.85	0.238	0.110	<0.10 - 0.124

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM < LOQ Significance test: chi-square test of independence (comparison of measured values below and above LOQ)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.7.4: 3-PBA (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM	CI GM
Total	598	15	98	0.16	0.43	1.67	3.80	6.80	15.7	0.908	**0.486**	0.447 - 0.527
Gender ***												
Boys	310	9	97	0.16	0.39	1.10	1.67	3.92	15.3	0.664	**0.406**	0.367 - 0.448
Girls	288	6	98	0.16	0.49	2.85	4.76	8.27	15.7	1.17	**0.589**	0.518 - 0.670
Age *												
3 to 5 years	138	3	98	0.15	0.50	3.33	5.31	9.71	15.7	1.22	**0.577**	0.475 - 0.700
6 to 8 years	144	1	99	0.19	0.38	1.38	3.85	8.05	10.8	0.841	**0.470**	0.403 - 0.547
9 to 11 years	148	1	99	0.16	0.52	1.63	3.12	4.73	8.37	0.828	**0.523**	0.450 - 0.608
12 to 14 years	168	10	94	0.14	0.38	1.19	2.85	6.45	15.3	0.780	**0.406**	0.348 - 0.474
Socioeconomic status												
Low	128	1	99	0.14	0.39	1.40	2.62	6.38	10.8	0.780	**0.451**	0.382 - 0.533
Intermediate	283	12	96	0.15	0.41	1.72	3.80	6.84	10.4	0.877	**0.471**	0.417 - 0.533
High	183	1	99	0.17	0.48	1.77	4.25	9.33	15.7	1.06	**0.544**	0.471 - 0.629
Migrant status												
Migrant	45	1	97	0.13	0.34	3.13	4.45		6.52	0.822	**0.439**	0.324 - 0.595
Non-migrant	553	14	98	0.16	0.44	1.69	3.68	6.84	15.7	0.915	**0.489**	0.450 - 0.533
Place of residence												
East Germany	77	1	99	0.16	0.42	1.94	4.37	10.4	10.8	0.920	**0.497**	0.397 - 0.621
West Germany	521	14	97	0.16	0.44	1.58	3.80	6.59	15.7	0.906	**0.484**	0.443 - 0.528
Community size (inhabitants)												
< 100 000	280	6	98	0.17	0.42	2.50	4.70	8.09	15.3	1.02	**0.500**	0.441 - 0.568
≥ 100 000	318	9	97	0.16	0.44	1.52	2.66	5.27	15.7	0.813	**0.473**	0.425 - 0.526

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes;
Significance test: t test or variance analysis (differences of GMs)
* (p≤0,05), ** (p≤0,01), *** (p≤0,001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

Table 4.7.5: F-PBA (µg/L) in the urine of children (3 to 14 years) in Germany

[Limit of quantification: 0.1 µg/L]

	N	n<LOQ	%≥LOQ	P10	P50	P90	P95	P98	MAX	AM	GM
Total	598	484	**19**	<0,10	<0,10	0,21	0,43	0,81	5,04	0,125	<0,10
Gender											
Boys	310	251	**19**	<0,10	<0,10	0,23	0,41	0,75	5,04	0,136	<0,10
Girls	288	233	**19**	<0,10	<0,10	0,19	0,45	0,83	2,64	0,114	<0,10
Age											
3 to 5 years	138	112	**18**	<0,10	<0,10	0,22	0,48	0,65	1,54	0,107	<0,10
6 to 8 years	144	109	**24**	<0,10	<0,10	0,34	0,45	0,58	1,02	0,112	<0,10
9 to 11 years	148	125	**16**	<0,10	<0,10	0,15	0,25	3,02	5,04	0,158	<0,10
12 to 14 years	168	138	**18**	<0,10	<0,10	0,19	0,46	0,92	2,64	0,122	<0,10
Socioeconomic status											
Low	128	100	**22**	<0,10	<0,10	0,19	0,36	0,85	2,23	0,116	<0,10
Intermediate	283	234	**17**	<0,10	<0,10	0,19	0,50	0,84	4,65	0,127	<0,10
High	183	146	**20**	<0,10	<0,10	0,25	0,37	0,56	5,04	0,131	<0,10
Migrant status											
Migrant	45	32	**29**	<0,10	<0,10	0,36	0,45		0,76	0,122	<0,10
Non-migrant	553	452	**18**	<0,10	<0,10	0,19	0,40	0,83	5,04	0,126	<0,10
Place of residence											
East Germany	77	64	**17**	<0,10	<0,10	0,18	0,54	2,10	2,64	0,121	<0,10
West Germany	521	419	**19**	<0,10	<0,10	0,22	0,44	0,76	5,04	0,126	<0,10
Community size (inhabitants)											
< 100 000	280	228	**19**	<0,10	<0,10	0,23	0,36	0,55	1,99	<0,10	<0,10
≥ 100 000	318	256	**20**	<0,10	<0,10	0,19	0,51	0,97	5,04	0,149	<0,10

Notes: N = sample size; n<LOQ = number of values below the limit of quantification (LOQ);
% ≥ LOQ = percentage of values above the limit of quantification;
P10, P50, P90, P95, P98 = percentiles;
MAX = maximum value; AM = arithmetic mean; GM = geometric mean;
CI GM = approximate 95% confidence interval for GM;
values below LOQ are set at LOQ/2 for calculation purposes; no CI GM is given if GM < LOQ Significance test: x^2 test of independence (comparison of measured values below and above LOQ)
* (p≤0.05), ** (p≤0.01), *** (p≤0.001)

Source: Federal Environment Agency, German Environmental Survey for Children 2003/06

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6 Lists

6.1 List of abbreviations

3-PBA	3-phenoxybenzoic acid
AAS	atomic absorption spectroscopy
AM	arithmetic mean
As	arsenic
Cd	Cadmium
CI	confidence interval
CVAAS	cold-vapour atomic absorption spectroscopy
DCP	dichlorophenol
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DEDTP	diethyl dithiophosphate
DEP	diethyl phosphate
DETP	diethyl thiophosphate
DFG	Deutsche Forschungsgemeinschaft (DFG)
DMDTP	dimethyl dithiophosphate
DMP	dimethyl phosphate
DMTP	dimethyl thiophosphate
ECD	micro electron capture detection
F-PBA	4-fluoro-3-phenoxybenzoic acid
GC	gas chromatography
GerES	German Environmental Survey
GM	geometric mean
HBM	human biomonitoring
HCB	hexachlorobenzene
HCH	hexachlorocyclohexane
Hg	mercury
HGAAS	hydride-generation atomic absorption spectroscopy
HPLC	high performance liquid chromatography
IARC	International Agency for Research on Cancer
KiGGS	German Health Interview and Examination Survey for Children and Adolescents
LGA	Landesgesundheitsamt (State Health Office)
LOQ	limit of quantification
MAX	maximum value
MCP	monochlorophenol
MS	mass spectrometry
n	number of values from the sample
N	sample size
OH-phen.	hydroxyphenanthrene
OH-pyrene	hydroxypyrene
p	probability of error
P	percentile

PAHs	polycyclic aromatic hydrocarbons
Pb	lead
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
QA	Quality assurance
RKI	Robert Koch Institute
TCP	trichlorophenol
TeCP	tetrachlorophenol
UBA	Federal Environment Agency (Umweltbundesamt)
WHO	World Health Organization

6.2 List of Tables

7 Annex

7.1 Analytical methods

Medium	Analyte	Analytical method	References	Laboratory
Blood	**Lead**	Electrothermal AAS with Zeeman background compensation	According to Koreckova-Sysalova, 1997	Federal Environment Agency, Laboratory II 1.2
	Cadmium			
	Mercury	DFG method, cold-vapour AAS (CVAAS)	Schaller, 1988	
	HCH, HCB, DDE, PCB	Modified DFG method, GC with µECD	Schulte et al., 1991 ; StMGEV, 2002	Institute and Outpatient Clinic of Occupational, Social and Environmental Medicine, University of Erlangen-Nuremberg
Urine	**Cadmium**	Electrothermal AAS	Dube et al., 1989	Federal Environment Agency, Laboratory II 1.2
	Arsenic	Based on DFG method, hydride-generation AAS (HGAAS) (batch method)	Schaller, 1991	Department of Hygiene, Social and Environmental Medicine, University of Bochum
	Nickel	On the basis of DFG method, electrothermal AAS	Angerer, 1985	
	Mercury	Cold-vapour AAS (flow injection method)	Internal method	
	Nicotine, cotinine	HPLC with UV detection qualitative assurance by means of GC/MS	Merkel, 1992	Institute of Medical Microbiology, Virology and Hygiene, University Hospital of Rostock
	Creatinine	Jaffé method	Larsen, 1972	Institute and Outpatient Clinic of Occupational, Social and Environmental Medicine, University of Erlangen-Nuremberg
	PAH metabolites	DFG method, HPLC after hydrolysis	Lintelmann und Angerer, 1999	
	PCP, chlorophenols	DFG method, GC/MS after derivatisation	Angerer 2001, Heinrich-Ramm, 2001	
	Organophos-phate metabolites	Internal method, GC/MS after derivatisation	Hardt und Angerer, 2000	
	Pyrethroid metabolites	Internal method, GC/MS after derivatisation	Schettgen et al., 2002	

7.2 Explanation of variables used for stratification

The variables used for a stratified description were taken from the following sources:

Questionnaires of the German Environmental Survey for Children (GerES IV):
Questionnaire addressed to parents
Questionnaire on the residential environment of the child
Sampling documentation form

Questionnaires of the German Health Interview and Examination Survey for Children and Adolescents (German acronym: KiGGS):
Questionnaires addressed to children aged 11 – 13, and 14 - 17 years
Questionnaires addressed to parents of children aged 3 – 6, 7 – 10, 11 – 13, and 14 - 17 years
Medical measurement record sheets for children aged 3 – 6, 7 – 10 and 11 – 17 years

The GerES IV questionnaires are available (in German) as pdf files for download at: www.umweltbundesamt.de/survey/frage/index.htm.
The KiGGS questionnaires (in German) are available on request from the Robert Koch Institute at www.kiggs.de/experten/frageboegen/index.4ml

In addition to the explanations of all variables used for stratification, information is given below regarding the analytes and media for which each variable has been tabulated in this report (Chapter 4).

Sociodemography

Gender (variable SEX_N)	
Categories	• Boys • Girls
Analyte/medium	All analytes/media

Age (variable ALT_N)	
Variable	Age in years completed
Categories	• 3 to 5 years • 6 to 8 years • 9 to 11 years • 12 to 14 years (including 2 subjects having completed the age of 15 shortly before examination)
Analyte/medium	All analytes/media except organochlorine compounds in blood
Categories	• 7 to 8 years • 9 to 11 years • 12 to 14 years (including 2 subjects having completed the age of 15 shortly before examination)
Analyte/medium	Organochlorine compounds/blood: HCB, (α-, β-, γ-HCH), DDE, PCB-138, PCB-153, PCB-180, ∑PCB (138+153+180)

Migrant status (variable Migrant)	
Index	Composed of the data: country of birth of the child, countries of birth of father and mother, nationalities of father and mother
Categories	• Migrant • Non-migrant
Note	Migrants are defined as children and adolescents who either were born in another country or whose parents both have immigrated and/or hold a nationality other than the German one (personal communication Schenk et al. 2006, RKI)
Analyte/medium	All analytes/media

Socioeconomic status (variable SCHICHTZ)	
Index	Winkler index, composed of the data on: education, occupational standing and income of parents (Lange et al., 2007)
Categories	• Low • Intermediate • High
Analyte/medium	All analytes/media

Home and residential area

Community size (inhabitants)	
Variable	BIK community size (BIK Aschpurwis und Behrens GmbH)
Categories	• Less than 100 000 inhabitants (< 2 000, 2 000 to <5 000, 5 000 to <20 000, 20 000 to <50 000, 50 000 to <100 000, commuter belt, 50 000 to <100 000, town) • 100 000 inhabitants and above (100 000 to <500 000, commuter belt, 100 000 to <500 000, town, „500 000 and above, commuter belt, 500 000 and above, town)
Analyte/medium	All analytes/media

Place of residence	
Categories	• West Germany (including West Berlin) • East Germany (including East Berlin)
Note	Place of residence of the interviewed person at the time of the survey
Analyte/medium	All analytes/media

Food

Fish consumption within the last 48 hours prior to sampling (Fisch1 for blood, D06C for urine)	
Question	"When did your child eat fish the last time before **urine sampling**? (Please make sure not to forget e.g. tuna in salad or on pizza, or prawn cocktail.)" "When did your child eat fish the last time before **blood sampling**? (Please make sure not to forget e.g. tuna in salad or on pizza, or prawn cocktail.)"
Categories	• Within the last 48 hours („Yesterday", "Day before yesterday") • More than 48 hours ago ("Three days ago", "More than three days ago")
Analyte/medium	As/urine, Hg/blood

Frequency of fish consumption (S58G)	
Question	„How often did your child eat fish in the last four weeks? (Please make sure not to forget e.g. tuna in salad or on pizza, or prawn cocktail etc.)"
Categories	• Up to three times per month ("Almost never", "Once per month", "Two or three times per month") • More than three times per month ("Once per week", "Several times per week", "Daily", "Several times per day")
Analyte/medium	As/urine, Hg/blood

Breastfeeding

Breastfeeding (E066)	
Question	"Was your child breastfed?"
Categories	• No • Yes
Analyte/medium	Organochlorine compounds/blood: HCB, (α-, β-, γ-HCH), DDE, PCB-138, PCB-153, PCB-180, ∑PCB (138+153+180)

Teeth

Teeth with amalgam fillings (S35A_Z)	
Question	"How many teeth with amalgam fillings has your child?"
Categories	• None • One or two teeth • More than two teeth
Analyte/medium	Hg/urine

Smoking habits

Smoking status, two categories (variable COTRAUCH)	
Index	Composed of the question addressed to the child aged 11 or older: "Do you smoke at present?" and the question addressed to the parents, whether the child examined was a smoker or a non-smoker, and cotinine levels in urine of 90 µg/L and above (classification as a smoker)
Categories	• Non-smoker • Smoker
Note	A child has been classified as a smoker if at least one of the three conditions applies.
Analyte/medium	Cd/blood, Cd/urine, 1-hydroxypyrene/urine, 1-hydroxyphenanthrene/ urine,2/9-hydroxyphenanthrene/urine, 3-hydroxyphenanthrene/urine, 4-hydroxyphenanthrene/urine, $\Sigma_{1,2/9,3}$-hydroxyphenanthrene/urine, nicotine/urine, cotinine/urine

Passive exposure to smoke

Passive smoking at home (S65A_K3)	
Question	"How often does your child usually stay in rooms at home where people smoke?"
Categories	• Never • Not daily ("Seldom", "Once per week", "Twice or three times per week", "Four to six times per week") • Daily
Sub-sample	Only children who do not actively smoke
Analyte/medium	Cd/blood, Cd/urine, 1-hydroxypyrene/urine, 1-hydroxyphenanthrene/urine, 2/9-hydroxyphenanthrene/urine, 3-hydroxyphenanthrene/urine, 4-hydroxyphenanthrene/urine, $\Sigma_{1,2/9,3}$-hydroxyphenanthrene/urine, nicotine/urine, cotinine/urine

Number of smokers in the household (S72RA_ZZ)	
Index	Smoking habits of all persons in the household asked by the environmental interviewer
Categories	• No smokers • One smoker • More than one smoker
Sub-sample	Only children who do not actively smoke
Analyte/medium	Cd/blood, Cd/urine, 1-hydroxypyrene/urine, 1-hydroxyphenanthrene/urine, 2/9-hydroxyphenanthrene/urine, 3-hydroxyphenanthrene/urine, 4-hydroxyphenanthrene/urine, $\Sigma_{1,2/9,3}$-hydroxyphenanthrene/urine, nicotine/urine, cotinine/urine