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Blood lead levels in children

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The level of lead in the blood of children in a community, a region or a country is expressed as the geometric mean of individual blood lead concentrations in micrograms per decilitre (µg/dl).

KEY MESSAGE

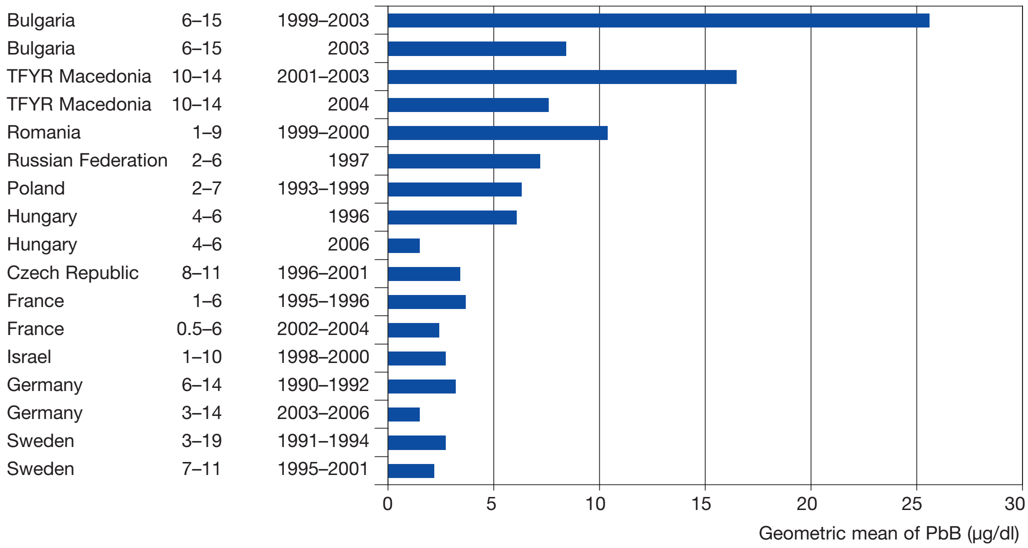
The phasing out of lead from petrol, first in western Europe and later in central and eastern Europe, has resulted in a significant decrease in blood lead levels in children during the last two decades. Industrial emissions are still important local sources of lead exposure in some countries. Since lead was phased out from petrol, other sources of exposure to lead that had previously been ignored have become increasingly significant. It is still necessary to reduce the levels of lead in the blood further because there is no known safe level in children.

An efficient surveillance system, using comparable methods of blood sampling, analysis and data presentation to monitor lead levels in children's blood, is urgently required for the identification and elimination of the remaining sources of exposure to lead and monitoring of the effectiveness of preventive action.

RATIONALE

Lead is one of the best known toxic heavy metals. The level of lead in the blood is a highly reliable biological marker of recent exposure to lead. Elevated blood lead level (10 µg/dl or above) has been associated with toxicity in the developing brain and nervous system of young children, leading to lower intelligence quotient (IQ) *(1)*. According to recent evidence, however, loss of IQ was observed in children with blood lead levels below 10 µg/dl, so prevention activities should be initiated to bring down the levels of lead in the blood to the lowest possible level.

Fig. 1. Mean blood lead levels (PbB) of children measured in selected European countries, 1991–2006 (age ranges in years)



Note. *TFYR Macedonia = The former Yugoslav Republic of Macedonia.*
Bulgaria 1999–2003: data represent industry
Bulgaria 2003: data represent traffic
The former Yugoslav Republic of Macedonia 2001–2003 and 2004: data represent industry (see Assessment section below, third paragraph)
Data for Bulgaria (2003), the Czech Republic and The former Yugoslav Republic of Macedonia are arithmetic means.
Source: Country case studies (4–15).

PRESENTATION OF DATA

Figure 1 shows average levels of lead in children's blood in 11 countries (Bulgaria, the Czech Republic, France, Germany, Hungary, Israel, Poland, Romania, the Russian Federation, Sweden and The former Yugoslav Republic of Macedonia) at different times between 1990 and 2006. This array of data was used due to the paucity of recent data, to allow data from many countries to be considered and to provide some indication of trends. Where possible, average blood lead levels are given as the geometric mean as the distribution of blood lead levels is generally log-normal.

HEALTH – ENVIRONMENT CONTEXT

Lead in the environment has multiple sources (e.g. petrol, industrial processes, paint, solder in canned foods, water pipes) and reaches people via a number of pathways (such as air, household dust, street dirt, soil, water, food). As a consequence, evaluation of the relative contribution of different sources is complex and is likely to differ between areas and population groups. Lead-containing petrol remains the most important source of atmospheric lead and is a significant contributor to the lead burden in the body in the countries where it is still used. Industrial emissions are also important sources of lead contamination of the soil and ambient air. Lead from atmospheric air or flaked paint deposited in soil and dust may be ingested by children and may substantially raise their blood lead levels. In addition, food and water may also be important media of baseline exposure to lead *(2)*.

In children, the potential for adverse effects of exposure to lead is increased because (i) the intake of lead per unit of body weight is higher for children than for adults; (ii) young children often place objects in their mouths, resulting in ingestion of dust and soil and, possibly, increased intake of lead; (iii) physiological uptake rates of lead in children are higher than in adults; and (iv) young children are undergoing rapid development, their systems are not fully developed and consequently they are more vulnerable than adults to the toxic effects of lead.

Epidemiological studies show that exposure to lead during the early stages of children's development is linked to, among other things, deficits in later neurobehavioral performance. Studies suggest that for each 10μg/dl of blood lead, IQ is reduced by 1–3 points. At the individual level, this drop may seem small and reasonably inconsequential, but at the population level, small effects on many individuals may be a significant burden to society, with reduced overall intellectual performance and resulting economic losses. This has been studied by researchers in the United States, who have calculated the financial earnings that could be achieved if the level of lead in children's blood were to be reduced. Cognitive ability affects school performance, educational attainment and success in the labour market, and is thus positively associated with earnings. Improvements in cognitive ability benefit society by raising economic productivity, including profits and tax revenues, and by reducing crime and other behaviour which has a negative impact on other people *(2,3)*.

The following public health measures may be used to reduce the exposure of children to lead in the environment and thus to lower the level of lead in their blood *(2)*:

- phasing out lead additives in fuels and removing lead from petrol;
- reducing and phasing out the use of lead-based paints;
- eliminating the use of lead in food containers;
- identifying, reducing and eliminating lead used in traditional medicines and cosmetics;
- minimizing the dissolving of lead in water treatment and water distribution systems;
- improving identification of populations at high risk of exposure on the basis of monitoring systems;
- improving the promotion of understanding and awareness of exposure to lead;
- placing greater emphasis on adequate nutrition, health care and attention to socioeconomic conditions that may enhance the effects of lead.

POLICY RELEVANCE AND CONTEXT

International conventions and action programmes as well as European Union (EU) directives and resolutions have acknowledged the importance of exposure to lead as a key public health issue.

Global and pan-European context

The Convention on the Rights of the Child (United Nations General Assembly resolution 44/25 of 20 November 1989) and Agenda 21 (adopted by more than 178 governments at the United Nations Conference on Environment and Development held in Rio de Janeiro, Brazil, in 1992) form the general framework to protect children's health from hazardous environmental exposures *(16,17)*.

The 1979 Convention on Long-Range Transboundary Air Pollution on Heavy Metals and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal recognize the need for international cooperation in reducing exposure to toxic heavy metals *(18,19)*. The Rotterdam Convention promotes the exchange of information as well as shared responsibility and cooperative efforts among the parties in the international trade of certain hazardous chemicals *(20)*.

The recently adopted strategic approach to international chemicals management goes a step further in committing the parties to ensuring that chemicals are produced and used in ways that minimize significant adverse impacts on the environment and on human health *(21)*.

In addition, international commitments are made that specifically address the exposure of children to lead. In February 1996, the environment ministers of the Organisation for Economic Co-operation and Development (OECD) issued a Declaration on Lead Risk Reduction seeking voluntarily to develop and strengthen national and cooperative efforts considered necessary to reduce the risks from exposure to lead. Their goals include efforts to phase out leaded gasoline and eliminate the exposure of children to lead *(22)*.

The 1997 Declaration of the Environment Leaders of the Eight on Children's Environmental Health commits the G8 countries to fulfil and promote internationally the OECD Declaration on Lead Risk Reduction. They specifically called for further action to reduce the levels of lead in children's blood to below 10 μg/dl. When this level is exceeded, further action is required. They agreed to conduct public awareness campaigns on the risks to children from exposure to lead and to develop scientific protocols and programmes to monitor the levels of lead in children's blood to track progress in this important area *(23)*.

In September 2006, the Intergovernmental Forum on Chemical Safety was the setting for the Budapest Statement on Mercury, Lead and Cadmium, which recognizes that the risks from these three substances need to be addressed by further global, regional, national and local action, as appropriate *(24)*. In the same context, the Declaration of Brescia on Prevention of the Neurotoxicity of Metals supported the revision of lead exposure standards and promoted an immediate reduction of the level of lead in children's blood to a concentration of 5 μg/dl worldwide *(25)*. This level is proposed as a temporary measure that may need to be revised further downwards in future years as new evidence accumulates on toxicity at still lower levels of lead in the blood.

In 2004, the Fourth Ministerial Conference on Environment and Health adopted the Children's Health and Environment Action Plan for Europe (CEHAPE), which includes four regional priority goals to reduce the burden of environment-related diseases in children. One of the goals (RPG IV) aims to reduce the risks of disease and disability arising from exposure to hazardous chemicals (such as heavy metals), physical agents (such as excessive ultraviolet radiation) and biological agents and to hazardous working environments during pregnancy, childhood and adolescence. In CEHAPE RPG IV specific action is set out to reduce the exposure of children to lead, such as the enactment of legislation on the content of lead in petrol and building materials, to develop and enforce regulations to minimize the risks from hazardous building materials (such as lead) and to carry out biomonitoring of lead in infants and mothers at risk *(26)*.

EU context

The Seventh Research Framework Programme (2006–2013) of the EU emphasizes the development of a coherent approach to human biomonitoring, which is necessary to assure appropriate risk assessment and management for chemicals that influence human health *(27)*.

In 1977, Council Directive on Biological Screening of the Population for Lead (77/312/EEC) committed the EU member states to apply a common procedure for biological screening in order to assess the exposure of the population to lead outside the working environment *(28)*. Several European policy initiatives on reducing the amount of leaded petrol (the main source of elevated levels of lead in children's blood) are in place in the member states. The Fourth Ministerial Conference "Environment for Europe" in June 1998 endorsed the United Nations Economic Commission for Europe's Declaration on the Phase-out of Added Lead in Petrol for general use by road vehicles as early as possible, and not later than 1 January 2005. Thirty governments signed this declaration, including most central and eastern European countries; this can be seen as an important step to reducing airborne lead pollution *(29)*. Resolution No. 99/6 on phasing out lead in petrol by the Council of Ministers of Transport, meeting in Warsaw on 18 and 19 May 1999, reiterated the recommendation that where they have not already done so, governments should encourage the more rapid and widespread introduction of unleaded fuel by measures including the use of fiscal incentives and information campaigns *(30)*.

ASSESSMENT

In general terms, levels of lead in the blood started to decline earlier in the western European and Scandinavian countries than in eastern Europe, largely because the gradual introduction of unleaded petrol began earlier in the western and northern countries. In the mid-1980s, a collaborative study between WHO and the Commission of the European Communities on levels of lead in children's blood found levels of 18.2–18.9 μg/dl in Bulgaria, Hungary and Romania, compared to 11.0 μg/dl in Italy and 7.4 μg/dl in Germany *(31)*. This difference was still evident in the 1990s, with considerably lower levels in France, Germany, Israel and Sweden than in Hungary, Poland and the Russian Federation. The beneficial effects of a switch to unleaded petrol are shown by a series of measurements of levels of lead in the blood of children living in an urban environment in Sweden: the geometric mean lead level was 5.8 μg/dl in 1978–1982, 3.4 μg/dl in 1989 and 2.3 μg/dl in 1993.

Data suggest that following the phase-out of leaded petrol, the rate of decline of lead in the continued, albeit more slowly. For instance, the mean level of lead in children's blood in Germany has fallen by more than 50% over the past 12–14 years. The evidence of reduced levels is positive, but many children still have levels that may harm their health. For example, in France there has been a significant fall in the amount of lead in the blood over the past eight years, but the level in about 10% of children is still above 5.0 μg/dl. This may affect their neurobehavioral performance.

Besides car exhausts, industrial emissions are important sources of exposure to lead. Data from industrial areas in Bulgaria, Poland and The former Yugoslav Republic of Macedonia show the significant impact of lead emitted by nearby plants on the level of lead in children's blood (Fig. 1). In The former Yugoslav Republic of Macedonia, Fig. 1 shows two measurements made in the same community: one during the time a lead and zinc smelter plant was active (up to 2003), the second after the plant had closed in the second half of 2003 (2004). In Poland, the geometric mean of lead levels in the blood of children living in the vicinity of zinc and copper mills ranged between 7.4 μg/dl and 11.4 μg/dl, in contrast to 3.0–6.3 μg/dl among children living in five towns with no industrial lead emitters *(32)*.

The questionnaires that accompanied the surveys of lead levels in the blood identified other determinants of higher levels in children, including tap water, the age of the dwelling, poor housing conditions, environmental tobacco smoke, breastfeeding by mothers exposed to lead, the use of painted ceramic dishes and cosmetic kohl, low milk intake and poor socioeconomic status. These findings indicate the importance of public education and risk communication. Regularly conducted harmonized assessments of the levels of lead in children's blood are needed to identify and eliminate existing sources of environmental exposure to lead and to monitor the effectiveness of preventive action. This monitoring would be preferable in pre-school age children, as young children tend to have high levels of lead in their blood due to their tendency to put things into their mouths, and lead levels may affect their school performance.

DATA UNDERLYING THE INDICATOR

Data source

Data were kindly provided by: the National Centre for Public Health Protection, Bulgaria; Centre of Environmental Health, National Institute of Public Health, Czech Republic; National Institute of Public Health Sruveillance, France; Landesinstitut für den Öffentlichen Gesundheitsdienst NRW, Germany; National Institute of Environmental Health, Hungary; Hebrew University-Hadassah International School of Public Health and Community Medicine, Israel; Institute of Occupational Medicine and Environmental Health, Poland; Institute of Public Health, Romania; National Board of Health and Welfare, Sweden and Institute for Health Protection, The former Yugoslav Republic of Macedonia.

Data for the Russian Federation were taken from reference *(4)*.

Description of data

The levels of lead in children's blood were determined mostly from venous blood samples using atomic absorption spectrometry or ICP-MS. Three countries reported the use of capillary samples and blood test kits (based on electrochemistry).

According to the comparison tests performed in each case, these data were claimed to be comparable with the results produced by the above-mentioned methods *(4,10,11,13)*.

Levels of lead in the blood were provided in the form of arithmetic mean and/or geometric mean. One country presented only the percentages of lead in children's blood.

Method of calculating the indicator

As the data were provided in various forms and for various time periods and age groups, it was not possible to do a meta-analysis. In the case of Romania, geometric mean was estimated on the basis of frequency distribution among blood lead level categories.

Geographical coverage

Bulgaria, the Czech Republic, France, Germany, Hungary, Israel, Poland, Romania, Russian Federation, Sweden and The former Yugoslav Republic of Macedonia.

Period of coverage

1991–2006.

Frequency of update

None.

Data quality

The accuracy and precision are high for measurements of lead in the blood reported by the countries, regardless of different methods of analysis. All samples were analysed by laboratories participating in international proficiency programmes. Only the report from Germany for 2003–2006 was based on representative samples of the population in one part of the country. Other data presented in this fact-sheet are specific to the areas, time of the study and the given age groups. Comparison of the data over time and between countries should, therefore, be made with extra caution. Harmonized methods of blood sampling, analysis and data presentation with improved comparability are needed in the future for monitoring the level of lead in children's blood.

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