Lead exposure: a serious health problem

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ABSTRACT

Lead (Pb) is the most distributed of the heavy metals in the Earth's crust. Exposure to and uptake of lead, the non-essential element, have increased. Environmental exposures to lead remain a serious problem in many developing and industrializing countries, as well as in some developed countries. In recent years, in most developed countries the introduction of lead into the human environment has decreased largely because of public health problems and a decrease in its commercial usage, especially in petrol. Severe lead poisoning has become rare in these countries, but chronic exposure to low levels of the lead is still a big health problem. In developing countries, awareness of the public health effects of lead exposure is growing but relatively few of these countries have policies and regulations for minimizing the problem.

Keywords*: lead, severe effects; lead toxicity; environmental exposure; occupational diseases; epidemiologic studies.*

Introduction

Lead, has been used since prehistoric times. It has become widely occurred and moved in the environment, and human exposure to and uptake of this non-essential element have consequently increased (1). Exposure to high levels of lead, it almost damages all organs and organ systems, most importantly the central nervous system, kidney sand blood, culminating in death at excessive levels of lead. At low levels, it affects the haeme synthesis and other biochemical processes and it impairs the psychological and neuro behavioral functions, and there is a range of other effects (2–4).

A long history of public exposure to lead in food and drink exists. Lead poisoning was common in Roman times because they used lead in water pipes and in wine storage. Lead poisoning attached with occupational exposure was first reported in 370 BC (5). In the 19th and early 20th century, it became common among industrial workers, when workers were exposed to lead in smelting, painting, plumbing, printing and many other industrial activities. In 1767, Franklin obtained a list of patients in La Charite´ Hospital in Paris who had been admitted because of symptoms, which, although not recognized then, were evidently those of lead poisoning. All the patients were engaged in occupations that exposed them to lead (1, 5).

From 1830 to 1838, Tanqueral des Planches described the symptoms of acute lead poisoning, on the basis of 1213 admissions to La Charite' Hospital, in 1839. His study was complete and since then little has been added to the clinical picture of the symptoms of severe lead poisoning in adults (6). Due to occupational lead poisoning, there was a common disease in the UK in mid-19th century. Because, in 1882, there was deaths of several employees in the Pb industry, a parliamentary enquiry was initiated into working conditions in lead factories (1, 6, 7). This resulted in the 1883 Factory and Workshop Act (Prevention of Lead Poisoning), which required lead factories to conform to certain minimum standards.

Various serious problems caused by lead exposure on human health have been recognized (1, 2, 5–10). The working environment of the lead industry, especially in developed countries, has been better (2, 5–9). In the developed countries, severe occupational Pb poisoning has largely been controlled in through improved working conditions. However, concerns have grown over the possible adverse effects of exposure to low levels of environmental lead. Especially, lead poisoning in children experiencing non-occupational exposure has attracted much attention (1, 3, 10).

Sources and Global lead contamination

Before the industrial revolution, exposure to environmental leas was low but it has increase with large-scale mining and industrialization. Environmental lead contamination is high relative to the other nonessential elements (12). This resulted in an increase in society exposure to environmental lead.

When the consumption of lead rose to 5.6 million tonnes between 1965 to 1990 the global lead consumption increase steadily (13). World lead contamination, relatable to the increased occurrence of lead in soil, water and air as a result of human activities, is significant (14).

Lead and children

A lot of research has been done recently on children with relatively raised blood lead levels associated with environmental exposure. The potential for severe effects of lead exposure in children has high-lighted because of intake of lead per unit body weight is higher for children than for adults; – often children puts objects in their mouths, so they ingest dust and soil, and possibly, an increased intake of lead; –children are growing rapidly, they are not fully developed, and therefore, they are more vulnerable than adults to the effects of lead (2, 11, 15, 16).

High lead levels is a serious problem between the children of poor families. Often poor people live in substandard houses and near industry and heavy traffic, so are exposed to lead dust brought home by lead workers, and are therefore susceptible. There is an ongoing debate over the nature, magnitude and persistence of the negative effects on human health of low-level exposure to lead. However, the collected epidemiological evidence states that such exposure in the early childhood causes a diagnosable deficit in the development during the immediately after childhood years (2, 10, 17–20). Recent data, however, illustrates that these effects are largely irreversible (21, 22).

Sources of environmental lead Unlike obvious lead toxicity, where often there is one recognizable source, low-level environmental exposure to lead is accompanied with multiple sources (petrol, industrial processes, paint, solder in canned foods, water pipes) and pathways (air, household dust, street dirt, soil, water, food). Evaluation of the relative portions of sources is therefore complicated and is likely to differ from areas and populations (23). Lead contamination from petrol contributes the major portion of atmospheric lead and it is a large contributor to the body lead and is the most widespread source of the metal in the environment. It is thus very useful to phase out the use of lead additives in fuels, on the global scale. Atmospheric lead which is accumulated in soil and dust may then be ingested by children and increase their blood lead levels. For the population, largely which is not occupationally exposed to lead, in addition to atmospheric lead food and water are significant sources of exposure to lead. Table 1 represents the relationship between the median level of blood lead and the intake of lead for the general population (2).

Occupational exposure

Although the existence of serious lead toxicity has largely reduced in many countries, occupational exposure to lead which results in average and clinically symptomatic poisoning is still common. In many occupations, workers are exposed to lead, including transportation vehicles, panel beating, battery manufacture and recovery, lead mining, lead alloy production, and in the glass, plastics, printing, ceramics industries among others. In most highly industrialized countries, strict controls and improvements in industrial methods have ensured that occupational lead poisoning is reduced than before. In developing countries, however, it remains a big problem (23).

Table 2 states occupations and operations in which lead may be a hazard for workers (24). In developing countries, occupational lead exposure is generally not regulated and little monitoring of exposure is carried out. The potential for hazardous exposure to lead during fusion and refining of the metal is well recognized, both for primary new metal and secondary metal, i.e. scrap lead, and refineries. Small domestic secondary smelters in many countries are commonly close to people’s homes. This can result a severe health hazard to children and adults live nearby.

Environmental exposure

Developed countries

In most developed countries, consistent efforts have led to a decrease in the introduction of lead into the blockade environment in recent years, which reflects a deduction of the commercial use of lead, particularly in petrol (8, 25). In general, blood lead levels in the common population of these countries have declined significantly over the past 20 years, due to the removing lead from petrol (25–28).

In the United States of America from 1976 up to 1991, the average blood lead level of persons aged 1–74 years decreased by 78%, from 12.8 mg/dl to 2.8 mg/dl (41). average blood lead levels of children aged 1–5 years declined by 77% (from 13.7 mg/dl to 3.2 mg/dl). The major cause of the reduction in blood lead levels was phasing out lead from petrol.

In Australia, blood samples of 1575 children of aged 1-4 years were taken during 1995–96 (29). The geometric average blood lead level was 5.05 mg/dl. For 7.3% of these children the blood lead level was 510 mg/dl. Only 1.7% of children had levels of 515 mg/dl. From 1978 to 1988, there was a decreases in the average blood lead levels of adults which were noted in many countries, including Belgium, Federal Republic of Germany, New Zealand, Sweden, and UK (23).

Fig. 1. **Dose-effect relationships for adverse health effects of lead exposure.** (Adapted from ref. *24,* with updating) ALA-U = δ–aminolevulinic acid in urine; CP-U = coproporphyxin in urine; NCV = nerve conduction velocity; CNS = central nervous system

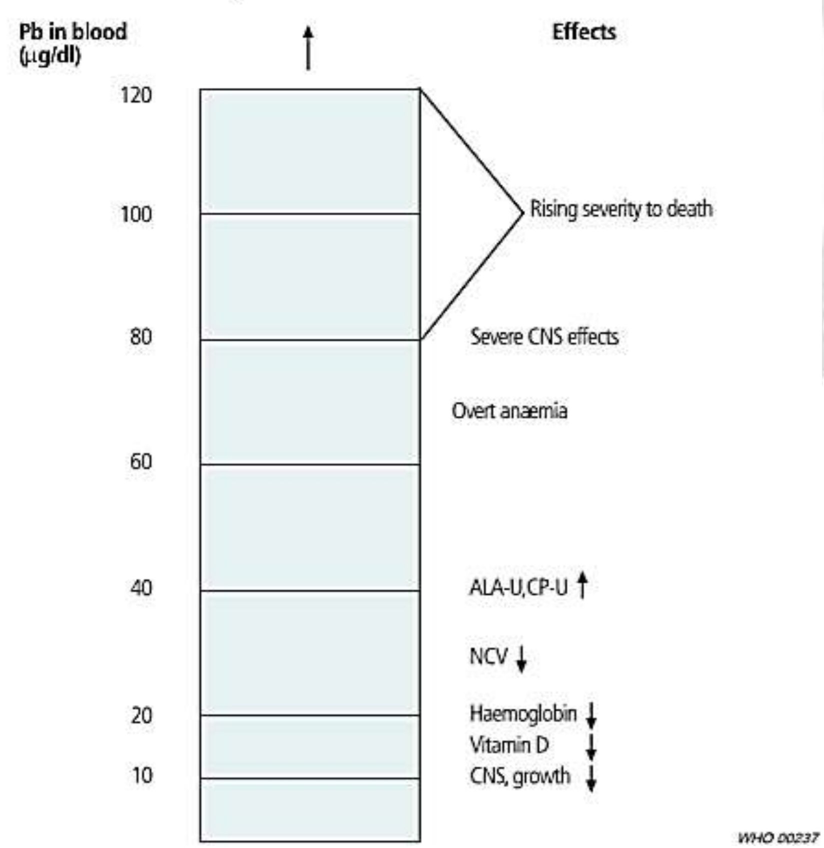

Table 1. Representative relationships of blood lead median level to intake of lead for the general population [a] (Source ref. 2).

Medium	Median blood lead level among:	
	Children	Adults
Air[b]	0.09 µmol Pb per litre (1.92 µg P Pb/dl) per µg Pb/m^3 air	0.079 µmol Pb/litre (1.64 µg Pb/dl)[c] per µg Pb/m^3 air
Water	–	0.003 µmol Pb/litre (0.06 µg Pb/dl) per µg Pb/litre
Food	0.01 µmol Pb/litre per µg Pb/day (0.16 µg Pb/dl)	0.002–0.003 µmol Pb/litre (0.04–0.06 µg Pb/dl) per µg Pb/day [c]
Dust[b]	0.09 µmol Pb/litre (1.8 µg Pb/dl) per 1000 µg Pb/g dust	–
Soil[b]	0.11 µmol Pb/litre (2.2 µg Pb/dl) per 1000 µg Pb/g soil	

a These data are provided for illustrative purposes only. The relationships are curvilinear and are broad guidelines that are not applicable at lower or higher levels of exposure.

b A value in the range 0.144–0.24 mmol Pb/litre or in the range 3–5 mg Pb/dl per mg/m3 is obtained when one considers indirect contribution through deposition on soil/dust.

c The air to blood lead relationship in occupational settings is best described by a curvilinear relationship with slopes in the range 0.02–0.08 mg/m3 air. The slope is variable but lower than that for humans in the general environment (1.6–1.9 mg/m3).

Table 2. Operations that may present lead hazards for workers (Source ref. 24).

Primary and secondary lead smelting	Lead mining
Welding and cutting of lead-painted metal constructions	Plumbing
Welding of galvanized or zinc silicate coated sheets	Cable making
Other welding	
Shipbreaking	Wire patenting
Nonferrous founding	Lead casting
Storage battery manufacture: pasting, assembling, welding of battery connectors	Type founding in printing shops
Production of lead paints	Sterotype setting
Spray painting	Assembling of cars
Mixing (by hand) of lead stabilizers into polyvinyl chloride	Shot making
Mixing (by hand) of crystal glass mass	
Sanding or scraping of lead paint	Lead glass blowing
Burning of lead in enamelling workshops	Pottery/glass making
Repair of automobile radiators	

Developing countries

Lead will to be a serious public health problem in developing countries (16), there are eminent differences in the sources and ways of exposure. For example, in many Latin American countries, leaded paint is not an important source of exposure, but leaded ceramics are (30). Lead exposure from lead mining, smelting, battery and cottage industries is an eminent environmental problem in developing countries.

In Jamaica there was a survey conducted to check the distribution of environmental and blood lead levels in people staying near areas of lead smelters (31). Geometric average blood lead levels in exposed groups were almost twice as high as those in unexposed groups; 44% of exposed sub-6-yearold had blood lead levels 525 mg/dl. In China, childhood lead poisoning is widespread as a consequences of rapid industrialization and the use of leaded fuels (32). Children living in industrial and heavy traffic had average blood lead levels of 21.8–67.9 mg/dl. The proportion of blood lead levels > 10 mg/dl ranged from 64.9% to 99.5%. Even about 50% of children living in non-industrialized areas had blood lead values >10 mg/dl (32). The problem of lead exposure to children is especially important in small towns with a lot of small factories (33). Also in India, they directly tested the blood lead levels of 2031 children and adults in five populated cities where leaded petrol had contributed to environmental lead levels. Approximately 51% had levels >10 mg/dl, and 13% had values >20 mg/dl. In Bangalore and Mumbai, the proportion of children with levels 510mg/dl ranged from 40% (34).

However, the level of exposure to lead is declining in some developing countries because of the decreasing the use of lead in petrol and elsewhere. In Thailand, for example, leaded petrol was removed during the years 1984–96 (35) and was associated with a significant decrease in atmospheric lead levels in Bangkok (36). From February to September 1994 the blood lead levels in maternal and cord blood of 37 pregnant women from urban areas, 53 from urban and 28 from rural areas of Chiang Mai were low and did not differ eminently: the geometric average levels were 4.16 mg/dl and 3.32 mg/dl; 4.12 mg/dl and 3.11mg/dl; and 4.50 mg/ dl and 4.12 mg/dl respectively. A total of 4.2% of maternal blood samples and 1.7% of cord blood samples had lead levels >10 mg/dl (37).

Conclusions

Exposure to environmental lead is evidently one of the main public health problems of world. As the controlling and observing the transfer of lead to the environment are implemented in most developed countries through, for example, the removing of lead from fuel, paints and other consumer products, and as tighter control of industrial emissions is, environmental exposure to lead will to continue to decline. However, because of rapid industrialization and the consistency of environmental lead, exposure is likely to remain a serious health problem for society of most developing countries. Screening, monitoring, intervention and evaluation are critical for the development of rational, cost-effective and science-based public health policies aimed at achieving these goals.

The main public health issues of many international conventions are as follows:

1) The 1989 Convention on the Rights of the Child.
2) Agenda 21 adopted by the United Nations Conference on Environment and Development in 1992.
3) The 1997 Declaration on the Environment by the Leaders of the Eight (on Children's Environmental Health).
4) The OECD Declaration on Lead Risk Reduction (23).

Public health measures should continue to be directed to the reduction and prevention of exposure to lead by reducing the use of the metal and its compounds and by minimizing lead-containing emissions that result in human exposures. This can be achieved by:

1) Phasing out lead additives in fuels and removing lead from petrol as soon as is practicable.
2) Reducing and phasing out the use of lead-based paints.
3) Eliminating the use of lead in food containers.
4) Identifying, reducing and eliminating lead used in traditional medicines and cosmetics.
5) Minimizing the dissolving of lead in water treatment and water distribution systems.
6) Improving control over exposure to lead in workplaces.
7) Improving identification of populations at high risk of exposure on the basis of monitoring systems.
8) Improving procedures of health risk assessment.
9) Improving promotion of understanding and awareness of exposure to lead.

10) Increasing emphasis on adequate nutrition, health care and attention to socioeconomic conditions that may exacerbate the effects of lead.
11) Developing international monitoring and analytical quality control programs (23).

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