Lead pollution and its implications for children in Pakistan

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Summary
Lead is one of the leading problems of environmental health. It is a major risk to health of the population particularly children. Higher lead levels in blood cause encepthalopathy and death while lower levels may result in neurotoxicity, hypertension, renal impairment, and altered cognitive functions. Human brain in its developmental stages, prenatal and early childhood, is very sensitive to the toxic insults. Since placenta offers no barrier to lead, prenatal exposure to lead results in impaired cognitive development, abnormal fine motor functioning, behavioral problems, low intelligent quotient and antisocial and delinquent behavior in childhood and adolescence. Malnutrition acts as effect modifier and leads to high levels of lead in malnourished children.

Over 40% of Pakistan's population is aged less than 15 years and malnutrition is a common problem among them. Several studies in Pakistan have found high ambient air lead levels and consequently higher levels in blood. Various groups such as psychiatric patients, preschool children in a low and high ambient air lead areas, and ammunition factory workers have been studied. Consistent findings of high lead have been found in Pakistan. A 1989 study reported mean blood lead levels among males, females, soldiers and school children as 34.4, 31.8, 29.9 and 38.2 µg/dl, respectively. Another recent study conducted by Community Health Sciences Department at Aga Khan University showed that 80% of less than five year children in various communities of Karachi had lead level greater than 10 µg/dl. While the mean lead level was 15.6 µg/dl. The important predictors of blood lead levels were environmental lead level measured by distance of house from traffic cross-section, traveling in open vehicle, application of surma, father's occupation in lead related industry. Incidentally, a coastal community away form road traffic also demonstrated very high lead levels. A study on metals in drinking water from Karachi has reported that the quantity of lead is significantly higher than the WHO recommended criteria. Also food is cooked in metal containers that leach lead and other metals during cooking and storage.

The number of vehicle has increased from 0.28 million in 1980 to 1.16 million in 1998 in cities of Pakistan. Till recently leaded gasoline was used in Pakistan. However, in last couple of years regulation to phase out lead from gasoline has been implemented in Pakistan. As a result, petroleum companies have decreased the lead level in gasoline. United Nation Industrial Development Organization is also helping government in shifting towards cleaner fuels by providing technical expertise for upgrading refineries. Vehicle manufacturers have started installing catalytic converters in their vehicles which are compatible with the low lead fuel. This will reduce the tail pipe emissions. However actions are also necessary for regulating industrial emissions. The effect of already present lead in environment at household level needs to be studied and interventions designed especially for children This may include awareness and ban on use of pottery coated with lead alloys, use of surma, water purification, avoidance and effects of lead based paints is needed.

Background

Lead is one of the leading problems of environmental health. Lead is a chemical present in environment and is well known for its toxicity. It is still the single most important chemical toxin for children and is probably the best known example of a neurotoxin to which children are particularly vulnerable. The children (early 2-3 years) special vulnerability to lead is related to their exposure in multiple ways. The hand–mouth activity in oral phase of life of children is important determinant of exposure. Similarly, absorption of lead (the fraction of absorption in children is 40% compared with 10% in adults). Thirdly and most importantly, the susceptibility of children because they at a critical period of brain development. Lead is distributed in blood, soft tissues and bone. Renal elimination is very slow and can take many years. It takes 25 days to excrete from the blood, while approximately 40 days in soft tissue and may take 20-25 years to excrete from the bone.

Since placenta offers no barrier to lead the maternal blood lead levels correlate with fetal blood levels and can be detrimental to the brain at its very developmental stages. Lead may cause neurological, physiological and behavioral problems in children. At lower levels its effects range from hearing difficulties to decrease intelligence quotient (IQ). While at higher concentration it may lead to acute encephalopathy, memory loss and death. The neurotoxic effects of lead depend on the exposure level and the stage of brain development at the time of exposure. Studies have documented beyond doubt that developmental exposure to lead adversely affects several specific brain functions, resulting in particular in neuro-developmental impairment, learning impairments, attention deficit disorders, poor motor muskuloskeletal coordination, visual coordination dysfunction and poor language and speech development. Globally, the estimated annual costs of these effects are US$ 43.4 billion. The World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) considers that $\geq$ 10 µg /dl as harmful for humans.

Sources of lead are varied in the environment and these include petrol, paint, water, food, cosmetics etc. Children may be exposed to lead in leaded petrol from car emissions, water contaminated by lead pipes, old paint, emissions from factories, contaminated soil, and food contaminated by environmental sources, including improperly glazed ceramic ware for cooking and food storage. Lead particles can move with water, soil, dust and wind. Lead finds its way into the body through inhalation, ingestion and dermal penetration.

Malnutrition in children lead in increase absorption of lead and other chemicals therefore, it acts as effect modifier. Malnutrition amplifies the effect of lead toxiciy.

Lead in children in Pakistan

Pakistan ranks 7th in the world's most populous states (pop. 134.8 million). It doubling time is 27 years and more than 5.5 million children are born every year (larger than the entire population of New Zealand). Health indicators of Pakistan are gloomy compared to other low-income countries with similar gross national product (GNP). Infant mortality is 77 per 1000 live births. Pakistan's population of under-5 year old children is 23.8 millions and those of under-18 years consist of 73.7 million, literally half of the population. Every year 700,000 children die, mostly due to common preventable problems. Approximately 40% of the children are malnourished in Pakistan and approximately 24% are born low birth weight.

Several studies in Pakistan have found high ambient air lead levels and consequently higher levels in blood. Various groups such as psychiatric patients, preschool children in a low and high ambient air lead areas, and ammunition factory workers have been studied. Consistent findings of high lead have been found in Pakistan. There are very few ecological environmental evidence available to estimate the average ambient air level of lead in Pakistan. Similarly, automobiles are assumed to be an important source of lead exposure in urban areas of Pakistan. The leads from emissions is deposited and ultimately are taken up by the children. Leaded paint is another well-established cause, however, no study has been conducted so far in Pakistan to determine the levels of lead in paints.

A study has been conducted in Faisalabad city of Pakistan regarding lead content in "surma" samples. The "surma" are preparations of powders, gels and water-based fluids used for eye make-up. This study demonstrated that 80% of the samples of surma had at least 65% lead content. Therefore, it is expected that blood levels of children using surma would be higher than others. There is high proportion of household use surma as eye make-up in Pakistan. Also women use surma for cosmetic purposes and mother-fetus transmission of surma is high possibility.

Manser et al., reported a mean blood lead levels of 38.2 µg /dl among school children in Karachi city of Pakistan. The school was situated in a comparatively less congested traffic area. This study also reported lead levels in among males, females, soldiers as 34.4, 31.8 and 29.9 µg/dl, respectively.

Another recent study conducted by the department of Community Health Sciences of Aga Khan University, in various groups of Karachi. The average level estimated by this study was 15.6 µg/dl. A total 430 children between the age of 36-60 months were selected from different geographic areas within Karachi city: city center, two suburbs, a rural community and an island situated within the harbor at Karachi. Cooked food, drinking water and house dust were sampled from the households at these places. About 80% of the children had blood lead levels of $\geq$ 10µg/dl. This study went a step further to determine the types of exposure which contribute most to elevated blood lead concentrations in children. Houses nearer to the main intersection in the city center, application of surma to children's eyes, father's exposure to lead at workplace, parent's illiteracy and child's habit of hand-mouth activity were found associated with elevated blood lead levels in children. Another interesting finding of the study was that they found highest levels of lead in the coastal community (island) away form road traffic. This shows that besides traffic exhaust there are other sources of lead exposure to children are available in the environment in Pakistan. The seawater in the harbor is contaminated due to the presence of ships and boats in the area.

A study on metals in drinking water from Karachi has reported that the quantity of lead is significantly higher than the WHO recommended criteria. Also food is cooked in metal containers that leach lead and other metals during cooking and storage. These could be major sources of exposure in children in Pakistan.

The number of vehicles in Pakistan has increased considerably in Pakistan. The number of vehicle increased from 0.28 million in 1980 to 1.16 million in 1998 in cities of Pakistan. The number is increasing has started to increase at alarming rate since car financing was made available by the various banks recently in Pakistan.

Till recently leaded gasoline was used in Pakistan. However, authorities in Pakistan have recently taken a positive step towards cleaning of fuel from lead. In the last couple of years regulation to phase out lead from gasoline has been implemented in Pakistan. There has been enforcement of legislation regarding unleaded fuel in Pakistan. There are claims that the fuel now has less lead contents than before. As a result of this legislation, petroleum companies have decreased the lead level in gasoline. This will reduce the tail pipe emissions.

In another step United Nation Industrial Development Organization is also helping government in shifting towards cleaner fuels by providing technical expertise for upgrading refineries. Vehicle manufacturers have started installing catalytic converters in their vehicles which are compatible with the low lead fuel. The tail pipe emission may have decreased, however actions are also necessary for regulating industrial emissions.

There are also availability of smuggled leaded fuel from neighboring countries which are possible threat and continue to pollute the environment. Therefore, are necessary for the further enforcement of the regulation to completely phase out lead from the feul.

Studies also suggests that besides petrol there are other sources of lead toxicity in children. This include the use of surma and the availability of lead in paints. The levels in blood of children by various studies suggest that action are also necessary at the household levels. The effect of already present lead in environment at household level needs to be studied and interventions designed especially for children This may include awareness and ban on use of pottery coated with lead alloys, use of surma, water purification, avoidance and effects of lead based paints is needed.