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REVIEW OF LEAD POISONING IN CHILDREN OF PAKISTAN: A GEOGRAPHICAL PERSPECTIVE

SYED HUSSAIN HAIDER RIZVI*, SALEHA MAHMOOD**, ISMA YOUNES***, MUHAMMAD SHAFIQ*, JAWAD NASIR* AND MUHAMMAD MANSHA*

* Pakistan Space & Upper Atmosphere Research Commission (SUPARCO), P.O.Box 8402, SUPARCO Road, Karachi 75270

** Sustainable Development Study Center, Government College University, Lahore

*** Department of Geography, University of the Punjab, New Campus, Lahore

ABSTRACT

Lead is poisonous heavy metal causing toxic effects among children since two thousand years ago. Children are the most vulnerable and sensitive to lead poisoning. Global burden of various diseases caused by lead poisoning is 0.6% with 9.0 million Disability-adjusted life series (DALYs) worldwide. In 2014, WHO announced that lead poisoning causes 143,000 deaths annually with highest disease burden in less developing countries. Its use in less developing countries like Pakistan is increasing day by day affecting children of age 1-12 years. The major sources of lead by which it can reach toxic levels in the bodies of children are automobile emissions (gasoline), lead based paint, industrial emissions, contaminated drinking water, traditional cosmetics and traditional drugs (ayurvedic remedies). Acute exposure causes headache, depression, nervousness, hypertension, body pain, learning, language and speech disabilities, violence propensity and decreased concentration. Chronic exposure to lead results in high blood lead levels and lead poisoning that causes neurological, haemotological, renal, cardiovascular, hepatic, carcinogenic, behavioral, physiological, growth and developmental effects. Minimizing the use of lead and exposure to it is the best control measure. The urgent need of time is to adopt effective measures to control the activities responsible for the introduction of toxic levels of lead in the environment. Hence, lead is a deadly toxic heavy metal that is causing serious health impacts among children of Pakistan which are needed to address and control. It could be argued that with current circumstances lead pollution in Pakistan may become more severe and alarming in coming years.

KEY WORDS: Lead; Sources; Children; Effects; Pakistan; Toxic kinetics

INTRODUCTION

Lead is found in the earth's crust as a normal constituent naturally found in soil, water and plants in trace quantities (Weiss et al. 2002). The toxic potential of lead is never lost because it is highly persistent in environment and a subtle poison (Shi et al. 2008). Lead toxicity commonly known as 'plumbism' is becoming a threat for children's health (Kenyon 2001) since two thousand years ago (Farooq et al. 2008). The principle routes of entry of lead are inhalation and ingestion (Nadal, Schuhmacher, and Domingo 2004, Ahamed, AlSalhi, and Siddiqui 2010). Young children and infants are more susceptible to lead poisoning as they are the most sensitive population with bodies and central nervous system at developing stages

(Lidsky and Schneider 2003). Among the six main environmental threats to children addressed by World Health Organization (WHO) in a theme known as Healthy Environments for Children Alliance (HECA) on World Health Day, 7 April, 2003 exposure to lead was considered an important environmental risk to the health of children (Suk et al. 2003). Blood lead levels (BLLs) greater than or equal to 10 µg/dl of lead concentration was an indicator of lead exposure in children (CDC 2005, WHO 1998). Use of lead has still not completely phased out in developing countries therefore lead toxicity is spreading day by day. In Pakistan, lead is widely used as it is easily available, exhibit anti- corrosive properties and cost effectiveness (Farooq et al. 2008). Lead toxicity is more common in children of age 1-12 year in the country (Ahmad et al. 2009). Children of Karachi city are adversely affected by environmental and occupational lead exposures (Hozhabri et al. 2004, Rahbar et al. 2002, Rahman, Maqbool, and Zuberi 2013, Siddique et al. 2012). Lead absorption is responsible for many health problems but the most widespread is the neurotoxicity in Pakistan (Hozhabri et al. 2004, Khwaja 2003b, Rahbar et al. 2002). A study conducted by Agha Khan University in Karachi declared 10 µg/dl of lead concentration in about 80% of the children of age between 36 to 60 months (Rahbar et al. 2002).

This review paper synthesize the possible factors and sources that stimulates lead toxicity, its effects on quality of human life, solutions, control measures and treatments in order to minimize the hazardous effects of lead especially in children of developing countries like Pakistan.

SOURCES OF LEAD

Air, house dust, soil, food and drinking water contaminated with lead are significant sources of lead poisoning. According to CDC some imported products such as candies (tamarind candies), spices, jewelry, cosmetics (mainly eye cosmetics) and pottery are also the common sources of lead poisoning. In Asian countries, hazardous waste dumping sites contaminated with toxic lead are increasing global disease burden especially in children by badly polluting soil and water (Caravanos et al. 2013). In Pakistan, the significant sources of lead poisoning are exposure to automobile emissions, leaded paints, contaminated soil and vegetation, contaminated drinking water, house dust, industrial atmospheric lead emissions, traditional cosmetics, drugs, and occupational lead exposure (Farooq et al. 2008, Hozharbi 2002, Janjua et al. 2008, Khwaja 2003b, Rahbar et al. 2002, Shams 2000, Siddique et al. 2012, Ahmad et al. 2009).

Lead emissions to atmosphere are one of the most important environmental threats to children among the many other environmental problems in Southeast Asia and Western Pacific. These environmental problems were addressed and discussed in the International Conference on Environmental Threats to the Health of children, 2002.

In leaded petrol the end-product is lead which is released into the environment and is one of the major causes of lead poisoning among children of Pakistan (Khwaja 2003b). Lead (tetraethyl lead) was also used as anti-knocking agent in vehicles to increase the efficiency of engines. Although it is claimed by all petroleum refineries of the country that they produce lead-free petrol, the quantities of lead due to the use of petrol were found to be extremely high in the air of major cities of Pakistan i.e. Karachi, Peshawar, Lahore and Rawalpindi. Prior to July 2001, it was reported that petrol contains 0.35-0.84 g/l of lead (Lovei 1998, MoE 2001). It is reported that lead levels in air ($\mu g/cm^3$) were 0.13-0.24 (1980-1981), 0.21-0.79 (1994-1995) and 0.89-7.85 (1999-2000) in Karachi, Peshawar and Lahore respectively. In Karachi, children living in urban areas having high level of traffic congestion reported high blood lead concentrations where as those residing in rural areas showed low blood lead concentrations. Utilization of open transportation system such as motor bikes, rickshaws, cycles is also responsible for high level of lead accumulation in tissues of young children (Rahbar et al. 2002). Another study reveals an alarming situation in major urban cities of Pakistan i.e. Islamabad, Rawalpindi and Lahore where significantly high lead content was found in air. Five sites were selected to estimate the lead concentration in air from the three major cities. Significant lead concentration was found in all the five sites selected from Lahore as compared to Islamabad and Rawalpindi. It was estimated that lead concentrations in air of Lahore, Rawalpindi and Islamabad ranges from 0.89-7.85 $\mu g/m^3$, 0.71-10.00 $\mu g/m^3$ and 0.96-10.93 $\mu g/m^3$ respectively (Shigeta 2000).

Lead based paint is another major source of lead exposure after the use of leaded petrol in automobile. Lead is used in paints as a pigment to give it characteristic bright color. In oil-based paints it is used as drying agent to make them durable by preventing and inhibiting the growth of molds on painted surfaces. Specifically during remodeling when lead based wall is broken down into powder form or minute chips, it contributes to lead dust (Hozharbi 2002). There are three common routes of exposure or media by which children can be exposed to lead based paint. These three media are: lead-based paint itself, lead-containing dust present in interior of homes, and dust or soil outside homes (WHO 2010). Therefore, it can be argued that adults working in lead based paint manufacturing industries or those who are engaged in painting walls of houses and buildings can bring about significant level of risk to lead exposure into their homes.

ead emission has exponentially increased in the atmosphere as a result of industrialization (Rothwell et al. 2007). Lead from contaminated soil along roadside is absorbed into the bodies of children as this soil can be tracked into the interior of homes via family pets, shoes and deposition of soil (dust) when wind blows. National Highway and Motorway which are the linking roads between Faisalabad and Lahore having lead content of 125 mg/kg and 87 mg/kg respectively. The main source of lead contamination is rapid increase in the use of petroleum products in vehicles. (Hashim Farooq et al. 2012). In Pakistan, children living near battery recycling industries and smelters are at great risk and reported high blood lead levels (Khan et al. 2010). Mining, smelting and oaring are important sources of contributing atmospheric lead emissions and children exposure to lead in Pakistan (Kazmi and Omair 2005).

Another significant but negligible source of lead exposure in Pakistan is drinking water supplies contaminated with lead. Lead in drinking water get absorbed in 35 to 50% of adults while 60% absorbs in children. A research report showed high lead concentrations in both ground water and surface water near the industrial area of Karachi. The condition of ground water resources is alarming as compared to surface water resources with respect to heavy metal toxicity (Ul Haq et al. 2011). Another recent study illustrates that drinking water of Charsadda district, Khyber Pakhtunkhwa (KPK), Pakistan is heavily polluted by heavy metals like Lead and its concentration exceeds the acceptable limits. According to Pakistan Environmental Protection Agency (PAK-EPA) the concentration of Pb in drinking water should be 0.05 mg/L. On the other hand, the permissible limit set by World Health Organization (WHO) is 0.001 mg/L or 10 µg/L. The evaluated concentration of lead in drinking water of Charsadda district ranged from 1.59 – 372.2 µg/L i.e. far exceeding lead concentrations (Khan et al. 2013).

In South Asia, lead toxicity is becoming a serious and prevalent health issue for children of big industrial cities (Gao et al. 2001). In Pakistan, it has been reported that about half of the children residing in industrial cities are exposed to lead (Kadir et al. 2008). Groundwater lead contamination is becoming a serious environmental and health issue for the inhabitants of Karachi city. Risk zone classification of groundwater in Karachi (Figure 1) shows that the coastal belt (Port Qasim and areas adjoining it) and industrial area near Lyari River are affected with relatively higher levels of lead in ground water. Sind Industrial Trading Estate (SITE) is responsible for relative high levels of lead in Lyari River and surrounding developments as this area consists of large number of industries such as textile processing industries, chemical manufacturing industries, pharmaceutical industries, heavy steel manufacturing industries, paint manufacturing industries and auto batteries manufacturing industries. Lead rich industrial effluent and domestic waste is discharged into the Lyari River without treatment. Thus, lead contaminated water in various parts of Karachi is considered hazardous for the health of inhabitants (Siddique et al. 2012).

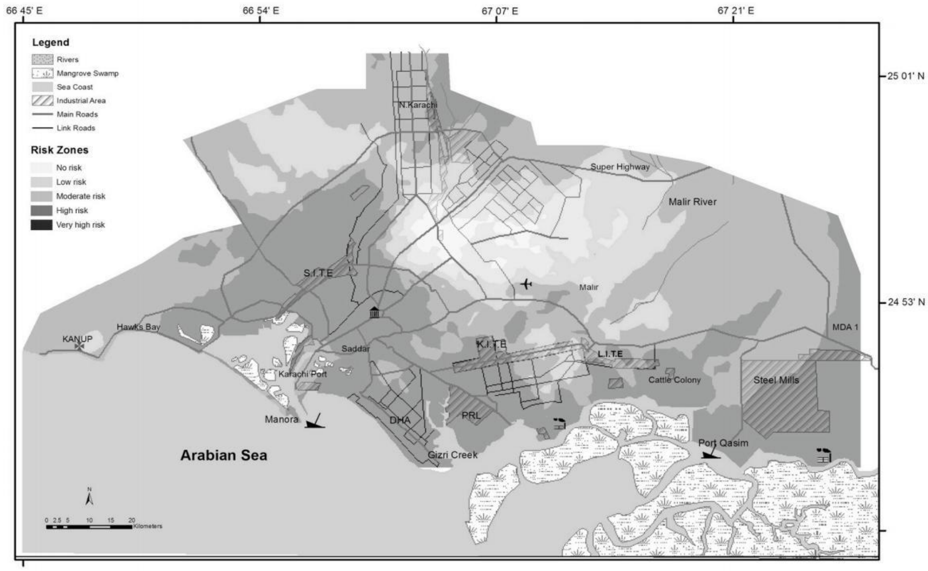

Figure1: Risk zone classification for lead level in groundwater based on estimated background value (Adopted from Siddique et al., 2012)

Traditional cosmetics and folk remedies are becoming a threat to the health of young children specifically in Asia, Africa and Middle East countries (Woolf et al. 2008). Application of these cosmetics to children's eyes is a perilous tradition. Common eye cosmetics responsible for lead poisoning are 'surma', 'kajal', 'kohl' and 'tiro'. But all eye cosmetics like 'surma' or 'kajal' do not contain lead. The product 'surma' and 'kajal' is used in Asia (mainly Pakistan and India) while 'kohl' is commonly used in Middle Eastern countries (Gorospe and Gerstenberger 2008, Harvey 2002). 'Surma application to children's eyes is also a common tradition in Pakistan which contains significant amounts of lead and frequently enters to blood at dangerous concentrations. A study conducted in Faisalabad showed very high levels of lead in eye cosmetics and surma i.e. above 65% (Ali, Iqbal, and Yaqub 1988). A cross-sectional study conducted in 540 mothers in Karachi shows that daily application of surma by pregnant mothers had umbilical cord BLLs of 11.5 µg/dl. Those women who use it regularly on their eyes had less umbilical cord blood lead level i.e. 9.4 µg/dl (Janjua et al. 2008).These eye cosmetics are applied to children's eyes for the purpose of improving visual development and promoting attractiveness, protecting from 'evil eye', relieving eye pain and burden, protecting from sun rays and eye infections (Al-Hawi et al. 1980, Hardy et al. 1998). Despite of all these advantages it is becoming a significant source of lead poisoning in developing countries like Pakistan. Similarly, herbal and ayurvedic medicines are commonly used in Pakistan especially in low-income households and villages. In South Asia lead contaminated medicines are manufactured. Lead content in such products range from 5-37,000 µg/g (Saper et al. 2004). Welding, plumbing, lead smelting, pottery production, ship breaking, automobile repairing are the major occupations in Pakistan that impose a higher risk of lead poisoning among children (Kazmi and Omair 2005). A recent study showed that in Karachi children of age less than 4 years living around the lead batteries repair workshop had 11.4 µg/dl of lead concentration in blood and it causes severe lead poisoning (Ahmad et al. 2009).

FACTORS STIMULATING THE LEAD TOXICITY IN CHILDREN

Dietary deficiencies make children more susceptible to lead and stimulate lead absorption into the body (Khwaja 2003b). Early childhood iron deficiency is becoming an increasingly nutritional problem in developing countries (Gökçay 2006). Chronic exposure to lead and iron deficiency show synergistic effects on blood lead levels (BLLs) and increases susceptibility to its toxic effects among children of Pakistan living near lead utilizing industrial areas used (Bradman et al. 2001). Contrarily, hair lead levels in children do not differ significantly when children with different iron status were compared (Rahman et al. 2012). Another study on pregnant mothers and neonates showed that women who intake < 58.5 mg/day of iron supplement had umbilical cord blood lead levels equal to 10.0µg/dl while those women whose iron supplement intake is greater than 58.5 mg/day had lower levels i.e. 8.4 µg/dl (Janjua et al. 2008). The umbilical cord blood lead levels in Pakistan are higher as compared to United States (Janjua et al. 2008). Lead causes neurotoxicity. The bodies and nervous system of children is sensitive as it is at developing stages (Lidsky and Schneider 2003). So children become more vulnerable to lead products. When lead levels are so high that it can compete with Calcium then Vitamin D receptor (VDR) gene influence the absorption of Calcium and encode Calcium binding proteins (Schwartz et al. 2000).

TOXIC KINETICS OF LEAD IN CHILDREN

Lead enters into the bodies of children via absorption through inhalation, ingestion and dermal contacts. It is then distributed and transported to all body organs through blood and finally very little amount of lead is excreted out of the body through kidneys (Papanikolaou et al. 2005). Infants and children absorb 50% of lead through ingestion while adults absorb 10-15% (Markowitz 2000a, Philip and Gerson 1994a). Children with nutritional deficiency such as iron, zinc, calcium and phosphorous have more sensitive digestive systems and thus have increased lead absorption rate through gastrointestinal tract (Gökçay 2006, Khwaja 2003b, Lacasana et al. 2000). (Fischbein and Hu 1998, Markowitz 2000b). About 99% of lead is transferred to erythrocytes and only 1% is found in serum and plasma (Rabinowitz 1991). Half-life of lead in all the three compartments is not the same. Its half-life is approximately 35 days in blood (Roberts et al. 2001), whereas in soft tissues it is 40 days (Organization 1996). In contrast, half-life of lead in bones is longer i.e. 20 to 30 years (Rabinowitz 1991). Lead has comparatively long half-life in children as compared to adults (Organization 1996). It takes 4 to 6 weeks to move from blood to soft tissues (Philip and Gerson 1994b, c) and from here it is transported to target and vital organs: brain, liver, kidneys, spleen, lungs, aorta, bones and teeth (Skerfving et al. 1993). Later on from bones lead is accumulated in teeth of children. In skeleton, more than 95% lead is accumulated. Some autopsy studies also indicate large amounts of lead accumulation in bones and teeth i.e. 90-95%. Concentration of lead in skeletal bones and teeth greatly depends on age and increases with the increase in age (Philip and Gerson 1994c, Rabinowitz 1991). It acts as labile pool as the lead accumulated in blood and soft tissue is readily exchanged (Philip and Gerson 1994b, c, Rabinowitz 1991). Research shows that umbilical cord blood has 80-100% of lead concentration as compared to maternal blood lead levels (BLLs) (Gulson et al. 1998, Silbergeld 1991). Pregnancy and lactation increases the mobility of lead from bones towards blood, where it crosses placenta and fetus readily absorb it into blood (Gulson et al. 1998). Lead level in scalp hair in exposed (exposure to industrial area) was significantly high as compared to control group of children (Shah et al. 2011). Kidneys absorb lead from blood and it is excreted out of the body through urine but very little amount of lead is excreted via renal system which facilitates its accumulation in target organs (Philip and Gerson 1994b, c). Sweat and nails also remove very little amounts of lead. During lactation lead moves on from bones but ultimately it is absorbed by fetus.

DEADLY EFFECTS OF LEAD

Exposure of people working in lead factories to its fumes in molten state was recognized as the cause of poor skin color (Farooq et al. 2008, Basel Convention Technical Working Group 2001). In ancient times, other deleterious effects of lead identified by Hippocrates and Nikander were neuropathy, sterility, nephropathy and coma (Bellinger and Bellinger 2006, Landrigan et al. 1990) describes the major toxic effects of lead in children at different blood lead concentrations that ranges from developmental toxicity at blood lead level below 10µg/dl to death above 100 µg/dl.The most dangerous symptoms of lead poisoning among children appear at 70 µg /dl (Laraque and Trasande 2005). Concentrations of lead greater than 70µg/dl cause ataxia, papilledema, apathy, poor coordination, disturbance in mental status, coma and even death (White et al. 2007). In Pakistan, a study showed that along with nervous system, the endocrine, circulatory, renal, hepatic, reproductive and haematopoietic systems of children are also adversely damaged (Rahbar et al. 2002) but very few studies have been conducted to determine the effects of lead poisoning among children (Rahman and Hakeem 2003). Neurological toxicity, retarded, impaired and delayed mental development is one of the most serious effects of lead poisoning among children. It is prevailing in developing countries (Kazmi and Omair 2005). Early childhood exposure to lead at low levels delays neuropsychological development and effects intelligence especially at the age of seven years (Baghurst et al. 1992). Every year due to lead exposure about 600,000 children are estimated to have intellectual disabilities (WHO 2014). The impaired brain development due to severe lead poisoning is widely reported among the children of Karachi, Lahore, Rawalpindi, Islamabad and Peshawar resulting from school children’s exposure to leaded petrol (Khwaja 2003b, Manser et al. 1990).

A negative correlation of high BLLs with RBCs and haemoglobin is present which results in haematological and hepatic problems (Ahmad et al. 2009, Khan et al. 1994). It has been reported by a systematic review that half of the children of Pakistan have high BLLs exceeding the WHO standards (Kadir et al. 2008). In Karachi, a cross sectional survey was conducted in the young children living in a fishing village. Results showed that 98% of the children had BLLs above 10 µg/dl and causes severe neurotoxicity (Hozhabri et al. 2004). Inverse and negative relation of BLLs was found with IQ, height and haemoglobin in children of Karachi city, Pakistan (Rahman, Maqbool, and Zuberi 2002). From blood, lead is absorbed by kidneys through glomerulus and causes significant damages to kidney structure and functions. Its toxic effects include damage to proximal tubular function, nephropathy, glomerular sclerosis, lowered filtration rate of glomerulus and interstitial fibrosis (Bravo et al. 2007). Fanconi’s syndrome is a frequently occurring disease in children which can persist even after treatment of lead poisoning. In this disease proximal tubular dysfunction occurs (Philip and Gerson 1994b). According to a study it was concluded that even after treatment of lead poisoning the persistence of partial Fanconi’s syndrome extend up to 13 years (Loghman-Adham 1998). According to a study conducted at Wah (Gujranwala) the renal and hepatic function is significantly damaged in children of lead related occupational workers living close to battery recycling industries with a significantly high range of BLLs i.e. 1-20µg/dl (Khan et al. 2010). Toxic effects include hypertension, heart stroke, peripheral arterial disease and coronary heart injury (Menke et al. 2006). According to research conducted in Islamabad the BLLs in hypertensive patients was found to be 25µg/dl (Rahman et al. 2006). Similarly the concentration of lead was found to be very high in patients of ischemic heart disease with hypertensivity as compared with the hypertensive nonischemic heart patients (Bukhari et al. 2005). In Pakistan, lead poisoning causes behavioral and physiological problems among children even at very low BLLs such as hearing problems and reduced IQ levels (Rahbar et al 2002). High BLL can cause acute memory loss, encephalopathy and even death (Manser, Khan, and Hasan 1989). Headache, depression, fever, nervousness, hypertension and severe body pain are the common effects resulted from exposure to lead contaminated traffic smoke (Khan et al. 1994). Lassitude, tiredness, irritability and minor abdominal disturbance in children are also some of the symptoms of lead poisoning (Gerlach et al. 2002).

THRESHOLD LIMIT OF LEAD

As a result of considerable research in the neurotoxicity among children the threshold limit was finally dropped to 10 µg/dl in 1991 (Pueschel, Linakis, and Anderson 1996). But, effects of lead also occur at the concentrations < 10 µg/dl. Research shows that even nanomolar and picomolar concentrations of lead are toxic to nervous system of children (Bouton et al. 2001, Bressler et al. 1999). Thus, there is no 'safe' acceptable level for lead in blood (Lidsky and Schneider 2003). Lead concentrations < 10 µg/dl also affect the sensory function of children. Blood lead levels (BLLs) of 6-59 µg/dl effects cortical visual response among children of age 3-12 years (Otto and Fox 1992). Prenatal exposure to lead at concentration of 7.7 µg/dl causes brainstem auditory response (BAER) among children of age 5-7 years (Rothenberg, Poblano, and Schnaas 2000). Low blood lead levels also changes the neurochemistry of children. Low level exposure at prenatal stage results in neurotoxic effects on the serotonergic system of infants (Tang et al. 1999). Lack of attention and focusing power are also associated with concentration below 10 µg/dl i.e. mean value of 4.3 µg/dl (Walkowiak et al. 1998). BLLs < 5.0 µg/dl causes negative effects on academic skills of children.

DIAGNOSTIC AND TREATMENT

BLL is considered a significant diagnostic and good screening test (Ahmad et al. 2009). Tooth lead level is not considered an effective indicative marker of lead poisoning as compared to BLL as lead accumulates later in the hair and tooth of children (Rahman, Maqbool, and Zuberi 2002). Lead levels can also be detected in bones by using Radiograph fluorescence technique commonly in children of 11 years for research purposes but it do not have any clinical significance (Todd et al. 2001). In developing countries like Pakistan, the chelation therapy is preferred for the removal or detoxification of lead from the body (Farooq et al. 2008). In Pakistan, Ethylene diamine tetraacetic acid (EDTA), Dimercapto Succinic Acid (DMSA), D-penicillamine, Dimercapto propane sulfonate (DMPS) and British antilewisite (BAL) are commonly used as chelating agents for the detoxification of lead among the children (Farooq et al. 2008). For asymptomatic patients oral chelating agents are available. Once, high BLL have been detected in body, it is very difficult to prevent the toxic effects of lead especially among children. It is clearly evident from literature that low BLLs are also deleterious, therefore, it is strongly recommended to avoid lead exposure (Lidsky and Schneider 2003). According to a case study reported by Centers of Disease Control and Prevention avoiding the use of 'tiro' a Nigerian eye-cosmetic on child's eye for three months can drop down elevated blood lead levels from 13 µg/dl to 8 µg/dl (CDC 2012). Compulsory legislative measures should be introduced, adopted and emphasized through collaboration of government, public, non - government organizations (NGOs), industrialists, researchers, scientists and health professionals (Kazmi and Omair 2005). Creating public awareness on the sources and effects of lead poisoning is one of the important strategies recommended by these organizations (Kazmi and Omair 2005). There is an urgent demand to take these preventive and regulatory actions (Khan et al. 2001, Rahman, Maqbool, and Zuberi 2002). In 1999, this plan was approved by Pakistan Environmental Protection Council (PEPC). Its goal was to produce lead free petrol in Pakistan (Khwaja 2003a). Research shows that among the countries of Southeast Asia, Pakistan, India, Bangladesh and Thailand have introduced pollution programs to protect children from hazardous effects of lead by reducing its use in gasoline (Suk et al. 2003). However, since 2001 the atmospheric lead exposure has been reduced to some extent as consequence of introducing lead free-petroleum fuel in the country (Kadir et al. 2008). World Health Organization and United Nations Environment Programme had jointly taken initiative to remove the use of lead in paints in order to protect children from lead poisoning. This initiative was taken under the umbrella of International Conference on Chemicals Management in 2009. It is an intergovernmental body and consist the agreement of 162 countries to phase out use of lead in paints (WHO 2010). Use of lead should also be removed or minimized in traditional cosmetics (surma; kohl), medicines and pipes of water distribution systems (Kazmi and Omair 2005). The problem of lead poisoning can be solved by simply removing it from our environment especially industries. But minimizing the use of lead is one of the best control measures for preventing lead poisoning. On the other hand standard management protocols should be introduced and implemented in the country (Farooq et al. 2008). Special medical facilities and proper medical management should be developed primarily for children (Kalia and Flora 2005, Ziegler et al. 1978). Further research should be conducted to characterize the genetic, environmental and socio-economic factors of children and their families in order to control the biological response of a child to lead (Lidsky and Schneider 2003). Countries of Southeast Asia and Western Pacific have had initiated necessary prevention measures and research programs at local and national level by bringing together environmentalists, pediatricians, public representatives and health workers, educators, researchers, government and non-governmental organizations (NGOs) in cooperation (Suk et al. 2003). A commitment of all the above mentioned organizations is important to ensure that these programs and strategies will be implemented at all levels (Awang 2002). Introduction of nutritional and diet support programs for nutrient deficient children (specifically for Iron and Calcium deficient children) is inevitable in Pakistan (Kazmi and Omair 2005). From another research conducted in Karachi, it is strongly recommended to develop national health strategies to reduce and prevent iron deficiency in children of Pakistan (Rahman et al. 2012). Data on lead pollution provides an interactive mechanism and relationship with respect to different industrial and demographic information layers. GIS can also be used to identify the possible sources contributing in lead pollution (Siddique et al. 2012).

RECOMMENDATIONS

The main obstacle in implementing the above mentioned solutions and control measures is the lack of awareness, and realization of problem both at public and government level. In this situation electronic, print and social media should play role. On raising the issue by media, it government could be forced to seriously implement environmental protection laws and policies that are only in written form. Minimizing the use of lead in industries and using safe and environmental alternatives to it is one of the best solutions. Most of the research is conducted in city Karachi. The problem should be well addressed in other regions of the country by following the new reference value given by CDC i.e. 5 µd/dl. Until now problem is confined to research only, it is important to introduce the sources, effects and preventive measures of lead poisoning at public level so that prevention could occur at source and from homes.

CONCLUSIONS

Lead poisoning among the children of Pakistan is becoming a serious problem for many decades especially in Karachi. Only at face level research had been carried out and no importance had been given to the toxic effects and remediation measures of this deadly and inexpensive heavy metal particularly because of lack of awareness. Petrol, local paints, automobile workshops, lead utilizing industries, water distribution pipelines and traditional cosmetics are the major sources of causing lead poisoning in Pakistan. Among all the organ systems nervous system of children is adversely affected. Government is recommended to implement the health and safety policies and introduce effective legislation against the ineffective use of lead especially in the manufacturing and recycling processes for the safety of children of Pakistan.

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