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Evaluation of Lead Exposure in Uruguayan Children

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Lead is one of the most widespread environmental and industrial toxics and it is known that even in low concentration, exposure to this metal produces adverse effects (Al Saleh 1994). Children are the most susceptible to behavioral problems with learning disabilities as the first symptoms (Needleman 1991; Behrman 1992; Goyer 1995; ACSH 2000).

Montevideo has several lead emitting industries, most of them in residential areas. Old buildings and houses still have lead pipelines in their water systems. The primary gasoline used in Uruguay contains lead tetraethyl as an antiknock (0.15 – 0.30 g/L). A clear decrease of Blood Lead Level (BLL) has been associated with the elimination of lead in gasoline in the USA and Sweden (Pirkle et al. 1994; Stromberg et al. 1995). The population is exposed to lead due to environmental pollution because half of them live in urban areas and probably drink water that comes from lead pipelines.

Uruguay has not sufficiently studied the environmental contamination with lead as a problem. There are no systematic environmental studies that could provide data on the actual situation. Contamination with lead and exposure of the population have not been taken into account in any official way. Therefore there are no uruguayan background lead levels (OPP-BID 1992).

MATERIALS AND METHODS

In this work lead exposure was determined by measuring blood lead level (BLL).

After cleaning the skin, 10 mL of blood were obtained from the cubital vein in heparin moistened evacuated disposable syringes using injectable sodium heparin 25000 UI (NIOSH 1984) or Vacutainer® tubes (Carreón Valencia et al, 1995). Both had been found to contain no detectable amounts of lead (corresponding to less than 3 µg/dL blood). Samples were kept in the same labeled syringe or Vacutainer and frozen at –20ºC until their analysis.

Blood Lead Level (BLL) were determined by flame atomic absorption spectrophotometry (FAAS 283.3 nm, Perkin Elmer 306).

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This method was contrasted with intercalibration programs (APDC-MIBK /AAS) (Hessel 1968; Taylor 1975). It was based on the NIOSH method (National Institute for Occupational Safety, Health), original method P,CAM 208 (Hessel 1968) modified by substituting the APDC (ammonium pirrolidin dithiocarbamate) with DDDC (N, N dithio-carbamate diethilammonium) resulting a lead complex more stable over time. This allows processing several samples at the same time, without risk of decomposition at the moment of the measurement.

In practice two millilitres of the chelation/ extraction agent (0.12 mL DDDC, 1 g Triton X100 in 100 mL of MIBK) were added to four mililiters of whole blood and vigorously shaken for ten minutes (IKA-IBRAX-VXR, 1800 rpm). Detection limit was 3 µg/dL blood.This method was validated by the Laboratory of Occupational and Environmental Medicine of the University of Lund (Sweden) and results were contrasted with techniques such as ETA (Electrothermal Atomization) and ICP-MS (Inductively Coupled Plasma- Mass Spectroscopy).

Field studies were made in volunteer randomly sampled children (0-14 years old) from Montevideo city and a rural area of Uruguay. This children were divided in three groups: the first one included children who were presumably only exposed to environmental pollution (112 children). The second group included those children who lived in a contaminated area (62 children). A third group was formed by four siblings who lived in a house with a familiar lead industry.

The unexposed group (112 children) was sampled from 3 Centres of Montevideo (107 children) and a rural Centre (5 children). These Centres received children from various neighborhoods of Montevideo or rural areas for different purposes (Table 1).

Table 1. Distribution of unexposed children according to sex, age.

Centres I, II, III	**Children**	**Number**	**Age (years)**
	Total	107	7.8 (2 – 14)
	Girls	51	7.6 (3 – 14)
	Boys	56	7.5 (2 – 14)
Rural Centre	**Children**	**N**	**Age**
	Total	5	8 (6 – 11)
	Girls	3	8.6 (7 – 11)
	Boys	2	7.5 (6 – 9)

The exposed population (62 children) lived in a contaminated area.This contamination was due to an iron and lead scrap smelter. (Table 2).

Table 2. Distribution of exposed children according to sex, age.

Children	Number	Age (years)
Total	62	7.5 (0-14)
Girls	25	6.8 (0-14)
Boys	37	7.5 (0-14)

The third group describes 4 children (6,7,8,9,11 years old) from a family whose father recovered batteries at their home.

Data were collected from each individual, regarding age, house and school addresses, intensity of traffic near their houses and smoking habits of their parents.

RESULTS AND DISCUSSION

Determination of lead in blood is the most widely used indicator to evaluate the integral exposure to this metal. Recommended values for BLL are less than μg/dL (US. CDC 1991)

Uruguay, as the rest of Latin America, does not have official data of lead in blood in general children population. Available background data are from the Department of Toxicology and Environmental Hygiene of the Faculty of Chemistry (Schutz et al.1997; Mañay et al. 1999; Cousillas et al. 1996, 1998). 112 unexposed children were tested. Average BLL in this population was 9.4 μg/dL (s = 2.9μg/dL), with an interval of confidence of 8.5 – 9.5 μg/dL, considering a population Log – Normal and a level of confidence of 95%. This average BLL in children is definitely more elevated than those reported in other countries. The Shapiro – Wilks test was used, applied to neperian logarithms of the original data obtaining a significant probability of 0.14 ($p<0.1436$).

It is interesting to notice that although the unexposed children from the rural Centre have low BLL values they show an inverse relation with their age (Fig. 1).

BLL of unexposed Uruguayan children was relatively high compared with children from developed countries. Approximately 30% of the tested children, presumably unexposed, presented values of BLL above the intervention level adopted by the US. CDC in 1991 (10 μg/dL).

According to Phase 2 of the Third National Health and Nutrition Examination on Survey III (Nhanes III), blood lead levels of USA children is betweeen 2.0 and 2.3

μg/dL (Bowers et al. 2000). In the 90's, European countries like Denmark and Germany had already determined BLL values for their children population that were lower than those from our country (Lyngbye et al. 1990, Brockhaus et al. 1988).

Also, in some Latin American countries like Brasil (San Pablo), lower values were determinated (Figueiredo 2001). It is supposed that this difference can be due to the decrease and/or suppression of lead in gasoline and to the control of other emission sources. However, average BLL in Uruguay is lower than those reported in other countries like Mexico, where the average was 19.4 μg/dL for children of about 8 years old (Muñoz et al. 1993) when leaded gasoline was used. At present, although blood lead levels of mexican children have decreased, 25 % of children from Mexico valley have BLL higher than 10 μg/dL (Vicke S. 2003).

No significant correlation between BLL and sex has been found in the different Uruguayan children populations studied. The average age studied was 7.5, and it has been described in Sweden that from 8 or 9 years old, girls gradually present lightly lower levels than boys (Schutz et al. 1984). Parents smoking habits also contributes to lead absorption of children, but in these studies no significant correlation has been found concerning these subject (Lyngbye et al. 1990; Baghurst et al. 1992). There has not been found either a significant correlation between BLL and the traffic in the area.

In developing countries, where many socioeconomic an cultural problems are present, it is difficult to attribute health problems related to lead exposure only to this environmental contamination.

Obviously, exposure to lead is more important in areas near industries that contribute to environmental pollution (air, soil, water).

62 exposed children were tested. All of them presented high blood lead levels. The soil of their contaminated area had been analyzed and the results varied from 0.1 and 2.1 mg/g (Schutz et al. 1997). Average BLL in this population was 11.8 μg/dL (1–26 μg/dL, s = 6.2μg/dL).

It is observed that 59% of the total exposed children had values above 10 μg/dL (US CDC, 1991) and 29% of the total were above the values of 15 μg/dL (OMS1980).

The results of the third group (4 sibilings) are shown in Fig 2. All of them presented very high exposure. Presence of lead was also studied in the soil of their garden and in one of the windows' dust, finding very high levels of lead, 86 mg/g and 41mg/g respectively.

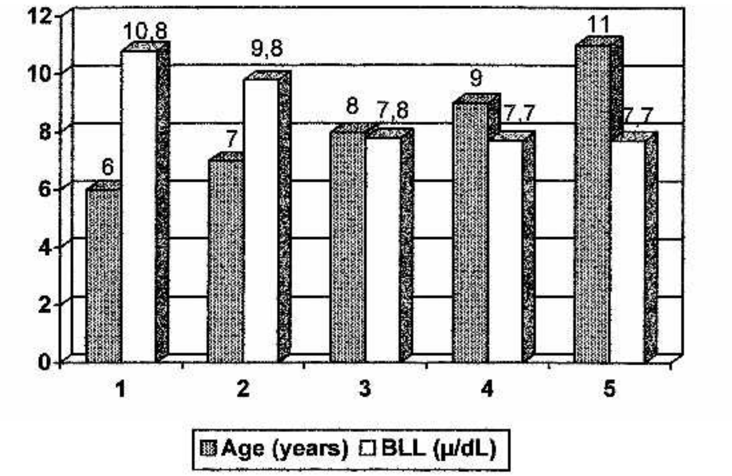

Figure 1. Blood lead level accoding to the age from unexposed rural children.

Lead body burden (according to the US CDC 1991) was studied for this four exposed siblings in order to determine if a treatment with chelates was convenient. For that study, elimination of lead in bones and of circulating lead is provoked by means of a treatment with $CaNa_2EDTA$ (Calcium EDTA). The amount of lead excreted in urine (µg) is determined in relation to the dose of EDTA administered (mg). This relation correlated well with blood lead levels. The test is positive if the relation of excretion is greater than 0.6 (Markovitz & Rosen, 1991). The results were: 0.3 (4 years old); 0.6 (7 years old); 0.7 (11 years old) and 0.5 (13 years old).

As treatment with chelants has many renal and hepatic secondary effects, physicians refused to apply the treatment to those children, taking also into account the low socio-cultural status and the difficulty to follow the health process. In other Latin American countries (Chile, Ecuador, Peru, Colombia, Venezuela), similar studies to the ones made in Uruguay contribute with data of BLL in children with alarming levels, and they confirm that as they get farther from lead processing industries, BLL decline considerably.

As in other Latin American countries, population living around lead industries is exposed to higher environmental concentrations of lead, being children more sensitive to have both chronic and acute intoxications. Development of prevention methods is of high importance, since damage to intelligence, infertility, drug addiction, and criminal behavior caused by lead, are predictable and avoidable. Uruguay must urgently take prevention measures to enhance normal development of its children population.

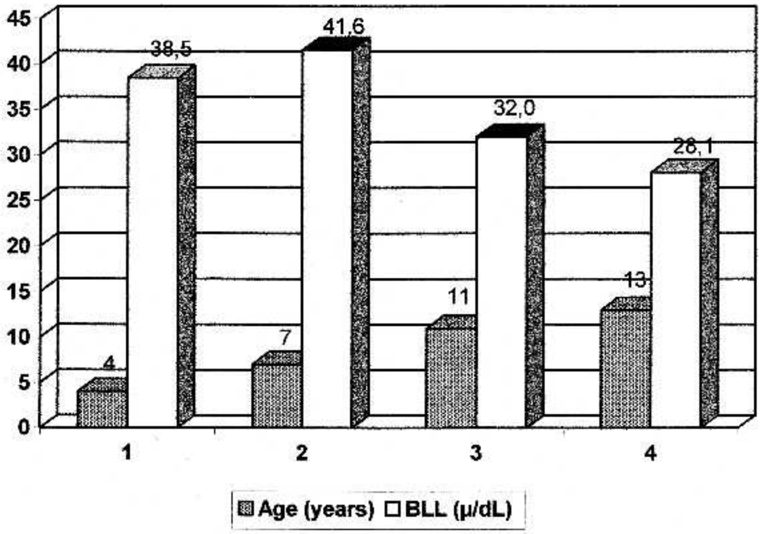

Figure 2. Blood lead level according to age from 4 exposed children

This can be made through programs containing systematic studies of childhood development, and also routine analysis of BLL. Therefore measures must be taken in order to reduce the environmental pollution, and as a result, the exposure of the population.

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