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Effect of the Reduction of Petrol Lead on Blood Lead Levels of the Population of Barcelona (Spain)

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Lead is a heavy metal ubiquitously distributed in the environment and arising from natural and anthropogenic sources. It has no known essential role in living organisms and its accumulation in human tissues may cause several health hazards including neurotoxicity, hematotoxicity and reproductive disturbances (Perlstein et al.1966, Clarkson et al.1985, Rodamilans et al. 1988). Although lead acute toxicity and chronic work place exposure has been known since antiquity, the main concern in our days is the subtle effects of low concentrations of lead on the general population, specially the possible neurological disorders induced by the metal in children living in urban areas.

Lead body burden in the general human populations arises from different sources including food and drinking water but there is a general agreement that in most industrialized areas, lead exposure through the air is a very important risk factor, being the combustion of leaded gasoline the main source of lead into the urban environment (Page et al. 1988, Gilli et al. 1990). Important efforts have been made in different European countries and in the USA in order to minimize or completely remove lead additives in petrol resulting in significant reduction in lead concentrations in the air and in the whole blood of the inhabitants living in these countries (Annest et al. 1983, Chartsias et al. 1986, Maresky et al. 1993, Ponka et al. 1993).

In Spain the lead content in the petrol additives has been decreasing over the past years from 0.6 g/L in 1983 to 0.15 g/L in 1991. Since 1990 unleaded petrol has also been introduced as an available choice. A concomitant reduction of the urban air lead levels in most Spanish cities has been observed and quantified during the last years by governmental agencies which monitor air quality.

In the urban area of Barcelona a very significant decline of lead concentration in the urban air has been observed since 1987 when reported concentration was 1.03 -1.55 µg/m3, to current 0.18 -0.30 µg/m3 (table 1).

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The purpose of this study was to determine the effect of this reported decrease in the air lead level, on the blood lead levels of the urban human population of Barcelona during the period 1984-1994.

MATERIALS AND METHODS

Two different studies were performed, the first one in 1984 (215 blood samples analysed) and the second one in 1994 (468 blood samples analysed).

The blood samples were obtained from volunteers, blood donors, of the "Hospital Clínic i Provincial de Barcelona" without any known occupational exposure to lead. A minimum of 10 years of residence in the metropolitan area of Barcelona was required.

From a large set of volunteers with available occupational, medical, residential and smoking histories, a group which covered a uniformly wide age range was finally selected in both cases. First group (1984) age range was 20-60 years and second group (1994) was 19-63 years with a similar frequency of ages distribution (table 2). Alimentary habits, smoking status, and number of men and women within the group was similar in both sets.

Table 1. Air lead concentration in the city of Barcelona

BARCELONA	Pb in air μg/m3 Range (X min - Xmax)
1987	1.03-1.55
1988	1.10-1.15
1989	1.17-1.30
1990	0.95-1.13
1991	0.36-0.64
1992	0.38-0.58
1993	0.33-0.44
1994	0.18-0.30

Whole blood samples were collected in the Vacutainer tubes treated with EDTA K_3 and kept at 5° C until analysis. All the volunteers were informed of the purpose of the study and gave consent for the blood extraction and the further analyses.

Blood lead concentrations were determined by graphite furnace atomic absorption spectrometry (FLAAS) with a PERKIN ELMER Zeeman 3030 spectrometer, HGA-600 furnace and AS-60 automatic sampler. L'vov platform, Zeeman background correction and other specifications of S.T.P.F. (Stabilized temperature platform furnace) concept were followed.

Lead concentration was calculated by internal standard addition using HNO_3 15%(suprapur Merck 4371) for protein precipitation (spiked blood).

Table 2. Population studied in the two sampling campaings.

YEAR	N	MALE	FEMALE	AGE (Xmin-Xmax)
1984	215	112	103	34.3 (20-60)
1994	468	228	240	32.4 (19-63)

The accuracy and precision of the results was assessed by a simultaneous analysis of the Liphocheck ® whole blood control levels I,II and III of Bio-Rad (561,562,563), and by means of an external interlaboratory quality control program for the whole blood lead concentration (Instituto Nacional de Higiene y Seguridad en el Trabajo, Zaragoza,Spain).

The results obtained were evaluated using a Statview II TM statistical program on a Macintosh SE/30 computer.

RESULTS AND DISCUSSION

Whole blood lead concentration found in the Barcelona population are shown in the Table 3.

Table 3. Whole blood lead concentration in the human population of Barcelona.

BARCELONA	Pb in petrol g/L	Pb in blood µg/dL X ± SD
1984	0.6	18.63 ± 6.62
1985	<0.4	
1986		
1987		
1988		
1989		
1990	unleaded	
1991	<0.15	
1992		
1993		
1994		8.81 ± 4.48

In the first study the lead concentration ranged from 6.83 to 38.92 µg/dL and in the second study ranged from 0.9 to 31.8 µg/dL.The mean values of blood lead concentrations dropped from 18.63 to 8.81 µg/dL in the last

ten years, this progressive decrease is statistically significant according to the t-student test ($p < 0.001$).

The accuracy and precision of the method used for the lead concentration analysis (mean, standard deviations and coefficient of variation) are show
in the Table 4.

This study was started after lead content in the petrol was reduced in Spain from 0.6 g/L in 1983 to 0.15 g/L in 1991. This reduction was followed by a decrease in the lead air concentration i.e., the values of lead in the air of Barcelona dropped from 1.03 µg/m 3 to 0.18 µg/m^3 in 1994.

Table 4. Whole blood lead concentration obtained with the Lyphocheck Bio - Rad controls.

CONTROL BIO-RAD	N	X ± SD (µg/dL)	CV %
LEVEL I	5	7.5 ± 1.3	5
LEVEL II	5	22 ± 2.5	6.3
LEVEL III	5	56 ± 4.1	7

The results obtained on the blood lead concentration for this population showed a significant decrease during the last ten years, with the mean concentration decreasing drastically from 18.63 to 8.81 µg/dL. In spite of a cause and effect relationship between blood lead levels and lead concentration in petrol not being demonstrated, the most probable explanation for the reduction of the blood lead levels is the reduction in the lead content in petrol additives during the period 1984-1994, since no changes in the dietary habits, nor changes in the concentration of lead in food have been reported over this period of time.

Nevertheless, the results currently found show an important number of people (28%) with a blood lead level greater than 10 µg/dL, which is considered a threshold for health risk by several authors (Davis JM.1992, Foner HA. 1993).

This report shows that in the population of Barcelona there is still some potential risk of lead toxicity. The main concern should be with the young inhabitants of this area since, according to several studies, even low levels of lead may effect the cognitive development and function in children (Bellinger et al. 1987, Needleman et al. 1990).

The results obtained suggests that the legislation introduced to eliminate the lead additives in petrol caused a positive effect by diminishing lead concentration in the air and blood and thus protected human health. As a conclusion, further reductions in the lead emissions should be encouraged.

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