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Influence of Lead on Pregnant Women in Metropolitan Mexico City

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The most serious problem associated with the growth of Mexico City is the registering of high levels of atmospheric pollution. Since the late 1970's, this has been a growing concern for the entire population of the city. This problem is particularly serious during the winter months (December to February) when the low temperatures stabilize the atmosphere above the city, and the thermal inversion permits the accumulation of pollutants in the mass of stationary air that covers the city. Studies of lead pollution in the air particles of Mexico City have shown that for several years the majority of this pollution is generated by automobile exhaust.

Until in 1986 lead was perhaps the most critical contaminant in the city's atmosphere, primarily because of the use of leaded gasoline. The concentration of this element was augmented by the number of vehicles, reaching an average of 5 micrograms per cubic meter in 1968 and an average of 8 micrograms per cubic meter in 1988. The tolerable Mexican norm is 1.5 micrograms per cubic meter (Avediz 1984).

Establishing the problem. Lead is a toxic metal with no known benefits for physiological functions for living creatures. It is a heavy metal, dangerous to most of the human body's organ systems and interferes with body metabolism and cellular functions. In human beings, it produces damaging effects in the hematopoetical, hematic, renal, reproductive and gastrointestinal systems, and most importantly, reverberates the growth of organisms due to its effects on the central nervous system. Recent research has shown that the period most sensitive to exposure is during fetal gestation and the first stages of development, as much in animals as well as human beings (Rothenberg et al 1989).

During the combustion of gasoline the following are generated and released into the atmosphere: hydrocarbons, inorganic lead oxide, carbonates, and lead halides. Petroleos Mexicanos has marked a maximum limit of tetraethyl lead in gasoline, 2.0 ml/gal. With respect to industry, one must consider that automobiles release into the atmosphere 32 tons/day of lead and 81% of the contaminants in mass.

Industry also contributes lead into the atmosphere, principally the metallurgic, chemical and oil industries. Lead has been widely used by industry because of its characteristics that make it easy to manage: resistant

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to corrosion, has high ductibility and is also highly electric and heat conductive. See figure 1.

Thus in the 70's and 80's, measurements of lead content in the air showed levels that frequently exceeded 5 micrograms per cubic meter. See figure 2. In various studies carried out during these years, significant levels of lead were found in residents of Mexico City. The World Health Organization's study of a Sample of public school professors revealed an average blood level of over 20 ug/dl, the highest among ten principal population centers in the world that were included in the study (Friberg and Vahter 1983). The investigation carried out by the National Institute of Public Health in 1988 on a group of government workers reported and average blood-lead count 19.5 ug/dl of the total sample, 22.6 ug/dl for the men and 16.6 ug/dl for the women (Lara Flores et al 1989). Another study reported average levels of 20 ug/dl in a group of 405 pregnant women, who gave birth in the Centro Medico Nacional (Montoya-Cabrera et al 1981). The exclusion criteria was the same presented in materials and methods.

This last study has special implications, since the levels of lead which are shown highly correlated, strengthen until the moment of delivery, in the mother as well as in the umbilical cord (Ernhart et al 1986). Other research shows that the level of lead in the umbilical cord falls to an amplitude of 10 to 25 ug/dl that shows a delay associated with the mental development to the child in this first few years of life (Bellinger et al 1984).

If one wishes to evaluate the impact of the damages caused by lead exposure in the metropolitan area of Mexico City, they must determine present-day levels of exposure in high-risk groups. Among them are considered pregnant women, fetuses, and infants, due to their sensitivity to even low concentrations of the metal.

The prospective study of the lead problem that is being carried out by the Instituto Nacional de Perinatologia (INPER), is following a sample of pregnant women beginning with 12 weeks of pregnancy. In this study, they elaborate a detailed history of lead exposure that in the long run is the same, until the birth of the infant. Afterwards, the baby's neurological and psychological development is evaluated every six months.

MATERIALS AND METHODS

250 women who came to INPER before or during the 12th week of pregnancy were selected, determined by beginning with the date of the last menstruation, respectively with the following exclusion criteria used in the INPER; nevertheless these conditions not change the lead levels:

1) Age: under 15 or over 42 years of age, 2) High blood pressure; medically controlled, 3) Diabetes, 4) Active psychosis, 5) Toxoplasmosis of German measles during pregnancy, 6) Habitual drug consumption, 7) Daily consumption of alcohol. The exclusions were 19.

The patients selected were interviewed to obtain their consent to participate

Table 1. Characteristics of the subjects.

	Mother's age in years	Residence in years	Weeks of pregnancy	Babies weight in grams
Mean	28.2	24.0	39.8	3 131
Median	28.0	24.5	40.0	3 100
Standard deviation	6.6	9.0	1.36	395.5
Extreme values	15-42	1-42	36.0 - 42.5	2000 - 4325

Table 2. Lead statistics in mothers and their babies.

	Mean ug/dl	Median	Standard deviation	Cases
Lead in women of 12th weeks pregnant	9.0	8.0	6.0	244
Lead in women in childbirth	8.5	7.0	6.2	123
Lead en children at six months of age	12.0	10.5	6.1	79
Lead in children at 12th months of age	15.3	15.5	6.6	75

in the study, these babies were selected considering the following criteria for exclusion:

1) Serious congenital abnormalities; exclusions none. 2) Less than 36 weeks of gestational age; exclusions 4, 3) Weight less than 2000 grams; exclusions 4. Between the 12th and 32nd week of pregnancy, every 8 weeks a blood sample was taken. Afterwards, similar samples were obtained each week until the moment of delivery, on which a maternal sample was taken an also a sample of the umbilical cord. Every six months samples were collected from the baby.

When the results are less than 5 ug/dl, they are reanalyzed in duplicate with the photospectometry method using atomic absorption in a grafite oven. The mean of the two results was the average used in the subsequent statistical analysis.

Utilizing the results of the univaried tests, the variables predicted significantly to lead with $p<0.10$ were employed in an analysis of multiple regression scaled to construct a model, in which each included variable constributed in a significant and independent manner of lead in the sample. The value of $p<0.10$ is normaly employed in INPER and the multiple regression equation support principal component analysis.

Table 1 shows the basic characteristics of the selection. The majority of the mothers were found between 20 and 30 years of age, with few children and the majority had lived in Mexico City for 20 years. Table 2 shows the lead statistics in mothers and her babies.

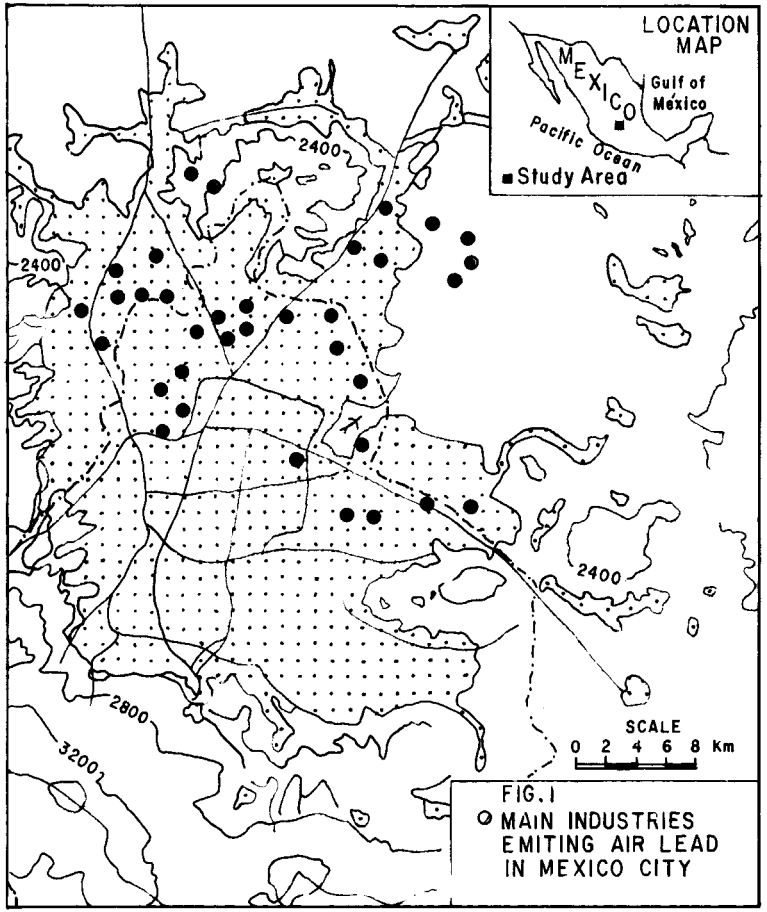

FIG. 1
MAIN INDUSTRIES EMITING AIR LEAD IN MEXICO CITY

From: Secretaría de Desarrollo Urbano y Ecología, México.

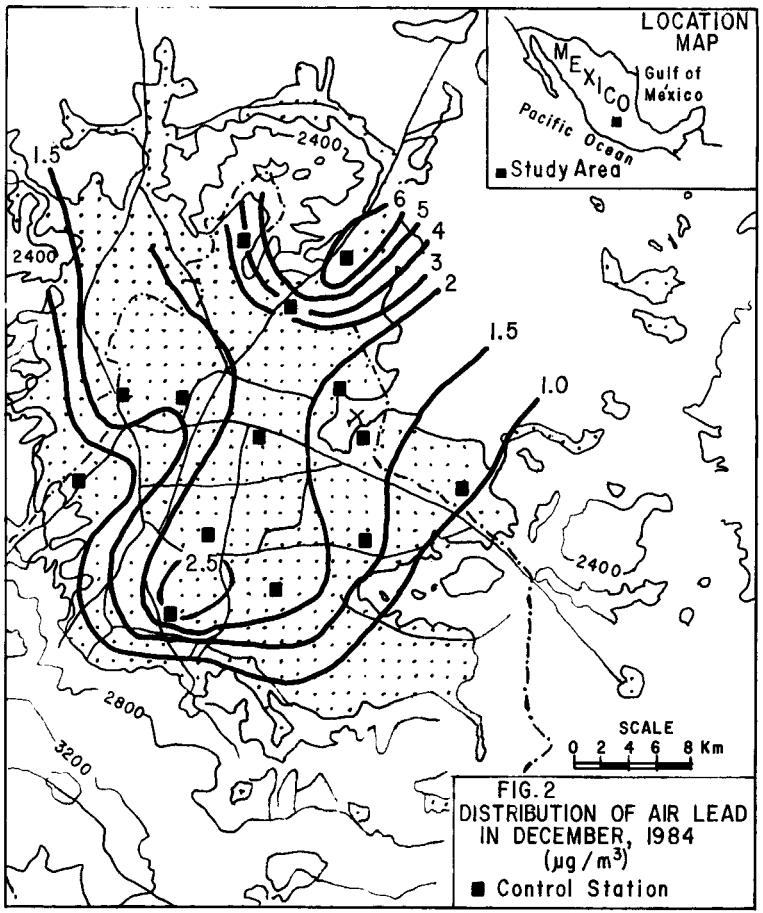

FIG. 2
DISTRIBUTION OF AIR LEAD IN DECEMBER, 1984
($\mu g / m^3$)
■ Control Station

RESULTS AND DISCUSSION

In figures 3, 4 and 5, one can see the proportional distribution of frequencies of the lead samples obtained from the mothers at 12 weeks of pregnancy and the mean values of the 3 distributions.
It is obvious that as much for the reduced size of the sample as well as the criteria used in the selection to exclude patients from the study, these results do not represent the total population of pregnant women in Mexico City and its surrounding areas. The mothers and their babies basically represent a healthy sample of this population. These results could only describe a population of mothers with similar characteristics, just as the optimum age of procreation, without serious complications during pregnancy or delivery and with superior prenatal care on the average, proportioned by INPER; and could generalize babies free of complications that could have threatened their lives and that have gestational age and weight withing the normal limits.

Previously it has been reported that the association between elevated levels of lead and the growth of the children (Bornschein et al 1985), in which 2 factors seem to conjugate to produce this tendency. Between the ages of 14 and 24 months, the stomach and intestines of the child show a greater efficiency to absorb lead, and this reflects in the blood and other tissues; in addition, the habits and conduct of the baby at this age favor greater contact with substances that contain lead, such as dust, household dirt, wall paint, toys and other surfaces; often the baby puts his hands to his mouth, augmenting the possibility of ingesting it (Bellinger et al 1986). It appears that the average amount of lead reaches its peak only between 12 and 24 months, and afterwards diminishes gradually.

Figure 6 shows lead concentrations in the air. These were measured every month during 1987. The figures were computed by averaging those that were reported to the Secretaria de Desarrollo Urbano y Ecologia (SEDUE) from all of the stations of the network for every day of the month. It is important to indicate that for some months there were no available data. The other line in the same figure shows the monthly mean of lead concentration of the women in the 12th weeks of pregnancy that participated in the study during the months in which they were recruited at less than 7 a month.

In that year were present 2 periods of high concentration of lead levels in the air. The first corresponds to the end of the dry season in June. During this time it is expected that the greater part of lead in the air is transported by suspended particles. During the entire dry season a large part of the lead in the air falls to the ground and the maximum concentrations of lead particles are carried upwards by wind before the beginning of the rainy season. In July, the following mark in lead levels in the air are produced by a combination of the washing of the air by the rain, along with the reduction of transported particles. The 2nd period of high concentration corresponds to the time of maximum thermal inversions in the months of December and January. Still when the total of suspended particles is not found in the highest levels of the period, the concentration of all contaminants, including lead, are augmented.

The relation between lead in the air and maternal lead in the 12th weeks of pregnancy of the subjets of the study, continues the well-known dynamics of the distribution and emission of lead. Lead from only one period of exposure

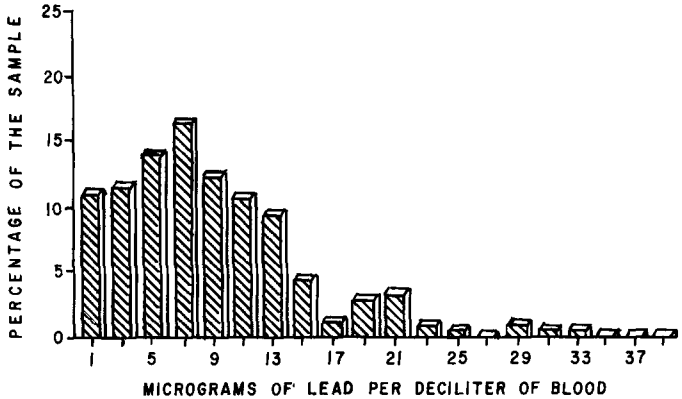

FIG. 3 LEVELS OF LEAD DISTRIBUTION IN WOMEN OF 12 WEEKS PREGNANT

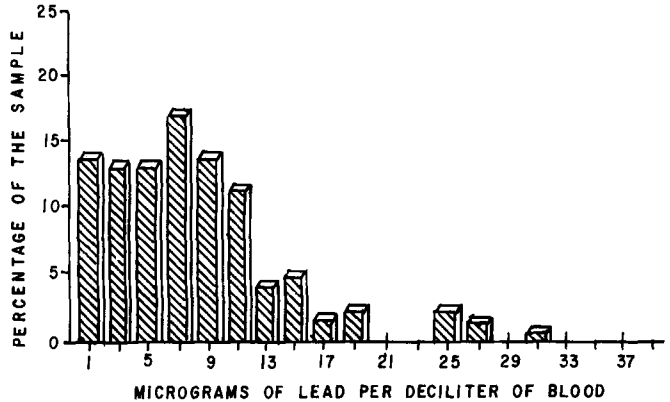

FIG. 4 LEVELS OF LEAD DISTRIBUTION IN WOMEN IN CHILDBIRTH

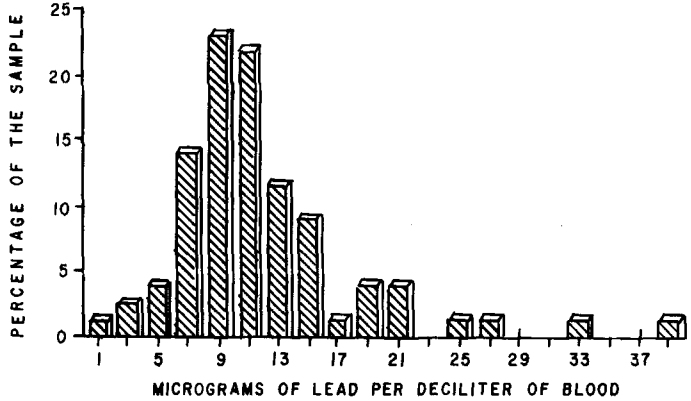

FIG. 5 LEVELS OF LEAD DISTRIBUTION IN CHILDREN AT SIX MONTHS OF AGE

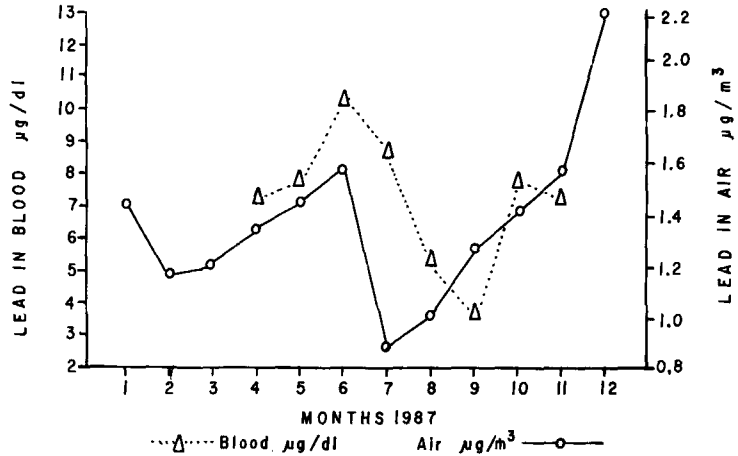

FIG. 6 CONCENTRATIONS OF LEAD IN AIR AND IN BLOOD

From : Instituto Nacional de Perinatología, México.

appears in the soft tissues for a period of 24 to 28 hours. The average life of lead is 30-45 days in the soft tissues after one period of exposure. In this way, if the lead in the air rises during the dry season, the lead in people gradually rises as well. After a marked decline of lead in the air at the beginning of the rainy season, it takes 1 or 2 months for the reductions in the measurements to be noticed in the subjects. As the lead in the air begins to rise during Autumn, lead in the subjects also rises. If this seasonal fluctuation of lead in the blood is due to atmospheric lead, the lower limit of lead exposure measurements in the sample (September 3.5 ug/dl) can represent residue that would cause the origins not to be stationary.

The results suggest an apparent tendency to decrease lead in blood levels of pregnant women and the air levels during the last years, permiting the assumption that the government program through Petroleos Mexicanos to reduce lead in gasoline is getting positive results. Nevertheless, we can't derive definite conclusions in this respect, as the results were obtained from a small not significant sample. However, the exposure of lead in this susceptible population still represents levels that permit probable expectations that an important part of the mothers and children studied will suffer effects in their health.

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