Sources of Lead Exposure in Mexico City

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Many countries, including Mexico, are facing a largely unrecognized epidemic of low-level lead poisoning. Mexico is the sixth largest lead-producing country in the world, and 40% of its production is used locally in different industrial processes that cause lead contamination of the environment. The major sources and pathways of lead exposure among the Mexican population are gasoline emissions, lead-glazed ceramics, leaded paint, and lead in canned foods and beverages. In this paper we present evidence for the presence of lead in different environmental media and its impact on blood lead levels of the Mexican population. Although during the last few years important measures have been implemented to decrease lead exposure, our findings suggest that lead poisoning is still an important problem in Mexico. There is an urgent need for regulatory policies that implement stricter control to protect the Mexican population. There is also a need to develop adequate programs to reduce the lead burden and the associated health effects in the population that has been chronically exposed. *Key words:* blood lead, environmental lead, epidemiology, Mexico. *Environ Health Perspect* 102:384-389(1994)

Environmental lead pollution and its potential adverse health effects were observed in Mexico as early as 1682 (*1*). However, only in recent decades have studies on environmental lead been carried out in Mexico. Many of these studies have focused on environmental lead determination in different media and biological sampling among exposed workers and their families. This literature has been reviewed by Albert and Badillo (*2*), who concluded that available data were dispersed and had many discrepancies in the results and were therefore difficult to interpret. The use of different analytical procedures and laboratory techniques to determine lead levels may explain part of the discrepancy of the results. At present, data on blood lead levels in the general population of Mexico (*3–6*) and on the determinants of such levels (*7,8*) are still sparse. In this paper, we review the major sources and pathways for lead exposure in Mexico and present results of studies we and other research groups have conducted.

Methods

In recent years, different research groups have investigated the sources of lead exposure and their impact on blood lead level in the general population of Mexico. Some of the results have already been published by our research team or other groups, and the methodology of these studies has been described elsewhere (*5–9*). The other results in this paper are reported for the first time, and the study methodologies are described below.

To determine the sources of lead exposure in the Mexican population, we collected information and performed analysis on different types of samples. All samples (colored pencils, ceramics, cans, and cigarettes) were randomly selected from products available on the Mexican market. We obtained water samples from randomly selected households using lead-free containers that had been immersed for several hours in 3% nitric acid and thoroughly rinsed with deionized water. The first flush from the tap was collected to sample water that was standing over night. Analytical procedures followed the methodologies proposed by different authors according to the media in which lead was determined (*10–13*). Internal quality control included calibration curves with lead standards. All analyses were performed using atomic absorption spectrophotometry (Perkin Elmer 360, 3100) with a graphite furnace (except for the lead content of total suspended particulates, which was measured at the governmental laboratory of SEDESOL).

To determine the impact of potential sources on the blood lead levels of schoolchildren, we selected private and public schools located in different areas of Mexico City. All children from a specific age group were asked to participate. Refusal rate was low (less than 1%). Information on potential lead exposure was obtained through a detailed questionnaire that our group developed. Blood lead samples were drawn at school by trained pediatric nurses, using lead-free tubes. Blood analysis was conducted by laboratories using atomic absorption spectrophotometry (Perkin-Elmer 360 and 2100) according to the technique described by Vahter (*3*), and the standardization of the equipment and quality control was provided by the Centers for Disease Control laboratory (*7–9*). Blood lead measurements are reported in micrograms per deciliter; the converting factor to micromoles per liter is 1 μg/dl = 0.0484 μmol/l.

Sources of Lead and Impact on Blood Lead Levels

Mexico is the world's sixth largest lead-producing country. In 1988 the production of lead reached 170,200 tons (*14*). Almost 60% of this production is exported, while the rest is used locally in industrial processes (pigments, leaded pipes, batteries, and tetraethyl lead), leading to different sources of lead exposure (*15*).

Airborne Lead

The industrial and demographic growth that occurred in Mexico during the last few decades has generated important problems of environmental pollution in the larger cities and particularly in the metropolitan area of Mexico City. At present, one-fourth (20 million) of the Mexican population lives in this area, producing 36% of the national GNP and representing almost 26% of Mexico's total energy consumption. It has been estimated that 14 million liters of leaded gasoline and 4 million liters of diesel fuel are consumed every day in Mexico City (*16*), and that 1500 metric tons of lead are deposited annually in the environment from combustion of leaded gasoline (*17*).

Recognition of this problem has driven the Mexican government to decrease the use of tetraethyl lead in gasoline by 300% between 1981 and 1986 (3.5 ml to 1.0 ml per gallon; see Table 1). At present, two types of gasoline are used in Mexico, the "nova" type that contains 0.5–1.0 ml of tetraethyl lead per gallon and the "magna sin" (unleaded) type that contains 0.1 ml of tetraethyl lead per gallon (*18*). Vehicles can use unleaded gasoline only if they are equipped with a catalytic converter and if the model is post–1985 (due to engine characteristics). However, among the 3 million vehicles in Mexico City, 80% were manufactured before 1980 and some before 1970. Therefore, despite the introduction of unleaded gasoline, con-

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sumption of leaded gasoline (*17*) is still high in Mexico City. Other sources of airborne lead within the Valley of Mexico City include lead smelters, battery manufacturing plants, battery repair shops, and paint factories.

Figure 1 presents the atmospheric lead measured at two monitoring stations in Mexico City during 1990 (Xalostoc, located in the northern part of Mexico City close to the industrial park, and Pedregal, located in the southern part of Mexico City in a residential area). In Xalostoc, where traffic and industrial emissions are particularly high, atmospheric lead greatly exceeds the standard guideline for lead in Mexico [similar to the guideline provided by WHO of 1.5 μg/m^3 (*19*) over 3 months]. In comparison, estimates for the major cities in the United States are typically between 0.1 and 0.2 μg/m^3 (*20*). In the last 2 years, however, possibly due to an increment in the use of unleaded gasoline and to the closure of several lead-manufacturing industries, particulate lead content has decreased by more than 100% (annual mean = 1.8 μg/m^3 in 1991 versus 2.8 μg/m^3 in 1989) (*21*).

Inhalation or ingestion of dust and soil contaminated with lead can play an important role in the total lead body burden of children. It has been estimated in the United States that for each 1 μg/m^3 increase in airborne lead levels, on average, a child's blood lead level rises 5–6 μg/dl (*20*). For a specific exposure to lead in gasoline of 1 μg/m^3, the impact has been estimated to exceed 8 μg/dl (*22*), possibly related to the small size of particulates produced by automobile exhaust.

A study conducted by our research team among pediatric patients illustrates the impact of airborne lead on children's blood lead levels (*8*). A random sample of 90 children, 1–10 years old, were selected among patients attending a pediatric clinic for a routine visit in Mexico City. Mothers were asked to fill out a questionnaire on demographic variables and potential sources of lead exposure, and total venous blood samples were obtained from the children. Blood lead levels ranged from 3.4 to 25 μg/dl, with a mean of 12.7 μg/dl (SD = 4.4), and 80% (n = 71) of the children had a blood lead level >10 μg/dl. In this sample, the main determinant of blood lead level was the place of residency. Children living on residential streets had a mean blood lead level of 10.3 μg/dl (SD = 4.2), whereas children living on avenues or main roads had a mean blood lead level of 15.5 μg/dl (SD = 4.0; p = 0.0001). Results remained unchanged after adjusting for age and other factors.

Table 1. Content of tetraethyl lead in Mexican gasoline (ml/gal) from 1970 to 1990

	Type of fuel						
Year	Mexolina	Superxolina	Gasolmex	Pemex 100	Extra[a]	Nova[b]	Magna sin[c]
1970	3.0	2.7	2.8	3.9	—	—	—
1971	3.0	2.7	2.8	3.9	—	—	—
1972	3.0	2.7	2.8	3.9	—	—	—
1973	3.0	2.7	2.8	3.9	3.5	3.5	—
1974	3.0	—	—	—	3.5	3.5	—
1975	3.0	—	—	—	3.5	3.5	—
1976	3.0	—	—	—	3.5	3.5	—
1977	—	—	—	—	3.5	3.5	—
1978	—	—	—	—	3.5	3.5	—
1979	—	—	—	—	0.083	3.5	—
1980	—	—	—	—	0.083	3.5	—
1981	—	—	—	—	0.083	3.0	—
1982	—	—	—	—	0.083	2.19	—
1983	—	—	—	—	0.083	2.0	—
1984	—	—	—	—	0.083	1.0	—
1985	—	—	—	—	0.05	0.5–1.0	—
1986	—	—	—	—	0.05	0.5–1.0	—
1987	—	—	—	—	0.05	0.5–1.0	—
1988	—	—	—	—	0.05	0.5–1.0	—
1989	—	—	—	—	0.05	0.5–1.0	—
1990	—	—	—	—	0.05	0.5–1.0	No lead added

[a]Called extra plus since 1986.
[b]Called nova plus since 1986.
[c]Since September 1990, replaces extra plus. Lead content is 0.01 ml/gal. Lead is not added.
[d]No lead added.

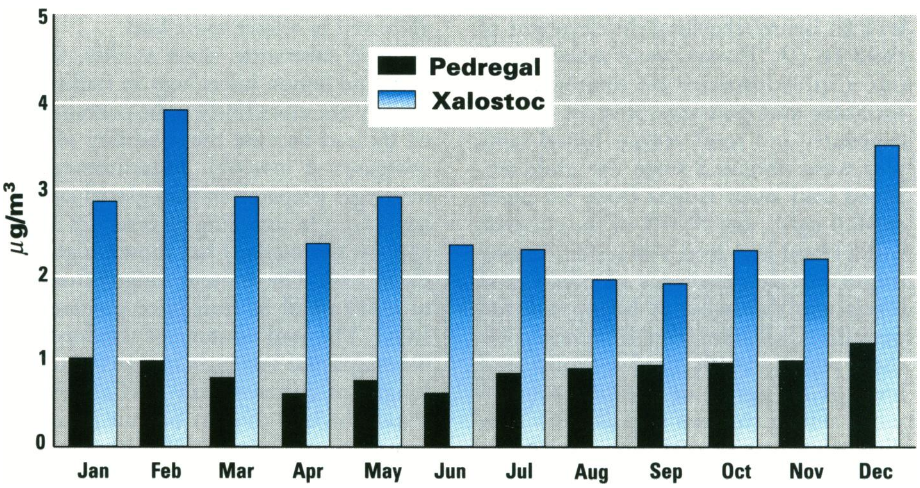

Figure 1. Atmospheric lead measured at two monitoring stations in Mexico City during 1990. Xalostoc is in the northern part of Mexico City, near an industrial park, and Pedregal is in the southern part, in a residential area.

These data document the high lead exposure among children living in Mexico City and suggest that leaded fuel could play an important role in determining blood lead levels in this population.

Lead in Paint

Lead-based paint and pigments that contain lead chromates are frequently used in Mexico. The proportion of lead can reach 50% for exterior lead-based paint, such as the type used on roads, sidewalks, bridges, and expressways. Although this product is not soluble in water, it is soluble in acid liquids, and therefore lead may be released into the environment (dust and water) by contact with acid rain and drainage water. Also, the dissociation of lead chromates by gastric acid can be responsible for the bioavailability of the lead contained in the ingested dust or soil contaminated by leaded paint (*23*).

Lead pigments are also used in children's toys and pencils. Our group analyzed different types of colored pencils, using the technique proposed by Evans (*10*). Results showed a wide variety of lead contents depending on the pencil's origin. Most colored pencils had a high lead content (Table 2). This source of lead exposure can contribute to the total body burden of children, who tend to bite pencils and therefore ingest chips.

At present there are no data on the impact of paint on blood lead levels in

Table 2. Lead content of colored pencils from different countries of origin

Origin	Color	No. of samples	Lead content, inside/outside (ppm)[a]
Mexico	Bright red	10	16,894/43,369
	Carmine	10	1.97/1,440
	Sienna	10	74/5,759
	Light yellow	10	63,911/68,114
	Grey	10	38,693/3,194
	Green	10	37,443/34,949
Germany	Violet	5	2.94/1.64
	Yellow	5	4.22/1.49
China	Light yellow	2	0.91/2.84
	Green	2	3.32/3.13

[a] "Inside" refers to the pencil lead; "outside" refers to the paint on the outer surface of the pencil.

Mexican children. However, a study conducted by our research team in schoolchildren could illustrate the potential impact of colored pencils on children's blood lead levels. In this study, all second and third graders (age 7–9 years) from two public schools located in the southern part of Mexico City were enrolled (n = 124). The main objective of the study was to determine the major sources of lead exposure in this population and the impact of elevated blood lead on neurobehavioral development of children (*9*). Parents were asked to fill out a questionnaire on demographic variables and potential sources of lead exposure, and total venous blood samples were obtained from the children. Blood lead levels ranged from 5.0 μg/dl to 40.6 μg/dl, and 88.6% of the children had a blood lead level >10 μg/dl. Among important determinants of blood lead levels was the habit of biting colored pencils. Children who frequently bit their pencils (41%) had a blood lead level of 21 μg/dl, as compared to 18 μg/dl among children who did not. This difference was statistically significant. Other important predictors of blood lead levels were the use of lead-glazed ceramics and the amount of traffic close to the child's home.

Lead-Glazed Ceramics

Leaded glaze is commonly used in Mexico to cover ceramics that are used to cook, store, and serve foods and beverages. This traditional pottery is hardened at low temperatures, and therefore the lead remains in the glaze and can be released into foods and beverages. To determine the factors that may affect the lead content of substances kept in traditional ceramics, our research team has conducted several experiments on samples obtained in Mexican markets.

Measurements of samples of glaze used to cover ceramic, lead-glazed, and unglazed ceramics have shown that most of the lead released comes from the glaze (*9*) (Table 3). The place of origin of the pottery is also an important factor. Other authors have analyzed the lead content of ceramics from different areas of Mexico (Table 4). The highest content was observed in dishes and pitchers from Guadalajara, Mexico City, and Oaxaca, although within a single area there was variation in the amount of lead released (Rothenberg S, Schnaas L, personal communication, 1990). It also seems that pottery that has been used for a long time is more likely to have altered glaze and to release more lead.

Acid substances (such as chili, tomatoes, and lemon juice) kept in traditional pottery are more likely to be contaminated by lead because the solubility of lead increases at low pH. Measurement of beverages prepared in lead-glazed ceramics (LGC) (a sampling of ceramics available on the market) has shown high levels of lead. The content ranged from 89 to 8000 μg/dl in fruit juice prepared in LGC. The lead content of the foods or beverages also increases in relation to the length of contact with LGC. Table 5 shows the lead content of fruit juice and tomato sauce kept in LGC dishes for different time periods. The quantity of lead released varies between samples (LGC originated from different areas) and increases with time.

Several studies have been conducted of populations occupationally exposed to lead through the manufacturing of LGC and their families (*2*). We conducted several studies in different groups of the general population of Mexico. Results clearly document the impact of the use of lead-glazed ceramics on blood lead levels among adults and children living in Mexico.

In a study conducted in the southern part of Mexico City, 99 women 21–57 years old, from middle to low socioeconomic status, provided a blood sample and filled out a general-purpose and lead-exposure questionnaire (*7*). The lead exposure questionnaire included the use of LGC to prepare, store, and/or serve foods, the frequency of consumption of such foods, the consumption of canned food, and other types of potential exposure to lead. Questions on the use of LGC were illustrated with photographs because the lead content of such items varies according to the type used.

Blood lead levels ranged from 1 to 52 μg/dl, with a mean of 10.6 μg/dl. The main determinant of blood lead level was the use of LGC to prepare food (p<0.005). There was a significant increasing trend in blood lead level with increasing consumption of food prepared in LGC. Women who reported they frequently ate foods prepared in LGC had a mean blood level of 12.7

Table 3. Lead released by ceramics with and without glaze

Type[a]	Lead released (mg/l)
Glaze of ceramic pot	3052.99
Lead-glazed ceramic pot (dark brown)	10935.07
Ceramic pot without glaze	2.15

[a]Analysis of one sample per type of ceramic.

Table 4. Lead released by lead-glazed ceramics according to place of origin and typea

Origin	Type	Lead released (ppm)
Oaxaca	Dish	1960
Hidalgo	Dish	978
Hidalgo	Saucer	61.3
Mexico City	Dish	1470
Mexico City	Earthen casserole	3640
Mexico City	Pitcher	844
Mexico City	Pitcher	93.4
Tepoztlan	Dish	<0.1
Tepoztlan	Cup	<0.1
Guadalajara	Pitcher	3730
Guadalajara	Pitcher	1150
Guadalajara	Pitcher	1.6
Metepec	Earthen casserole	0.8
Morelos	Earthen casserole	1.8
Michoacan	Dish	8.1

[a]Source: Rothenberg S, Schnaas L, personal communication, 1990.

Table 5. Lead content (μg/dl) of fruit juice and sauce prepared and stored in lead-glazed ceramics, according to time

Type	No. of sample	Time in container 30 min	60 min	24 hr
Sauce	1	3,200	3,690	127,000
	2	1,170	2,560	21,600
	3	2,060	2,640	15,600
	4	1,540	1,990	2,940
	5	1,860	1,920	2,940
	6	1,560	1,820	2,540
Juice	1	8,000	15,200	283,000
	2	2,550	4,680	12,210
	3	760	5,700	14,890
	4	330	1,040	2,780
	5	89	1,070	2,780
	6	93	810	1,710

Table 6. Blood lead and major sources of lead exposure among Mexican children, 1990–1991

Population	Location	SES	N	Blood lead (µg/dl)				Major sources	% >10 mg/dl (*n*)
				Age (yr)	Mean	(SD)	Range		
Pediatric visit	Northwest Mexico City	High	89	1–10	12.7	4.4	3.4–25.0	Airborne lead	79.8 (71)
Private school	Northwest Mexico City	High	30	7–11	8.6	3.7	2.0–16.0	Airborne lead	40 (12)
Private school	Southwest Mexico City	High	80	6–12	10.7	4.7	2.0–23.5	LGC	53.1 (43)
Public school	Southwest Mexico City	Low	40	6–8	15.3	8.5	6.0–48.0	LGC, colored pencils[a]	67.5 (27)
Public school	Southwest Mexico City	Low	124	7–9	19.5	7.8	5.0–40.6	Airborne lead, LGC, colored pencils	88.6 (109)
Rural school	Jalisco	Low	46	6–8	7.3	2.8	2.7–15.2	LGC	17.4 (8)

Abbreviations: SES, socioeconomic status; LGC, lead-glazed ceramics.
[a]Biting colored pencils.

µg/dl (SD = 9.0), whereas women who used LGC only occasionally had a mean blood lead level of 7.1 µg/dl (SD = 4.5), and women who never ate food prepared in LGC had a mean blood lead of 7.2 µg/dl (SD=4.6; test of trend, $p = 0.001$).

Similar results have been observed among schoolchildren of different socioeconomic status in urban and rural areas. We conducted a study enrolling all children 7–9 years old who were students in a public school in the southern part of Mexico City. Blood samples were obtained, and parents filled out a questionnaire on sociodemographic variables and sources of lead exposure. Overall blood lead levels ranged from 3.0 µg/dl to 48.0 µg/dl, with a mean of 13.2 µg/dl (SD = 7.6). The mean blood lead level of children living in households that reported using LGC (23%) was 18.8 µg/dl (SD=11.4), whereas the mean blood lead level was 11.8 µg/dl (SD = 5.5) among children living in households that did not use LGC (*t*-test, $p = 0.02$). A major factor was the consumption of fruit juice kept in LGC. Children who drank juice kept in LGC had a mean blood level of 22.2 µg/dl (SD = 12.5), whereas children who did not had a blood lead level of 12.4 µg/dl (SD = 6.3; *t*-test, $p = 0.004$). We observed similar results in other groups of children from urban and rural areas (Table 6).

In addition, among a cohort of pregnant women and their offspring, Rothenberg et al. (*6*) reported that women who used LGC and their infants had higher blood lead levels than women who did not use this type of pottery. These findings demonstrate the major role of traditional pottery as a contributor to blood lead levels in the general Mexican population and emphasize the need for interventions to produce lead-free pottery.

Lead in Cans and Canned Food

Lead-soldered side-seam cans are still available in Mexico. As with food prepared and kept in traditional pottery, acidic foods processed in cans with lead solder are more likely to be contaminated. In 1990, measurements of lead content in different types of canned foods were performed by the National Laboratory of Industrial Work. Among the cans analyzed, 33% of chili cans, 37% of tuna fish cans, and 33% of sardine cans had levels exceeding 2 ppm (*24*). Measurements performed recently by the National Laboratory of Public Health on a random sample of 300 cans with different types of solder showed that 33% had a lead content exceeding 0.30 ppm, the recommended guideline of the Mixed Commission of FAO/OMS (*25*). Among the cans that exceeded the norm, 61% were lead-soldered, and 18% had an electronic solder (*26*). Our team also performed measurements on samples of cans available on the market to determine the amount of lead released by empty cans of different sizes with different types of coating and solders (*10*). In addition, we analyzed the lead content of canned foods (*9*). Results are shown in Table 7.

Table 7. Lead released by cans and lead content of canned foods

Can size[a]	Type of coating	Type of solder	Product	Lead content (mg/kg)
211–208 (160 g)	Aluminum	Lead	—	2.11
307–304 (750 g)	Epoxiphenolic	Lead	—	0.37
211–300 (225 g)	Epoxiphenolic	Lead	—	0.05
211–300 (225 g)	Type C[b]	Electronic	—	0.03
211–208 (160 g)	Aluminum	Lead	Ham	<0.03
307-304 (750 g)	Epoxiphenolic	Lead	Chili	0.77
211–300 (225 g)	Epoxiphenolic	Lead	Peas	3.52
211-300	Type C	Lead	Vegetable	3.70

[a]Analysis of three cans per size.
[b]"Type C" is the term used by the industry to refer to a coating used primarily in vegetable canning.

Food may also be contaminated before processing. High lead content has been observed in food grown in "urban gardens" if the soil is high in lead or if there is high lead concentration in the air or the water used for irrigation (*27*). A study conducted in Tula (State of Hidalgo) showed high levels of lead in vegetables grown using residual water (range 0.14–3.74 mg/kg) (Cortez MJ, personal communication).

Lara et al. (*5*) studied the sources of lead exposure among a random sample of civil servants residing in Mexico City. Among 142 men, the mean blood lead level was 22.6 µg/dl (SD = 6). The major predictor of blood lead was the consumption of canned chili. Subjects who consumed canned chili on a daily basis had a mean blood lead level of 24 µg/dl as compared to 21 µg/dl among their counterpart ($p = 0.001$). However, these findings were not observed in other studies (*7,8*). In this study the use of LGC was also an important determinant of blood lead levels.

Lead in Drinking Water

Lead in drinking water may come from contamination at the source, but it can also result from the water treatment and distribution system. Lead levels in drinking water can be high when soft/acidic water flows through lead pipes. For a long period, in Mexico it was required that houses be connected to a street collector through a lead-pipe connection. This could potentially contaminate the water, especially acidic/soft water. However, since July 1991 this regulation is no longer valid.

Measurements of lead in drinking water (*11*) performed by our team in different households in Mexico City have shown lead levels close to 0.1 ppb [below the WHO guideline for drinking water of 0.01 ppm. (*28*)]. The fact that the water in Mexico City is alkaline may explain the low lead levels observed because heavy metals such as lead will tend to precipitate. Similar results have been reported by other authors (*2*).

Other Sources of Lead

Other potential sources of lead exposure are cigarettes, cosmetics, and traditional medicine. We analyzed the lead content of cigarettes in samples of different Mexican and U.S. brands sold in Mexico (*13*) (Table 8). Results show that cigarette smoking may contribute to the lead body burden of smokers. Some cosmetics, such as eyeliner or kohl, contain lead and may be a source of exposure if used on a regular basis (*29*). Traditional medicines such as azarcon (used as a treatment for diarrhea) have a high lead content and have been related to lead intoxication in Mexican children (*30*).

Table 8. Lead content of tobacco sold in Mexico

Type	No. of samples	Range of lead content (mg/kg)
Cigar	30	2.23–25.46
Mexican cigarettes	30	0.91–14.690
American cigarettes	30	0.55–10.22
Pipe tobacco	30	2.40–6.27

Health Regulation on Lead in Mexico

In June 1991, the Mexican government signed the Agreement for Joint Actions for the integral solution of problems related to lead products that pose a risk to human health and the ecosystem (31). In addition, a national consultant committee for the establishment of regulations to prevent the use of lead has been established under the coordination of the Health Ministry.

Several regulations have been established to control different sources of lead exposure: pigments, glaze, and paint must carry a warning label if they contain lead (*32*); the lead content of toys, pens, colored pencils, playdough and other school equipment, cosmetics, furniture, and paints used for dwellings is regulated (<90 mg/kg) (*33*); and the lead content of high-temperature glazed ceramic ware and glassware is regulated (2.5–7.0 ppm) (*34*). Other regulations refer to the technichal aspect of determining soluble lead in different media (*31*). Also, the use of paint containing lead oxides and carbonates has been prohibited on road or sidewalk signals, and, since 1988, lead arsenate insecticide, which was used mainly on tobacco plantations, has been banned from Mexico (*35*).

Under the Agreement for Joint Actions, industries must withdraw the use of lead-soldered cans for foodstuffs and beverages (*36*). The solubility of the lead content of LGC has also been regulated (2.5–7.0 ppm depending on the type of utensil) (*37*). However, the regulation allows three years for its application, and during 1994, a solubility of 75–210 ppm will still be authorized (*37*). One of the possible alternatives is the substitution, in the production process, of low-temperature wood ovens with high-temperature gas ovens to avoid the release of lead from the glaze. However, the implementation of such a program requires a major investment. Another alternative could be the substitution of leaded glaze by an unleaded, nontoxic glaze that could provide the same characteristics as the leaded glaze. Although regulation has been established, there is a need for enforcement and development of alternative technologies to decrease the lead content of these utensils.

Conclusion

The lead content of environmental samples and the blood lead levels observed in different groups of the population indicate that lead exposure is still a major problem in Mexico. The blood lead levels that we observed were higher in residents of Mexico City than those from rural areas. Among children who lived in Mexico City, blood lead levels varied according to the socioeconomic level and the place of residency. The major predictors of blood lead levels across studies were the use of LGC to prepare foods or store juice, traffic in relation to place of residency, and the habit of biting colored pencils (Table 6). These findings point out that leaded gasoline and LGC play a major role in the population's exposure to lead.

Recently, several measures to decrease lead exposure have been implemented, and a decreasing trend in blood lead levels has been observed among some groups of the population in Mexico City (*31*). Nevertheless, the results presented emphasize the urgent need for strict regulatory policies for lead control to protect the Mexican population. In addition, there is a need for more extensive screening of the population to get a better estimate of the magnitude of the problem.

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