J. Phys. IV France **107** (2003)
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DOI: 10.1051/jp4:20030259

Determinants of blood lead levels in an adult population from a mining area in Brazil

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Abstract. During the last fifty years the Ribeira river valley, Brazil, had been under the influence of the full activity of a huge lead refinery and mining along the riverside. The plant completely stopped all kind of industrial activities at the end of 1995, and part of the worker population and their families still remain living nearby in small communities. The objective of the present study was to assess the determinants of blood lead levels (BLL) in these mining areas, where residual environmental contamination from the past industrial activity still remains. Blood samples of 350 adults aged 15 to 70, residing in areas around the mine and the refinery were collected. A questionnaire was given in order to gather information on food habits, current and former residential places, occupational activities, among other variables. Blood lead concentrations were analysed by graphite furnace atomic absorption spectrometry using Zeeman background correction. Logistic regression analysis was conducted to examine the independent contribution of selected variables in predicting BLL in those subjects. The following variables showed significant association with high BLL: residential area close to the lead refinery, former dwelling at the refinery village, male gender, smoking habits, and consume of fruits from home back yard.

1. INTRODUCTION

During the last fifty years the Ribeira river valley, in the Southern part of the State of São Paulo and East of State of Paraná in Brazil had been under the influence of the full activity of a huge lead refinery and mining along the riverside. The plant completely stopped all kind of industrial activities at the end of 1995, and part of the worker population and their families still remain living nearby in small communities. The objective of the study was to assess the determinants of blood lead levels in those mining areas, where residual environmental contamination from the past industrial activity still remains.

2. MATERIALS AND METHODS

The studied population was of 350 adults, aged between 15 and 70 years old, from three municipalities of Ribeira valley (Brazil). There were collected blood samples from June 1999 to June 2000. The subjects signed a well-instructed consent form authorizing the blood sample procedures. A standardized questionnaire was applied, aiming to get information on food consumption habits, leisure activities, current and former occupation, current and former dwelling place and conditions, and other issues.

The blood lead concentrations were determined by graphite furnace atomic absorption spectrophotometry with Zeeman background correction (model SIMAA 6000, Perkin Elmer). The samples were diluted 1:10 with 1% Triton X-100 in 0.1% nitric acid, and a mixture of ammonium dihydrogen phosphate and magnesium nitrate was used as chemical modifier.

Logistic regression models were used to correlate some independent variables to blood lead levels and to assess the especific effect of each adjusted variable by the others. The dependent variable was blood lead level, categorized as 14 μg/dl or greater and lesser [10]. The independent variables were gender (female or male), age (15-34 or over 34 years), residential area (mining community far from or near to the lead refinery), former dwelling at the refinery village (yes or no), alcohol consumption (yes or no), smoking habits (yes or no), daily consumption of milk (yes or no) and consumption of fruits from home backyard (yes or no).

3. RESULTS

The lead concentration in blood ranged from less than 1.8 μg/dl (limit quantification) to 48.70 μg/dl.There were significant differences in median blood lead levels in the population from mining area near to the refinery, mining area far from the refinery and non-exposed population (Table 1).

The logistic regression analysis was carried out using data from 350 adults. Five of the variables studied were independently associated to high blood lead levels in adults. For residential area (near to or far from lead refinery), the odds ratio (OR) was equal to 7.27 (2.61 to 20.24, 95% CI); for gender, OR was 18.36 (5.40 to 62.35, 95% CI); for variable former dwelling at the refinery village, the OR was 5.42 (1.88 to 15.59, 95% CI); for smoking habits, OR was 4.24 (1.44 to 12.48, 95% CI) and for consumption of fruits from home backyard, OR was 3.63 (1.32 to 9.97, 95% CI). The other studied variables did not show any association with blood lead levels (Table 2).

4. DISCUSSION

It became evident in this study that the vicinity to the lead refinery influenced in the blood lead levels. The lead refinery was shut down at the end of 1995 and there were no remediation activities at the site since then. Probably the association between the blood lead levels and the consumption of fruits grown in the backyard of the houses is related to the potential importance of contaminated soil as a lead exposure route through ingestion.

In this study, the gender was a variable with very strong association to blood lead levels. Several other authors, whose differences vary from study to study, comment on this subject [1,2,3,4,6,7,10,12,13]. Considering that the lead levels in blood are generally associated to the hematocrit levels, the more elevated concentration normally found in men when compared to the women can partially explain the higher levels of lead [1,3,6,12]. Probably the difference in the levels of lead in blood among the genders can also be explained by the higher potential risk of lead exposure among men due to a higher occupational exposure [1,12], to the differences in habits and behavior [1,6,12] and to the differences in the lead metabolism regulatory mechanisms [3]. In this study, 42,6% of men confirmed that they had worked in mines and/or in the lead refinery, and only 2,8% of women had worked in the refinery.

Compared to the smoking habit, some data in this study have been confirmed by a series of previous studies, and demonstrate that the smoking habit increases the levels of lead in blood in men and/or women [3,4,5,6,7,9,13]. It is accepted that the tobacco contains lead, and this contributes to the body load of the metal in smokers. Other hypothesis to be considered is the decreasing of pulmonary clearance in smokers, and this would increase the retention of lead particles, and make easy lead absorption.

The fact of the person has previously dwelt in the refinery village also has contributed to the body load of the metal.

In the present study the consumption of milk was not associated with blood lead levels although there is evidence demonstrating that absorption of lead through the gastrointestinal tract can be substantially reduced if the diet is relatively high in calcium [8].

5. CONCLUSION

In this study, the factors that influenced blood lead levels were dwelling near to the refinery, gender, former living at the refinery village, smoking habits and consumption of fruits from home backyard.

It became evident that the presence of lead refinery had great influence in the encountered blood lead levels in the population that was living in the vicinity of the same area. After its closure, approximately 3.5

years prior to the beginning of this study, there were still found high blood lead levels in these population when compared to the population from mining areas far from the refinery and the non-exposed population.

TABLE 1– Comparing blood lead levels among exposed and non-exposed adults (n=350) aged 15-70 years old, Ribeira valley in Brazil

VARIABLE	n	Median[a]	values[a]	Percentile[a]	P[b]
			min. - max.	25th - 75th	
RESIDENTIAL AREA					<0,0001
Exposed population: mining area near from the lead refinery	101	8,80	1,80 - 48,70	4,60 - 14,90	
Exposed population: mining area far from the lead refinery	209	2,80	1,80 - 24,20	1,80 - 4,50	
Non-exposed population	40	1,80	1,80 - 6,90	1,80 - 1,90	

[a]µg/dL
[b]Kruskal-Wallis test

TABLE 2 – Blood lead levels in adults with regard to some variables studied in a logistic regression analysis

Variables	Adjusted Odds Ratio	95% Confidence interval
Sex		
Female	1.00	
Male	18.35	5.41 – 62.35
Residential area		
Far from the lead refinery	1.00	
Near to the lead refinery	7.27	2.61 – 20.24
Former dwelling at the refinery village		
No	1.00	
Yes	5.43	1.89 – 15.60
Alcohol consumption		
No	1.00	
Yes	0.45	0.13 – 1.48
Smoking habits		
No	1.00	
Yes	4.24	1.44 – 12.49
Daily consumption of milk		
No	1.00	
Yes	1.13	0.22 – 5.92
Consumption of fruits from home backyard		
No	1.00	
Yes	3.63	1.32 – 9.98
Age		
15 to 34 years	1.00	
Over 34 years	0.69	0.23 – 2.08

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