Lead concentrations in whole blood, serum, saliva and house dust in samples collected at two time points (12 months apart) in Santo Amaro, BA, Brazil

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Whole Blood Lead Level (BLL) is the main marker used to verify lead contamination. The present study explores how BLL is associated with lead concentrations in serum, saliva and house dust. Samples were collected twice from Santo Amaro, BA, Brazil, a region that was contaminated by a lead smelter in the past; a time interval of 12 months was allowed between the two collections. It is noteworthy that the following measures have recently been taken to diminish exposure of the population to lead: streets have been paved with asphalt, and educational campaigns have been launched to reduce exposure to contaminated dust.

Results: Compared with the first time point, all the samples collected at the second time point contained lower lead concentration (p < 0.05), which suggested that the adopted measures effectively reduced exposure of the population to lead present in contaminated soil and dust. Statistically significant correlations only existed between lead in blood collected in the first year and lead in blood collected in the second year (Spearman’s r = 0.55; p < 0.0001; n = 62), and lead in house dust collected in the first year and lead in house dust collected in the second year (Spearman’s r = 0.5; p < 0.0001; n = 59).

Conclusions: Results support the validity of lead determination in blood and in house dust to assess lead exposure over time. However, lead in blood and lead in dust did not correlate with lead in serum or lead in saliva.

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1. Introduction

Lead is a well-known toxic metal that is usually associated with the enormous burden of social, financial, and medical/psychological issues faced by the population living in areas where it is or was smelted (Warren, 2000; Denworth, 2009; Markowitz and Rosner, 2013).

Blood lead levels are the golden standard to determine present...
exposure to lead. In children and adolescents, blood lead levels can partly reflect the current exposure and partly represent the endogenous exposure to lead stored in bone, which undergoes constant remodeling during growth (Barbosa et al., 2005). Therefore, albeit still exploratory, comparison of blood lead levels with other markers is interesting. For instance, Rezende et al. (2010) have reported correlations of lead in plasma and in serum. Costa de Almeida et al. (2009a) have also investigated the association between lead in saliva (a filtrate from plasma) and the degree of environmental pollution. Furthermore, to distinguish between past and current exposure, it is important to obtain the levels of lead in house dust. The impact of dust as a contributor to lead contamination in children is well known and has been recently discussed by Yoshinaga et al. (2014).

Santo Amaro, a town in the Brazilian state of Bahia, has 57,800 inhabitants (2010 census) and a human developmental index for municipalities of 0.646, according to IBGE, the Brazilian Institute of Geography and Statistics (BRASIL, 2014). A lead smelter operating from 1956 to 1993 contaminated this city (Carvalho et al., 2003; Machado et al., 2013). This company was a subsidiary of a French company (Penarroya Oxide) and was initially called COBRAC; its name was changed to PLUMBUM Co in the last years of operation. The same company also operated a plant in the Ribeira River Valley, on the border between the states of Sao Paulo and Paraná, in a city called Adrianópolis (PR). Reports of chronic environmental lead exposure also exist in the Ribeira River Valley (Paoliello et al., 2002). These two lead smelter sites are the ones with the highest levels of environmental lead contamination reported so far in Brazil (Paoliello and De Capitani, 2007). Reports on chronic lead contamination in the work place also exist, especially in connection with lead battery recycling plants (Paoliello and De Capitani, 2007). Indeed, some of these battery recycling plants do not rely on proper environmental control measures, and reports about the contamination of the population in the surroundings exist (Freitas et al., 2007; Costa de Almeida et al., 2007; de Almeida et al., 2008).

The lead company plant operating in Santo Amaro, BA, was located 3 km away from the city center, on Rui Barbosa Avenue. The chimney of the former plant still exists, and it is 80 m high (Fig. 1). The plant was destroyed, and the lead slag was encapsulated in 2000. However, in the 1990s, the lead slag had been used to pave streets; the slag had also been used as landfill throughout the town; particularly, the entire Rui Barbosa Street was paved using slag (where the study population lives). Together, these facts worsened lead contamination within the community. Many authors have investigated this contamination as well as the ineffective handling of this issue by public authorities (Andrade and Moraes, 2013).

According to Machado et al. (2013) analysis performed in 223 superficial soil samples from Rui Barbosa Street, in the metallurgy neighborhood, indicated that approximately 80% of them presented values above the lead limits established by CONAMA No. 420/2009 (Brazilian Resolution on soil elements accepted limits) for residential areas (300 mg/kg). It was also observed that 50% of the samples had concentrations above the limit set for industrial areas (900 mg/kg). For cadmium, 26.6% of samples presented values above the agricultural investigation limit (3 mg/kg), and 11.7% of the samples presented values above the residential investigation limit (8 mg/kg). Furthermore, the residue is typically composed of 3 to 4% by weight lead oxide (PbO), classified according to NBR 10004/2009 as a dangerous material (Anjos, 1998; Machado et al., 2004). Regarding lead in dust, Oliveira (2010) made a study on the dust concentrated in air conditioners. This study suggests that the amount of lead in dust is more related to heavy traffic than to distance to the former metallurgy. It also suggests that the slag might be the reason why high lead levels in dust are found throughout the city.

In recent years, efforts have been made to mitigate the effects of this contamination and even reduce lead levels in the environment. In 2010 (the first year of sample collection), digging was conducted on Rui Barbosa Avenue, to change the pipes in preparation for street paving with asphalt; paving occurred in 2011. Many scientists and health and environmental sciences experts have made suggestions on how to mitigate the contamination and reduce exposure. Paving back and front yards and repaving the streets to cover the slag were some of such measures. In 2013, the Brazilian Federal Justice Attorney required that the former companies clean the environment and pay compensations for the health problems caused to former employees (Environmental Justice Atlas: eiatras.org/conflict/lead-contamination-in-santo-amaro-bahia-brazil).

The aim of this study was to determine lead concentrations in whole blood, serum, saliva, and house dust at two time points (12 months apart), to find out whether these markers are associated, and to assess the effectiveness of the remediation measures taken by the authorities in recent years.

Fig. 1. Map of the city of Santo Amaro, BA, depicting the former lead smelter plant (upper left small square), with the white square inset showing the 80-meter high chimney that is still visible on site. The Rui Barbosa Avenue is also shown; collections were done mainly on this Avenue and nearby streets. The Subae River is indicated. In the far right low corner is downtown Santo Amaro. Scale = 200 m.
2. Materials and methods

2.1. Study population

This study protocol was approved by two Ethics Committees on Human Research (one in the State of Sao Paulo and one in the State of Bahia), subject to Resolution 196/96 of the National Commission of Ethics in Research. The parents or a guardian signed an informed consent form prior to inclusion of the child in the study.

In 2010, the study population included 99 children and adolescents. In 2011, the sample consisted of 75 children and adolescents, who had also been part of the group analyzed in 2010. The samples were taken in October 2010 and October 2011.

All the children lived in homes located close to the former lead smelter plant (< 2 km), most homes were located on the Rui Barbosa Avenue, in the urban area of Santo Amaro, BA (Fig. 1). Researchers visited the families and explained the purposes of the study; the informed consent was obtained from the parents/guardians, who signed the consent and subsequently answered a questionnaire about their child’s habits. On a later date, the researchers visited the houses again and collected blood and dust samples.

Information on pavement of the Rui Barbosa Street, years of residency in the house, use of slag in the yard etc had been collected in 2009 by a group that studies lead in soil, and residents of the entire Rui Barbosa Street were visited. On this street, 34/63 lots (54%) had slag used in their yards (as informed by the residents). Twenty eight % of the residents did not know this information. None of the houses included in this study had their yard cemented (to incapacitate the slag). This measure is slowly being adopted in the town, but in 2010 only 40/274 yards had been cemented (corresponding to 14.5%) (Rabelo, 2010).

2.2. Materials

Milli-Q water (resistivity 18.2 MΩ cm) (Milli-pore, Bedford, MA, USA) was used throughout the study. All the reagents were high-purity analytical grade. All the materials were washed in nitric acid-transfer pipettes, centrifuge tubes, plastic bottles, autosampler cups, and glassware materials were soaked in 10% v/v HNO₃ overnight, washed in 5 changes of MilliQ water, and dried in an oven (oven for drying on a laminar flow hood). All nitric acid used for analysis was double-distilled nitric acid.

2.3. Sample collection

2.3.1. Whole blood and serum

Before blood collection, the skin of the child was cleaned with 70% ethanol. Venous blood samples were collected in two 6-mL evacuated tubes. The first tube contained EDTA, for whole blood lead determination (TraceMetal Free EDTA Tube, Dark Blue Cap, Vacutainer BD, Becton-Dickinson, Brazil), and the second tube was ideal for serum collection (Trace Element Serum, plain/no preservative, Ref. 368380, Royal Blue Cap, Vacutainer, BD). Samples employed to measure Pb-serum were centrifuged between 1 and 4 h of sample collection (at 800 g, for 6 min at room temperature). The serum fractions were then pipetted into an ultraclean centrifuge tube (2 mL). All the samples were kept at ~20 °C until lead determination. At the time of analysis, the serum samples were examined with the naked eye, to observe the degree of hemolysis. In some samples, this occurred at separation. Slightly discolored samples were excluded from this study.

2.3.2. Saliva

Unstimulated saliva was collected by asking the child to spit for 5 minutes into a 50 mL Falcon Tube, which was later centrifuged to pellet and avoid cell and food debris. The mouth had been cleaned with tooth brushing before collection. A tooth brush and a tooth paste was distributed to the children, and the brushing was carried out by a pedodontist (C.S.G.) in children under 6 years of age. Small children that were unable to spit had their saliva collected by using a plastic Pasteur pipette that had been cleaned as described above.

2.3.3. Sample centrifugation and storage

Serum and saliva samples were transported from the collection to a lab, where they were centrifuged and the supernatant was stored in the refrigerator.

2.3.4. House dust

Dust was collected from three sites in each home, using a baby wipe that had been previously cleaned in the same way as described above for all the other materials (wipes were soaked in HNO₃ overnight, washed in 5 changes of MilliQ water, and dried in a Class 100 hood). The collection method followed the NIOSH protocol for performing spot tests on wipes. Three wipes were collected in separate rooms of each home (bedroom, living room, and kitchen). A 0.3x0.3 m² square area was defined with tape on the floor for dust collection with the wipes. Collection was done using “S” shape movement.

Prior to analysis, the wipes were digested using a microwave reaction system (Microwave 3000, Anton Paar, Ashland, VA, USA). Glass tubes were cleaned by immersion in nitric acid and copious washing in MilliQ water, as stated for all materials.

Two hundred milligrams of wipe cut into pieces was inserted into the glass tubes with 7 mL double-distilled HNO₃ plus 1 mL H₂O₂ (Supra Pure from Merck). Complete digestion was obtained using a program with a hold of 11 min at 250 °C, then a hold of 5 min at 450 °C, and the final hold of 5 min at 600 °C (holds were preceded by a 5 minutes-ramp and a 1 min exhaust). Thereafter samples were diluted with the Magnesium matrix modifier (Mg(NO₂)₂, 5H₂O prepared in 17% HNO₃ (v/v)) and the Palladium modifier (Pd(NO₂)₂ in 5% HNO₃ (v/v) prepared as follows: 100 ul of the Magnesium matrix modifier + 1000 ul of the Palladium modifier and water to 10 mL. Samples were then analyzed for lead by graphite furnace Atomic Absorption Spectrometry (GFAAS) (AANalyst 600, Perkin-Elmer, USA) in the Department of Morphology, Physiology, and Basic Pathology at the Faculty of Dentistry of Ribeirao Preto, University of Sao Paulo, Campus of Ribeirao Preto (FORP-USP).

2.4. Chemical analyses

All the samples were stored and analyzed together at the end of the study. Lead levels in whole blood and dust were measured by GFAAS (AANalyst 600, Perkin-Elmer, USA) in the Department of Morphology, Physiology, and Basic Pathology at the Faculty of Dentistry of Ribeirao Preto, University of Sao Paulo, Campus of Ribeirao Preto (FORP-USP). Lead in blood was measured according to the method described by Parsons and Slavin (1993). Method detection limit for lead in blood by GFAAS measurements (s/3) was based on the analysis of 10 base blood samples (SRM 955c level 1) and taking in account 1 + 9 dilution factor.

Lead levels in serum and saliva were determined at the Laboratory of Metals Toxicology, Faculty of Pharmaceutical Sciences of Ribeirao Preto, University of Sao Paulo, in Ribeirao Preto (FCRP-USP), by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) (Perkin-Elmer Elan DRC II). The detection limit for lead was 1 µg/dL, 0.01 and 0.02 µg/L for whole blood, serum and saliva, respectively.

The reference materials were diluted and processed in the same way as the samples; it was assayed after every ten samples.
NIST (Standard Reference Material) 955c Lead in Caprine Blood was used in this study when running blood samples, particularly the two lower standards, with 0.424 μg/dL and 13.95 μg Pb/dL of blood. For lead in dust, the reference material used was NIST SRM 2586-Trace Elements in Soil Containing Lead from Paint (containing 432 ± 71 mg/kg), with a dilution that resulted in a 10 mg amount/sample. The calibration curves were prepared with a lead solution in water (1000 mg/L) from Merck.

2.5. Educational measures aimed at reducing exposure to lead

One week prior to the collections, during the interview with the families and the collection of the informed consent, measures to reduce lead in the house and yard environment were discussed with the families, and given to them in writing. Those were among others: the need to reduce the opportunity of the children to play with soil (and try to completely avoid this), the need to reduce dust in the housed by cleaning surfaces of furniture and floors with a wet wipe several times a week, and the need to wash hands and change towels often.

2.6. Statistical analysis

The distribution of all the continuous variables was analyzed for normality, to select the appropriate statistical method. Correlations between Pb-blood, Pb-serum, Pb-saliva, and Pb-dust were tested using Spearman’s correlation. A probability level of 5% was applied (0.05 divided by the number of comparisons: 18 that are biologically and toxicologically relevant). Statistical analyses were performed using the Graph Pad Prism (Version 3.0).

3. Results

Table 1 lists data on the sample size collected in each year, the medians, the 25th percentile, the 75th percentile, the minimum and maximum values, the mean, CI95%, and standard deviations, and the normality test results. This study started with 99 children aged from two to 16 years, but it was not possible to collect all the types of samples (whole blood, serum and saliva) from every child. The mean age of the children at the start of the study was eight years and 7 months. In 2010, 52 boys and 47 girls participated in this study.

Fig. 2 contains a graphical comparison of all the values of lead in blood (blood lead levels, BLL) for samples collected in 2010 (n = 99) and 2011 (n = 67). Comparison of the results obtained in 2010 with results achieved in 2011 (12 months later) indicated that lead concentrations decreased significantly in the children that participated in this study (p < 0.0001, Mann–Whitney test). The difference remained statistically significant when only the 62 paired values were assessed; that is, the values obtained for samples collected from the same participant in both time points. Medians (Q1; Q3, and n) for the 2010 samples were 3.4 μg/dL (2.8; 4.7, n = 99) and 3.4 μg/dL (2.8; 4.7, n = 62). For the 2011 samples, medians (Q1; Q3, and n) were 1.04 μg/dL (1.04; 2.7, n = 67) and 1.04 μg/dL (1.04 2.7, n = 62), showing that dropout did not underlie the observed reduction in whole blood lead concentrations.

Fig. 3 displays the values of lead in serum for samples collected in Santo Amaro, BA, in 2010, and 12 months later, in 2011. The values did not present normal distribution. The medians (Q1; Q3) were 0.50 μg/L (0.31; 0.91) and 0.09 μg/L (0.04; 0.13) for 2010 and 2011 serum samples, respectively. Indeed, values were significantly lower in the second collection (p < 0.0001), regardless as to whether the analysis included all the data or only the paired data.

Fig. 4 shows the values of lead in saliva for samples collected in Santo Amaro, BA in 2010 and 2011. The values did not show normal distribution. The medians (Q1; Q3) were 5.00 μg/L (1.00; 12.5)

![Fig. 2. Blood lead levels (BLL) expressed as μg/dL found in samples collected in 2010 (n=99) and 1 year later (n=67). Values from 2011 are significantly lower than the values observed in 2010. *p < 0.0001, Mann–Whitney test.](image)

![Fig. 3. Displays the values of lead in serum for samples collected in Santo Amaro, BA, in 2010, and 12 months later, in 2011. The values did not present normal distribution.](image)

![Fig. 4. Displays the values of lead in saliva for samples collected in Santo Amaro, BA in 2010 and 2011. The values did not show normal distribution.](image)

Table 1

<table>
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<td>&lt; 0.01</td>
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<td>No</td>
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Ribeirão Preto, SP, 2012.
for 2010, and 0.82 μg/L (0.1; 0.4) for 2011. Also, the results of lead in saliva were lower in the second year (p < 0.001).

Comparisons shown in Figs. 2–5 were analyzed using paired analysis, but unpaired analysis also resulted in significant differences.

We determined lead in wipes that were used to obtain dust from a 0.3 × 0.3 m square. Lead is expressed as the mass/area, i.e., micrograms per square meter (μg/m²). The lead measured in dust confirmed the trend verified in the other analyses regarding the decrease in lead concentrations on going from 2010 to 2011. Fig. 5 brings the results for lead in house dust (mean of three wipes collected in separate rooms of the house). Lower lead values emerged in 2011 as compared with 2010 data (p < 0.0001). Like most variables in this study, the values did not follow a Gaussian distribution; the medians (Q1; Q3, and n) for were 87.78 (51.56; 167.78, n = 82) and 20.56 (10.67; 35.22, n = 64) for 2010 and 2011, respectively.

Table 2 summarizes the correlation values. Only BLLs in 2010 and 2011 (shown in Fig. 6) and in the house dust in 2010 and 2011 correlated significantly (p = 0.0001 for both correlations). Those 2 correlations remained significant after Bonferroni correction (0.05 divided by 18 comparisons, p = 0.0031).

It is noteworthy that BLL correlation relied on 62 pairs; that is, we were able to obtain blood samples from the same 62 participants in 2010 and 2011 (Spearman’s r = 0.56 and p < 0.0001). The one sample that showed BLL above 10 μg/dL did not affect the results appreciably: without these two values, we achieved Spearman’s r = 0.53 and the p value was the same.

In 2011, the mean age of the children enrolled in this study was 9 years and 9 months.

For all the types of samples used in this study, we collected a reduced number of samples in the second year, this is particularly true for blood. This happened because some parents/guardians failed to see that a second collection was important, or because the participant moved from the study site.

4. Discussion

Data from this study showed that lead levels decreased from 2010 to 2011 in the city of Santo Amaro, BA, as attested by the different biomarkers tested here. For this investigation, we determined lead in whole blood, serum, saliva, and house dust. The last sample did not consist of a biological sample collected from the children, so it served to corroborate the trend toward lower lead concentrations on going from the year 2010 to 2011. If it were not for the results obtained with the dust samples, we would not be sure whether the lower lead concentrations were related to the children’s growth or to a real change in the environment. This indicates that paving the Rui Barbosa Avenue contributed to mitigating the impact of the contamination.

Santo Amaro, BA, is a town where former employees of the lead smelting plant still live. Some publications (Carvalho et al., 2003; Machado et al., 2004; Andrade and Moraes, 2013) and many talks in the city have dealt with the risk of undue exposure to high lead levels due to the lead-contaminated rejected material (slag form of
the refining process) left uncovered for decades on the ground at
the plant site and encapsulated only a decade ago (Machado et al.,
2013; Magna et al., 2013). To make matters worse, the munici-
pality authorities used the rejected material contaminated with
lead to pave the streets on many occasions in the past.
The results presented here are consistent with decreased ex-
posure to lead in the tested population. Since the shutdown of the
plant during the 1990s, consecutive epidemiological studies have
reported significantly lower BLL (Blood lead levels) in children,
from 59.1 μg/dL (SD=25) in 1985, during full operation of the re-
fining plant, to 17.1 μg/dL (SD=7.3) in 2003, 10 years after the end
of all plant operations (Carvalho et al., 2003). At the same time
that the declining BLLs indicate that exposure has diminished, and
that not so many children have BLL above 5 μg/dL, which is the
current definition of elevated BLL proposed for children in the U.S.
A. (Binns et al., 2007; ACCLPP-CDC, 2012. Therefore, even though
the results suggest a successful outcome, they should motivate the
community and health authorities to act aiming to reduce
exposure.

Although the median BLL of 3.4 μg/dL in 2010 may be con-
sidered higher than reference values produced in a cohort of six-
to-eight-year-old children from Ribeirao Preto, SP (median: 2.2 μg/

**Table 2**

Correlation values between lead concentrations found in samples of individuals aged from two to 16 years. Whole blood, serum, saliva and house dust were collected in Santo Amaro, BA, in October 2010 and October 2011. Spearman’s r is shown. Ribeirao Preto, SP, Brazil, 2014.

<table>
<thead>
<tr>
<th></th>
<th>Blood 2010</th>
<th>Serum 2010</th>
<th>Serum 2011</th>
<th>Saliva 2010</th>
<th>Saliva 2011</th>
<th>Mean Lead in 3 House Dust samples 2010</th>
<th>Mean Lead in 3 House Dust samples 2011</th>
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<td>r=0.56 n.s.</td>
<td>p&lt;0.0001 n=89</td>
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<td>Mean House Dust 2010</td>
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*Spearman r is shown.*

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**Fig. 5.** Mean of lead in dust obtained with wipes in 3 rooms of the houses. Lead content is expressed as the mass/area, i.e., micrograms per square meter (μg/m²). The house areas were the living room, the kitchen and the child’s bedroom. Collections were done in October 2010 (n=82 houses) and October 2011 (n=64 houses). *p<0.0001 for the decrease in lead found in 2010 versus 2011.

**Fig. 6.** Correlation between BLLs from children aged 2–16 living in Santo Amaro, BA, in 2010 and 1 year later, in 2011. A moderate significant correlation was found (Spearman’s r=0.55; n=62; p<0.0001).
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Using correlations and simple comparisons. Multivariate analyses could have been used. However, in our view, the results presented are robust, and may contribute for future work on lead in our country. The few correlations found make sense from a biological and toxicological point of view, and may therefore indicate important aspects for further studies for those aiming at comparing lead in multiple fluids and in dust.

Unfortunately, despite these promising data, the lead already stored in the bones of the investigated children may reenter the circulation during intense growth periods. In other words, in the children that participated in this study, a growing population, BLLs may change and even increase, so regular and continuous BLL monitoring is mandatory. Based on results from primary teeth collected in the city of Santo Amaro in the years 2007–2009, we have data showing that 8% of the teeth collected in the different parts of the city have high levels of lead (when compared with the distribution of hundreds of teeth that we have determined over the years, with particular interest in the outer enamel) (Guerra, 2010). This clearly demonstrates that biomarkers that mimic bone reveal high levels of lead, which is not an unexpected finding at all. Indeed, the excellence of primary teeth as markers of past exposure to lead is well known when lead levels in dentine are used with standard analytical techniques for lead determination. Dentine lead levels were crucial to determine that chronic exposure to lead had negative effects on school performance of children (Needleman et al., 1979). Nonetheless, we have been working with lead determination in the superficial enamel in the past decade, and the outer enamel is also a good marker of past (probably cumulative) exposure to lead (Gomes et al., 2004; Costa de Almeida et al., 2007; de Almeida et al., 2008; Costa de Almeida et al., 2009b; Costa de Almeida et al., 2011; Molina et al., 2011), and it seems that extreme care has to be taken regarding the selection of the methodologies to determine lead, since even extra sensitive methodologies like synchrotron-radiation induced X-ray fluorescence is not in the least comparable to the excellency of the determination of lead in solutions of superficial enamel obtained by successive acid etches and measured by GF-AAS or ICP-MS, where lead is highly concentrated (de Souza Guerra et al., 2014).

Results shown in this study suggest that measures such as paving contaminated soil and educational campaigns succeeded in decreasing exposure to lead in the target community, as attested by the lower BLLs found in the studied population. However, it will only be possible to accurately assess the true toxicological risk connected with exposure to lead of children that live and grow in Santo Amaro if a long-term biomarker of lead body burden is available. Nowadays, bone constitutes the best of such markers (Barbosa et al., 2005), but such analyses are only done for research and are not yet used for surveillance purposes. We are currently working on the analysis of dentin and enamel collected from these children, to gain further insight into the degree of exposure of this growing population, BLLs may change and even increase, so regular and continuous BLL monitoring is mandatory. Based on results from primary teeth collected in the city of Santo Amaro in the years 2007–2009, we have data showing that 8% of the teeth collected in the different parts of the city have high levels of lead (when compared with the distribution of hundreds of teeth that we have determined over the years, with particular interest in the outer enamel) (Guerra, 2010). This clearly demonstrates that biomarkers that mimic bone reveal high levels of lead, which is not an unexpected finding at all. Indeed, the excellence of primary teeth as markers of past exposure to lead is well known when lead levels in dentine are used with standard analytical techniques for lead determination. Dentine lead levels were crucial to determine that chronic exposure to lead had negative effects on school performance of children (Needleman et al., 1979). Nonetheless, we have been working with lead determination in the superficial enamel in the past decade, and the outer enamel is also a good marker of past (probably cumulative) exposure to lead (Gomes et al., 2004; Costa de Almeida et al., 2007; de Almeida et al., 2008; Costa de Almeida et al., 2009b; Costa de Almeida et al., 2011; Molina et al., 2011), and it seems that extreme care has to be taken regarding the selection of the methodologies to determine lead, since even extra sensitive methodologies like synchrotron-radiation induced X-ray fluorescence is not in the least comparable to the excellency of the determination of lead in solutions of superficial enamel obtained by successive acid etches and measured by GF-AAS or ICP-MS, where lead is highly concentrated (de Souza Guerra et al., 2014).

5. Conclusions

Concerning the area of Santo Amaro, BA, Brazil, located near a former lead smelting plant, as well as homes localized on Rui Barbosa Avenue, this study showed that lead concentrations found in the participants’ blood and, serum and saliva decreased from 2010 to 2011; lead amount in house dust samples also diminished. The structural measure of paving streets, as well as the educational measures to reduce exposure to the contaminated dust are the


