Blood levels of metallic chemical element exposure patterns and associated factors in a population living in an Industrial District in Brazil

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INTRODUTION

Natural and industrial exposures to metals continue to be prevalent, and environmental and occupational exposures to metals are a concern for public health, especially where there is less stringent environmental and labor legislation [1]. In Brazil, industrial activities are critical sources of environmental pollution [7,8], and steel mills are among the most polluting. In 2010, a steel mill was established in Santa Cruz, Rio de Janeiro-RJ [31]. In 2012, episodes of silver rain occurred in the area, due to the storage of pig iron without any control by the company. After the silver showers, the local population reported health problems, raising concerns about possible environmental and health impacts [33]. Considering the lack of HBM studies in Brazilian populations residing near Steel companies, in 2016 we conducted a cross-sectional study aiming to biomonitoring the population residing in this vicinity, in Santa Cruz [11] and to estimate the level of metallic chemical elements in this population; and estimate the association between the residence distance from the Steel company and these blood elements concentrations patterns.

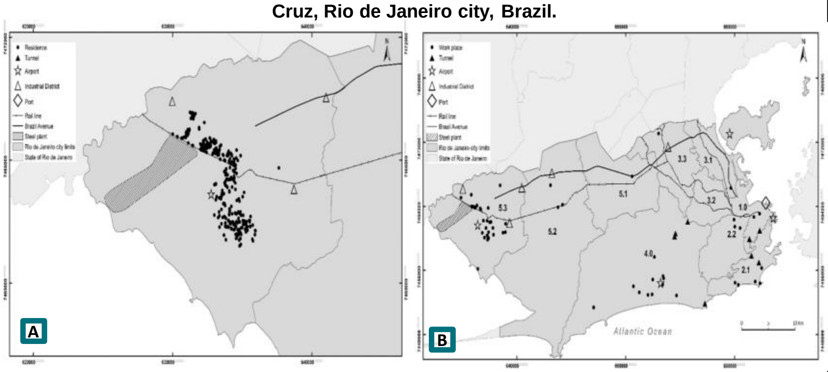
MATERIALS AND METHODS

Study design: Santa Cruz was divided into 3 zones according to the health units to characterize the different scenarios of exposure for the population residing in the area [11]; A cross-sectional study carried out in a population residing in the Steel company vicinity, to assess exposure to metallic chemical elements, such as arsenic, aluminum, barium, and others, and the effect of distance from the company in the blood metallic chemical concentrations. **Strata-I:** exposed area included residences up to 9.18 km from the Steel company, covering the six micro-areas.

Study population: sampling was performed for strata-I and distributed proportionally in the six micro-areas. We included 463 individuals aged 18+ years, of both sexes, residing 1+ years in the Steel company vicinity, who were selected through simple random sampling based on a residents' list obtained from the Family Health Strategy Program (FHSP), matched by sex and age (+ 5 years), were able to understand and answer the questionnaire. Based on a metal exposure prevalence of 0.5, a confidence level equal to 0.95, an admissible error of 0.04, and an estimation of refusals of 0.30.

Data collection: occurred from January 2017 to March 2020, including the interview and blood sample collection for metallic element concentration analyses, within 15 days after the interview.We analysed sociodemographic characteristics, household conditions, occupational and non-occupational exposures, blood metallic chemical elements concentrations, and distances (Km), georeferenced by GPS, from residence (A) and workplace (B) to the Steel company, tunnel, highway, and railway. Mg, Be, Co, Ba, Ni, Cd, Al, and Pb were assessed in blood by DRC-ICP-MS. Metallic chemical elements concentrations patterns were obtained by exploratory factor analysis in the studied population. Outcome was set as the positive factor loadings in the factor analysis, including Mg and Be (Factor-1), Co, Ba and Ni (Factor-2), Cd, Al, Pb(Factor-4). Crude and adjusted odds ratios (OR), and their respective confidence interval (95% CI), were estimated to explore associations between independent variables and the exposures to metallic elements positively associated to the factors using polychotomous logistic regression.

Distribution of participant's residence (1 A) and workplace (1B) addresses in Santa Cruz, Rio de Janeiro city, Brazil.



RESULTS

From 463 participants recruited between 2017 and 2020 in the 6 micro-areas of strata-I, the mean age ranged from 46.8 in micro-area 3–51.5 years in micro-area 6, 54 % were female, with the majority coming from the Southeastern Region (88.7 %). A reduction of 19% was found between each km distance from the residence and the steel company and P50 concentration of Cd, Al and Pb (ORP50=0.81; 95%CI:0.67-0.97), after adjusting by age, sex and smoking. No statistically significant associations were observed for the distance from residences and the steel company, after adjusting for age, gender, having a domestic vegetable garden and chewing gum for Mg and Be concentrations (Factor-1) (ORP50=0.84; 95%CI:0.70- 1.01; ORP75=1.10; 95%CI:0.91-1.34); nor for Co, Ba and Ni (Factor-2) blood concentrations (OR ORP50=1.10; 95%CI:0.91- 1.33; OR ORP75=1.03; 95%CI:0.84-1.26), in the adjusted analysis

Multivariate polychotomous analysis for the association between residence distance from Steel Company and metallic chemical elements, adjusted by sociodemographic, occupational, and other environmental exposures. Santa Cruz, Brazil.

Variables	Mg, Be (Factor-1)		Co, Ba, and Ni (Factor-2)		Cd, Al, and Pb (Factor-4)	
	P50 *OR(95% CI)	P75 *OR(95%CI)	P50 *OR(95% CI)	P75 *OR(95% CI)	P50 *OR (IC95 %)	P75 *OR (IC95 %)
Distance between the residence and Steel company	0.84 (0.70–1.01)	1.10 (0.91–1.34)	1.10 (0.91–1.33)	1.03 (0.84–1.26)	0.81 (0.67–0.97)	0.96 (0.78–1.17)
Age	1.00 (0.98–1.01)	0.99 (0.98–1.01)	1.01 (0.99–1.02)	0.99 (0.98–1.01)	1.01 (0.99–1.02)	1.01 (0.99–1.03)
Sex						
Female	1.12 (0.72–1.75)	1.54 (0.95–2.49)	1	1	1	1
Male	1	1	2.57 (1.58–4.18)	3.71 (2.19–6.29)	2.50 (1.56–4.02)	2.70 (1.62–4.50)
Domestic Vegetable garden						
No	1	1	-	-	-	-
Yes	**0.34 (0.15–0.75)**	**0.36 (0.16–0.86)**	-	-	-	-
Chewing Gum			-	-	-	-
Not consume	1	1	-	-	-	-
1 x / month	1.53 (0.49–4.83)	**3.72 (1.29–10.79)**	-	-	-	-
>= 2 x / month	0.84 (0.39–1.81)	1.18 (0.54–2.56)	-	-	-	-
Number of occupational and non-occupational exposures						
No exposure	-	-	1	1	-	-
At least one exposure	-	-	**0.49 (0.27–0.89)**	**0.40 (0.21–0.74)**	-	-
Smoking						
Never smoked	-	-	1	1	1	1
1–6 pack year	-	-	1.14 (0.60–2.16)	1.34 (0.68–2.65)	1.08 (0.58–2.03)	1.74 (0.90–3.35)
> 6 pack year	-	-	0.61 (0.30–1.21)	1.44 (0.72–2.86)	1.19 (0.52–2.71)	**4.46 (2.08–9.58)**
Existence of a highway near the workplace						
No / not working	-	-	1	1	-	-
Yes	-	-	0.50 (0.21–1.19)	0.89 (0.39–2.02)	-	-
Vitamin intake						
No	-	-	1	1	-	-
Yes	-	-	0.63 (0.32–1.26)	1.06 (0.54–2.08)	-	-

*OR adjusted for age, sex, and other variables in the model

CONCLUSIONS

The present study showed that there is a 19 % reductionin the concentration of Cd, Al, and Pb for each km of distance from the residencies to the Steel company in Santa Cruz, RJ. The study's RVs for Pb, Cd, Al, Ni, and Co were above the international RVs. Therefore, people living in a Steel company vicinity are at higher risk of metal exposure, regardless of the complex interaction between sociodemographic factors, lifestyle habits, and working conditions.

Disclosure: The authors declare no conflict of interest

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