www.scielo.br/rbepid

Revista Brasileira de Epidemiologia

https://doi.org/10.1590/1980-549720220003.supl.2

ORIGINAL ARTICLE

Protocol of the Longitudinal Study on Child Health in Brumadinho (MG): "Bruminha Project"

Protocolo do estudo longitudinal de saúde infantil em Brumadinho (MG): Projeto Bruminha

Carmen Ildes Rodrigues Fróes Asmus[I], Aline de Souza Espindola Santos[I], Renan Duarte dos Santos Saraiva[I], Ana Paula Natividade de Oliveira[II], Ivisson Carneiro Medeiros da Silva[I], Maíra Lopes Mazoto[I], Michele Alves Costa[I], Volney de Magalhães Câmara[I]

[I]Universidade Federal do Rio de Janeiro – Rio de Janeiro (RJ), Brazil.
[II]Fundação Oswaldo Cruz – Rio de Janeiro (RJ), Brazil.

ABSTRACT

Objective: To present the research protocol and to describe the preliminary results of the Bruminha Project. **Methods:** This project is part of the set of health actions proposed under the Brumadinho Health Project. It is a prospective cohort study with periodic follow-ups for four years. The eligible population was all children aged 0 to 6 years living in four rural communities of the affected municipality. Sociodemographic and health data were collected, as well as urinary samples, for assessment of exposure to metals. **Results:** In the first year of study, we evaluated 62% (217) of the eligible population and collected 172 (79%) valid urine samples. At least one metal was detected in all samples, and in 50.6% (n=87) or them, the metal concentration was higher than the reference value. In 38% (n=82) of the children, neuropsychomotor development was considered at risk. Report of respiratory allergy was four times (4.27) more frequent and of bronchitis 62% higher (1.62) in children living in locations exposed to dust from ore residues, compared to those living more than 10 km away from the site of the dam disaster. **Conclusion:** The study protocol was proven adequate to evaluate the proposed outcomes. The strategy used for population selection required adjustments regarding the long-term community awareness process, with new participants in the upcoming follow-ups (2022 and 2023).

Keywords: Environmental disasters. Cohort studies. Metals. Child health.

CORRESPONDING AUTHOR: Carmen Ildes Rodrigues Fróes Asmus. Rua Jorge Emilio Fontenelle, 758, apto 301, Recreio, CEP: 22790-147, Rio de Janeiro (RJ), Brasil. E-mail: carmenfroes@medicina.ufrj.br

CONFLICT OF INTERESTS: nothing to declare

HOW TO CYTE THIS ARTICLE: Asmus CIRF, Santos ASE, Saraiva RDS, Oliveira APN, Silva ICM, Mazoto ML, et al. Protocol of the Longitudinal Study on Child Health in Brumadinho (MG): "Bruminha Project". Rev Bras Epidemiol. 2022; 25:e220003.supl.2. https://doi.org/10.1590/1980-549720220003.supl.2

Received on: 07/13/2022
Reviewed on: 08/23/2022
Accepted on: 08/29/2022

INTRODUCTION

The Longitudinal Study of Child Health in Brumadinho, the so-called "Bruminha Project", developed by Universidade Federal do Rio de Janeiro (UFRJ), is part of the Program of Integrated Actions in Health of Brumadinho[1], proposed and funded by the Ministry of Health of Brazil and coordinated by Fundação Oswaldo Cruz (Fiocruz) from Minas Gerais. The Bruminha Project aims to investigate exposure to metal residues and its impacts on the health and development of children aged 0 to 6 years living close to the area affected by the disaster[2].

This article presents the research protocol and sociodemographic, health profile, and data regarding exposure to metal residues of the population of the Bruminha Project.

METHODS

Study design and population

This is a prospective cohort study with annual follow-ups, whose population consisted of all children aged 0 to 6 years living in the localities of interest, that is, the rural area of the municipality of Brumadinho, from 2021 to 2025, whose respective guardians consented to their participation.

Targeted locations

The Bruminha Project does not cover all neighborhoods/localities of Brumadinho[3]. The places of interest for this study were considered: Córrego do Feijão, Parque da Cachoeira, Tejuco and Aranha. The map with locations of interest is in the Supplementary Material.

Córrego do Feijão and Parque da Cachoeira were directly affected by the 2019 disaster, as there are households within a radius of up to 1.5 km from the path covered by the mud and because the tailings are deposited there. The populations residing in the aforementioned locations have been exposed to dust from the mud residues since the disaster occurred because of rescue activities and, afterwards, because of remediation activities, which persist to date.

Tejuco was included due to its geographical position, below an active mining area, with potential exposure of its population to dust originating from this process.

Aranha is located about 10 km from the tailings mud, 11.6 km from Córrego do Feijão, 11.3 km from Parque da Cachoeira, and 15.8 km from Tejuco. As it is farther from the disaster site, it was considered a location whose population would not possibly have been exposed to dust from the sedimented mud tailings in the disaster area, originating from the mobilization of waste during damage remediation activities.

Study population selection strategy

The municipality of Brumadinho is widely covered by the primary care network, with all families in this territory registered in the Family Health Strategy[4]. The selection of the study population took place in conjunction with the Municipal Health Department and community leaders.

Community health agents scheduled appointments with the mothers or guardians of children for the interviews and other assessments provided for in the project. The children were brought by their guardians to health centers or community centers in the studied locations, where the questionnaires and tests were administered by the research team and urine samples were collected by the hired laboratory team.

Data collection

Sociodemographic and health data

Two questionnaires were applied during interviews to parents/guardians of the participating children: a socio-environmental questionnaire and a clinical form. Both were adapted from the general questionnaire and respiratory events questionnaire of the PIPAUFRJ Project (https://pipaufrj.me.ufrj.br/). A pre-test of the socio-environmental questionnaire was carried out on a subsample of the study population, and the flaws and imperfections identified were corrected and added to the final questionnaire.

The socio-environmental questionnaire comprises seven blocks of questions:

- Block 1: Identification and contacts;
- Block 2: Sociodemographic characteristics, education (mother) and family income;
- Block 3: Home characteristics and surrounding environment;
- Blocks 4 and 5: Identification and education of the child;
- Block 6: Habits and behavior of the child;
- Block 7: Eating habits[5].

The clinical form comprised: the child's previous health conditions, including hospital admissions and/or illnesses and medication use; birth data, extracted from the child's medical record (weight, length, head circumference, Apgar score, gestational age and size for gestational age); perception of parents/guardians of the child's health; and record of respiratory signs and symptoms before and after the disaster.

Anthropometric assessment included: measurements of weight and length/height, with calculation of body mass index (BMI) according to the World Health Organization's development pattern charts[6]; and measurement of head circumference in children up to two years old.

The Denver II developmental screening test was applied to all children to assess their neuropsychomotor development. It consists of a set of 125 items representing skills in four areas of development (personal-social, fine-adaptive motor, language and gross motor development). It is applied by having the child perform tasks and by the report

of their caregivers/parents, to verify their abilities in four domains, defined as follows:

- ability to socialize and self-care;
- fine motor coordination;
- recognition, understanding and use of language;
- motor control of large muscles, used for sitting, walking, balancing, and other functions.

As a screening tool, the Denver II test provides information that signals whether the child's current development status is in line with the expectations for their age group, alerting to the presence of possible development limitations that imply the need for further investigation and/or specialized monitoring, not aimed at elaborating diagnoses[7].

The Modified Checklist for Autism in Toddlers (M-CHAT), in turn, was applied to children over two years of age as a screening tool for signs of risk for autism spectrum disorder[8].

The Swanson, Nolan and Pelham-IV Scale (SNAP-IV) was applied to children aged five years or older as an auxiliary diagnostic tool for attention deficit hyperactivity disorder[9,10].

The Modified Ashworth Scale (MAS) was applied to all children to assess their muscle tone[11-14].

Biological Samples

Collection and Transportation

The children's urine samples were collected in metal-free containers to measure the concentrations of total arsenic (As), cadmium (Cd), lead (Pb), mercury (Hg) and manganese (Mn), and were kept refrigerated and transported to analysis in thermal boxes with temperature control under the responsibility of the laboratory. Parents/guardians were oriented about not using ointments or talc in the genital region of children on the eve of sample collection and about hygiene measures before collection. Collector recipients were provided to parents, and, while in children under two years of age a collection bag was placed by the laboratory staff.

Methodology for Metal Analysis

Metal analyses were performed by method inductively coupled plasma mass spectrometry (ICP-MS), brand Agilent, model ICPMS7850. The samples were prepared using diluted acid and Internal standard addition (ISA). The standards used were multi-element calibration standard 2A, Agilent (8500-6940 and 8500-6940 HG), and the internal standard Mix, Agilent (5183-4681). The limits of detection and quantification for As, Cd, Pb, Hg and Mn were 0.1 µg l-1. The Laboratory "Associação Fundo de Incentivo à Pesquisa" (Research Incentive Fund Association) was responsible for the analysis; it has level 3 accreditation from the National Accreditation Organization and is certified by the International Society for Quality in Health Care.

Quality Analysis

The analytical runs for dosage of metals were monitored using five levels of internal quality control, with three controls prepared by the laboratory itself, at pre-established concentration levels, and two ClinCheck commercial controls or by the National Quality Control Program (PNCQ). The maximum variation allowed for each control was 15%, according to Resolution 27/2012 of the Collegiate Board of Directors. The average monthly coefficient of variation (CV%) obtained for each analyte ranged from 5.3 to 7.1%.

Creatinine Dosage

Urinary creatinine was measured using Siemens Atellica® CH Analyzer biochemical analyzers, through picric acid reaction with creatinine in alkaline medium (Jaffe procedure). The sensitivity of the test was determined by the value of 3 mg/dL, which is the limit of quantification for urine. The reference range used was 0.3 to 3 g/L.

Reference Values Adopted for Selected Metals

The reference values (RV) adopted for urinary concentrations of As (10 µg/gr of creatinine), Cd (2 µg/gr of creatinine) and Hg (5 µg/gr of creatinine) were those established by Regulatory Norm (NR) 7 (1994), in force during the study period (July 2021)15. For Mn concentrations, the RV adopted was based on the recommendation of the Agency for Toxic Substances and Disease Registry (1 to 8 µg/L)16. The RV adopted for urinary Pb concentrations was based on the study carried out by Saravanabhavan et al.17 (1.7 µg/L). Urinary metal concentrations were adjusted for creatinine levels (0.3 to 3 g/L).

Data Analysis

Data were analyzed using proportions, frequencies, arithmetic means, maximum-minimum, standard deviation and confidence intervals (95%CI). For the variables age, education and per capita income of mothers or guardians, a filter was applied to the database to contain duplicates, given that a mother can have more than one child. The proportion ratio was calculated for the occurrence of respiratory complaints and abnormal results (failures) in the Denver test, with children living in Aranha as reference group.

Ethical Considerations

This study was approved by the Research Ethics Committee of Hospital Clementino Fraga Filho, UFRJ, under opinion no. 3,897,305, on December 6, 2019. Parents/guardians gave written informed consent for their children's participation, as well as authorization for communication through application WhatsApp.

All participants tested for urine received the printed results at their homes. The research team prepared individual reports with a description of results of anthropometric assessment and neuromotor development, as well as a brief explanation of the results of the urine test and, when indicated, orientation to go to a basic health unit for evaluation and follow-up. These reports were sent to all participants via WhatsApp.

RESULTS

First evaluation: July 19-30, 2021.

The Municipal Health Department of Brumadinho provided a list of children residing in the desired locations and within the selected age group. Of 348 children, 217 (62%) were recruited, with percentage distribution between locations shown in Figure 1.

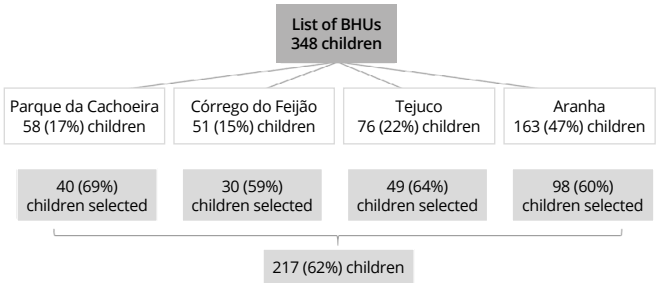
The mean age of the study population was 43 months (3.5 years). Forty-three percent (93) of the children were 4 years old or older, representing 45% of children living in Aranha and 49% in Tejuco. The average time of residence in the evaluated locations was three years. Male sex was more frequent in the general population, 52% (114), and in all locales, except in Tejuco (female sex=55%). The majority of mothers or guardians declared the children were non-white, 61% (123). The largest number of children declared to be white was found in Aranha, 48% (44).

The family income of 60% (91) of the sample was one to three minimum wages. The average per capita income was R$ 625.80. Aranha had the highest per capita income (R$ 660.37), while Córrego do Feijão had the lowest (R$ 483.50).

More than 90% (183) of the sample reported using a pit/sewerage system, except in Tejuco, where 31% of participants (13) reported absence of any type of sanitary sewage ("open air sewer"). Mineral water was mentioned as a source for water consumption by 60% (125) of the participants; however, in Aranha, 75% (71) of the sample reported using other sources of water for consumption (Table 1).

In Parque da Cachoeira, 95% (38) of the households are located on dirt roads. After the disaster, 87% (180) of the population reported an increase in vehicle traffic, 89% (182) reported a change in the amount of dust, and 82% (167) mentioned greater frequency of house cleaning. Aranha and Tejuco were the locations with the highest percentages of participants reporting not having noticed a change in the amount of dust and/or in the frequency of cleaning after the disaster.

Almost half of parents/guardians (49%) reported health changes in their children after the disaster. These changes were more commonly observed in children living in the three communities located close to the disaster area, being proportionally 60% higher in Parque da Cacheira compared to Aranha, which is further away from the dam failure site.



BHU: basic health unit.
Source: Bruminha Project, UFRJ.

Figure 1. Flowchart population selection in the first wave of the cohort, according to place of residence, Brumadinho (MG), Brazil, 2021.

The main health problems in the last 12 months reported by parents/guardians were related to the respiratory system (rhinitis/sinusitis — 21%; bronchitis — 15%; respiratory allergy — 15%) and to the skin (allergy — 29%). Respiratory allergy was four times more frequently reported, and the frequency bronchitis was 62% higher in children living in Parque da Cachoeira when compared to those living in Aranha. Skin infection/impetigo in children was three times more frequent in Parque da Cachoeira and in Tejuco, when compared to reports in children from Aranha (Table 2).

The assessment of neuropsychomotor development brought conclusive results in 193 children, with 57% (111) being normal, that is, having reached the expected abilities for their age. In 43% (82) of them the test result was considered at risk. That is, at the time of the assessment, these children had not yet developed the skill(s) expected for their age group in one or more domains assessed by the test. The Denver-Risk ratio was 51.5% higher in Tejuco, 55% higher in Parque da Cachoeira and 73% higher in Córrego do Feijão compared to Aranha (Table 3).

Anthropometric assessment was performed in 215 (99%) children. In 79% (171) of them, the BMI was normal, 10% of them (22) were considered obese (BMI>30) and 5% (11) were considered overweight (BMI>25).

A total of 197 (90.7%) urine samples were collected from 217 children. Twenty-five samples with non-standard urinary creatinine values were excluded from the analysis. The analysis of exposure to metals was performed in 172 children (79% of the total children enrolled). In all children (100%), at least one of the five metals was detected in urine. Urinary concentration of one or more metals above the RV was observed in 51% (87) of the samples. In 12 (7%) samples, urinary concentrations of two metals were above the RV. In 56% (44) of the children living in Aranha and in 55% (22) of the children living in Tejuco, concentrations of metals above the RV were detected.

Table 4 shows the analysis of urinary concentrations of each metal, by location, having the RV as the cut-off point. There were no significant differences in the frequencies of urinary metals above and below the RV between locations: As (p=0.063), Pb (p=0.138), Hg (p=0.883) and Mn (p=0.721). Urinary As concentrations were above the RV in 42% (72) and Pb in 13% (23) of the samples. Urinary Mn and Hg concentrations were above the RV in two children each. None of the children had urinary Cd concentrations above the RV. Aranha was the area with the largest number of children with urinary As concentrations above RV (50%), and Tejuco, the area with the largest number of children with urinary Pb concentrations above the RV (25%).

DISCUSSION

It is clear that a situation of environmental imbalance such as the collapse of the Fundão Dam can determine changes in the living and health conditions of affected populations in the short, medium and long term2. Added to this is the fact that diseases and conditions are not even-

ly distributed in the territory, making socio-environmental factors important conditioning and determining factors for new health problems in children.

The participants reported an average per capita income below the current minimum wage, and about a third of mothers in all locations, except for Córrego do Feijão, have completed elementary school. The high percentage of mineral water consumption (60%) is due to its supply by the mining company responsible for the disaster; even though in Aranha, where there is no water supply by the company, 75% of the population mentions other water sources, such as a well, spring or cistern. These data indicate a population in a scenario of greater economic and social vulnerability, to which direct and indirect impacts of the 2019 disaster was added.

In this scenario of socio-environmental vulnerability18,19, almost half of parents/guardians reported changes in the health conditions of their children after the disaster. The highest percentages of health problems reported as medical diagnoses in the last 12 months refer mainly to respiratory and skin disorders, with emphasis on allergies. This picture is consistent with the greater exposure to dust resulting from disaster remediation activities reported by residents, particularly in Parque da Cachoeira, where the proportion of respiratory allergies and skin infections are, respectively, four and three times more frequent than in Aranha. Additionally, Aranha and Tejuco were the locations where the perception of dust increase after the disaster was lower when compared to Córrego do Feijão and Parque da Cachoeira. These differences may be related to the fact that these areas were not directly impacted by tailings mud dust. It is important to note that the population of Tejuco also reports skin infections three times more frequently than the population of Aranha, which may also be

Table 1. Sociodemographic profile by location. Brumadinho (MG), Brazil, 2021.

Sociodemographic profile	Total	AR	CF	PC	TJ
	n (%)	n (%)	n (%)	n (%)	n (%)
Age group					
0–11 months	29 (13)	10 (10)	5 (16)	6 (15)	8 (16)
1–2 years	28 (13)	16 (16)	3 (10)	5 (12)	4 (8)
>2–4 years	67 (31)	28 (29)	11 (37)	15 (38)	13 (27)
>4 years	93 (43)	44 (45)	11 (37)	14 (35)	24 (49)
Total	217 (100)	98 (100)	30 (100)	40 (100)	49 (100)
Sex					
Female	103 (48)	44 (45)	13 (43)	19 (47)	27 (55)
Male	114 (52)	54 (55)	17 (57)	21 (53)	22 (45)
Total	217 (100)	98 (100)	30 (100)	40 (100)	49 (100)
Skin color					
White	78 (39)	44 (48)	7 (27)	14 (38)	13 (28)
Non-white	123 (61)	47 (52)	19 (73)	23 (62)	34 (72)
Total	201 (100)	91 (100)	26 (100)	37 (100)	47 (100)
Per capita income (Mean±SD) US$	123±84	130±106	95±49	125±62	119±60
Mother's education (years of study)					
None	3 (1)	1 (1)	0 (-)	0 (-)	2 (5)
1 to 9	58 (33)	30 (37)	3 (14)	12 (33)	13 (33)
>9	117 (66)	51 (62)	18 (86)	24 (67)	24 (62)
Total	178 (100)	82 (100)	21 (100)	36 (100)	39 (100)
Sewerage					
Others*	18 (9)	3 (3)	1(4)	1 (3)	13 (31)
Pit/public system	183 (91)	90 (97)	27 (96)	37 (97)	29 (69)
Total	201 (100)	93 (100)	28 (100)	38 (100)	42 (100)
Water source					
Mineral water	125 (60)	24 (25)	28 (100)	37 (93)	36 (80)
Other sources†	83 (40)	71 (75)	0 (0)	3 (7)	9 (20)
Total	208 (100)	95 (100)	28 (100)	40 (100)	45 (100)

AR: Aranha; CF: Córrego do Feijão; PC: Parque da Cachoeira; TJ: Tejuco; SD: standard deviation; *open sky/river/lake; †well/spring/cistern.
Source: Brumadinho Health Project, UFRJ.

linked to the lack of basic sanitation, reported by 31% of the sample.

The findings related to neurodevelopmental patterns in the population studied should be analyzed in light of the sanitary conditions of the last two years. The years 2020 and 2021 were marked by restrictive measures in Brazil and in the world aimed at containing the transmission of COVID-19. With social distancing, children were deprived of school environment and leisure activities, that is, of the process of socialization with peers, essential for the development of skills such as cooperation, negotiation of conflicts, coexistence with differences. Furthermore, the absence of formal learning, which is promoted in school environment, may have had negative impacts on their growth and development. Studies have reported the negative effects of

Table 2. Health problems reported by caregivers in the last 12 months in the study population. Brumadinho (MG), Brazil, 2021.

Statements	Total	PC	CF	TJ	AR
	n (%)	n (%)	n (%)	n (%)	n (%)
Health changes					
Yes	75 (49)	21 (64)	10 (53)	19 (51)	25 (40)
No	77 (51)	12 (36)	9 (47)	18 (49)	38 (60)
Total	152 (100)	33 (100)	19 (100)	37 (100)	63 (100)
Bronchitis					
Yes	32 (15)	9 (23)	1 (3)	8 (17)	14 (14)
No	182 (85)	30 (77)	28 (97)	40 (83)	84 (86)
Total	214 (100)	39 (100)	29 (100)	48 (100)	98 (100)
Rhinitis/sinusitis					
Yes	43 (21)	9 (23)	4 (14)	11 (22)	19 (20)
No	167 (79)	30 (77)	24 (86)	38 (78)	75 (80)
Total	210 (100)	39 (100)	28 (100)	49 (100)	94 (100)
Respiratory allergy					
Yes	32 (15)	14 (35)	4 (14)	6 (12)	8 (8)
No	182 (85)	26 (65)	24 (86)	42 (88)	90 (92)
Total	214 (100)	40 (100)	28 (100)	48 (100)	98 (100)
Skin allergy					
Yes	61 (29)	10 (26)	8 (29)	19 (39)	24 (24)
No	153 (71)	29 (74)	20 (71)	30 (61)	74 (76)
Total	214 (100)	39 (100)	28 (100)	49 (100)	98 (100)
Skin infection					
Yes	22 (11)	8 (20)	0	9 (19)	5 (5)
No	188 (89)	32 (80)	27 (100)	39 (81)	90 (95)
Total	210 (100)	40 (100)	27 (100)	48 (100)	95 (100)

PC: Parque da Cachoeira; CF: Córrego do Feijão; TJ: Tejuco; AR: Aranha.
Source: Brumadinho Health Project, UFRJ. Data collected in July 2021.

Table 3. Resultados do teste de Denver II por localidade estudada.

Locations (adjusted residual)	Normal Denver n (%)	Risk Denver n (%)	Total n (%)	Proportion ratio*
Aranha	59 (68) (2.6)	28 (32) (-2.6)	87 (100)	0
Tejuco	22 (51) (-1.0)	21 (49) (1.0)	43 (100)	1.51
Parque da Cachoeira	18 (50) (-1.0)	18 (50) (1.0)	36 (100)	1.55
Córrego do Feijão	12 (44) (-1.5)	15 (56) (1.5)	27 (100)	1.73
Total	111 (57)	82 (43)	193 (100)	-

*p=0.066 (Pearson's χ^2).
Source: Brumadinho Health Project, UFRJ. Data collected in July 2021.

Table 4. Urinary concentrations of metals in the population studied by location against reference value.

	Total n=172 (%)	AR n=78 (%)	CF n=23 (%)	PC n=31 (%)	TJ n=40 (%)
As (10 µg/g)					
≤RV	100 (58)	39 (50)	14 (61)	22 (71)	25 (63)
>RV	72 (42)	39 (50)	9 (39)	9 (29)	15 (37)
Cd (2 µg/g)					
≤RV	172 (100)	78 (100)	23 (100)	31(100)	40(100)
>RV	0	0	0	0	0
Hg (5 µg/g)					
≤RV	170 (99)	77 (99)	23 (100)	30 (97)	40 (100)
>RV	2 (1)	1 (1)	0	1 (3)	0
Mn (8 µg/L)					
≤RV	170 (99)	77 (99)	23 (100)	31(100)	39 (98)
>RV	2 (1)	1 (1)	0	0	1 (2)
Pb (1.7 µg/L)					
≤RV	149 (87)	69 (89)	21 (91)	29 (94)	30 (75)
>RV	23 (13)	9 (11)	2 (9)	2 (6)	10 (25)

AR: Aranha; CF: Córrego do Feijão; PC: Parque da Cachoeira; TJ: Tejuco; RV: reference value; As: total arsenic; Cd: cadmium; Pb: lead; Hg: mercury; Mn: manganese.
Source: Brumadinho Health Project, UFRJ. Data collected in July 2021.

a sedentary lifestyle caused by the pandemic on children's health, especially when it comes to weight gain20.

The entire population studied has detectable arsenic concentrations in urine samples. As the speciation of the substance was not performed, the quantified concentrations may be in organic forms, whose main sources of exposure are related to diet, and in inorganic forms, whose sources may be mining activities or natural geological contamination of environmental compartments21. The main form of exposure to inorganic arsenic is water. At least half of the children with excessive exposure to this metal are residents of Aranha, where consumption of water from other sources is high. Although about 10% of the population had urinary lead concentrations above the RV, one must measure its concentrations in venous blood in order to establish excessive exposure22.

The tests identified a situation of exposure to, not intoxication by, the analyzed metals. A diagnosis of intoxication requires a complete clinical health assessment along with laboratory and complementary tests; however, lead and arsenic are toxic metals to children's health and development. Lead exposure during pregnancy and in the first two years of life is widely associated with changes in children's neuromotor, social and cognitive development23-26. Exposure to arsenic has been investigated because of its potential toxic action on metabolic pathways, as well as on the nervous system27.

To date, the direct and indirect impacts of environmental disasters in Brazil on children's health are not well known. With the Bruminha Project, we intend to contribute to the production of knowledge about the effects of exposure to ore residues dispersed in the environment on the health and development of children affected by the collapse of Córrego do Feijão dam, in Brumadinho. As this is an initiative of great relevance to public health following a major environmental disaster, the study design moves towards an open cohort, with the inclusion of new participants in the upcoming assessments (2022 and 2023).

REFERENCES

1. Brasil. Ministério da Saúde. Secretaria de Ciência, Tecnologia, Inovação e Insumos Estratégicos em Saúde. Gabinete. Apresentação do "Programa de Ações Integradas em Saúde de Brumadinho" [Internet]. 2020 [cited on Apr 10, 2022]. Available from: http://www.minas.fiocruz.br/saudebrumadinho/assets/doc/carta_brumadinho_comunidade.pdf
2. Peixoto SV, Asmus CIRF. O desastre de Brumadinho e os possíveis impactos na saúde. Cienc Cult 2020; 72(2): 43-6. http://dx.doi.org/10.21800/2317-66602020000200012
3. Brasil. Instituto Brasileira de Geografia e Estatística. Cidades. Brumadinho [Internet]. 2022 [cited on May 14, 2022]. Available from: https://cidades.ibge.gov.br/brasil/mg/brumadinho/panorama
4. Brasil. e-Gestor. Atenção Básica. Informação e Gestão da Atenção Básica. Cobertura da atenção básica [Internet]. 2020 [cited on May 14, 2022]. Available from: https://egestorab.saude.gov.br/paginas/acessoPublico/relatorios/relHistoricoCoberturaAB.xhtml
5. Brasil. Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento de Atenção Básica. Orientações para avaliação de marcadores de consumo alimentar na atenção básica. Brasília: Ministério da Saúde; 2015 [Internet]. 2015 [cited on Jun 29, 2022]. Available from: https://bvsms.saude.gov.br/

bvs/publicacoes/marcadores_consumo_alimentar_atencao_basica.pdf

6. World Health Organization. WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. Geneva: World Health Organization; 2006.
7. Frankenburg WK, Dodds JB, Archer P, Bresnick B, Maschka P, Edelman N, et al. Manual Técnico DENVER II. Teste de triagem do desenvolvimento. São Paulo: Hogrefe; 2018.
8. Sociedade Brasileira de Pediatria. Departamento Científico de Pediatria do Desenvolvimento e Comportamento. Triagem precoce para autismo. Transtorno do espectro autista [Internet]. 2017 [cited on Jun 20, 2022]. Available from: https://www.sbp.com.br/fileadmin/user_upload/2017/04/19464b-DocCient-Autismo.pdf.
9. Costa DS, Paula JJ, Malloy-Diniz LF, Romano-Silva MA, Miranda DM. Parent SNAP-IV rating of attention-deficit/hyperactivity disorder: accuracy in a clinical sample of ADHD, validity, and reliability in a Brazilian sample. J Pediatr 2019; 95(6): 736-43. https://doi.org/10.1016/j.jped.2018.06.014
10. Mattos P, Serra-Pinheiro MA, Rohde LA, Pinto D. Apresentação de uma versão em português para uso no Brasil do instrumento MTA-SNAP-IV de avaliação de sintomas de transtorno do déficit de atenção/hiperatividade e sintomas de transtorno desafiador e de oposição. Rev Psiquiatr Rio Gd Sul 2006; 28(3): 290-7. https://doi.org/10.1590/S0101-81082006000300008
11. Bastos ACFH, Silva LP. Tônus e equilíbrio: os distúrbios psicomotores na visão da fisioterapia [monografia]. Fortaleza: Universidade Federal do Ceará; 2007.
12. Fernandes AJA. Influência da capacidade equilibratória na performance. Revista do Instituto Politécnico da Guarda. Educação e Tecnologia 1992; 10: 1. [Internet]. [cited on Jun 15, 2022]. Available from: http://bdigital.ipg.pt/dspace/bitstream/10314/791/3/revista%20N%C2%BA10%20-%20Fernandes%20%281992%29.pdf
13. Bohannon RW, Smith MB. Interrater reliability of a modified Ashworth scale of muscle spasticity. Phys Ther 1987; 67(2): 206-7. https://doi.org/10.1093/ptj/67.2.206
14. Villela LD, Hurigil MGC, Cunha PVS. Avaliação clínica e prevenção de alterações do desenvolvimento neuropsicomotor no primeiro ano de vida [Internet]. 2017 [cited on Jun 30, 2022]. Available from: https://portaldeboaspraticas.iff.fiocruz.br/wp-content/uploads/2018/09/Avalia%C3%A7%C3%A3o-cl%C3%ADnica-e-preven%C3%A7%C3%A3o-de-altera%C3%A7%C3%B5es-do-desenvolvimento-neuropsicomotor-no-primeiro-ano-de-vida.pdf
15. Brasil. Ministério do Trabalho e Previdência. Norma Regulamentadora No. 7 (NR-7) [Internet]. 2020 [cited on Jun 15, 2022]. Available from: https://www.gov.br/trabalho-e-previdencia/pt-br/composicao/orgaos-especificos/secretaria-de-trabalho/inspecao/seguranca-e-saude-no-trabalho/ctpp-nrs/norma-regulamentadora-no-7-nr-7
16. Agency for Toxic Substances and Disease Registry. Relevance to public health. In: Toxicological profile for manganese. Atlanta: Agency for Toxic Substances and Disease Registry; 2012. p. 11-38 [Internet] 2012 [cited on Jun 29, 2022]. Available from: https://www.atsdr.cdc.gov/ToxProfiles/tp151-c2.pdf
17. Saravanabhavan G, Werry K, Walker M, Haines D, Malowany M, Khoury C. Human biomonitoring reference values for metals and trace elements in blood and urine derived from the Canadian Health Measures Survey 2007–2013. Int J Hyg Environ Health 2017; 220(2 Pt A): 189-200. https://doi.org/10.1016/j.ijheh.2016.10.006
18. Freitas CM, Carvalho ML, Ximenes EF, Arraes EF, Gomes JO. Vulnerabilidade socioambiental, redução de riscos de desastres e construção da resiliência: lições do terremoto no Haiti e das chuvas fortes na Região Serrana, Brasil. Ciênc Saúde Coletiva 2012; 17(6): 1577-86. https://doi.org/10.1590/S1413-81232012000600021
19. Silva MA, Freitas CM, Xavier DR, Romão AR. Sobreposição de riscos e impactos no desastre da Vale em Brumadinho. Cienc Cult 2020; 72(2): 21-8. http://dx.doi.org/10.21800/2317-66602020000200008
20. Linhares MBM, Enumo SRF. Reflexões baseadas na Psicologia sobre efeitos da pandemia COVID-19 no desenvolvimento infantil. Estud Psicol (Campinas) 2020; 37: e200089. https://doi.org/10.1590/1982-0275202037e200089
21. Chung JY, Yu SD, Hong YS. Environmental source of arsenic exposure. J Prev Med Public Health 2014; 47(5): 253-7. https://doi.org/10.3961/jpmph.14.036
22. Centers for Disease Control and Prevention. National report on human exposure to environmental chemicals [Internet]. 2022 [cited on Aug 9, 2022]. Available from: https://www.cdc.gov/exposurereport/index.html
23. Centers for Disease Control and Prevention. Childhood lead poisoning prevention [Internet]. 2022 [cited on Jul 11, 2022]. Available from: https://www.cdc.gov/nceh/lead/default.htm
24. Lanphear BP, Hornung R, Khoury J, Yolton K, Baghurst P, Bellinger DC, et al. Low-level environmental lead exposure and children's intellectual function: an international pooled analysis. Environ Health Perspect 2005; 113(7): 894-9. https://doi.org/10.1289/eph.7688
25. Bellinger DC. Very low lead exposures and children's neurodevelopment. Curr Opin Pediatr 2008; 20(2): 172-7. https://doi.org/10.1097/MOP.0b013e3282f4f97b
26. Liu J, Chen Y, Gao D, Jing J, Hu Q. Prenatal and postnatal lead exposure and cognitive development of infants followed over the first three years of life: a prospective birth study in the Pearl River Delta region, China. Neurotoxicology 2014; 44: 326-34. https://doi.org/10.1016/j.neuro.2014.07.001
27. Tolins M, Ruchirawat M, Landrigan P. The developmental neurotoxicity of arsenic: cognitive and behavioral consequences of early life exposure. Ann Glob Health 2014; 80(4): 303-14. https://doi.org/10.1016/j.aogh.2014.09.005

RESUMO

Objetivo: Apresentar o protocolo da pesquisa e descrever os resultados preliminares da linha de base da população de estudo do Projeto Bruminha. **Métodos:** Este projeto é parte do conjunto de ações propostas no âmbito do Programa de Ações Saúde Brumadinho. Trata-se de um estudo de coorte prospectiva, com seguimento periódico por quatro anos, cuja população elegível foi constituída de todas as crianças de 0 a 6 anos de idade residentes em quatro localidades situadas na zona rural do município afetado, com coleta de dados sociodemográficos e de saúde e de amostras urinárias para avaliação da exposição a metais. **Resultados:** No primeiro ano de estudo foi avaliada 62% (217) da população elegível e se coletaram 172 (79%) amostras de urina válidas. Em todas as amostras analisadas foi detectado pelo menos um metal, e em 50,6% (n=87) concentrações urinárias acima do valor de referência. Em 38% (n=82) das crianças a avaliação do desenvolvimento neuropsicomotor foi considerada de risco. O relato de alergia respiratória foi quatro vezes (4,27) mais frequente e de bronquite 61% maior (1,62) nas crianças residentes nas localidades expostas à poeira de resíduos de minério, proporcionalmente àquelas residentes a mais de 10 km do local do desastre. **Conclusão:** O protocolo do estudo mostrou-se adequado para avaliação dos desfechos propostos. A estratégia de captação da população de estudo necessitou de reajustes quanto ao processo de sensibilização da comunidade a longo prazo com entrada de novos participantes nos próximos seguimentos (2022 e 2023).

Palavras-chave: Desastres ambientais. Estudos de coortes. Metais. Saúde infantil.

ACKNOWLEDGMENTS: We would like to thank the population of Brumadinho, especially the parents and guardians of the children participating in the Bruminha Project, for their trust in the research team. We are grateful to Fundação Oswaldo Cruz, represented by researcher Sergio Vianna Peixoto, for their partnership in the development of this study. We would also like to than the consulting researchers from Universidade Federal de Minas Gerais and Universidade Estadual de Campinas, and the Municipal Health Department of Brumadinho.

AUTHORS' CONTRIBUTIONS: Asmus, C.I.R.F.: project administration, formal analysis, conceptualization, data curation, writing – review & editing, investigation, methodology, funding acquisition, resources, supervision, validation, visualization. Santos, A.S.E.: data curation, writing – first draft, investigation, methodology, software, supervision, validation. Saraiva, R.D.S.: data curation, writing – first draft, writing – review & editing, investigation, methodology, software, supervision, validation. Oliveira, A.P.N.: data curation, writing – review & editing, investigation, validation. Silva, I.C.M.: funding acquisition, resources, supervision, validation. Mazoto, M.L.: data curation, writing – review & editing, investigation, supervision, validation. Costa, M.A.: data curation, writing – review & editing, validation. Câmara, V.M.: formal analysis, conceptualization, writing – review & editing, methodology, supervision, validation.

FUNDING: The Bruminha Project, from Universidade Federal do Rio de Janeiro, is funded by the Department of Science and Technology (Decit) of the Secretariat of Science, Technology and Strategic Inputs (SCTIE) of the Ministry of Health (MS) (Process 25000.127551/2019-69).