

## ORIGINAL ARTICLE



## Chronic respiratory diseases and respiratory symptoms after a mining dam rupture: Brumadinho Health Project

### Doenças respiratórias crônicas e sintomas respiratórios após rompimento de barragem de mineração: Projeto Saúde Brumadinho

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## ABSTRACT

**Objective:** To identify factors associated with asthma and chronic obstructive pulmonary disease (COPD) and respiratory symptoms, in Brumadinho, state of Minas Gerais, Brazil, after a dam rupture. **Methods:** This is a cross-sectional study, including a representative sample of adults (aged 18 years and over) in the municipality. Associations were assessed between dependent variables (medical diagnosis of asthma and COPD; symptoms of wheezing, dry cough, and nose irritation) and exploratory variables (sex, age group, smoking habit, having worked at Vale S.A. company before the dam rupture, time and area of residence in relation to the dam rupture). Logistic regression models with odds ratio (OR) calculation and 95% confidence interval were used. **Results:** We identified a prevalence of 7.2% of asthma; 3.5% of COPD; 8.8% of wheezing; 23.6% of dry cough; and 31.8% of nose irritation. We observed a greater chance of asthma among women and residents in the affected and mining regions, while a greater chance of COPD was observed in smokers and in those with longer time of residence in the municipality. Among the symptoms, we verified a higher chance of nose irritation among women, while a higher chance of wheezing and dry cough were found among smokers (current and former). Residents of regions affected by the mud reported a greater chance of presenting all the analyzed symptoms. Conversely, level of education was negatively associated with wheezing and dry cough. **Conclusion:** We found respiratory changes and identified the groups most vulnerable to developing them, which could contribute to directing actions to reduce the population's respiratory problems.

**Keywords:** Chronic obstructive pulmonary disease. Asthma. Epidemiology. Disaster. Mining.

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**CONFLICT OF INTERESTS:** nothing to declare

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## INTRODUCTION

Chronic noncommunicable diseases (NCDs) are mainly represented by diseases of the respiratory and circulatory systems, diabetes and cancer, constituting the greatest burden of disease in the world<sup>1</sup>. These diseases cause absenteeism from work, affecting the productive period<sup>2</sup> and quality of life, generating economic and social impacts<sup>3</sup>.

Symptoms, such as wheezing, dry cough, and nose irritation, may be associated with chronic respiratory diseases — such as asthma, chronic obstructive pulmonary disease (COPD), and pneumonia. Although not directly associated with a specific diagnosis, they also generate economic and social impacts<sup>4-6</sup>.

Asthma and COPD have multifactorial causes and are associated with exposure factors related to the occupational or home environment (tobacco and wood smoke), unfavorable socioeconomic status, and genetic factors<sup>7-10</sup>. According to the literature, air polluting agents are related to lung diseases and respiratory symptoms<sup>11</sup>. Although there are some studies on the prevalence of these diseases<sup>6,12-14</sup> and respiratory symptoms<sup>4,15-18</sup>, we found only one that was carried out in a mining region<sup>14</sup>.

Brumadinho, a municipality in the state of Minas Gerais, Brazil, has mining as its main source of revenue<sup>19</sup>. On January 25, 2019, the Córrego do Feijão Mine, located in the municipality and operated by the mining company Vale S.A., had its dam ruptured. This disaster caused the death of around 270 people and the spillage of tailings sludge that affected around 10.0% of the population. A few days after the dam rupture, the tailings sludge dried up, turned to dust, and spread throughout the municipality, generating uncertainties regarding the possible impacts on the population's health<sup>20</sup>.

Taking this into consideration, the study on chronic respiratory diseases and respiratory symptoms of the population of this municipality is relevant and innovative because it is conducted in a mining area, especially after the dam rupture. Few studies in the country have addressed respiratory diseases in mining regions<sup>14</sup>, which is relevant knowledge considering that the findings may contribute to health strategies, both for the population of Brumadinho and for other municipalities with this economic profile. Thus, the objective of this study was to identify factors associated with chronic respiratory diseases, asthma, and COPD as well as symptoms of wheezing, dry cough, and nose irritation in a mining area after the dam rupture.

## METHODS

### Data source

This is a cross-sectional study with data collected at the baseline of the Brumadinho Health Project (Projeto Saúde Brumadinho), conducted in the city of Brumadinho, state of

Minas Gerais, Brazil, with an estimated population of 41,208 inhabitants in 2021<sup>21</sup>. This project is a cohort study coordinated by Fundação Oswaldo Cruz in Minas Gerais (Fiocruz Minas) and Universidade Federal do Rio de Janeiro (UFRJ). It was approved by the Research Ethics Committee of Fiocruz Minas (Certificate of Presentation for Ethical Consideration — CAAE: 20814719500005091). All interviewees signed an informed consent form to participate in the study.

The Brumadinho Health Project sample design was formulated to represent the population residing in the municipality, aged 12 years or older. In addition, this sample aimed to obtain information from three different domains, according to area of residence in relation to the dam rupture:

1. "Sample from other regions," which included the population not directly affected by the dam rupture or mining activity;
2. "Directly affected by the mud," which included the communities closest to the area affected by the mud; and
3. "Mining area," which included individuals residing in an area with mining activity.

The sample design considered the stratification of the surveyed population by census tract, as established by the Brazilian Institute of Geography and Statistics (IBGE) in 2019<sup>22</sup>. All households in regions directly affected by the mud or mining area (census) were included, as well as a random sample of private households in sectors considered not directly affected by the mud. The sample of this last domain included seven households (primary sampling units), which were selected by simple inverse sampling in each of the 107 census tracts sampled. For each selected household, both in the census regions and in the sampling regions, all residents aged 12 years and over were interviewed, between June and November 2021, totaling 3,080 participants and a response rate of 86.4%. In this article, 2,772 participants aged 18 years or over were considered (98.8% of the total number of adult participants in the Brumadinho Health Project).

More details about the research can be seen on the project homepage (<http://www.minas.fiocruz.br/saudebrumadinho/>) and in the methodological article<sup>23</sup>.

### Collection variables and procedures

The dependent variables of this study were self-reported by the participants and consisted of the medical diagnosis of asthma and COPD. In addition, the presence of symptoms, such as wheezing, dry cough, and nose irritation, in the last 30 days prior to the interview were considered. The 30-day period for reporting symptoms was chosen because these are transient conditions, in an attempt to avoid information bias due to the possible difficulty in reporting these signs and symptoms in a longer time window.

The exploratory variables, selected according to the literature<sup>4,13,24,25</sup>, were as follows: sex (man, woman); age

group in years (18–24, 25–39, 40–59, 60 or more), level of education (some elementary school, elementary school, middle school, high school, higher education or more), smoking habit (nonsmoker, former smoker, current smoker), having worked at Vale S.A. company before the dam rupture (no, yes), time of residence in the municipality divided into tertiles (1<sup>st</sup> tertile  $\leq$ 13 years, 2<sup>nd</sup> tertile 14–33 years, and 3<sup>rd</sup> tertile  $\geq$ 34 years), and area of residence in relation to the dam rupture, obtained according to the strata defined for the sampling process (sample from the other regions, directly affected by the mud, mining area).

The variables included in this study were described for the total sample analyzed. Subsequently, odds ratios (OR) and respective confidence intervals (95%CI) were estimated, by logistic regression, for each variable and mutually adjusted for the set of exploratory variables included in the research. All variables that presented  $p < 0.05$  in the adjusted analysis were considered associated with the evaluated outcomes. All analyses were performed using the Stata<sup>®</sup> software version 14.0 (StataCorp LLC, CollegeStation, TX), using the procedures for complex samples, which include sample weighting and the sample design effect.

## RESULTS

The prevalence of asthma was 7.2% (95%CI 5.8–8.8) and that of COPD was 3.5% (95%CI 2.5–4.9). Regarding symptoms, the prevalence of people who reported wheezing was 8.8% (95%CI 7.3–10.5); dry cough, 23.6% (95%CI 21.1–26.4); and nose irritation, 31.8% (95%CI 28.7–35.1).

In Table 1 we present the distribution of study participants' characteristics for the total adult population. The sample had a higher frequency of women (57.1%), aged between 40 and 59 years (36.1%), and who have a high school degree (28.9%). In addition, most of them never smoked (66.1%), had not worked for Vale S.A. until 2018 (89.2%), and resided in a sample of other regions (95.5%).

In Table 2 we present the association between the exploratory variables of interest and chronic conditions, asthma and COPD. In both the crude and the adjusted models, we found that women (adjusted OR=2.4; 95%CI 1.4–3.9) and those who lived in an area directly affected by the mud (adjusted OR=1.8; 95%CI 1.2–2.5) or in a mining area (adjusted OR=1.6; 95%CI 1.1–2.5) were more likely to have been diagnosed with asthma. Regarding COPD, current smokers (adjusted OR=2.6; 95%CI 1.1–6.4) and individuals belonging to the 2<sup>nd</sup> and 3<sup>rd</sup> tertiles of residence time in the city (adjusted OR=4.5; 95%CI 1.6–12.5 and 4.0; 95%CI 1.3–12.4, respectively) were more likely to be diagnosed with this condition, both in the crude and adjusted models. Conversely, after adjustment, the area of residence was no longer associated with COPD.

In Table 3 we show the association between the exploratory variables surveyed and the symptoms of wheezing, dry cough, and nose irritation. As for the report of wheez-

ing, on the one hand, the highest level of education was inversely associated with this symptom (adjusted OR=0.4; 95%CI 0.2–0.8 for high school, and adjusted OR=0.3; 95%CI 0.1–0.8 for higher education or more). On the other hand, former smokers (adjusted OR=2.4; 95%CI 1.2–4.6), current smokers (adjusted OR=7.1; 95%CI 4.2–11.9), and living in an area directly affected by mud (adjusted OR=1.4; 95%CI 1.1–2.0) were directly associated with this outcome.

We verified a similar pattern of association for the report of dry cough, with those with higher education having a lower chance of reporting this symptom (adjusted OR=0.5; 95%CI 0.3–0.9 for higher education or more) and a higher chance of reporting this symptom being observed among former smokers (adjusted OR=1.9; 95%CI 1.3–2.8) and current smokers (adjusted OR=2.6; 95%CI 1.8–3.9). Furthermore, individuals belonging to the 2<sup>nd</sup> tertile of residence time in the municipality (adjusted OR=1.7; 95%CI 1.1–2.5) and living in an area directly affected by the mud

**Table 1. Distribution of characteristics assessed in the total study population. Brumadinho Health Project, 2021.**

Variables	Total
Sex	
Man	42.9
Woman	57.1
Age group (years)	
18–24	11.4
25–39	21.9
40–59	36.1
60 or over	30.6
Level of education	
Some elementary school	19.4
Elementary school	17.7
Middle school	16.4
High school	28.9
Higher education or more	17.6
Smoking habit	
Has never smoked	66.1
Former smoker	17.5
Current smoker	16.4
Has worked at Vale S.A. before the dam rupture	
No	89.2
Yes	10.8
Time of residence in the municipality (years)	
1 <sup>st</sup> tertile ( $\leq$ 13)	33.7
2 <sup>nd</sup> tertile (14–33)	34.3
3 <sup>rd</sup> tertile ( $\geq$ 34)	32.0
Area of residence in relation to the dam rupture	
Sample from other regions	95.5
Directly affected by the mud	2.9
Mining area	1.6

(adjusted OR=2.0; 95%CI 1.6–2.6) were more likely to present this outcome.

Finally, the report of nose irritation was directly associated with women (adjusted OR=1.5; 95%CI 1.2–2.0) and living in an area directly affected by the mud (adjusted OR=2.3; 95%CI% 1.9–2.9).

## DISCUSSION

Our results showed significant associations between socioeconomic variables, smoking habit, time of residence in the municipality, and area of residence in relation to the dam rupture and the medical diagnosis of asthma and COPD and respiratory symptoms.

According to data from the World Health Survey conducted in 2002–2003, the worldwide prevalence of the medical

diagnosis of asthma among adults aged 18 to 45 years was 4.3%, and that of people who had already been treated for asthma was 4.5%. In this study, Brazil was the fifth country with the highest prevalence of people who had already been treated for asthma, with 13.0%<sup>12</sup>. Some surveys on the prevalence of asthma in adults in Brazil showed an increase in this disease over the years such as in 2003 (3.6%), 2008 (3.7%), 2013 (4.5%), and 2019 (5.3%)<sup>6,13,26</sup>. This increase can be attributed to the greater access to health care, the availability of medicines with the implementation of the Popular Pharmacy Program, and the greater dissemination of access to medicines and guidance to the population<sup>6</sup>. In Brumadinho, the prevalence of asthma with data collected in 2021 was higher (7.2%), which may reflect this gradual increase over time. In addition, the coverage of the Family Health Strategy (FHS) in the municipality is 100%<sup>19</sup>, which may favor the diagnosis.

**Table 2. Crude and adjusted analysis of the association between the assessed characteristics and medical diagnosis of asthma and chronic obstructive pulmonary disease. Brumadinho Health Project, 2021.**

Variables	Asthma		COPD	
	Crude OD (95%CI)	Adjusted OD (95%CI)	Crude OD (95%CI)	Adjusted OD (95%CI)
Sex				
Man	1.0	1.0	1.0	1.0
Woman	2.1 (1.3–3.4)	2.4 (1.4–3.9)	0.9 (0.5–1.9)	1.0 (0.5–2.2)
Age group (years)				
18–24	1.0	1.0	1.0	1.0
25–39	0.8 (0.4–1.7)	0.9 (0.4–2.0)	0.5 (0.1–2.2)	0.6 (0.2–2.5)
40–59	0.6 (0.3–1.2)	0.9 (0.4–1.9)	0.6 (0.2–2.5)	0.6 (0.1–2.3)
60 or over	0.8 (0.4–1.7)	1.2 (0.5–3.0)	1.3 (0.3–4.7)	1.1 (0.3–4.4)
Level of education				
Some elementary school	1.0	1.0	1.0	1.0
Elementary school	1.0 (0.5–2.0)	1.0 (0.5–2.2)	1.7 (0.6–4.8)	1.9 (0.7–5.2)
Middle school	1.4 (0.7–3.0)	1.5 (0.6–3.6)	1.6 (0.5–5.1)	2.2 (0.7–6.6)
High school	1.6 (0.8–3.0)	1.6 (0.7–3.2)	0.7 (0.2–1.9)	1.0 (0.3–3.3)
Higher education or more	1.3 (0.5–3.1)	1.2 (0.5–2.8)	1.6 (0.6–4.6)	2.9 (0.9–9.1)
Smoking habit				
Has never smoked	1.0	1.0	1.0	1.0
Former smoker	1.2 (0.7–2.2)	1.5 (0.8–2.9)	2.3 (0.9–5.4)	2.0 (0.8–5.3)
Current smoker	1.1 (0.6–2.0)	1.4 (0.7–2.7)	2.4 (0.9–5.7)	2.6 (1.1–6.4)
Has worked at Vale S.A. before the dam rupture				
No	1.0	1.0	1.0	1.0
Yes	0.8 (0.4–1.8)	1.1 (0.5–2.8)	0.4 (0.1–1.6)	0.4 (0.1–1.5)
Time of residence in the municipality (years)				
1 <sup>st</sup> tertile (≤13)	1.0	1.0	1.0	1.0
2 <sup>nd</sup> tertile (14–33)	1.1 (0.6–2.0)	1.1 (0.6–1.9)	3.5 (1.3–10.0)	4.5 (1.6–12.5)
3 <sup>rd</sup> tertile (≥34)	0.7 (0.4–1.3)	0.7 (0.4–1.3)	3.1 (1.1–8.8)	4.0 (1.3–12.4)
Area of residence in relation to the dam rupture				
Sample from other regions	1.0	1.0	1.0	1.0
Directly affected by the mud	1.7 (1.2–2.3)	1.8 (1.2–2.5)	0.4 (0.2–0.8)	0.5 (0.3–1.0)
Mining area	1.5 (1.1–2.2)	1.6 (1.1–2.5)	0.9 (0.5–1.8)	0.9 (0.4–2.0)

COPD: chronic obstructive pulmonary disease; OR (95%CI): odds ratio (95% confidence interval), crude and adjusted for all variables listed in the table.

Women were more likely to have a medical diagnosis of asthma when compared with men. This result is in line with previous surveys conducted on the Brazilian adult population, which used data from the National Household Sample Survey (PNAD) 2003 and 2008 and the National Survey of Health (PNS) 2013 and 2019<sup>6,13,21</sup>, in addition to studies conducted on the North American population<sup>27,28</sup>. Some authors consider that a possible explanation for this relationship is the hormonal and behavioral variation related to the time of puberty and genetic polymorphisms, which can lead women to be more susceptible to asthma in adulthood, as puberty is the time when they start having a higher frequency of asthma diagnosis compared with men<sup>14,15,26,27</sup>. In addition to hormonal variation during puberty, women have different behaviors regarding asthma in other stages of life, such as pregnancy and postmenopause, periods in which the disease is commonly exacerbated<sup>26,27</sup>.

The population residing in areas directly affected by the mud and mining areas were more likely to report a medical diagnosis of asthma. This finding can be explained by the greater exposure to dust, as environmental pollutants can contribute to the onset and exacerbation of the disease<sup>11,13,14</sup>, although this hypothesis must still be better evaluated in the region. However, although we are not aware of studies investigating the composition of dust in Brumadinho, the air quality monitoring campaign carried out for a week, in October 2016 in Barra Longa, Mariana (state of Minas Gerais, Brazil), a municipality that suffered a disaster similar to that of Brumadinho, showed that the levels of particulate matter PM<sub>10</sub> (diameter less than or equal to 10 µm) reached a concentration higher than those found in large Brazilian metropolises. These particles have as their main source the action of the wind on the ground

**Table 3. Crude and adjusted analysis of the association between the assessed characteristics and wheezing, dry cough, and nose irritation. Brumadinho Health Project, 2021.**

Variables	Wheezing		Dry cough		Nose irritation	
	Crude OD (95%CI)	Adjusted OD (95%CI)	Crude OD (95%CI)	Adjusted OD (95%CI)	Crude OD (95%CI)	Adjusted OD (95%CI)
Sex						
Man	1.0	1.0	1.0	1.0	1.0	1.0
Woman	0.8 (0.6–1.3)	1.3 (0.8–2.1)	1.0 (0.8–1.3)	1.2 (0.9–1.6)	1.3 (0.9–1.7)	1.5 (1.2–2.0)
Age group (years)						
18–24	1.0	1.0	1.0	1.0	1.0	1.0
25–39	0.9 (0.4–2.0)	0.9 (0.4–2.3)	1.2 (0.7–2.0)	1.3 (0.7–2.2)	1.2 (0.7–2.0)	1.2 (0.7–2.0)
40–59	1.1 (0.5–2.4)	0.4 (0.4–2.0)	1.2 (0.7–1.9)	1.0 (0.6–1.8)	1.1 (0.7–2.0)	1.1 (0.7–1.9)
60 or over	1.3 (0.6–2.8)	1.1 (0.4–2.7)	1.3 (0.8–2.2)	1.2 (0.6–2.2)	0.8 (0.5–1.3)	0.9 (0.5–1.6)
Level of education						
Some elementary school	1.0	1.0	1.0	1.0	1.0	1.0
Elementary school	0.8 (0.5–1.4)	0.7 (0.4–1.2)	0.9 (0.6–1.4)	0.9 (0.6–1.3)	1.1 (0.7–1.7)	1.0 (0.6–1.6)
Middle school	1.0 (0.5–1.8)	1.0 (0.5–1.9)	0.8 (0.5–1.3)	0.9 (0.6–1.5)	1.0 (0.7–1.5)	0.9 (0.6–1.4)
High school	0.3 (0.2–0.6)	0.4 (0.2–0.8)	0.6 (0.4–0.9)	0.7 (0.5–1.1)	1.5 (0.9–2.2)	1.3 (0.8–2.0)
Higher education or more	0.3 (0.1–0.6)	0.3 (0.1–0.8)	0.4 (0.2–0.7)	0.5 (0.3–0.9)	0.9 (0.6–1.5)	0.9 (0.6–1.6)
Smoking habit						
Has never smoked	1.0	1.0	1.0	1.0	1.0	1.0
Former smoker	2.4 (1.4–4.2)	2.4 (1.2–4.6)	1.8 (1.3–2.6)	1.9 (1.3–2.8)	0.9 (0.7–1.3)	1.1 (0.7–1.6)
Current smoker	7.4 (4.5–11.9)	7.1 (4.2–11.9)	2.6 (1.8–3.8)	2.6 (1.8–3.9)	1.3 (0.9–2.1)	1.5 (0.9–2.4)
Has worked at Vale S.A. before the dam rupture						
No	1.0	1.0	1.0	1.0	1.0	1.0
Yes	1.1 (0.5–2.1)	1.0 (0.4–2.4)	1.0 (0.7–1.6)	1.0 (0.6–1.6)	1.4 (0.9–2.1)	1.5 (0.9–2.4)
Time of residence in the municipality (years)						
1 <sup>st</sup> tertile (≤13)	1.0	1.0	1.0	1.0	1.0	1.0
2 <sup>nd</sup> tertile (14–33)	1.6 (0.9–2.7)	1.5 (0.9–2.5)	1.8 (1.2–2.6)	1.7 (1.1–2.5)	1.2 (0.8–1.6)	1.1 (0.8–1.5)
3 <sup>rd</sup> tertile (≥34)	1.4 (0.8–2.4)	1.1 (0.6–2.0)	1.8 (1.2–2.6)	1.6 (0.9–2.4)	1.0 (0.7–1.4)	1.0 (0.7–1.5)
Area of residence in relation to the dam rupture						
Sample from other regions	1.0	1.0	1.0	1.0	1.0	1.0
Directly affected by the mud	1.5 (1.1–2.0)	1.4 (0.9–2.0)	2.0 (1.6–2.5)	2.0 (1.6–2.6)	2.3 (1.9–2.9)	2.3 (1.9–2.9)
Mining area	1.0 (0.7–1.5)	1.0 (0.6–1.6)	1.2 (0.9–1.6)	1.1 (0.9–1.5)	1.0 (0.7–1.2)	0.9 (0.7–1.2)

OR (95%CI): odds ratio (95% confidence interval), crude and adjusted for all variables listed in the table.

and can reach the lower respiratory tract, causing chronic respiratory diseases such as asthma and bronchitis<sup>14</sup>.

The prevalence of chronic bronchitis, emphysema, or COPD among adults in Brumadinho was 3.5%, higher than that observed in the PNS 2019, which was 1.7%<sup>25</sup>. This higher prevalence may reflect a characteristic of this population, but another aspect that can also be considered is the fact that the city has 100% FHS coverage, which may contribute to a greater diagnosis of this condition.

Regarding COPD, we found that there was a greater chance of this outcome in current smokers and those who had lived in the city for a longer time. Regarding smoking habit, this finding is consistent with the literature, as smoking is one of the main risk factors for COPD<sup>4,7,15,16,24,29</sup>. A retrospective study carried out in the state of Goiás, Brazil, showed that 44.1% of patients exposed to tobacco smoke had severe or very severe COPD<sup>15</sup>. Regarding the longer period of residence in the municipality, long-term exposure to dust may probably justify this relationship, considering that COPD is influenced by environmental pollution<sup>22</sup>. These aspects should be further investigated in future studies in the region.

In Brumadinho, the prevalence of wheezing was 8.8%. According to the World Health Survey conducted in 2002–2003, the worldwide prevalence of this symptom in the previous 12 months among asthmatic individuals was 8.6%<sup>12</sup>, and Brazil was the fourth country with the highest prevalence (22.6%). Other studies conducted in Brazil among young adults showed higher prevalence (24.9% in Pelotas, state of Rio Grande do Sul, and 20.2% in Lages, state of Santa Catarina, both in the south region, and 17.9% in Cezarina, state of Goiás), but these studies also used a longer period for symptom reporting (12 months), which may have contributed to the higher prevalence of this outcome<sup>4,17,26</sup>.

Factors associated with wheezing report included level of education, smoking habit, and area of residence. Adults with higher level of education were less likely to report wheezing. This relationship between worse socioeconomic status and greater reporting of respiratory symptoms has already been observed in other Brazilian studies and demonstrates that worse socioeconomic conditions tend to increase the population's vulnerability to these symptoms, perhaps due to greater exposure to risk factors: smoking habit, low level of education, and occupational exposure to dust<sup>4,17</sup>. Conversely, the greater chance of reporting wheezing among former and current smokers demonstrates the possible effects of smoking on the respiratory system, an association already well-established in the literature<sup>1,4,15,16</sup>. The higher chance of the existence of this symptom among residents of the area directly affected by the mud, where the tailings from the dam approached the community, demonstrates a possible greater exposure to dust, which is in line with the association between environmental pollutants and respiratory symptoms<sup>14</sup>.

Cough is commonly related to an inflammatory process in the airways, which occurs in the common cold, rhinitis, sinusitis, exposure to irritating factors, allergens, or exacerbation of preexisting conditions<sup>30</sup>. It is known that cough is the symptom that most often leads individuals to medical care due to the discomfort and social embarrassment caused by it<sup>31</sup>. The worldwide prevalence of chronic cough (cough on most days in a period equal to or greater than three consecutive months) in a systematic literature review and meta-analysis was 9.6%<sup>29</sup>. The prevalence of cough found in a study carried out with the population of Barra Longa (state of Minas Gerais, Brazil), one year after the Fundão dam rupture, in Mariana, was 27.0%, which is the most reported symptom<sup>14</sup>. Although this and other symptoms were spontaneously reported in the study on Mariana, without a specific question about cough, the prevalence found in Brumadinho (23.6%) was similar to that observed in Barra Longa, suggesting a possible relationship between this symptom and the disaster. It is worth considering that the aforementioned worldwide prevalence is of chronic cough, and our study and that of Barra Longa reported the prevalence of cough with unknown duration, making it impossible to characterize the cough as chronic or not.

The report of dry cough was associated with level of education, smoking habit, and area of residence. The hypotheses for these associations corroborate those discussed for the report of wheezing, and may reflect the greater vulnerability of groups with lower socioeconomic status<sup>4,17</sup>, the influence of smoking on the inflammatory process of the airways<sup>1,4,15</sup>, and greater exposure to environmental toxic agents in those residing in an area directly affected by the mud after the dam rupture<sup>14</sup>.

The prevalence of rhinitis or coryza (runny nose) found in Barra Longa, Mariana, after the dam rupture was 14.6%, and that of respiratory allergy was 15.4%<sup>14</sup>. In the United States of America, the prevalence of allergic rhinitis, characterized by nasal symptoms (sneezing, runny nose, itchy, or stuffy nose) for seven days or more over a period of 12 months, was 30.2%<sup>18</sup>. In Brumadinho, the prevalence of people who had nose irritation in the 30 days prior to the interview was 31.8%, a value close to the prevalence reported in the North American population, although the question period and the symptom (nose irritation) evaluated in our study were different. Nevertheless, our results demonstrate the important burden of this symptom for the adult population of Brumadinho.

Factors associated with nose irritation in Brumadinho were similar to those for asthma. Women were more likely to report nose irritation as well as residents of the area directly affected by the mud. These factors are likely justified by the same reasons mentioned for asthma, that is, the great hormonal variation of women<sup>18,26,27</sup> and the possibility of greater exposure to dust in the area directly affected

by the mud. It is also noteworthy that asthma and rhinitis are diseases that often coexist in an individual, as the same inflammatory cells and the same mediators are part of the pathophysiology in the upper and lower airways, as it is a single airway<sup>32</sup>. Therefore, it makes sense that factors associated with asthma are the same as those associated with nose irritation.

Among the limitations of our study, we should mention the use of questions based on previous medical diagnosis for respiratory diseases, which may have underestimated the reported prevalence due to the need for evaluation by a specialist. These diseases are usually underdiagnosed, due to the fact that not everyone seeks medical care<sup>25</sup>. Despite this limitation, the self-reported diagnosis has been widely used in the literature for several chronic conditions<sup>4,6,12,13,25</sup>. Another limitation, inherent in the research design, is the impossibility of establishing temporal relationships between the outcomes and the exploratory variables, although the associations can demonstrate the groups that are more vulnerable to the studied conditions. Finally, we found no studies in the literature that evaluated the prevalence of asthma, COPD, and respiratory symptoms in a mining area or in a dam rupture region — in addition to the one carried out in Barra Longa<sup>14</sup>, in which health conditions were spontaneously reported, making comparisons difficult. Even when considering other populations, studies on the prevalence of specific respiratory symptoms are scarce and, when they exist, they show differences in relation to the evaluated symptom and the reference period.

Nonetheless, this research is important because of the scarcity of studies after the dam rupture and for indicating that areas affected by mud and mining areas had a higher prevalence of asthma and respiratory symptoms, which can socially and economically impact the municipality through absenteeism from work, school, and by the overburden in the health system, burdening the public treasury.

Our study is the first to be conducted in a representative sample of the population of Brumadinho, after the tailings dam rupture, enabling to assess the burden of these diseases and symptoms for the municipality and the most vulnerable groups. These results demonstrate that the high prevalence of respiratory diseases and symptoms can lead to greater demand for health services in regions with mining economic activity, especially in those that were directly affected by the mud after the dam rupture. Moreover, monitoring the population with respiratory diseases can help to understand how these conditions evolve and the possible medium- and long-term impacts on other health conditions and health services.

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## RESUMO

**Objetivo:** Identificar fatores associados a asma, doença pulmonar obstrutiva crônica (DPOC) e sintomas respiratórios em Brumadinho (MG), após rompimento de barragem. **Métodos:** Estudo transversal com amostra representativa de adultos. Verificaram-se associações entre variáveis dependentes (diagnóstico médico de asma e DPOC e os sintomas chiado no peito, tosse seca e irritação nasal) e variáveis exploratórias (sexo, faixa etária, tabagismo, ter trabalhado na Vale S.A. antes do rompimento da barragem, tempo e área de residência em relação ao rompimento da barragem). Modelos de regressão logística com cálculo da *odds ratio* e intervalo de confiança de 95% foram empregados. **Resultados:** Identificou-se prevalência de asma de 7,2%, de DPOC de 3,5%, de chiado no peito de 8,8%, de tosse seca de 23,6% e de irritação nasal de 31,8%. Maior chance de asma foi observada no sexo feminino e nos residentes em área diretamente atingida pela lama e área de mineração, enquanto maior chance de DPOC foi vista nos fumantes e naqueles com maior tempo de residência no município. Entre os sintomas, maior chance de irritação nasal foi observada no sexo feminino, e de chiado no peito e tosse seca em fumantes (atuais e no passado). Residentes em área atingida pela lama relataram maior chance de apresentarem todos os sintomas analisados. Já a escolaridade apresentou associação negativa com chiado no peito e tosse seca. **Conclusão:** O estudo mostrou alterações respiratórias e identificou os grupos com maior vulnerabilidade para desenvolvê-las, podendo contribuir com o direcionamento de ações para a redução de problemas respiratórios da população. Palavras-chave: Doença pulmonar obstrutiva crônica. Asma. Epidemiologia. Desastre. Mineração.

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