

## ORIGINAL ARTICLE



## Brumadinho Health Project: food and nutrition insecurity versus socioeconomic statuses and dimensions of the food system after the dam rupture

### Projeto Saúde Brumadinho: insegurança alimentar e nutricional *versus* condições socioeconômicas e dimensões do sistema alimentar após desastre

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## ABSTRACT

**Objective:** To describe the situation of food insecurity of families according to the socioeconomic characteristics and dimensions of the food system in Brumadinho, state of Minas Gerais, Brazil, after the dam rupture in Córrego do Feijão mine. **Methods:** This is a descriptive study focused on households carried out from the baseline of the Brumadinho Health Project. Food insecurity, the main outcome, was assessed by the short version of the Brazilian Food Insecurity Scale. Other investigated variables were: socioeconomic data; geographic stratum of the households; family's assets; income; expenses; cultivation of food and animal husbandry for consumption. Descriptive analyses were performed comparing the food insecurity of the household according to the other variables by the  $\chi^2$  test to compare the proportions.

**Results:** Of the investigated households (n=1,441), 35.1% were facing food insecurity. facing food insecurity had: lower prevalence of masonry households with coating (91.4%; 95%CI 87.7%–94.1% vs. 96.7%; 95%CI 94.9%–97.8%); highest proportion of rudimentary cesspit (16.9%; 95%CI 13.3%–21.2% vs. 9.4%; 95%CI 7.4–11.9); lower prevalence of own and paid-off homes (63.9%; 95%CI 56.8–70.5 vs. 77.3%; 95%CI 72.3–81.7); and income reduction after the dam rupture (33.0%; 95%CI 27.1–39.6 vs. 14.1%; 95%CI 11.2–17.6), when compared with those in a food security situation. **Conclusion:** The prevalence of food insecurity was high, with report of a reduction in household income after the dam rupture. Moreover, most of the households had worse structural quality and sewage outfall. These results evidence the vulnerability of families and possible violation of the human right to adequate food, denoting the urgency of continuous reparative actions.

**Keywords:** Structure collapse. Man-made disasters. Socioeconomic factors. Health. Food security.

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## INTRODUCTION

Disasters are events that result in the interruption of the normal functioning of a community, affecting its daily life and resulting in material, economic, environmental, and health losses<sup>1</sup>. These events mobilize the entire health structure and can distance the population from healthy and sustainable food systems and, therefore, expose them to food and nutrition insecurity (FNI). FNI occurs when the right of regular and permanent access to quality food in sufficient quantity is not guaranteed<sup>2</sup>.

In Brazil, in 2019, the disaster caused by the rupture of the tailings dam at the Córrego do Feijão mine, in Brumadinho, state of Minas Gerais<sup>3</sup>, stood out.

Industrial production systems, such as mining, are constantly denounced for their unsustainability and damage to the environment and health. In Brumadinho, mining is a historic activity, and its production system, as well as that of other mining companies, degrades natural resources and produces tons of tailings<sup>3,4</sup>, which, in Brumadinho, were stored in dams, using a method not entirely safe yet<sup>5</sup>.

This disaster involved, among other aspects, the loss of land, soil and water contamination, configuring an obstacle to food and nutrition security (FNS)<sup>6-9</sup>. However, Brumadinho had probably already been experiencing a scenario of violations of the Human Right to Adequate Food, considering the return of Brazil to the map of hunger and recession in the country. In this sense, the dam rupture demonstrated a devastating panorama, denoting the urgency of this investigation.

Furthermore, little is known about the impacts of this disaster on the productive capacity of small producers. Taking this into consideration, this article aimed to describe the food insecurity (FI) of families according to socioeconomic characteristics and dimensions of food systems after the disaster.

## METHODS

### Study design and location

This is a descriptive study developed based on household data from the baseline of the Brumadinho Health Project (*Projeto Saúde Brumadinho*)<sup>10</sup>.

Brumadinho is a Brazilian municipality in the south-east macro-region of the country with 643.52 km<sup>2</sup>, located in the metropolitan region of Belo Horizonte. In 2018, its estimated population was 39,520 inhabitants, composed of 52.1% people who self-reported to be black and mixed-race. The municipal human development index of the municipality is 0.747 (2010), and its main economic activities are mining and agriculture and livestock farming<sup>11</sup>.

In January 2019, the municipality experienced a disaster that released about 11.7 million cubic meters of mud and resulted in hundreds of fatalities<sup>7-10</sup>.

### Study population and sample

For the sample design, three estimation domains were considered:

1. Households directly affected by the rupture of the tailings dam at the Córrego do Feijão mine;
2. Households located in areas with mining activity; and
3. Households located in areas not directly affected by the rupture of the dam or mining activity<sup>10</sup>.

In domains 1 and 2, all households were eligible to participate in the study. In domain 1, residents of the Córrego do Feijão region at the time of the disaster were included, in addition to those who no longer lived there. Conversely, in domain 3, households from other regions of Brumadinho were included<sup>10</sup>.

The sample design also considered the stratification of the research population by census tract. In all the households visited, residents aged 18 years and over were invited to answer questions about the household<sup>10</sup>.

For the sizing of the sample, the balance between affected individuals (by mud or mining activity) and those not affected was considered. Thus, the sample size of the unaffected area was estimated specifying a minimum proportion equal to 3%, with a relative margin of error for the estimation of, at most, 45%, and a confidence coefficient equal to 95% (1- $\alpha$ ). As the sample was stratified, an estimate of the sample design effect (SDE) of 1.1 was also considered. Sample weights were estimated for each of the interviewed households, so as to produce estimates with a lower margin of error<sup>10</sup>.

### Study variables

Data were obtained by face-to-face interviews<sup>10</sup>. Household data were analyzed, including: FI; socioeconomic data; geographic stratum of the households; family's assets, income, and expenses; cultivation of food and animal husbandry for own consumption.

### Food insecurity: outcome variable

The Brazilian Food Insecurity Scale (*Escala Brasileira de Insegurança Alimentar* – EBIA), short version, was used to assess FI of the families participating in the Brumadinho Health Project. This version of EBIA is composed of eight closed-ended questions (yes/no). For each positive question (yes), a point is assigned<sup>12,13</sup>.

The EBIA analysis was based on the final score gradient resulting from the sum of affirmative answers to the questions. For analysis purposes, the final score was categorized into food security (FS) (0 point) or FI (>0 point)<sup>12,13</sup>.

### Other variables

The investigated socioeconomic variables referred to: characteristics of the households, assets, the household residents' income, and the household expenses, including food. Furthermore, the geographic stratum in which the

household was located (directly affected/mining region/ other regions) was investigated.

As for the characteristics of the household, the following were investigated: number of residents; whether the house was the same as before the disaster (yes/no); type of materials of the external walls (masonry or other material); number of rooms and bathrooms; electricity (yes/no); sewage outfall (general sewage system; septic tank; rudimentary cesspit; others, such as ditch or land, direct to river, stream, or lake); and waste disposal.

As for the assets, the following were evaluated: ownership situation of the household currently and before the dam rupture (own and paid-off house; own house, but not paid off; rented; relative's or friend's house, loaned, or other condition) and if this situation changed after the dam ruptured (yes/no). Loaned property was considered when the participant reported that the house was granted by a relative, employer, or other.

Variables related to household income were investigated, such as: current total income (in the Brazilian currency *reais* [BRL]); whether the income changed after the dam rupture (yes/no); whether participants were beneficiaries of the Bolsa Família Program (*Programa Bolsa Família* – PBF)<sup>1</sup> (yes/no); whether participants received the Continuous Welfare Benefit (*Benefício Assistencial de Prestação Continuada* – BPC)<sup>2</sup> (yes/no); and whether they received or receive a benefit due to the dam rupture (yes/no). Moreover, the authors investigated whether household expenses with food changed after the dam rupture (yes/no).

Additionally, current practices and those before the dam rupture for fruit and vegetable cultivation and animal husbandry were investigated. It is noteworthy that, in this study, food cultivation and animal husbandry were analyzed as one of the dimensions of food systems.

### Statistical analysis

The descriptive analyses performed consisted of frequency distributions for categorical variables and measures of central tendency and dispersion for continuous variables. Data were presented as percentage or mean and respective 95% confidence intervals (95%CI).

Significant differences between the prevalence values were identified by Pearson's  $\chi^2$  statistical test with Rao-Scott correction. In cases in which there were significant differences, two-by-two comparisons were made with Bonferroni correction.

The analyses were performed in the STATA software using the *svy* command, which considers the calibrated weight of the household and correction for the design effect.

### Ethical aspects

The study was approved by the Research Ethics Committee (process No.: 20814719.5.0000.5091), and all respondents agreed to and signed the Informed Consent Form.

## RESULTS

Of the total number of families investigated ( $n=1,441$ ), 35.1% were facing FI, with no significant differences according to geographic stratum of the household ( $p=0.078$ ) (Table 1).

Approximately 80% of the investigated families remained in the same households after the dam rupture. The average number of residents per household was  $2.7\pm 2.3$ , being statistically higher among families facing FI when compared with those in FS ( $2.9\pm 9.4$  vs.  $2.6\pm 6.3$ ,  $p=0.025$ ) (Table 1).

As for the characteristics of the households, most of them had electricity (99.3%), and the waste was directly collected by the municipal cleaning service (95.9%). Nevertheless, families facing FI lived in households with fewer rooms and bathrooms when compared with the others ( $p<0.001$ ).

Most households had masonry walls with coating (94.9%), and this prevalence was statistically lower among families facing FI (91.4% vs. 96.7%,  $p=0.004$ ) (Table 1).

Half of the households had a general sewage system, with no differences concerning the FS situation of the families. However, when investigating other types of sanitation, we found that 36.5% of the households had a septic tank and 12.0% had a rudimentary cesspit, with the prevalence of rudimentary cesspit being higher when compared with those in FS (16.9 vs. 9.4%,  $p=0.001$ ) (Table 1).

In Table 2 we present the housing situation currently and before the dam rupture as well as the assets, income, and expenses of families according to the FI situation. Over 70% of the investigated households were own and paid-off, with this prevalence being lower among families facing FI (63.9 vs. 77.3%,  $p=0.005$ ). A similar trend was observed when we investigated the situation before the dam rupture, with the prevalence of own and paid-off households also being lower among families facing FI (70.2 vs. 80.7%,  $p=0.024$ ).

The average income of families was BRL  $2,088.00\pm 104.20$ , being lower among those facing FI when compared with the others (BRL  $1,209.90\pm 105.24$  vs.  $2,607.22\pm 176.02$ ,  $p<0.001$ ). Families in FI reported even lower income maintenance (30.2 vs. 44.2%,  $p<0.001$ ) and its greatest reduction after the dam rupture (33.0 vs. 14.1%,  $p<0.001$ ) when compared with those in FS. When investigating the lack of change in household expenses after the dam rupture, we observed a lower prevalence of affirmative answers to this question among families facing FI compared with those in FS (16.1 vs. 32.5%,  $p<0.001$ ). Furthermore, less than 2% of families received BPC, and approximately 7% were PBF beneficia-

1 Brazilian conditional direct cash transfer program aimed at households in extreme poverty or poverty situation.

2 Social Assistance Benefit targeted at people aged 65 or over and persons of any age with disabilities who can prove that they have no means of supporting themselves or being supported by their families.

**Table 1. Characteristics and geographic stratum of the household according to the families' food insecurity situation. Brumadinho Health Project. Brumadinho (MG), Brazil, 2021.**

Variables	Total (n=1,441) % (95%CI)	FI (n=499) % (95%CI)	FS (n=942) % (95%CI)	p-value
Number of people in the household; mean±standard deviation	2.7±2.3	2.9±9.4	2.6± 6.3	<b>0.025*</b>
Kept living in the household after the dam rupture	78.1 (74.3–81.5)	77.4 (70.2–83.2)	78.6 (73.5–83.0)	0.774 <sup>†</sup>
Geographical stratum of the household				
Not directly affected	96.2 (96.2–96.2)	96.3 (95.8–96.8)	96.1 (95.8–96.4)	0.078 <sup>†</sup>
Directly affected	2.4 (2.4–2.4)	2.0 (1.7–2.4)	2.6 (2.4–2.8)	
Mining region	1.4 (1.4–1.4)	1.7 (1.3–1.9)	1.3 (1.1–1.4)	
Electric lighting	99.3 (98.7–99.7)	99.2 (98.0–99.7)	99.4 (98.3–99.8)	0.615 <sup>†</sup>
Material on the external walls of the household				
Masonry with coating	94.9 (93.3–96.1)	91.4 (87.7–94.1) <sup>a</sup>	96.7 (94.9–97.8) <sup>b</sup>	<b>0.004<sup>†</sup></b>
Masonry without coating	3.4 (2.5–4.8)	6.2 (4.1–9.4) <sup>a</sup>	2.0 (1.1–3.5) <sup>b</sup>	
Wood, straw, uncoated adobe walls, or other material	1.7 (1.0–2.7)	2.3 (0.1–5.4)	1.3 (0.1–2.4)	
Number of rooms, mean±standard deviation	7.0±9.2	6.5±15.5	7.5±12.8	<b>&lt;0.001*</b>
Number of bathrooms, mean±standard deviation	1.9±0.4	1.9±0.4	1.4±0.6	<b>&lt;0.001*</b>
Sewage outfall				
General sewage system	50.0 (48.6–51.3)	52.3 (46.9–57.7)	48.4 (45.2–51.7)	<b>0.001<sup>†</sup></b>
Septic tank	36.5 (34.6–38.5)	29.6 (24.1–35.8) <sup>a</sup>	40.5 (37.1–44.0) <sup>b</sup>	
Rudimentary cesspit	12.0 (10.2–13.7)	16.9 (13.3–21.2) <sup>a</sup>	9.4 (7.4–11.9) <sup>b</sup>	
Other (ditch or land; direct to river or stream; others)	1.4 (0.1–2.2)	0.1 (0.0–2.5)	1.6 (0.1–2.7)	
Waste disposal				
Directly collected by cleaning service	95.9 (94.7–96.7)	96.1 (94.0–97.5)	95.7 (94.0–96.9)	0.533 <sup>†</sup>
Burnt or buried	2.4 (1.6–3.6)	1.9 (0.1–4.0)	2.7 (1.7–4.4)	
Other	1.7 (1.4–2.0)	1.9 (1.1–3.0)	1.6 (1.0–2.4)	

FI: food insecurity; FS: food security. Different letters in the lines indicate that prevalence values differed. Bold indicates statistical differences. Food (In)security, assessed by the Brazilian Food Insecurity Scale – 8-item version. \*Student's *t*-test; <sup>†</sup>Pearson's  $\chi^2$  statistical test with Rao-Scott correction.

ries, with this prevalence being higher among those facing FI ( $p=0.015$ ) (Table 2).

The animal husbandry and the cultivation of fruits/vegetables for consumption currently and before the dam rupture were above 85%, with no statistical differences according to the FI situation of the families. We identified an exception for animal husbandry before the disaster. Families facing FI raised animals less frequently when compared with those in FS (88.5 vs. 95.5%,  $p=0.004$ ) (Table 3).

## DISCUSSION

We found a high prevalence of FI in Brumadinho. Families facing FI, when compared with those in FS, reported lower per capita income, with a reduction after the dam rupture, higher number of people in the household, and greater proportion of PBF beneficiaries. In addition, these families lived in households with poorer structural quality, fewer rooms and bathrooms, external walls without coating, and primary sanitation systems.

FNI is a critical global issue<sup>14</sup>. It is estimated that, in 2020, 2.3 billion of the world's population did not have sufficient access to food<sup>15</sup>. In Brazil, the Consumer Expenditure Survey (*Pesquisa de Orçamento Familiar* – POF 2017-2018) showed that 36.7% of Brazilian families faced some level of FI<sup>16</sup>. In 2020, results from the National Survey on FI in the context of the COVID-19 pandemic, conducted by the Brazilian Research Network on Food and Nutrition Sover-

eignty and Security (*Rede Brasileira de Pesquisa em Soberania e Segurança Alimentar e Nutricional* – PENSSAN Network), showed that 55.2% of families faced FI, an increase of 54% compared with 2018 (36.7%). The number of individuals in severe FI, that is, in situation of hunger, reached 19 million Brazilians<sup>17</sup>. In the second edition of the survey, carried out in 2022, it was found that 58.7% of the population faced some degree of FI and 33.1 million faced severe FI<sup>18</sup>.

Access to food and FI has also been investigated at critical moments in the country, such as the 2014-2015 economic crisis<sup>19</sup> and, more recently, during the truck drivers' strike<sup>20</sup> and the COVID-19 pandemic with the closure of commercial establishments<sup>21</sup>. Researchers found that the Brazilian economic crisis of 2014-2015 was associated with a sharp increase in the prevalence of FI in the state of Alagoas<sup>19</sup>. Conversely, the truck drivers' strike was associated with a reduction in the availability and variety of food and an increase in the prices of fruit and vegetables<sup>20</sup>. Strategies to combat the COVID-19 pandemic related to the closing of commercial establishments, in turn, may have reduced the demand for fresh food<sup>21</sup>.

The prevalence of FI in Brumadinho, despite being similar to national data, promotes an additional reflection for resulting from a disaster. In Brumadinho, the disaster promoted a profound transformation in the natural, social, and built environment. For instance, a documentary analysis of the disaster similar to our study demonstrated that FI took place by the impossibility of fishing, the devastation of

**Table 2. Family's assets, income, and expenses according to the families' food insecurity situation. Brumadinho Health Project. Brumadinho (MG), Brazil, 2021.**

Variables	Total (n=1,441) % (95%CI)*	FI (n=499) % (95%CI)*	FS (n=942) % (95%CI)*	p-value
Assets				
Current housing situation				
Own and paid-off	72.6 (68.7–76.2)	63.9 (56.8–70.5) <sup>a</sup>	77.3 (72.3–81.7) <sup>b</sup>	0.005 <sup>†</sup>
Own house, but not paid off	4.8 (2.9–7.7)	4.2 (2.0–8.6)	5.1 (2.6–9.8)	
Rented	13.9 (11.4–16.8)	17.7 (13.1–23.5) <sup>a</sup>	11.7 (9.0–15.2) <sup>b</sup>	
Relative's or friend's house, loaned, or other condition*	8.7 (6.3–11.8)	14.1 (9.0–21.6) <sup>a</sup>	05.8 (4.2–8.0) <sup>b</sup>	
Housing situation before the dam rupture				
Own and paid-off	77.1 (73.1–80.6)	70.2 (63.7–75.9) <sup>a</sup>	80.7 (75.4–85.1) <sup>b</sup>	0.024 <sup>†</sup>
Own house, but not paid off	5.1 (3.1–8.2)	4.6 (2.2–9.4)	5.3 (2.7–10.4)	
Rented	14.6 (12.0–17.6)	19.4 (14.4–25.6) <sup>a</sup>	11.9 (9.1–15.4) <sup>b</sup>	
Relative's or friend's house, loaned, or other condition*	3.2 (2.0–5.1)	5.8 (3.2–10.2) <sup>a</sup>	2.0 (1.0–3.8) <sup>b</sup>	
Income				
Beneficiary of the Bolsa Família Program <sup>‡</sup>	6.8 (5.2–8.8)	10.0 (7.0–14.1)	5.1 (3.4–7.7)	0.015 <sup>†</sup>
Continuous Welfare Benefit	1.6 (0.1–2.8)	1.8 (0.1–3.6)	1.2 (0.0–3.2)	0.465 <sup>†</sup>
Total household income (in BRL); mean±standard deviation	2,088.00±104.20	1,209.90±105.24	2,607.22±176.02	<0.001 <sup>§</sup>
Household income after the dam rupture				
It did not change	39.4 (35.5–43.4)	30.2 (24.5–36.5) <sup>a</sup>	44.2 (39.6–48.9) <sup>b</sup>	<0.001 <sup>†</sup>
It increased	39.9 (36.1–43.8)	36.8 (30.3–43.8) <sup>a</sup>	41.7 (37.3–46.2) <sup>b</sup>	
It decreased	20.7 (17.9–23.7)	33.0 (27.1–39.6) <sup>a</sup>	14.1 (11.2–17.6) <sup>b</sup>	
Receives/received benefits due to the dam rupture	89.3 (86.8–91.3)	90.5 (86.1–93.6)	88.8 (85.6–91.3)	0.486 <sup>†</sup>
Expenses				
Household expenses after the dam rupture				
It did not change	27.0 (23.6–30.7)	16.1 (11.9–21.5) <sup>a</sup>	32.5 (28.2–37.0) <sup>b</sup>	<0.001 <sup>†</sup>
It increased	72.1 (68.4–75.4)	82.3 (76.9–86.8)	66.8 (62.3–71.1)	
It decreased	0.1 (0.0–1.8)	1.5 (0.0–4.0)	0.1 (0.0–1.8)	
Food expenses after the dam rupture				
It did not change	6.3 (3.8–10.3)	5.7 (1.7–17.2)	6.7 (4.4–10.2)	0.617 <sup>†</sup>
It increased	95.5 (88.6–95.2)	92.5 (82.2–97.1)	92.5 (88.9–95.0)	
It decreased	1.2 (0.1–2.5)	1.8 (0.0–5.2)	0.1 (0.0–2.3)	

FI: food insecurity; FS: food security. Food (In)security, assessed by the Brazilian Food Insecurity Scale – 8-item version. Equal letters in the columns indicate that the prevalence values did not differ from each other, while different letters indicate differences between the categories of the variable. Columns without letters indicate that there was no difference between the prevalence values. Bold indicates statistical differences.

\*Loaned by a relative or not, or by an employer; <sup>†</sup>Pearson's  $\chi^2$  statistical test with Rao-Scott correction; Current Auxílio Brasil Program; <sup>§</sup> Student's *t*-test.

**Table 3. Prevalence (%) of food cultivation and animal husbandry for domestic consumption, currently and before the dam rupture, according to the families' food insecurity situation. Brumadinho Health Project. Brumadinho (MG), Brazil, 2021.**

Variables	Currently		p-value*	Before the dam rupture		p-value*
	FI	FS		FI	FS	
	% (95%CI)	% (95%CI)		% (95%CI)	% (95%CI)	
Growing fruits and/or vegetables	98.3 (94.9–99.4)	96.8 (94.4–98.2)	0.327	91.5 (84.5–95.5)	95.9 (93.1–97.6)	0.101
Animal husbandry for domestic consumption (chicken, pig, goat, and cattle)	90.0 (81.9–95.4)	94.5 (89.0–97.3)	0.299	88.5 (80.2–93.6)	95.5 (91.1–97.8)	<b>0.004</b>

FI: food insecurity; FS: food security. Food (In)security, assessed by the Brazilian Food Insecurity Scale – 8-item version. Bold indicates statistical differences. \*Pearson's  $\chi^2$  statistical test with Rao-Scott correction.

cultivation and pasture areas, and the uncertainty of food innocuousness<sup>22</sup>.

It is likely that the lower productivity of small farmers and fishermen due to the disaster may have had a negative impact on the availability of food, leading to an increase in prices in food stores. In the social environment, the loss of the local food culture was notorious. Brumadinho was prominent for its multiple festivals, such as the Jaboticaba, Tangerine, and Corn Festivals, which had to be suspended<sup>11</sup>.

The hiatus caused by this cultural damage associated with the loss of family members, photographs, books, and other personal belongings are also deemed as violations of the Human Right to Adequate Food.

We verified a lower per capita income among families facing FI, with a reduction after the dam rupture as well as a greater number of people receiving the PBF benefit. The reduction in income and the inefficiency in the management of damages and compensation for victims can



make the FI condition even more complex<sup>4</sup>. Likewise, the extinction and restructuring of successful programs, such as the PBF, replaced by the Auxílio Brasil Program, with unclear rules and an undefined budget, can affect families.

The lower prevalence of own and paid-off households, associated with the higher proportion of uncoated masonry houses, may indicate the lower purchasing power of families facing FI. Similarly, according to the 2019 Continuous National Household Sample Survey (Continuous PNAD), the poorest regions of the country had the highest prevalence of loaned and uncoated houses<sup>23</sup>.

Regarding alternative forms of sanitation, families facing FI had a higher prevalence of rudimentary cesspits and a lower prevalence of septic tanks. Rudimentary cesspits are pits or holes dug in the ground, without waterproofing or with partial waterproofing. This route of sanitation, therefore, can affect the groundwater and cause the spread of diseases<sup>24</sup>. This suggests greater precariousness of families facing FI in the municipality.

Structural differences in the households of families in a situation of FI have also been identified in other studies. POF data analyses (2008–2009) indicated that the prevalence of FI was associated with poor housing conditions, worse lighting, worse waste collection and sanitation services<sup>25</sup>.

These socioeconomic and structural inequalities of households, as well as the vulnerability of the population prior to the disaster, can potentiate FI and directly affect the impacts of the disaster. The lack or reduction of income, unemployment, housing deficiencies, insufficient access to education, and precarious health conditions are directly interrelated with the worsening of FI, as shown by the last survey of the PENSSAN Network<sup>18</sup>.

This current FI scenario is triggered after a series of political and economic events in the country. The years from 2014 to 2016 were marked by a serious economic and political crisis. Subsequently, a new tax regime was approved by the Constitutional Amendment No. 95, which entailed the freeze of spending on health and education<sup>26–28</sup>. At the same time, labor and social security laws were revised, reducing workers' social security<sup>26–28</sup>. In 2019, the National Council for Food Security and Nutrition (*Conselho Nacional de Segurança Alimentar e Nutricional* – CONSEA) was extinguished, compromising the functioning of the National Food and Nutrition Security System (*Sistema de Segurança Alimentar e Nutricional* – SISAN)<sup>29</sup>. All these issues weakened social policies and FS in Brazil and probably in Brumadinho as well.

One aspect that can contribute to the FS of families is the cultivation of food and the animal husbandry for domestic consumption, especially regarding the most vulnerable population. The production of food is less expensive than the purchase in commercial establishments. Moreover, animal husbandry can produce, in addition to meat, products such as eggs and milk, complementing food.

Domestic food production is associated with FS for both economic and nutritional aspects, in addition to promoting appreciation of local production, self-sufficiency, and sustainability. In addition, families that produce their own food know its origin and value assured quality<sup>30</sup>. This result shows the need for remedial actions that focus on FS to address issues related to domestic food production.

Food production and animal husbandry can also contribute to increasing household income. However, in recent years, there has been a significant reduction in the financing of programs to encourage family farming. Likewise, we can mention the reduction of public inventory of the National Supply Company (*Companhia Nacional de Abastecimento* – CONAB), which could guarantee the price and income of the producer and mitigate fluctuations in food prices.

In parallel to austerity policies and Brazil's return to the hunger map, the flexibilization of environmental legislation is accelerating. This legislative framework may have directly affected the municipality of Brumadinho<sup>4</sup>.

In Brazil and in the world, mining companies have the strength to influence power relations so that they benefit from them. In this sense, the environmental system seems to adjust to the economic interests of large corporations<sup>4</sup>. Part of this discourse is justified by the economic development produced by mining in the municipalities. Nonetheless, it is known that mining is a short-term activity with little articulation with other sectors of the economy, in addition to harming the environment. In this sense, the economic advances achieved in the short- and medium-terms do not necessarily contribute to the reduction of social inequalities, the eradication of poverty, and sustainable development<sup>4</sup>, which are key aspects for guaranteeing the Human Right to Adequate Food.

Our results are unprecedented and relevant, but their interpretation requires caution. Using the short version of the EBIA limits the investigation of FI levels of families and does not allow the analysis of the nutritional dimension of the FNS concept. However, to date, there is no validated scale available in Brazil that encompasses such complexity. As for the fact that the short version of the EBIA was used, it is noteworthy that this scale was developed by the same authors as the original scale, with good results. Furthermore, its use is recommended in large epidemiological studies, which have limitations in terms of interview time and/or funding resources for data collection<sup>13</sup>.

Another limitation of our study concerns the time difference between the time of the disaster (2019) and data collection (2021), which may have generated information bias, especially due to the COVID-19 pandemic. Nevertheless, it was not possible to control such effects.

Conversely, this is the first quantitative study to assess the FI situation of families after a disaster of these proportions, being a differential in the national and international literature. A subsequent step in understanding

this phenomenon should involve performing multivariate and multilevel analyses. We should also mention the importance of carrying out longitudinal analyses of data on food cultivation and animal husbandry to better investigate food systems.

The prevalence of FI among families after the dam rupture denotes the urgency of implementing continuous actions aimed at guaranteeing this right. In addition, the worst socioeconomic and structural conditions of households can directly influence the impacts of the disaster on the population's diet, which could worsen in the coming decades due to the country's return to the hunger map.

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## RESUMO

**Objetivo:** Descrever a situação de insegurança alimentar das famílias segundo as características socioeconômicas e dimensões do sistema alimentar em Brumadinho, Minas Gerais, Brasil, após desastre. **Métodos:** Estudo descritivo com foco no domicílio realizado pela linha de base do Projeto Saúde Brumadinho. A insegurança alimentar, desfecho principal, foi avaliada pela Escala Brasileira de Insegurança Alimentar curta. Outras variáveis investigadas foram: socioeconômicas; estrato geográfico do domicílio; ativos (bens); renda; despesas familiares; cultivo de alimentos e criação de animais para consumo. Foram realizadas análises descritivas comparando a insegurança alimentar do domicílio segundo as demais variáveis pelo teste  $\chi^2$  para comparação das proporções. **Resultados:** Dos domicílios investigados (n=1.441), 35,1% estavam em situação de insegurança alimentar. As famílias em insegurança alimentar apresentavam: menores prevalências de domicílios de alvenaria com revestimento (91,4%; IC95% 87,7%-94,1% vs. 96,7%; IC95% 94,9%-97,8%); maior proporção de fossa rudimentar (16,9%; IC95% 13,3%-21,2% vs. 9,4%; IC95% 7,4-11,9); menor prevalência de domicílios próprios e quitados (63,9%; IC95% 56,8-70,5 vs. 77,3%; IC95% 72,3-81,7); e redução da renda após o rompimento da barragem (33,0%; IC95% 27,1-39,6 vs. 14,1%; IC95% 11,2-17,6), quando comparadas àquelas em segurança alimentar. **Conclusão:** A prevalência de insegurança alimentar foi elevada, com relato de redução da renda das famílias após o rompimento da barragem. Ademais, boa parte dos domicílios apresentava pior qualidade estrutural e escoamento de esgoto. Esses resultados evidenciam a vulnerabilidade das famílias e possível violação do direito humano à alimentação adequada, denotando a urgência de ações reparadoras contínuas.

**Palavras-chave:** Colapso estrutural. Desastres provocados pelo homem. Fatores socioeconômicos. Saúde. Segurança alimentar e nutricional.

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