

Between Suffering and Silence: Mental Health Hospitalizations after the Brumadinho Dam Disaster

1. INTRODUCTION

On January 25, 2019, the collapse of the Córrego do Feijão mine tailings dam in Brumadinho (Minas Gerais, Brazil) released approximately 12 million cubic meters of mining waste, devastating communities, waterways, and ecosystems along the Paraopeba River (Ibama, 2019). The disaster caused 272 direct deaths and profoundly affected the region's socioeconomic structure. As argued by Siena & Valencio (2009), the event powerfully exposed pre-existing vulnerabilities inherent to the mining model in Minas Gerais.

From a sociological perspective, the Brumadinho collapse exemplifies what Valencio (2016) and Zhouri (2023) call "socially constructed disasters," where risks and human losses result from political and economic decisions that normalize socio-environmental inequality. These vulnerabilities extend to the health domain: international research indicates that exposure to environmental disasters can trigger anxiety disorders, depression, and post-traumatic stress (Freitas et al., 2019).

Qualitative studies in Brumadinho and Mariana point to profound and prolonged psychological impacts, especially among women and children (Freitas et al., 2019). However, quantitative analyses measuring these effects at the municipal scale using public health administrative data remain scarce.

Objective: This study examines whether the Brumadinho dam collapse was associated with changes in hospitalization rates for mental and behavioral disorders (ICD-10, Chapter V) in 18 affected municipalities of the Paraopeba River Basin between 2010 and 2023, emphasizing gender, age, and territorial dimensions.

2. METHODS

2.1 Data Source and Variables

We used data from Brazil's Hospital Information System (SIH-SUS/DATASUS) for 2010–2023, which records hospitalizations in public and SUS-affiliated facilities, including

diagnosis (ICD-10), sex, age, and municipality of residence (Brasil, 2022). Data were aggregated by municipality, year, sex, and age group (0–14, 15–39, 40–59, 60+ years). Hospitalization rates were calculated using harmonized annual population estimates combining 2010 Census data (IBGE) and RIPSAs intercensal estimates.

2.2 Study Design

The Paraopeba River Hydrographic Basin (BHRP) comprises 48 municipalities. We classified them as: Treatment group (n=18): municipalities affected by tailings, located in the middle basin (IBGE, 2019); Control group (n=17): non-affected municipalities in the upper basin. The observation period was divided into "before" (2010–2018), "during" (2019), and "after" (2020–2023). It is important to note SIH-SUS covers only hospital admissions, excluding outpatient care and private services. The COVID-19 pandemic (2020–2021) significantly affected bed availability.

2.3 Statistical Analysis

We applied a Difference-in-Differences (DiD) model with municipality and year fixed effects, comparing temporal trends in hospitalization rates between affected and non-affected municipalities before and after 2019:

$$\log(Y_{it}) = \beta_0 + \beta_1(\text{Treated}_i \times \text{Post}_t) + \mu_i + \lambda_t + \log(\text{Pop}_{it})$$

Where Y_{it} represents hospitalizations in municipality i at year t ; $\text{Treated}_i \times \text{Post}_t$ estimates the disaster effect; μ_i and λ_t are municipality and year fixed effects; $\log(\text{Pop}_{it})$ is the population offset.

After overdispersion testing ($z=10.79$, $p<0.001$), models were estimated via Negative Binomial regression with robust standard errors clustered by municipality. Results are presented as Incidence Rate Ratios (IRR): values >1 indicate increased hospitalizations; <1 indicate reductions.

3. RESULTS

3.1 Overall Effects

Table 1 presents main disaster effects on hospitalizations. No statistically significant increase was observed after the collapse: Immediate effect (2019): IRR = 1.03 (95% CI: 0.86–1.23; p=0.75) and Aggregated effect (2019–2023): IRR = 1.09 (95% CI: 0.90–1.30; p=0.35).

Term	Estimate	95% CI (Lower–Upper)	p-value	Interpretation
Immediate effect (D_imediato)	1.0277	0.8624 – 1.2256	0.753	No statistically significant effect
Aggregated effect (D_agregado)	1.0856	0.9047 – 1.3027	0.3539	No statistically significant effect

Nota: Incidence Rate Ratio. Estimates obtained from **Negative Binomial regression** with log-link, municipality and year fixed effects, and 95% robust standard errors clustered by municipality.

3.2 Stratified Results by Sex and Age

Table 2 presents subgroup results, revealing two relevant patterns: Girls aged 0–14 years: downward trend in hospitalizations post-disaster (IRR=0.38 immediate; IRR=0.43 aggregated), though not statistically significant and Men aged 15–39 years: significant reduction in the aggregated period (IRR=0.74; 95% CI: 0.56–0.99; p=0.037).

Sex	Age group	Term	IRR	95% CI (Lower–Upper)	p-value
Female	0–14	Immediate	0.38	[0.06 – 1.85]	0.244
Female	0–14	Aggregated	0.43	[0.15 – 1.16]	0.101
Female	15–39	Immediate	01.06	[0.58 – 1.94]	0.858
Female	15–39	Aggregated	0.84	[0.59 – 1.19]	0.316
Female	40–59	Immediate	1.26	[0.70 – 2.30]	0.439
Female	40–59	Aggregated	0.92	[0.66 – 1.28]	0.605
Female	60+	Immediate	01.03	[0.35 – 3.01]	0.961
Female	60+	Aggregated	0.96	[0.54 – 1.69]	0.883
Male	0–14	Immediate	0.58	[0.07 – 3.86]	0.584
Male	0–14	Aggregated	0.97	[0.26 – 3.62]	0.965
Male	15–39	Immediate	0.93	[0.56 – 1.56]	0.793
Male	15–39	Aggregated	0.74	[0.56 – 0.99]	0.037
Male	40–59	Immediate	1.17	[0.68 – 2.02]	0.576

Male	40–59	Aggregated	1.21	[0.88 – 1.65]	0.229
Male	60+	Immediate	1.10	[0.54 – 2.25]	0.790
Male	60+	Aggregated	0.92	[0.60 – 1.40]	0.695

Nota: Incidence Rate Ratio. Estimates obtained from Negative Binomial regression with log-link, municipality and year fixed effects, and 95% robust standard errors clustered by municipality.

4. DISCUSSION AND CONCLUSIONS

This study found no statistical evidence of increased hospitalizations for mental disorders in municipalities affected by the Brumadinho dam collapse. However, this absence should not be interpreted as absence of psychological suffering, but rather as an epidemiological paradox: the intensification of suffering coexisting with the retraction or invisibility of formal care.

Three factors explain this pattern. First, SIH-SUS covers only hospitalizations, excluding outpatient, emergency, and mental health follow-up care — the predominant forms of treatment for common disorders. Institutional collapse and the COVID-19 pandemic (2020-2021) may have further reduced registration capacity and bed availability. Second, studies on technological disasters highlight that mental health conditions remain underreported, especially among women, youth, and informal workers (Freitas et al., 2019; Catalán-Vázquez & Riojas-Rodríguez, 2015). In disaster territories, care often shifts to community or informal circuits that generate no administrative records. Third, the significant reduction among young men (15–39 years) may relate to labor factors, stigma, or post-disaster migration, while the downward trend among girls (0–14 years) may reflect prioritization of adult beds and underreporting of child/adolescent cases.

These findings align with international literature indicating that isolated hospital indicators inadequately capture long-term psychosocial suffering (WHO, 2013). The apparent stability masks complex processes of vulnerabilization and access inequalities mediated by gender, age, and territory. Our results reinforce the need for integrated surveillance systems combining hospital data with outpatient care (SIA/SUS) and self-inflicted violence records (SINAN), alongside mixed-methods approaches to comprehend the full spectrum of post-disaster mental health impacts and inform policies responsive to structural inequalities in mining territories.

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