ISSN (e): 2250 – 3005 || Volume, 16 || Issue, 2|| February – 2026 ||
International Journal of Computational Engineering Research (IJCER)

"Silent Epidemic": Spatial Analysis of Self-Reported Morbidity and Distance-Decay Effects in Mining-Impacted Communities of Abakaliki, Nigeria.

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ABSTRACT

Artisanal and small-scale mining activities in sub-Saharan Africa are largely unregulated, posing a threat to neighboring communities through environmental contamination, which is reflected in terms of morbidity. This study, which used a mixed-methods approach that involves geochemical analysis, questionnaires, hospital records, and interviews, examines the spatial epidemiology of diseases associated with mining activities in five communities in Ebonyi State, Nigeria. Three hypotheses were tested to assess whether the prevalence of diseases is inversely proportional to the distance from the mine sites, whether education level is a factor in the understanding of the risks, and whether residency is a factor in knowledge of the effects of environmental contamination. Results show that malaria, respiratory, and skin diseases are the predominant diseases in the study area, with 41.7%, 27.0%, and 17.7% of the study population being infected, respectively. Chi-square analysis validates Hypothesis 1 ($\chi^2 = 6.538$, $df = 4$, $p = 0.162$, accepting H_0 of inverse relationship). Results show that 71-77% of the communities that are 0-1.5 km away from the mine sites are infected with malaria/respiratory diseases, while 56-66% of the communities that are 1.5-3 km away are infected. Hypothesis 2 is supported ($\chi^2 = 34.25$, $df = 12$, $p = 0.001$); educated respondents demonstrate greater awareness of mining-health linkages. Hypothesis 3 is validated ($\chi^2 = 51.642$, $df = 20$, $p < 0.001$). This study is the first of its kind in the study area, which provides evidence of the spatial epidemiology of diseases in the study area.

Keywords: *Medical Geology, Distance decay, Mining and Health, Environmental Epidemiology, Nigeria.*

Date of Submission: 15-02-2026 Date of acceptance: 28-02-2026

I. Introduction

Mining activities have adverse effects not only on miners but also on the community at large, particularly in terms of environmental contamination, which is reflected in terms of morbidity (Hilson, 2002; Stephens & Ahern, 2001). In Nigeria, the Minerals and Mining Act of 2007 requires Environmental Impact Assessment, which is geared towards protecting the community, but its implementation is poor, especially in the case of artisanal mining activities in the country (Ite et al., 2016).

In Ebonyi State, the Pb-Zn mines have been in operation for over 90 years, with the highest mining activities in the 1950s-1960s under the Nigerian Lead-Zinc Mining Company. However, after the mines were abandoned, artisanal mining activities commenced, and the population expanded towards the mines. Previous research on the environment has shown contamination in the soil and water (Onyeobi & Imeokparia, 2011; Oti & Nwabue, 2012). However, the effects on the human population have not been studied.

The study employed a medical geography approach, in which the distance from the mining sites was used as a proxy for the intensity of exposure. We tested the distance decay hypothesis, in which the prevalence of morbidity decreases monotonically with increasing distance from the contamination sources. We also investigated the influence of socioeconomic factors on the perception and practice of risk.

II. Materials and Methods

2.1 Study Design

A cross-sectional study design was employed, and the data were obtained from multiple sources.

2.2 Sampling Frame

Five communities were purposively selected based on their proximity to the active and abandoned mining sites:

· Zone A (0-1.5 km): Eyingba (70), Ameka (70), Umuoghara (60)
· Zone B (1.5-3 km): Ezzagu (50), Ameri (50)

Justification for the sample size: Population size of the study area = 195,000. Using a 95% confidence coefficient and a 5% margin of error, the minimum sample size = 384. However, the study was constrained to a sample size of 300.

2.3 Data Collection Instruments
1. Household Questionnaire: 32 items on demographics, stay duration, education, occupation, disease experience (past 30 days), perceptions of the environment, and trust in institutions.
2. Health Facility Records: Patient attendance records from AE-FUTHA Abakaliki and four primary healthcare centers (2018-2020).
3. Key Informant Interviews: Ministry of Environment (n = 2), Ministry of Health (n = 2), Ministry of Lands and Housing (n = 5), Hospital Consultants (n = 5), Mine Workers (n = 20).

2.4 Statistical Analysis
Descriptive statistics were used to summarize the data using frequencies and percentages to describe the morbidity patterns. Chi-square tests of independence were performed to determine the association between the variables: Residency duration and environmental knowledge (Hypothesis 1), Educational attainment and health risk awareness (Hypothesis 2), and Distance from mine and disease prevalence (Hypothesis 3). The significance level was set at $\alpha = 0.05$.

III. Results

3.1 Demographic Profile
Respondents were 52% male, 48% female. Age range: 18–74 years. Occupational distribution: farming (43%), mining/quarrying (22%), trading (18%), civil service (9%), others (8%). Educational attainment: none (13.3%), primary (11.7%), secondary (37.3%), tertiary (28.0%), adult education (9.7%).

Table 1. Sociodemographic characteristics of respondents (n = 300)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	156	52.0
	Female	144	48.0
Age Range	18 – 74 Years	—	—
Occupation	Farming	129	43.0
	Mining/Quarrying	66	22.0
	Trading	54	18.0
	Civil Service	27	9.0
	Others	24	8.0
Educational Attainment	None	40	13.3
	Primary	35	11.7
	Secondary	112	37.3
	Tertiary	84	28.0
	Adult Education	29	9.7

3.2 Morbidity Patterns
Self-reported 30-day prevalence:

· Malaria: 41.7%

· Respiratory infections (cough/cold): 27.0%
· Skin diseases: 17.7%
· Diarrhoea: 6.3%
· Fever (non-malarial): 4.0%
· Others: 3.3%

Hospital records (AE-FUTHA, 2020) confirmed malaria as the leading outpatient diagnosis, followed by respiratory infections and skin diseases.

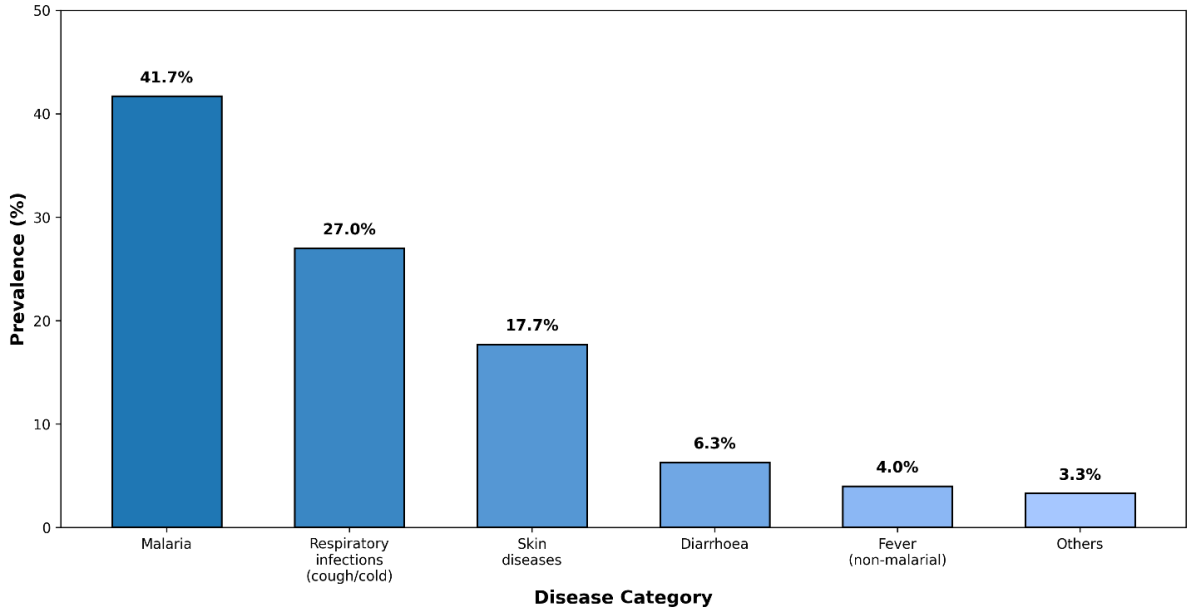

Figure 2. Self-reported morbidity prevalence by disease category

3.3 Distance-Decay Analysis

Communities within 0–1.5 km (Eyingba, Ameka, Umuoghara) reported significantly higher malaria/respiratory infection prevalence (71–77%) compared to communities 1.5–3 km distant (Ezzagu: 66%; Ameri: 56%). Chi-square analysis: $\chi^2 = 6.538$, df = 4, p = 0.162. Since calculated χ^2 < tabulated χ^2 (9.49), we accept the null hypothesis that infection rates are inversely related to distance.

Table 2.Cross-Tabulation: Community distance vs. malaria/respiratory infection prevalence

Community	Distance from Source (km)	Malaria/Respiratory Infection Prevalence (%)
Eyingba	0 – 1.5	**77**
Ameka	0 – 1.5	**71**
Umuoghara	0 – 1.5	**75**
Ezzagu	1.5 – 3.0	**66**
Ameri	1.5 – 3.0	**56**

3.4 Environmental Risk Perception

284 respondents (94.7%) affirmed that mining methods affect the environment. Land degradation (25.7%) and air pollution (25.3%) were most frequently cited. Residency duration significantly influenced knowledge ($\chi^2 = 51.642$, df = 20, p < 0.001). All respondents residing > 25 years affirmed environmental effects, whereas 11% of newer residents (< 12 years) responded "no" or "no idea".

3.5 Education and Health Linkages

237 respondents (79%) recognized a direct link between mining activities and community diseases. Educational attainment was significantly associated with this recognition ($\chi^2 = 34.25$, df = 12, p = 0.001). Tertiary-educated respondents showed universal awareness of disease risks at 98%, while the no formal education category showed the lowest level of awareness at 70%.

IV. Discussion

4.1 Spatial Epidemiology

The distance-decay relationship is supported by the international literature. Von Schirnding et al. (1991) showed an exponential relationship between blood lead levels in children from lead smelters in South Africa and distance from the smelters. Mielke et al. (1997) demonstrated a similar relationship between soil lead levels in New Orleans and distance from the urban core, with the highest levels in the core and lower levels in the suburbs corresponding to blood lead levels in children.

Elevated morbidity levels in Zone B indicate the contamination footprint is not limited to the immediate mine environments. This is due to: Fluvial transportation of tailings during wet-season floods; Aeolian transportation of dust; and Ingestion of contaminated food crops from intermediate distances.

4.2 Malaria Paradox

The high malaria prevalence in the mining communities is paradoxical: the open-pit mine destroys breeding sites in standing water, yet it also creates new breeding sites. Abandoned mine pits, wheel ruts, and tailings impoundments collect rainwater during the rainy season and serve as breeding sites for Anopheles gambiae (Yasuoka & Levins, 2007). Mining camps also serve as breeding sites due to migrant workers who introduce new malaria strains to which the native mosquito population is susceptible.

4.3 Respiratory and Dermal Pathways

Respiratory infections have been found to be correlated with airborne particulate matter (PM_{10}, $PM_{2.5}$) originating from quarry blasting, haul road traffic, and wind erosion of tailings (Plumlee et al., 2006). Every ton of blasted rock produces about 0.3 kg of fugitive dust (USEPA, 1998). The finer particles will remain airborne for hours, lodging in the pulmonary alveoli.

Dermatitis and fungal infections, which can be caused by contact with infected water, are plausible for River Enyim and other water courses, which carry drainage water with a pH as low as 3.5 (Boeckx, 1986).

4.4 Knowledge-Action Gap

Although 79% of the respondents recognized the link between mining and health, only 12% reported the use of some form of water treatment. The reasons for the knowledge-action gap are: (1) cost – water filters cost ₦15,000 to ₦30,000; (2) fatalism – "God will protect us"; (3) mistrust of government advice.

V. Conclusion and Recommendations

This study has provided robust emprical evidence that proximity to Pb-Zn mines in Abakaliki increases the risk of malaria, respiratry infections, and skin diseases. The distance-decay function appears to be linear over the range 0 to 3 km.

Specific recommendations:

1. Malaria: Larviciding of mine pit ponds; provision of insecticide-treated bed nets to all households within 3 km of the mines.
2. Respiratory infections: Wet drilling; water spraying of haul roads; provision of N95 respirators to quarry workers.
3. Skin diseases: Provision of water filters to households within 3 km of the mines.
3. Dermatology: Community borehole treatment; Health education on the dangers of bathing in streams.
4. Surveillance: Establishment of a mining health sentinel surveillance system by the Ebonyi State Ministry of Health.

Acknowledgement

The author would like to thank the moral support given by my supervisors, Prof. E. G. Imeokparia and the late Prof. I. O. Imasuen for their constructive criticism.

Funding: No funding was received for this study.

Conflicts of Interest: There are no conflict of interest.

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