

An Assessment of the Environmental and Health Effects of Coal Mining in Okobo Community, Ankpa L.G.A., Kogi State, Nigeria.

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Abstract

The study investigated the environmental and health implications of coal mining in the Okobo community of Ankpa LGA. Coal is one of the major sources of global energy supply, contributing over 27% of the world's electricity supply. Coal mining results in environmental consequences such as greenhouse gas emissions, deforestation, air and water pollution, which call for global concern about its sustainability as a source of energy supply. Its negative consequences on climate change and water pollution remain a critical issue, with acid mine drainage releasing toxic substances into water bodies, threatening aquatic life and human health. The objectives of the study are: to identify the consequences of coal mining in the area, to find out whether residents' health issues are related to coal mining activities, to find out the perceptions of coal mining operations in the area, and to develop strategies for reducing the environmental and health problems associated with coal mining in the area. The study adopts a mixed-methods approach, integrating both qualitative and quantitative research techniques. A total of nine (9) water samples were collected from the community, three (3) samples each from upstream, midstream, and downstream, respectively, from the Okobo River. Six (6) Soil samples were also collected, three (3) were randomly collected from the farmlands around the coal mining site, while three (3) were collected from controlled mining sites. These samples were analyzed in the laboratory. In addition, survey data were equally collected using structured questionnaires. The findings revealed the presence of heavy metals such as cadmium, chromium, manganese, and magnesium in high concentrations exceeding the WHO or NESREA safe limits in both water and soil samples. It also revealed that 55% of the participants are male, while 45% are female. About (25%) are farmers, (22.5%) are traders, (20%) are miners, and (12.5%) are civil servants. Most participants (87.5%) agreed that coal mining causes serious air pollution, particularly heavy dust from blasting, loading, and vehicular movement. About (52.5%) participants had various levels of respiratory issues, such as chronic cough, asthma, and bronchitis.

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I. INTRODUCTION

Coal is one of the major sources of global energy supply, contributing over 27% of the world's electricity supply (International Energy Agency, 2021). Until recently, most coal-producing nations relied heavily on coal to meet their industrial and energy demands. However, the environmental consequences of coal mining, such as greenhouse gas emissions, deforestation, air and water pollution, and its negative consequences on climate change calls for global concern about its sustainability as a source of energy supply (World Bank, 2019). Coal mining is a major contributor to carbon dioxide (CO₂) emissions, which account for approximately 40% of total emissions from the energy sector (IEA, 2022). This has significantly exacerbated climate change, with rising global temperatures and extreme weather events becoming more frequent. In addition, the extraction process often involves the destruction of ecosystems, as seen in large-scale mining operations in Australia and Indonesia, where deforestation and habitat loss have endangered biodiversity (UNEP, 2022). Water pollution remains a critical issue, with acid mine drainage releasing toxic substances into water bodies, threatening aquatic life and human health (WHO, 2022).

In Africa, coal mining remains a vital economic activity, particularly in South Africa, where it accounts for over 90% of the continent's coal production (Department of Mineral Resources, South Africa, 2020). Although coal mining helps to create employment and guarantee a considerable level of energy security, it has been linked to significant environmental degradation, including acid mine drainage and air pollution, which adversely affect both ecosystems and public health (Ochieng et al., 2018). Mpumalanga Province in South Africa, known for its extensive coal mines, has been described as one of the world's most polluted areas due to high sulfur-dioxide and nitrogen-oxide emissions from coal-burning (Nkosi et al., 2023). Similarly, in Zimbabwe, coal mining in the Hwange region has led to water contamination with heavy metals such as lead and cadmium, resulting in

increased cases of waterborne diseases among local communities (Chigumira & Moyo, 2023). The Moatize coal basin has experienced significant environmental disruptions, including the displacement of local populations and soil degradation. Health assessment in the region reveals high incidents of respiratory conditions and skin disorders among residents exposed to coal dust (Tembe et al., 2023). Similarly, in Botswana's Morupule coalfields, studies showed significant air pollution, contributing to respiratory ailments and cardiovascular issues (Phiri et al., 2023). The situation may not be different in Nigeria, where coal mining has long been an essential part of the country's industrial and energy sectors, with significant impacts on the environment and the health of the people. The adverse effects may include degradation of agricultural land, water pollution, and the presence of heavy metals such as lead and mercury, posing significant risks to both ecosystems and human health. These may cause reduced agricultural yields and gastrointestinal diseases in humans (Ezekwe & Oghenerobor, 2023; Global Rights, 2024). Mining activities are found to cause a reduction in agricultural productivity and impair the qualities of agricultural produce in the area where minerals are mined (Adaikpoh et al., 2024; Abu and Ifatimehin, 2016).

The Okobo community in Ankpa Local Government Area has seen an increase in coal mining activities over recent years, which may have brought both economic gains and negative environmental and health impacts on the residents. While the socio-economic benefits of coal mining in the area cannot be ignored, detail assessment of the link between the socio-economic benefits and environmental consequences of coal mining in the region is yet to be unpacked, thereby prompting this investigation. The objectives of this study include: to identify the consequences of coal mining in the Okobo community, to find out whether health issues in the area are related to coal mining activities, to find out the perceptions of coal mining operations in the area, and to develop strategies for reducing the environmental and health problems resulting from coal mining in the area.

II. METHODS

The study employs a mixed-methods approach, combining both quantitative and qualitative research techniques to achieve a nuanced understanding of the environmental and health implications of coal mining. The quantitative techniques focus on measuring variables such as air quality indices, water and soil contamination levels, and health outcomes among the Okobo population. This yielded numerical data that supports statistical analysis and provides evidence-based insights into patterns, correlations, and trends related to environmental degradation and health effects. Soil and water samples, air quality measurements, and health surveys analysis help to establish clear, measurable links between coal mining activities and their impacts in the region.

Qualitative methods, on the other hand, focus on exploring the lived experiences, perceptions, and attitudes of people in the Okobo community toward coal mining activities. This enables a deeper understanding of how residents view environmental degradation, land and water source changes, and the socio-economic impacts caused by mining (Patton, 2020). In-depth interviews were used to capture personal experiences and uncover underlying concerns that might not be revealed through quantitative analysis alone. These methods are crucial for understanding the socio-cultural and environmental context of the community's daily interactions with the mining industry (Creswell, 2022).

The investigation covers a period of over fourteen years, from 2010 to 2024. This period provides sufficient time to assess the effects of coal mining on the environment and public health, allowing for a comparison of past conditions with the current state and enabling the identification of patterns over time.

A stratified random sampling technique is used to ensure representation across different socio-economic groups. The sample population includes households, miners, and local officials. A total of nine water samples were collected from the community (three samples from upstream, midstream, and downstream points of the Okobo River). Six soil samples were randomly collected from farmlands around the coal mining site; out of these, three were from control sites and three from non-control sites, making a total of six soil samples.

The Study Area is located between Latitude 7°22'14"N and 7°33'N and Longitude 8°37'31"E and 8°21'31"E. It covers an area of 1,200 km² and had a population of 67,353 according to the 2016 census. It is situated in the eastern part of Kogi State and is bordered by Dekina L.G.A to the west, Omala L.G.A to the north, Otukpo (Benue State) to the east, and Olamaboro L.G.A to the south.



Fig 1: Nigeria showing Kogi State.

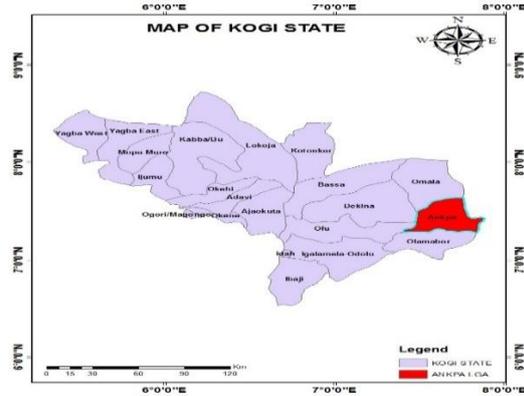


Fig 2: Kogi State showing Ankpa LG

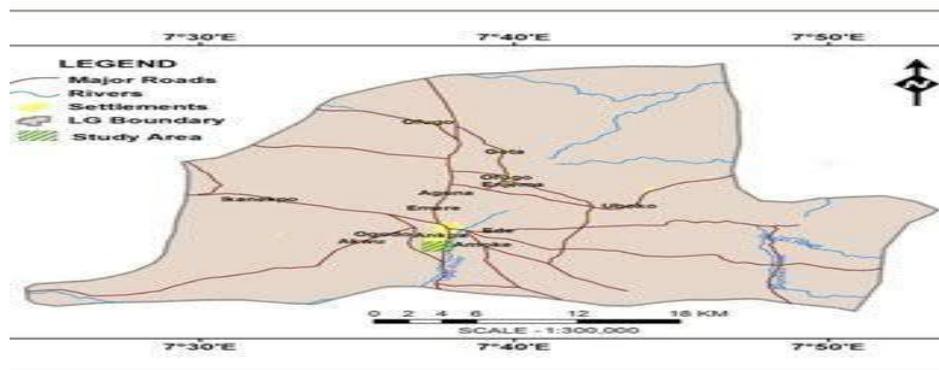


Figure 3: Okobo showing Mining Site

Source: Geography Department, Prince Abubakar Audu University, Anyigba, 2024

The area features a gently undulating landscape, a nearly level floodplain averaging 100m-250m, with occasional features like Selbergs, Knolls, and lateritic structures. These floodplains are characterized by extensive swamps and ponds, which are suitable for dry-season irrigated farming. Adjacent to the area, the terrain is marked by steep slopes, deep-incised valleys, and generally rugged relief. The climate consists of two distinct seasons: the rainy season from April to October and the dry season from November to March. Average annual rainfall ranges from 1000mm to 1,250 mm, temperatures typically range between 20 °C and 24 °C, and relative humidity varies from 36% in the dry season to 80% during the wet season (Ejiofor, 2021; Ukabiala, 2022). The major soils in the area include lithosols, alluvial soils, and ferruginous soils. These soils are mainly sandy to clay-loam, containing up to 50% sand, 15-20% silt, and 8-15% clay, with an acidic level ranging from (pH 4.24) to slightly alkaline (pH 7.8) (Ejiofor, 2021). Sulphate levels are adequate for crop production (Ejiofor, 2021). Vegetation is primarily Guinea savannah, supporting over 120 plant species, with *Panicum maximum* and *Mimosa pudica* forming the largest colonies in some areas, thereby dominating the vegetation. The other prevalent plant families include Poaceae, Fabaceae, Caesalpinoideae, Mimosoideae, and Papilionoideae, as well as Asteraceae (composites) and Euphorbiaceae.

According to the 2016 report from the National Population Commission, the region's population has increased to 67,353 due to an influx of people engaging in mining within the community. This indicates a population growth rate of about 3.25% (National Population Commission, 2016). Using the 2016 population projection, the current population is estimated to be around 209,252 people.

These people are Igalas, who carry out their traditional occupations such as farming, artisanship, and trading. The farmers grow cassava, maize, beans, yams, millet, groundnuts, and vegetable crops such as peppers, tomatoes, and Okra. The traders deal in foodstuffs, household supplies, and general merchandise. The women engage in food processing activities such as Garri production, Fufu production, and the baking of groundnut cake. A significant number of youths in the area are involved in artisanal work and commercial ventures, such as carpentry, mechanics, and others (Ejiofor, 2021).

III. RESULTS AND DISCUSSION

Variable	Category	Frequency	Percentage (%)
Gender	Male	220	55.0
	Female	180	45.0
Age	18–25	80	20.0
	26–35	120	30.0
	36–45	100	25.0
	46–60	60	15.0
	60+	40	10.0
Occupation	Farmer	100	25.0
	Trader	90	22.5
	Miner	80	20.0
	Civil Servant	50	12.5
	Student	40	10.0
	Unemployed	40	10.0
Education Level	No Formal Education	60	15.0
	Primary	120	30.0
	Secondary	140	35.0
	Tertiary	80	20.0
Income Level	< ₦20,000	160	40.0
	₦20,000–₦50,000	140	35.0
	₦50,001–₦100,000	60	15.0
	> ₦100,000	40	10.0

Table 1: The demographic characteristics of the participants. **Source: Field Work, 2025**

The results show that 55% are male and 45% are female. This slight male dominance reflects a trend in coal mining communities, where men are more likely to participate in direct mining activities, which are physically demanding and risky for women. The implication is that men may have greater exposure to occupational hazards such as dust inhalation, heavy machinery accidents, and musculoskeletal disorders. Although Women may also experience an indirect exposure to the negative consequences of coal mining as they carry out domestic and socio-economic activities in the mining community, this may be in the disruption of farming and water access. Coal mining in this community is largely male-dominated, reinforcing gender inequalities in employment and adverse health consequences.

The results showed a large portion of the population falls within the economically active age groups (18–45 years), making up 75% of the total participants. The age group between 25–35 is the most represented (30%), followed by 36–45 (25%) and 18–25 (20%). The concentration of young, productive adults indicates they are more actively involved in mining activities and, therefore, more vulnerable to the environmental and health impacts of coal mining. Younger individuals are more likely to take informal mining jobs due to limited employment opportunities, placing them at greater risk of unsafe practices. This aligns with Bamisebi et al. (2020), who highlight that young adults in Nigerian mining communities are often involved in hazardous, informal mining operations without proper training or safety equipment, significantly increasing their health risks.

The occupational distribution indicates that the largest portion of participants are farmers (25%), followed by traders (22.5%), miners (20%), and civil servants (12.5%). Students and unemployed individuals each make up 10% of the population. This diversity of occupations reflects a rural, informal economy where subsistence farming and petty trading are common. The presence of 20% miners clearly shows the impact of coal mining on local employment. However, the smaller size of this group compared to farmers and traders suggests that mining has not significantly changed local livelihoods, although it may disrupt farming through land degradation, soil contamination, and water pollution. Aigbedion & Iyayi (2007) and Abu & Ifatimehin (2016) observed that mineral exploitation often destroys farmland and contaminates water sources, affecting food security and forcing residents to find alternative, often less stable, sources of income.

About 45% of the participants have no formal education, 15% have primary education, while 35% completed secondary school, and 20% attended tertiary education. The high proportion of respondents with low educational attainment has serious implications for public health and environmental awareness. Low-level education may mean limited understanding of environmental risks, low health literacy, and low levels of conformity with environmental regulations. This may lead to unsafe practices in farming, mining, and waste disposal. Nriagu et al. (2016) reported that individuals in mining communities with low education are less likely to recognize symptoms of exposure to pollutants or adopt protective measures, thereby worsening the health effects of environmental degradation.

The results showed that most participants, 75%, earn less than ₦50,000 per month (under \$100), while 15% earn between ₦50,000 and ₦100,000. Only 10% make more than ₦100,000 monthly. This indicates a low-income and economically disadvantaged community despite the presence of natural resources in the area. The

low-income levels suggest limited access to healthcare, nutritious food, clean water, and education. This finding supports Watts (2008), who described the “resource curse” phenomenon, where resource-rich regions remain impoverished due to poor governance, weak infrastructure, and unequal wealth distribution. This suggests that coal mining benefits external actors more than the local population.

Parameter	Water Sample Value	WHO/NESREA Standard	Remarks
Turbidity (NTU)	14.2	< 5 NTU (WHO)	Above limit
pH	5.4	6.5 – 8.5	Acidic
Temperature (°C)	31.6	≤ 30°C	Slightly elevated
Electrical Conductivity (µS/cm)	580	< 500 µS/cm	High
Total Dissolved Solids (mg/L)	412	< 500	High
Hardness (mg/L)	196	< 200	High
Total Suspended Solids (mg/L)	96	< 50	Excessive
Calcium (mg/L)	72	< 75	Within a safe limit
Potassium (mg/L)	9.4	< 12	Within a safe limit
Nitrogen (mg/L)	4.6	< 10	Within a safe limit
Sodium (mg/L)	68	< 100	Within a safe limit
Color (TCU)	35	< 15 TCU	Discolored
Cadmium (mg/L)	0.012	< 0.003 (WHO)	Toxic
Chromium (mg/L)	0.06	< 0.05	Above safe limit
Magnesium (mg/L)	48	< 50	Within a safe limit
Manganese (mg/L)	0.91	< 0.1	Very high

Table 2: Analysis of Water Samples

Source: Laboratory Result, 2025

Parameter	Soil Sample	WHO/NESREA Standard	Remarks
Turbidity (NTU)	6.8	< 5 NTU (WHO)	Slightly high
pH	5.8	6.5 – 8.5	Acidic
Temperature (°C)	32.3	≤ 30°C	Slightly elevated
Electrical Conductivity (µS/cm)	820	< 500 µS/cm	High
Total Dissolved Solids (mg/L)	674	< 500	High
Hardness (mg/L)	312	< 200	High
Total Suspended Solids (TSS) (mg/L)	112	< 50	Excessive
Calcium (mg/L)	128	< 75	High
Potassium (mg/L)	24.7	< 12	High
Nitrogen (mg/L)	12.3	< 10	High
Sodium (mg/L)	142	< 100	High
Cadmium (mg/L)	0.019	< 0.003 (WHO)	Toxic
Chromium (mg/L)	0.11	< 0.05	Above safe limit
Magnesium (mg/L)	91	< 50	Elevated
Manganese (mg/L)	1.22	< 0.1	Very high

Table 3: Analysis of Soil Samples

Source: Laboratory Result, 2025

The results in Tables 2 and 3 showed that both water and soil qualities were degraded due to coal mining activities: pH values below 6 indicate acidification, a known consequence of acid mine drainage (AMD). This condition promotes the leaching of heavy metals into the environment. Electrical conductivity (580 µS/cm in water; 820 µS/cm in soil) and TDS values exceed safe thresholds, indicating the presence of dissolved ions, likely from leaching of mining waste. According to Tiwary (2001) and Lad et al. (2018), coal mining often releases sulphate, carbonates, and heavy metals, increasing salinity and decreasing pH levels in nearby water bodies and soils. Heavy metals like cadmium, chromium, manganese, and magnesium also surpass the WHO or NESREA safe limits, especially cadmium, which is highly toxic even at low concentrations. Cadmium can cause kidney damage and skeletal deformities, while chromium is known for its carcinogenic potential when present as Cr (VI), as reported by Nriagu et al. (2016). Nriagu et al. (2016) also found that high concentrations of manganese are neurotoxic, posing risks to children. They reported elevated levels of cadmium and manganese in mining areas of Nigeria, warning of long-term public health risks, including cognitive decline and organ toxicity.

The soil samples show high levels of potassium, sodium, nitrogen, and calcium, which can cause soil salinization and nutrient imbalance, negatively affecting agricultural productivity. Elevated nitrogen levels may also raise the risk of nitrate pollution in water sources, leading to methemoglobinemia (Blue Baby Syndrome). High concentrations of calcium and magnesium contribute to water hardness, making water undesirable for domestic use. Aigbedion and Iyayi (2007) pointed out that mineral exploitation often causes long-term changes in soil chemistry, reducing crop yields and threatening food security in rural communities.

Turbidity (14.2) and color (35) indicate high water pollution, likely caused by suspended coal particles, sediments, and fine tailings. Total Suspended Solids (TSS), which measure 96 mg/L in water and 112 mg/L in soil, reflect a substantial particulate matter load, reducing water clarity and impacting aquatic life. These conditions are typical of coal surface runoff, especially during rainy seasons, as documented by Bamisebi et al. (2020) in Nigerian coal-mining zones.

Water and soil temperatures were slightly above standard limits (31.6°C and 32.3°C), which may be due to surface exposure caused by the removal of vegetative cover and the discharge of warm mining effluent. High temperatures reduced dissolved oxygen in the water, posing a significant threat to aquatic organisms, a concern raised by Dutta et al. (2004) in coal-impacted wetlands.

These analyses revealed that coal mining has contributed to the acidification of the Okobo environment, which has affected water quality and soil fertility. It also showed heavy metal contamination of both water and soil, posing severe health risks to humans and animals, reducing the productive capacity of agricultural land, threatening livelihoods, and causing thermal and sediment pollution, as well as degrading aquatic ecosystems.

These findings strongly suggest that coal mining in Okobo has adversely impacted the physicochemical and biological quality of both the water and soil environments. They align with trends observed in other coal mining areas worldwide and highlight the urgent need for consistent environmental monitoring.

Perceived environmental impacts of coal mining in Okobo

Table 4: Perceived Environmental Impacts of Coal Mining (N = 400)

Environmental Impact	Strongly Agree	%SA	Agree	%A	Total	SA+ A %	Disagree	%D	Strongly Disagree	%SD	Total	SD+D %
Air pollution (dust/smoke)	220	55.0%	130	32.5%	350	87.5%	30	7.5%	20	5.0%	50	12.5 %
Water pollution	200	50.0%	150	37.5%	350	87.5%	30	7.5%	20	5.0%	50	12.5 %
Soil/land degradation	190	47.5%	140	35.0%	330	82.5%	40	10.0%	30	7.5%	70	17.5 %
Deforestation	180	45.0%	150	37.5%	330	82.5%	50	12.5%	20	5.0%	70	17.5 %
Noise pollution	160	40.0%	140	35.0%	300	75.0%	60	15.0%	40	10.0%	100	25 %
Loss of biodiversity	150	37.5%	120	30.0%	270	67.5%	80	20.0%	50	12.5%	130	32.5 %

Source: Field Work, 2025

The results in Table 4 show that most participants (87.5%) agreed that coal mining causes serious air pollution, particularly due to dust from blasting, loading, and vehicular movement, compared to fifty (50) participants, representing 12.5%, who disagreed. This aligns with Aigbedion and Iyayi (2007), who revealed that high levels of particulate matter around mining areas contribute to respiratory issues among residents. They stressed that airborne pollutants such as sulfur dioxide and coal dust can worsen asthma, bronchitis, and other health problems.

About three hundred and fifty (350) participants, representing 87.5%, agreed that coal mining contaminates surface and underground water, while fifty (50) participants, or 12.5%, disagreed. Acid mine drainage (AMD), where sulfur-bearing minerals react with water and air to form Sulphuric acid, leaches toxic metals into water bodies. This aligns with Tiwary (2001) and Nriagu et al. (2016), who found elevated levels of cadmium, chromium, and manganese in Nigerian coal-mining communities, contributing to diseases like kidney failure and neurological disorders.

About three hundred and thirty (330) participants, representing 82.5%, also agreed that soil and land degradation are major impacts of coal mining, leading to loss of topsoil, soil compaction, erosion, and nutrient imbalance, which reduce agricultural productivity. In contrast, seventy participants (70), or 17.5%, disagreed. This aligns with Bamisebi et al. (2020), who observed declining crop yields in Nigerian mining communities due to loss of arable land and contamination.

Additionally, about three hundred and thirty (330) participants, representing 82.5%, agreed that coal mining has led to widespread deforestation, mainly caused by site clearing, road construction, and expansion of mining infrastructure, compared to seventy (70) participants, or 17.5%, who disagreed. Loss of vegetation results in habitat destruction and microclimate changes. Lad and Samant (2018) emphasized that coal mining in India and Africa has caused large-scale vegetation loss, leading to reduced carbon sequestration and biodiversity.

Noise pollution caused by drilling, blasting, the movement of heavy trucks, and heavy machinery was agreed upon by 300 participants, representing 75%, compared to 100 participants who disagreed. Prolonged noise exposure can result in hearing loss, stress, and sleep disturbances. Ogundele et al. (2018) revealed that excessive noise levels in Nigerian mining towns often exceeded the permissible limit of 55 dB for residential areas.

Approximately two hundred and seventy (270) participants, representing 67.5%, agreed that there is a steady and significant decline in flora and fauna due to coal mining in the area. This decline may result from habitat fragmentation, water pollution, landscape disturbance, and species displacement or extinction. The results reflect a community-wide recognition of environmental degradation caused by coal mining. The impacts identified

include air and water pollution, land degradation, and deforestation. These activities are directly linked to mining operations and pose risks to both ecological health and human well-being.

Health Issues Associated with Coal Mining

Table 5: Health Challenges Among the participants (N = 400)

Health Challenge	Frequency	Percentage (%)
Respiratory problems (e.g., cough, asthma, bronchitis)	210	52.5%
Skin diseases and irritation	130	32.5%
Eye irritation/redness	95	23.8%
Waterborne diseases (e.g., diarrhea, cholera, typhoid)	170	42.5%
Hearing problems from noise	60	15.0%
Headaches and fatigue	185	46.3%
No reported health issue	45	11.3%

Source: Field Work, 2025

The results in Table 5 showed that more than half of the participants (52.5%) have respiratory issues such as chronic cough, asthma, and bronchitis. This aligns with known effects of inhaling coal dust and particulate matter, which are common in mining communities. Ogundele et al. (2018) suggested that residents of coal mining areas may be exposed to dust emissions, leading to respiratory tract infections and long-term lung damage. Similarly, Aigbedion and Iyayi (2007) linked coal mining to higher rates of asthma and bronchitis due to fine particulate emissions (PM_{2.5} and PM₁₀). A significant number of participants, 32.5%, reported skin problems like rashes, itching, and discoloration. These are often caused by direct contact with polluted water or soil, or through bathing in contaminated streams. Nriagu et al. (2016) documented high levels of heavy metals such as cadmium and chromium in mining communities, which are known to cause skin irritation. Long-term exposure can also result in more serious skin conditions like eczema and dermatitis.

About 23.8% of participants also reported redness, tearing, and blurry vision, likely caused by dust particles in the air and exposure to acidic gases like sulfur dioxide. Diseases such as typhoid, cholera, and diarrhea were reported by 170 participants, representing 42.5%, clearly pointing to poor water quality. Some of these illnesses are linked to contamination of streams and boreholes with mining effluent, heavy metals, and pathogens. WHO (2011) highlighted that exposing drinking water to cadmium and manganese increases the risk of gastrointestinal and kidney diseases. A smaller percentage of participants, 15.0%, complained of hearing loss or ringing in the ears, likely due to noise pollution from drilling, blasting, and machinery. These symptoms may not be solely attributed to mining activities because they can also be hereditary or related to other biological factors. However, Ogundele et al. (2018) emphasized that many mining sites operate above safe decibel levels (>85 dB), especially without sound barriers or protective gear for workers and nearby residents.

A significant portion of participants, accounting for 46.3%, report experiencing chronic headaches, fatigue, and dizziness, which they associate with air pollution, noise-induced poor sleep, exposure to chemical substances, and nutritional deficiencies due to coal mining. These symptoms are non-specific but are frequently observed in polluted mining environments. They may not be entirely due to mining activities, as some could be hereditary or biological factors. Nonetheless, Nriagu et al. (2016); Zang et al. (2017); and Watts (2008) documented similar symptoms in extractive zones, especially among children and women, resulting from ongoing exposure to toxicants in mining regions. Only 11.3% of participants did not report any noticeable health issues. These individuals are likely newer residents, those with better access to healthcare, or people living away from the periphery or close to mining areas in the community.

This investigation has confirmed that coal mining in Okobo may have caused widespread health issues, especially those linked to air pollution (respiratory and eye problems), water pollution (waterborne diseases), direct contamination (skin problems), noise pollution (hearing damage), and chronic stress and fatigue (headaches, weakness).

Conclusively, the most notable impacts of coal mining in the Okobo community include heavy contamination of soil and water, air pollution, and vegetation degradation, among others. This study showed that the leaching of heavy metals such as lead (Pb), arsenic (As), cadmium (Cd), and manganese (Mn) into soil and water systems exceeds the permissible limits set by regulatory bodies like NESREA and WHO. This may have resulted in acid mine drainage (AMD), which is a major concern in the area. Coal dust and gas emissions (e.g., NO₂, SO₂, CO, H₂S) significantly affect air quality; particulate matter (PM_{2.5} and PM₁₀) in the area was found to be far above recommended levels, posing respiratory risks to both miners and residents. Mining operations have led to deforestation, displacement of vegetation, and land use changes, contributing to erosion and loss of biodiversity. Inhalation of coal dust and toxic gases has been linked to cases of bronchitis, asthma, persistent coughing, and other respiratory ailments in the area. Miners and nearby residents report symptoms consistent with exposure to poor air quality and toxic particulates. High concentrations of metals like Pb, Cd, and Cr in local water sources have been implicated in health issues such as kidney damage, liver dysfunction, anemia, and neurological

disorders (Ipeaiyeda & Dawodu, 2021). Limited access to healthcare, loss of livelihoods due to environmental degradation, and fear of long-term illnesses have contributed to mental stress in the community.

The following recommendations are therefore proposed

► There is a need to conduct comprehensive baseline surveys (air, water, soil, health) in the area and compare these with the Environmental Impact Assessment (EIA) conducted before coal mining begins. This will help experts address the urgent need to control the current level of environmental degradation occurring in the community.

► Coal mining companies should be required to dedicate a certain percentage of their profits to developing community infrastructure, such as boreholes for clean water, improved electricity, and building a clinic for both the community and their staff.

► There is a need for regular health screenings, the provision of personal protective equipment (PPE), and regular training for local workers to ensure safe operations.

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