A CASE REPORT ON THE IMPACT OF PARTICULATE MATTER AND GASEOUS EMISSIONS FROM SAWMILLS ON THE HEALTH OF SAWMILL WORKERS IN OSISIOMA NNGWA, ABIA STATE, NIGERIA".

ABSTRACT

Sawmill workers are exposed to wood dust, which may cause skin irritation, allergy, and respiratory symptoms including asthma. This study investigates the concentration level of air pollutants in two major saw mills in Osisioma L.G.A in Abia state, Nigeria. Comprehensive air quality measurements were conducted using Hand held mobile multi-gas monitor, BLATN air quality monitor (model BR—Smart Series) and Air quality multimeter (model B SIDE EET100) focusing on key pollutants such as ammonia, hydrogen sulphide, sulphur dioxide, carbon monoxide, nitrogen dioxide, methane, ozone, photochemical smog, volatile organic compounds (VOCs), particulate matter ($PM_{2.5}$ and PM_{10}). Results revealed elevated concentrations of several pollutants, with particulate matter significantly exceeding permissible limits. At Timber Plaza, $PM_{2.5}$ levels reached 70.0 mg/m³ and PM_{10} levels increased to 130.0 mg/m³ in the working hours, both far above the regulatory limits of 0.25 mg/m³ and 0.50 mg/m³ respectively. Similarly, at Uratta Timber Market, $PM_{2.5}$ concentrations were as high as 60.0 mg/m³, and PM_{10} levels reached 120.0 mg/m³ in some locations. Health impact assessments conducted through questionnaires among sawmill workers revealed a high prevalence of respiratory problems, including shortness of breath, frequent coughing, chest tightness, wheezing, throat irritation, and nasal congestion. For instance, in Uratta Timber Market, 23 (92%) out of 25 respondents experienced shortness of breath, with 64% reporting it occurring 'often' or 'sometimes'. Similar patterns were observed in Timber Plaza, where 22 (88%) of the respondents reported shortness of breath. Majority of respondents reported a perceived impact of poor air quality on their health, with frequent visits to doctors and reliance on medication for respiratory issues. The findings show the urgent need for implementing effective dust control measures, regular air quality monitoring, and health surveillance programs to mitigate the adverse effects on workers' health.

Keywords: Particulate matter, Dust particles, Gaseous emissions, saw-mill, workers health

1. INTRODUCTION

Sawmills are crucial parts of the timber industry because they provide a wide range of wood products that are needed for building, making furniture, and other uses. On the other hand, sawmill operations present serious air quality issues that could have an impact on employees' health. The most common occupational exposure risk in the wood industry is wood dust that is airborne (Siew et al., 2012; Ediagbonya et al., 2014). Quality air is considered as one of the basic and important necessity for human well-being and the environment. The accessibility of every human being to good and quality air is a fundamental human right (WHO, 2005). Recognizing this fact, World Health Organization (WHO) in 1987 published air quality guidelines containing health risk assessments of major air contaminants. The WHO reports on state of global air highlighted urbanization and industrialization as the major sources of air pollution (Daniel, 2019). The leading

and most significant air pollutants include carbon monoxide (CO), carbon dioxide (CO_2), oxides of nitrogen (NOx), sulphur dioxide (SO_2) and particulate matters (PM_1, $PM_{2.5}$ and PM_{10}). Others are black carbons, organic carbons, heavy metals, volatile organic compounds (VOCs) and straight-chain hydrocarbons. Also, polycyclic aromatic hydrocarbons (PAHs), persistent organic pollutants (POPs) and ground level ozone (O_3) are highly notable (Gaveau & Brodley, 2015). Most of these pollutants can be found in saw mills. For example, CO emissions can occur during various wood processing operations such as sawing, cutting, grinding, and drying. These emissions primarily stem from the combustion of wood dust particles in equipment such as saw blades, grinders, and dryers, especially in cases where combustion conditions are not optimized (Jarrett *et al.,* 2015). Similarly, Formaldehyde emissions from wood dust can also disperse into the surrounding outdoor air, contributing to ambient air pollution and impacting nearby communities and ecosystems (Valavanidis *et al.,* 2018). As wood undergoes processing, such as cutting, chiseling, and filling, organic matter decomposes, releasing ammonia as a byproduct (Athenasiadou *et al.,* 2008). Additionally, saw mills often handle wood waste and residues, which can further contribute to ammonia emissions. Another significant source of ammonia in saw mills is animal waste. Many saw mills are situated in rural areas where livestock farming is common. The proximity of these facilities can lead to the release of ammonia from animal manure and urine (Sommer *et al.,* 2013). Moreover, saw mills may use animal by-products, such as bone meal, as additives or fuel, which can also release ammonia when heated.

In addition, the use of certain wood preservatives, such as those containing sulphur compounds, can contribute to hydrogen sulphide emissions in saw mill environments (Schnabel, 2015). Exposure to hydrogen sulphide gas can pose significant health risks to workers in saw mills. The toxic effects of H_2S are primarily attributed to its ability to inhibit cytochrome c oxidase, a key enzyme involved in cellular respiration, leading to cellular hypoxia and metabolic disruption (Bragança *et al.,* 2019). Short-term exposure to high concentrations of H_2S can cause immediate health effects, including irritation of the eyes, nose, and throat, as well as respiratory symptoms such as coughing, shortness of breath, and chest tightness (Occupational Safety and Health Administration [OSHA], 2010). Chronic exposure to lower levels of hydrogen sulphide can result in more severe health effects, including neurological symptoms such as headache, dizziness, and cognitive impairment (Guidotti, 2018). Prolonged occupational exposure to ozone in saw mill environments has been associated with increased risk of respiratory illnesses, including bronchitis, rhinitis, and sinusitis, among woodworkers and saw mill workers (Rybka *et al.,* 2020). Dust particles from wood processing activities further enhance smog formation by providing surfaces for chemical reactions and influencing the photolysis of nitrogen dioxide (EPA, 2022). Of particular concern is Particulate Matter < 2.5 μm (PM2.5), which has been linked to heart disease, lung cancer, birth defects, and early mortality (Rockström, 2019. Several researchers have evaluated the effects of sawdust particles on workers' health at both the local and regional levels Tobin et al., 2016; Nazari et al., 2016; Oluwatosin et al.,2015; Ajao et al., 2018; Elbayoumi et al., 2020; Olujimi et al. ,2023; Prasanth et al.,2022. The purpose of this study therefore, is to ascertain the impact of air pollutants on human health and ambient air quality by identifying and characterizing the concentration level of these pollutants within saw mills.

2. Study Area

Osisioma Ngwa is located within Latitudes: 5.0167° N, Longitudes: 7.4833° E. It has an area of 198 km2 (76 sq mi) and a population of 219,632 as per 2006 census data of Nigeria NPC (2006). Osisioma Local Government is situated in the southeastern part of Nigeria (Fig.1),

specifically in Abia State. It is bordered by Obingwa Local Government Area to the east, Isiala Ngwa North and Ugwunagbo Local Government Areas to the west, and Aba North Local Government Area to the south NPC (2006). The primary source of income for the residents of Osisioma Ngwa is agriculture. Skilled craftsmen and artisans working in a variety of trades can be found in Osisioma LGA. These include, among others, shoemaking, tailoring, metalworking, and carpentry. These craftsmen' goods are frequently offered for sale locally.

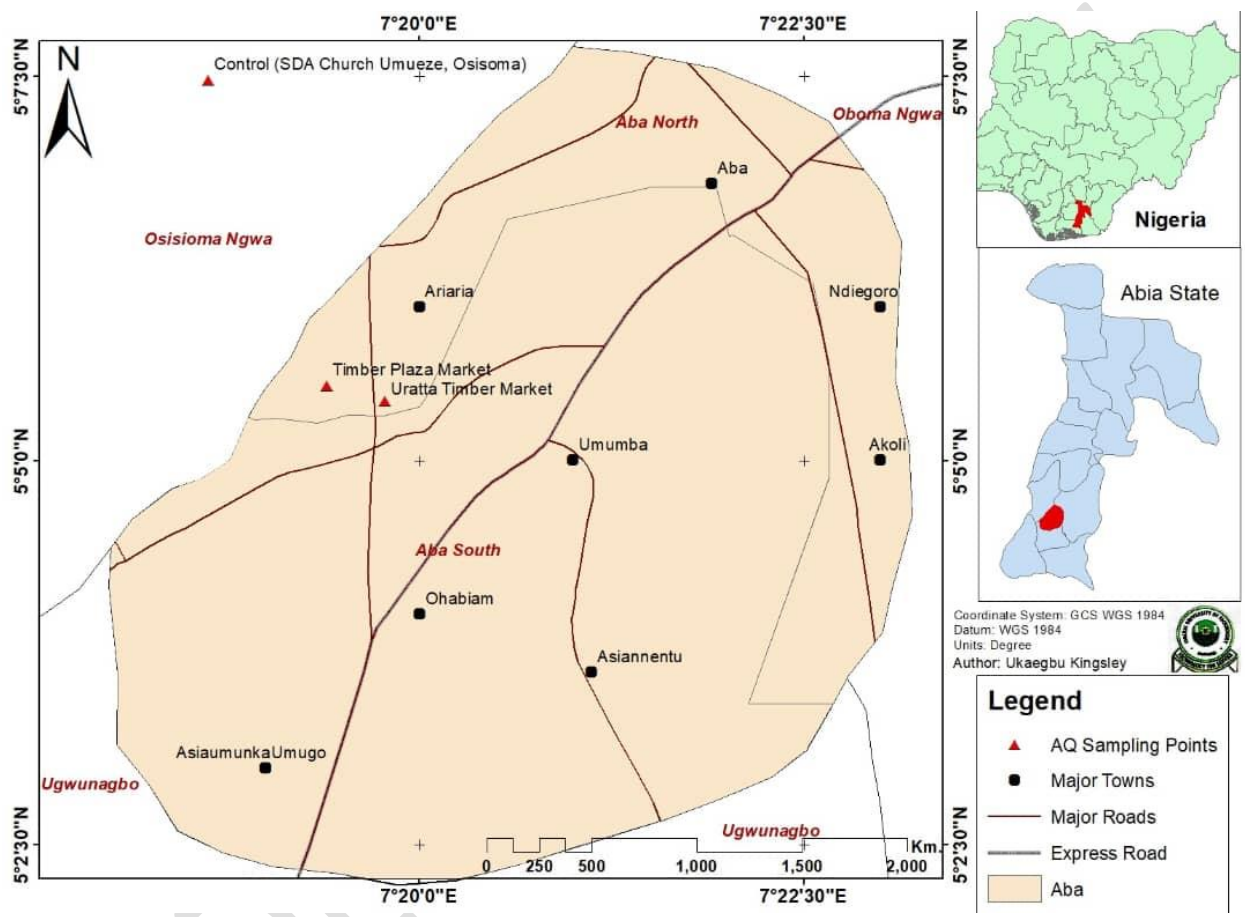

Figure 1: Study area showing sampling points
Source: Authors field work, 2024.

3. MATERIALS AND METHOD

3.1 Different equipment such as the handheld Gas Detector Hand held mobile multi-gas monitor with model AS8900 [for Carbon Monoxide (CO), Hydrogen Sulphide (H_2S), and Oxygen (O_2)], BLATN with model BR—Smart Series air quality monitor (Particulate Matter (PM10) and Formaldehyde) and air quality multimeter with model B SIDE EET100 (Dust ($PM_{2.5}$), VOC, Temperature and Relative Humidity) equipment were used to detect the presence and precise

quantity of the following individual gases: Carbon Monoxide (CO), Particulate Matter ($PM_{2.5}$), Particulate Matter (PM_{10}), Volatile Organic Compounds (VOCs) and Formaldehydes. The instruments were mounted in the various sampling points for a minimum of 30 minutes each where they assessed the air quality of the surroundings and the readings of the pollutants were recorded on the meters of each instrument.

3.2 Sample Collection

Air quality sampling was carried out using the systematic sampling technique at three different locations, two saw mills and a non-industrial area as the control all located within Osisioma LGA. The different sampling locations are denoted a (Location A) for the first wood mill, (Location B) for the second wood mill and (Location C) as the control (Table 1). The sampled points are separated from the control point by a distance of 4 kilometers. The monitoring exercise was conducted in the daytime, between 8.00am and 4.00pm.

Table 1. Coordinates of the study locations

	LOCATIONS	**LATITUDE**	**LONGITUDE**
A	**Uratta Timber Market**	5° 05' 20" N	7° 19' 25" E
B	**Timber plaza**	5° 05' 19" N	7° 19' 19" E
CONROL POINT	(SDA Church Umueze, Osisoma)	5° 09' 08" N	7° 20' 34" E

3.3 Questionnaire Survey

Structured questionnaires were administered to 25 respondents each in the saw mills. The questionnaire included questions relating to the: socio-demographic information, exposure assessment, health effect, awareness of air pollution and behaviour towards it. These questions were aimed at gathering insights into the experiences, perceptions, and needs of individuals working in saw mills regarding exposure to air pollution and air quality management.

4. Results and Discussion

Table 2: Results of the air quality analysis at Uratta Timber market

Parameters Ppm	Point 1 Non-working Hour	Point 1 Working Hour	Point 2 Non-working Hour	Point 2 Working Hour	Point 3 Non-working Hour	Point 3 Working Hour	Control	FM Env. Limits
Ammonia	0.04	0.2	0.07	0,05	0,06	0,1	ND	0.6
Hydrogen Sulphide	0.002	0.006	0.004	0.002	0.003	0.005	0.001	0.05
Surphur dioxide	0.01	0.07	0.02	0.04	0.03	0.08	0.005	0.01
Carbon Monoxide	0.4	2	0.8	1.2	0.7	2.5	0.1	10
Nitrogen dioxide	0.01	0.06	0.03	0.04	0.02	0.08	ND	0.5

Methane	0.9	1.8	1.3	1.3	1.1	2.2	ND	NS
Ozone	0.009	0.03	0.015	0.015	0.017	0.025	0.0005	0.06
Photochemical Smog	0.015	0.05	0.025	0.03	0.019	0.06	ND	NS
Volatile Organic Compound	0.2	0.6	0.4	0.4	0.3	0.7	0.05	0.15
Particulate Matter PM (2.5) mg/m^3	20	35	30	50	25	60	ND	0.25
Particulate Matter PM (10) mg/m^3	40	70	60	100	50	120	ND	0.5

ND = Not detected, NS = Not Stated
Point 1 - Where the wood is packed
Point 2 - Where the wood processing (cutting, filling, chiseling etc) activities are carried out
Point 3 - Where they keep their machines (petrol and diesel engines)

4.1 Concentration of Average ambient air pollutants at Uratta Timber Market

The air quality analysis conducted in Uratta Timber Market shown in Table 2, provides significant insights into the concentration of various pollutants at different points of the sawmill during both working and non-working hours. The data highlights the variation in air quality parameters at three key locations within the sawmill—where wood is packed, where wood processing activities are conducted, and where machinery is stored—as well as control points situated away from the sawmill activities.

Ammonia levels were observed to be highest in the working hours, particularly at Point 1 (0.12 ppm), which is where the wood is packed. This concentration exceeds the values recorded in the Non-working hours and is significantly higher than the control readings, which were either not detected or at minimal levels (0.01 ppm). Despite the increase, all measured values remain well below the Federal Ministry of Environment (FM Env.) limit of 0.6 ppm. This suggests that while ammonia emissions are present, they are not at harmful levels according to regulatory standards.

Hydrogen sulphide concentrations follow a similar pattern, with the highest readings occurring in the working hours at Point 1 (0.006 ppm) and Point 3 (0.005 ppm). Non-working hours values were lower across all points, with the control point showing negligible levels (0.001 ppm). These concentrations are significantly below the FM Env. limit of 0.05 ppm, indicating minimal risk from hydrogen sulphide exposure.

Sulphur dioxide (SO_2) levels displayed notable variation, particularly with working hours readings at Point 3 reaching up to 0.08 ppm, which is higher than both the Non-working hours values and the control points (0.005 ppm). This increase is still within the regulatory limit of 0.01 ppm but indicates that sawmill activities contribute to elevated SO_2 levels, especially in areas with concentrated machinery and wood processing activities.

Carbon monoxide (CO) concentrations were considerably higher during the working hours, especially at Point 3 (2.5 ppm) where machinery is stored. Non-working hours values were notably lower, and the control point recorded minimal CO presence (0.1 ppm). Despite the elevated levels, the concentrations remain well within the FM Env. limit of 10 ppm, though the substantial increase during active hours indicates a potential risk for workers in close proximity to machinery.

Nitrogen dioxide (NO_2) also saw its highest levels in the working hours at Point 3 (0.08 ppm), compared to lower Non-working hours values and control readings that were not detected or very minimal. These values are well below the FM Env. limit of 0.5 ppm but highlight the contribution of wood processing and machinery to NO_2 emissions.

Methane levels were highest in the working hours at Point 3 (2.2 ppm), with Non-working hours levels and control values showing a stark contrast (ND and 0.2 ppm, respectively). Although methane does not have a stated FM Env. limit, its elevated presence during peak sawmill activities points to significant emissions from wood processing and machinery operations.

Ozone concentrations were observed to peak at 0.03 ppm in the working hours at Point 1, while the control values were considerably lower (0.005 and 0.007 ppm). These concentrations remain well below the regulatory limit of 0.06 ppm, suggesting that ozone formation, likely due to photochemical reactions involving VOCs and other precursors, is not at critical levels.

Photochemical smog and Volatile Organic Compounds (VOCs) also showed increased levels during the working hours, with VOCs reaching up to 0.7 ppm at Point 3. The control point exhibited much lower concentrations (0.05 ppm), indicating that VOC emissions from sawmill activities contribute significantly to air quality degradation.

Particulate matter ($PM_{2.5}$ and PM_{10}) concentrations were alarmingly high, especially in the working hours at Point 3, with $PM_{2.5}$ reaching 60.0 mg/m³ and PM_{10} reaching 120.0 mg/m³(Figure 2). These values far exceed the FM Env. limits of 0.25 mg/m³ for $PM_{2.5}$ and 0.50 mg/m³ for PM_{10}, indicating a severe air quality issue that poses health risks to workers and nearby residents. The control points recorded non-detectable levels, showing the impact of sawmill operations on particulate pollution.

The air quality analysis at Uratta Timber Market as shown in Table 2, indicates that sawmill activities contribute to elevated levels of various pollutants, especially during peak operational hours in the working hours. While most gaseous pollutants remain within regulatory limits, particulate matter and noise levels significantly exceed safe thresholds, highlighting the need for improved dust and noise control measures to protect the health of workers and surrounding communities.

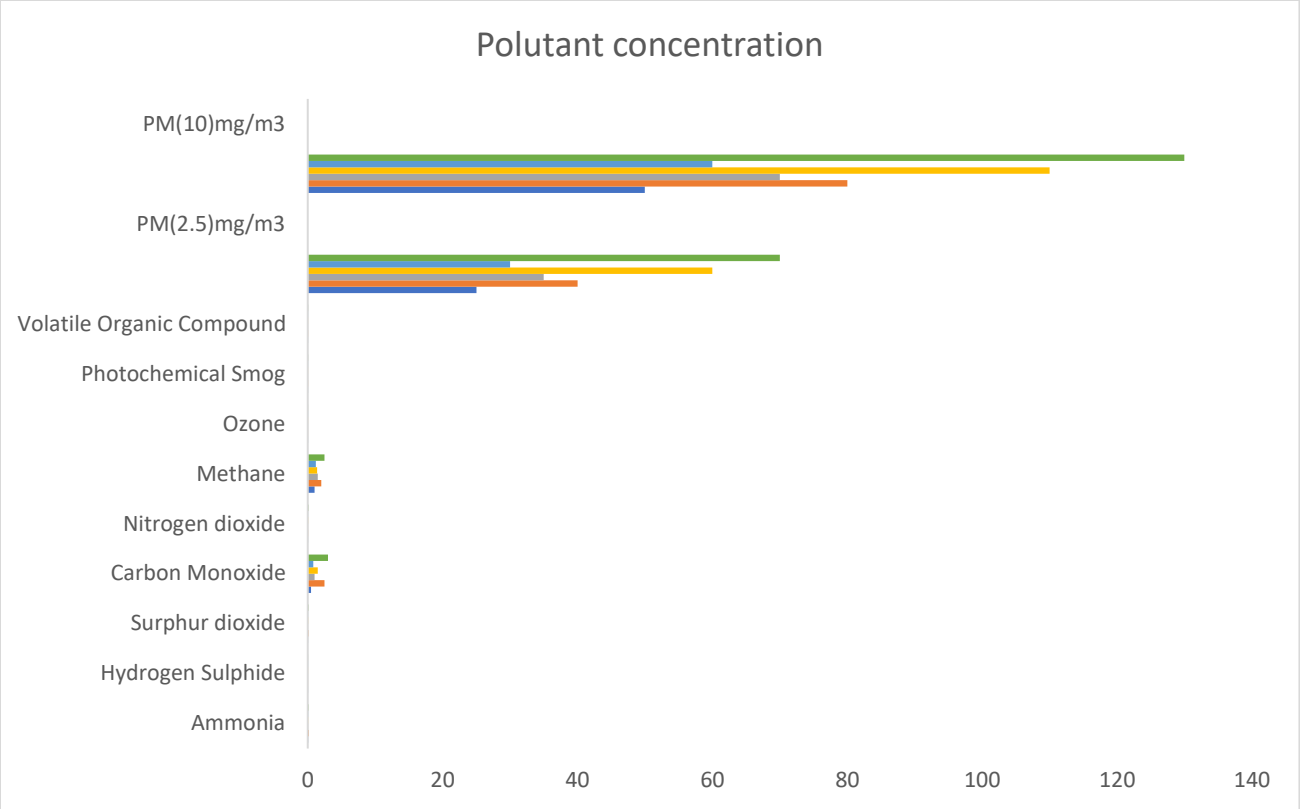

Figure 2: Air quality analysis in Uratta Timber Market

Source: Authors Field analysis

4.2 Results of the air quality analysis in Timber Plaza

The air quality analysis at Timber Plaza (Table 3), conducted at three key points during working and non-working hours, provides a comprehensive overview of pollutant concentrations and their variations. The points of measurement include where the wood is packed (Point 1), where wood processing activities occur (Point 2), and where machinery is stored (Point 3).

Table 3: **Air quality analysis in Timber Plaza**

Parameters Ppm	Point 1 Non-working Hour	Point 1 Working Hour	Point 2 Non-working Hour	Point 2 Working Hour	Point 3 Non-working Hour	Point 3 Working Hour	Control	FM Env. Limits
Ammonia	0.05	0.15	0.08	0.06	0.07	0.12	ND	0.6
Hydrogen Sulphide	0.003	0.008	0.005	0.003	0.004	0.006	0.001	0.05
Surphur dioxide	0.02	0.09	0.03	0.05	0.04	0.1	0.005	0.01
Carbon Monoxide	0.5	2.5	1	1.5	0.8	3	0.1	10
Nitrogen dioxide	0.02	0.08	0.04	0.05	0.03	0.1	ND	0.5
Methane	1	2	1.5	1.4	1.2	2.5	ND	NS
Ozone	0.01	0.04	0.02	0.02	0.02	0.03	0.005	0.06
Photochemical Smog	0.03	0.06	0.02	0.04	0.04	0.07	ND	NS
Volatile Organic Compound	0.03	0.06	0.02	0.04	0.04	0.07	ND	NS
Particulate Matter PM(2.5)mg/m^3	25	40	35	60	30	70	ND	0.25
Particulate Matter PM(10)mg/m^3	50	80	70	110	60	130	ND	0.5

ND = Not detected, NS = Not Stated
Point 1 - Where the wood is packed
Point 2 - Where the wood processing (cutting, filling, chiseling etc) activities are carried out
Point 3 - Where they keep their machines (petrol and diesel engines)

4.3 **Concentration of Average ambient air pollutants at Timber Plaza**

Ammonia levels were higher in the working hours across all points as shown in Table 3, with the highest concentration recorded at Point 1 (0.15 ppm). Non-working hours levels were lower, with the highest non-working hours concentration being at Point 1 (0.05 ppm). Control measurements showed negligible or undetectable ammonia levels, indicating that sawmill activities significantly contribute to ammonia emissions. Nevertheless, all recorded values are well below the FM Env. limit of 0.6 ppm, suggesting that while ammonia is present, it is not at harmful levels.

Hydrogen sulphide concentrations were higher in the working hours, peaking at Point 1 (0.008 ppm). Non-working hours levels were lower and control points showed minimal concentrations (0.001 ppm). These values are significantly below the FM Env. limit of 0.05 ppm, indicating minimal risk from hydrogen sulphide exposure within the sawmill.

Sulphur dioxide (SO_2) levels were highest in the working hours at Point 3 (0.1 ppm), with Non-working hours values being lower and control points consistently at 0.005 ppm. The concentrations within the sawmill significantly exceed the FM Env. limit of 0.01 ppm, highlighting a potential health risk and the need for effective emission control measures.

Carbon monoxide (CO) concentrations were notably higher in the working hours, particularly at Point 3 (3.0 ppm). Non-working hours values were substantially lower, and the control measurements were minimal (0.1 ppm). Despite the higher readings during operational hours, these values remain well within the FM Env. limit of 10 ppm. However, the increase indicates a considerable emission from machinery and wood processing activities, suggesting the need for better ventilation or emission control strategies.

Nitrogen dioxide (NO_2) also showed elevated levels in the working hours, with the highest concentration at Point 3 (0.1 ppm). Non-working hours readings and control points were significantly lower. Although these values are within the FM Env. limit of 0.5 ppm, the data underscores the impact of sawmill operations on NO_2 levels in the ambient air.

Methane levels were highest in the working hours at Point 3 (2.5 ppm), while Non-working hours levels were lower across all points. Control measurements showed negligible methane presence. Although there is no specified FM Env. limit for methane, its elevated levels during peak activities suggest substantial emissions from sawmill operations.

Ozone concentrations peaked at 0.04 ppm in the working hours at Point 1, while control measurements were much lower. These values are within the FM Env. limit of 0.06 ppm, indicating that ozone formation is not at critical levels but still present due to sawmill activities.

Photochemical smog and Volatile Organic Compounds (VOCs) were higher in the working hours, with VOC levels reaching 0.8 ppm at Point 3. Control points had much lower VOC concentrations (0.05 ppm), suggesting significant emissions from sawmill activities. VOC levels exceed the FM Env. limit of 0.15 ppm, indicating potential air quality issues and health risks.

Particulate matter ($PM_{2.5}$ and PM_{10}) concentrations were alarmingly high, especially in the working hours at Point 3, with $PM_{2.5}$ reaching 70.0 mg/m³ and PM_{10} reaching 130.0 mg/m³. These values far exceed the FM Env. limits of 0.25 mg/m³ for $PM_{2.5}$ and 0.50 mg/m³ for PM_{10}, indicating severe air quality issues that pose significant health risks to workers and nearby residents. The air quality analysis at Timber Plaza indicates that sawmill activities contribute to elevated levels of various pollutants, especially during peak operational hours. While most gaseous pollutants remain within regulatory limits, particulate matter and noise levels exceed safe thresholds significantly, showing the need for improved dust and noise control measures to protect the health of workers and surrounding communities.

4.3 Health Impact Assessment Conducted at Uratta Timber Market

The health impact assessment conducted through questionnaires at Uratta Timber Market provides detailed insights into the demographics, occupational roles, health symptoms, and perceptions of air quality among the workers. This assessment involved 25 respondents, with their ages ranging across different groups: 24% under 30, 28% are between 30-39, 24% are in the 40-49 age group, and 24% are between 50-60. The gender distribution shows majority of the respondents (72%) to be male, with 28% females. The duration of their work or ownership in the sawmill varies, with the largest group (36%) having been there for 1-3 years.

Occupational roles include 15 workers, six supervisors, and four owners. The majority of the respondents spend most of their time in Point 2, where wood processing activities are conducted (52%), followed by Point 1 (28%), and Point 3 (20%).

Health and respiratory symptoms are prevalent among the respondents. Shortness of breath is experienced by the majority, with the most frequent responses being 'sometimes' (36%) and 'often' (20%). Frequent coughing is reported by 17 respondents, with significant proportions experiencing it 'sometimes,' 'often,' or 'always.' Chest tightness or pain is also a common complaint, with 15

respondents experiencing it at least sometimes. Wheezing, throat irritation, and nasal congestion are similarly prevalent, with substantial proportions of respondents reporting these symptoms frequently. Skin irritation or rashes are also reported by 15 respondents, indicating a common health issue within the sawmill environment.

General health ratings show that only 24% of the respondents consider their health as excellent, while the majority rates their health as good or fair, and 16% rate it as poor. Chronic respiratory conditions, such as asthma, are present in 36% of the respondents. Visits to the doctor for respiratory issues in the past year were reported by 44% of the respondents, with the frequency of visits ranging from once to four times. Since starting work at the mill, several respondents have had multiple hospital visits, with the highest frequency being seven times. Medication for respiratory issues has been taken by 36% of the respondents in the past year.

The perceived impact of air quality on health is significant, with the majority of respondents (68%) feeling worse on days they work at the mill. Only two respondents (8%) believe that the air quality does not affect their health at all, while a substantial number perceive a moderate to significant impact. Despite these health issues, the use of protective measures like masks is relatively low, with only eight respondents using them. Awareness of air quality monitoring or control measures is also limited, with only 20% of the respondents aware of any such measures in place.

4.4 Health Impact Assessment Conducted at Timber Plaza

The health impact assessment conducted through questionnaires at Timber Plaza provides a detailed view of the demographics, occupational roles, health symptoms, and perceptions of air quality among the workers. The sample size includes 25 respondents, with a varied age distribution: 28% are under 30, 32% are between 30-39, 20% are in the 40-49 age group, and another 20% are between 50-60. The majority of respondents are male (72%), with females making up the remaining 28%. Their experience in the sawmill ranges from less than a year to over five years, with the largest group (40%) having worked there for 1-3 years.

Occupationally, most respondents are workers (60%), with supervisors and owners comprising 24% and 16% respondents, respectively. The majority spend most of their time in Point 2, where wood processing activities occur (48%), followed by Point 1 (32%) and Point 3 (20%).

Health and respiratory symptoms are prevalent among the respondents. Shortness of breath is reported by 22 individuals to varying degrees, with the most common frequency being 'sometimes' (40%).

Coughing is another typical symptom that nine respondents reported having frequently or usually. Another common complaint is chest tightness or pain, which is reported by 15 respondents as occurring occasionally. Similar numbers of respondents reported experiencing wheezing, throat irritation, and nasal congestion occasionally, frequently, or always. Although less common, skin irritation and rashes are nevertheless reported by a considerable proportion of respondents (14 reporting at least occasional experience with these symptoms). Just 20% of people believe their general health to be good, compared to 32% who believe it to be fair and 16% who believe it to be poor. Nine respondents have long-term respiratory disorders like asthma. However, 48% of respondents reported that they have seen a doctor for respiratory related health issue in the previous year, with visits occurring once to three times on average. Significant percentage of respondents

have visited the hospital more than once since resuming work at the saw mill. About 28% reported five visit and 32% reported three visit. About 8% of the respondents think that the quality of the air has no effect at all on their health, while a sizable percentage (40% and 32%) think that it has a moderate to considerate effects. Only seven respondents reported using masks or other protective gear, despite the obvious health risks.
About 24% of the respondents were aware that any air quality monitoring or control methods were in place, indicating a low level of awareness of these procedures. In summary, the health impact assessment conducted at Timber Plaza and Uratta Timber Market shows that a high frequency of general health and respiratory problems are experienced by workers, which was greatly attributed to the working environment. Forty percent (40%) of the respondents agreed to using medication for respiratory problems in the previous year. Significant health effects are perceived by respondents to air quality; 72% of them reported feeling worse on days when they worked at the mill. There is a need for better health and safety procedures given the sparse application of protective gear and minimal knowledge of air quality management techniques in the sawmills assessed. It is therefore, essential to enhance the safety and well-being of the workers by implement more stringent air quality monitoring and control measures as well as enforcing the use of personal protective equipment for the workers.

CONCLUSION

The study shows elevated concentrations of particulate matter significantly exceeding permissible limits. At Timber Plaza, $PM_{2.5}$ levels reached 70.0 mg/m³ and PM_{10} levels increased to 130.0 mg/m³ in the working hours, both far above the regulatory limits of 0.25 mg/m³ and 0.50 mg/m³ respectively. Similarly, at Uratta Timber Market, $PM_{2.5}$ concentrations were as high as 60.0 mg/m³, and PM_{10} levels reached 120.0 mg/m³. Health impact assessments conducted through questionnaires among sawmill workers revealed a high prevalence of respiratory problems, including shortness of breath, frequent coughing, chest tightness, wheezing, throat irritation, and nasal congestion. The majority of respondents reported a perceived impact of poor air quality on their health, with frequent visits to doctors and reliance on medication for respiratory issues. The findings from the study show the urgent need for implementing effective dust control measures, regular air quality monitoring, and health surveillance programs to mitigate the adverse effects on workers health. Efforts should be made to reduce particulate pollution at these sites. This could involve improving industrial processes, reducing vehicle emissions, or using air filtration systems. it may be necessary to investigate the source of emissions, as these could contribute to health issues and the formation of photochemical smog. Although many pollutants are under the environmental limit, continuous monitoring, especially of VOCs and particulates, is essential to ensure air quality remains safe.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

References

[1] Ajao, A. M., Oluseyi, T. O., & Osibanjo, O. (2018). Characterization and Assessment of Dust Emissions from Sawmill in Nigeria. *Journal of Environmental Protection*, **9**(11), 1303-1317.

[2] Athenasiadou, M., Rappolder, M., Ruepert, C., & Grueter, A. (2008). A contribution to the measurement of ammonia emissions from wood chips in wood-based panel production. *Biomass and Bioenergy*, **32**(5), 460-466.

[3] Bragança, I., Gândara, J., Costa, C., & Tavares, P. (2019). Hydrogen sulfide toxicity: The case of oxidative stress and mitochondrial damage in insects. *Insects*, **10**(10), 348.

[4] Daniel, D. C. (2019). Environmental Science: A framework for Decision Making (High school edition). Addison-Wesley Publishing Company. Chp. **8**, 12- 17.

[5] Ediagbonya, T.F, Tobin A.E, Ukpebor E.E, Okieimen F.E (2014.) Prevalence of respiratory Symptoms among Adults from Exposure to Particulate Matter in Rural Area of Niger Delta Region of Nigeria. Biological and environmental sciences journal for the tropics. 11: 463-466.

[6] Elbayoumi, M., Moustafa, M., & Younis, A. M. (2020). Air Quality Assessment around Sawmills in Urban Areas of Egypt. *Journal of Environmental Science and Health, Part A*, **55**(2), 189-200.men. Cancer Manag Res 4: 223-232.

[7] EPA. (2022). Ozone Pollution. U.S. Environmental Protection Agency. Retrieved from https://www.epa.gov/ground-level-ozone-pollution.

[8] Gaveau, D. L. A & Brodley T. (2015). Major atmospheric emissions from peat fires in Southeast Asia during non-drought years: Evidence from the 2013 Sumatran fires. Science Report, 4, 6112.

[9] Guidotti, T. L. (2018). Hydrogen sulfide: Advances in understanding human toxicity. *International Journal of Occupational and Environmental Medicine*, **9**(3), 125-132.

[10] Jarrett, M., Burnett, R. T. M. A. R., Pope, C. A. III, Krewski, D., & Newbold, K. B. (2015). Spatial analysis of air pollution and mortality in Los Angeles. *Epidemiology*, **16**(6), 727-736.

[11] National Population Commission of Nigeria. (2006). Population Census of the Federal Republic of Nigeria. Retrieved from http://www.population.gov.ng/

[12] Nazari S.h, Kermani M, Fazlzadeh M, Alizadeh-Matboo S, Yari A.R(2016). The origins and sources of dust particles, their effects on environment and health and control strategies: A review. Journal of Air Pollution and Health. 1(2): 137-152.

DOI: 10.5455/jeos.20140512123536

[13] Occupational Safety and Health Administration [OSHA]. (2010). Hydrogen sulfide. OSHA Fact Sheet. Schnabel, R. (2015). VOCs, carbonyls, and hazardous air pollutants emissions from sawmill wastewater. *Journal of the Air & Waste Management Association*, **65**(9), 1081-1093.

[14] Olujimi, O.O.,Nofiu,M.A., Oguntoke, O., and Soaga, J.A. (2023). Occupational exposure to wood dust and prevalence of respiratory health issues among sawmill workers in Abeokuta metropolis, Ogun state, Nigeria. j. nat. sci. engr. & tech. 2023, 22(1): 11-27

[15] Oluwatosin, A. A, Adeleye, A. A, Adefi, S. O. Adewole, O. K. Israel, Abiola, O. Temitayo-Oboh, Sunday O. O (2015). Wood dust particles: Environmental pollutant in Nigerian sawmill industries. Journal of Environmental and Occupational Science.

[16] Prasanth N, V. Arutchelvan, S.J (2022). The impact of wood dust particles on the pulmonary function of sawmill workers . International Journal of Contemporary Medical Research ;9(7): G1-G4.

[17] Raimi M.O., Adio Z.O., , Odipe O.E. , Timothy K.S , Ajayi B.S & Ogunleye T.J (2020). Impact of Sawmill Industry on Ambient Air Quality: A Case Study of Ilorin Metropolis, Kwara State, NigeriaEnergy and Earth Science Vol. 3, No. 1, doi:10.22158/ees.v3n1p1

[18] Rockström, J. (2019). A safe operating space for humanity. Nature, 461, 472-475.

[19] Rybka, J., Sroka, J., Nawrot, W., & Zgoda, M. (2020). Wood dust and occupational health hazards in the furniture industry. *International Journal of Occupational Safety and Ergonomics*, 1-10.

[20] Siew S.S, Kauppinen T, Kyyronen P, Heikkila P, Pukkala E (2012) Occupational exposure and to wood dust and formaldehyde and risk of nasal, nasopharyngeal and lung cancer among Finnish

[21] Sommer, S. G., Hutchings, N. J., & Schjoerring, J. K. (2013). Ammonia emission from field applied manure and its reduction — invited paper. *European Journal of Agronomy*, **49**, 115-123.

[22] Tobin EA, Ediagbonya TF, Okojie OH, Asogun DA (2016) Occupational Exposure to Wood Dust and Respiratory Health Status of Sawmill Workers in South-South Nigeria. J Pollut Eff Cont 4: 154. doi:10.4172/2375-4397.1000154

[23] Valavanidis, A., Fiotakis, K., & Vlachogianni, T. (2018). Airborne particulate matter and human health: Toxicological assessment and importance of size and composition of particles for oxidative damage and carcinogenic mechanisms. *J Environ Sci Health C Environ Carcinog Ecotoxicol Review*, **26**, 339-362.

[24]WHO. (2005). Air Quality Guidelines: Global Update 2005. World Health Organization. https://www.who.int/airpollution/publications/aqg2005/en/