MEDICAL EFFECT OF EMISSION FROM UNREGULATED REFINERIES AT RUMUOLUMENI COMMUNITY IN PORT HARCOURT RIVERS STATE NIGERIA.

ABSTRACT

This study investigates air quality in the Rumuolumeni environs, River State, Nigeria, which started in November 2016 when soot became a public health hazard to date. The study identified the cause of the soot, which is unregulated refineries (known as kpoo fire), and compared effluent from a regulated refinery and the source in the chosen community. The population of the study area and its environs have witnessed adverse environmental influences as a result of the emissions and accumulation of unburnt carbon materials (soot) within the first four quarters of 2016.This research has provided a solution that will ensure that federal government environmental agency/ regulatory bodies in terms of environmental protection should carry out their functions effectively and efficiently on soot pollution, which has resulted in a decline in public health in the study area. In addition, numerous local refineries built in the area by quacks should be eliminated so as to reduce environmental pollution and public health hazards further. In conclusion, the investigation has further revealed that the numerous home-made petroleum refineries are the major sources of black carbon pollution, which has a direct link to the host community and its environs.

Keyword: Air pollution, health, sooth, petroleum refineries, government agency.

1.0 INTRODUCTION

Having an excellent environment to live and work in is everyone's dream. Nevertheless, a situation where unregulated industrial activity has caused good air quality to be challenging to achieve is very problematic as it affects everybody living in the vicinity, especially children and people with respiratory issues. Knowing the quality of air in a community before the onset of pollution is very important because it helps to understand the cause of illnesses and land and water pollution, which affects fishing and farming. In the case of Port Harcourt, there was no proper Environmental Impact assessment before the oil and gas exploration started over 75 years ago. What we have is the word of mouth and observation by residents.

One type of air pollution that can seriously harm both the environment and public health is carbon black pollution. Ewubare et al. (2021) and Akagbue*et al*. (2023b) state that particulate materials, ashes, and other gaseous emissions eventually find their way to the atmosphere, resulting in negative influences on the immediate environment. In addition, air pollution affects atmospheric visibility as well as the quality of local air intake, including climate, the environment, and human health (Wang et al., 2014; Ilten and Akpinar et al., 2007; Baba Aminu, 2023a).

As a result of this, some populace in the states have developed a local method of refining petroleum products by applying local equipment and machines, as well as some innovation, in an

effort to close the gap between production and consumption of these refined products (Akeredolu and Sonibare, 2015; Sonibare et al., 2009).By heating the distilleries that contain crude oil over an open flame, this method uses a straightforward, locally available distillery process to produce refined products. Premium Motor Spirit, or PMS, as it is locally called in Nigeria, as well as other liquids, are the products of the refining process. Drilling machinery, drums, Cotonou boats, pipes, firewood, crude oil, pumping machines, rubber hose, dried wood, storage facilities, and other items are produced and obtained locally for the operation.

A small staff efficiently and easily runs the operation. Depending on the processing capacity used or the level of entrepreneurial skill, it can be setup with little financial outlay. Setting up the refinery is inexpensive, easy, and efficient. For local private investors, its comparatively low cost makes it an easy-going business (Asuru and Amadi, 2016). In the Niger Delta region, over 20,000 artisanal refineries have been set up in the Rumuolumeni Community by private investors who profit from the region's cheap labor and raw material availability, polluting the environment with soot (Akeredolu and Sonibare, 2015).

Based on estimates from the Rivers State Government (2016), the total population of people residing in Rumuolumeni in Rivers State, which is also within the Niger Delta region of Nigeria and has a population of about 7,745,000 as of 2018, was the survey site. Also, based on the reports of the River State Government in 2016, the states comprise 23 local government areas with different ethnic groups, and the region is known for its hydrocarbon (oil and gas) production in the Niger Delta complex.The Rumuolumeni metropolis, which is part of River State, contains giant crude oil and natural gas reserves, which are believed to contain over 60% of Nigeria's crude oil. The booming oil and gas sector in the Rumuolumeni metropolis, as well as other parts of the state, has resulted in a population explosion. NPC and ICF International (2019) conducted research on the literacy level of the populace in Port Harcourt, Nigeria, and found the literacy level for women to be 84% and 95% for men who have education up to senior secondary cadre/level. Due to its vastness, soot poses a serious threat to public health as a result of its small size. Particulate matter (PM) can readily find its way into your bloodstream and lungs, where it may in turn cause harm to the body in different ways (Akagbue et al., 2023a).The method by which soot damages the human body is outlined by the Environmental Protection Agency: Small particles from this unburnt carbon material that are released into the environment find their way to the lungs. This is linked directly to a number of adverse health conditions, such as heart attacks, strokes, early death, acute bronchitis, and even an increase in the rate of asthma in children (Jackie Weidman, 2012).Many resources that are essential to human survival can be found in our immediate environment. In this way, environmental resources that contribute to a longer lifespan include clean air, drinkable water, healthy food, and so on. Contrary to this, the environment has lost value throughout time due to advancements in sanitation, agriculture, and mineral extraction for human consumption. A social problem has emerged as a result of this depreciation. Infections such as cholera, gastritis, diarrhea, meningitis, and schistosomiasis can be brought on by contaminated drinking water, as demonstrated in this scene. An estimated 1.8 million children worldwide pass away from diarrheal infections each year, making them the

primary cause of infant mortality in underdeveloped nations (Peter and Umar, 2018; Aminu et al., 2022b).

A study for a 5-year period (2003–2007) was carried out, and the epidemiological data set found that all of the qualifying air pollutants in Rivers State had values that were significantly higher than the World Health Organization's (WHO) specification (Nwachukwu et al., 2012). The state's air-related morbidities and fatalities were found to be linked to air pollution. In the aforementioned years under examination, it was reported that pneumonia was the most common air-related morbidity, accounting for the greatest number of deaths in 2005. Other air-related morbidity included cerebrospinal meningitis (CSM), chronic bronchitis, measles, pertussis, pulmonary tuberculosis, pneumonia, and upper respiratory tract infections (URTIs).

The research emphasizes the dire implications of particle pollution exposure for humans and the necessity of enforcing current nationwide environmental control as well as management. It also suggests translating the lessons learned from effective government action in preventing soot pollution. It also highlights the importance of conducting additional studies to ascertain the health effects of the pollution on exposed residents and the effects of home-made technology in some crude petroleum refineries in the Niger Delta.The study's main goal is to examine soot pollution as a consequence of uncontrolled crude refineries in Rumuolemeni and its environs, as well as the community's significant social challenge associated with it. It also seeks to critically assess the role that environmental agencies play in identifying a long-term solution to this issue.

Based on WHO (2017), it states that of all environmental dangers, air pollution is the most significant, with exposure to outdoor air pollution linked to about 3 million deaths annually. Only in 2012 was outdoor air pollution a factor in 11.6 percent of all deaths worldwide, or 6.5 million deaths. Non-communicable diseases, such as lung cancer, chronic obstructive pulmonary disease (COPD), and cardiovascular diseases (CVDs), account for 94% of the nearly 90% of air pollution-related deaths that occur in low- and middle-income countries.Air pollution primarily originates from industrial operations. One issue linked to the increasing number of people living in different cities is air pollution. Due to urbanization, related industrial expansion, and greater mobility, this has greatly grown, worsening the quality of the air and increasing air pollution in highly populated places (Aminu *et al*., 2022a; Baba Aminu *et al*., 2023). According to APMA (2002), the intensity of air pollution issues in urban areas is directly linked to the level and rate of urbanization. The majority of these pollutants originate from "short-lived" sources, such as solvent evaporation, industrial facility leaks, incinerators, and flare stacks (FAP, 2014).

The type of soot present in the research area is classified as black soot. Air pollutants include elements like black soot which are roughly 2.5 mm in diameter. It is a type of pollution that includes metals, dust, and chemical acids, among other contaminants. It can exist in a solid, liquid, or gaseous state due to its inherent characteristics. Usually, burning fossil fuels produces products like soot, which comes from oil refinement and car emissions. Some particles become gas and can travel thousands of kilometers from their source, while soot, being a microscopic particle, is released into the air. Throughout time, soot has been identified as a potential hazard to public health. Public health, in general, is to promote and safeguard the health of individuals as well as the communities in which they reside, learn, work, and play (American Public Health

Association, 2020). Accordingly, an incident that has the potential to compromise public health or improve people's safety and well-being is classified as a public health crisis.

The incomplete burning of biomass, biofuels, and fossil fuels results in unburnt carbon material pollution (Rajesh & Ramachandran., 2018). One of the worst air pollution agents in the world, according to the US Environmental Protection Agency (EPA), is soot pollution. Regarding both climate change and human health, it is one of the worst environmental risks. Nine out of ten people breathe air that contains high levels of pollutants, and the World Health Organization (WHO) estimates that air pollution causes seven million deaths worldwide annualy, accounting for 23 percent of all deaths worldwide, or approximately 12.6 million deaths.

Nigeria oil-rich The Niger Delta metropolis of Port Harcourt has witnessed a wave of environmental degradation lately, which has resulted in tensions amongst various stakeholders in the state (Aigbadon et al., 2021). Soot pollution, also referred to as black carbon, is the most destructive of these, having an impact on the city and its surroundings. As the hub of oil and gas development in the area, Port Harcourt, one of the nine states that make up Nigeria's oil-rich crude metropolis, is experiencing an increase in air pollution issues (Whyte et al., 2020). The major contributing reasons to this issue are the massive oil production and development activities as well as the rapid population growth (Yakubu, 2017). For more than 50 years, Nigeria has witnessed significant environmental deterioration as a result of gas flaring and oil spills, as well as oil and gas development and production (Brandt, 2020). Nigeria is committed to combating climate change, but it still primarily uses fossil fuels, which are a major source of flared gas (Whyte *et al*., 2020). The Rivers State Government has frequently claimed that the carbon black is the result of illicit oil refiners' operations, tyre burning, and security personnel's destruction of vehicles and drums that were confiscated from owners of artisanal refineries. One of the most oil-bearing states in Nigeria, Rivers State is also severely plagued by oil pollution, which is why the much-discussed and expected to cost billions of dollars Ogoni clean-up project is necessary. Activists and the town people think that the reason for Port Harcourt's soot pollution is because of local refineries, the burning of tires, and the flaring of petroleum-based products (Salami, 2018).

In the oil-rich Niger Delta region and its surroundings, pipeline theft has also increased recently. This involves people destroying pipelines and stealing crude oil to use in unauthorized or artisanal refineries that are erected in the bush. Given that they typically take place at night and change every day, these refining operations are difficult to forecast. According to Ihesinachi et al. (2019), around 40 clandestine refineries were found in Port Harcourt, Niger Delta. This facilitated the spread of soot pollution, which is made up of impure carbon particles that result from incomplete hydrocarbon burning. Some claimed that the government was unresponsive and that it only took action after people publicly voiced their worries on social media and criticized their neglect/non-intervention.

Fig. 1: Soot Pollution in the study area and environs

2.0 Impact of soot pollution of the study area

Because of all the oil activities that take place in Rumuolumeni, the ecosystem is clearly degrading in these areas. Gas flaring and oil spills are the causes of this pollution. As a result of an increase in the number of artisanal refineries that, over time, created black carbon, air pollution has taken on a new form and shape in this regard. These handmade refineries' owners depend on oil theft (Goodnews and Wordu, 2019). In an effort to stop this, the government established the Joint Military Taskforce (JTF) to keep an eye on these theft and crude oil bunkering. Currently, there are clandestine refineries in almost every coastal area. Since local refineries are set on fire every day and the enterprise is dispersed around the country, the task force operation approach is to burn these refineries. According to the July 11, 2014, Vanguard Newspaper, JTF demolished 110 illicit refineries. JTF states that this does not include 13,343 Jerry cans owned by illegal oil industry operators, 191 barges, 13,129 drums, 785 wooden cargo boats, and 3,872 surface tanks used by operators of artisanal refineries. The fact that the operators immediately install new ones after causing disruptions is highly intriguing in this case (Sweet Crude Report, 2018). Thus, the situation is to build, demolish, and then rebuild. Black smoke is released as long as this circle is kept in place.

Pollution of the land, water, and air has plagued the people of Rumuolumeni and other oil-producing coastal areas for many years. Since water has been contaminated, fishing, which is the primary occupation of the indigenous people, has become nearly impossible. Basic necessities like clean water have also become difficult to come by. Farmlands have been degraded by these pollutions, restricting farmers' ability to farm. Oil exploration is primarily to blame for the pollution. The increasing number of illicit refineries, according to Chief Timipre Sylva, Minister of State for Petroleum, was caused by the high cost of transportation for individuals living in coastal areas, who in turn purchase refined petroleum products at exorbitant prices.

Carbon black pollution, which has long affected people in rural, coastal areas, has now spread beyond borders to disturb people living in the city because the illicit refiners' activities are still ongoing. It's possible that this is the most recent development in Port Harcourt city. Considerable

evidence suggests that soot may pose a danger for a number of illnesses, such as cancer, birth defects, premature births, asthma, bronchitis, pneumonia, and even mortality. Kidney failure, skin conditions, lung cancer, nausea, and vomiting are among the other illnesses. A great deal of human activity is hindered by thesoot contamination of the soil and surface water.It has a negative impact on agricultural productivity as well as the environment. Based on the study of Niranjan and Thakur(2017) on the toxicological mechanisms of environmental soot (black carbon): with anemphasis on oxidation stress and inflammatory pathways,it was proved that soot pollution can be harmful to the public's health. According to their research, carbon black and soot can lead to a variety of illnesses. Apart from its carcinogenic properties, soot can cause a variety of illnesses in humans. In a different study, Parent et al., 1996 determined that there was a positive correlation between lung cancer risk and exposure to tuberculosis (TB) through their risk assessment of a population-based soot study conducted in Montreal, Canada. Niranjan and Thakur (2017) also conductedarelated investigation in Kuwait and found that soot particles from the oil fields in Kuwait in 1991 resulted to genetic mutations that are capable of damaging DNA. The new research, "Exposure to Heavy Metals in Soot Samples and Cancer Risk Assessment in Port Harcourt, Nigeria," by Kalagbor et al. (2019) corroborates previous findings in this area. These aforementioned researchers have established that soot causes skin, liver, and esophageal cancers, includingleukemia. The study also claims that there is a high rate of cancer in the investigated region and that the presence of soot in the region is associated with the prevalence of cancer.

Based on the investigation of Weli and Adekunle (2014), they were able to establisha strong correlation between air pollution, including soot, and morbidities like respiratory diseases, traumatic skin, outgrowth and respiratory health conditions, child deformities, stillbirth, and miscarriage in their study of environmental risk factors and hospital-based cancers in two Nigerian cities. Also, Yakubu (2017) asserts that data from much research links those who are frequently exposed to contaminated air to health concerns such as skin and eye disorders. A similar relationship between man and nature has been proven by Yakubu even Humanist Eco marxists like Clark. In particular, this theory asserts that there is a link of interdependence between man and the environment.In particular, this theory asserts that there is a link of interdependence linkbetween man and his environment. The Rift theory, which views the relationship as dynamic and the dynamics between people and non-humans in the natural world-which, although they are separate entities, are connected inside one metabolic system-further emphasizes this feeling of the intimate affinity between nature and man stated that, compared to Ibadan, Port Harcourt has a greater prevalence of skin and lung malignancies. In order to highlight how serious, the issue is, Yakubu (2017) notes that breathing in soot causes deep lung penetration, which can impact a person's risk of developing acute bronchitis, aggravated childhood asthma, heart attacks, strokes, and ultimately early death, as well as developmental difficulties and reproductive disorders. Peel et al. (1983) research on ambient air pollution and respiratory emergency room visits is supported by the results of this study. Researchers found

that patients who have been exposed to soot and have a history of hypertension are more likely to develop dysrhythmias and congestive heart failure in the emergency room.

2.1Soot origin in Port Harcourt, Nigeria

Since soot deposits were first observed in Rivers State residences and the surrounding area in November 2016, the state's citizens, as well as those across the nation and the world, are concerned about the state's environmental quality. In various regions of the state, the soot initially appears in the form of clouds packed with the dark particulate matter on the skyline. Had it not been for their soot-filled clouds and the fact that they do not exhibit lower temperatures, harmattan haze would have been confused with them. This scene is most visible in the morning and evening, and especially when the raining activities have reduceddrastically between November and March. Even with regular, thorough cleaning, black soot builds up in dwellings and gives the entire place an unclean appearance (Kalu, 2018). It can be seen on bedsheets, windowsills, pavement, walls, floors, includinginpublic and private spaces. In the same way that soot settles on cars, streets, water bodies, wetlands, plants, and animals, it also penetrates homes and other enclosed areas. The soot threat is not location- or person-specific, and there is hardly a safe spot in the state to avoid it. The absence of access to safe drinking water has been greatly linked to soot pollution; 76-80% of people in rural areas and 50-55% of people in urban areas do not have access to it. These conditions clarify why locals in the affected community experience marginalization and disadvantage in different ways (Yakubu, 2017). This may support the claim that Port Harcourt, with an air index of 188, is rated the world's most polluted city as of April 2018. In the same vein, with an air index of 207.817 in December 2020, Air Visualclassified Port Harcourt as toxic for vulnerable groups.

According to AirVisual's rating of Port Harcourt's air quality for July 2021, the city's air index was 152, which is significantly higher above the normal (0-50) and moderate (51-100) values. This suggests a trend. As of right now, Port Harcourt's Air Visual Air Quality Index stands at 150 US AQI, meaning it is considered unhealthy for sensitive groups. Air Quality Air Visual, 2022) went on to unequivocally declare that PM2.5, or black soot, is the primary pollutant, with a concentration that is more than 10.7 times higher than the WHO annual guideline limit. It is expected and the basis for significant public outcry that a thorough environmental audit to determine how the environment has fared is long overdue after 76 years of oil exploration and extraction in the Niger Delta, particularly in Rivers State. Unfortunately, this hasn't been accomplished yet. Thoughthe environmental impact assessment of Rivers State's 76 years of oil exploration and development is not well recognized and hence not given much credit.

This may help to explain why Rivers State's black soot pollution problem, which has persisted for roughly six years, has not yet received the attention it deserves. In addition to being a social issue, soot pollution may also be an organizational one. According to study, workers in the rubber and black carbon industries, for instance, are exposed to soot and carbon black, which can cause serious occupational disorders (Niranjan and Thakur, 2017). In addition, based on the works of Niranjan and Thakur (2017) and Bourguet et al. (1987) also found that soot from the

tyres and rubberss industries was a significant contributor to skin cancer. The state residents, federal government of Nigeria, including developed and undeveloped nations of the world now view environmental pollution as a serious environmental concern (Efekalam, 2022).

Fig. 2: The unregulated refinery at Rumuolumeni study location.

3.0 METHODOLOGY

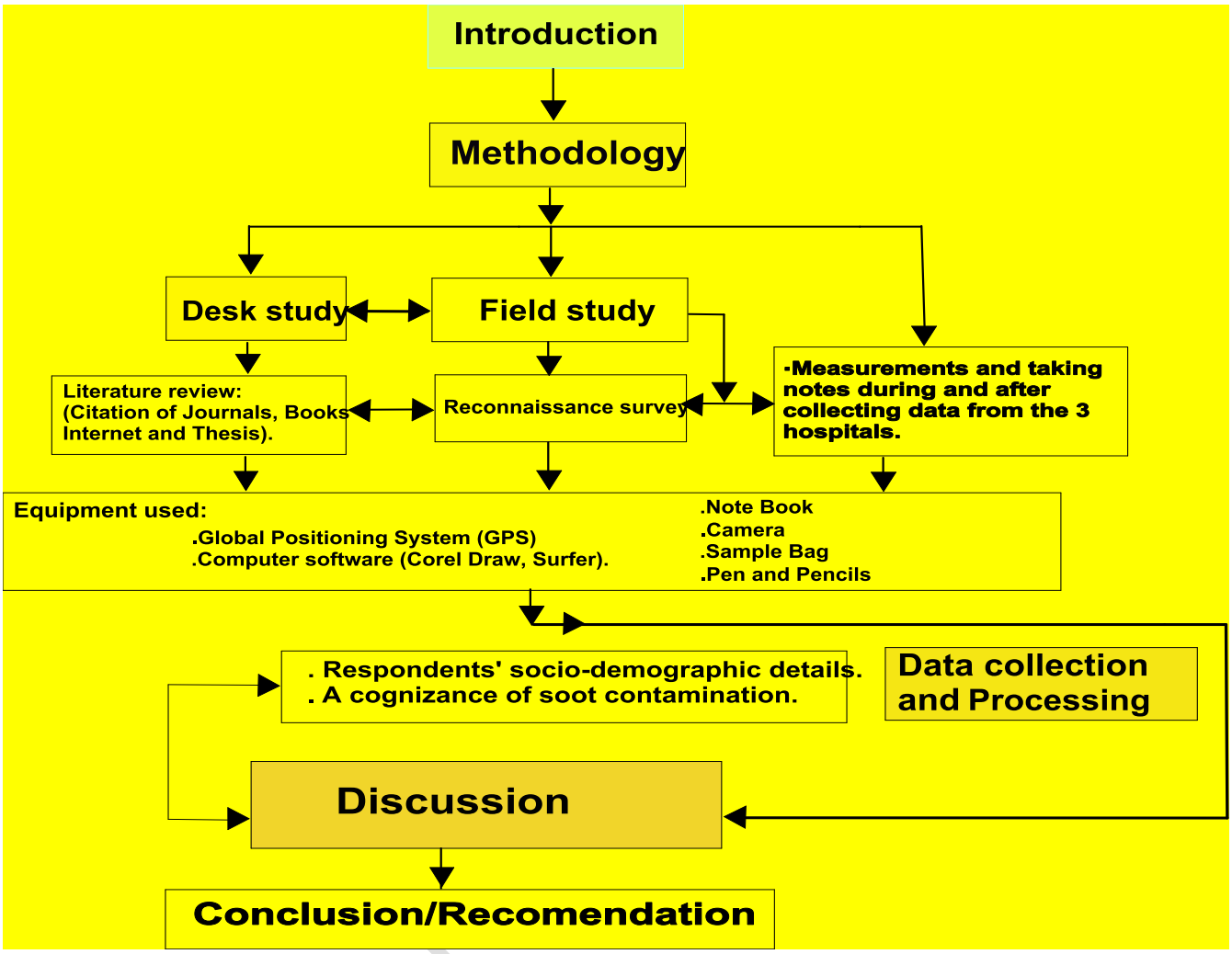

Fig. 3: Research workflow(Modified after Abdulbariu et al., 2023)

Data from the (3)three hospitals with the highest number of illnesses linked to soot were gathered. The majority of women with the diseases were between the ages of 23 and 85. The research area's results that could be obtained are listed below.

3.1 Data collection method

visitations were made to some hospital areas of operation in Rumuolumeni, Rivers States to acquire detailed information on patients. Records were obtained from three different hospitals, and it was identified that most diseases were caused by soot pollution in the research area and its environs.

3.2Respondents' socio-demographic details

Thirty records in total were acquired from three separate hospitals; of them, eighty-eight percent qualified as Rivers State citizens. Hospital records from hospitals throughout the state were gathered; the majority of the hospitals were located in Rumuolumeni's Local Government Area ObioAkpor. The patients' average age was 40.3 ± 20.3 years, and 88.5% of the respondents were mainly female.

3.3A cognizance of soot contamination

The vast majority of patients (96%) reported having seen soot in the area. The majority stated that between October 2021 and March 2022, they had first observed it.

3.4Results

Table 1: Medical Out Patient Department (MOPD)

S/N	Gender	Age	Diagnosis
1	M	59	ASTHMA
2	F	63	PTB
3	F	49	COPD
4	F	65	ASTHMA
5	F	40	ASTHMA
6	F	80	COPD
7	F	85	PTB
8	F	47	ASTHMA

Table 2: Rivers State University Teaching Hospital (RSUTH)

S/N	Gender	Age	Diagnosis
1	F	48	COPD
2	F	27	COPD
3	M	67	COPD
4	F	35	ASTHMA
5	F	63	ASTHMA
6	F	39	BRONCHIAL ASTHMA
7	M	44	LUNG ABSCEN
8	F	39	PTB
9	F	41	B/ASTHMA
10	F	60	COPD

11	F	48	CHRONICAL COUGH
12	F	60	B/ASTHMA

Table 3: University of Port Harcourt Teaching Hospital (UPTH)

S/N	Gender	Age	Diagnosis
1	M	62	ASTHMA
2	F	30	ASTHMA
3	F	41	COPD
4	F	79	PTD
5	M	30	ASTHMA
6	F	26	COPD
7	F	78	COPD
8	M	40	COPD

The result shows that the soot has reached a high level of pollution. Higher than the maximum limit for 24 hours established by WHO this leads to respiratory-related diseases.

3.5 Causes of soot pollution

According to perceptions, there were three main sources of soot: the burning of tires that had expired; the burning of confiscated crude oil and its byproducts (60.9%); and the burning of illegal or local crude oil refining ("kpofire") (85.2%).

3.6The consequences of soot pollution on health

A significant number of patients claimed that either their own health or a household member's health had been impacted by soot. The most often reported health impacts of soot pollution were cough (69.8%), irritation of the eyes, nose, or throat (64.2%), and Chronic Obstructive Pulmonary Disease (COPD) (32.6%). After adjusting for age, female patients were noticeably more likely than male patients to report health effects linked to soot pollution. There was no discernible correlation found between any other factor and the reported health impacts of soot pollution.

3.7The influences of the soot pollution on patients' day-to-day lives

89.5% of the patients who were asked how the soot pollution had affected their daily routine replied that they were cleaning floors and surfaces more often.Additional effects that were

mentioned included washing their hands and feet more frequently, being concerned about the health of their kids, engaging in fewer outside activities like farming, fishing, and recreation, and even considering moving to a less polluted location.

4.0 Discussion

Most of the operating locations in the study region had varying amounts of air pollution (HC, CO, NOx, SO_2, and H_2S) emissions that were measured. In that region of the state, black soot is a significant worldwide contributor to premature death. At Port Harcourt, one of Nigeria's coastal cities, there is a current significant emission of black soot containing PM2.5. The city of Port Harcourt has been beset by significant soot deposits since the fourth quarter of 2016. Due to their early respiratory organ development, children and the elderly are particularly at risk of negative health outcomes among Port Harcourt's more than 6 million inhabitants. In addition to soot's harmful effects on health and carcinogenicity, people in Port Harcourt have long complained about the black stain that always appears on their cars, floors, roofs, and furniture, necessitating frequent cleaning. The origins of soot are unknown, despite laboratory data indicating that it is a byproduct of burning petroleum. After roughly three months of continuous emissions of black soot, the Ministry of Environment declared an emergency situation in an attempt to combat the threat. Three enterprises that were discovered to be releasing large amounts of pollutants were also shut down. As of right now, more measures have been implemented, like the seizure of illicit refineries.

In Rumuolumeni, Rivers State, thepatients that were sampled were aware of the soot pollution. They first observed the soot in person between the final quarter of 2016 and the first quarter of 2017, respectively. January, when the Nigerian dry season peaks, was when the level of awareness was highest. Particulate matter levels have been demonstrated to vary seasonally in a number of African cities, including Rivers State, according to earlier research (Ogele and Egobueze, 2020). The dry season typically reports the highest values. One theory regarding the main contributors to soot in Rivers State was the illegal or artisanal refining of crude oil, theburning of crude oil and its byproducts that had been seized, and emissions from industries and other industrial sources.The results of earlier research conducted in Rivers State, where the majority of participants believed that illegal crude oil refining was a significant contributor to air pollution, are consistent with this one (Kalu, 2018).

Most patients believed that either their own health or the health of a household member had been impacted by the pollution. Similar results were observed by Omanga et al. (2014) in a study carried out in rural Kenya, where more than 80% of survey participants believed that air pollution constituted a major risk to their health. The majority of respondents in a different study conducted in Delta State, which is part of the Niger Delta region where our study is being conducted, firmly agreed that air pollution from gas flaring had detrimental, damaging consequences for health (Edino et al., 2010).

4.1Consequences and corrections for the research

Overall, the study found that regulatory bodies should create processes and preventive steps to deal with the affected population. It also gave pertinent agencies the proof they needed to create

suitable risk management plans and pass pertinent rules and regulations to stop the region from producing soot. The research's complex ramifications are then described.

4.2 Socio-cultural impacts of soot

Given that soot causes people to spend more time indoors, which reduces their ability to contact and converse with one another, it has a significant negative impact on residents' cultural activities and way of life. The findings supporting this indicate that locals prefer to spend the majority of their time indoors as opposed to outside, and parents often forbid their kids from participating in outdoor activities due to concerns about the health effects of soot. A section of the patient population also expressed intentions to move to different locations, perhaps leading to an economic disparity among the communities in the event that human resources in contaminated cities become scarce (Allen, 2017).

4.3 Awareness and sensitization of the public

This study can be a useful resource for raising theinhabitants of Rivers State's understanding of health issues and risk communication. In order to encourage legislators and environmental regulators to take action and to raise public awareness among the local populace about the need to lowering soot and related air pollution in Rivers State, information, education, and communication tools should be developed.Campaigns should pay special attention to conveying gender-sensitive information to women, as they appear to be more susceptible to the negative impacts of soot. Create a different source of income for artisan refiners. Studies show that youth's engagement in artisanal refining stems from unemployment and a belief that it is profitable, which downplays the immediate, long-term, and distant negative impacts on health, society, the economy, and the environment (Zeeuwet al., 2018). When the adolescentsmeans of subsistence improve, they will be less involved in artisanal refining, which will enhance the quality of the air in Rivers State and the surrounding area.

Conclusion

Residents of Rivers State, Nigeria, are impacted by soot pollution, which is a public health hazard. Nigeria has many environmental regulations, however the most of them are not put into practice. The soot epidemic under discussion is proof positive that industries are breaking these laws. The inability of the regulating agencies to conduct routine monitoring and guarantee the enforcement of such regulations is another fundamental reason for this state of affairs; with such periodic checks, the issue would have been identified early and addressed. The relevant authorities should look into and take steps to minimize the perceived causes of the current soot problem. Public health initiatives should be started to provide appropriate risk information about limiting exposure and gaining access to medical care. The appropriate authorities ought to work quickly to establish strict guidelines for preventing soot pollution, establish baselines for air quality, and look into the socioeconomic effects of soot on the local populace and economy. Furthermore, an epidemiological investigation is necessary to highlight the contextual health implications and/or potential hazards posed to the population of Rivers State, considering the

length of time they have been exposed to growing amounts of soot. It is also advised to launch a broad campaign and advocate for regulatory authorities, stricter air quality standards, legislation that is already in place, and the creation of alternative livelihood options for artisanal refiners. Environmental Impact Assessments, or EIAs, should be made mandatory for all company levels. Additionally, as Yakubu suggests in his study, businesses should create an environmental management system (EMS) model. In order to ensure successful environmental risk communication, government agencies must also use traditional, electronic, and social media to keep the public informed and updated on the outcomes of environmental monitoring. Despite these efforts, black soot is a constant problem for the people of Port Harcourt. Residents should take simple steps to lessen the harm caused by soot until all parties involved address the soot emission. These actions include the following:

- To prevent black soot from building up around the house, surfaces should be cleaned every day.
- As much as possible, windows and doors should be closed to keep soot from seeping inside.
- Hands need to be often cleaned, both before and after eating. Residents should bathe two or three times a day as well.
- Consume produce and fruits. According to research, eating foods high in vitamins C and E can assist to detoxify the body and mitigate the negative effects of particulate matter pollution. These foods provide anti-inflammatory and abundant antioxidant properties. These foods include spinach, broccoli, olive oil, tomatoes, avocado, flaxseed, and white wine.
- Food should always be covered, and exposed food should not be consumed.
- To lessen the amount of skin that comes into touch with soot, protective apparel should be worn.
- One way to lower the amount of particulate matter breathed is to wear a nose mask.
- When not in use, gadgets, equipment, and cars should be covered with coverings that provide protection.

Air pollution prevention should be the top priority for all tiers of government in Nigeria, aside from the primary goal of the government, which is to provide basic necessities like food, shelter, transportation, energy, and other essentials for the people. In a study Ede and Edokpa state that; "concerned stakeholders expect that mitigating air pollution in the Niger Delta of Nigeria will become more challenging in the nearest future if the present approach remains".

Ethical Approval:

As per international standard or university standards written ethical approval has been collected and preserved by the author(s).

Consent

As per international standards or university standards, patient(s) written consent has been collected and preserved by the author(s).

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