



PERCEIVED IMPACT OF SOOT POLLUTION ON RESIDENTS NEAR ARTISANAL CRUDE OIL REFINERIES IN TOMBIA COMMUNITY, RIVERS STATE, NIGERIA

*¹Onwuna, D. B., ¹Stanley, H. O., ¹Abu, G. O. and ²Immanuel, O. M.

¹Department of Microbiology, University of Port Harcourt, Port Harcourt, Rivers State, Nigeria

²Department of Biological Sciences, University of Africa Toru-Orua, Bayelsa State, Nigeria

*Corresponding authors' email: immanuelomega@gmail.com

ABSTRACT

Soot pollution arising from artisanal crude oil is on the increase in the Niger Delta. This development is worsening the already fragile ecosystem, occasioned by many years of oil and gas exploration. The implications are adverse environmental health outcomes. This study aimed to assess the perception of the impact of soot pollution among residents near artisanal oil refineries in Tombia Community, Rivers State, Nigeria. Four hundred and twenty (420) questionnaires were administered to residents to find out the perceived impact of soot. Obtained data was analysed using descriptive statistics (frequency and percentages) and inferential statistics (chi-square). Respondents were highly knowledgeable on the impact of artisanal crude oil refineries, with 79.9% affirming to that, though only 54.6% attributed the occurrence of soot in the area to artisanal crude oil refineries. The majority (67.3%) felt discomfort when in the building or shortly after using the building. The predominant health complaints by respondents were cough, sneezing, nose irritation, eye irritation and breathing difficulties. The Chi-square result revealed that the age and gender of respondents are significantly associated with the effect of soot pollution ($p < 0.05$). However, marital status, educational level and period of stay have no significant association with soot effect. During the period of soot pollution, the majority (65%) observed changes in plants. Soot pollution was more evident during the dry season, as reported by 95.4% of respondents. This study has shown that soot pollution adversely affects man and the environment. Artisanal crude oil refining should be fought to a standstill to protect the people of the Niger Delta.

Keywords: artisanal crude oil refineries, soot, pollution, environmental health

INTRODUCTION

Nigeria, a high-volume crude oil-producing nation in the continent of Africa, still grapples with the problem of refining its crude oil, which has given room for the booming industry of artisanal oil refining (Onuoha *et al.*, 2022a). As an energy giant of Africa without a fully functional refinery for nearly two decades, artisanal crude oil refineries help meet gasoline, kerosene and diesel needs for the local economy, albeit illegally (Mamudu *et al.*, 2019).

An artisanal crude oil refinery (*kpo fire*) is a rudimentary setup for the separation of petroleum fractions based on the principle of distillation as it is applied in local gin making. Thus, it is relatively cheap to set up and with free crude (stolen crude oil), it is an easy venture to enter into, for a guarantee of profit (Asuru and Amadi, 2016). These substandard refineries adorn the creeks of the Niger Delta Region of Nigeria and operate under conditions that contribute to daily emissions of soot into the environment (Akeredolu and Sonibare, 2015; Onuoha *et al.*, 2022b).

It is no news that artisanal oil refineries in Nigeria run on stolen crude oil. In 2022, Nigeria was estimated to lose between N30 trillion to N60 trillion annually to oil theft and illegal refining (The Guardian, 2023). Although the loss of revenue to oil theft is alarming for a country with economic frailties, it is nothing compared to the immediate and long-term health effects arising from the deposition of soot in air, soil and water. Residents in the most populous South-South city of Port Harcourt, have in recent times been living in apprehension over the indiscriminate oil exploration activities and uncontrollable exposure to impure carbon particles emitted by the incomplete combustion of petroleum hydrocarbons, especially after the 2016 soot pollution (The Guardian, 2017; 2023).

Soot forms from the incomplete burning of precursor molecules, following through multiple chemical and physical

processes which are greatly influenced by the composition of the fuel (Niessner, 2014; Omidvarborna *et al.*, 2015). The toxicity of soot is determined by its composition. Most persons are familiar with the effect of soot in the form of discolouration of surfaces (walls, soil, ceilings and flooring), giving it a black appearance. However, the impacts of soot can be multi-dimensional, also affecting humans and vegetation. Soot-contaminated air elevates the risk of coronary heart disease over a long period (Miller, 2007); causes various types of cancer and lung diseases (Bond *et al.*, 2013); causes DNA damage by reactive oxygen species (Niranjan and Thakur, 2017; Jia, *et al.*, 2020) and breathing/respiratory problems (Jack and Zibima, 2020). Soot can adhere strongly to soil, accumulate over time and get picked up by plants, thus entering the food chain (Swami, 2018).

Criminal elements, driven by pecuniary motives have continued to set up and operate artisanal refineries in the Niger Delta, even with the sustained efforts of the government to curb this illegal activity. Poverty and inequitable distribution of the gains of oil resources had been blamed in the past. How well persons in the communities were artisanal crude oil refinery knowledgeable on the impacts of artisanal refineries, is still a matter of speculation, as some have argued that if persons are knowledgeable of the impacts of the activities of crude oil refineries, they might be dissuaded from the practice. This study aimed to assess the perception of the impact of soot pollution among residents near artisanal oil refineries in Tombia Community, Rivers State, Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted in Tombia Community, a Kalabari commune in Rivers State, Nigeria, positioned at 40° 53' 12.7" North, 70° 07' 30.6" East. They are situated in the Degema

Local Government Area of the State. The area is surrounded by water and has a population of approximately 15,000. Thus, predominantly, the people of the area are fishermen and women before the discovery of oil in this region. Today, the area is crisscrossed by a network of pipelines with a buoyant military presence to help in the protection of lives and properties of the people, as well as to avert pipeline vandalism and oil theft.

Population for the Study

The target population for the study was the Tombia Community, which covers areas around artisanal refinery sites.

Sample Size

The sample size was determined using Scott’s equation:

$$N = \frac{(Z^2 pq)}{e^2}$$

where; n = Sample size, Z = 1.96 at 95% CI, e = latitude of correctness (5%), p = 0.5 (maximum variability), q=100-p, q=95, n = 384.27 = 384 approximate.

With 10% non-response:

Total sample size (n) = 384 + 38 = 422

Data from Residents

The questionnaire served as the research instrument for data collection on the impact of soot on residents in the study area. Four hundred and twenty (420) copies of this questionnaire were administered either by hard copy and/or through Google Forms. The questionnaire contained Nineteen (19) questions. The duration for the administration, filling and submission of

copies of the questionnaire was two (2) weeks and four (4) days. There were 406 returned surveys, for a response rate of 96.7 percent. However, 394 of the returned surveys were correctly filled or finished for analysis, resulting in a data completeness percentage of 97.0 percent.

Validity/Reliability of instrument

To ensure validity, interview questions formulated in the questionnaire were made simple and easy to understand, to elicit answers that have a critical bearing on the variables under investigation, and to guide the study in achieving its purpose.

Ethical Consideration

Community members and operators of artisanal refineries were informed and their consent was ascertained by directly meeting with them. They were allowed to willingly volunteer information. The research was certified by the Office of Research Management and Development, University of Port Harcourt, followed by the issuance of ethical approval.

RESULTS AND DISCUSSION

Socio-demographic Characteristics of Respondents

Socio-demographic characteristics reveal that 176 (44.7%) of respondents are females, while 218 (55.3%) are males. Two hundred and seven-eight (70.6%) of these respondents were singles and 116 (29.45) married. Twenty-three (5.8%) had no education, while 13 (3.3%), 140 (35.5%) and 218 (55.3%) earned primary, secondary and tertiary education respectively. A preponderance of respondents, 223(56.6), had lived in the area for more than 5 years (Table 1).

Table 1: Socio-Demographic Data (n=394)

Variables	Categories	Freq.	%
Age (Years)	<25	31	7.9
	26-35	124	31.5
	36-45	118	29.9
	46-55	98	24.9
	>55	23	5.8
Sex	Female	176	44.7
	Male	218	55.3
Marital Status	Single	278	70.6
	Married	116	29.4
Educational Qualification	No Education	23	5.8
	Primary	13	3.3
	Secondary	140	35.5
	Tertiary	218	55.3
How long have you been here?	<5yrs	171	43.4
	>5yrs	223	56.6

Perception of soot pollution

Table 2 reveals that 315 (79.9%) of respondents were knowledgeable about soot pollution. Majority of the respondents, 218 (55.3%), felt very bad when they breathed in soot-polluted air where they lived. The majority, 215 (54.6%), opined that the artisanal refinery (Okpo fire) was the major cause of soot pollution in the area, while the minority, 7 (1.8%) believed it was from firewood/cooking stoves. The management of soot pollution whenever observed was majorly home cleaning [224 (56.9%)] while washing off stains was the least reported practice [15 (3.8%)], wearing of face mask 155 (39.3%) and. More so, 248 (62.9%) respondents unconsciously make physical contact with the soot, while 146 (37.1%) consciously make physical contact. Respondents often clean their class/home/office above 3

times a week [148 (37.6%)] and less often once a week [51 (12.9%)]. Two hundred and sixty-five (67.3%) respondents feel discomfort when in the building or shortly after using the building associated with soot but 129 (32.7%) do not feel so. The majority of respondents [193 (49.0%)] reported nose retention as an allergy they experience and eye retention was the least [71 (18.0%)]. The preponderance of the respondents, 267 (67.8%), cough/sneeze while in the building or shortly after using the building but 127 (32.2%) do not. The majority 216 [54.8%] admitted that soot pollution does not take them away from school/office/home while 178 (45.2%) admitted that soot pollution does take them away from school/office/home. One hundred and seventy-eight (45.2%) and 220 (55.8%) opined that when in the school/office/home soot does make them lose concentration respectively. Two

hundred and fifty-six (65%), which is the majority, opined that during the period of soot-pollution, they observed changes in plants. The majority, 376 (95.4%), opined that they

experience more soot pollution in their community in the dry season, while 18 (4.6%) opted for the wet season.

Table 2: Perception of soot pollution (n=394)

Community Assessment	Response	Number	%
Do you know about Soot Pollution before now?	No	79	20.1
	Yes	315	79.9
How do you feel when you breathe in soot-polluted air where you live?	Very Bad	218	55.3
	Bad	154	39.1
	Good	20	5.1
	Very Good	2	0.5
What activities generate this soot pollution in your area?	Firewood/Cooking Stoves	7	1.8
	Ship/ Speed boat exhaust	48	12.2
	Bush burning	124	31.5
	Artisanal refinery	215	54.6
How do you manage soot pollution if ever observed?	Washing off stains	15	3.8
	Wearing of face mask	155	39.3
	Home cleaning	224	56.9
Do you make physical contact with the soot?	Unconsciously	248	62.9
	Consciously	146	37.1
How often do you clean your class/home/office?	Once a week	51	12.9
	2 times a week	62	15.7
	3 times a week	133	33.8
	>3 times a week	148	37.6
Do you feel any form of discomfort when in the building or shortly after using the building?	No	129	32.7
	Yes	265	67.3
Have you ever experienced any allergy of any form before?	Breathing difficulties	130	33
	Nose retention	193	49
	Eye retention	71	18
Do you Cough/Sneeze while in the building or shortly after using the building?	No	127	32.2
Does it take you away from school/office/home?	Yes	267	67.8
	No	216	54.8
Why in the school/office/home does it make you lose concentration?	Yes	178	45.2
	No	174	44.2
During the period of soot pollution do you observe any changes in plants?	Yes	220	55.8
	No	138	35
Which season do you experience more soot pollution in your community?	Yes	256	65
	Wet	18	4.6
	Dry	376	95.4

Association between Socio-demographic Parameters and the Effect of Soot

The chi-square result revealed that the age and gender of respondents are significantly associated with the effect of soot

pollution (p<0.05). However, marital status, educational level and period of stay have no significant association with the soot effect (Table 3).

Table 3: Chi-square test for association between socio-demographics and the effect of soot in the community

Variables	Categories	Soot Effect		Total	Df	Chi-Square	Decision
		Moderate	High				
Age (Years)	<25	17 (54.8)	14 (45.2)	31	4	10.096 (0.039)	Significant Association
	26-35	39 (31.5)	85 (68.5)	124			
	36-45	48 (40.7)	70 (59.3)	118			
	46-55	47 (48.0)	51 (52.0)	98			
	>55	7 (30.4)	16 (69.6)	23			
Sex	Female	81 (46.0)	95 (54.0)	176	1	4.643 (0.031)	Significant Association
	Male	77 (35.3)	141 (64.7)	218			

Marital Status	Single	107 (38.5)	171 (61.5)	278	1	1.0221	No Significant
	Married	51 (44.0)	65 (56.0)	116		(0.312)	Association
Educational Qualification	No Education	13 (56.5)	10 (43.5)	23	3	3.028	No Significant
	Primary	6 (46.2)	7 (53.8)	13		(0.387)	Association
	Secondary	54 (38.6)	86 (61.4)	140			
How long have you been here?	Tertiary	85 (39.0)	133 (61.0)	218			
	<5yrs	67 (39.2)	104 (60.8)	171	1	0.107	No Significant
	>5yrs	91 (40.8)	132 (59.2)	223		(0.744)	Association

Discussion

This study assessed the perception of the impact of soot pollution from artisanal crude oil refining by residents of Tombia. The preponderance of the respondents, 218 (55.3%), had tertiary education. This shows a high literacy level among respondents. Again, a preponderance of the respondents, 215 (54.6%) opined that artisanal refinery (*kpo fire*) was the main source of soot in the air. It was not surprising that a preponderance of the respondents, 315 (79.9%), were knowledgeable about soot pollution, given the high literacy rate in the area. Jack and Zibima (2020); Whyte *et al.* (2020) and Obi-udu *et al.* (2022) likewise identified artisanal crude oil refining as a major cause of black soot in Rivers State. This is consistent with reports since 2016 when the incidence of black soot became prominent in River State (Yakubu, 2017). The increase in soot pollution has led to the need to frequently clean homes and offices, as visible soot particles are seen more often on surfaces. The majority 248 (62.9%) of respondents unconsciously make physical contact with the soot, as against 146 (37.1%). This suggests a higher danger for the majority of residents, as they can do nothing on their own to avert being exposed to soot.

Two hundred and eighteen (55.3%) respondents feel they are badly impacted when they breathed in soot-polluted air where they live. The predominant complaints/symptoms of the residents in the study area include cough, sneezing, nose irritation, eye irritation and breathing difficulties. Obi-udu *et al.* (2022) listed complaints of residents impacted by black soot in the Woji Community of Rivers State to include severe catarrh, nasal congestion, frequent cough and difficulty in breathing. Jack and Zibima (2020) in their findings revealed that health challenges associated with the soot pollution in Port Harcourt include breathing problems, cough, catarrh and respiratory difficulties. Whyte *et al.* (2020) in their study reported that the majority of respondents perceived that the soot had caused them chronic cough and irritation to the eyes and nose. These complaints and symptoms are similar to the health risks found to be associated with exposure to Heavy metals, polycyclic aromatic hydrocarbons (PAHs), benzene, toluene, ethylbenzene and xylenes (BTEX), polychlorinated biphenyl (PCB) and total petroleum hydrocarbon (TPH) in ambient air (Emodi and Isife, 2019).

Respondents affirmed that soot pollution affects plants as evidenced by observable changes in vegetation. This is consistent with the finding by Emodi and Isife (2019) in which soot was reported to affect fruits and vegetables, making them unattractive to market and unsafe to consume. Soot pollution was more evident during the dry season, as reported by 95.4% of respondents. This is in agreement with Emodi and Isife (2019) that soot is more intense in the environment during the dry season.

The chi-square result revealed that the age and gender of respondents are significantly associated with the effect of soot pollution ($p < 0.05$). However, marital status, educational level and period of stay have no significant association with soot effect. Bebetedoh *et al.* (2020) similarly investigated the impact of the activities of the local refiners on the host

communities' farmlands, rivers and estuaries. The chi-square results likewise revealed that the age and gender of respondents are significantly associated with the effect of soot.

CONCLUSION

The study showed that a preponderance of the respondent perceived artisanal refineries to be the main cause of soot pollution in the study area. Respondent opined that increase in soot pollution has led to the need to frequently clean homes and offices, as visible soot particles were seen more often on surfaces. The impacts of soot pollution were reported to include unpleasant health effects, social disruption, physical discomfort and likely impact on the vegetation.

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