

## Short Communication

# Study of the impact of gas flaring on communities' health: methods and participants' demographics

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### ABSTRACT

The exploration and production of oil and gas in Nigeria have resulted in gas flaring. This has led to the release of excessive amounts of harmful pollutants possibly leading to ill-health, loss of lives and damage to properties in communities where gas is flared. This has resulted in various studies on the impact of gas flaring on the health of communities. This article described the methodology and demographics of respondents of research in Delta State Nigeria. This research was designed to be a cross-sectional mixed method study. About 500 self-administered questionnaires were distributed to individuals of 18 years and above and the response rate 97.4%. The questionnaire comprised six sections with closed and open-ended questions to ensure objectivity and accuracy of data. Demographic analysis showed that participants comprised 40.1% women, 99.1% reside in 12 oil-producing local government areas (LGA) across Delta State and 69.4% have lived in region for 3-20 years. On occupation, 97.7% work in communities distributed across oil-producing 11 LGAs and 68.2% have worked in the region for 3-20 years. Other participants lived and/or worked in neighbouring communities and states. Participants were well distributed in age groups with 89% consisting of 20-70 years old. Further, respondents comprised 96% who completed secondary or higher and 61.7% classified themselves as middle or upper-class socioeconomic status. The proposal has provision to generate nuanced perspectives of stakeholders. The distribution of respondents indicates satisfactory selection criteria for valid responses to survey questions.

**Keywords:** Gas flaring, Demographic analysis, Local government areas

### INTRODUCTION

Gas flaring is essentially the burning of gas associated with oil production and takes place in areas where there are inadequate infrastructures to handle the gas.<sup>1</sup> Toxic substances such as volatile organic compounds, oxides of nitrogen, sulphur dioxide, particulate matter, radon, lead, ammonia and methane are released into the environment during gas flaring.<sup>2,3</sup> Several studies have been carried out on environmental effects of gas flaring, however, there is little research on the association between diseases and gas flaring in the Niger Delta of Nigeria. The aim of the study was therefore to investigate the knowledge of

community as well as government and gas companies' policies on flaring in Delta region of Nigeria.

This paper articulated the methodology that related theoretical framework and empirical findings in the research on gas flaring in the Delta region and discussed the design, philosophies, approaches, strategies, data collection, description of the study area and ethical consideration. Research methodology is the theory of how research was conducted, including the theoretical and philosophical principles that were the basis for the study and their effects on the method or methods adopted while research methods were methods or techniques used to collect and analyse research.<sup>4</sup>

## METHODS

### *Purposes of research-brief of concept*

The purposes of research were exploratory, descriptive and explanatory or causal.<sup>5</sup> Exploratory research was used to discover new understanding and concepts into the general nature of a problem, the possible decision alternatives and relevant variables to be considered.<sup>6-8</sup> It was also conducted to examine the study questions and may not offer a final conclusion to the research. The research was conducted through research questions and this served as a basis for more specific data collection and several exploratory approaches included literature reviews, focus group interviews, interviewing experts and case studies. Exploratory research was carried out in this study through literature survey and open-ended survey questions. The literature search was done to understand such problems in other countries and open-ended questions allowed participants to articulate what was not covered in closed-ended questions.

Descriptive research explained the characteristics of a particular individual or group and was used to illustrate the behaviour of a specimen population.<sup>6,7</sup> The three main purposes of descriptive research were describing, explaining and validating the findings. Descriptive research was applicable to quantitative and qualitative methods and was often conducted via survey questionnaires hence adopted in this proposal.

Causal or explanatory research was conducted to understand the impact of certain changes in existing standard procedures. Explanatory research was intended to clarify and give reasons for the descriptive information. Causal studies test whether one variable causes another variable to change and the researcher was interested in delineating factors that were causing a problem. The focus was on analysing a situation or problem to understand the correlation between variables.<sup>8</sup> The research was conducted by using research hypotheses. Kothari stated that it was common to conduct exploratory research before moving to descriptive or causal studies to develop a thorough understanding of the phenomenon under study.<sup>7</sup> In this proposal, the prevalence of environmental and/or occupational effects of gas flaring constitute one of the objectives. That was, to enable discussion or explanation regarding gas flare causality of health problems. The hypothesis was that there was a strong association between gas flaring and prevalence of diseases of interest to this study in gas flaring host communities.

### *Research design 1-brief of considerations*

Aaker et al defined research design as a detailed plan to guide a study to achieve its objectives while Saunders et al described research design as the overall plan for research.<sup>6,8</sup> It was the conceptual context within which this research was structured. A research design was a

general plan that directed data collection and analysis phases and indicated the various approaches in solving the research problem. Several authors agreed that the quality of a research design depended on how carefully the design options were selected, taking into account the specific objectives, research questions and constraints of the project, such as access to data, time and/or resources.<sup>5-8</sup> The research design identified the procedures of section of the study population, how participants were used to yield the required data and how the data was collected and analysed. Research can be descriptive and according to Williams the three common approaches to research were qualitative, quantitative and mixed methods.<sup>9</sup>

Qualitative research aimed to explore and discover issues about a problem, because little was known and this approach presented data as a descriptive narration with words and attempts to understand phenomena in natural settings. It was a method that gathers data using informal, casual and relaxed methods where the participants were asked open-ended questions.<sup>10</sup> The feedback was collected and collated and this was essentially non-numerical. A major advantage of qualitative research was that it enabled a researcher had an in-depth understanding about how participants think and why they think in a specific way. However, Kothari stated that qualitative research was a function of researcher's insight and impression.<sup>7</sup> Qualitative research was based on the interpretivism research philosophy which involved research to interpret and tends to be inductive. Qualitative research was primarily exploratory and involved observing and interpreting information by the researcher. Data was collected through participant observation, in-depth interviews and focus groups. It was not converted into numerical form and was not statistically analysed. Qualitative methods explored why something was happening.<sup>11</sup> This method was generally appropriate when the primary purpose of the research was to explore, describe or explain. In this study, data was collected through focus group discussions and semi structured interviews to assess the community and religious leaders' knowledge, attitudes and perceptions on gas flaring and its impact on health among others, questions inquiring whether the presence of oil companies are beneficial or detrimental to the community and problems that their community face in regards to the impact of gas flaring were asked during the interviews.

Quantitative research was a technique that depended on numerical system to determine variables, use of statistical models to analyse the results and provided description of the report as it related with other variables.<sup>12</sup> It was based on the measurement of quantity, hence it was expressed in numbers and graphs and it was used to test or confirm theories and assumptions. Quantitative research was generally associated with the positivist philosophy and large data sets and statistical analyses were often used and conclusions drawn.<sup>13</sup> Quantitative research was characterized by deductive approaches to the research

process intended at proving, disproving or lending credence to existing theories. The values underlying quantitative research included neutrality, objectivity and the acquisition of a sizeable scope of knowledge.<sup>14</sup> This method was generally appropriate when the primary purpose of the research was to explain or evaluate.

Mixed methods research was a relatively recent development with various definitions.<sup>15,16</sup> In this study, mixed methods were defined as the general term when both quantitative and qualitative data collection techniques and analysis were used in a research design to comprehend a research problem.<sup>8,15</sup> Watkins et al stated that mixed methods provided figures and information that complemented and contrast to get information about the research problems.<sup>16</sup> This method enabled the researcher to get answers by combining the two approaches. A mixed method approach was therefore adopted for this study to obtain a thorough understanding of the research aims, objectives and questions. This followed the approach of studying patient safety incidents as well as community health and socioeconomic research.<sup>17-19</sup>

The data for this study were from questionnaires (quantitative research methods). Focus group discussions, semi structured interviews and documents (qualitative research methods) were also considered ideal. This intention however was limited by the COVID-19 restrictions. Consequently, focus group discussions and face to face interviews did not take place and open-ended survey questionnaire was used. Qualitative and quantitative research methods were used to address the first objective of this research, which was to evaluate public health impact of environmental pollution due to gas flares. Questionnaires were administered to community residents and closed and open-ended questions were used to gain in depth knowledge of the public health impacts of environmental pollution due to gas flares.

#### ***Research design 2-for specific objectives and/or hypothesis***

Flaring was a public concern and a policy priority due to health threats and environmental issues associated with this practice as well as wastage of valuable non-renewable resources. Previous gas flaring work in the Niger Delta focused primarily on environmental impacts, effects and harm rather than human health concerns.<sup>20,21</sup> However, some Niger Delta communities believed that gas flaring affected their health, crops, homes and livelihoods. While other factors may be at stake, the lack of attention to this crucial issue means villagers' questions and fears remain unanswered.<sup>21</sup> Therefore, assessing and understanding the impact of gas flaring on public health was imperative. Consequently, this research sought to identify the risks associated with gas flaring in relation to human health and the knowledge in the community of Delta region of Nigeria in regard to gas

flaring. To this end, the following objectives were developed: evaluate public health impact of environmental pollution due to gas flares; assess disease prevention and treatment for diseases that were expected to increase as a result of gas flaring; compare the impact on health in gas flaring host communities and non-gas flaring host communities; assess the association between gas flaring and prevalence of diseases-host communities versus neighboring communities; and evaluate the government's efforts in mitigating the adverse effects of gas flaring already being experienced by gas flaring host communities.

This research adopted the pragmatic research philosophy since pragmatic studies often drew upon mixed methods approaches. This study adopted a mixed approach (qualitative and quantitative) to allow the inclusion of data to enhance understanding on the risks associated with gas flaring in relation to human health and the knowledge in the community in Delta region of Nigeria in regards to gas flaring (Table 1).

#### ***Description of the study area***

The study was carried out in the Niger Delta region of Nigeria, which had the largest proportion of flare sites in Nigeria (Figure 1).<sup>22</sup> The Niger Delta region was covered by the natural delta of the Niger Delta and the areas East and West, which also produced oil. Nigeria's oil rich Niger Delta area lies between 4° and 6° N of the equator and between 5° and 9° of Greenwich, with an estimated area of 70,000 km<sup>2</sup>.<sup>23,24</sup> It has Africa's largest river, Niger River that begins at the city of Onitsha stretching about 266 km to the Atlantic Ocean. The region is composed of several ecological zones, typical of large river deltas in tropical regions. It supports a range of plant and animal life as well as the agriculture and fishing that many depend on for livelihoods. It is a large area of Southern Nigeria and consists of 9 states: Abia, Akwa Ibom, Bayelsa, Cross Rivers, Delta, Edo, Imo, Rivers and Ondo.

#### ***Study population***

Participants were above the age of 18 years of all sexes from the community, in oil companies, government, healthcare and local authorities. There was population of 239,760 in the study area.<sup>26</sup>

#### ***Inclusion criteria***

Adults above the age of 18 years of all sexes were included in the study.

#### ***Exclusion criteria***

People below the age of 18 years of all sexes or more than 18 years of sexes were declined to participate.

**Table 1: Proposal methods for specific objectives.**

Objectives	Hypothesis	Method/design	Statistics
<b>Evaluate public health impact of environmental pollution due to gas flares</b>	Pollution due to gas flares has had a negative impact on environment and community health.	Quantitative analysis	MANOVA
		Qualitative analysis	Chi square test
<b>Assess disease prevention and treatment for diseases that are expected to increase as a result of gas flaring</b>	Diseases that are more prevalent as a result of gas flaring are not easily prevented and treated	Quantitative analysis	Thematic analysis
			Chi squared test
<b>Compare the impact on health in gas flaring host communities and non-gas flaring host communities</b>	Impacts on health or wellbeing in gas flaring host communities are more severe as compared to non-gas flaring host communities	Quantitative analysis	Corr and MANOVA
			Thematic
<b>Assess the association between gas flaring and prevalence of diseases; host communities versus neighbouring communities</b>	There is a strong association between gas flaring and prevalence of diseases of interest to this study in gas flaring host communities	Quantitative analysis	Chi square test
			Correlation
<b>Evaluate the government’s efforts in mitigating the adverse effects of gas flaring already being experienced by gas flaring host communities</b>	Government’s efforts in mitigating the adverse effects of gas flaring already bring experienced by gas flaring host communities are not sufficient.	Quantitative analysis	Regression analysis
			Correlation
<b>Evaluate the government’s efforts in mitigating the adverse effects of gas flaring already being experienced by gas flaring host communities</b>	Government’s efforts in mitigating the adverse effects of gas flaring already bring experienced by gas flaring host communities are not sufficient.	Quantitative analysis	MANOVA
			Qualitative analysis
			Thematic analysis

\*Survey encompasses the qualitative and quantitative methods; qualitative data will be analysed thematically to supplement qualitative analysis.



**Figure 1: Map of Niger Delta showing the states in the region and map of Nigeria (source: Udotong, Udoudo<sup>25</sup>).**

**Sample size determination**

The sample size for community participants for the questionnaire was determined by the formula,

$$n = \frac{N}{(1 + Ne^2)}$$

where, n is sample size, N is population size and E is margin of error at 0.05%.

Therefore,

$$n = \frac{239760}{(1 + 239760 \times 0.052)} = 400.$$

Four hundred participants were surveyed in the communities and this number was derived using the Slovin's formula,

$$n = \frac{N}{(1 + Ne^2)}$$

This considered a confidence level of 95% (alpha level of 0.05).

### **Data collection and questionnaire**

Data was generated primarily from questionnaires. For this mixed methods study, closed and open-ended questions were used for the quantitative and qualitative components, respectively.

The questionnaire consisted of multiple questions written or typed on a form or series of forms in a definite order.<sup>7</sup> Structured questionnaires were reliable, simple to administer, easy to tabulate and administer. The use of structured questionnaires was efficient in collecting responses from a large sample prior to analysis, as each respondent responds to the same set of questions.

In this study, structured self-administered questionnaire with specific questions capturing the objectives was designed and administered. The questionnaires were organized based on the general gas flaring to individuals' ideas, emerging trends and information acquired from the initial readings of literature. The questionnaire was written in English and was titled 'impact of gas flaring on health of communities in Delta region of Nigeria' and had the following sections: section A: knowledge/attitudes/perspectives-this was the opening section and easy, non-threatening questions of people's knowledge, attitudes and perspectives towards gas flaring were asked first in order to make it easy for respondents to answer quickly; section B: personal health information; section C: family health information; section D: respondent characteristics.

### **Data analysis**

Data from the questionnaire were coded and entered into the computer and analysed using statistical package for the social science (SPSS) to describe the impact of gas flaring on the health of communities. MANOVA was used to analyse more complex sets of data. Chi square tests established relationship of variables, association between exposure and diseases. Correlations were used to establish relationship of variables and to quantify the degree of the relationship. Regressions ascertained the effects of one or several explanatory variables. Additionally, the data from the qualitative research was analysed using thematic analysis.

### **Ethical considerations**

Ethical approval (approval number H20004) was obtained from human research ethics committee of the Charles Sturt university, Australia. This study was sensitive to cultural and ethical considerations and sought the consent and approval of the paramount rulers of the communities, the people in the communities, the hospitals, oil companies and regulatory offices and the leadership/rulers approved the study. An overview of what the research entailed and how the results would be utilized was given to the respondents.

## **RESULTS**

In this section, the gender distribution, age distribution, occupation, duration at residence, duration at occupation, educational level and social status of the research population are presented. A total of 488 participants responded to the survey and they comprised 59.9% males and 40.1% females. Figure 2 shows that the majority of respondents are in the age group 36-50 years and the least was in the >70 years group. Further, most of respondents work in the civil service, this was followed by non-categorized occupations followed by traders and lastly farmers/fishermen (Figure 3). Fourteen respondents did not state their trade.

Figure 4 shows the distribution of the respondents working in different LGA and it was observed that over 50% of the respondents work in Ndokwa East LGA, Ughelli North LGA, Warri South LGA, Ukuani LGA, Ndokwa West LGA, Ethiope East LGA and Uvwie LGA while less than 6% of the respondents work in Udu LGA, Isoko South LGA, Patani LGA and Ughelli South LGA.

Table 2 shows the distribution of residential areas of the sample population. It was found that some respondents live in towns different from their occupational address. Furthermore, the highest proportion of respondents reside in Ughelli North (19.3%), while the lowest proportion of residents reside in Udu LGA, Isoko South LGA, Bomadi LGA, Oshimili South LGA and Patani LGA.

Most of the respondents have lived for 6-10 years in their residences and few had spent less than 3 years in their residence as illustrated in Table 3. Many respondents had been employed for 11-20 years, followed by those employed for over 20 years and the smallest group had been employed for less than 3 years (Table 4).

Figure 5 shows most of respondents holding diploma/certificate education, followed by secondary education then postgraduate, while a small group had only primary education. This was consistent with studies carried out in a community in Delta State where at least 84.17% of respondents possess at least a secondary school certificate or higher.<sup>27</sup>

In the context of this study, lower class individuals were the unemployed, junior level employees, daily pay workers and housewives; middle class were the senior level employee while the upper class individuals were the chiefs in communities, managers at work and religious leaders.

The majority of the respondents were middle class, followed by lower while the upper class was the smallest group (Figure 6).

**Table 2: Residential address of the respondents.**

Residential address		Frequency	Percent	Valid percent	Cumulative percent
Valid	Ughelli North LGA	89	18.2	19.3	19.3
	Ughelli South LGA	14	2.9	3.0	22.3
	Ethiope East LGA	42	8.6	9.1	31.5
	Udu LGA	1	0.2	0.2	31.7
	Isoko South LGA	1	0.2	0.2	31.9
	Warri South LGA	59	12.1	12.8	44.7
	Bomadi LGA	1	0.2	0.2	44.9
	Ndokwa East LGA	87	17.8	18.9	63.8
	Ndokwa West	52	10.7	11.3	75.1
	Ukwuanl LGA	64	13.1	13.9	88.9
	Patani LGA	2	0.4	0.4	89.4
	Uvwie LGA	45	9.2	9.8	99.1
	Benin city	1	0.2	0.2	99.3
	Sagbama LGA	1	0.2	0.2	99.6
	Oshimili South LGA	1	0.2	0.2	99.8
	Okpe LGA	1	0.2	0.2	100.0
	Total	461	94.5	100.0	
Missing	System	27	5.5		
<b>Total</b>		488	100.0		

**Table 3: Duration at residence.**

Duration of residence		Frequency	Percent	Valid percent	Cumulative percent
Valid (in years)	Less than 3	40	8.2	8.4	8.4
	3-5	99	20.3	20.9	29.3
	6-10	144	29.5	30.4	59.7
	11-20	86	17.6	18.1	77.8
	Over 20	105	21.5	22.2	100.0
	Total	474	97.1	100.0	
Missing	System	14	2.9		
<b>Total</b>		488	100.0		

**Table 4: Duration at occupation.**

Duration at occupation		Frequency	Percent	Valid percent	Cumulative percent
Valid (in years)	Less than 3	63	12.9	13.4	13.4
	3-5	92	18.9	19.5	32.9
	6-10	94	19.3	20.0	52.9
	11-20	135	27.7	28.7	81.5
	Over 20	87	17.8	18.5	100.0
	Total	471	96.5	100.0	
Missing	System	17	3.5		
<b>Total</b>		488	100.0		

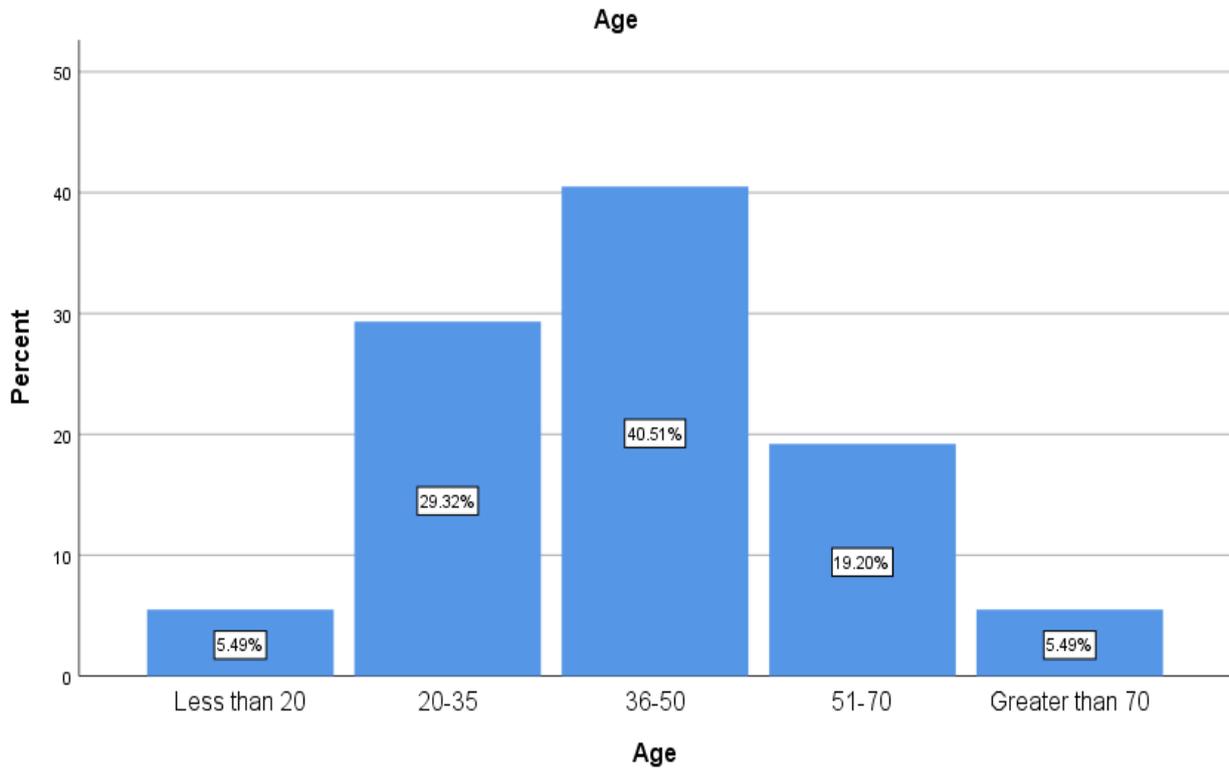


Figure 2: Age distribution of the respondents.

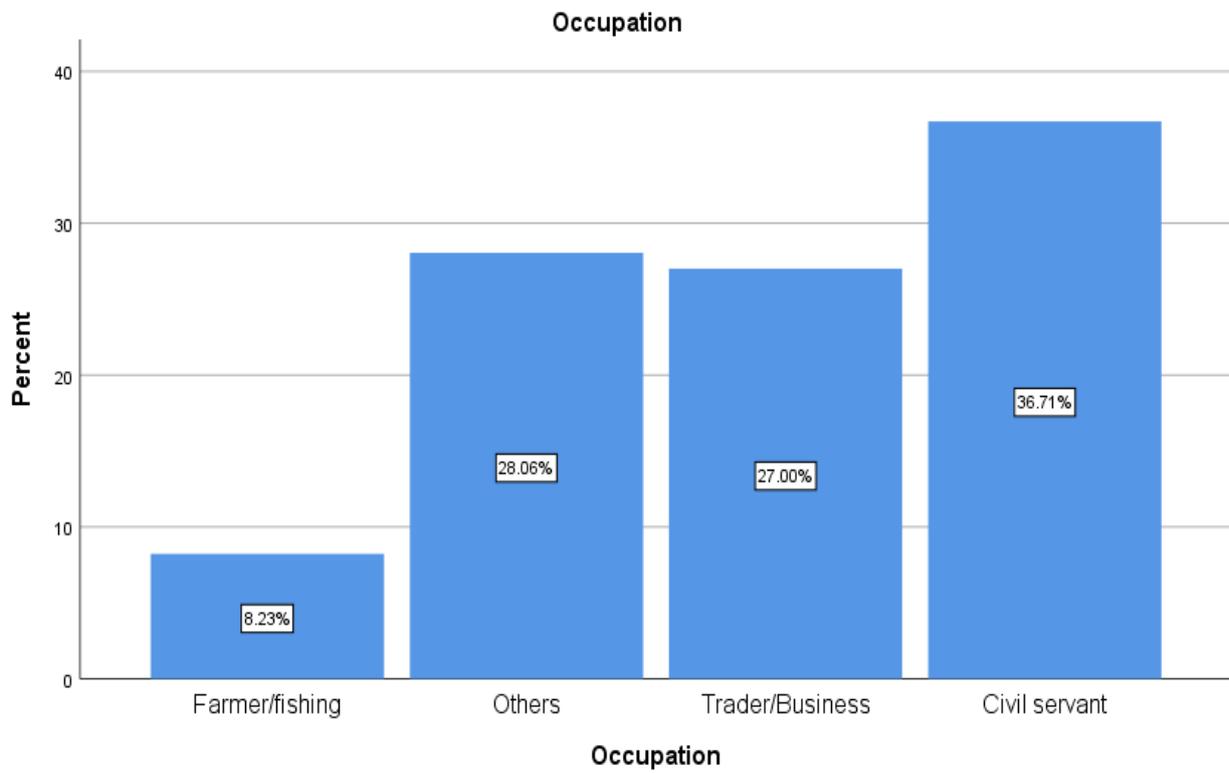


Figure 3: Occupation of the respondents.

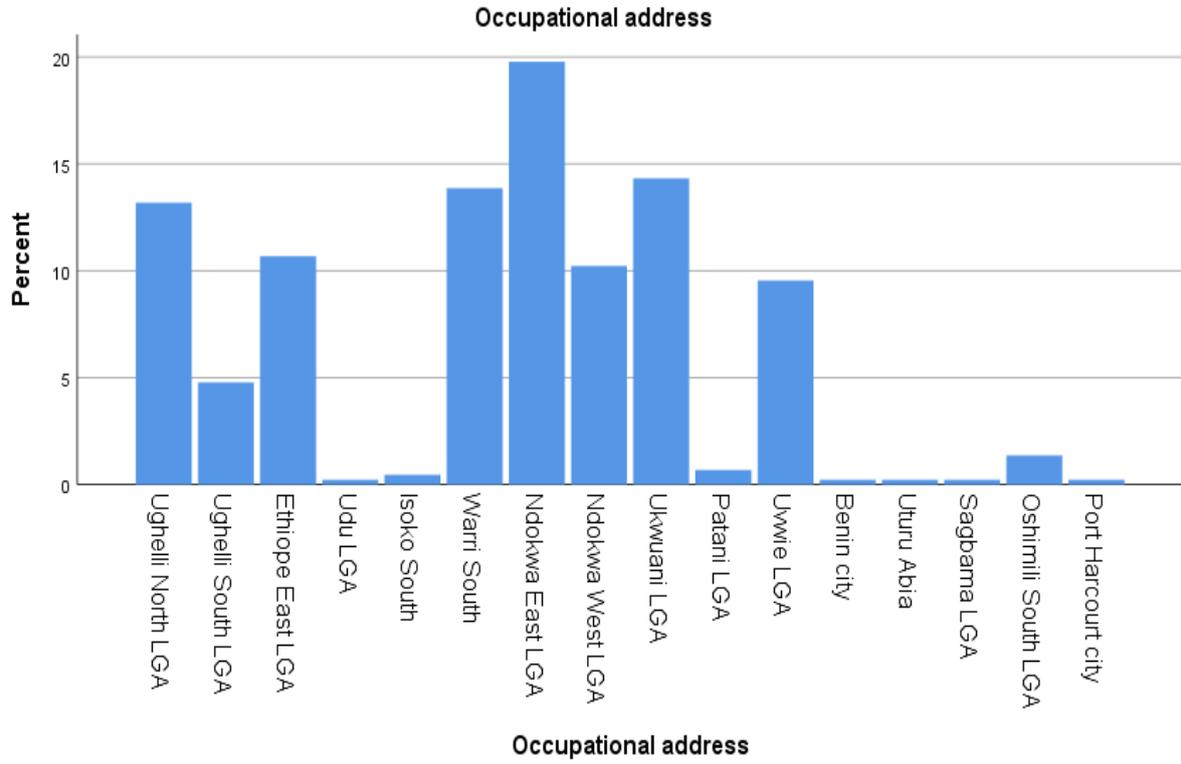


Figure 4: Occupational address of the respondents.

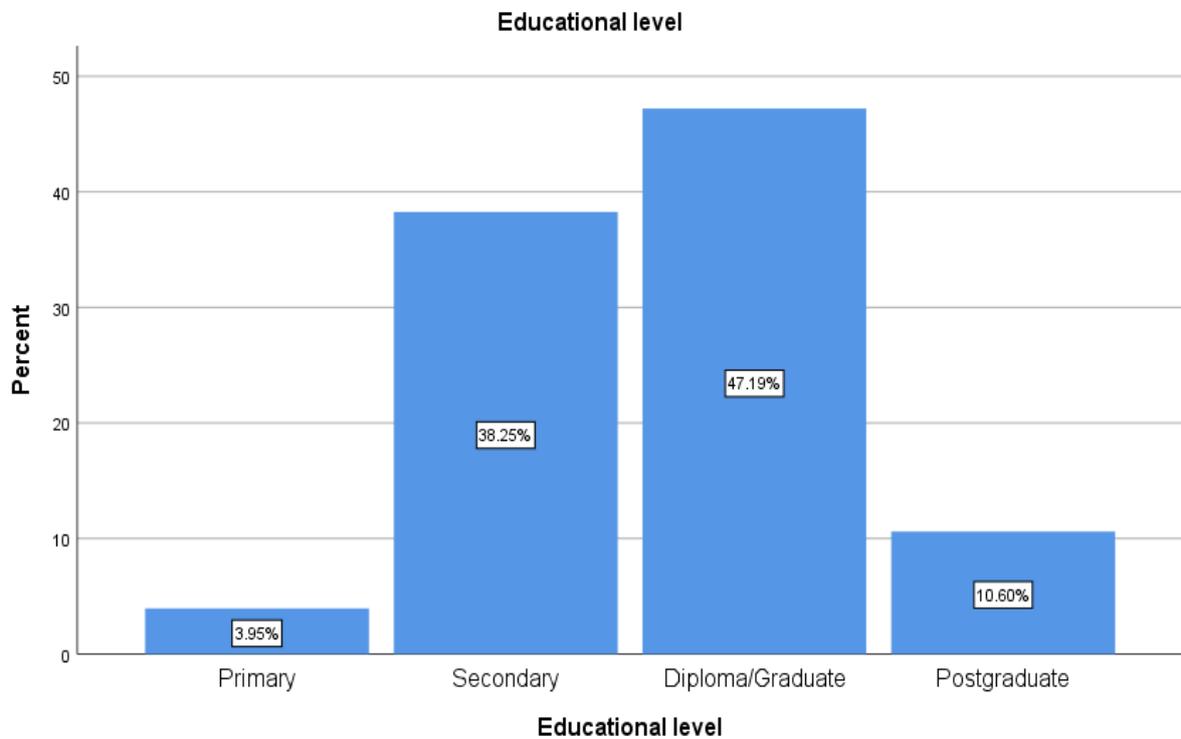
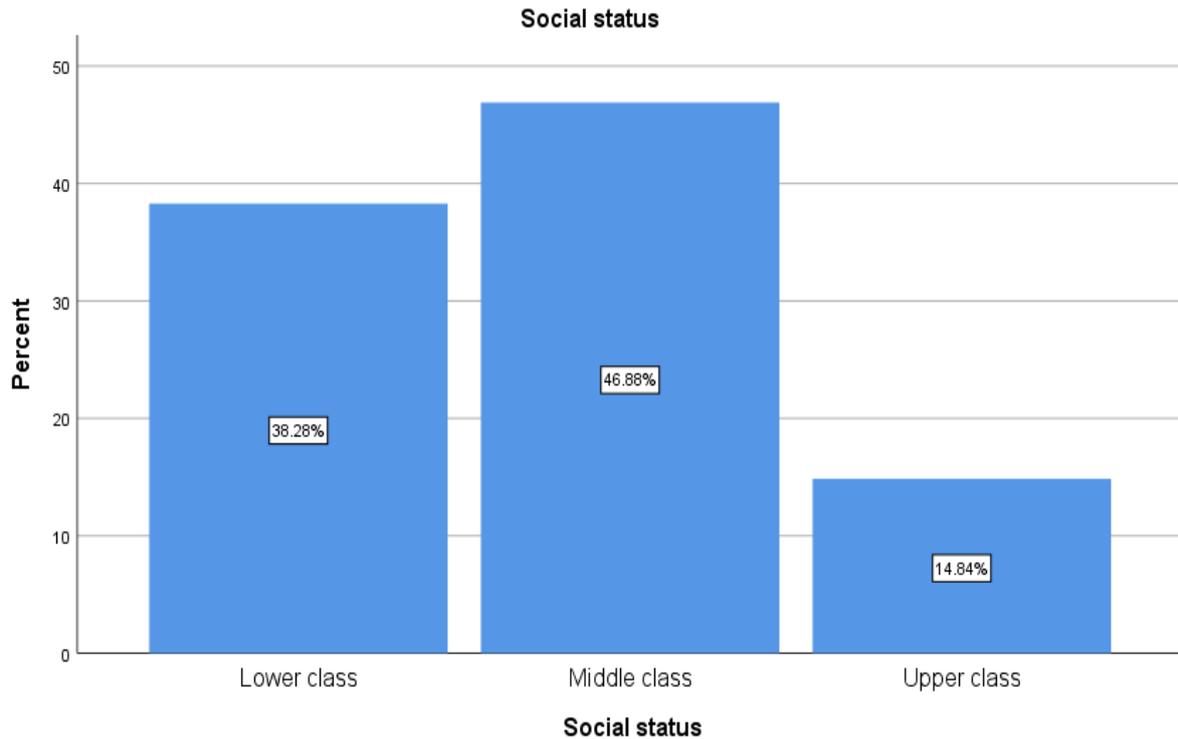


Figure 5: Percentage distribution of educational level of respondents.



**Figure 6: Social status of respondents.**

## DISCUSSION

As mentioned, this study intended to use interviews and focus group discussions to ascertain knowledge, attitudes and perceptions on gas flaring and its impact. However, due to the COVID-19 restrictions, these qualitative approaches did not take place. Therefore, open-ended questions approach was adopted as alternative. Focus group discussion was a technique where a researcher brought a group of individuals to discuss a subject, with a goal of drawing on the participants' diverse personal experiences, values, expectations and attitudes through a moderated dialogue.<sup>28</sup> Focus group discussion provided a variety of viewpoints on a research subject and gained an understanding of the problems.<sup>29</sup> Focus group discussion would have been useful for generating information that otherwise would not have been accessed.

In the alternative, open-ended questions were asked and this was aimed at understanding reasons behind attitudes and opinions. An open-ended question in a survey was one that had no suggested responses and required the respondent to answer in his or her words.<sup>30</sup> Participants were asked to present their opinions in writing. One advantage of this approach was that it saved time and enabled the researcher not to miss out on any salient point since the respondents put their thoughts and views in writing.

Questionnaires were administered to community residents and closed and open-ended questions were used to enable the research to gain in depth knowledge of the public health impacts of environmental pollution due to gas flares. Structured questionnaires were reliable, simple to administer, easy to tabulate and administer. The use of structured questionnaires was efficient in collecting responses from a large sample prior to analysis, as each respondent responds to the same set of questions.<sup>31,32</sup>

There were more male respondents than female respondents in the study population. This was consistent with similar studies carried by some scientists in the Delta region where of the study population, the males were more than the females.<sup>27,33</sup> On age of the participants, the findings that the majority of the respondents were in the age group 36-50 years and the least in the greater than 70 years group was in agreement to studies carried out in Delta communities which revealed that the highest number of respondents were within the age group 45-54 years (Figure 2).<sup>34</sup>

Regarding residential address, the results showed that communities tend to stay one place for a long time, perhaps consistent with Africans' cultural beliefs of staying in home villages where ancestors lived. Possibly the newcomers were traders or those that come to work in oil industry. Furthermore, the fact that majority of

respondents have lived for over 6 years in the communities implied that they may have been exposed to gas flaring for that much and this had health implications. On occupation, majority of the respondents have worked in the communities for over 6 years. This again indicated that they may have been exposed to gas flaring for a long period of time and this could affect their health, livelihood and wellbeing.

Considering educational status, it was apparent that the respondents were fairly literate perhaps giving strength to the validity of this research since they may understand the gas flaring phenomenon, healthcare and diseases (Figure 5).

### **Limitations**

Due to a combination of COVID-19 movement restrictions and citizenship of the research communities, data collection followed a canned project approach, a professor was engaged to oversee the distribution and retrieval of questionnaires.

The questions were mainly closed to enable results to be easily coded. However, open-ended questions were included in the questionnaires to provide for nuanced perspectives of the respondents.

A third limitation was in the survey of healthcare workers' opinion. The demographic section did not specifically discriminate healthcare profession from other occupations. Respondent being a healthcare worker was deciphered from a question about my clinic and your clinic.

Further, the demographic survey did not delineate respondent whether they were government or oil company officials. This was acknowledged limitation as the analysis of companies' and government's programs were based only on their indication of social status. However, this was purposely meant to deidentify respondents, evade conflict of interest and encourage participation.

Perhaps, it can be considered a limitation that this study was not by stratified random sampling technique. This limitation became apparent as stratified groupings were of unequal sizes. Nevertheless, the approach adopted enabled elucidation of bias in reports from other studies.

### **CONCLUSION**

This paper sets out to describe the research design and the participants employed to identify the risks associated with gas flaring in relation to human health and the knowledge of community as well as government and gas companies' policies on flaring in Delta region of Nigeria. Mixed methods (qualitative and quantitative) research was used. Demographics of participants show that a vast majority satisfied selection criterion to provide valid

responses to survey questions. Open-ended questions were included in the questionnaire to provide nuanced perspectives of the various stakeholders.

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*Ethical approval: The study was approved by the institutional ethics committee*

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