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Public Health Impact of Environmental Pollution in Areas with Gas Flares

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

Background: A variety of pollutants are discharged during gas flaring and these are detrimental to animals and the environment. These pollutants are linked to a range of adverse health impacts including cancer, neurological, reproductive and developmental effects. Furthermore, some of the pollutants such as sulphur dioxide cause environmental issues including acid rain as well as the production of greenhouse gases and this contributes to climate change. This article evaluates the public health impact of environmental pollution in areas with gas flares.
Methodology: This research followed a mixed method approach of quantitative and qualitative analysis. Descriptive statistics were followed with frequency distribution of respondents to the Likert scaled questions. The nominal knowledge level of respondents was determined from their Likert scaled responses to questions. ANOVA comparisons were made between the subgroups of demographic factors to determine differences in knowledge level. MANOVA was also carried out to determine the influence of educational and social levels as well as duration of stay in the community.
Outcome: Evaluation of the nominal knowledge level of respondents determined from Likert scale shows no statistically significant differences between demographic subgroups. Further, ANOVA of

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nominal knowledge between educational subgroups shows gradient increase but no statistical difference.
Conclusion: The community has knowledge on the negative impact of gas flaring. This report increases understanding of community awareness about the effects of gas flares on the environment and health.

Keywords: Community awareness; gas flare; human health; negative impact; Niger Delta.

1. INTRODUCTION

The flaring of gas day and night exposes people to toxins that threaten their health and livelihoods [1] and most gas flares are close to communities and often lack sufficient safety and security measures to protect inhabitants from the heat and toxins produced [2,3]. Gas flares emit a range of toxic chemicals such as oxides of nitrogen, carbon, sulphur, and volatile organic compounds including benzene, toluene, xylene and hydrogen sulfide, particulate matter, black carbon in addition to carcinogens inclusive of benzapyrene and dioxin [4], which may lead to serious health issues including asthma, chronic bronchitis and cancer. Reports highlight that communities with gas flaring are exposed to high risk of premature death [5].

Gas flaring also leads to ozone layer depletion, climate change, global warming, acid rain and rise in sea level as a result of the greenhouse gases released such as carbon dioxide, methane, ethane, propane and butane [6,7]. It has been reported that the environment of the Niger Delta has deteriorated due to the loss of flora and fauna, soil contamination and air pollution caused by gas flaring [8]. Further, some inhabitants of Niger Delta believe the region is bedevilled with discomfort, suffering, and obliteration, this is regardless of the region being the financial backbone of Nigeria [9]. A resident of Ebedei community in Niger Delta who lives near a gas flare expressed concern about the effects of gas flaring on lives and livelihood [10,11]. However, a survey on the impact of gas flaring in a community in Niger Delta [12], which was preliminary to this study yielded no significance findings to corroborate the concern. It is for these reasons that it is important to study the impact of gas flaring on communities to allow policy making that contributes to control of gas flaring thereby alleviating community concerns.

***What is Known*:** Gas flares has a negative impact on health.

***What is Unknown*:** The knowledge of the community members regarding public health impact of environmental pollution due to gas flares has yet to be fully ascertained.

***Objective*:** To evaluate public health impact of environmental pollution due to gas flares.

***Hypothesis*:** Pollution due to gas flares has a negative impact on environment and community health.

2. METHODS

***Ethical Considerations*:** This study is part of a doctoral thesis at Charles Sturt University, Australia; with Ethics approval (protocol number H20004).

***Design*:** This study followed a mixed method approach of quantitative and qualitative analyses. Survey of host community residents including community health workers was done using a validated questionnaire as previously published (submitted).

***Assumption*:** In this study, perception is assumed to be a correlate of knowledge [13-15].

***Statistical Analysis*:** First, descriptive statistics was followed with frequency distribution of respondents to the Likert scaled questions. The nominal knowledge level of respondents was determined from their Likert scaled responses to five questions (Table 1). The respondents were then categorized into two subgroups. In the categorization, a nominal score below 3 /5 is assumed <40% (poor) knowledge, while ≥3 /5 is assumed ≥60% (good) knowledge. Thus:

- Group 1: score < 3 /5 disagreement on the Likert scale implies lack of knowledge
- Group 2: score ≥ 3 /5 agreement on the Likert scale implies being knowledgeable

Therefore, second analyses were another frequency evaluation plus ANOVA comparisons between the subgroups of demographic factors.

This was performed to determine differences in the knowledge level. Further statistics (i.e. third analyses) were MANOVA to determine the influence of educational and social levels as well as duration of stay in the community. In the multivariate analysis, participants were categorized into dichotomous educational status of either primary (secondary or lower) or tertiary (diploma and above).

3. LIMITATION AND SCOPE OF STUDY

This piece of work has not compared participants' distance to gas flare sites from either their home or workplace. Consideration of this distance to gas flare sites would be published in a latter part of this series.

4. RESULTS

4.1 Descriptive Statistics and Frequency Distribution of Likert Scaled Questions

Table 1 shows the descriptive statistics of respondents (N = 438). Those whose nominal knowledge level of health were ≤40% comprised 41/438, which is approximately 9.4%. The proportion of respondents considered knowledgeable make 90.6% (Table 1).

On the questions regarding the effect of gas flaring on own's health, family health and air pollution: the majority of the respondents agreed, followed by the group that strongly agreed, then by the group that was not sure, disagreed and lastly by those who strongly disagreed. On the other two questions: the proportion who strongly agreed increased, while the groups that were unsure, disagreed or strongly disagreed constituted 13% and 15% for general human health and respiratory problems, respectively (Fig 1).

4.2 ANOVA Comparisons between the Subgroups of Demographic Factors

Evaluation of the nominal knowledge level of respondents determined from Likert scale shows no statistically significant differences between demographic subgroups. Although, social status showed close significance (Table 2, $p < 0.077$).

Table 1. Mean and standard deviation for participants' characteristics and nominal knowledge

Descriptive statistics				
	Knowledge group	**Mean**	**Standard deviation**	**N**
Duration at resident	1	3.68	1.386	41
	2	3.22	1.233	397
	Total	3.26	1.254	438
Duration at occupation	1	3.85	1.256	41
	2	3.10	1.298	397
	Total	3.17	1.311	438
Educational level	1	2.61	.891	41
	2	2.62	.748	397
	Total	2.62	.761	438
I think gas flaring is affecting my health	1	3.24	1.374	41
	2	3.86	1.031	397
	Total	3.80	1.081	438
I think gas flaring is affecting some members of my family	1	3.15	1.370	41
	2	3.87	.993	397
	Total	3.80	1.054	438
Gas flaring contribute to air pollution in my area	1	3.66	1.407	41
	2	4.14	.970	397
	Total	4.09	1.026	438
Air pollutants have detrimental impacts on human health	1	3.93	1.311	41
	2	4.24	.929	397
	Total	4.21	.973	438
Air pollutants from gas flared cause respiratory problems	1	3.78	1.255	41
	2	4.23	.934	397
	Total	4.19	.976	438

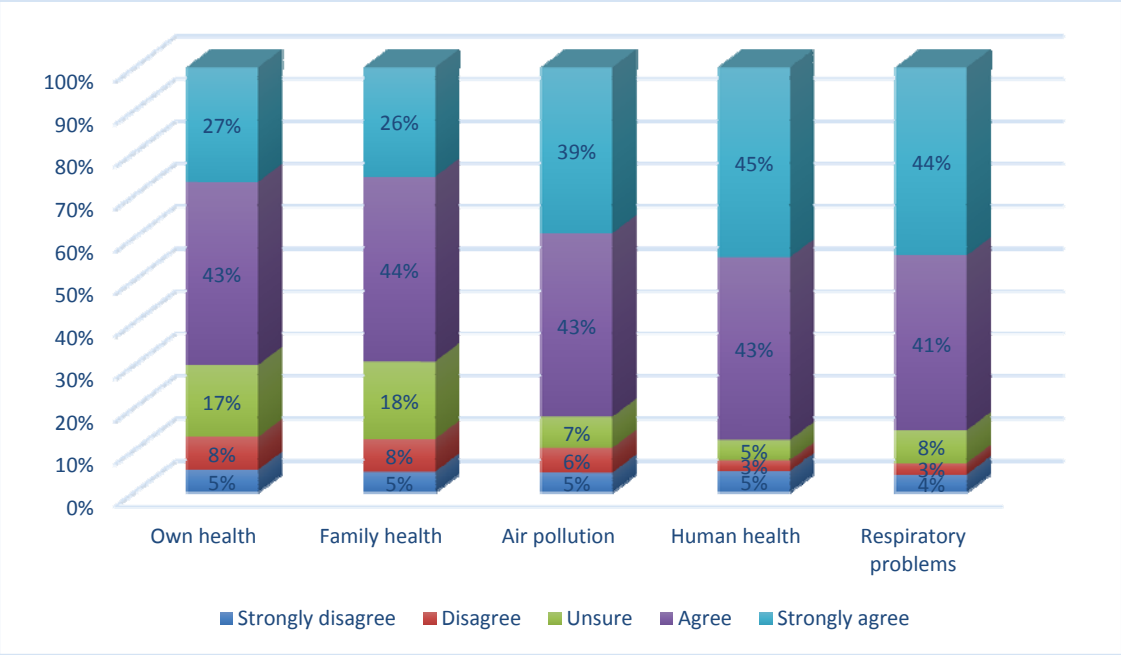

Fig. 1. Frequency distribution of respondents' perception on questions in table 1, about the effects of gas flaring on their health, family's health, pollution and respiratory problems

Table 2. One-way ANOVA outcome

		Sum of Squares	df	Mean Square	F	Sig.
Age	Between Groups	25.273	22	1.149	1.265	.189
	Within Groups	405.017	446	.908		
	Total	430.290	468			
Gender	Between Groups	4.755	22	.216	.772	.761
	Within Groups	126.198	451	.280		
	Total	130.954	473			
Social status	Between Groups	15.160	22	.689	1.476	.077
	Within Groups	204.467	438	.467		
	Total	219.627	460			
Duration at residence	Between Groups	36.345	22	1.652	1.061	.387
	Within Groups	694.456	446	1.557		
	Total	730.802	468			
Duration at occupation	Between Groups	42.442	21	2.021	1.191	.254
	Within Groups	753.560	444	1.697		
	Total	796.002	465			
Educational level	Between Groups	14.579	22	.663	1.285	.175
	Within Groups	233.530	453	.516		
	Total	248.109	475			

When the participants were distributed into dichotomous categories of based nominal values of their responses to the knowledge questions, frequency analysis affirmed that the majority were in the agreement (Fig. 2). Further, ANOVA of nominal knowledge between educational subgroups shows gradient increase but no statistical difference (Fig. 3).

4.3 MANOVA Tests

The outcome resonates with ANOVA that there is significant difference on duration of stay ($p < 0.014$); but knowledge of public impact between subgroups of either educational or social status. However, review of the mean-values shows that most respondents seem to have stayed longer in

the area (duration at residence and occupation), but less in educational status. Multivariate test indicates statistical significance (Table 3a; $p < 0.014$). Post-hoc test (LSD) show statistical significance durations in occupation and residence, but not for educational or social level (Table 3b).

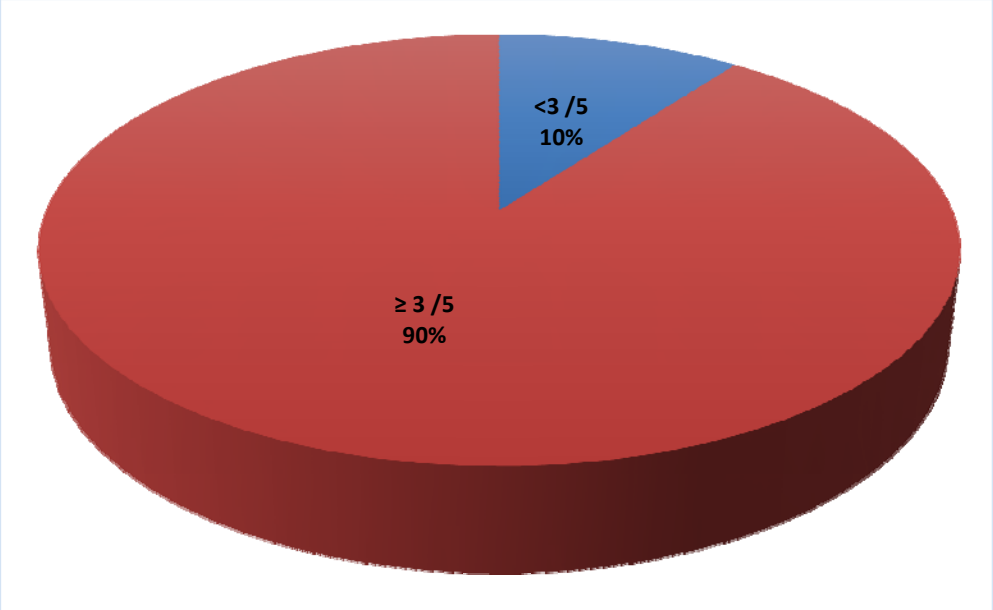

Fig. 2. Dichotomous frequency distribution of based nominal values of respondents' responses to the knowledge questions regarding gas flaring and public health impact

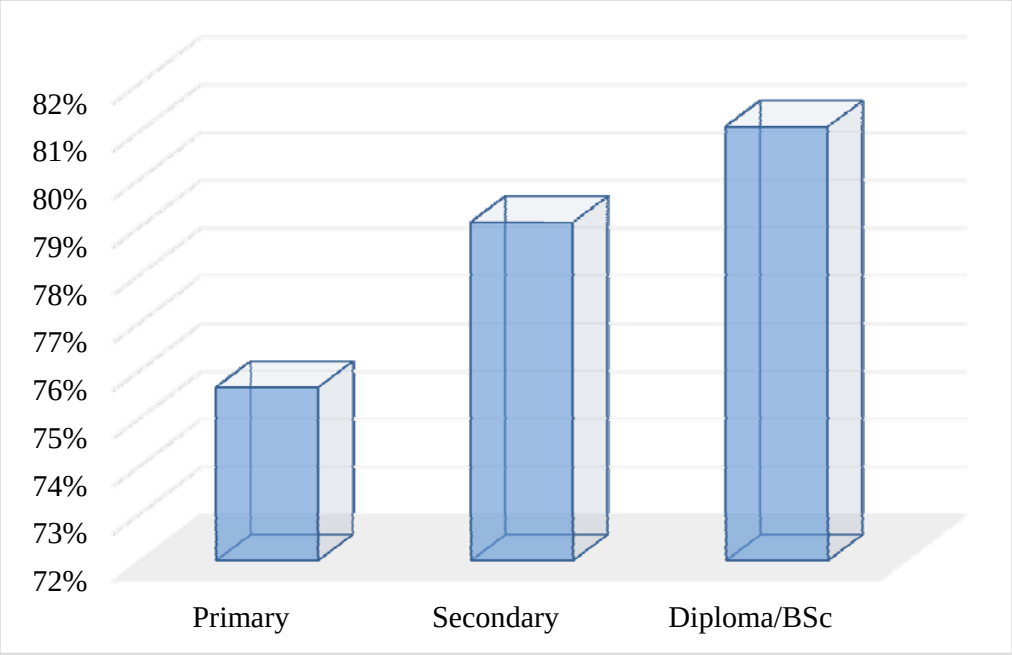

Fig. 3. ANOVA on extent of agreement of nominal knowledge on gas flaring and public health impacts amongst educational subgroups of respondents

Table 3a. Multivariate tests of effect showing the level of significance, error difference and hypothesis difference

Multivariate Tests[a]						
Effect		**Value**	**F**	**Hypothesis df**	**Error df**	**Sig.**
Intercept	Pillai's Trace	.884	811.720[b]	4.000	425.000	.000
	Wilks' Lambda	.116	811.720[b]	4.000	425.000	.000
	Hotelling's Trace	7.640	811.720[b]	4.000	425.000	.000
	Roy's Largest Root	7.640	811.720[b]	4.000	425.000	.000
K. group	Pillai's Trace	.029	3.169[b]	4.000	425.000	.014
	Wilks' Lambda	.971	3.169[b]	4.000	425.000	.014
	Hotelling's Trace	.030	3.169[b]	4.000	425.000	.014
	Roy's Largest Root	.030	3.169[b]	4.000	425.000	.014

Table 3b. Excerpt of post-hoc test of effect to determine where significant differences lie

Tests of Between-Subjects Effects						
Source	**Dependent Variable**	**Type III sum of squares**	**df**	**Mean square**	**F**	**Sig.**
Corrected Model	Educational 'categorical' levels: primary vs. tertiary	.227[a]	1	.227	.922	.338
	Social status	.050[b]	1	.050	.103	.749
	Duration at resident	6.063[c]	1	6.063	3.906	.049
	Duration at occupation	18.775[d]	1	18.775	11.268	.001
Intercept	Educational 'categorical' levels: primary vs. tertiary	358.887	1	358.887	1460.383	.000
	Social status	486.450	1	486.450	998.481	.000
	Duration at resident	1772.091	1	1772.091	1141.764	.000
	Duration at occupation	1812.263	1	1812.263	1087.647	.000
K. group	Educational 'categorical' levels: primary vs. tertiary	.227	1	.227	.922	.338
	Social status	.050	1	.050	.103	.749
	Duration at resident	6.063	1	6.063	3.906	.049
	Duration at occupation	18.775	1	18.775	11.268	.001

4.4 Hypothesis Test

On prevalent knowledge of whether 'pollution due to gas flares had a negative impact on environment and community health', the results shows significant difference for 'air pollutants from gas flared cause respiratory problems' ($p < 0.015$) and 'gas flaring contribute to air pollution in my area' ($p < 0.022$). Therefore, the hypothesis is accepted.

5. DISCUSSION

The work evaluated public health impact of environmental pollution due to gas flares with a hypothesis that 'pollution due to gas flares has had a negative impact on environment and community health'. Thus, the proposed outcome is to establish knowledge of the public health impact of environmental pollution due to gas flares in a broad demographic of participants. It is arguably common knowledge that air pollution from gas flares has public health impact including environmental pollution [16]. However, the level of perception or knowledge is yet to be clearly evaluated. Our preliminary observation was that knowledge of the public health impact was more in people living or working near the gas flare site [12], hence the current study investigated a large population.

Descriptive statistics and frequency distribution of Likert scaled questions show a very high proportion (90.6%) of the population with knowledge about the public health impact of gas flaring. This finding is consistent with other observations, which showed high perception of respondents' to gas flaring to be hazardous to health and social well-being of residents [17]. The proportion of those with little or no knowledge was low (Table 1), however this fraction may be high when specific questions are

evaluated. For instance, the frequency distribution further showed that 21% were either unsure or disagreed with the perceptions of public health impact of gas flaring (Fig. 1).

ANOVA comparisons between the subgroups of demographic factors based on evaluation of the level of knowledge extrapolated from participants' responses show that common demographic characteristics may not be an influential factor in the health impact of gas flaring, but social status is worth considering (Table 2). Based on dichotomous categorization of participants, analysis affirmed that approximately 90% were in agreement on all questions regarding health impact of gas flaring (Fig. 2). ANOVA did not show statistically significant differences between educational subgroups. However, given the linear increase in knowledge with education (Fig. 3), it can be inferred that the level of academic qualification may influence knowledge about public health impact of gas flares.

Initial MANOVA results corroborate with ANOVA that there is no statistically significant difference in nominal knowledge of the public impact of gas flare pollutions between subgroups of educational or social status. B Esu and O Dominic [18], similarly observed that the majority of respondents in their study regardless of their education or occupation, perceived flared gases to negatively affect their well-being. Of interest in this study is the observation of statistical significance due to factors of nearness. Unlike the ANOVA results (Table 2), MANOVA showed significance that the subgroup who had lived longer in the area (duration at residence and occupation) had high level of nominal knowledge on health impact of gas flare pollutions (Table 3a). It can therefore be concluded that the respondents' level of knowledge was significantly dependent on duration of residing or working in the area ($p < 0.02$). Post-hoc test (LSD) showed duration of working to possibly be more influential (Table 3b). This observation further corroborates with our preliminary report [12] and a study by I Mbachu [19].

Lastly, analysis was done to assess the hypothesis that '*pollution due to gas flares has had a negative impact on environment and community health'* and the result of test of between-subjects effects based on dichotomized subgroups showed significant difference for 'air pollutants from gas flared cause respiratory problems' ($p < 0.015$) and 'gas flaring contributes to air pollution in my area' ($p < 0.022$) thus accepting the hypothesis. This result agrees with other findings that showed air pollutants from the gas flaring stations to be responsible for respiratory and dermal diseases [20]. It is noteworthy that the perception of gas flaring on respiratory health impact was not statistical significant in our preliminary study [12], hence, acceptance of this hypothesis calls for further studies.

6. CONCLUSION

This report established knowledge of the impact of air pollution arising from gas flares. As much as nine-tenth of the population perceive the public health and environmental impact of gas flaring. This corroborates with prevailing notions and calls for epidemiological data to establish evidence-base for public health intervention. It is recommended that Governments and oil companies should put measures in place to mitigate gas flaring, Additionally, host communities should be educated on the health impacts of gas flaring.

CONSENT

Consent was implied by respondents returning their completed questionnaire.

ETHICAL APPROVAL

Granted as indicated in methods sections – re: Ethics approval (protocol number H20004).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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