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Comparison of Environmental and Occupational Health in Gas Flare Host Communities and those Farther from Gas Flare Sites

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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: Gas flaring occurs during crude oil extraction and can have adverse implications for the community' health and the environment. Reports show that residents complain about ill-health e.g. insomnia due to heat generated during gas flaring. This article therefore compares the impact on health in gas flaring host and non-gas flaring host communities.
Methodology: This research followed a mixed method approach of quantitative and qualitative analysis. Six questions were asked on occupation, residence, distance from the gas flare, social status in community, health status and family health history. Two questions assessed health status as well as family health history of participants and were semi-qualitative. All questions were adopted from a previously published report. Comparison of environmental and occupational data between host and neighbouring communities was done.
Outcome: Nearness of residence to gas flare sites show increased frequency in the number of ill health issues in respondents and their families. The impact of gas flaring i.e. ill health is high in those near to the site and diabetes is more prevalent amongst other ill-health conditions surveyed.

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Multiple comparisons show that the group farthest from gas flare site have significantly least proportion of members who are stressed or suffering respiratory problems.
Conclusion: Impact on health or wellbeing among members of gas flaring host communities are more severe when compared to those far. Government policies need to mitigate the adverse effects of gas flaring and the community needs to be educated on the impacts of gas flaring and how this can be minimised.

Keywords: Host communities; awareness; gas flare; human health; negative impact; wellbeing.

1. INTRODUCTION

In addition to noise and fire, flares emit volatile organic compounds such as methane, benzene, ethane, propane, and oxides of sulphur and nitrogen and hydrogen sulphide. These pollutants are detrimental to humans, animals and the environment and are linked to a range of adverse health issues including diabetes, stress, hypertension, neurological, reproductive and developmental effects [1,2]. Therefore, there have been concerns in regards to gas flaring on the health of people residing on working near gas flare sites. A study carried out in Niger Delta, showed that residents were at significant risk for respiratory and cutaneous disorders as a result of close proximity to gas flaring stations and continual exposure to gas flaring emission [3]. In another study in Texas, it was reported that exposure to a high frequency of flaring events in pregnancy resulted in a 50% increased risk of preterm birth compared to those who were not exposed [4]. In spite of this, only a few studies have compared the effects of gas flaring on the health of those residing near or working in gas flaring sites to those in non-gas flaring areas. Our preliminary study investigated the impact of gas flaring in Warri metropolis including Ekpan, Iffie, Ubeji communities, and Eku community in Delta State of Nigeria [5]. The study assessed the impact of gas flaring in the communities with regard to nearness to the flare site and comparison of toxic impacts of gas flaring activities on five communities was done. Questionnaires assessed perceptions of toxic health impact of gas flaring, among other objectives and the results showed linearity and non-linearity of responses. For instance, on one hand perceived prevalence of ill-health issues were high, but not linear relative to distance from gas flaring sites. There was observation of linear relationship between 'distance to gas flare site' and 'perception of poor air quality'. Further, the level of assessed health conditions also appeared to be significantly different, but not in a linear direction as per nearness to gas flare site. Therefore, the current study was developed from the preliminary study [5], as a scale-up with the agenda to use larger sample size and involve broader geographical reach.

What is known: Gas flares have a negative impact on environmental and human health [1-4].

What is unknown: The extent of ill-health in communities near gas flaring compared to those farther away has yet to be established as being significantly different.

Objective: Compare the impact on health in gas flaring host communities and non-gas flaring host communities.

Hypothesis: Impacts on health or wellbeing among members of gas flaring host communities are the same when compared to non- gas flaring host communities. Alternate hypothesis is that impacts on health or wellbeing among members of gas flaring host communities are more severe when compared to non- gas flaring host communities – severity indicated by level of prevalence.

2. METHODS

This study is with Charles Sturt University Ethics approval (H20004). It 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 (manuscript submitted). Summary of design, data and statistical analysis are as follows:

Design: Comparative descriptive study of host vs. neighbouring communities. This study followed a mixed method approach of quantitative and qualitative analyses – the latter being to enable open-ended suggestions from respondents. Further details of methodology are described fully in a separate protocol manuscript (In Press).
Questionnaire: Six questions were asked on occupation, residence, distance to gas flare site,

social status in community, health status and family health history. The 5th and 6th questions, i.e. health status and family health history, respectively, were semi-qualitative to enable more nuanced information from participants.

Discretional Presumptions: In this study, discretion was applied to assess environmental and occupational impacts by stress and respiratory problems, respectively. These discretional applications are based on various literatures [6-10]. Other health variables i.e. cancer, cardiovascular disease and diabetes where assessed as secondary.

Statistical Analysis: First, descriptive statistics was followed with frequency distribution of respondents to the Likert scaled questions. Comparison of environmental and occupational data between host and neighbouring communities was also done. Multivariate analysis (MANOVA) was carried out to evaluate the number of ill-health in individual respondents and in combination with family. All statistics were performed using SPSS, while Excel tool was used in constructing some graphics.

3. RESULTS

A total of 371 respondents participated in the survey and Fig. 1 shows the frequency distribution of respondents by age groups. The participants comprised 61% men and 39% women. Farmers constituted the least proportion of the participants (Fig. 2), and a majority of the respondents were in the low-middle social strata (Table 1).

Further, the majority of the respondents live or work within 5 Km distance to a gas flare site (Table 2). Most of the respondents indicated to be suffering environment impact (62.3%) and/or have family member who suffer from the same (50.9%). However, occupational impact assessed by respiratory problems were indicated in about one-quarter of the participants and one-third of family members. Among the other ill-health conditions that were surveyed, diabetes is more prevalent (Fig. 3).

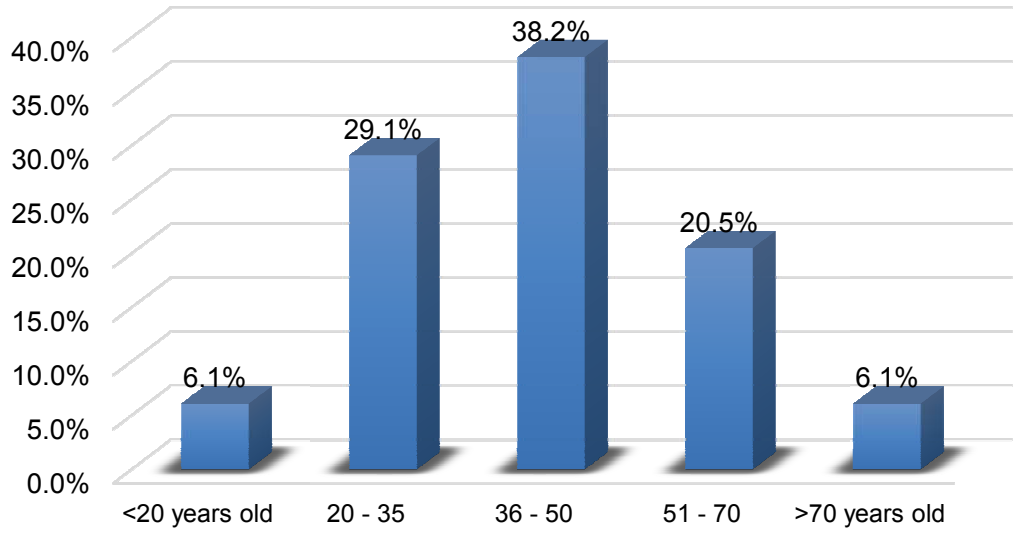

Fig. 1. Frequency distribution of participants by stratified age groups

Table 1. Frequency distribution of participants by social status in community

	Frequency	Valid Percent	Cumulative Percent
1. Low	146	40.6	40.6
2. Middle	161	44.7	85.3
3. High	53	14.7	100.0
Total	360	100.0	

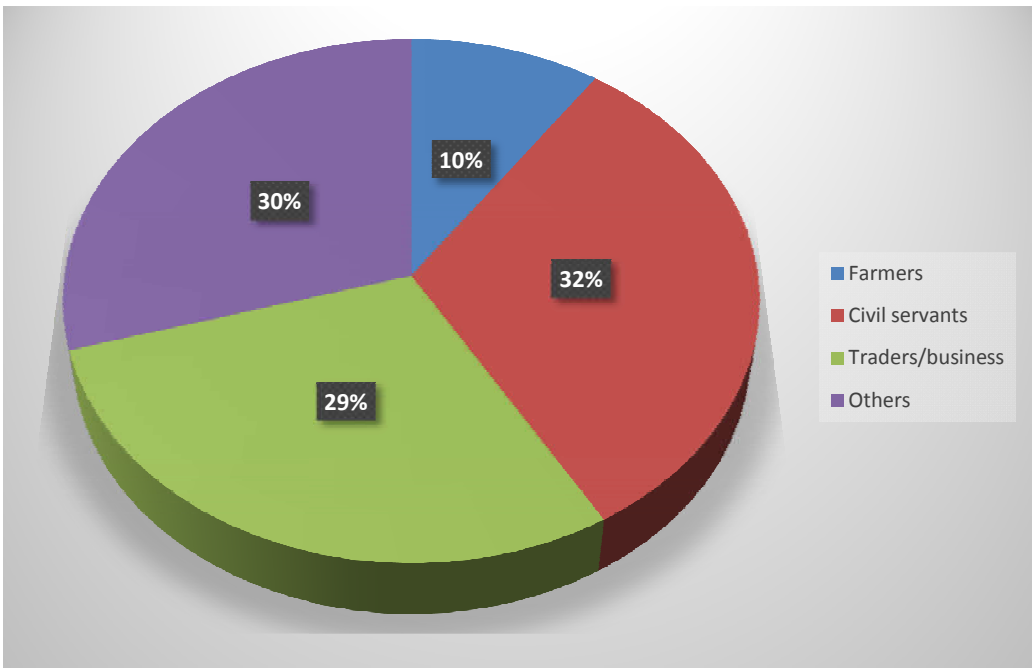

Fig. 2. Frequency distribution of participants by occupation

Table 2. Frequency distribution of respondents by nearness to gas flare site

Distance	Frequency	Valid Percent	Cumulative Percent
<1 Km	36	10.5	10.5
2 – 5 Km	187	54.5	65.0
6 – 10 Km	78	22.7	87.8
11 – 20 Km	13	3.8	91.5
>20 Km	29	8.5	100.0
Total	343	100.0	

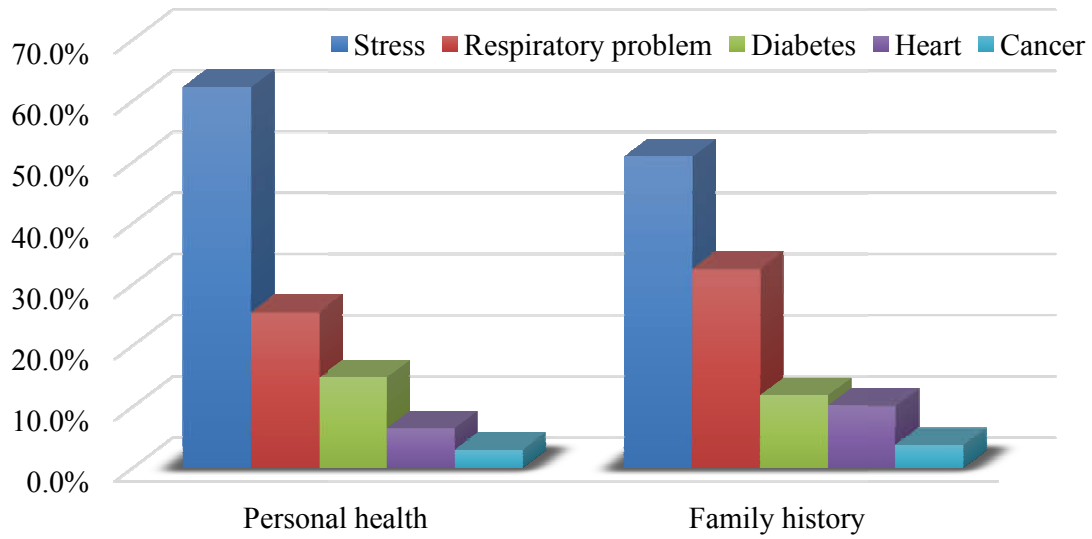

Fig. 3. Prevalences of indicated ill-health in participants and their families

Multivariate analysis (MANOVA) evaluated the number of ill-health (x5) in individual respondents and in combination with family (x10) and the results show that distance to gas flare site, but not occupation is statistically significant. Both residential address and nearness of either residence or occupation to gas flare sites show significance (Table 3). That is, impact is dependent more on individuals' nearness to the site of gas flaring. Therefore, the null hypothesis is rejected, and alternate version is accepted i.e. *impacts on health or wellbeing among members of gas flaring host communities are the same when compared to non- gas flaring host communities*.

Multiple comparisons show that the group farthest from gas flare site have significantly least proportion of members who are stressed or suffering respiratory problems. Comorbidities of the phenomenal health conditions in participant and family (x/10) were also least in this group compared to those nearer the gas flare site ($p < 0.001$).

4. DISCUSSION

This study is based on a preliminary report of perceived prevalence of ill-health issues being high, but not linearly related to distance from gas flaring sites [5] and it was assumed that sampling scope may have confounded the result. In this study, 54.5% of respondents are clustered in 2 – 5 Km group while the remaining 45.5% constitutes remaining four groups (Table 2). This may be a limiting factor that confound the results. However, this limitation may be ameliorated by the strengths of distributions of participants by age, occupation, and social status. Hence the justification of this piece of further study.

Table 3. Output of MANOVA analysis (unedited SPSS results)

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.612	91.488[b]	4.000	232.000	.000
	Wilks' Lambda	.388	91.488[b]	4.000	232.000	.000
	Hotelling's Trace	1.577	91.488[b]	4.000	232.000	.000
	Roy's Largest Root	1.577	91.488[b]	4.000	232.000	.000
Occupation	Pillai's Trace	.055	.818	16.000	940.000	.666
	Wilks' Lambda	.946	.818	16.000	709.409	.666
	Hotelling's Trace	.057	.818	16.000	922.000	.666
	Roy's Largest Root	.043	2.514[c]	4.000	235.000	.042
Resid_add	Pillai's Trace	.297	2.091	36.000	940.000	.000
	Wilks' Lambda	.729	2.127	36.000	871.149	.000
	Hotelling's Trace	.337	2.157	36.000	922.000	.000
	Roy's Largest Root	.191	4.976[c]	9.000	235.000	.000
Dist2Flare	Pillai's Trace	.112	1.693	16.000	940.000	.043
	Wilks' Lambda	.890	1.723	16.000	709.409	.038
	Hotelling's Trace	.121	1.745	16.000	922.000	.034
	Roy's Largest Root	.098	5.774[c]	4.000	235.000	.000
Occupation *	Pillai's Trace	.301	1.007	76.000	940.000	.465
Resid_add	Wilks' Lambda	.729	1.008	76.000	916.251	.462
	Hotelling's Trace	.333	1.009	76.000	922.000	.459
	Roy's Largest Root	.153	1.897[c]	19.000	235.000	.015
Occupation *	Pillai's Trace	.235	1.334	44.000	940.000	.074
Dist2Flare	Wilks' Lambda	.783	1.334	44.000	889.529	.074
	Hotelling's Trace	.254	1.333	44.000	922.000	.075
	Roy's Largest Root	.115	2.449[c]	11.000	235.000	.007
Resid_add *	Pillai's Trace	.318	1.014	80.000	940.000	.447
Dist2Flare	Wilks' Lambda	.714	1.022	80.000	917.632	.430
	Hotelling's Trace	.357	1.029	80.000	922.000	.412
	Roy's Largest Root	.184	2.168[c]	20.000	235.000	.003
Occupation *	Pillai's Trace	.420	1.060	104.000	940.000	.331
Resid_add *	Wilks' Lambda	.641	1.053	104.000	922.926	.346
Dist2Flare	Hotelling's Trace	.472	1.047	104.000	922.000	.362
	Roy's Largest Root	.153	1.385[c]	26.000	235.000	.108

This study expanded the scope of population survey and evaluated more specifically the prevalence of phenomenal ill-health in participants and their family members. Results show a predominance of environmental health impact as assessed and indicated by stress (≈ 62% among participants) while about 25% have occupational hazards of respiratory problems. There are several studies that reported on similarly high level of stress in various occupations. For instance, a recent systematic review has reported the same approximate level (61.9%) among healthcare workers [11].

Perhaps, it is pertinent to differentiate scenarios of how stress may cut across various environments, but the health outcome is different. In this discourse on gas flaring, the health outcomes are speculated to be primarily respiratory problems [3], though diabetes, cardiovascular disease and cancer are speculated [12]. In the example with healthcare workers, stress has headache as ill-health outcome [11].

The results from this study also appear different from the observation regarding prevalence of cardiovascular disease reported by some scientists [13]. However, a critical appraisal show different scenario whereby their study was specific on hypertension [14], whereas this survey asked about 'heart disease' in general. Nevertheless, the observation of average of 8.4% can be surmised as low compared to the recently indicated 11% contribution to death rate [15]. Another observation is the averaged 13.4% prevalence of diabetes mellitus among the participants. This rate is higher than observed from previous cross-sectional studies [16-18] and this warrant further investigations.

The results from multiple comparison when the cumulative number of comorbidities (i.e. x/10 based on the 5 phenomenal health conditions in 'participant + family' making 10) were analysed, it is observed that nearness to the gas flare site was the main influential factor to stress and comorbidities. It is noteworthy that in this study, people working in the gas flare host community were not delineated nor their individual occupational specifications. In fact, this study expounded the scope of previous work to survey more people from non-host communities. Other research reported hypertension to be more prevalent among those living in host communities. This study is mindful that the toxins can travel far distances and therefore communities that may be seen as non hot to gas flaring are still exposed but perhaps to less extend. The findings of this study affirm that health impact of gas flares is dependent on nearness to the gas flaring site. On this basis, the study's alternate hypothesis is upheld that *impacts on health or wellbeing among members of gas flaring host communities are more severe when compared to non- gas flaring host communities.*

5. CONCLUSION

The focus of this study was to compare prevalence of ill-health in communities delineated into groups based on nearness to gas flare site as an index of impact on health. The observation has affirmed that the impacts on health in members of gas flaring host communities are more severe when compared to non- gas flaring host communities. Government policies need mitigate the effects of gas flaring on the health and environment. The community needs to be educated on the impacts of gas flaring on their health and the environment. Oil companies should also provide personal protective equipment such as nose masks, hearing protection, eye protection, hand and foot protection, face shields and safety glasses to communities exposed to gas flaring. Further studies should be carried out to determine the occurrence, severity and prevalence of specific diseases in gas flaring host communities compared with non-gas flaring host communities.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

Consent was implied by respondents returning their completed questionnaire.

ETHICAL APPROVAL

Granted as indicate in methods sections – re: Charles Sturt University ethics #H20004.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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