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Effect of Gas Flaring on Lung Function among Residents in Gas Flaring Community in Delta State, Nigeria

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Absract: The study determined the impact of gas flaring on lung function by specifically evaluating changes in Peak Expiratory Flow Rate (PEFR) of residents in Ugberikoko, a gas flaring community. Participants for the study were drawn from the representative group in the gas flaring community in Delta State, Nigeria and values obtained were compared with those from non gas flaring community (Irhodo). Peak Expiratory Flow Rate (PEFR) was measured and used to assess lung function of the selected participants (n = 400) each for both. The peak expiratory flow rate was determined using the (Wright peak flow metre as a spirometric device) results obtained for children, young adults and older adults from the gas flaring community are 270.05±3.30 (13-17 years), 222.17±6.03 (18-30 years) and 245.00±8.66 (41-50 years), respectively. Age-matched values from non-gas flaring community are 432.05±5.57 (13-17 years), 420.75±16.22 (18-30 years) and 428.57±19.41 (41-50 years). Differences in matched values were significant ($p<0.05$). The findings showed that residents in gas flaring community had reduced peak expiratory flow rate.

Keywords: Gas flaring, Irhodo, peak expiratory flow rate, ugberikoko

INTRODUCTION

Gas flaring is the burning off of gas, which sends a cocktail of poisons into the atmosphere. It is necessary to have an understanding of the adverse impact of chronic exposure from multiple flaring discharges on the health of people who live and work in proximity to the industry. Proximity has been defined as any distance between 0.2 to 35 km from the flare stack (Argo, 2002).

Gas flares have harmful effects on the health and livelihood of the communities in their vicinity, as they release a variety of poisonous chemicals. Some of the combustion by-products include nitrogen dioxides, sulphur dioxide, volatile organic compounds like benzene, toluene, xylene and hydrogen sulfide, as well as carcinogens like benzapyrene and dioxin. Humans exposed to such substances can suffer from variety of respiratory problems, which have been reported amongst many children in the Niger Delta. These chemicals can aggravate asthma, cause breathing difficulties and chest pain as well as chronic bronchitis (Environmental, 2005).

Nigeria is said to have emitted more than 3,438 metric tons of gas in 2002. While flaring gas in the western countries has been minimized, in Nigeria it has grown proportionately with oil production (Friends of the Earth Nigeria, 2008). The volume of associated gas produced and subsequently burnt off, is directly linked to the amount of oil produced. The World Bank reported in 2004 that, "Nigeria currently flares 75% of the gas it produces". Between 70 and 75% is the generally accepted percentage of gas flared (Friends of the Earth Nigeria, 2008). The Niger Delta region of Nigeria has suffered from all forms of pollution and degradation arising from oil and natural gas exploitation. The impact of these include a decrease in agricultural yield, depression in flowering and fruiting in crops and palm trees, deformities in children, lung damage and skin problems, increasing concentrations of airborne pollutants, acidification of soils and rainwater, corrosion of metal roofs and significant increases in concentrations of sulphates, nitrates and dissolved solids, with associated socio-economic problems (Ologunorisa, 2001).

Gas flares are often located close to local communities and regularly lack adequate fencing or protection for villagers who may risk nearing the tremendous heat of the flare in order to carry out their daily activities. Many of these communities claim that nearby flares cause acid rain which corrodes their homes and other local structures, many of which have zinc-based roofing. Some people resort to the use of asbestos-based material, which is stronger in repelling acid rain deterioration (Castleman, 2005). Unfortunately, this creates its own health hazard. Asbestos exposure increases the risk of lung cancer, mesothelioma and asbestosis (Essential, 2001).

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Flares which are often older and inefficient are rarely relocated away from villages and are known to coat the land and communities in the area with soot and to damage adjacent vegetation. Almost no vegetation can grow in the area directly surrounding the flare due to the tremendous heat it produces (Environmental Resources Manager Limited, 1997).

The adverse health effects of air pollutants are now commonly accepted as ranging from mortality and hospital admissions to respiratory symptoms and decrements in lung function. Daily changes in lung function and particularly Peak Expiratory Flow (PEF) as a measure of airflow limitation are commonly used as an outcome in panel studies (Ward *et al*., 1999). There is dearth of information regarding lung function of inhabitants in communities known to be exposed to gas flares. We therefore, attempt to report the PEFR as a measure of lung function among residents in Ugberikoko, established to be highly exposed to gas flares arising from oil exploration activities in the Niger Delta area of Nigeria.

MATERIALS AND METHODS

Study centre and period: This research was conducted in the tropical area of Ugberikoko and Irhodo of Delta State, Nigeria between April and December, 2011.

Study design: The study was carried out using the following methods:

An open ended questionnaire: Covering bio-data and other relevant information. They were directly administered to sampled participants.

The peak flow meter: As a spirometric device to access peak expiratory flow rate in litre/minute for all participants. The recorded values represented the mean of at least three satisfactory readings.

Selection of participants: The study adopted the direct administration of questionnaire and observation/recording method.

The population used for this cross-sectional study is made up of a total of 800 participants.
This comprises of:

- 400 participants (183 children and 217 adults) in Ugberikoko (gas flaring community). This represents about 20% of children and adult population of ages 13-60 years
- 400 participants (183 children and 217 adults) in Irhodo (non-gas flaring community)

Both communities are entirely rural community.

The stratified random sampling method was adopted for the study. A total of 826 sampled participants were assessed.

The selection of male/female and children/adult was based on the relative proportion of the different sexes and age distribution of the study population. At the different communities participants were randomly selected into the different age group (children and adult) and different sex (male and female)

Inclusion/exclusion criteria: Children (male and female) of ages between 13-17 years and adults male and female of age 18-60 years were included while children less than 12 years, tobacco smokers, asthmatic patients and those with chronic respiratory disease, poultry and sawmill workers, subjects with spinal cord injuries and residents who resided less than one (1) year in the community were excluded.

Ethical consideration: approval was sought from school heads, parents and community heads where applicable with a view to obtaining informed consent from participants. Accordingly the necessary input of the ethical committee of the College of Health Sciences, of the Delta State University was obtained at the initial stage of the study.

Data analysis: The data generated were subjected to statistical analysis using frequency tabulation, simple percentage, one way analysis of variance (ANOVA) and unpaired Student t test, using statistical Package of Social Sciences (SPSS) version 16. Values at $p<0.05$ were considered significant.

RESULTS

The results obtained from the study are shown below: The peak flow rate values for children and adults in the gas flaring community are significantly ($p<0.05$) less than those for participants of the non gas flaring community. However, the peak flow rate was significantly different within the adult age spectrum between gas flaring and non gas flaring communities.

As regards the Gas Flaring community 55% of the participants have lived for six years and above and 45% have lived for five years and below. On the other hand, 77.5% of the participants have lived for 6 years and above in the Non Gas Flaring community and 22.5% have lived for 5 years and below.

Irrespective of gender, the mean peak flow rates significantly decreased with longer duration of exposure to gas flaring.

DISCUSSION

In the design of the study attempt was made to ensure that the sample from the two communities studied were

Table 1: Age distribution of participants in Gas Flaring Community (GFC) and Non Gas Flaring Community (NGFC)

Age	GFC	NGFC
13-17 year	183 (45.75%)	183 (45.75%)
18-60 year	217 (54.25%)	217 (54.25%)
Total	400	400

similar, especially with respect to the proportion of children and adults participating in it (Table 1). Previous reports have shown that peak expiratory flow rate progressively decreases with increasing age (Prasad *et al*., 2006; Ezeilo, 2002). This initial observation is further confirmed by this study (Table 2). The mean peak expiratory flow rate for children (male and female) was significantly ($p<0.05$) greater than that for adults.

The study also shows that gas flaring decreases peak expiratory flow rate of both male and female participants. Table 2 shows that the mean values for peak expiratory flow rate, for both children and adult residents in the gas flaring community were significantly lower ($p<0.05$) than those for residents of non gas flaring community. This observation is in agreement with earlier report (Samet *et al*., 1996) that students who had moved to areas with less particulate matter (microscopic particles in the air, such as dust and smoke) showed enhanced lung function when compared with those who moved to areas with more particulate showed a slowdown in lung function growth . There are other reports that environmental factors such as exposure to air pollution adversely affects lung function leading to respiratory symptoms (Castillejos *et al*., 1992; Leonardi *et al*., 2000). Other similar reports also exist (Castillejos *et al*., 1995; Romieu *et al*., 1997; Stvendsen *et al*., 2007; Gauderman *et al*., 2007).

The Gas Flaring Community, being rural in nature, is inhabited by many persons who may have lived all their life in the area. About 60% of the participants in this study, from the gas flaring community have lived for at least 6 years in the community (Fig. 1). Unfortunately, results of the study have shown that mean peak flow rate significantly ($p<0.05$) decreases with duration of stay in the community. This is irrespective of gender (Table 3). For example, mean peak expiratory flow rate of 428.57±19.41 L/min for adult male participant resident in the Non Gas Flaring Community reduced to 166±4.27 L/min at about 10 years of living in the Gas Flaring Community. This observation is in consonant with the finding of Samet *et al*. (1969) that reduction in lung function was more for residents with longer duration in environment highly polluted with particulate matter.

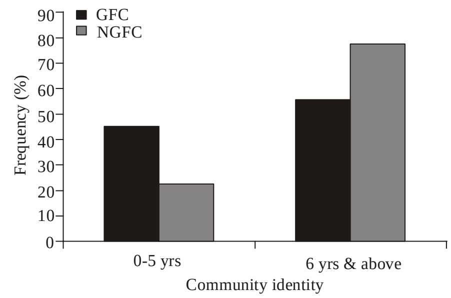

Fig. 1: Duration of participants in different communities

CONCLUSION

The study has established that gas flaring impact negatively on lung function of children and adults (males and females) residents in gas flaring community by reducing their mean peak expiratory flow rates. The severity of impact on peak expiratory flow rate worsens with longer exposure to gas flaring and hence marked reduction in Peak Expiratory Flow Rate.

The outcome of this study has provided additional basis for the formulation and implementation of policies

Table 2: Peak flow rates of participants in gas flaring community and non-gas flaring community

	MALE		FEMALE	
Age (Years)	GFC	NGFC	GFC	NGFC
Children (13-17)	270.05±3.30	432.05±5.57	242.15±7.34*	393.79±4.53
Young adult (18-30)	222.17±6.03	420.75±16.22	237.89±8.42*	356.00±14.0
Young adult (31-40)	259.00±6.40	410.23±12.32	248.42±10.27*	347.00±6.60
Older adult (41-50)	245.00±8.66	428.57±19.41	246.43±4.87*	351.25±13.15
Older adult (51-60)	259.75±5.14	421.18±14.27	246.67±31.80*	370.00±8.73

*: Significantly different ($p<0.05$); Values are expressed as Mean±SD for n samples

Table 3: Peak flow rates for participants of gas flaring community grouped by duration of participants in the community (L/min)

	Children		Adult	
Duration of stay.(Years)	Male	Female	Male	Female
1-5	^{a}292.4±1.39 n = 50	^{b}289.67±1.89 n = 30	^{c}309.43±2.01 n = 55	^{d}305.11±2.37 n = 45
6-10	^{a}246.60±1.89 n = 25	^{b}245 .00±2.47 n = 12	^{c}257.72±2.54 n = 23	^{d}258.5±2.44 n = 20
>10	^{a}166±4.27 n = 43	^{b}170.00±2.47 n = 23	^{c}206.57±2.75 n = 35	^{d}204.36±2.55 n = 39

Values expressed as means±SEM; $p<0.05$: for significance, using the single factor ANOVA test for addressing the adverse effect of gas flaring in this part of the world. However, an account of other indicators of lung function is recommended for further study.

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