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Impact of gas flaring on acute respiratory distress among pregnant women and newborn babies in Delta State Central Senatorial District, Nigeria

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ABSTRACT

Introduction: Gas flaring is a vital environmental issue that has a negative influence on health of population that host natural gases and oil wells. Exacerbated risk of abnormal outcomes for pregnant women and newborn babies are of great concern in maternal and child health. The researchers aimed to examine how gas flaring impact acute Respiratory Distress Syndrome (RDS) in women that were pregnant and newborn babies.

Materials and methods: A descriptive cross-sectional survey involving 483 pregnant women of reproductive age, antenatal caregivers and healthcare professionals at health facilities in Delta State Central Senatorial District. Using a multi-stage random sampling technique, a structured survey questionnaire was used to collect respondents' RDS experiences and that of their new borne. Data were statistically analysed with the use of SPSS. Significant level was considered at $P<0.05$

Results: Among the 326 children recruited, 205 (42.4%) had experienced respiratory distress. Of the 483 women, 54% suffered from respiratory disease and 33% of the children had been admitted for respiratory distress on a weekly basis. While the age, educational level, gender, and marital status of women were not significant statistically with having children experiencing RDS, bearing children was statistically significant ($P<0.001$). Health professional reported that developing severe lung infection, release of black carbon and asthma sufferers were major risk factors to RDS.

Conclusion: Findings showed that there was an increased prevalence of RDS among the study sub-population. RDS contributes more to cardiovascular disease and diabetes, hence it is important to address this public health issue

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Introduction

Gas flaring is one of the major environmental burdens that stand as a primary cause of adverse health-related problems to populations hosting natural gases and oil wells [1]. Flaring of gases is a usual practice of crude oil companies resident in different communities of Delta State, Nigeria. Nearly every community in the over 100 countries that are home to an estimated 70,000 oil fields has at some point encountered gas flaring [2–6]. Gas flares release combustion-generated contaminants like nitrogen oxides, heavy metals, benzene, fine particulate matter pollutants, carbon monoxide, and black carbon into the ecosystem of host communities. These pollutants are known leading aetiology of various environmental related health issues [7]. Air pollution has a number of detrimental impacts on the cardiovascular system. 80% of all premature mortalities due to air contamination are linked to Cardiovascular Disease (CVD). Brief exposure to particulate matter 2.5 ($PM_{2.5}$), a key component of gas flares, may lead to acute CVD-associated deaths and nonfatal events. Meanwhile, long-term exposure raises the risk of CVD-associated death and shortens lifespan [8]. Deep penetration of tiny particles into the lung airways, raises the risks of developing health condition including infection of respiratory system, cardiovascular diseases, and cancer of the lung especially in susceptible groups, such as children, pregnant women and the elderly [9]. Findings showed that Non-Communicable Diseases (NCDs) such as ischemic heart disease, cancer of the lung, Chronic Obstructive-Pulmonary Disease (COPD), stroke, asthma, and diabetes accounted for over 85% of the approximately 6.7 million deaths in 2019 that were caused by air pollution. Thus, behind tobacco, air contamination is the second most common cause of NCDs worldwide [9]. Pollutants from gas flares are also associated with the deposition of acids and acidic particles [10] such as nitrate and sulphate result in rust of metallic roofs [11], deaths of aquatic life and soil micro-organisms, leading to food insecurity [12] as well as various health effects such as dermatitis and respiratory disorders in humans [13]. According to the information now available, the health status of the local population, especially pregnant women and newborn babies have been significantly impacted by the exponential increase in concentrations of air pollution brought on by flaring of gases in the Niger-Delta region. Research showed that gas flare increases mean blood pressure, pulse rate and respiratory rate, along with decreased mean of peak expiratory-flow rate of community dwellers where gases are flare [14]. Thus, people living in surroundings where gases are flare may be susceptible to serious health issues like respiratory conditions, diseases of the blood, and cancers [1, 15] with its potentiating stress [16]; that cause or worsen diabetic and cardiovascular diseases [17–20]

Respiratory Distress Syndrome (RDS), interchangeably called Hyaline Membrane Disease, Infant Respiratory Distress Syndrome, Neonatal Respiratory Distress Syndrome, and Surfactant Deficit is a disease that primarily cause difficulty in breathing and often affects newborn babies. RDS is often seen in preterm children born before 28 weeks of gestation, and less often term newborns. Premature newborns suffer from RDS due to insufficient surfactants to make their lungs expand fully, leading to difficulty in breathing [21], non-cardiogenic pulmonary oedema with hypoxemia and death [22]. Although, acute RDS rarely occur in pregnant women having an approximated prevalence rate of 16–70 per 100,000 pregnancies [23, 24], it is a frequent aetiology of hospital admission among infants [25] with prevalence of 15% in infants with term gestational age and 29% in infants with late preterm gestational age admitted into neonatal intensive care unit [26, 27]. The clinical manifestations of breathing distress in newborn babies include difficulty in breathing (characterized by nasal flaring, recessions or retractions in the intercostal, subcostal, or supracostal spaces, grunting, head nodding); too fast breathing (characterized by tachypnoea respiratory rate greater than 60 breaths per

minute); shallow-breathing (characterized by bradypnoea respiratory rate less than 30 breath per minute, apnea); noisy breathing (characterized by Stentor, expiratory, wheezes, inspiratory stridor, grunting) or hypoxaemia (cyanosis); with or without associated disorders like poor feeding, poor activities, poor colour, vomiting. Whatever the reason, breathing distress can advance to apnea, respiratory failure, cardiopulmonary collapse, and death if it is not identified and treated promptly [27].

Despite the heavy burdens of environmental health hazards from gas flaring, there are paucity of evidence based literatures relating impact of gas-flaring and respiratory distress among pregnant women and newborn babies. Hence, this study aimed to find out whether or not gas-flaring is a risk factor of acute respiratory-distress among pregnant women, and newborn babies in Delta State Central Senatorial District, Nigeria.

Materials and methods

Research design and data collection

The research was pretest-posttest descriptive cross-sectional survey of 485 pregnant women of fertile age as well as antenatal caregivers at health facilities in Delta State Central Senatorial District. Multi-stage random sampling technique was used, and data were obtained with the use of structured questionnaires divided into three (3) sections. In section A, socio-demographic information of study participants including age, sex, marital status, religion were obtained. In section B, information from the pregnant women on their health experiences during pregnancy and about the newborn children were obtained. Section C was to survey antenatal care professionals on the characteristics of their clients and the newborns.

Study area and study population

The research work was carried out in Delta State Central Senatorial District which comprises eight (8) Local Government Areas Vis a Vis Ethiope West, Sapele, Ethiope East, Okpe, Ughelli North, Udu, Ughelli South, and Uvwie. Udu Town is the headquarters of Delta State Central Senatorial District. Delta StatecCentral Senatorial District has a population of about 1,570,858 inhabitants (Nigeria's National Population Census, 2006). The larger number of the people engages in trading, small-scale farming and fishing. The study population consisted of pregnant women of fertile age (15 – 49 years), caregivers of newborn babies, and health care providers in the senatorial district.

Selection criteria

The participants included in this survey met the following criteria;

- Pregnant women of all ages
- Caregivers of children (when mother is either dead or abandoned the child) and
- Healthcare workers in the senatorial district.

The participants excluded from this survey were;

- Pregnant women with mental illnesses due to , their disorientation and
- Those on intensive medical care due to complications of pregnancy.

Sample size

The number of sample for this research was determined by adopting the Raosoft [28] sample-size calculation, with provision of 5% error, 95% confidence and 50% response on estimated 2,000,000 women/child in Delta Central Senatorial District. In essence, the Raosoft sample-calculator is a piece of software that is used primarily to determine a survey's sample size in order to ameliorate the confusion and frustration of manual computation. Raosoft sample size calculator make use of complex computation of the equation below to generate sample size.

$$X = Z(^{c}/100)^2 r(100-r)$$

$$N = N^{x/}(N-1)E^2 + x) \quad (1)$$

$$E = Sqrt[^{(N-n)x}/n(N-1)]$$

Where,

N is equal to the population size, r is equal to the fraction of response that you are interested in, and Z(c/100) is equal to the critical value for the confidence level c.

Using the validated online sample size calculator, N = 377.

Sampling technique

Multi-stage sampling technique was used for the study as follows.

1) Stage I: Three Primary Healthcare Centres (PHC) were selected at random from each LGA, amounting to 24 PHC used.

2) Stage II: The first eighteen women of children bearing age that walk into the PHCs and gave consent were recruited into the study, amounting to 432 women from the 24 PHCs.

3) Stage III: Two healthcare professionals were recruited from each one of the 24 PHCs. Questionnaires were presented to every health workers present in the PHCs. The first two healthcare professionals that submitted both questionnaire and consent form were recruited amounting to forty-eight (48) healthcare professionals.

4) Total Sample Size: A total of 483 respondents from both women of child bearing age and healthcare workers were recruited for the study.

NB: It is worthy of note that the minimum calculated sample size was 377, but a total sample of 483 respondents were used for this study.

Ethical approval

Ethics approval was obtained from Eku Government Hospital, Eku, Delta State, Nigeria with reference number EBGH/AD/115/REM/V/103, authorized and approved on the 16th September 2021—approved. Every respondents signed informed consents prior to their participation in the study. Confidentiality of information was assured the respondents, and participation was totally voluntary with freedom of exit from the study at a will.

Statistical analysis

Data obtained were subjected to descriptive analysis of frequency counts and percentages and presented in tables and figures. Multivariate Analysis of Variance (MANOVA) was done to compare Sociodemographic factors and suffer of respiratory distress syndrome. Level of significance was considered at 95% ($P< 0.05$).

Limitation of study

The survey failed to measure clinical parameters of respiratory distress and gas flaring pollutants on pregnant women and newborns. Rather, it relied on self-report questionnaire from the respondents. Bias due to recall barrier is a major limitation to this study. Moreover, this study could not ascertain the causality of respiratory distress on gas flaring among the study population. Further research is therefore, required to establish cause, effect and interconnection between acute respiratory distress and gas flaring.

Results and discussion

Results

Out of the 483 respondents in this study (Table 1), majority of respondents (47.00%) fall within age group 36-45 years, over three-quarter were married, and 94.82% were females. Respondents bearing children were 79.50%, and over three-quarter had tertiary education.

Table 1. Sociodemographic characteristic of respondents

Factor	Subgroup	Frequency (N=483)	Percent (%
Age (Years)	<18	16	3.31
	19-25	48	9.94
	26-35	142	29.40
	36-45	227	47.00
	>45	50	10.35
Marital status	Married	366	75.78
	Divorced	12	2.48
	Widow	15	3.11
	Single (never married)	90	18.63
Gender	Female	458	94.82
	Male	25	5.18
Bearing a child	Yes	384	79.50
	No	99	20.50
Educational level	No education	3	0.62
	Primary	8	1.66
	Secondary	93	19.25
	Tertiary	379	78.47

Fig. 1 shows that the prevalence of RSD among respondents was 42.4% (205 cases). Multivariate analysis was performed to compare association between sociodemographic factors (SDF) and RSD. It was found that bearing children was statistically significant ($P<0.001$; $F=11.211$). While age groups, educational level, marital status and gender were not statistically significant as shown in Table 2.

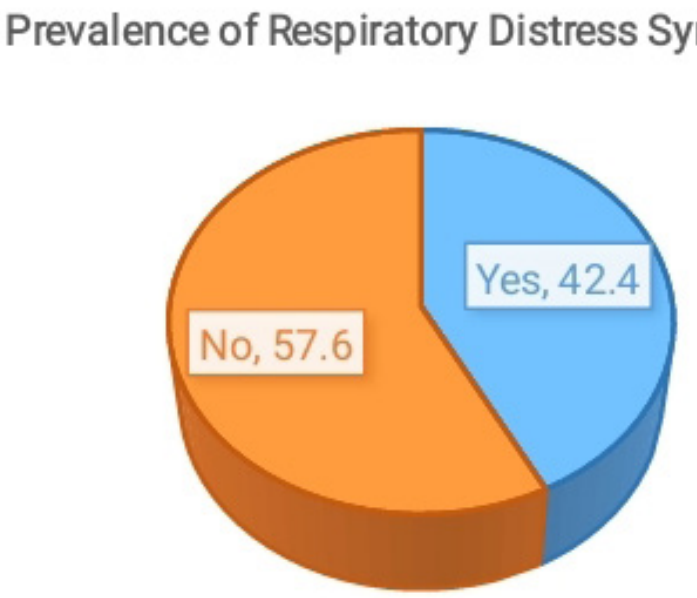

Fig. 1. Prevalence of RDS among respondents' children

Table 2. Comparison of sociodemographic factors of those that suffers from respiratory distress syndrome

Source	Dependent variable	Type III sum of squares	Df	Mean square	F	Sig.
Suffers RDS	Age	2.410	1	2.410	2.825	.093
	Marital status	2.286	1	2.286	1.612	.205
	Gender	.051	1	.051	.969	.325
	Having a child	1.738	1	1.738	11.211	.001*
	Education	.003	1	.003	.012	.912

* $P < 0.001$

In Table 3, analysis of responses to impact of gas-flaring on the risk factors of respondents (section B) showed averaged responses to be [No], and differences between categorical groups in the responses to all ten questions were significant.

Table 3. Impact of gas-flaring on the risk factors by respondents (Section B)

Questions on Risk Factors of Gas Flares	Suffers RDS	Mean	Std. Deviation	Frequency (n=477)
B1. Is your house close to a gas flare area?	Yes	1.52	.530	201
	No	1.86	.349	276
B2. Does the gas flaring affect your health?	Yes	1.24	.430	201
	No	1.82	.389	276
B3. Does gas flare contribute to air pollution in your area?	Yes	1.22	.418	201
	No	1.76	.427	276
B4. Do you suffer from any health disease like diabetes, high blood pressure, stress?	Yes	1.05	.218	201
	No	1.85	.360	276
B5. Do you experience any health issues like skin irritation and eye irritation?	Yes	1.44	.498	201
	No	1.92	.266	276
B6. Have your children been admitted in hospital for respiratory problem?	Yes	1.51	.501	201
	No	1.93	.254	276
B7. Have you (or has your wife) ever been pregnant?	Yes	1.04	.196	201
	No	1.16	.370	276
B8. Did you (or your wife) ever go to hospital during pregnancy for respiratory problem?	Yes	1.20	.400	201
	No	1.93	.247	276
B9. Have you ever had any problem with child's birth concerning breathing problem?	Yes	1.30	.461	201
	No	1.76	.425	276
B10. Did you ever have preterm (neonatal) childbirth?	Yes	1.40	.549	201
	No	1.79	.434	276

On analysis of risk factors indicated by healthcare professionals (Table 4), results show agreement in responses to all the 5 survey questions including four of them being strong (C1 – C5). However, statistically significant differences were achieved only on C3 – C5 ($P<0.05$).

Table 4. Impact of gas-flaring on the risk factors by health professional respondents (Section C)

Questions on Risk Factors of Gas Flares	Experience of RDS	Frequency (n = 378)	Mean	Std. Deviation
C1. Inhaling of toxic substances, such as chemicals, smoke, and gas flare can cause respiratory distress.	Yes	168	4.57	.553
	No	210	4.55	.562
C2. Developing a severe blood infection is a cause of respiratory-distress in pregnancy and new born.	Yes	168	4.56	.654
	No	210	4.43	.703
C3. Developing a severe infection of the lungs, such as pneumonia is also a cause of respiratory distress.	Yes	168	4.67	.509
	No	210	4.53	.620
C4. Is the release of black carbon experience in your area linked to respiratory distress?	Yes	168	4.67	.604
	No	210	4.26	.814
C5. Majority of patients with asthma suffer from respiratory distress due to smoke.	Yes	168	4.79	.453
	No	210	4.51	.686

Multivariate analysis of responses to Healthcare Professional responses to respiratory distress and health disease (C6 – C15) questions shows significant differences (MANOVA p <0.032), but only to 3 (C6, C7 & C12) out of 10 achieved significances (Table 5). Findings showed that RDS contributes more to Cardiovascular Disease (CVD) and diabetes. In other words, cardiovascular disease linked to respiratory disease are common and majority of patients with diabetes have respiratory disease syndrome respectively than other diseases (C11 & C12).

Table 5. Contribution of respiratory distress to other diseases

Source	Health professional response	Type III sum of squares	Df	Mean square	F	P-Value (P<0.05)
RDS experience	C6. There are many of these cases in your clinic that are associated with respiratory-distress in pregnancy and new born.	7.031	1	7.031	10.351	0.001*
	C7. These cases frequently present to my clinic in weekly basis.	4.956	1	4.956	7.834	0.005*
	C8. Cases of newborn with brief stop in breathing (apnea) is common & associated with respiratory distress in pregnancy.	1.707	1	1.707	3.451	0.064
	C9. Low-birth weight is common & associated with respiratory distress.	1.280	1	1.280	2.904	0.089
	C10. Chronic obstructive-pulmonary disease complications of respiratory distress are common.	1.721	1	1.721	2.063	0.152
	C11. Cardiovascular disease linked to respiratory distress is common.	1.478	1	1.478	3.705	0.055
	C12. Majority of patients with Diabetes have respiratory distress syndrome.	6.077	1	6.077	12.479	0.001*
	C13. Majority of patients with symptoms of stress are living with respiratory distress syndrome.	2.014	1	2.014	2.701	0.101
	C14. Breathing problems at birth that get worse due to respiratory distress.	1.057	1	1.057	2.788	0.096
	C15. Premature infants suffer respiratory distress syndrome due to surfactant deficit and underdeveloped lung anatomy.	0.001	1	0.001	0.002	0.965

Discussion

Prevalence of RDS

This survey examined the impact of gas-flaring on acute RDS among pregnant women and newborn babies in Delta Central Senatorial District. Finding showed that the prevalence of RDS was 42.4% which confirmed the work of Akpoghelie [29], who asserted that air pollution has detrimental effect on nearly all phase of human lives. Researchers opined that chronic bronchitis and emphysema were some of the diseases linked to air pollution [30]. Furthermore, the prevalence obtained in this survey agree with the prevalence of 43% obtained in an observational study conducted by other reserachers [31].

Relationship between socio-economic factors and RDS

Multivariate analysis of SEC factors showed that those who have children were identified with risk of RDS. Having children was statistically significant ($p < 0.001$; $F = 11.211$). This study showed that age was not a statistically significant risk factor of RDS. The outcome of our research was in agreement with the findings of Patel et al. [31] which demonstrated a nonlinear relationship between age and risk of RDS. This study also showed that gender, education, and occupation were not statistically significant. In other words, common socio-economic factors characteristics are insufficient to indicate risk of RDS in pregnancy and newborn. This results were consistent with reports of other researchers [32]. On the contrary, older age and gender were reported by Wu et al as risk factors linked with acute RSD [33]. Furthermore, low socioeconomic and educational status were reported to increase risk of RDS [34]. While analysis of respondents' responses to impact of gas-flaring on the risk factors of RDS was not statistically significant, World Health Organization [35] as well as a study [36] in their findings claims that the routine gas flaring used by Nigerian oil exploration corporations presents a serious risk to the health of those dwelling around the site. Gas flaring emits green-house gases into the environment, warms the air, and pollutes it [21].

On the risk factors indicated by healthcare professionals, results showed that developing a severe infection of the lungs, such as pneumonia, release of black carbon experience in area of residence, and patients with asthma were statistically significant risk factors of respiratory distress. This study was in one accord with studies conducted in Tanzania and India [37, 38]. Nevertheless, our result was in contrast to a study reported in Jimma zone, Ethiopia in which the risk factor of low-birth-weight babies was found higher in those mothers who were dwelling in urban settlements than those dwelling in rural area [39–41].

Healthcare professionals assertions on RDS

Findings showed that RDS in pregnancy and newborns is a common disorder ($P=0.001$) that are frequently presented to the clinic in weekly basis ($P=0.005$). These findings corroborate with a study which asserted that respiratory distress syndrome is one of the health risk human are exposed to [42]. This results also agreed with the findings of two studies that low quality of air is a contributory factor to frequent respiratory problems reported by people residing close to flare site [21, 43].

People that have Diabetes mellitus were found to significantly relate to RDS ($P<0.001$). The finding of this study is of the same view with the report of some researchers [44] who said respiratory system failure is the primary source of mortalities in children hosptalized to Pediatric-Intensive-Care-Unit (PICUs). Many reserachers claimed that acute RDS accounts for 1% to 10% of PICUs admissions [45-47]. Some reserachers find that the pooled mortality rate for pediatric acute RDS is 24%. Over 30 years ago, mortality has generally decreased, which is probably due to increased awareness and diagnosis [21, 48].

People with heart related diseases were also found to be linked to respiratory distress. Though, it was not significant statistically ($P=0.055$) which was in consonant with reports in a study which assessed how gas flares affected several cardiopulmonary

characteristics of people living in gas flaring villages or towns in certain Niger Delta states [14]. Further addition from this section is that RDS exacerbate cardiovascular disease and diabetes, thereby, making it statistically significant and contribute to morbidity. While other disease like chronic obstructive pulmonary disease, stress, breathing problems at birth which get worse due to RDS, premature infants that suffers RDS from surfactant deficiency and poorly developed lung anatomical structures were not statistically significant. This finding asserted that the interaction of contaminants from gas flare with other tissues in the body may cause cellular injury and hence, damage to body cells [49, 50]. Due to their increased susceptibility to major ARDS risk conditions including sepsis or pneumonia due to immune system attention, people with diabetes may be more susceptible to developing ARDS [51, 52], aspiration through gastroparesis [53, 54] and hypotension through autonomic neuropathy [55, 56]. Therefore, the protective interconnection between diabetes and ARDS may be present only in people that have already developed a predisposing ARDS condition.

Conclusion

Gas flaring is widely regarded as an unacceptable practice globally being that it has negative implications on the individuals and environment. This study has been able to reveal yet another aspect of pollution on pregnant women and newborn babies in our environment. The acceleration of natural oxidation processes resulting to soot makes gas flaring a formidable enemy of man because of the chronic effects that results from it. This is simply because the basic amenities of man are all affected. The release of these gases adds to the already built up environmental pollutants, thereby, increasing the prevalence of harm caused on the ecosystem and health of the people. The resulting impacts of gas-flaring are not limited but include damage to human health especially pregnant women and newborn babies. This study also shows that RDS exacerbate heart related diseases and diabetes than other diseases. The morbidity rates were lofty in children with experience of respiratory distress than those who had never suffered respiratory distress. Stricter regulation of gas flaring industry, education on adverse gas-flaring effect on human health as well as advocacy, policies and intervention programs gear towards reduction in maternal exposure to gas-flaring in the Delta State Central Region of Nigeria are recommended.

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Competing interests

The authors declare no competing interests.

Authors' contributions

OAA, JOA and EUN conceptualized the research idea and designed the study. JEM, COC and EAA were involved in data acquisition, analysis, and interpretation. JOO and KEM participated in the literature search and provided technical inputs. OAA and JEM prepared the draft manuscript. EUN, EAA and JOO participated in revising the manuscript for intellectual content. All the authors read and gave approval for the final version of the manuscript.

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Ethical considerations

Ethical issues (Including plagiarism, Informed consent, misconduct, data fabrication and/ or falsification, double publication and/ or submission, redundancy, etc) have been completely observed by the authors.

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