Original Article

Does environmental crude oil pollution affect pregnancy outcomes? A comparison of two communities in Rivers State Nigeria

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Abstract

Background: Pregnant women interact with the environment and may be physiologically vulnerable in event of any chemical-related environmental catastrophe. This study examined the effect of environmental crude oil pollution on pregnancy outcomes in selected midwife-led Primary Health Care Centres in Rivers State, Nigeria.
Methods: A retrospective-cohort design was applied using facility-based records. Pregnant residents of K-Dere (an oil polluted community) served as the exposed group, while pregnant residents of Iriebe served as the non-exposed group. A sample size of 338 systematically selected perinatal records was examined (169 records for each group). A data extraction sheet was used for data collection. Data were analyzed using Statistical Package for Social Sciences (SPSS) version 21. The level of significance was set at < 5%.
Results: At 32 weeks of pregnancy, participants in the exposed group weighted significantly less than those in the non-exposed group ($\chi^2 = 22.34$, df = 2, p = <0.001) and had a 60% higher risk of anaemia (64.5% vs. 40.2%, RR 1.6, 95%CI=1.29-1.99, p = 0.001). The exposed group had 108% higher risk of having preterm birth when compared to the non-exposed group (16% vs. 7.7%, RR 2.08, 95%CI=1.11-3.89; p=0.018).
Conclusions: Pregnant women resident in crude oil polluted environments have increased risk of preterm birth, maternal anaemia and lower maternal body weight. The immediate clean-up of oil spills might improve pregnancy outcomes in crude oil polluted communities.

Keywords: Midwifery, petroleum pollution, environmental pollutants, pregnancy outcome, Nigeria

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INTRODUCTION

Pregnancy tasks the health and coping mechanisms of the mother and her foetus. As pregnant women interact with their environment, physiological changes occur that could make them more susceptible to harm in event of environmental and chemical catastrophe.[1] Clandestine and illegal crude oil processing techniques and poor pipeline maintenance are considered major causes of oil spills and chemical catastrophe in developing nations. [2-4] The leakage of crude oil into the environment results in environmental pollution and degradation. [5,6] These may pose hazards to humans.[7] The human population especially pregnant women in such polluted communities may be at risk of inhalation and ingestion of hydrocarbons.[1]

Environmental crude oil pollution refers to the seepage of liquid petroleum hydrocarbons into the environment due to human activity, consequently causing toxic contamination of land and marine ecosystem upon which humans depend for survival.[4] The effect of environmental crude oil pollution on pregnancy outcomes has caught the attention of researchers for a while. [8] Previous studies on this topic show no clear consensus.[9] A study set in Oklahoma found no significant association between proximity of maternal residence to areas of crude oil activity and adverse pregnancy outcomes.[10] This finding was contradicted by other studies.[3, 8] The equivocal results on this subject justifies the need for further investigation, required to add evidence to community advisory services of healthcare providers. This study examined the effect of environmental crude oil pollution on pregnancy outcomes using facility-based perinatal records in two communities in Rivers State, Nigeria.

MATERIALS AND METHODS

A retrospective cohort design was used for this study in Rivers State Nigeria, between February and April of 2020. It is a crude oil producing state with onshore oil spills often seen in some of its communities.[4] A previous study had documented seven communities with crude oil spill such as Mogho, Kpoi, Bomu, Goi, K-Dere, Biara and B-Dere.[11] The researcher wrote the names of these communities in tiny strips of paper and put them in a ballot mail bag. While blinded, the researcher drew one strip from the mail bag (random selection) to reveal K-Dere. It is one of Rivers state's communities often documented as severely environmentally polluted.[11] It is a community in the Gokana area (Ogoniland) of Rivers State.[11] It is a rural community that is located about 52km south-east of Port Harcourt City. It has one midwife-led Primary Health Centre (PHC) which serves a population of approximately 3,180 women of childbearing age within a 15km radius. It offers a broad spectrum of perinatal services to women. Pregnant residents of K-Dere represented the exposed group in this study. In addition, other areas of Rivers state not documented to have experienced crude oil spill such as Old Port Harcourt, Rumukurushi, Iriebe, Rumuomasi, Rumuigbo, and Rumuokoro were also written in tiny strips of paper and put into another ballot mail bag. While blinded, the researcher drew one strip from the mail bag to reveal Iriebe. It is a community situated within Obio-Akpor area of Rivers State, and was chosen as the non-exposed community. It lies about 25km north-east of Port Harcourt City and approximately 41km north-west of K-Dere community. It is noticeably not listed among the severely environmentally polluted communities in Rivers State.[11] It has one midwife-led PHC which serves about 2,205 women of childbearing age within a 5.2 km radius. Iriebe PHC offers a wide spectrum of maternity services to women. Pregnant residents of Iriebe were the non-exposed group for this study.

The research team considered K-Dere and Iriebe PHCs as very similar in terms of skill mix of personnel, quality of maternity care and service administration. The perinatal case notes in both PHCs contained information related to pregnancy progression from 20weeks to 4weeks postnatal. The target population for this study was a total of 3088 individual perinatal records in both PHCs covering a period of 5 years from 2015 to 2019 (1698 in K-Dere and 1390 in Iriebe). A total sample of 338 perinatal records was used for the study (169 from K-Dere and 169 from Iriebe PHCs). It was calculated using Cochran (1977) formula for studies involving proportion: $n_s = \{[Z_{1-\alpha/2}^2 * P(1-P)] \div d^2\}$.[12] Here, n_s = minimum sample size; $Z_{1-\alpha/2}$ = Type 1 error at $p < 5\% = 1.96$; P = Prevalence of first parity preterm birth in mothers living in exposed areas relative to reference areas = 12.5%; [4] d = Precision = 0.05.[13] Approximately 169 perinatal case notes was computed to be selected for each

group (Total = 338). Systematic sampling technique was used for selection of case notes documented between January 2015 and December 2019. A point of random origin "6" was determined by throwing a dice. The sampling interval was determined by dividing the total number of records in each of the facilities (1698 in K-Dere and 1390 in Iriebe) by 169 thus having systematic intervals of 10 and 8 for K-Dere and Iriebe respectively. A data extraction sheet designed by the research team was used for data collection. To assure content validity of the instrument, five midwifery research experts were requested to score each item dichotomously as relevant and not-relevant. Agreement between raters (Content Validity Index) was calculated and 0.917 was obtained, so the instrument was considered valid.[14]

Data were collected between 2nd and 30th of March 2020. Systematically selected perinatal records where inspected for outcome parameters on the most recent pregnancy, then data was extracted using our data extraction sheet. Data collected were information related to miscarriages between 20-28weeks of gestation, maternal blood pressure, maternal haemoglobin at 32weeks gestation, stillbirths, preterm births, term births, birth weight and birth defects. The decision to assess maternal haemoglobin at 32 weeks was based on the findings of a population-based study which noted that more babies were likely to be born at 32 weeks gestation by pregnant women with anemia in comparison with those without anaemia.[15] Descriptive statistics was used to summarize categorical data and test of hypotheses was done using Chi square, Fisher exact test and Relative Risk test at 5% level of significance. Data analyses was done with the aid of Statistical Package for Social Sciences (SPSS) version 21 (IBM, Chicago, IL, USA).

Ethical considerations

The procedure for this study was approved by the Research Ethics Committee, University of Port Harcourt (No:UPH/CEREMAD/REC/MM68/020). Administrative permission was obtained from Rivers State Primary Health Care Management Board. Selected perinatal records were kept anonymous throughout the period of data collection. All collected data were protected and used only for the approved academic purpose.

RESULTS

Data extracted from all 338 case notes were found fit for analysis. Table 1 summarised the background characteristics of the participants and showed that the exposed group was similar to the non-exposed group in many ways such as age (p = 0.335), parity status (p = 0.288) and previous number of pregnancies and births (p = 0.903).

Table 1: Background characteristics of study participants **N = 338**

Variable	Exposed group (n = 169) n(%)	Non-exposed group (n = 169) n(%)	χ^2	*p*
Age				
15-24 years	39(23.1)	30(17.8)	2.07†	0.355
25-34 years	112(66.3)	115(68.0)		
35-44 years	18(10.7)	24(14.2)		
Previous pregnancies				
1-3 pregnancies	134(79.3)	135(79.9)	0.20†	0.903
4-6 pregnancies	32(18.9)	32(18.9)		
7-9 pregnancies	3(1.8)	2(1.2)		
Parity status				
Primipara	47(27.8)	56(33.1)	1.13	0.288
Multipara	122(72.2)	113(66.9)		
Previous births				
1-3 births	134(79.3)	135(79.9)	0.20†	0.903
4-6 births	32(18.9)	32(18.9)		
7-9 births	3(1.8)	2(1.2)		

Key: * flags significant difference between groups. † Fisher statistic. **Decision rule**: $p < 0.05$ = significant

Table 2: **Prenatal health status of participants at 32weeks gestation** **N = 338**

Variable	Exposed group (n = 169) n (%)	Non-exposed group (n = 169) n (%)	Fisher	p	Relative Risk 95%CI
Weight category					
45-64 kg	82 (48.5)	47 (27.8)	21.34	<0.001*	
65-84 kg	78 (46.2)	93 (55.0)			
85-104 kg	9 (5.3)	29 (17.2)			
Blood Pressure					
Normotensive	169 (100.0)	168 (99.4)	1.00	1.000	
Hypertensive	-	1 (0.6)			
Haemoglobin					
Normal (≥10.5g)	60 (35.5)	101 (59.8)	19.94	<0.001*	1.60(1.29-1.99)
Anaemic (<10.5g)	109 (64.5)	68 (40.2)			

Key: * flags significant difference between groups. **Decision rule**: p < 0.05 = significant

Table 3: Outcomes of participants' pregnancy **N = 338**

Variable	Exposed group (n = 169) n (%)	Non-exposed group (n = 169) n (%)	Fisher	p	Relative Risk 95%CI
Duration of pregnancy					
Preterm (<37weeks)	27 (16.0)	13 (7.7)	5.56	0.018*	2.08(1.11-3.89)
Term (≥37weeks)	142 (84.0)	156 (92.3)			
Labour onset					
Spontaneous onset	169 (100)	169 (100)			
Mode of birth					
Vaginal birth	169 (100)	169 (100)			
Birth status					
Live birth	168 (99.4)	165 (97.6)	1.83	0.371	
Stillbirth	1 (0.6)	4 (2.4)			
Birth weight	**n = 168**	**n = 165**			
Normal (>2.5 Kg)	145 (86.3)	153 (92.7)	3.65	0.056	
Low (≤ 2.5 Kg)	23 (13.7)	12 (7.3)			

Key: * flags significant difference between groups. **Decision rule**: p < 0.05 = significant

Table 2 summarised data on prenatal health status of participants at 32 weeks gestation and showed that participants in the exposed group weighted significantly less than those in the non-exposed group (χ^2 = 21.34, df = 2, p = <0.001). The exposed group also had a 60% increase in risk of anaemia in pregnancy at 32 weeks gestation (64.5% vs. 40.2%, RR 1.6, 95%CI=1.29-1.99, p = 0.001). Table 3 summarised data on outcomes of pregnancy and showed that the exposed group had a 108% increase in risk of having preterm birth (16% vs. 7.7%, RR 2.08, 95%CI=1.11-3.89; p = 0.018).

DISCUSSION

This study found that pregnant women resident in environmentally crude oil polluted communities would have significantly lower body weight at 32weeks gestation compared to unexposed pregnant women. This could be as a result of accidental ingestion of hydrocarbon contaminated food produce from the exposed community. In addition, this study found that pregnant women exposed to environmental crude oil pollution would have a sixty percent increase in risk of anaemia in pregnancy at about 32weeks of gestation. This finding probably suggests that the chances of proper nutrition are lower for pregnant women in crude oil polluted

communities. This assertion corroborated a Nigerian study which noted that farmlands and streams are often polluted by crude in oil producing communities.[11] Polluted farmlands and streams may denote lost sources of food and livelihoods; hence, reduced maternal weight at 32 weeks, which may imply reduced maternal weight gain and slower foetal growth. This assertion was affirmed by two other Nigerian studies which found that pregnancies in areas of crude oil pollution led to negative developmental health effects on foetuses, neonates and other resident groups. [4,16] One study also noted that ingested hydrocarbon pollutants which have the potential of accumulating on the foetal side of the placenta was responsible for slow foetal growth in environmentally polluted communities.[7] The consistence in findings could be explained by the idea that the named studies were conducted in the Niger Delta region of southern Nigeria. In line with this reason, similar results were expected.

This study also found that the exposed pregnant women had approximately one hundred percent increase in risk of having preterm birth. This finding was in line with a Texas study which found that pregnant women resident in areas of crude oil exploration had 20% higher risk of preterm births.[3] The similarity in findings was expected based on the premise that both studies utilized retrospective cohorts nested from facility based case notes. Furthermore, this finding was in line with a study conducted in California that found that closure of crude oil processing plants that are situated 0-10km of residential areas reduced preterm births from 7% to 5%.[8] Nonetheless, this finding was in contrast to another US study which showed no consistent association between hydrocarbon-based air pollutants and preterm birth.[17] The contrast in findings could be explained by differences in the exposure variable of interest as the US study considered hydrocarbon air pollutants generated from traffic and factories only.

The major limitation of this study is that of design. Left for ethical issues relating to intentionally exposing pregnant women to a crude oil spilled environment (potential harm), a randomized prospective cohort design is more suited for a study of this nature. This study did not control for confounding variables such as maternal utilization of antenatal services, compliance with prescribed prenatal medicines, occupation and genetic variations that might influence weight differences in populations. The fore mentioned thus imposes some threat to the conclusion validity of this study. Some caution must be exercised when suggesting that exposure to crude oil pollution resulted in the observed increased risk of preterm birth, maternal anaemia and lower maternal body weight. A larger multi-centre prospective study is required to confirm these findings.

CONCLUSION

Pregnant women exposed to environmental crude oil pollution had an increased risk of preterm birth, maternal anaemia and lower maternal body weight. Prompt clean-up of crude oil spills might further protect pregnant women in crude oil polluted communities.

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Conflicts of interest
There are no conflicts of interest

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