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OIL SPILL, MISCARRIAGE AND INFERTILITY: A COMPARATIVE CROSS-SECTIONAL STUDY OF OKRIKA AND PORT HARCOURT LOCAL GOVERNMENT AREAS, RIVERS STATE

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ABSTRACT: *Oil production and exploration is highly lucrative, and a significant source of revenue in Nigeria. There is a mixture of evidence on the impact of oil spill contaminants on reproductive failure, such as infertility and human miscarriage, with occasional research indicating significantly increased risk. This study determined and compared the prevalence of miscarriage and infertility among women of childbearing age in a community (Ekerekana) that has recently been exposed and another community (Ozuboko) not exposed to oil spills in Rivers State. Cross- comparative sectional study design was adopted that employed a convenient sampling technique. From each community, a sample of 187 women in their childbearing age (18-45years) was drawn. A semi-structured, interviewer-administered questionnaire was used for data collection. Ethics committee of the University of Port Harcourt gave ethical clearance for the study. Findings revealed that prevalence of miscarriage and infertility in Ekerekana community is 22.2% and 6.1% respectively; while in Ozuboko community it is 14.4% and 5.0% respectively. There was no statistical difference in the prevalence of miscarriage and infertility in Ekerekana community and Ozuboko community. Alcohol intake and age are not associated factors of miscarriage and infertility experienced by women in both communities. Based on the findings, it was concluded that oil spills may not have long-term effects on maternal experience of miscarriage and infertility. It was recommended that economic and environmental impact assessments, irrespective of the source of the spill, should be conducted to ensure that the potential health effects of spills are properly addressed.*

KEYWORDS: Oil Spillage, Miscarriage, Infertility, Women, Childbearing Age, Nigeria

INTRODUCTION

Nigeria is Africa's most populous country, and is blessed as the largest oil producer in this region. Oil production and exploration is highly lucrative, and a significant source of revenue in Nigeria. Negative oil exploration results cannot however be wished away. Oil spill has remained a problem for public health worldwide, in the country and most particularly to the host community where oil exploration is taking place. It creates environmental hazards like most industrial practices, which are "slow poisons," in that they often take months and years to

cause disease and death. Often times, the destruction of oil pipelines by vandals when attempting to steal small amounts of oil for sale on local markets or for personal use while others damage pipes and facilities for extortion by corporations for compensation payments or clean-up contracts (Mba, 2013) have led to these environmental distortions.

The United Nations report (UNEP) provides irrefutable evidence of the destructive impact of oil emissions on the lives of people in the Delta (one of the most biodiverse regions in Africa), causing damage to agriculture and fisheries, which has disrupted livelihoods and sources of food. Onshore oil activities have polluted local soil and water supplies, and endangered public health in neighboring areas (UNEP, 2011). One of the most important evidence to come to light is the extent of drinking water contamination, which has exposed communities to extreme health risks. In the past, oil spillage accidents have caused irreparable damage in producing areas, sometimes reducing the residents of the villages and communities affected. Also, the spillage has caused people to die directly or indirectly (UN Environment Programme, 2011).

Several epidemiological studies have demonstrated adverse effects of parental hydrocarbon exposure on fetal development, pregnancy outcomes and child health before or after birth. Crude oil use in daily life can lead to reproductive defects, sterility, miscarriages and early childhood problems (Anwar & Anwar, 2016; Zhou et al, 2016). Infertility and miscarriage are two issues of great concern for women of child-bearing age and how they are affected by oil spillage remains a public health importance. There is a mixture of evidence for the impact of oil spill contaminants on reproductive failure, such as infertility and human miscarriage, with occasional research indicating significantly increased risk (Duong et al. 2011), while other studies found no effect (Dechanet et al. 2011). Evidence of abortion among pregnant women exposed to petroleum products at their place of work has also been documented (Merhi, 2010). There is also evidence that women living in communities where oil production takes place have a greater likelihood of spontaneous abortion than women living far from those oil fields (Sebastian, et al. 2002). Perinatal exposure to hydrocarbons is associated with higher rates of spontaneous abortion (Bruederle & Hodler, 2017).

Rivers State is one of the 36 states of Nigeria. The state is famous for its vast reserves of crude oil and natural gas. Its capital and largest city, Port Harcourt, is economically significant as the centre of Nigeria's oil industry. The study was conducted in Ekerekana community and Ozuboko community in Okrika Local Government Area and Port Harcourt City Local Government Area, respectively. Ekerekana community is a settlement of Ngemebiri people of Koniju in Okrika Island, Okrika Local Government Area. The Ekerekana community is made up of an average population of 7000 people including women of childbearing age. Most common occupation is predominantly fishing and trading. There are two petroleum refining companies in the area and refining activities had been on since the early 60s. There is also huge products distribution center which discharge through tanker trucks. A considerable amount is also exported through a pipeline to the sea port. The mode of production, discharge of effluents and distribution system exposes the inhabitants to a considerable amount of pollution. The increasing occurrence of miscarriage and infertility observed among women in their childbearing years in most coastal regions of Rivers state is a cause for concern. Unfortunately, to date an unresolved question persists as to whether oil spills in Ekerekana community in Okrika have contributed to infertility and miscarriage. Hence, it is necessary to ascertain whether women's contact with oil spill leads to these phenomena. Unfortunately, no published research in the Ekerekana culture has examined the effect of oil spill on sterility and miscarriage among women in their childbearing years. This study therefore seeks to determine

and compare the prevalence of, and associated factors of miscarriage and infertility among women in their childbearing years in Ekerekana community that has been exposed and compare findings with Ozuboko community that has never been exposed to oil spill.

MATERIALS AND METHOD

The study involved a community-based, comparative cross-sectional study design to find out the prevalence and possible relationships between oil spillage, miscarriage and infertility among women of childbearing age resident in two communities in Rivers State (Ekerekana community in Okrika that was exposed to oil spillage, and Ozuboko community Port Harcourt LGA that was not exposed to oil spillage).

A total population of 400 women of childbearing age 18 – 45 years and 450 women of childbearing age reside in these communities. A sample size of 187 women in each community was derived after adjusting for attrition (10%) using the sample size determination for two population proportions as shown; $n = Z_{\alpha/2}Z_{\beta})^2 *\{(p^1q^1) + (p^2q^2)\}/ (p^1 – p^2)^2$ where: *n* = desired sample size,

p_1= the prevalence of infertility in women resident in an oil spill community = 32% (Odunveun et al 2015); therefore, p_1= 0.32, $q_1=1.0-p_1$= 1.0- 0.32 = 0.68, p_2= prevalence of infertility in women resident in a community without oil spill = 22.5% or 0.23 (Erigbani & Eruom 2010); q_2= 1-0.23= 0.77, Z_α = standard variation usually set at 1.96 and corresponds to 95% confidence interval, Z_β = power set at 80% = 0.84, $p_1 - p_2$ = difference in proportion of prevalence of miscarriage in women resident in a community with oil spill and prevalence of miscarriage in women resident in a community without oil spill = 32% - 23% = 9% or 0.09.

Data collection was through a semi-structured, interviewer-administered questionnaire. The questionnaire is made up of three sections (A, B and C): Section A is the demographic and socio-economic characteristics of respondents which is made up of ten (10) item; Section B is on prevalence of infertility with 6 items while Section C is on prevalence of miscarriage with 4 items. The instrument was given to experts for corrections and suggestions which were effected to assure face and content validity. The instrument was pretested by administering the questionnaire to 20 women in a community which has similar characteristics with the study setting and a Chronbach alpha of 0.7 was calculated making it reliable. An introductory letter was then submitted to the Research Ethics Committee (REC) of the University of Port Harcourt who gave ethical clearance for the study. The introductory letter and the ethical clearance letter were subsequently submitted to the Community Development Committee of the communities who then gave permission to carry out the study. A written inform consent detailing the purpose of the study and the rights of the prospective respondents was attached with the questionnaire and verbal consent was sought from respondents before data was collected. A student nurse served as research assistance and was trained on the research instrument and data collection process for two days. Data gathered was sorted, cleaned and tallied using an Excel worksheet. It was then transferred into Statistical Product and Service Solutions (SPSS) version 25 which was used for data analysis. Data was presented on tables and analyzed using descriptive and inferential statistics as appropriate. Descriptive statistics of frequency distribution and simple percentages was used to describe data on socio-demographic characteristics and other research objectives. Chi-square test was used to measure the association of selected socio-demographic

factors such as alcohol intake and age with miscarriage and infertility after which comparism was made between the two study populations. It was also employed to test the hypotheses to ascertain the relationship between oil spill and prevalence of miscarriage and infertility. The level of significance was set at p-value of 0.05.

RESULT

A total of 187 eligible women of childbearing ages were chosen in each of the communities (374 in total). However, 180 of the respondents duly completed the filling of the questionnaire, given a response rate of 96%.

Socio-Demographic Characteristics of Respondents

Table 1 below shows the response of respondents regarding the sociodemographic data. With regards to age, the majority of respondents in Ekerekana community 67(37.2%) are aged 39 - 45years while in Ozuboko community 80(44.4%) are aged 25 – 31years. The majority of respondents are married in both communities with Ekerekana and Ozuboko having 162(90%) and 168(93.3%) married women respectively. The educational level of respondents in both communities showed that majority have secondary education. With regards to number of children, 114(63.3%) have more than 2 children in Ekerekana community while 74(41.1%) have 2 children in Ozuboko community.

Table 4.1 Socio-Demographic Characteristics of Women of Childbearing age in Ekerekana and Ozuboko

Socio-Demographic Variables	Oil Spill Community (Ekerekana) n = 180 n (%)	Non-Oil Spill Community (Ozuboko) n = 180 n (%)
Age (years)		
18-24yr	5 (2.8)	6(3.3)
25-31yrs	56(31.1)	80(44.4)
32-38yrs	52 (28.9)	74(41.2)
39 - 45yrs	67(37.2)	20(11.1)
Marital Status		
Single	18(10)	12(6.7)
Married	162(90)	168(93.3)
Educational Level		
Primary	46(25.6)	30(16.7)
Secondary	120(66.6)	108(60.0)
Tertiary	1(.6)	25(13.9)
Other	13(7.2)	17(9.4)

Number of children		
None	26(14.4)	6(3.3)
One	34(18.9)	51(28.3)
Two	6(3.3)	74(41.2)
More than 2	114(63.4)	49(27.2)

Miscarriage Among Women in Ekerekana and Ozuboko Communities

This section assessed the prevalence of miscarriage among women in their childbearing age resident in a community exposed to oil spill (Ekerekana in Okrika LGA) and a community not exposed to oil spill (Ozuboko in Port Harcourt LGA). Table 2 displays the results from the self-report obtained from the questionnaire. Prevalence of miscarriage was measured as the proportion of participants who admitted to a history of past miscarriage. Table 2 revealed the number of respondents with miscarriage in Ekerekana and Ozuboko communities respectively. Forty (22.2%) of the respondents reported having a history of miscarriage in the oil spill community (Ekerekana) while 26(14.4%) of the respondents had miscarriage in the community not exposed to oil spill (Ozuboko).With regards to the time of having miscarriage, majority had miscarriage in both communities with24(60%) experiencing it after the oil spill in Ekerekana community (between years 2011 – 2020) while in Ozuboko community 17(65.4%) of the respondents had miscarriage between same years. Majority reported having experienced only one miscarriage event in both communities with 20(50%) in Ekerekana community while in Ozuboko it was 17(65.4%) of the respondents. The history of induced abortion showed that majority 95(52.8%) have not indulged in it in Ekerekana community and this was also the case in Ozuboko community where 137(76.1%) of the respondents indicated No.

Table 2: Prevalence of Miscarriage Among Women of Childbearing Age in Ekerekana and Ozuboko

Variable	**Oil Spill Community (Ekerekana) n (%)**	**Non-Oil Spill Community (Ozuboko) n (%)**
History of miscarriage	**n=180**	**n=180**
Yes	40 (22.2)	26 (14.4)
No	140 (77.8)	154 (85.6)
Year of miscarriage	**n=40**	**n=26**
2000-2010	16(40)	9 (34.6)
2011-2020	24(60)	17 (65.4)
Number of miscarriages	**n=40**	**n=26**
One	20 (50)	17(65.4)
Two	12 (30)	4(15.4)
Three	8 (20)	5(19.2)
History of Induced Abortion		
Yes	85 (47.2)	43 (23.9)
No	95 (52.8)	137 (76.1)

n = frequency *% = Percentage*

Comparing the Prevalence of Miscarriage in Ekerekana and Ozuboko Community

Table 3: Comparative Analysis of Prevalence of Miscarriage in Ekerekana and Ozuboko Communities

	Had Miscarriage Before the Spill (2000-2010)	**Had Miscarriage After the Spill (2011-2020)**	**Total**	**df**	***X*² Cal**	***Sig (2-tailed)***	***Decision***
Exposed (Ekerekana)	16	24	40	1	0.194	0.66	Not significant the null hypothesis is accepted
Not exposed (Ozuboko)	9	17	26				
	25	**41**	**66**				

The table above shows the chi-square analysis of prevalence of miscarriage between Ekerekana and Ozuboko community respectively. Result showed that at p-value of 0.05, df = 1, X^2cal value of 0.194 was obtained with p-value of 0.66. The obtained p-value of 0.66 is greater than the critical p-value of 0.05. This implies that there is no significant difference between prevalence of miscarriage in the two communities (exposed and not exposed) before and after the spill therefore the null hypothesis is accepted.

Infertility Among Women in Ekerekana and Ozuboko Community

This section assessed the prevalence of infertility in Ekerekana and Ozuboko communities. Infertility was measured as the proportion of participants who admitted to a history of infertility.

Table 4: Prevalence of Infertility Among Women of Childbearing Age in Ekerekana and Ozuboko

Variable	**Oil Spill Community (Ekerekana) n=180**	**Non-Oil Spill Community (Ozuboko) n=180**
Pregnant before		
Yes	169(93.9)	171(95.0)
No	11(6.1)	9(5.0)
Attempting to get pregnant	**n = 11**	**n = 9**
Yes	8(72.7)	9(100.0)
No	3(27.3)	0(0.0)
Duration of not being able to conceive	**n = 8**	**n = 9**
1-5years	4(50)	6(66.6)
6-10years	3(37.5)	3(33.4)
16-above	1(12.5)	-

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Table 4 shows that majority 169(93.9%) of the respondents in Ekerekana have been pregnant before while 11(6.1%) have never conceived. Similarly, in Ozuboko community majority of the respondents 171(95.0%) have conceived before while 9(5.0%) have not. The result also revealed that 8 out of the 11 respondents who have never conceived in Ekerekana community were attempting to get pregnant. On the contrary, all 9 of the respondents who have never conceived in Ozuboko community were attempting to get pregnant. With regards to the duration of not being able to conceive, majority 4(50%) in Ekerekana community and 6(66.6%) in Ozuboko community indicated 1 – 5years respectively.

Comparing the Prevalence of Infertility in Ekerekana and Ozuboko community

Table 5: Comparative Analysis of Prevalence of Infertility in Ekerekana and Ozuboko Community

	Infertility (Pregnant Before)		
Groups	**Yes n (%)**	**No n (%)**	***Chi-square (df), P-value***
Oil Spill (Ekerekana)	169(93.9)	11(6.1)	*0.212 (1), 0.65*
Non- Oil Spill (Ozuboko)	171(95.0)	9(5.0)	
Total	**340(94.4)**	**20(5.6)**	

Result showed that at a p-value of 0.05, df = 1, X^2cal value of 0.212 was obtained which yielded a p-value of 0.65. The obtained p-value of 0.65 is greater than the critical p-value of 0.05. This implies that there is no significant difference between prevalence of infertility in the two communities (exposed and not exposed). Therefore, the null hypothesis is accepted.

Associated Factors of Miscarriage Among Women in Ekerekana and Ozuboko Communities

Chi-square test was used to ascertain the factors associated of miscarriage in the two-comparison study populations.

Table 6: Comparative Analysis of Factors of Miscarriage in Ekerekana and Ozuboko Community

	Miscarriage in Oil Spill (Ekerekana)			**Miscarriage in Non- Oil Spill (Ozuboko)**		
Variable	**Yes n**	**No n**	***Chi-square (P-value), df***	**Yes N**	**No n**	***Chi-square (P-value), df***
Alcoholic drink intake						
Yes	8	11	**4.859 (0.080), 1**	7	11	**1.449 (0.229), 1**
No	32	129		19	143	
Total	**40**	**140**		**26**	**154**	
Age						
18-31	3	61	**0.351, (0.554), 1**	2	85	**2.586, (0.108), 1**
32 – 45	8	108		7	86	
Total	**11(6.1)**	**169(93.9)**		**9(5.0)**	**171(95.0)**	

df = difference, n = frequency

The chi-square value for alcohol intake in the community exposed to oil spill (Ekerekana) is 4.859 and p-value of 0.080, while the chi-square value for the community not exposed to oil spill (Ozuboko) is 1.449 and a p-value of 0.229. The above result implies that alcohol as a factor is not associated with miscarriage and there is no significant difference between the two communities (exposed and not exposed) regarding alcohol as an associated factor of miscarriage.

The chi-square value for age of women in the community exposed to oil spill (Ekerekana) is 0.351 and p value of 0.554 while the chi-square value for the community not exposed to oil spill (Ozuboko) is 2.586 and a p-value of 0.108. Since all the p-value for age of women of child bearing age in both communities are greater than the criterion p-value of 0.05, the null hypothesis was accepted, this implies that there is no significant difference in the associating factors of miscarriage in the two-comparison study populations.

Associated factors of Infertility among women in Ekerekana and Ozuboko communities

Chi-square test was used to ascertain the factors associated of infertility in the two-comparison study populations.

Table 7: Comparative Analysis of the Factors of Infertility in Ekerekana and Ozuboko Community

	Infertility in Oil Spill (Ekerekana)			**Infertility in Non- Oil Spill (Ozuboko)**		
Variable	**Yes n**	**No n**	***Chi-square (P-value), df***	**Yes N**	**No n**	***Chi-square (P-value), df***
Alcoholic drink intake						
Yes	3	16	**3.468 (0.063), 1**	2	16	**1.572 (0.210), 1**
No	8	153		7	155	
Total	**11**	**169**		**9**	**171**	
Age						
18-31	3	61	**0.351, (0.554), 1**	2	85	**2.586, (0.108), 1**
32 – 45	8	108		7	86	
Total	**11(6.1)**	**169(93.9)**		**9(5.0)**	**171(95.0)**	

df = difference, n = frequency

The chi-square value for alcohol intake in the community exposed to oil spill (Ekerekana) is 3.468 and p-value of 0.063, while the chi-square value for the community not exposed to oil spill (Ozuboko) is 1.572 and a p-value of 0.210. The above result implies that alcohol as a factor is not associated with infertility and there is no significant difference between the two communities (exposed and not exposed) regarding alcohol as an associated factor with infertility.

The chi-square value for age of women in the community exposed to oil spill (Ekerekana) is

0.351 and p value of 0.554 while the chi-square value for the community not exposed to oil spill (Ozuboko) is 2.586 and a p-value of 0.108. Since all the p-value for age of women of child bearing age in both communities are greater than the criterion p-value of 0.05, the null hypothesis was accepted, this implies that there is no significant difference in the associating factors of infertility in the two-comparison study populations.

DISCUSSION

The study found the prevalence of miscarriage to be about one-fifth of the population among women in their childbearing age residing in Ekerekana, a community exposed to oil spill in Okrika LGA and this is higher when compared with that of the Ozuboko community in Port Harcourt LGA not exposed to oil spill which was less than one-fifth. However, the comparative analysis found that there was no statistically significant difference in the prevalence of miscarriage between the two populations. This finding is in line with the results of the study by Emily et al (2017), who reported that no specific feature of exposure to oil spills was highly associated with the outcomes of miscarriages and that pre-oil spill pregnancy effects were just as high. Also, result showed that residing in a community that has been exposed to oil spill was not associated with experiencing miscarriages.

The prevalence of infertility was reported to be 6.1% and 5.0% among women in their childbearing age residing in Ekerekana, a community exposed to oil spill in Okrika LGA and Ozuboko community in Port Harcourt LGA not exposed to oil spill respectively. Findings also showed that prevalence of infertility did not indicate significant difference between the two populations. Findings from the statistical analysis showed that residing in a community that has been exposed to oil spill was not associated with experiencing infertility. This result contradicts Harville et al (2017) study which reported that women exposed to oil spills were equally vulnerable to pregnancy complications that occurred before and after the oil spill.

For associated factors of miscarriage and infertility, it was found that alcohol intake was not significantly associated with miscarriage and infertility in Ekerekana community (X^2= 4.859, p-value = 0.080) and (X^2 = 3.468, p-value = 0.063) respectively, for Ozuboko community(X^2 = 1.449, p-value = 0.229)(X^2 = 1.572, p-value = 0.210) respectively. Also, it was found that in both communities, age was not significantly associated with occurrence of miscarriage and infertility because calculated p-values (p; 0.554 – 0.108) were greater than the critical p-value of 0.05.Thus, it was concluded that alcohol and age are not significantly associated with the occurrence of miscarriage and infertility in communities exposed to oil spills and the one not exposed to oil spills. This contradict the finding of Bray et al. (2006) that reported that levels of miscarriage grow gradually with age, with more severe rises after age 35. The risk is 10 percent in those under the age of 35 while it is about 45 percent in those over the age of 40.

IMPLICATION TO RESEARCH AND PRACTICE

Though the findings of this study showed there is no statistically significant difference in the prevalence of miscarriage and infertility between the two study settings, the incidence of miscarriage and infertility has implication for government, non-governmental agencies, midwives and clinical practice.

First, government should conduct economic and environmental impact assessments to ensure that the potential health effects of contact to spills are properly addressed. Second, the relevant oil exploration regulators in Nigeria should have well-trained regional facility inspectors who should periodically go on-site to inspect facilities in accordance with the relevant legislation.

Third, midwives should encourage women of childbearing age to observe regular health and gynaecological screening in order to identify early medical causes of miscarriage and infertility and refer women to appropriate specialist for prompt intervention.

CONCLUSIONS

The study's findings did not find evidence of clear associations between oil spill exposure, miscarriages, infertility and pregnancy complications, of which few associations for pregnancy occurring prior to spill were nearly as high as after. Previously, few studies examine the correlation of complications of maternal pregnancy with either a chemical or natural disaster, and the findings are contradictory. This relationship should be further explored in studies with more detailed exposure measures and outcome measures.

Further Research

Based on the findings in this study, it is recommended that the study should be carried out in other communities that have experienced oil spill and other form of pollutions in the past.

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