Original Article

Antenatal urinary hydrocarbon biomarkers and birth outcomes among mothers in selected oil-host and non-host communities of Southern Nigeria

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Abstract

Background: Exposure to environmental pollutants from crude oil activities has been implicated in adverse maternal and neonatal outcomes. This study examined antenatal urinary monocyclic aromatic hydrocarbon biomarkers and birth outcomes among mothers in selected oil-host and non-host communities of southern Nigeria.
Methods: A prospective cohort design was adopted for the study of pregnant women in Eleme, Rivers state and Umuahia South, Abia State. At baseline, 146 pregnant women (73 per group) were recruited using a convenience sampling technique, but 136 participants (69 from Eleme and 67 from Umuahia South) completed the study, as 10 (6%) were lost to follow-up. Data were collected using a validated proforma (content validity = 0.91). Midstream urine samples were collected for laboratory analysis of benzene, toluene, ethylbenzene and xylene using Gas Chromatography–Mass Spectrometry (GC–MS). Data were analysed using descriptive and inferential statistics, including independent sample t-tests and chi-square tests at a 5% significance level.
Results: Findings showed that xylene was predominant and recorded the highest mean concentration (0.21 ± 0.46 ppm) in Eleme and (0.15 ± 0.33 ppm) in Umuahia-South. Significant differences were observed in urinary benzene ($p < 0.001$) and toluene ($p < 0.03$) concentrations with Eleme having higher levels than Umuahia south. Mothers in Eleme had shorter pregnancy durations ($p = 0.030$) and more birth complications ($p = 0.001$). Newborns from Eleme had significantly shorter body lengths, smaller head circumferences, and lower Apgar scores ($p = 0.030$), though birth weight differences were not significant.
Conclusion: Maternal exposure to hydrocarbons in oil-host environments may adversely influence pregnancy and neonatal outcomes.

Keywords: Antenatal, birth, BTEX, hydrocarbons, pregnancy, oil-host communities, Nigeria

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INTRODUCTION

The substantial reliance of middle and low income countries of the world on crude oil exploration has contributed immensely to environmental pollution.[1] Environmental pollutants from the combustion of aromatic hydrocarbons from crude oil have become a very crucial public health concern due to its global adverse effects on human health.[2] Aromatic hydrocarbons such as benzene, toluene, and xylene are often released into the environment by the illegal extraction of crude oil using unconventional methods in addition to poor pipeline maintenance resulting to crude oil spills in oil producing communities.[3] Additionally, Yang and colleagues. noted that waste materials from crude oil processing and transportation can pollute air, land, and water.[4] When the pollutants are ingested, it may potentially risk the health of people in the geographical locations where oil exploration is common.[4]

The pollutants from aromatic hydrocarbons contribute to a higher rate of carcinogenic disease conditions in several sub-Saharan African countries with specific environmental conditions augmenting these risks.[5] In fact a study report indicated a 22% greater incidence of lung cancers in areas with increased levels of aromatic hydrocarbon exposures.[6] Additionally, reports have enumerated the health risk of women exposed to aromatic hydrocarbon pollutants in the sub-Saharan African region. Approximately 25% of pregnant women were reported to have elevated levels of aromatic hydrocarbon exposure due to urban air pollution and household combustion. The adverse pregnancy outcomes were associated to 20% increase in the risk of preterm birth .[7] Further reports have stated that crude oil and gas exploration, gas flaring, and burning of biomass constitute the largest environmental health risk in Nigeria.[8]

Nigeria is the second largest crude oil producer in the continent of Africa.[9] Much of Nigeria's crude oil deposits are located in the Niger Delta region and the region is recognized as suffering gross environmental pollution from oil spills and crude oil processing.[10] These crude oil processing activities have resulted in significant environmental impact on the livelihood of communities in the Niger Delta region. It has been noted that the Niger Delta region is rated as one of the most oil spill vulnerable areas in the world with about 123 gas flaring sites in close proximity to residents of the host communities.[3] Specifically, studies indicate that in some communities in Rivers State, residents are unduly exposed to environmental pollutants due to illegal crude oil refining.[11] Affected communities such as the Eleme and it's close neighbours the Ogoni people have their farmlands, rivers and drinking well water polluted with crude oil related hydrocarbons.[3,8] Meanwhile, the mentioned communities still have pregnant women and children residing in the area. This increases the chance of exposure and possible ingestion of pollutants, especially the pregnant woman and her foetus.[12]

Pregnancy and it's outcome has become a crucial concerns in community midwifery practice.[13] This is because adverse events in pregnancy, foetal development, and birth remain one of the leading causes of newborn mortality worldwide.[14] About 7% of newborns in developed countries and 16% in developing countries would have low birth weight at the point of birth.[8] A study has also indicated that exposure to aromatic hydrocarbons increases the pregnant mother's risk of giving birth to a baby with congenital heart defect.[15] This has drawn the attention of researchers towards examining the pregnant woman's environment in search of possible environmental pollutants that could result in adverse newborn outcomes like preterm birth, low birth weight, birth asphyxia and congenital heart defects [15,16]

Literature indicated that aromatic hydrocarbons may affect pregnant women's inflammatory systems by increasing production of pro-inflammatory cytokines.[17] Benzene, toluene, ethylbenzene and xylene(BTEX) exposure have been reported to be associated with endocrine inflammatory biomarkers in the plasma of pregnant women.[17] Additionally, BTEX has been observed in the Niger Delta region of Nigeria, especially oil producing parts of Rivers State.[18] Other previous studies confirm crude oil pollution in Eleme.[19, 20] Earlier observations in Eleme, Rivers State, suggested poor local pregnancy outcomes.[8] Nonetheless, previous studies have not examined the impact of BTEX on birth outcomes.

BTEX is volatile and it's sources of exposure to airborne have been studied among pregnant mothers but limited literature measured the biomarkers in their urine, hence this study was carried out to bridge this identified knowledge gap. Given that crude oil pollution has been documented in Eleme in Rivers State but not in Umuahia South in Abia State, it was more appropriate to compare pregnancy outcomes in these communities.[19, 20] The objective of this study was to evaluate the impact of antenatal urinary concentration of monocyclic aromatic hydrocarbons biomarkers (BTEX) and birth outcomes among mothers residing in selected crude oil-host and non-host communities of Southern Nigeria.

MATERIALS AND METHOD

The study was a comparative prospective cohort design which involved two cohorts of pregnant women. One cohort was drawn from an oil-host community (Nchia in Eleme, Rivers State) and the other from a non-host community (Ubakala in Umuahia South, Abia State). Given that crude oil pollution has been documented in Eleme in Rivers State but not in Umuahia South in Abia State, it was more appropriate to compare birth outcomes in the mentioned communities[19, 20] Participants were enrolled during the third trimester of pregnancy (between 28 and 36 weeks of gestation) and were followed until delivery to obtain data on birth outcomes. Recruitment was conducted on designated antenatal clinic days when mothers presented for regular care visits at the Model Primary Health Care Centres during the study period (July 2024 to August 2025). Eligible participants who met the inclusion criteria and consented to the study were enrolled consecutively by convenience until the required sample size was reached. The use of this approach enabled steady participant enrolment while minimizing disruption to ongoing clinical activities.

The study population consisted of 191 pregnant mothers who were attending antenatal clinics at the selected Primary Health Care Centres in Nchia, Eleme (n = 102) and Ubakala in Umuahia South (n = 89) Local Government Areas of Rivers and Abia States, respectively. The sample size was determined using Cochran's (1977) formula for finite populations in comparative studies involving proportions after controlling for fallout or non-response. Cochran's (1977) formula for comparative cohort studies was mathematically expressed by Bolarinwa's published article as follows:[21]

$$n = \frac{N - [Z^2 \times P \times (1 - P)]}{K\,[(N - 1) \times e^2 + Z^2 \times P \times (1 - P)]}$$

Where:

n = Minimum sample size

K = Number of groups = 2

N is the finite population = 191

Z is the Confidence level from the z table (1.96)

P is the estimated proportion of the population (P = 0.5)

e is the desired level of precision or the margin of error (0.05)

The minimum sample size was computed to be 66 for each group. However, possible attrition in the study was managed by increasing the minimum sample size by 10% using the non-response formula described in Bolarinwa's article as follows: Final sample size = n / (1 – 0.1).[21] A final sample size of 146 pregnant mothers was used for the study (Eleme = 73 and Umuahia South = 73).

A convenience sampling technique was employed for this study. The method was considered the most feasible and contextually appropriate given the logistical, financial, and operational realities surrounding data collection. Applying convenience sampling ensured optimal utilization of available resources while preserving data quality and ethical integrity. This approach had been successfully adopted in a similar study in the Niger Delta by Oghenetega and colleagues, who faced comparable logistical and operational constraints. The data collection instrument was a structured Urinary Hydrocarbon Biomarkers and Birth Outcomes Data Collection Proforma developed by the researcher. The proforma was divided into three major sections (A–C) to capture relevant variables aligned with the study objectives. Section A (Demographic and Obstetric Characteristics) recorded background information such as age, occupation, weight, gravida, parity, and gestational age. These variables provided contextual data necessary for assessing exposure risk and confounding factors related to birth outcomes. Section B (Urinary Hydrocarbon Biomarker Concentrations) contained laboratory-derived measurements of hydrocarbon metabolites obtained from urine samples collected during the third trimester (28–36 weeks gestation). The analysis included total monocyclic aromatic hydrocarbons and individual BTEX compounds (benzene, toluene, ethylbenzene, and xylene) expressed in micrograms per litre (µg/L). Section C (Birth Outcomes) captured post-delivery data obtained from the delivery register at the health facilities. Parameters included type of delivery, baby condition at birth, presence of an obvious birth defect, birth weight, birth length, head circumference, and Apgar score. Each participant was assigned a unique follow-up code to maintain anonymity while allowing the linking of the antenatal and post-delivery data of same client.

Data collected through the proforma were coded, cleaned, and entered into the IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp..2017. Armonk. New York, USA) for analysis. Data was screened for completeness and consistency prior to analysis. The results were presented in tables and figures with corresponding descriptive and inferential statistics, as appropriate. All analyses were conducted using a significance level of 0.05. Descriptive statistics were used to summarise the socio-demographic characteristics of the participants, BTEX levels, and birth outcome variables. Inferential statistics were applied to test the hypotheses and determine the relationships between variables.

Ethical considerations

This study was approved by the Institutional Ethical Review Boards of the University of Port Harcourt (approval No: UPH/CEREMAD/REC/MM93/020), Rivers State Hospitals Management Board (approval No: RSHMB/RSHREC/2024/047) and Abia State Primary Health Care Development Agency (approval No: ABSPHCDA/AD/80/71). The study adhered strictly to the Declaration of Helsinki for studies involving human respondents.

RESULTS

Table 1 presents the demographic characteristics of participants and revealed that a total of 146 participants (73 in each group) provided urine samples for laboratory testing, but 136 completed the study (69 in Eleme oil-host community and 67 in Umuahia South non-oil host community). About 6% (n = 10) of the participants were lost in follow-up as they gave birth at home using the services of traditional birth attendants. The findings revealed that both groups had a mean age of approximately 29 years and had no significant difference in occupational distributions. Trading was the most common occupation in both groups. Additionally, no significant difference was observed for gravidity. Nonetheless, there was a significant difference in parity, where the oil-host community had a higher proportion of nulliparous women and the non-oil host community had a higher proportion of multiparous women.

Figure 1 shows the concentrations of BTEX compounds in urine samples of 73 pregnant women from Eleme (an oil-host community). The results indicated that xylene had the highest mean concentration at 0.21 ± 0.46 ppm, followed by toluene at 0.06 ± 0.09 ppm, benzene at 0.06 ± 0.07 ppm, and ethylbenzene at 0.04 ± 0.05 ppm. Xylene was the most abundant BTEX compound detected in the urine samples.

Table 2 presents birth outcomes among 69 mothers from Eleme (an oil-host community) and showed that the mean pregnancy duration was 38.8 ± 1.3 weeks. Most births were by spontaneous vaginal delivery (95.7%), while 4.3% had caesarean births. Documented birth complications included postpartum haemorrhage (15.9%), preeclampsia (8.7%), and maternal Exhaustion (4.3%), with 71.0% experiencing no complications. Among newborn outcomes, the mean birth length was 47.6 ± 3.0 cm, head circumference was 32.8 ± 2.0 cm, birth weight was 3.1 ± 0.6 kg, and the Apgar score at 5 minutes averaged 8.6 ± 0.6.

Figure 2 presents the concentrations of BTEX compounds in urine samples of 73 pregnant women from Umuahia South (non–oil-host community), measured in parts per million (ppm). The results showed that xylene had the highest mean concentration at 0.15 ± 0.33 ppm, followed by ethylbenzene at 0.03 ± 0.04 ppm, toluene at 0.03 ± 0.02 ppm and benzene at 0.02 ± 0.01 ppm. Thus, xylene was the most predominant BTEX compound detected in the urine sample.

Table 3 presents birth outcomes among 67 mothers from Umuahia South (a non–oil-host community). The mean pregnancy duration was 39.3 ± 1.6 weeks. All mothers (100%) had spontaneous vaginal births, with no caesarean births recorded. There were no reported birth complications. Among newborn outcomes, the mean birth length was 49.0 ± 1.2 cm, head circumference was 33.7 ± 1.4 cm, birth weight was 3.2 ± 0.4 kg, and the Apgar score at 5 minutes averaged 8.9 ± 0.4.

Table 4 compares BTEX concentrations in urine samples of pregnant women from Eleme (oil-host community) and Umuahia South (non–oil-host community) using an independent sample t-test. Significant differences were observed in urinary benzene (*$t = -3.88$, $p = <0.001$*) and Toluene (*$t = -2.19$, $p = 0.03$*) concentrations. Urinary Ethylbenzene and Xylene concentrations did not differ between groups (*$p > 0.050$*).

Table 5 presents a comparison of birth outcomes between mothers in Eleme (oil-host community, n = 69) and Umuahia South (non–oil-host community, n = 67) using t-tests and chi-square analyses. The mean pregnancy duration was significantly shorter in Eleme (38.8 ± 1.3 weeks) than in Umuahia South (39.3 ± 1.6 weeks, p = 0.030). Although all mothers in Umuahia South had spontaneous vaginal births, 4.3% of Eleme mothers had caesarean births ($\chi^2 = 2.98$, p = 0.084). Birth complications were significantly higher in Eleme ($\chi^2 = 22.77$, p < 0.001), with postpartum haemorrhage (15.9%), preeclampsia (8.7%), and maternal distress (4.3%) reported as against no birth complication in umuahia south. For newborn outcomes, infants in Eleme had significantly shorter body lengths (47.6 ± 3.0 cm vs. 49.0 ± 1.2 cm, p < 0.001), smaller head circumferences (32.8 ± 2.0 cm vs. 33.7 ± 1.4 cm, p = 0.030), and lower Apgar scores (8.6 ± 0.6 vs. 8.9 ± 0.4, p = 0.003). Nevertheless, birth weight did not differ significantly between the groups (p = 0.344).

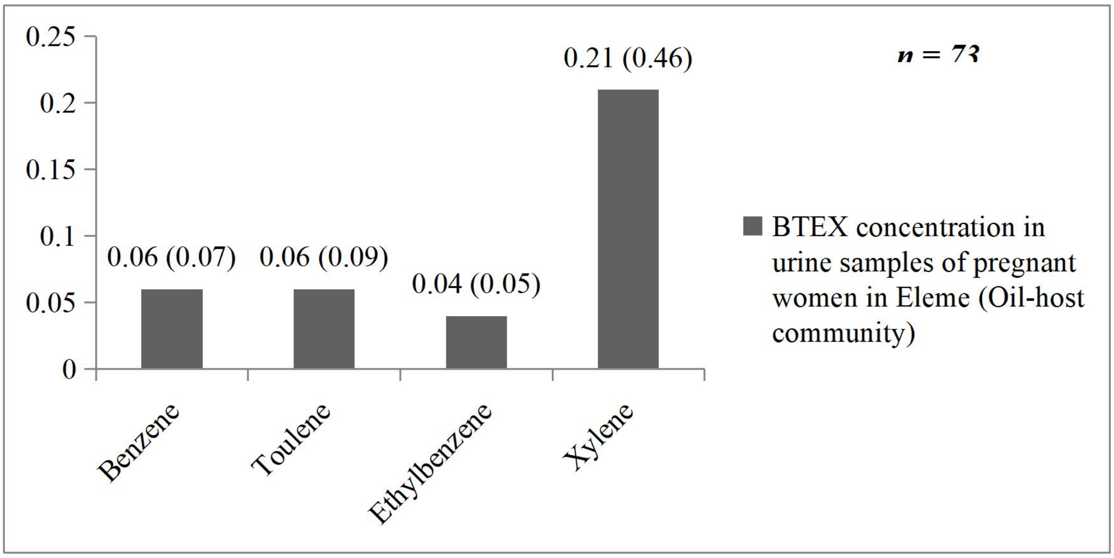

Figure 1: **The BTEX concentration in urine samples of pregnant women in Eleme (oil-host community)**

Table 1: Socio-demographic characteristics of the study participants (n = 146)

Variable	Eleme (Oil Host community, n = 73)		Umuahia South (Non-oil Host Community, n = 73)		p value
	f (%)	Mean (SD)	f (%)	Mean (SD)	
Age					0.59
20-29	26 (35.6)		32 (43.8)		
30-39	44 (60.3)		38 (52.1)		
40-49	3 (4.1)		3 (4.1)		
Mean		29.4 (4.7)		29.7 (4.5)	0.65
Occupation					
Student	3 (4.1)		0 (0.0)		0.09
Artisan (Apprentice)	12 (16.4)		8 (11.0)		
Seamstress	11 (15.1)		9 (12.3)		
Civil Servant	8 (11.0)		15 (20.5)		
Unemployed (Stay at home wife)	12 (16.4)		21 (28.8)		
Trading	27 (37.0)		20 (27.4)		
Gravidity					0.05
Primigravida	42 (57.5)		29 (39.7)		
Multigravida	28 (38.4)		35 (47.9)		
Grand multigravida	3 (4.1)		9 (12.3)		
Parity					0.03
Nullipara	42 (57.5)		29 (39.7)		
Primipara	0 (0.0)		3 (4.1)		
Multipara	31 (42.5)		41 (56.2)		

% = percent, f = frequency, M = mean, SD = standard deviation, n = sample size , p-value < 0.05 = Significant

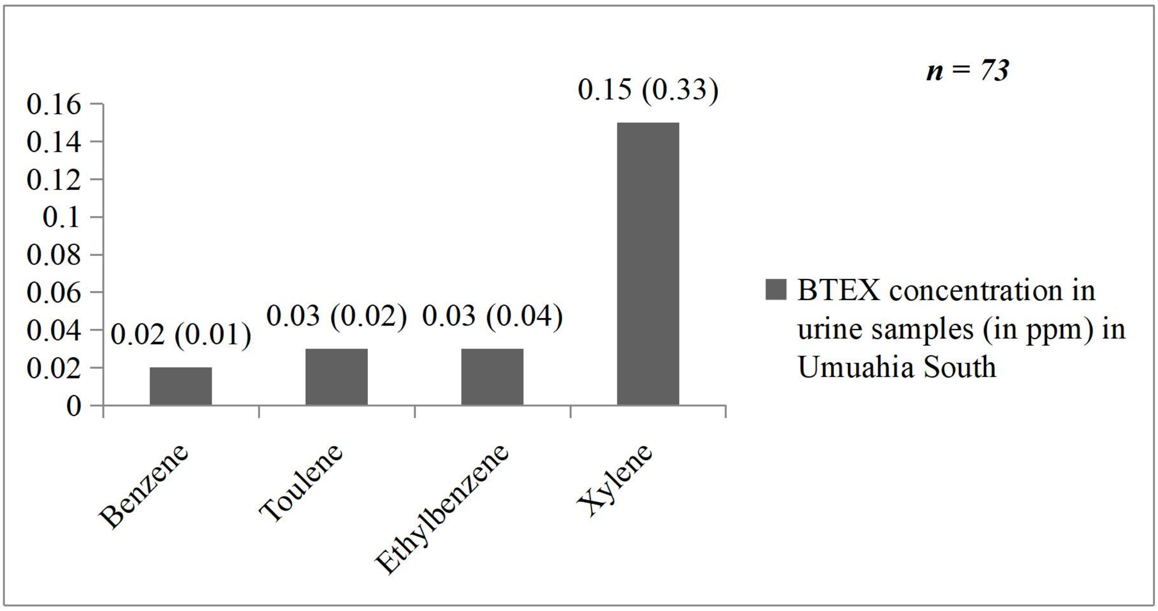

Figure 2: **The BTEX concentration in urine samples of pregnant women in Umuahia South (non oil-host community)**

Table 2: **Birth outcomes among the mothers in Eleme (crude oil-host community)**

Variable	Eleme (Oil Host community, n = 69)	
	f (%)	**Mean (SD)**
Maternal outcomes		
Pregnancy duration		38.8 (1.3)
Mode of birth		
Spontaneous vaginal birth	66 (95.7)	
Cesarean birth (C/S)	3 (4.3)	
Birth Complication		
Postpartum Haemorrhage	11 (15.9)	
Preeclampsia	6 (8.7)	
Maternal Exhaustion	3 (4.3)	
None	49 (71.0)	
Newborn Outcomes		
Length (in cm)		47.6 (3.0)
Head circumference (in cm)		32.8 (2.0)
Birth weight (in kg)		3.1 (0.6)
Apgar score at 5 minutes		8.6 (0.6)

% = percentage, f = frequency, SD = standard deviation, n = sample size

Table 3: Birth outcomes among the mothers in Umuahia South (non oil-host community)

Variable	Umuahia South (Non Oil Host community, n = 67)	
	f (%)	**Mean (SD)**
Maternal outcomes		
Pregnancy duration		39.3 (1.6)
Mode of birth		
Spontaneous vaginal birth	67 (100.0)	
Caesarean birth(C/S)	0 (0.0)	
Birth Complication		
Postpartum Haemorrhage	0 (0.0)	
Preeclampsia	0 (0.0)	
Maternal exhaustion	0 (0.0)	
None	67 (100.0)	
Newborn Outcomes		
Length (in cm)		49.0 (1.2)
Head circumference (in cm)		33.7 (1.4)
Birth weight (in kg)		3.2 (0.4)
Apgar score at 5 minutes		8.9 (0.4)

% = percentage, f = frequency, SD = standard deviation, n = sample size

Table 4: Independent sample t-test for difference in BTEX levels between urine samples collected from pregnant mothers at Eleme (oil-host community) and Umuahia South (non oil-host community)

Monocyclic Aromatic Hydrocarbon	Eleme (oil-host community, n = 73)	Umuahia south (non- oil-host community, n = 73)	t test	p
	mean (SD)	mean (SD)		
Benzene	0.06 (0.07)	0.02 (0.01)	-3.88	**<0.001**
Toulene	0.06 (0.09)	0.03 (0.02)	-2.19	**0.030**
Ethylbenzene	0.04 (0.05)	0.03 (0.04)	1.97	0.051
Xylene	0.21 (0.46)	0.15 (0.33)	0.98	0.327

SD = standard deviation, n = sample size, p < 0.05 =significant

Table 5: T-test of difference in birth outcomes between mothers in Eleme (oil-host community) and Umuahia South (non oil-host community)

Variable	Eleme (Oil Host community, n = 69)		Umuahia South (Non Oil Host community, n = 67)		t-test	Chi-squared	p
	f (%)	**Mean (SD)**	**f (%)**	**Mean (SD)**			
Maternal outcomes							
Pregnancy duration		38.8 (1.3)		39.3 (1.6)	2.19		0.030
Mode of birth						2.98	0.084
Spontaneous vaginal birth	66 (95.7)		67 (100.0)				
Caesarean birth	3 (4.3)		0 (0.0)				
Birth Complication						22	**< 0.001**
Postpartum Haemorrhage	11 (15.9)		0 (0.0)				
Preeclampsia	6 (8.7)		0 (0.0)				
Maternal exaushtion	3 (4.3)		0 (0.0)				
None	49 (71.0)		67 (100.0)				
Newborn Outcomes							
Length (in cm)		47.6 (3.0)		49.0 (1.2)	3.72		**<0.001**
Head circumference (in cm)		32.8 (2.0)		33.7 (1.4)	2.99		**0.030**
Birth weight (in kg)		3.1 (0.6)		3.2 (0.4)	-0.95		0.344
Apgar score at 5 minutes		8.6 (0.6)		8.9 (0.4)	-3.03		0.003

% = percentage, f=frequency, SD=standard deviation, n=sample size, p-value<0.05 =significant

DISCUSSION

The study revealed that xylene had the highest mean urinary concentration in both communities (Eleme and Umuahia south) but higher levels were observed in Eleme an oil- host community. Thus, xylene was the most predominant BTEX compound detected in the urine samples of pregnant women in the oil-host and non-oil host communities. This finding suggests that the participants were exposed to mixed aromatic hydrocarbons, with xylene being the dominant pollutant absorbed and excreted. The elevated urinary concentration of xylene may be attributed to its high environmental prevalence in crude oil–producing regions such as Eleme and its rapid absorption through inhalation and dermal contact pathways. Furthermore, domestic and occupational exposure sources, such as the burning of fossil fuels and petrochemical emissions could have intensified xylene levels. The current study revealed substantially higher xylene and toluene values in Eleme compared with the levels observed among pregnant women in Wang and colleagues' study which were much lower, ranging around trace levels below 0.01 mg/L. This discrepancy may arise because his study participants were in urban hospital settings where exposure control and environmental monitoring were more stringent.[15] Additionally, the observed lower BTEX levels in Umuahia South (a non-oil-host community) indicates that although the women were not residing in areas directly affected by crude oil extraction, measurable levels of hydrocarbon metabolites were still present in their urine. The detection of these levels suggests background environmental exposure, likely through urban emissions, vehicular exhaust and household cooking with kerosene. The finding implies that low-level hydrocarbon exposure is not limited to oil-producing regions. It can also occur in non-industrial areas due to widespread human activities and environmental persistence of volatile organic compounds. The relatively low mean value compared to that reported in oil-host regions may reflect reduced direct environmental contamination.

Findings on the birth outcomes revealed that mothers residing in Eleme (an oil-host community) had a lower mean pregnancy duration, majority of births were through spontaneous vaginal delivery, while 4.3% had caesarean delivery. Birth complications included postpartum haemorrhage, pre-eclampsia and maternal exhaustion. For neonatal outcomes, the mean birth length, head circumference, birth weight and Apgar score at five minutes were lower than measurements in Umuahia south. The relatively shorter birth length and lower head circumference imply mild foetal growth impairment, which may be associated with maternal exposure to hydrocarbons. Hydrocarbon exposure has been shown to induce oxidative stress and interfere with placental function, leading to reduced oxygen and nutrient transport to the foetus. Rahman's study also reported a lower birth weight which align with findings in this present study.[23] This similarity in findings may be explained by comparable mechanisms of foetal growth suppression from chronic maternal exposure to environmental hydrocarbons. In contrast, a higher mean birth length and birth weight was observed among pregnant women in South Korean.[24] The discrepancy may be from markedly lower pollutant levels in the South Korean cohort, reflecting stronger environmental regulations and reduced crude oil exposure.

In Umuahia South (a non–oil-host community), findings in the birth outcomes revealed a higher mean pregnancy duration with 100% spontaneous vaginal deliveries and no reported birth complications. Newborn outcomes indicated a higher mean birth length, head circumference, birth weight, and 5-minute Apgar score. These outcomes suggest that pregnancies in the non–oil-host community progressed normally, with healthy maternal and neonatal parameters comparable to expected obstetric norms. This finding implies that the mothers experienced pregnancies within safe physiological limits, likely supported by lower environmental hydrocarbon exposure. The absence of birth complications indicates minimal exposure to toxic pollutants capable of disrupting placental function, oxygen transport, or foetal growth. Similarly, Lamichhane and colleagues found a high value in mean birth weight close to this study's 3.2 kg mean.[24] The similarity reinforces that reduced hydrocarbon exposure supports optimal foetal growth and birth outcomes. This finding implies that residing in low-pollution, non-oil-host environments supports healthier pregnancies, minimizes obstetric complications, and enhances neonatal outcomes by reducing toxicant-related stress on maternal and foetal systems.

Comparison of the urinary BTEX concentrations among pregnant women from Eleme (an oil-host community) and Umuahia South (a non–oil-host community), revealed significant differences in urinary benzene ($t = -3.88$, $p < 0.001$) and toluene ($t = -2.19$, $p = 0.03$) levels between the two groups. This means that pregnant women residing in the oil-host community of Eleme had higher benzene and toluene concentrations in their urine, recorded at approximately 0.06 mg/L each. This finding implies that environmental hydrocarbon contamination is more intense in oil-producing areas, possibly due to frequent oil leaks, gas flaring, and ambient air pollution from petrochemical activities Similarly, a significant links was found between ambient BTEX exposure and preterm birth in Detroit, where estimated exposure ranged around 0.03 mg/L for benzene and toluene.[17] The current study's higher urinary concentration align with Cassidy-Bushrow's findings, supporting that BTEX exposure at or above this threshold can produce biologically relevant maternal effects. The similarity may be explained by comparable levels of industrial pollution and residential proximity to emission sources. Contrast to this finding, a study in Philadelphia observed no significant association between BTEX and preterm birth.[23] The discrepancy may be due to Nigeria's poorly regulated oil operations and likely reflects better pollution monitoring systems in the USA. In general, this finding implies that pregnant women living in crude oil-host environments face disproportionately higher hydrocarbon exposure risks, which may increase their vulnerability to toxic pregnancy outcomes such as preterm delivery, low birth weight, and postpartum complications.

The study also compared difference in birth outcomes between mothers in oil-host and non- oil host at follow-up revealed that mothers residing in Eleme (oil-host community) exhibited poorer pregnancy and birth outcomes compared with those in Umuahia South (non–oil-host community). Significant differences were found with new born in Eleme having shorter body lengths ($p < 0.001$), smaller head circumferences ($p = 0.030$), and lower Apgar scores ($p = 0.003$). However, no significant difference was observed in birth weight. This finding suggests that residence in oil-host communities such as Eleme is associated with increased risk of adverse maternal and neonatal outcomes. One possible explanation is the elevated exposure of mothers in Eleme to environmental hydrocarbons, with a higher total urinary hydrocarbon concentration which could induce oxidative stress and endocrine disruption during pregnancy. A similar pattern was observed by Oghenetega and colleagues, who reported a significantly higher risk of postpartum haemorrhage and premature rupture of membranes among women living in high oil-exposure areas.[3] Similarly, Freije and colleagues observed that higher second-trimester urinary hydrocarbon concentrations were linked to spontaneous preterm birth corroborating the reduced gestational duration observed in Eleme in this study.[26] The similarity supports the hypothesis that hydrocarbon metabolites impair placental function, promoting early delivery. The divergence in outcomes could stem from the comparatively lower exposure intensity in South Korea and stricter environmental regulations limiting emissions. Therefore, the present study's finding implies that maternal residency in hydrocarbon-polluted environments may be a risk factor for elevated delivery complications, and compromised neonatal well-being. This highlights a pressing need for targeted environmental health interventions in oil-producing communities.

CONCLUSION

This study investigated urinary levels of monocyclic aromatic hydrocarbons and their association with birth outcomes among pregnant mothers in Eleme (an oil-host community) and Umuahia South (a non–oil-host community). The findings revealed measurable urinary concentrations of BTEX compounds in both groups, with significantly higher levels of benzene and toluene in Eleme. These results indicate greater environmental exposure to petroleum-related hydrocarbons in oil-host areas, likely due to ongoing crude oil extraction and industrial activities. Birth outcome analysis showed that mothers in Eleme experienced shorter pregnancy duration, higher rates of obstetric complications, and less favourable neonatal measurements compared to those in Umuahia South. The data suggest that environmental hydrocarbon exposure may contribute to adverse pregnancy and neonatal health effects. Despite variations in exposure and outcomes, both communities exhibited detectable BTEX compounds, reflecting the pervasive nature of environmental pollution. The study provides baseline biological evidence of hydrocarbon exposure among pregnant women in Nigeria and underscores the need for continuous environmental monitoring, improved maternal health surveillance, and pollution control measures. Overall, the results emphasize the potential reproductive health risks of living in oil-exploration zones and highlight the necessity for public health interventions targeting vulnerable populations.

Limitations of the study

This study has two notable limitations. Firstly, the research relied on urine samples collected at a single point in time (third trimester), which limits the ability to establish a temporal or causal relationship between hydrocarbon exposure and birth outcomes. Short-term fluctuations in exposure due to environmental or behavioural changes may not have been captured, potentially leading to underestimation or overestimation of actual exposure levels throughout pregnancy. Repeated sampling over the trimesters could have provided a more accurate exposure profile. Nevertheless, doing this was not feasible due to the high logistics cost and the price of laboratory analysis per sample.

Secondly, the study was limited by its relatively small sample size and focus on two specific communities (Eleme and Umuahia-South). This restricts the generalizability of the findings to other oil-host or non-oil-host populations in Nigeria. Additionally, potential confounding factors such as height of the mothers, dietary habits, occupational exposure, and household fuel use were not controlled. The confounders may have influenced urinary BTEX concentrations. These factors introduced possible biases that should be addressed in future, larger-scale, multi-site investigations.

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Conflict of interest:

There are no conflicts of interest.

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