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RESEARCH ARTICLE

A qualitative study on the morbidity experiences of under-five children in oil spill communities

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Abstract: Introduction: Under-five years old (U5) children that reside in oil spill communities are exposed to various pollutants, and therefore are prone to respiratory symptoms and diseases. This study aimed to develop a deeper understanding on the lived experiences of U5 children residing in these communities. Methods: The study was done in August, 2022 , on eleven caregivers/parents of U5 children, aged 26-45 years old via purposive sampling. This study utilized a phenomenological research design through in-depth interviews and audio recordings. Results: Findings revealed that numerous oil spills have occurred, and are still occurring. According to the respondents, these spills are caused majorly by poor maintenance of old, rusted pipelines of oil companies; and pipeline vandalism, leading to land, water and air pollution. Results also showed that these spills have led to several adverse respiratory health (RH) experiences in U5, including cough, catarrh, chest pain and other health emergencies that have resulted in frequent hospital visitations and admissions like difficulty/fast breathing, pneumonia, hemoptysis, exacerbation of previously existing conditions, asthma development, *etc*. The destruction of their source of livelihood, have contributed to worsening these symptoms. Conclusion: U5 children living in crude oil polluted areas are burdened with a high prevalence of respiratory symptoms and diseases. Implementation of already existing regulatory laws on oil pollution, prompt clean-up of oil spills, provision of standard health facilities, and trained health personnels, were some of the measures recommended to curb the menace of crude oil spills and its RH effects.

Keywords: respiratory health, under-five children, phenomenology, crude oil spill, air quality

1 Introduction

Crude oil is the world's main energy source [1]. It consists of hydrocarbons with differing molecular weights and trace amounts of heavy metals [1–5]. More than 550 million gallons of oil have been spilled from 1958 to 2010 with about 11million gallons of oil spilled per year [6]. The discovery of crude oil in the 1950s in commercial quantities has negatively impacted on the lives and livelihood of the inhabitants of the Niger Delta region of Nigeria. They are faced with myriads of problems which include poverty, biodiversity loss, water, land and air pollution, disease and death [7]. The Niger Delta region of Nigeria has numerous pipelines through which crude oil and other petroleum products are conveyed to every part of the nation. These pipes get corroded when not well maintained and sometimes sabotaged, thus resulting in oil spillages and environmental pollution. Oil spillage can therefore be defined as the release of crude oil into the natural environment with its attendant problems [8]. The once beautiful region of Niger Delta that was naturally endowed with the tropical rain forest, and swamps and home to different plants and animal species, with clean air, is now characterized by contaminated water ways, polluted air, and loss of biodiversity [9, 10].

Spills occur for many reasons. Oil is spilt into the environment (land or oceans) either naturally or via anthropogenic activities which may be intentional or accidental. In the Niger Delta, spills usually occur and linger as a result of corroded old pipelines due to lack of maintenance, pipeline vandalism, slow and bureaucratic procedures in implementing the already existing clean-up protocols, difficulty in getting to spills sites, community hostility, *etc*. [6]. Developing countries are faced with issues of neglect and ill-treatments as these spills are seldom reported. When reported, concise efforts are not usually made to restore the ecosystem system to its original state [11].

Oil spilled into the environment undergo a series of compositional changes known as weathering [12, 13]. They include physical, chemical and biological processes. Some of the spilled oil evaporates and aerosolizes due to its high volatility. Some crude oil spills can result in fires/explosions thereby releasing toxic chemicals into the air and reducing the quality of air that we breathe in [14]. The weathering processes (evaporation and aerosolization) of spilt oil leads to the reduction of the concentration of the toxicants (crude oil) in its liquid state in the environment and the formation of new compounds that pollutes the ambient air [12]. This can then result in harmful effects on the human RH [15, 16]. The air inhaled in the areas affected by oil spill is usually not clean and safe as it contains components of crude oil that exceeds the recommended World Health Organization (WHO) air quality guidelines and the Clean Air Act of the National Ambient Air Quality Standards (NAAQS) [17].

According to the World Health Organization (WHO), globally, it is estimated that more than 6.9 million people die yearly as a result of air pollution with greater than 90% of the world population inhaling contaminated air with concentrations that surpasses the acceptable WHO limits [18]. Ambient air pollution (AAP) is responsible for the deaths of about 4.1 million people globally in 2016, and this was predominantly due to exposure to fine PM ($PM_{2.5}$) that resulted in respiratory and cardiovascular diseases, and cancers [19]. AAP is in fact a major environmental and public health issue affecting the populace, especially, the U5 children [18]. Globally, about 630 million U5 children are exposed to air pollution level above the WHO air quality guidelines [20, 21]. Environmental factors indeed affect the health of children, with 26% of all under five deaths attributable to the environment [21].

Respiratory disease is the leading reason for mortality and morbidity around the world, with higher susceptibility found in infants and young children [22]. Many environmental risks are implicated in this. Children that are five years old and below have been shown to have more severe respiratory symptoms and illnesses than older children and adults when exposed to crude oil spills and its components. In a study conducted by Noh and colleagues, children that were exposed to Hebei Spirit oil spill had higher prevalence of respiratory tract infections (RTI), and developed asthma symptoms [23]; there are several reasons to back this up. The physiological make-up of children makes them more susceptible to respiratory diseases when exposed to crude oil [24]. Their bodies are less efficient in detoxifying environmental chemicals [23], they do not recognize dangers and sources of air pollution and so can be in harms' way. They are also physically active, breathe in more air per minute, and spend enough time playing outdoors [21].

Epidemiological studies on the respiratory health outcomes associated with exposures to crude oil spills among children limited. A study by Noh and colleagues revealed a significant relationship between exposure to crude oil spill and asthma in children [23] and another study also showed that children who lived in close proximity to oil spill sites had reduced lung volumes and greater prevalence of allergic rhinitis, when compared to those residing at a greater distance from the spill [25].

There is paucity of data on the impact of crude oil spill on U5 RH in developing countries, including Nigeria. This study therefore, qualitatively assessed the impact of crude oil spills on the RH of U5 children residing in oil spill impacted communities through their experiences.

2 Materials and methods

2.1 Study area

The Niger-Delta, which is the seat of oil activities in Nigeria, is situated in the South-South geopolitical zone of the country. It is a fan-shaped, low-lying landform area with approximately 70,000 km^2 in land mass, draining two major 2 rivers, the Benue River and the Niger River into the Atlantic Ocean [6, 26]. This study was conducted in Bodo and K Deere communities in Gokana local government area (LGA) of Rivers State. Bodo is an oil impacted community that was founded in about 1650 [27]. It is located within Latitude 4° $37'$ North of the equator and longitude 7° $16'$ east of the meridian. More than 60% of Bodo is the Bodo Creek which comprises of brackish water creeks, and mangrove swamps forests [27]. K Deere is also an oil-impacted community located within 4.6568° N, 7.2518° E.

2.2 Study design

A phenomenological study design was used in this study to describe the lived experiences [28].

2.3 Participants and recruitment

A purposive sampling approach was used to recruit the participants and the maximum variation sampling variant was used to recruit widespread interviewees that rendered adequate information necessary for the project. A semi-structured in-depth interview was conducted with

the caregivers/guardians/parents whose children were study participants. The interview focused on oil spills experiences but also contained information on respiratory health experiences, environmental effects and suggestions on ways to curb the menace of crude oil spill. We therefore used thematic saturation to determine the sample size. Thematic saturation may be defined as the point where no additional insights are gotten during data collection, rather a repetition of data is observed, implying that an adequate sample size has been reached [29]. Eleven (11) caregivers (parents/guardians) were randomly recruited into the study. Those recruited had stayed in the community for a minimum of one year and caregivers of U5 children with neurological and congenital disorders were not recruited. All interviews were conducted in the native languages of Bodo and K-Deere people and transcribed into English language. These interviews took place in August, 2022.Both the participants and the researcher were alone during the interviews. Interviews were audio recorded, intelligent verbatim transcription was done into their native languages, and subsequently translated into English. Interview questions were developed by the researcher to elicit the necessary responses.

Prior to the interview, study participants were given a brief questionnaire to fill in their socio-demographic data. An informed consent was also obtained from participants. Participants' names were not included on transcriptions to maintain anonymity. Approximately 30 minutes was used for each interview.

2.4 Data analysis

We familiarized with the transcripts and generated initial codes. We searched for themes and sub-themes and reviewed them. We then defined and named the themes and sub-themes before we proceeded in producing a report [30].

To ensure trustworthiness of the data, member checking was done as feedback was obtained from the study participants. Identified themes, sub-themes and quotes were reviewed by the study participants. Issues and discrepancies observed were reviewed. Peer examination was also done to improve the credibility of the study. Triangulation of investigators was another method employed in ensuring confirmability.

2.4.1 Example of interview questions

1. Have you experienced oil spills in the past year in K Deere or Bodo in the Niger Delta? If yes, tell me about the oil spill you experience.
2. How has your community been affected by the spills?
3. How has the spill affected your source of livelihood?
4. Do you believe that oil spills have affected the air quality in the community? If yes, throw more light.
5. Do you think oil spillage has affected your children's health? If yes, how?
6. Please describe any health care and treatments you sought after being affected by these spills.
7. Do the seasons (dry or wet) worsen the respiratory symptoms?
8. Describe your feelings regarding the spills in the Niger Delta?
9. What are your suggestions to prevent or reduce these spills in the Niger Delta?
10. What are your suggestions to improve the children's health and in particular their respiratory health?

2.4.2 Socio-demographic characteristics of Parent/Guardian

1. Gender: 1. Male 2. Female
2. Age at last birthday: .....
3. Educational level: 1. None 2. Primary 3. Secondary 4. Tertiary 5. Post Graduate
4. Occupation: 1. Professional (Doctor, Lawyer, Surveyor, Engineer, Banker) 2. Civil Servant 3. Fishing/Farmer 4. Artisans 5. Others (specify .....)

2.5 Ethical consideration

The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the "Ethical Review Board of University of Port Harcourt, Port Harcourt, Rivers State, with approval number UPH/CEREMAD/REC/MM79/031". Approval was given on the 24th of August, 2021. Taking part in the study was made optional and research subjects were referred to anonymously throughout the study. A written consent was obtained from the participants before they were interviewed. The participants were informed that they had the freedom to withdraw at any point during the interview. All participants were safe.

3 Results

The descriptive statistics for socio-demographic characteristics of the caregivers are shown in Table 1.

Table 1 The socio-demographic characteristics of the guardians/parents/care givers

Characteristics	Frequency (n=11)	Percentage (%)
Age of Parent		
26-30 years	1	9.1
31-35 years	1	9.1
36-40 years	6	54.5
41-45 years	3	27.3
Sex of Parent		
Male	6	54.5
Female	5	45.5
Educational Level		
None	1	9.1
Primary	3	27.3
Secondary	5	45.5
Tertiary	1	9.1
Post Graduate	1	9.1
Occupation		
Civil servant	2	18.2
Fisherman/Farmer	6	54.5
Artisan	3	27.3

Table 1 shows that 27.3% of parents/guardian surveyed were 41-45years old, 54.5% were 36-40years old, 9.1% were 31-35years old and 9.1% were 26-30years old. While 54.5% were males, 45.5% were females.

Parents/Guardians with no education were 9.1%. While 27.3% had primary school education, 45.5% had up to secondary education, 9.1% had tertiary education, and 9.1% had post-graduate education. 18.2% were civil servants, 54.5% were fishermen/farmers and 27.3% were artisans.

3.1 Report on the qualitative data

The responses of participants were coded into major themes and sub-themes. Four major themes and ten sub-themes were identified. The major themes were: Crude oil spills, Environmental effects, Respiratory health effects and Recommendations. Each major theme had sub-themes. The sub-themes for crude oil spills were Experience and causes of the oil spills; for environmental effects, the sub-themes included air quality, water quality and land quality; for respiratory health effects, the sub-themes were: respiratory symptoms, exacerbation of respiratory diseases and frequent hospital visits; and for recommendation as a major theme, the sub-themes included recommendations on reducing/stopping the spills and recommendations on improving the respiratory health of the children. A description of the identified theme and sub-theme, followed by quotes that reflect perspectives associated with each of them and sub-theme are stated below.

3.1.1 On crude oil spills

The respondents shared their experiences on the oil spills they witnessed in their communities, what caused these spills and how it impacted them negatively. It was clear from the interviews that the respondents had a horrible and devastating experience that affected their lives. Most respondents shared similar experiences on the spills and the cause.

(1) On experience

A respondent said:

"... Yes I have. I have experienced oil spill that happened in my community, Bodo in 2008, 2011, 2019 and twice this year 2022. They were so devastating. There was an intense fire outbreak at the scene of the incidence, the explosion of the pipeline got people scared. Following the incident, there were thick fumes and soot in the air. The fire kept burning for days and this was associated with severe heat that destroyed wildlife and some people lost their lives. The spillage caused a lot of tension in the community, residential areas were affected and people were internally displaced like the one that happened last month (August, 2022)."

Another respondent shared his experience:

"... it affected the creeks, our waterways, the soil and even the air. This was also associated with fire outbreaks. It was so scary because of the flames. The fire was so huge and hot. Thick plumes of smoke and soot swept across the community. The incident led to the displacement of

so many people as their homes were destroyed. Due to the thick smoke, the oil and the fire, so many crops and our farmlands were destroyed. The community has been affected negatively by these spills because it keeps occurring and it affects every area of our lives…".

(2) Causes of oil spills

In terms of the causes of crude oil spills, the most frequently identified causes of oil spills were pipeline vandalism, old and rusted pipelines due to poor maintenance leading to spills and consequently explosions.

A. On poor maintenance

One of the respondents said:

"… Yes. I have experienced oil spills at Gbaa Kpogoro, Numuu Ali, Nummu Tekuru and others that happened in my community. One of these spills was a result of pipeline explosion due to rusted pipelines. Maintenance of these pipelines were not done at the appropriate time. This resulted in leakage of crude oil, which exploded and caused great havoc...".

Another respondent had a similar opinion:

"… Yes, I have at Nummu Ali in Bodo community and many other creeks in the community. This occurred along the oil pipelines. These pipelines were worned out and olds, this led to the oil spill at various spots. These pipelines run across the community to Bonny. The spill was so massive...".

B. On pipeline vandalism

A respondent said:

"… Some of the spills were due to old pipelines, while some were as a result of pipeline vandalism. Due to hunger caused by pollution of the lands and waterways by previous spills , with nothing done to clean it up, the only alternative is to vandalize these pipelines, take the oil and either sell the crude oil or cook the oil *i.e.* bunkering (artisanal refining) …".

A respondent with a similar opinion said:

"… The spill was a result of pipeline vandalism. The youths in a bid to make money to care for themselves and their families because of the destruction of their farmlands and waterbodies, destroyed the already weakened and old pipelines and fetched the crude oil to sell…".

3.1.2 Environmental effects or destruction of the biosphere

All participants acknowledged that the crude oil spill has impacted negatively on the environment. Most of the respondents who are fishermen/farmers (54.5%) also identified that the destruction of the environment has led to the destruction of their source of livelihood.

(1) On air quality

All respondents recognized that there was indeed a decline in the quality of air that they breathe, as a result of the oil spills.

A respondent said:

"… Yes, it has indeed affected the air. When there is pipeline explosion and the oil spills, there is fire outbreak that generates a lot of smoke, thick black smoke, that you cannot even see through it. In addition, the smell of the crude oil is unpleasant. Our air is constantly smelling of crude oil because of the recurring spills. It is really affecting us…".

Another respondent shared a similar opinion:

"… Yes, the air is affected. This is because the crude oil contains gases which I think are poisonous. The smell of these gases emitted from the crude oil chokes. Also, the thick black smoke released into the atmosphere from the explosion and burning of the crude oil affects the air in our community as it causes black soot to fall from the sky and we inhale it...".

A participant commented that the air is foggy as if it is harmattan and cloudy due to the thick smoke:

"… Yes, it definitely has. Look at the air for yourself, it is cloudy. Early in the morning it is foggy as if there is harmattan. Are you not perceiving the smell of crude oil? Then imagine when there is an explosion of a pipeline, and thick smoke everywhere. Every day of our lives, our air smells of crude oil, because of the spills that have occurred. Nothing much has been done about them, and we are still experiencing oil spills. Our air is no more fresh, clean and pure…".

(2) On Water quality

All participants recognized and acknowledged that oil spills have negatively affected their water, and most of them agreed that their sources of livelihood were affected.

A respondent commented:

"… the fishes and other sea foods like the periwinkle and the shrimps have become scarce commodities and very expensive. There is poverty in the land. We are suffering. People are

frequently falling sick and dying. So many people are dying of cancer, and they don't grow old as before. The drinking water from the wells are brownish because the water underground has been contaminated by the crude oil."

Another respondent had similar opinion:

"... It has caused various harm to the community. Our coastal borders have been destroyed. There are no more beach parties because the sea shores have been drastically affected. Oil is floating on the water. We cannot swim in the water like we used to because when you do, the oil settles on your skin and it itches a lot. Apart from that, the oily water can enter your eyes, mouth and nose and it is very irritating. It is not easy to catch crabs, periwinkles and fishes like it used to be. Some of the fishes have gone extinct and the mangroves are coated with oil, this causes them to die off. Even the salt water that we used to boil to make salt, we cannot do it again because of the oil...".

(3) Oil spills have also affected the lands

There was a recognition among participants that oil spills and pollution affected the lands and soils thereby destroying their crop produce, polluting the underground water. According to some participants, the land is soaked with oil and discoloured because of the oil.

A respondent said:

''... I am a farmer and also a fisherman. My farm has been destroyed because of the spills. It is from the farm that I feed my family and I sell some of the crops I grow, but because of oil spills, our food crops wilt making them lose their value, and taste...".

Another respondent gave a similar opinion:

"... Oil spill has destroyed our farmlands and mangroves and has also caused a reduction of the agricultural productivity of the people. The land is laid bare.... The land turned brownish after the spills, grasses died immediately.... The land has become barren. Crops are not growing well. The leaves of our crops are covered with soot and some are even oily and that's what we have to eat. I have lost my means of livelihood and I have no means of feeding my children well as they should be cared for...".

3.1.3 Opinions on the respiratory health effects

The participants acknowledged that oil spills have negatively affected the respiratory health of U5 children and this was discussed under the following sub-themes:

(1) Respiratory symptoms and diseases

All respondents agreed that their U5 children came down with respiratory symptoms because of the spills. A respondent said:

"... Yes, they have cough, dry cough because nothing comes out when they cough, sometimes, it sounds so dry, ...".

Another respondent said:

"... Yes it really has. The children come down with cough, which is usually dry and they keep coughing repeatedly without stopping, their eyes will be itching them. There was a time my U5 child had severe cough that he started having difficulty breathing. At night, he will cough till he started complaining of chest pain with fever. It was really a bad experience. I had to rush to him to the hospital and he was admitted...".

A participant also commented:

"... Yes, It causes them to cough, and they produce black sputum due to the soot that comes from the burning of the crude oil due to explosion. They also complain of persistent body weakness which they are not complaining of before the spills. They have catarrh and they sneeze a lot because of the smell of crude oil and the thick fumes from the burning crude oil...".

Another respondent said:

"... Children will always be children and would want to play outside. When they play outside and swim in the oily water, they sometimes drink the polluted water and have itchy throat, ..., they have repeated episodes of cough, and catarrh. This is happening more frequently than before. When the spills occur, throughout that period, they will be restless, cannot sleep at night, and will be coughing which is usually worse at night. Sometimes they have runny nose and will be sneezing a lot...".

A respondent said:

"... Yes, the children are so much affected. They have catarrh, cough, black sputum, runny nose and their eyes will be itching them. Some of them come down with frequent fever and itchy rashes on the skin. Asthma is also becoming very common in the community. We have been in and out of the hospital...".

(2) Exacerbation of already existing respiratory diseases

A respondent said:

"... Yes. They are having allergies, cough, fever and this occurs frequently. One of them who had allergies currently has developed asthma and is using inhaler, all because of this pollution...".

Another respondent said:

"... Yes it has. The U5 children manifest all kinds of ailment from cough, dry cough which is worse at night. Sometimes, they cough out blood as if they have tuberculosis. They were once tested for tuberculosis and the result came out negative, but they still have chest pain, catarrh, itching of the nose and sore throat. One of them is currently asthmatic, which is getting worse by the day and she is using inhaler. You will see her breathing fast, sometimes she has difficulty breathing. I have spent a lot of money...".

(3) Frequent hospital visitations

A respondent said:

"... Ever since my U5 daughter was diagnosed with asthma, she has been in and out of hospitals. In fact, I have lost counts of the number of times I have rushed her to the hospital because of the asthma crises. ...".

Another respondent said:

"... We have been in and out of the hospital. On one occasion that I took my U5 daughter to the hospital, the doctor said she had pneumonia and she was admitted because she had fever, cough, catarrh, and difficulty breathing...".

3.1.4 Recommendations

Several respondents identified that oil spill is a very dangerous occurrence that pollutes their air and the respiratory health of the U5 children. The participants discussed recommendations to prevent or reduce these oil spills incidence in the Niger Delta and other oil producing areas in Nigeria to improve the health of the U5 children.

(1) On prevention/reduction of oil spills

Several participants were of the opinion that companies should be sanctioned, pipelines should be protected, maintained and victims should be compensated.

A respondent said:

"... Pipelines should be changed and the oil spill should be cleaned up. The pipelines should also be protected from vandalism. Government should compensate the affected communities. The Government should provide jobs for the youths so that they will not keep vandalizing the pipelines".

Another respondent also said:

"... Oil spill should be regulated by enforcing the laws regarding oil spillage. The right of way should be under close monitoring by placing law enforcement officers at strategic locations in the community to protect the pipelines. Clean-up of these spills should also be done".

(2) On improvement of children's health (create awareness, education)

Some participants acknowledged the need for improved hygiene for children, taking their immunization, eating a balanced diet, the need for a good health seeking behaviour and the provision of good health facilities that is adequately equipped.

A participant said:

"... They should use nose mask to cover their nostrils when they are outside so that it will reduce their breathing in of soot and developing cough. They should also take lots of fruits to build their immunity and their parents should take them to see a health practitioner when they are sick".

Another participant also suggested:

"... Good healthcare facilities should be provided and these healthcare facilities should be adequately equipped with staff, drugs and other consumables to work effectively".

A respondent commented:

"... Children should complete their immunization and try to eat well. They should take their bathe regularly to wash off the soot and use a damp handkerchief to clean their nostrils regularly. Also when they are sick, their parents should endeavour to take them to the clinic. Their care also should be free".

A respondent commented:

"... Health centres should be equipped and care should be free. The community members should be enlightened and educated on the harms' and dangers associated with oil spill. Town criers should be sent round the community to also sensitize the community of these dangers regularly. The community should also be heavily compensated because they have suffered a lot so that they can care for their loved ones".

4 Discussion

This study identified the lived experiences of U5 children with the view to create awareness, inform health and disease prevention. While U5 children are faced with the same oil spill pollutants as adults, they are more prone to health risks such as respiratory symptoms and other diseases because of the physiological make-up [24] and behavioural pattern [21].

One of the prevalent themes recognized by the respondents was about the crude oil spills, sharing their oil spill experiences and the causes of those spills. Oil spills are major phenomenon that destroys the environment and the health of the residents. Respondents revealed that numerous oil spills have occurred in their communities and are still occurring. According to the respondents, the oil spills were because of poor maintenance of oil equipment and pipelines and pipeline vandalism, leading to pipeline explosion, fire outbreaks, intense heat, thick black fumes and soot being released into the air, loss of lives, loss of biodiversity, and properties. The crude oil also spills into the water and on land. These findings corroborated with findings reported in another study [31] where oil spills were reported to have occurred because of pipeline vandalism, resulting in explosions with fire outbreak that led to loss of numerous lives and properties [31]. According to National Oil Spill Detection and Response Agency (NOSDRA), numerous oil spills have occurred in the Niger Delta, some due to oil companies (via ageing or poorly maintained infrastructures) and some due to third party involvement (via oil theft, artisanal refining, *etc.*) [32].

Another major theme recognized by the respondents is the destruction of the environment. Crude oil spills have negatively impacted the environment (the air, the water, and the land). Respondents revealed that the quality of air in their communities has drastically reduced since the inception of crude oil activities coupled with oil spills. The air is filled with crude oil components, that it chokes. The air is filled with thick black smoke because of pipeline explosion and fire outbreaks, polluting the air with crude oil toxicants. These findings also are similar to findings by Afshar-Mohajer and colleagues who reported that after oil spills into the sea, some of the compounds like the VOCs and PMs can become aerosolized thereby affecting the quality of air [15]. It is also similar to findings reported in a study conducted to assess the air quality of host communities to some Nigerian oil exploration companies who are exposed to crude oil pollution. The study revealed that higher concentrations of toxic pollutants were found in the air in oil polluted communities especially hydrocarbon, carbon monoxide, nitrogen dioxide, and $PM_{2.5}$ which exceeded the NAAQS limits [33].

The water and lands were also found to be contaminated with crude oil, as oil is seen floating in the seas, biodiversity, and farmlands were destroyed because of the oil spills. A study by [34] showed that heavy metals from crude oil such as Cadmium, Lead, Chromium, Nickel, which were above US EPA Maximum Contaminant Level (MCL) indicates water pollution [34]. The contamination of the air, land and seas as a result of the oil spills were also reported in other studies [35, 36].

Another important theme is the RH effects associated with exposure to crude oil from spills among U5 children. The respiratory symptoms and diseases observed include cough producing black sputum, which is due to the black soot inhaled, catarrh, difficulty in breathing, fast breathing, chest pain, frequent sneezing, wheezing, itchy eyes, to mention but a few. These findings agree with that by Jung and colleagues which revealed a significant relationship between oil spill and the RH of children [37]. Similar findings were also observed among children who were reported to have direct exposure to crude oil in another study [38]. They had odds of physical health problems (respiratory symptoms, visual impairment, skin irritations, headaches, and unusual bleeding) that were more than four times higher than the non-exposed (OR = 4.14, 95% CI 2.3–7.5) [38].

Exacerbation of existing respiratory symptoms leading to frequent hospital visitations were reported by respondents. Worthy of note is the development of asthma among children of some study participants due to the exacerbation of previously existing allergies. This finding is similar also to findings by Jung and colleagues [37]. Findings revealed that children exposed to oil spill due to their residential proximity to the oil spill site were significantly at a higher risk of developing asthma due to the high exposure than those who had low exposure (OR, 2.43; 95% CI, 1.27-4.65) [37]. Noh and colleagues also revealed that significant longitudinal association between oil spill exposure estimates, and asthma symptoms existed, with younger children being more affected. Children who resided in high exposure areas were more likely to develop asthma symptoms (OR:1.6; 95%CI: (1.2–2.2)) [23].

The respondents' opinion on recommendations to avert oil spills and its effects on their U5 children was also one of the prevalent themes in this study. Recommendation was based on prevention/reduction of crude oil spills and improving the health of the U5 children. Several participants opined that companies should be sanctioned, pipelines should be protected,

maintained and victims should be compensated. Also, some participants acknowledged the need for improved hygiene for children, taking their immunization, eating a balanced diet, the need for a good health seeking behaviour and the provision of good health facilities that is adequately equipped. The respondents' recommendation followed the four action points by the WHO to tackle air pollution which include reduce air pollution, reduce exposure, improve child health, and improve implementation and monitoring [39]. This study had some limitations including language barrier as data was collected in the respondents' native languages and then interpreted into English language. Some vital information may have been lost or misrepresented during the process of interpretation. Additionally, U5 children represent a small subset of the vulnerable population, hence future studies should include pregnant women, the elderly, those with disability, *etc.*

5 Conclusion

The purpose of this study was to determine the lived experiences of U5 children residing in oil polluted communities and how it has impacted their respiratory health. This study therefore addressed a significant research gap by investigating these lived experiences. The findings lend support to previous research on the respiratory effects of exposure to oil spill and its components among U5 children. This study therefore provides a unique perspective and gives more understanding of the phenomenon. It has also provided a foundation for future research.

Authors contribution

Pearl Abereton wrote the first draft of the manuscript and contributed to data collection, study design, and interpretation of the results. Best Ordinioha contributed to the interpretation of the results and the abstract. Jacob Mensah-Attipoe contributed to the interpretation of the results. Oluyemi Toyinbo coordinated the study and contributed to the study design, data collection, and interpretation of the results. All authors contributed to reading and commenting on the manuscript.

Conflict of interest and funding

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List of abbreviations

U5	Under-five children
RH	Respiratory health
RTI	Respiratory Tract Infections
AAP	Ambient Air Pollution
OR	Odds Ratio
WHO	World Health Organization
UNICEF	United Nations Childrens' Fund
MCL	Maximum Contaminant Level
NAAQS	National Ambient Air Quality Standards
US EPA	United States Environmental Protection Agency
NOSDRA	National Oil Spill Detection and Response Agency

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