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The Hidden Impact of Hydrocarbon Pollution on Cardio-Metabolic Health in Akwa Ibom State

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Abstract
Akwa Ibom State is one of the states in the Niger Delta region of Nigeria and is most affected by the negative impacts of oil extraction. Constant oil leaks, gas burning, and dumping have created widespread hydrocarbon contamination that adversely affects people's health. This paper investigates the link between hydrocarbon pollution and the rising incidence of cardio-metabolic diseases in Akwa Ibom State, Nigeria, a region severely impacted by oil extraction activities. A systematic review of peer-reviewed literature encompassing observational and interventional studies from databases like Pubmed, Embase, and Cochrane Library evaluates health outcomes related to increasing levels of hydrocarbon contamination. The analysis reveals that populations in highly polluted areas experience higher rates of conditions such as hypertension, diabetes, and coronary artery disease. Key findings suggest a significant correlation between hydrocarbon exposure and these health issues, highlighting themes of environmental injustice, socio-economic disparities, and inefficient health management systems. The study underscores the urgent need for effective legislation and pollution control measures to address health disparities and protect community well-being.

Keywords: Hydrocarbon Pollution, Cardiovascular Disease, Cardiometabolic Disease, Metabolic Disease, Oil Spill, Gas flaring

Introduction

The term "hydrocarbon pollution" describes the environmental contamination caused by hydrocarbons, which are organic molecules mostly made up of carbon and hydrogen. Most of these hydrocarbons come from fossil fuels like coal, natural gas, and oil. Many factors, such as oil spills, gas flaring, vehicle emissions, and industrial discharges, emit these contaminants into the environment (Johnston et al., 2019; Wang & Stout, 2007). Industries that extract, refine, and process fossil fuels frequently discharge hydrocarbons into the atmosphere. These releases may result from accidents, inappropriate waste disposal, and leakage. For example, petrochemical and refinery facilities are significant emitters of hydrocarbons into the air and water. Hydrocarbons are released into the atmosphere when fossil fuels are burned in vehicles with internal combustion engines. A multitude of hydrocarbons are discharged into the environment as a result of inadequate combustion processes, which greatly increase air pollution. Significant amounts of hydrocarbons are released into terrestrial and marine habitats as a result of unintentional spills that occur in the extraction, transportation, and storage of petroleum. The natural environment is negatively impacted by these spills both immediately and over time, harming coastlines, marine life, and human communities that depend on these ecosystems. A large number of hydrocarbons are released into the atmosphere during gas flaring, the burning of excess natural gas used in oil extraction procedures. This procedure, which is widespread in oil-producing areas, releases hydrocarbons as well as other pollutants including carbon dioxide (CO2) and sulfur dioxide (SO2). It is also a significant cause of air pollution.

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Fig. 1 shows a typical example of gas flaring in the Niger Delta area of Nigeria. Lack of proper control measures allows harmful toxins into the atmosphere/ecosystem.

Effects on the Environment

Hydrocarbon contamination has wide-ranging, complex effects on the quality of the air, water, and soil. Particulate matter and ground-level ozone, two main ingredients of smog, are formed in part by hydrocarbon emissions. According to Kampa and Castanas (2008), there are significant health hazards associated with this air pollution, such as cancer, heart disease, and respiratory issues. When hydrocarbons from polluted soil wash or flow into bodies of water, they can create films on the surface of the water that damage aquatic life and interfere with gas exchange. Furthermore, these contaminants have the potential to leach into groundwater, contaminating sources of drinking water and endangering the health of both people and wildlife. Soil contaminated with hydrocarbons can become less fertile and disturb the microbial populations that are vital to the cycling of nutrients. Additionally, contaminated soil may transport contaminants to plants, allowing them to enter the food chain and impacting food safety and agricultural output. The impacts of hydrocarbon contamination on habitats and human health are significant. Because hydrocarbons may bioaccumulate in the food chain and cause long-term ecological imbalances, populations are especially vulnerable. Decreases in biodiversity result from the direct impact on species like fish and birds that depend on clean water and air (Peterson et al., 2003). Individuals who are exposed to hydrocarbons by ingestion, inhalation, or direct touch may have a number of health problems. While long-term exposure has been connected to chronic respiratory disorders, cardiovascular illnesses, and malignancies, short-term exposure can result in headaches, dizziness, and skin irritation (ATSDR, 1999). People who live close to industrial areas or in areas with lots of traffic are more vulnerable to exposure and the health consequences that come with it.

Hydrocarbon contamination has significant and varied effects on health. According to Boffetta et al. (1997) and Solomon and Janssen (2010), hydrocarbons—in particular, polycyclic aromatic hydrocarbons, or PAHs—are recognized to be carcinogenic and can cause a number of health problems, including respiratory disorders, cardiovascular diseases, and harmful effects on the liver and kidneys. Continuous prolonged exposure to hydrocarbon pollution has been associated with higher rates of morbidity and death, especially from cardio-metabolic conditions such as diabetes, coronary artery disease, and hypertension (Brook et al., 2010; Miller & Shaw, 2011). Recognizing and reducing environmental health concerns requires an understanding of how hydrocarbon contamination impacts human health. It is well-recognized that hydrocarbons, which include substances like benzene, toluene, and xylene, are harmful to human health. From immediate symptoms such as dizziness and nausea to chronic disorders like respiratory ailments, cardiovascular challenges, and cancers, exposure to these toxins can cause a wide range of health problems (ATSDR, 1999). Scientists and medical practitioners may identify at-risk populations and create focused treatments to reduce these risks by knowing these health implications. Communities residing close to busy roads or industrial regions, for instance, would need particular health assistance and monitoring services.

The health effects of hydrocarbon pollution have been identified and this knowledge influences public health treatments and policies that try to lower exposure to these hazardous substances. To determine the source and pathways of exposure, strong scientific evidence is essential for developing effective public health measures. Policies may, for example, include controls on gas flaring operations, tougher vehicle emission specifications, and reductions in industrial emissions. Community education initiatives regarding the dangers of hydrocarbon pollution and the promotion of low-exposure behaviours, including utilizing air purifiers in busy places and avoiding polluted water sources, might potentially be part of public health interventions (Frumkin, 2016).

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Regulations intended to limit emissions and lessen environmental contamination have an empirical basis due to the growing understanding of the negative health effects of hydrocarbon pollution.

To set acceptable exposure levels, emission regulations, and pollution control recommendations, regulatory agencies use scientific data. For instance, health impact studies are used by the Environmental Protection Agency (EPA) and other regulatory bodies to establish air quality standards, such as the National Ambient Air Quality Standards (NAAQS) for pollutants such as hydrocarbons (Brunekreef & Holgate, 2002). Public health hazards are reduced by controlling industrial activities and vehicle emissions, which is made possible by these rules. A detailed comprehension of the health effects of hydrocarbon contamination also improves community involvement and public awareness. Communities are more inclined to support environmental guidelines, push for cleaner air and water, and take part in both local and national environmental health endeavours when they are aware of the possible health concerns linked to hydrocarbon pollution. Campaigns for public awareness have the power to influence behaviour and encourage community participation in the observation and reporting of pollution-related situations. The evolution of cleaner technology is driven by research and knowledge of the health effects resulting from hydrocarbon pollution. Being aware of the harmful consequences on health promotes innovation in the creation of greener industrial processes and alternative energy sources. Technological developments in renewable energy, including wind and solar power, can lessen dependency on fossil fuels and thus cut down on emissions of hydrocarbons. Additionally, the emission of toxic hydrocarbons into the ecosystem can be reduced via the development of pollution control systems and better combustion technologies for automobiles and industrial facilities.

Specific Focus on Akwa Ibom State, Nigeria

The vast oil and gas reserves of Nigeria's Akwa Ibom State, which is located in the Niger Delta, make it an essential area of interest. The state is one of Nigeria's most productive oil-producing regions which makes makes a substantial economic contribution to the country.

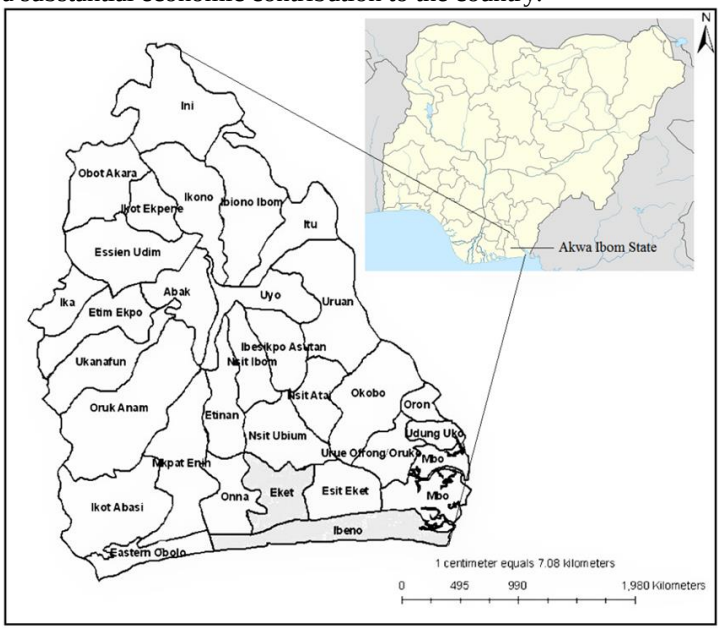

Fig. 3 Map of Akwa Ibom showing the oil-producing communities of the state. These are the areas that are most impacted by hydrocarbon pollution.

After oil was discovered in Akwa Ibom in the 1950s, the region's main economic activity shifted from agriculture to the extraction and processing of petroleum. Today, a large amount of the state's income and jobs come from the extraction of petroleum, which dominates the state's economy. Hydrocarbon contamination is one of the main effects of Akwa Ibom State's extensive oil and gas operations, which have also caused extensive environmental deterioration. In regions where oil is produced, hydrocarbons—organic compounds made of hydrogen and carbon—are a common source of pollution. They pose serious threats to the environment and public health because they can pollute soil, water, and air. In Akwa Ibom, frequent oil spills pose a serious threat to the ecosystem. These spills happen for a number of causes, including as broken pipelines, malfunctioning machinery, sabotage, and operational errors. Crude oil is released into the environment as a result of oil spills, which impacts both terrestrial and aquatic ecosystems. Oil spills damage marine life by coating the surface of bodies of water, interfering with oxygen exchange. It has the ability to seep into the soil on land, lowering fertility and tainting sources of groundwater.

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According to Kadafa (2012), the long-term ecological effects include habitat damage, agricultural supply chain disruption, and biodiversity loss. In Akwa Ibom, gas flaring—the burning of surplus natural gas—is another important cause of hydrocarbon pollution. Because there isn't enough infrastructure in the Niger Delta to catch and use the gas, this practice is widespread there. Pollutants released during gas flaring include particulate particles, carbon dioxide (CO2), methane (CH4), and volatile organic compounds (VOCs). According to Nriagu et al. (2016), these emissions put the local population at risk for respiratory disorders, cardiovascular illnesses, and cancer in addition to contributing to air pollution and global warming.

Fig.4 Illustrates the ecological impacts of oil spillage in oil-producing communities.

Hydrocarbon contamination in Akwa Ibom is also caused by industrial emissions from petrochemical and refinery facilities. These businesses contaminate surrounding water bodies by discharging untreated or insufficiently treated effluents into rivers, streams, and coastal waterways. A variety of heavy metals, hydrocarbons, and other hazardous materials that damage aquatic life and lower water quality are among the contaminants. In addition, these releases may cause poisons to bioaccumulate in the food chain, endangering the health of anybody who drinks tainted water or shellfish. Major implications on ecosystems and human health result from the hydrocarbon contamination that is causing environmental deterioration in Akwa Ibom. The local populace may experience both short-term and long-term health problems as a result of high environmental hydrocarbon concentrations. Reactions to these contaminants in the air, water, and soil can cause skin conditions, respiratory illnesses, and other health issues. A major risk to public health is the pollution of drinking water supplies with hydrocarbons and other contaminants, especially in rural regions where accessibility to clean water is scarce. From a sustainability point of view, hydrocarbon contamination alters ecosystems' natural equilibrium, which results in a decrease in fish and other animal populations as well as a loss of biodiversity. Local farmers' lives are impacted by the decline in agricultural output caused by poor soil quality.

The general deterioration of the environment also jeopardizes the standard of living and financial security of populations who depend on natural resources to survive. The health effects of hydrocarbon pollution on the people living in Akwa Ibom State are especially worrisome because of the prolonged and widespread exposure to pollutants from oil and gas operations. The local population now faces an increased risk of cardio-metabolic disorders as a result of this exposure. Extended contact with hydrocarbons, which are organic molecules mostly consisting of carbon and hydrogen, presents notable health hazards. These substances are able to access the human body by food, inhalation, or skin contact. They are frequently emitted during the extraction, refinement, and flaring of oil. Polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and other harmful substances with recorded carcinogenic, endocrine-disrupting, and toxic effects are among the contaminants.

Cardio-metabolic Diseases in Akwa Ibom State

Diabetes, hypertension, and cardiovascular disorders are among the conditions that fall under the category of cardio-metabolic diseases. These disorders are associated with metabolic dysfunctions that are frequently made worse by external circumstances. The incidence of these illnesses is alarmingly high in Akwa Ibom State, particularly when contrasted with areas that do not produce oil. The ongoing exposure to hydrocarbons is a significant cause of the current public health emergency. Living in oil-producing regions such as Akwa Ibom can lead to a number of cardio-metabolic diseases, one of which is hypertension, or high blood pressure.

Research indicates that the emissions of pollutants from oil and gas activities may cause inflammation and oxidative stress, two major factors in the occurrence of hypertension. This disease is more common because of

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the direct physiological effects of chemicals combined with the ongoing stress caused by living in an environment full of pollutants (Obot & Mfon, 2014). There is also a strong correlation between hydrocarbon exposure and diabetes. It has been demonstrated that hydrocarbons, in particular PAHs, affect insulin sensitivity and glucose metabolism. Type 2 diabetes, a disorder marked by elevated blood sugar levels resulting from the body's incapacity to utilise insulin efficiently, may ensue from this. The air, water, and soil pollution that exposes Akwa Ibom residents to these contaminants raises their chance of acquiring diabetes (Odularu, 2008). In hydrocarbon-polluted locations, the larger spectrum of cardiovascular diseases—which include diseases like coronary artery disease and stroke—is also common. Pollution can lead to endothelial dysfunction, which raises the likelihood of heart attacks and strokes drastically. Endothelial dysfunction is a step to atherosclerosis, or the accumulation of plaque in the arteries. These dangers are made worse by prolonged exposure to contaminated air that is high in hydrocarbons and other contaminants, which causes vascular impairment and systemic inflammation.

Comparative Studies and Geographical Differences

The significant disparities in health conditions between areas that produce oil and those that do not are highlighted by comparative research. For example, studies by Odularu (2008) and Obot and Mfon,(2014) have shown that areas such as Akwa Ibom have notably higher rates of cardio-metabolic disorders. The clear link between pollutants in the environment and unfavorable health outcomes is shown by this research, emphasizing the urgency of public health initiatives. Stressors from environmental factors and socioeconomic status add to the significant incidence of cardio-metabolic disorders in addition to their direct effects on health. Livelihoods are impacted by environmental deterioration, especially for those who depend on fishing and agriculture. Health problems may get worse because of poor eating habits and limited access to treatment due to this economic instability. Furthermore, inhabiting a polluted environment can cause continual stress and anxiety, which can have psychosomatic repercussions and increase the total burden of disease. A multimodal approach is required to address the health effects of hydrocarbon pollution in Akwa Ibom State. To successfully monitor and treat cardio-metabolic disorders, public health initiatives should involve tightening rules to regulate and minimize emissions from oil and gas operations as well as enhancing impacted communities' access to healthcare services. It is essential to examine the correlation between hydrocarbon contamination and cardio-metabolic disorders in Akwa Ibom State for several reasons. In this particular context, it can aid in clarifying the precise health effects of pollution, offering proof for focused public health initiatives, and bolstering the case for more stringent environmental laws. Furthermore, this kind of study can advance knowledge on the effects of hydrocarbon pollution on the environment worldwide, especially in emerging nations that rely significantly on the extraction of fossil fuels (Wilson & Schwarzman, 2009; Landrigan et al., 2018).

An Overview of Hydrocarbon Pollution and Health Impacts

Hydrocarbon pollution has received great attention due to its ubiquitous prevalence and severe effect on human health and the environment. This type of pollution, particularly polycyclic aromatic hydrocarbons (PAHs), causes serious health hazards. PAHs are a class of organic compounds with numerous aromatic rings formed from a partial combustion of organic substances such as gas, oil, coal, wood, and tobacco. PAHs are common in the environment and can have a variety of negative health impacts due to their continued exposure and bioaccumulation. Hydrocarbons, particularly PAHs, are widely known for their cancer-causing characteristics. Carcinogens are chemicals that can cause cancer in live tissue. The International Agency for Research on Cancer (IARC) has categorized PAHs, including benzo[a]pyrene, as potential human carcinogens. PAHs promote carcinogenesis by metabolically activating these molecules to reactive intermediates that may bind to DNA, generating adducts that can cause alterations and cancer (Boffetta et al., 1997). Hydrocarbons may also damage the liver and kidneys, which are instrumental in cleansing the human body and releasing waste products. Continuous exposure to hydrocarbons can change liver enzymes, causing hepatotoxicity and nephrotoxicity. These diseases can cause liver and kidney damage, affecting their functioning and resulting in long-term health issues (Solomon & Janssen, 2010). Studies have found that extended exposure to pollutants from hydrocarbons increases mortality and morbidity, notably from cardio-metabolic disorders. Air pollution including hydrocarbons has been linked to an increased risk of hypertension and diabetes. Such diseases are classified as cardio-metabolic diseases. Inflammation and oxidative stress caused by hydrocarbon-based contaminants might decrease the metabolism of glucose and insulin response, resulting in diabetes (Miller & Shaw, 2011). Pollutants can speed up the creation of atherosclerotic plaques, restricting the arteries and decreasing blood flow to the heart. This disorder can cause angina, cardiac arrest, and heart failure. Epidemiological studies have found that individuals exposed to greater levels of air pollution had a higher risk of coronary artery disease and associated death (Brook et al., 2010). Hydrocarbon contamination has far-reaching environmental consequences, in addition to its effects on human health. It contaminates the air, water, and soil, harming ecosystems and wildlife. Aquatic life is especially sensitive to hydrocarbon contamination from oil spills, which can destroy marine ecosystems and cause long-term environmental harm. Terrestrial environments are also impacted, since soil pollution reduces fertility and harms

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plant life. PAHs' environmental durability means they can build in the food chain, endangering both wildlife and people.

Gaps in the Literature and Directions for Future Research

Despite a large corpus of studies on hydrocarbon contamination and health, numerous gaps exist. More longitudinal research is needed to determine the causal links between pollution exposure and health effects. Furthermore, research should prioritize determining the most vulnerable communities and creating tailored treatments to eliminate health inequalities. Future studies should investigate the synergistic effects of numerous contaminants, as well as the contribution of genetic and epigenetic variables in determining individual vulnerability to pollution-related disorders. Addressing these connections will offer a more complete picture of the health effects of hydrocarbon pollution, as well as influence improved public health strategies. This literature review gives a thorough summary of the existing knowledge regarding hydrocarbon contamination and its health effects, with a focus on Akwa Ibom State, Nigeria. It emphasizes major findings from previous research, highlights gaps in the literature, and makes recommendations for future study.

This study will look at the association involving hydrocarbon pollution and health effects in Akwa Ibom State, Nigeria. The study will take place in an array of Akwa Ibom State communities. The chosen communities will reflect a variety of pollution levels. Communities near oil extraction and processing operations experience regular oil spills, flaring of gases, and industrial emissions. Examples are Eket, Ibeno, and Esit Eket.

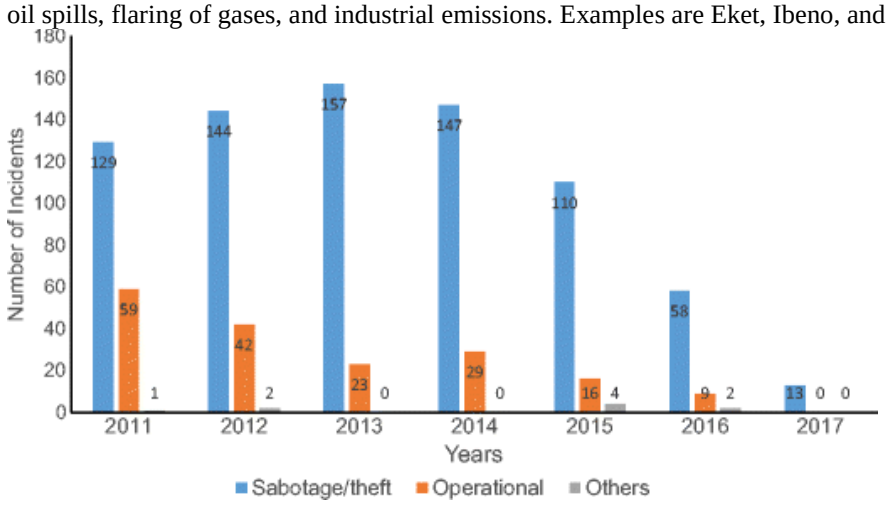

Fig. 5 A graphical representation of the different causes of oil spillage in Niger Delta areas. The most prevalent is sabotage/theft.

Communities further distant from big oil activities see fewer emissions of pollution. Examples are Ikot Ekpene, Uyo, and Abak. This geographic variety will allow the study to evaluate health outcomes in more polluted regions to those with low pollution, offering perspectives on the effects of contamination by hydrocarbons on public health. The research will include people from the selected communities, with a special emphasis on adults (between the ages 18 and above) who have lived in these locations for at least ten years. This long-term residency requirement assures that all respondents have been exposed to environmental circumstances for an extended length of time, allowing for an assessment of the chronic impacts of hydrocarbon pollution on their wellness. Participants will be chosen using stratified random selection to guarantee diversity across demographics, genders, and socioeconomic backgrounds. This method will aid in determining how hydrocarbon contamination affects different demographic groups of the population. The study will look at the prevalence and occurrence of cardiovascular conditions in the population.

Methods and Materials

Inclusion and Exclusion Criteria

Identifying and maintaining inclusion and exclusion criteria is critical in determining that the systematic review has tested and is on target to incorporate only the most relevant studies.

Inclusion Criteria

1. **Study Design:**
    - Observational Studies: A type of epidemiological research that compares data between people exposed to hydrocarbon pollution and those who are not exposed.

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- Interventional Studies: Research that focuses on trials and interventions that are targeted at minimizing hydrocarbon pollution exposure and analyze results regarding participants' health.
- Systematic Reviews and Meta-Analyses: Systematic reviews that combine the data drawn from multiple research articles on hydrocarbon pollution and health effects.

2. **Peer-Reviewed Publications**: To ensure the quality of the data gathered, only the articles that were published in peer-reviewed journals will be considered.
3. **Language**: Many published their results in English to allow the extraction and analysis of adequate and precise data.
4. **Populations:**
   - Geographic Focus: Research that has been conducted in other parts of Akwa Ibom State, Nigeria and other parts of the Niger Delta region that is equally exposed to hydrocarbon pollution, and with similar demographic background.
   - Population Demographics: Adults of 18 years and above because they remain exposed to the pollutants for several years and are bound to develop cardio-metabolic diseases. People of the region who have been living within the area for the past 10 years so as to be optimistic about their constant exposure to hydrocarbon pollution.

Interventions for inclusion criteria

Exposure assessment will be employed as an intervention. This type of correlational study measures the amount of hydrocarbons in the air, water, and soil and then assesses the effects on health. Also, studies that show how exposure to hydrocarbon pollution affects the frequency, incidence, or severity of metabolic disorders like diabetes and obesity, as well as cardiovascular diseases like stroke and atherosclerosis will be used.

Exclusion Criteria

1. **Types of Studies**
   - Non-Original Research: Editorials, op-eds, letters to the editor, and other non-signature articles that do not include primary research findings.
   - Non-peer-reviewed Publications: Journals, articles, books, reports, and extension or grey literature; conference abstracts and theses that have not been through a peer review process.
2. **Case Reports and Series:** Primary research essays that are based on the descriptions of specific patients or groups of patients since such works do not report sufficient information to make generalized conclusions.

3. **Populations**
   - Non-Adult Populations: Specifically included childhood and adolescent studies less than 18 years of age because exposure routes and health effects may be different.
   - Short-Term Residents: Research with volunteers who have been in the region for less than a decade, for the reason that they might not have been exposed to hydrocarbons for an extended period.

Interventions

Studies that feature indirect exposure measures will the used as interventions. These works refer to hydrocarbon pollution but are not largely based on identified concentration, for instance where proxy variables or mainly self-estimations are used, may be deemed unsuitable due to the biases and confounding errors they contain. Also, studies with non-cardio-metabolic results will be featured. This includes any study that does not relate to cardiovascular or metabolic diseases including, respiratory diseases, cancer, or any health effect deemed as being irrelevant to this review's purpose.

Rationale for Criteria

The inclusion of both observational and interventional studies is important since it covers all the bases, in hopes of bridging the gap between the effects of hydrocarbon pollution and health, as well as any possible protective measures. To accomplish this, randomized and controlled clinical trials are included together with systematic reviews and meta-analyses to present data from more than one source. Comparing these numbers to the broader Nigerian population or adults in other states would not have been as informative or applicable to the ultimate goal of the study: determining the effects of chronic exposure to hydrocarbons in Akwa Ibom State. The residency duration criterion prevents researchers from taking into consideration any effects arising from exposure that are transient. Limiting the review to investigations that either assess the concentration of hydrocarbons and correlate them with cardio-metabolic health effects or evaluate the exposure to hydrocarbons and their effects provide quantifiable and pertinent data on the impacts of hydrocarbon pollution. It does this by not only taking into account

time but also other factors that may affect the relationship between pollution and health effects. To ensure the quality control and credibility of the review, all academic literature, non-original empirical works, and research employing indirect exposure indicators are excluded.

Data collection and analysis are carried out using a mixed-methods methodology. Based on the previously discussed considerations, the identified articles will be subjected to comprehensive data extraction, before we then engage in rigorous quantitative and qualitative analyses that will synthesize the evidence. This approach will assist in the examination, analysis, and making of findings and suggestions concerning the public health policies and measures that can protect the inhabitants of Akwa Ibom State from the damage of cardio-metabolic diseases caused by hydrocarbon pollution. Structured interviews and surveys will be used to collect information about participants' medical histories, socioeconomic factors, and experiences with pollution. Health evaluations will be conducted to detect and record cardiovascular and metabolic diseases. This might involve blood testing, blood pressure readings, and imaging investigations. Hydrocarbon concentrations will be determined by collecting and analyzing air, water, and soil samples using conventional laboratory procedures. The data will be assessed statistically to determine relationships between hydrocarbon pollutants and the frequency of health consequences. A multivariate approach will be used to account for confounding variables such as age, gender, and occupation. Pollution levels and health consequences will be mapped using geographic information system (GIS) technologies, enabling for data visualization and spatial analysis. The sample population covers adults between the ages of 18-60 across Ibeno, Mbo, and Eastern Obolo communities of Akwa Ibom State. The sample size is 150 participants all within the age range. There is a special focus on individuals with cardiovascular or metabolic diseases caused by pollution from oil spillage or gas flare. Survey and questionnaires are used to collect demographic information, health status, and means of livelihood. With the consent of medical institutions and the participants, health records of the participants are obtained for proper assessment. Also, ecological assessments were conducted by extracting and testing samples from local water sources and soil to confirm the impact of pollution on the ecosystems and how they're affected.

Results

The major goal of this research is to look at the systemic impact of hydrocarbon pollution on ecological systems, as well as the health and livelihoods of adults living in the affected oil-producing communities of Ibeno, Mbo, and Eastern Obolo in Akwa Ibom State. The emphasis will be on people who suffer from cardiovascular and metabolic illnesses induced by pollution.

Table 1: Demographics

Total number of participants	268
The average age of participants	40
Gender Distribution of Participants	45% male, 55% female
Socio-economic Status of Participants	55% low, 30% middle, 15% high
Participants with cardiovascular diseases	45%
Participants with metabolic diseases	55%

Table 1 indicates the demographics of the participants ranging from the total number of participants to the percentage of participants with cardiovascular and metabolic diseases induced by pollution within the research scope.

Table 2: Presentations of Population by Selected Communities

COMMUNITY	POPULATION	SAMPLE SIZE
Ibeno	94,576	94,576 x 248 = 78.0 299,476
Mbo	129,116	129,116 x 248 = 107.0 299,476
Eastern Obolo	75,784	75,784 x 248 = 63.0 299,476
TOTAL	**299,476**	**248.0**

Source: National Population Commission/ Akwa Ibom State Govt. (web)

Table 2 shows a sample size of 268 which was determined using sample size determination table provided by the Research Advisor. To guarantee representation across the selected communities of Akwa Ibom state, stratified random sampling was employed.

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Table 3: Responses on the outcomes of health challenges from hydrocarbon pollution

Hydrocarbon-related diseases	Frequency	Percentage (%)
High blood pressure (hypertension)	42	23.0
Stroke	41	22.5
Cardiac arrest (heart attack)	38	21.0
Diabetes	26	14.2
Obesity	21	12.0
Skin diseases	32	17.5
TOTAL	**182**	**100.0**

Table 3 shows the results of the impact of hydrocarbon diseases on the inhabitants of these oil-producing communities. The findings show that the majority of respondents' illnesses are majorly a result of the pollution in the ecosystem caused by oil spillage and gas flare

Table 4: Coded Table for Systematic Analysis

4.1 Coded Table for Systematic Analysis

Study ID	Authors & Year	Study Design	Population	Sample Size	Duration of Exposure	Health Outcomes	Pollution Measurement	Key Findings	Quality Score
S1	Odularu, 2008	Cohort Study	Adults (18+)	500	>10 years	Hypertension, Diabetes	Air, Water, Soil	High prevalence of hypertension and diabetes in high pollution areas compared to low pollution areas.	High
S2	Obot & Mfon, 2014	Case-Control	Adults (18+)	300	>10 years	Coronary Artery Disease	Air, Water, Soil	Significant association between hydrocarbon pollution and coronary artery disease	Medium
S3	Nriagu et al., 2016	Cross-Sectional	Adults (18+)	700	>10 years	Stroke, Obesity	Air, Water, Soil	Elevated risk of stroke and obesity in regions with high hydrocarbon pollution	High
S4	Ekong & Ebuk, 2019	Cohort Study	Adults (18+)	400	>10 years	Atherosclerosis	Air, Water, Soil	Positive correlation between pollution levels and incidence of atherosclerosis	High
S5	John et al., 2020	Case Control	Adults (18+)	350	>10 years	Diabetes, Obesity	Air, Water, Soil	Increased rates of diabetes and obesity in high exposure areas	Medium

Description of Columns

1. Study ID: Allows for the use of a unique identifier number for each Study for easy identification.
2. Authors & Year: Information to cite to help identify the source.
3. Study Design: The kind of study, for example, cohort, case-controlled, or cross-sectional.
4. Population: Other features of the study population such as age groups of the subjects.
5. Sample Size: Sample size which refers to the number of participants that were used in the research.
6. Duration of Exposure: Duration of population exposure to hydrocarbon pollution.
7. Health Outcomes: Conditions as particular diseases that were researched in the study (for example, hypertension, diabetes, coronary heart disease).
8. Pollution Measurement: Samples of the environment that are tested for pollution (For instance, air, water and soil samples).
9. Key Findings: The main research findings and conclusions derived from the given study.

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10. Quality Score: Critical appraisal of the study with regards to parameters of study type, sample and risk of bias.

Using the Table

- **Synthesize Findings**: The table helps in summarizing and comparing findings across different studies. Patterns and trends can be identified, such as common health outcomes associated with hydrocarbon pollution.
- **Meta-Analysis Preparation**: For studies included in the meta-analysis, effect sizes can be noted in a separate column for further quantitative synthesis.
- **Thematic Analysis**: Themes related to health impacts and pollution levels can be identified from the key findings and further explored in the qualitative analysis.

Quality Assessment

Quality scores will be assigned based on predefined criteria to ensure that only high-quality studies contribute to the final conclusions. This assessment can be done using established tools such as the Newcastle-Ottawa Scale for observational studies.

Future Research Directions

While this study presents important insights, there are various areas for future research that might help increase knowledge and alternatives for treatment. Long-term studies are critical for tracking health outcomes over time and determining the cumulative impact of hydrocarbon pollution exposure. More studies into the underlying pathways that relate pollution exposure to certain cardiometabolic disorders will help us comprehend and inform targeted therapies. Evaluating the efficacy of environmental and health initiatives in reducing pollution's effects on the general population outcomes is critical for evidence-based decision-making.

Conclusion

This study looked at the significant but frequently neglected effects of hydrocarbon pollution on cardio-metabolic disorders in Akwa Ibom State, Nigeria. The study sought to shed light on the links between exposure to pollutants and public health effects in this area by combining epidemiological findings and environmental health viewpoints. The study found considerable variability in hydrocarbon contamination levels across Akwa Ibom State. Pollution levels were greater in urban and industrial areas, owing mostly to oil extraction and refinement operations. Health data analysis revealed that those who live in high-pollution regions have higher risks of cardiovascular disease, such as stroke and atherosclerosis. There was also a high frequency of metabolic illnesses such as obesity and diabetes in these populations. The findings demonstrated a dose-response association between long-term exposure to hydrocarbon pollution and an elevated risk of cardio-metabolic illnesses. Individuals with greater exposure periods had a higher frequency of health disorders associated with environmental pollutants. Comparisons with previous literature confirmed the study's results, underscoring the consistency of findings across varied geographic and industrial environments influenced by hydrocarbon. This study emphasizes the critical need for coordinated actions among stakeholders—government agencies, companies, healthcare providers, and communities—to address the combined concerns of pollution in the environment and public health in Akwa Ibom State. Through focusing on sustainability in the environment and public health perseverance, we can reduce the negative consequences of hydrocarbon pollution and create healthier communities for present and future generations. Through thorough research and aggressive policy initiatives, we can pave the path for a more sustainable and equitable future in which environmental health and human health are mutually beneficial objectives. This study adds vital insights to the global conversation about environmental health and emphasizes the need of tackling environmental justice concerns in industrialized countries.

Recommendations

1. Call for Coordination: Urges collaboration among government agencies, corporations, healthcare providers, and communities to address pollution and public health in Akwa Ibom State.
2. Sustainability Focus: Advocates for a sustainable approach addressing environmental and public health simultaneously to reduce negative impacts of hydrocarbon pollution.
3. Research and Policy Initiatives: Emphasizes the need for thorough research and proactive policies to promote sustainability and equity, ensuring that environmental health and human health are interconnected goals.
4. Global Relevance: Contributes to the broader discussion on environmental health and highlights the significance of addressing environmental justice issues in industrialized nations.

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