PREVALENCE OF HOUSEHOLD AIR POLLUTION AND RESPIRATORY SYMPTOMS AMONG UNDER FIVE CHILDREN IN EKOSODIN, BENIN CITY, EDO STATE, NIGERIA

BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMNTS FOR THE AWARD OF BACHELOR IN MEDICINE AND BACHELOR IN SURGERY (MBBS) DEGREE IN THE UNIVERSITY OF BENIN, BENIN CITY

DECLARATION

We hereby declare that this research project titled "Prevalence of Household Air Pollution and Respiratory Symptoms Among Under Five Children in Ekosodin, Benin City, Edo State, Nigeria" will be conducted under supervision and has not been submitted in part or in full for any purpose.

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CERTIFICATION

This is to certify that this research study titled "**PREVALENCE OF HOUSEHOLD AIR POLLUTION AND RESPIRATORY SYMPTOMS AMONG UNDER FIVE CHILDREN IN EKOSODIN, BENIN CITY, EDO STATE, NIGERIA**" will be conducted by **ERICA OBUZOME** with matriculation number **MED1807441** and **SONIA OGHRORO** with matriculation number **MED1807449** under the supervision of Prof. A. R. Isara in the Department of Public Health and Community Medicine, College of Medical Sciences, University of Benin as part of the requirements for the award of Bachelor of Medicine, Bachelor of Surgery (MBBS) degree.

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LIST OF ABBREVIATIONS

ARI:	Acute Respiratory Infection
CO:	Carbon Monoxide
HAP:	Household Air Pollution
LGA:	Local Government Area
LPG:	Liquefied Petroleum Gas
PM2.5:	Particulate Matter ≤2.5 micrometers
SDG:	Sustainable Development Goals
SPSS:	Statistical Package for the Social Sciences
WHO:	World Health Organization

DEFINITION OF TERMS

Acute Respiratory Infection

It is an infection that interferes with normal breathing and affects the respiratory tract, including the nose, throat, airways, or lungs, often presenting with symptoms such as cough, fast breathing, and difficulty breathing.

Biomass Fuel

Organic materials such as firewood, charcoal, crop residues, and animal dung used as fuel for cooking or heating, typically associated with high levels of indoor air pollution.

Clean Fuel

Energy sources such as electricity, liquefied petroleum gas (LPG), and natural gas that produce minimal harmful emissions during use.

Household Air Pollution

It refers to indoor air contamination resulting from the use of solid fuels (such as wood, charcoal, crop waste, or dung) and inefficient cooking practices, leading to the release of harmful pollutants that affect human health.

Particulate Matter (PM2.5)

Fine inhalable particles with a diameter of 2.5 micrometers or less, capable of penetrating deep into the lungs and bloodstream, causing adverse health effects.

Under-Five Children

Children aged 0–59 months (less than five years), considered a vulnerable population group due to their developing immune and respiratory systems.

ABSTRACT

Introduction: Household air pollution (HAP) remains a major public health concern in low- and middle-income countries, particularly in Nigeria where biomass fuel use is still common. Under-five children are especially vulnerable due to their developing respiratory systems and increased exposure within household environments. Despite existing global data, there is limited community-specific evidence in peri-urban areas such as Ekosodin, Benin City.

Objectives: This study aimed to determine the prevalence of household air pollution and respiratory symptoms among under-five children in Ekosodin, Benin City, Edo State. It also sought to identify common sources of HAP and assess the association between exposure and respiratory symptoms.

Methodology: A descriptive cross-sectional study was conducted among caregivers of under-five children using a multistage sampling technique. A minimum sample size of 298 was calculated, with 280 respondents participating. Data were collected using a structured interviewer-administered questionnaire and analyzed using IBM SPSS version 27. Chi-square test and logistic regression were used to assess associations at a significance level of $p < 0.05$.

Results: The majority of households used cleaner fuels, with gas (61.1%) and electricity (14.6%) being the most common, although some still used firewood (12.9%) and kerosene (7.5%). Most households had ventilation (94.6%), but only 18.6% had smoke outlets. Cough was the most prevalent respiratory symptom (31.4%), while wheezing (8.6%) and shortness of breath (3.2%) were less common. Diagnosed respiratory illnesses such as pneumonia (2.9%) and bronchitis (2.9%) were relatively low. Significant associations were found between respiratory symptoms and use of unclean fuels ($p = 0.018$), child proximity to cooking areas ($p < 0.001$), indoor pollution sources such as mosquito coils ($p = 0.001$), place of cooking ($p < 0.001$), and indoor tobacco smoking ($p = 0.002$).

Conclusion: Despite the predominant use of cleaner fuels, household air pollution exposure remains prevalent due to other contributing factors such as cooking location, poor smoke outlet availability, and indoor pollution sources. These factors significantly influence the occurrence of respiratory symptoms among under-five children. Interventions should focus on improving household environmental practices alongside promoting clean energy use.

KEYWORDS: Household air pollution, Respiratory Symptoms, Ekosodin, Edo State, Nigeria.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Household air pollution (HAP) refers to the contamination of indoor air resulting from the use of solid biomass fuels such as firewood, charcoal, crop residues, and animal dung for cooking and heating in inadequately ventilated spaces. Combustion of these fuels releases a mixture of harmful pollutants including carbon monoxide, nitrogen dioxide, formaldehyde, and fine particulate matter which easily penetrate deep into the lungs and bloodstream. Globally, more than 2.6 billion people, mostly in low and middle-income countries, depend on these polluting fuels daily, thereby exposing themselves to toxic emissions that threaten their health and wellbeing.[1]

Children under the age of five are among the most vulnerable to the effects of household air pollution because of their smaller airways, higher breathing rates, and immature immune systems. Exposure to these pollutants increases the risk of respiratory symptoms such as persistent cough, difficulty in breathing, wheezing, and frequent colds, as well as serious conditions such as pneumonia and bronchiolitis.[2] The World Health Organization (WHO) estimates that around 3.2 million people die prematurely each year from illnesses linked to household air pollution, including about 237,000 deaths among children under five from acute lower respiratory infections.[1] This highlights the magnitude of the burden and the urgency for local-level interventions, especially in developing regions.

In Nigeria, reliance on solid biomass fuels remains widespread, particularly in rural and peri-urban communities where access to electricity or clean energy sources like liquefied petroleum gas is limited. The Nigeria Demographic and Health Survey has shown that over 70% of Nigerian households use firewood or charcoal as their main cooking fuel, with poor ventilation compounding exposure risk.[3] This practice is linked to increased cases of acute respiratory infections, chronic cough, and other respiratory symptoms among under-five children,[4] which contributes significantly to child morbidity and mortality, undermining national efforts to achieve Sustainable Development Goal 3, which aims to ensure healthy lives and promote well-being for all ages.

Furthermore, while several international studies have examined the health impacts of household air pollution, there remains a shortage of context-specific data in Nigeria particularly at the community level.[4] Urban centers like Benin City contain pockets of low-income settlements where traditional cooking practices are still prevalent, yet there is limited documentation of how these practices affect the respiratory health of children.[4] The absence of localized data makes it difficult for policymakers to design effective, targeted interventions for reducing household air pollution related health problems among vulnerable groups.

1.2 STATEMENT OF PROBLEM

Despite global efforts to reduce indoor air pollution, household air pollution remains a major and persistent public health challenge. In 2020, household air pollution was estimated to contribute to about 3.2 million premature deaths annually, including more than 237 000 deaths among children under five years of age. Approximately one-third of the world's population still depends on solid biomass, kerosene, or coal for cooking and heating in inadequately ventilated homes, leading to the release of harmful pollutants such as carbon monoxide, nitrogen dioxide, and fine particulate matter.[1] This widespread exposure to indoor air pollution has contributed significantly to the growing burden of respiratory illnesses among children who are particularly vulnerable because of their higher breathing rates, developing respiratory systems, and increased time spent near household cooking areas.[5] Hence, this remains one of the leading causes of morbidity and mortality among under-five children worldwide.

About 70% of acute respiratory infections (ARI) morbidity occurs among under-five children with a global estimate of 1.6 million deaths annually. Among under-fives, many experience about five to six episodes of ARIs yearly though those living in developing countries are reported to be 10 to 50 times more likely to die from ARIs than those in developed nations. A report from WHO states an incidence rate of 15-21% in developing countries, with over two-thirds of the global burden occurring in Africa.[6]

ARIs contribute about 3.5% of the global disease burden, these infections are responsible for 30-50% of pediatric outpatient visits and over 30% of hospital admissions in low- and middle-income countries because of the continued reliance on biomass fuels in these countries. According to UNICEF, pneumonia alone caused over 700,000 deaths among children under five in 2019, highlighting the persistent burden of respiratory illnesses in this vulnerable population.[7]

In Nigeria, the burden of household air pollution is particularly severe with the highest number of air pollution-related pneumonia deaths among children accounting for over 140,000 annually which is one of the highest burdens worldwide. National data revealed that over 70% of households rely on biomass fuels for cooking, often in poorly ventilated environments, thereby exposing children to harmful indoor smoke and increasing their vulnerability to respiratory illnesses.[8]

In Abuja, Nigeria, a study involving 317 under-fives reported that 65.2% of households used biomass fuels for cooking, and children exposed to such environments showed increased risk of acute respiratory infections. Households where there was tobacco smoking further increased the likelihood of ARIs among the children. The combined effect of biomass fuel use and poor kitchen structure increased the risk by 36%.[9]

Studies conducted in other developing countries support the link between household air pollution and respiratory illnesses in children. In Ethiopia, among 265 under-fives involved in a study, 67.5% were living in households that use biomass fuel and the prevalence of acute respiratory infections among them was 16%, with children living in households using biomass fuels being four times more likely to develop respiratory infections compared to those using cleaner energy sources.[10]

Similarly, a study in Bangladesh among 10,575 mothers having at least one under-five child showed that 40% of these mothers exclusively used biomass fuel, while 54% practiced indoor cooking. Consequently, among in-house biomass fuel users the prevalence of respiratory symptoms was 23% compared to outdoor users which was 21.9%, this further emphasizes the respiratory risk associated with household air pollution.[11] Reports from a study done in Indonesia also highlights the impact of indoor air pollution on respiratory health, as 7.2% of under-fives among 4,936 who were reported to have respiratory symptoms were associated with household air pollution.[12]

Despite various studies demonstrating the link between household air pollution and respiratory illnesses among under-five children, many households, especially in developing countries,

continue to rely on biomass fuels for daily cooking and heating. This persistent exposure, coupled with poor ventilation and other household risk factors, continues to place children at significant risk of respiratory symptoms and infections. Therefore, assessing the prevalence of household air pollution and its associated respiratory symptoms among under-five children is essential for understanding the magnitude of the problem and informing effective public health interventions.

1.3 JUSTIFICATION OF STUDY

In Nigeria, despite increasing awareness of the dangers of household air pollution, there remains a persistent gap between national-level data and the lived realities of individual communities. Many interventions and policies designed to promote clean cooking and reduce exposure to indoor smoke are developed with a general focus, often overlooking the specific social and environmental contexts that shape household energy use in peri-urban areas.

While prior studies from Nigeria have documented elevated particulate matter levels and increased respiratory symptoms in children exposed to biomass fuels,[3] these investigations seldom focus on under-five children in distinct peri-urban contexts like Ekosodin where fuel use patterns, housing design and socio-economic factors differ from rural or purely urban settings. Understanding these community-level dynamics is essential for designing strategies that are both effective and sustainable.

By generating community-level data on the prevalence of HAP and its association with respiratory symptoms among children under five in Ekosodin, this study will fill a critical evidence gap. The findings will support targeted health education campaigns, enhance local policy design (for example clean-cooking fuel promotion, improved ventilation strategies), and contribute to the achievement of SDG3 (Good Health and Well-being) and SDG7 (Affordable and Clean Energy) in similar Nigerian peri-urban environments. Moreover, the study provides a replicable model for other Nigerian communities where solid fuel dependence remains entrenched despite national progress.

1.4 AIM AND OBJECTIVES

1.4.1 GENERAL AIM

The aim of this study is to determine the prevalence of household air pollution and respiratory symptoms among under five children in Ekosodin, Benin City, Edo State, Nigeria. By generating community-level evidence, this study aims to contribute to the understanding of household air pollution and its health impacts in Nigeria, and to provide data that can support public health planning, awareness creation, and promotion of clean cooking energy use.

1.5 SPECIFIC OBJECTIVES

1. To identify the common sources of household air pollution in households with under-five children.
2. To determine the prevalence of respiratory symptoms among under-five children exposed to household air pollution.
3. To assess the association between levels of household air pollution exposure and the occurrence of respiratory symptoms in under-five children.

CHAPTER TWO

LITERATURE REVIEW

Exposure to smoke and toxic fumes from household fuel use, remains one of the leading causes of poor indoor air quality in many developing countries. In several parts of the world, especially across Africa and Asia, families continue to rely on firewood, charcoal, and other traditional fuels for cooking and heating. When these fuels are burned in kitchens that lack adequate airflow, they release harmful substances such as fine particulate matter and carbon monoxide that can irritate or damage the lungs.[1] Children under five are particularly at risk because their respiratory systems are still developing and they tend to spend more time close to cooking areas where smoke levels are highest.[2] Continuous exposure to indoor pollutants has been associated with symptoms such as frequent coughing, wheezing, and respiratory infections like pneumonia. In Nigeria, where many households still depend on biomass energy sources, the combination of economic constraints, cultural practices, and poor housing ventilation increases children's exposure to indoor smoke and its related health problems.[3]

This review will explore existing research to identify the common sources of household air pollution in households with under-five children, examine the prevalence of respiratory symptoms among children exposed to household smoke, and assess the relationship between levels of exposure and the occurrence of these symptoms. By reviewing both local and international studies, this chapter aims to highlight patterns, gaps, and key findings that provide context for understanding the burden of household air pollution on child respiratory health in Nigeria and similar settings.

2.1 COMMON SOURCES OF HOUSEHOLD AIR POLLUTION IN HOUSEHOLDS WITH UNDER-FIVES.

A community based cross-sectional study using the systematic sampling technique was conducted in 2019 in a suburban community in Edo State, Nigeria. Among the 62 households sampled with under-fives, 31 households use clean fuels such as liquefied petroleum gas (LPG) and electricity and 31 use unclean fuels such as firewood and kerosene. A combination of short-term daytime $PM_{2.5}$ monitoring with a standardized questionnaire was used to collect data and this showed that median daytime $PM_{2.5}$ concentrations were elevated across households that used unclean fuels, and a large proportion exceeded WHO guideline levels. The study identified firewood, kerosene and other household combustion activities from generators, candles and indoor frying as key local sources of indoor pollution.[4]

A community based cross-sectional study was conducted using cluster sampling method in 2018 among 436 care givers with under-fives in Ekiti State. A structured interviewer-administered questionnaire was used to collect data and findings revealed that the common household air pollutants identified in these communities were smoke from tobacco, smoke from biomass cooking fuels (such as firewood and charcoal), kerosene stove emissions, and smoke from mosquito coils and candles, with smoke from biomass cooking fuels being the most prevalent source of indoor air pollution.[13]

In 2016, a community based cross-sectional study was conducted among 715 households with under-fives in a community in Gondar City, Ethiopia. Multistage sampling technique was used to select the respondents and the questionnaire used in eliciting information was interviewer-administered. The results revealed that three fuel types were identified which were used to group the households into three categories. The first category was the high pollution fuels which included wood, dung, or straw, second category was the medium pollution fuels which included kerosene or charcoal, and the third category was low pollution fuels which included LPG and electricity.[14]

A descriptive cross-sectional study was conducted in 2018 among households with under-fives in the city of Gisenyi, the Western province of Rwanda using multistage sampling technique and 600 households were selected. A structured questionnaire was used for data collection and results showed that a large proportion of the household air pollutants observed were fine particulate matter ($PM_{2.5}$) and carbon monoxide (CO), both of which arise from indoor combustion of solid fuels such as wood and charcoal, and were primary contributors to household air pollution in the study setting.[15]

2.2 PREVALENCE OF RESPIRATORY SYMPTOMS AMONG UNDER-FIVE CHILDREN EXPOSED TO HOUSEHOLD AIR POLLUTION

A cross-sectional study was conducted in 2017 among 28,596 under-fives using cluster sampling technique, to identify household air pollution and respiratory symptoms of children in North-Western and South-Southern communities in Nigeria. The findings revealed 55.4% of the households use indoor biomass fuel in the Northern-Western province and 5.3% in the South-Southern province with a prevalence of 5.7% of ARIs in the North-Western province and 1.4% in the Soth-Southern province.[16]

In 2014, a cross-sectional study was conducted using georeferenced data from the 2014 Kenya Demographic and Health Survey with the aim to determine the association between long-term exposure to fine particulate matter and symptoms of acute respiratory infection using multistage sampling to select 7036 under-fives in Kenya. An interviewer-administered questionnaire was used to collect data and the findings showed that a prevalence of 46.8% under-fives had symptoms of acute respiratory infection.[17]

A cross-sectional study was conducted in 2016 using a structured interviewer administered questionnaire among 7006 households in Kintampo, Ghana. The study was carried out with the aim of determining the prevalence of respiratory symptoms among under-fives. The study showed that 97% of these households use polluting fuels particularly wood and charcoal, while about 0.5% use clean fuels. The results revealed the prevalence of 13.7% under-fives in households using unclean fuels had ARIs such as cough, fast breathing, and blocked nose, that is 957 out of the children in the sample.[18]

In Afghanistan, among 27,565 under-fives, a cross-sectional study was conducted in 2019 using the Afghanistan Demographic and Health Survey conducted in 2015, to assess the association between the household air pollution and acute respiratory infections in under-fives. A stratified sampling design was used in selecting the respondents and an interviewer-administered questionnaire was used to elicit information. The findings revealed that 65.2% of households use polluting solid fuels such as coal, animal dung, wood and charcoal while 34.8% use clean fuels such as natural gas, LPG, electricity and biogas. The prevalence of ARIs symptoms in under-fives living in households using solid unclean fuels was about 18.7%, while under-fives living in households using clean fuels was 15.2%.[19]

2.3 THE ASSOCIATION BETWEEN LEVELS OF HOUSEHOLD AIR POLLUTION EXPOSURE AND THE OCCURRENCE OF RESPIRATORY SYMPTOMS IN UNDER-FIVE CHILDREN.

In 2022, a cross-sectional study was conducted with the aim to determine the prevalence of ARIs among children under five and systemic sampling was used to select 251 under-fives in Sokoto state, Nigeria. A structured interviewer-administered questionnaire was used to collect data and the findings revealed that the prevalence ARIs was 17.0% among the sampled under-fives. This study concluded that the higher exposure to household air pollution and poor home environmental conditions significantly increased the likelihood of respiratory symptoms in under-fives.[20]

A cross-sectional study was conducted using cluster sampling method with the aim to identify the prevalence of ARIs in under-fives and its association with smoke exposure from wood and charcoal cooking stoves in 2012 among 520 under-fives in Western Sierra Leone in areas outside Freetown, the capital city. A structured questionnaire was used to collect data and findings revealed that 64% of under-fives who lived in households using wood stoves had ARI symptoms while there was 44% in households using charcoal stoves. This study concluded that both fuel types were linked to higher ARI prevalence, indicating a strong association between household air pollution from biomass fuels and respiratory symptoms in under-fives.[21]

In West Africa, a cross-sectional study was conducted in 2014 using a structured questionnaire among 681 households in Abidjan, Côte d'Ivoire. The aim of the study was to identify the association between respiratory symptoms and household air pollution among under-fives. The results revealed 25.6% prevalence of respiratory symptoms and the study concluded that higher household air pollution exposure was linked with higher prevalence of respiratory symptoms in under-fives.[22]

A descriptive cross-sectional study was done in 2013 using data from the Bangladesh urban health survey conducted 2013, to identify the association of biomass fuel smoke with respiratory symptoms among under five children in Bangladesh. A cluster sampling technique was used and a total of 10,575 mothers in households with under-fives were selected. The results showed that around 40% used biomass fuel irrespective of the kitchen location and 54% of them were habituated in indoor cooking with the prevalence of respiratory symptoms of under-five children among biomass users was 44.9%. This study implies that the use of in-house biomass fuel is a significant risk factor associated with respiratory symptoms of children under 5 years of age.[23]

CHAPTER THREE

METHODOLOGY

2.1 STUDY AREA

This study was conducted in Ovia North-East Local Government Area (LGA) of Edo State, Nigeria, with a specific focus on Ekosodin Community. The Ovia North-East LGA, with its administrative center in Okada town, covers an expanse of 2,301 square kilometers. It is situated within the coordinates of 5^{o} 451 to 6^{o} 151 east longitude and 5^{o} 151 to 6^{0} 451 north latitude, within the central province of Edo State.[24]

Ekosodin is a peri-urban settlement that is bounded by the University of Benin on the South, Evbhomhore community on the West, Isiohor on the North and the Ovia river on the East. Its population has increased considerably over the years, and historical records indicate that the population was about 177 in 1963, rising to 1,811 in 1991, and approximately 7,000 by the early 2000s. Due to continuous urbanization and the influx of students from the nearby University of Benin, the population has been projected to reach over 40,000 residents in recent years.

Historically, Ekosodin was established in the 19th century as a small farming settlement when the land was allocated to early settlers during the reign of Oba Obanosa of the Benin Kingdom. The early inhabitants were mainly farmers and hunters. Over time, the settlement gradually expanded due to migration and economic activities.

Ekosodin is predominantly a residential community but has evolved into a vibrant commercial area largely because of its proximity to the university. The community hosts many students, traders, artisans, and civil servants, creating a heterogeneous population structure. The presence of students has encouraged the development of several private hostels, rental apartments, and shared accommodations within the community.

In terms of infrastructure and amenities, it has experienced gradual improvements over the years. The area is accessible through several roads linking it to the University of Benin and other parts of Benin City. Government infrastructural projects such as road construction have also been undertaken to improve accessibility and economic activities in the area.

Basic social amenities available within the community include markets, small retail shops, restaurants, hostels, primary and secondary schools, boreholes, and private health facilities. Many residents depend on boreholes as the primary source of water supply, while sanitation facilities such as household toilets are available in many homes, although improvements are still needed.[25]

Administratively, Ekosodin operates under the traditional leadership system typical of Benin communities, headed by an Odionwere (village head) alongside community chiefs who oversee local affairs and community development. The community also falls under the administrative jurisdiction of Ovia North-East Local Government Area, which is responsible for providing governmental services and development initiatives within the locality.

3.2 STUDY DESIGN

A descriptive cross-sectional study design was conducted.

3.3 STUDY POPULATION

This study was carried out among caregivers of under-fives.

3.4 SELECTION CRITERIA

3.4.1 INCLUSION CRITERIA

Caregivers who were 18 years and above.

3.5 SAMPLE SIZE DETERMINATION

The minimum sample size (n) was calculated using the Cochran's formula for descriptive studies.[26]

$$n = \frac{Z^2pq}{d^2}$$

Where:

n = Minimum sample size

Z = Standard normal deviation set at 95% confidence interval (1.96)

P = Prevalence rate of a particular characteristic of the target population

q = 1- p

d = Degree of precision set at 0.05 confidence interval

For this study, p was assumed to be 77.4% which was based on a descriptive cross-sectional study done in Isiohor, Benin city to investigate household air pollution and respiratory symptoms of children and the reported prevalence was 77.4%.[4]

A p-value of 77.4% was used

P = 77.4%

=77.4/100

= 0.774

q = 1 - 0.774

= 0.226

d = 0.05

The minimum sample size was calculated as:

$$n = \frac{(1.96)^2 (0.774) (1- 0.774)}{(0.05)^2}$$

n = 269

Therefore, the minimum sample size for this study was 269

To account for the non-response (nR), a 10% non-response rate was added to the minimum sample size, using the formula for non-response rate;

$n = n0/ 1 - r$

Where;

n0 - Initial sample size = 269

r - non-response rate = 10% =0.10

Hence;

= 269/ 1 – 0.10

= 298

A minimum sample size of 298 was calculated.

3.6 SAMPLING TECHNIQUE

A multistage sampling technique was employed to select respondents for this study.

STAGE ONE: SELECTION OF STREET

There was a total of 15 streets, out of which 7 streets were selected by simple random sampling method using balloting.

STAGE TWO: SELECTION OF HOUSES

The total number of houses in the selected streets were enumerated and then houses chosen by simple random sampling through balloting.

STAGE THREE: SELECTION OF RESPONDENTS

In the selected houses, eligible respondents were selected. This approach enhanced the fairness of participant selection by ensuring each household had an equal chance of being included in the study.

3.7 DATA MANAGEMENT

3.7.1 METHOD OF DATA COLLECTION

This study utilized a quantitative method of data collection, using a structured pre-tested interviewer-administered questionnaire.

3.7.2 TOOLS FOR DATA COLLECTION

The questionnaire was adapted from a community-based cross-sectional survey and Nigeria Demographic and Health Survey on household air pollution and respiratory health in Nigeria. It was designed to collect information from caregivers of under-five children on household air pollution sources and respiratory symptoms.[4,27] The questions were divided into three (3) sections as follows:

Section A: Socio-demographic Data

Section B: Sources of Household Air Pollution

Section C: Prevalence of Respiratory Symptoms Among Under-Fives Exposed to Household Air Pollution

3.7.3 PRETESTING

The pretesting was conducted using 10% of the sample size to prevent complexity in the google form questionnaire. It was carried out among caregivers of under-fives in Oba Ewuare community, Benin City.

3.7.4 DATA ANALYSIS

Data was analyzed using IBM SPSS (Statistical Package for Social Sciences) version 27.0. Univariate analysis was conducted to assess measures of central tendency (mean, median and mode) and measures of dispersion (standard deviation and variance). Bivariate analysis using the chi-square test was employed to examine association between HAP exposure and the occurrence of respiratory symptoms in under-fives. A p-value of less than 0.05 was considered statically significant.

3.7.5 MEASUREMENT OF VARIABLES AND SCORING

SOURCES OF HOUSEHOLD AIR POLLUTION

There were nine questions (Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16) designed to assess sources of household air pollution under the domains of type of cooking fuel, location of cooking, ventilation of cooking area, indoor smoking, presence of other indoor smoke sources, and the child's exposure to the cooking environment. The results were analyzed using frequencies and percentages to identify the common sources of household air pollution among households with under-five children.[4]

PREVALENCE OF RESPIRATORY SYMPTOMS AMONG UNDER-FIVES EXPOSED TO HOUSEHOLD AIR POLLUTION

There were seven questions (Q21, Q22, Q23, Q24, Q25, Q26, Q27) designed to assess respiratory symptoms among under-five children under the domains of cough, duration of cough, wheezing, shortness of breath, chest congestion, physician-diagnosed respiratory illness and absenteeism from school/daycare due to respiratory illness.

Responses were coded as Yes = 1 and No = 0.

A child was classified as having symptoms of ARI if the caregiver reported cough within the last two weeks (Q21) together with difficulty or fast breathing (Q24), children who did not meet this criterion were classified as not having ARI symptoms.

The prevalence of respiratory symptoms was calculated by dividing the number of under-five children with respiratory symptoms by the total number of under-five children surveyed, expressed as a percentage.[27]

ASSOCIATION BETWEEN HOUSEHOLD AIR POLLUTION EXPOSURE AND THE OCCURRENCE OF RESPIRATORY SYMPTOMS

The association between household air pollution and respiratory symptoms among under-five children was examined using binary logistic regression analysis.

Respiratory symptoms were coded as 1 (presence of a respiratory symptom) and 0 (absence of a respiratory symptom), independent variables included types of cooking fuel and other household environmental factors.

Variables significant at $p < 0.05$ in bivariate analysis were entered into the multivariable logistic regression model to determine adjusted odds ratios and 95% confidence intervals.

3.7.6 DATA PRESENTATION

Results obtained were presented using frequency distribution tables, contingency tables, charts and prose.

3.8 ETHICAL CONSIDERATION

Ethical approval for the study was sought from the Ethics and Research Committee of the University of Benin Teaching Hospital (ADM/E22/A/VOL.VII/14865491272121) and permission requested from the Odionwere of Ekosodin community. Prior to questionnaire administration, verbally informed consent was obtained from all participants. The confidentiality and privacy of respondents was strictly maintained throughout the study. Participation was entirely be voluntary, and respondents retained the right to withdraw from the study at any time without any consequences.

CHAPTER FOUR

RESULTS

A total of 280 respondents participated in the study with 100% response rate. The results are presented in the following sections in line with the specific objectives.

SECTION A: Socio-demographic characteristics of respondents

SECTION B: Sources of air pollution

SECTION C: Prevalence of respiratory symptoms

SECTION D: Association between levels of air pollution and occurrence of respiratory symptoms

Table 1: Sociodemographic characteristics of respondents

Variables	Frequency (n = 280)	Percent
Age group (months)		
0 – 23	63	22.5
24 – 59	217	77.5
Mean±SD	29.6±12.5	
Sex of child		
Male	146	52.1
Female	134	47.9
Ethnicity		
Benin	105	37.5
Esan	35	12.5
Estako	35	12.5
Yoruba	18	6.4
Hausa	14	5.0
Urhobo	26	9.3
Others*	16	5.7
Religion		
Christianity	254	91.0
Islam	25	9.0
Size of household		
<4	20	7.1
≥4	260	92.9
Number of siblings		
<3	197	70.4
≥3	83	29.6
Position of child in family		
<3	168	60.2
≥3	112	39.8
Informant		
Father	70	25.0
Mother	188	67.1
Siblings	17	6.1
Aunty	2	0.8
Grandmother	3	1.1
Primary caregiver of child		
Father	84	30.0
Mother	196	70.0
Family type		
Nuclear	251	89.6
Extended	29	10.4
Occupation of father		
Skill level 0	3	1.1
Skill level 1	46	16.4
Skill level 2	201	71.8
Skill level 3	9	3.2
Skill level 4	21	7.5
Occupation of mother		
Skill level 0	3	1.1
Skill level 1	77	27.5
Skill level 2	157	56.1
Skill level 3	8	2.9
Skill level 4	35	12.5

Most children were aged 24–59 months, accounting for 217 (77.5%), while 63 (22.5%) were aged 0–23 months. The mean age was 29.6 ± 12.5 months. Slightly more than half of the children were male 146 (52.1%), while females accounted for 134 (47.9%).

In terms of ethnicity, Benin constituted the largest group 105 (37.5%), followed by Esan 35 (12.5%), Estako 35 (12.5%), Urhobo 26 (9.3%), Yoruba 18 (6.4%), Hausa 14 (5.0%), and others 16 (5.7%).

Most respondents were Christians 254 (91.0%), while 25 (9.0%) were Muslims.

Regarding household characteristics, most children came from households with four or more members 260 (92.9%), while only 20 (7.1%) were from households with fewer than four members. In terms of number of siblings, 197 (70.4%) had fewer than three siblings, while 83 (29.6%) had three or more. Similarly, 168 (60.2%) of the children were within the first to third birth order, while 112 (39.8%) were in the fourth birth order or higher.

With respect to informants, most information was provided by mothers 188 (67.1%), followed by fathers 70 (25.0%), while siblings, aunts, and grandmothers accounted for a small proportion. Likewise, the primary caregivers were mainly mothers 196 (70.0%), compared to fathers 84 (30.0%).

Most households were nuclear families at 251 (89.6%), while 29 (10.4%) were extended family structures.

Regarding parental occupation, most fathers were in skill level 2 occupations 201 (71.8%), followed by skill level 1 46 (16.4%), while fewer were in skill level 4 21 (7.5%), skill level 3 9 (3.2%), and skill level 0 3 (1.1%). A similar pattern was observed among mothers, where 157 (56.1%) were in skill level 2 occupations, 77 (27.5%) in skill level 1, 35 (12.5%) in skill level 4, 8 (2.9%) in skill level 3, and 3 (1.1%) in skill level 0.

Table 2: Sources of household air pollution

Variables	Frequency (n = 280)	Percent
Main type of cooking fuel used		
Gas	171	61.1
Electricity	41	14.6
Firewood	36	12.9
Kerosene	21	7.5
Charcoal	11	3.9
Where cooking is usually done		
Inside a separate kitchen	221	78.9
Outside the house	40	14.3
Inside the house (no separate kitchen)	19	6.8
Cooking area has ventilation (windows/chimney)		
Yes	265	94.6
No	15	5.4
Smoke outlet in cooking area		
Yes	52	18.6
No	228	81.4
How often smoke from cooking fills the house		
Rarely	180	64.3
Sometimes	56	20.0
Never	43	15.4
Household members smoke tobacco indoors		
Yes	9	3.2
No	271	96.8
Indoor sources of smoke used		
None	240	85.7
Mosquito coils	36	12.9
Generator	2	0.7
Burning waste	2	0.7
Child stays near cooking area while cooking is ongoing		
Yes	42	15.0
No	238	85.0
Average hours of child exposure to indoor smoke per day		
<1 hour	252	90.0
1–3 hours	27	9.6
>3 hours	1	0.4

Most households used cleaner sources of cooking fuel, with gas being the most common at 171 (61.1%), followed by electricity 41 (14.6%), while smaller proportions relied on firewood 36 (12.9%), kerosene 21 (7.5%), and charcoal 11 (3.9%). Most respondents reported cooking inside a separate kitchen 221 (78.9%), whereas fewer cooked outside the house 40 (14.3%) or inside the house without a separate kitchen 19 (6.8%).

A large proportion of cooking areas had some form of ventilation, as 265 (94.6%) reported the presence of windows or chimneys. However, only 52 (18.6%) had a designated smoke outlet, while the majority 228 (81.4%) did not. In terms of smoke exposure, most respondents indicated that smoke rarely filled the house 180 (64.3%), while 56 (20.0%) reported this occurred sometimes, 43 (15.4%) never experienced it, and only 1 (0.4%) reported it always occurred.

Exposure to other indoor pollutants was relatively low, as most households reported no indoor smoking 271 (96.8%) and no additional indoor sources of smoke 240 (85.7%). Among those who reported other sources, mosquito coils were the most common 36 (12.9%), while very few used generators or burned waste indoors 2 (0.7%) each.

Regarding child exposure, most respondents indicated that children did not stay near the cooking area during cooking 238 (85.0%), while 42 (15.0%) reported that they did. Consequently, most children were exposed to indoor smoke for less than one hour daily 252 (90.0%), while smaller proportions were exposed for 1–3 hours 27 (9.6%) or more than 3 hours 1 (0.4%).

Overall, the findings suggest that while most households adopt relatively cleaner cooking practices and maintain good ventilation, gaps remain in the provision of smoke outlets and in minimizing indoor smoke exposure.

Table 3: Socio-demographic characteristics and exposure to air pollution among respondents

Variables	Air pollution		Test statistic	p-value
	Exposed n (%)	Not exposed n (%)		
Age Group of Child			3.640*	0.074
0–23 months	63 (100.0)	0 (0.0)		
24–59 months	205 (94.5)	12 (5.5)		
Sex of Child			0.193	0.661
Male	139 (95.2%)	7 (4.8)		
Female	129 (96.3%)	5 (3.7)		
Religion			1.234*	0.609
Christianity	242 (95.3)	12 (4.7)		
Islam	25 (100.0)	0 (0.0)		
Ethnicity			0.093*	0.768
Edo Indigene	168 (96.0)	7 (4.0)		
Non-Edo	100 (95.2)	5 (4.8)		
Occupation of Father			21.237*	**<0.001**
Skill 0	3 (100.0)	0 (0.0)		
Skill 1	46 (100.0)	0 (0.0)		
Skill 2	195 (97.0)	6 (3.0)		
Skill 3	7 (77.8)	2 (22.2)		
Skill 4	17 (81.0)	4 (19.0)		
Occupation of Mother			16.483*	**0.002**
Skill 0	3 (100.0)	0 (0.0)		
Skill 1	73 (94.8)	4 (5.2)		
Skill 2	155 (98.7)	2 (1.3)		
Skill 3	6 (75.0)	2 (25.0)		
Skill 4	31 (88.6)	4 (11.4)		
Family Type			0.055*	1.000
Nuclear	240 (95.6)	11 (4.4)		
Extended	28 (96.6)	1 (3.4)		
Household Size			0.964*	1.000
<4 members	20 (100.0)	0 (0.0)		
≥4 members	248 (95.4)	12 (4.6)		
Number of Siblings			1.012*	0.519
<3	187 (94.9)	10 (5.1)		
≥3	81 (97.6)	2 (2.4)		
Position of Child			3.782*	0.070
<3	164 (97.6)	4 (2.4)		
≥3	103 (92.8)	8 (7.2)		
Informant			0.464*	0.736
Father	68 (97.1)	2 (2.9)		
Mother	200 (95.2)	10 (4.8)		
Primary caregiver			0.149*	1.000
Father	81 (96.4)	3 (3.6)		
Mother	187 (95.4)	9 (4.6)		

Age group of the child was not significantly associated with exposure to air pollution (p = 0.074). However, all children aged 0–23 months were exposed 63 (100.0%), while among those aged 24–59 months, 205 (94.5%) were exposed and 12 (5.5%) were not exposed.

Sex of the child showed similar distributions and was not statistically significant (p = 0.661). Male children had 139 (95.2%) exposed and 7 (4.8%) not exposed, while females had 129 (96.3%) exposed and 5 (3.7%) not exposed.

Religion was also not significantly associated with exposure (p = 0.609). Among Christians, 242 (95.3%) were exposed and 12 (4.7%) not exposed, whereas all respondents practicing Islam were exposed 25 (100.0%).

Ethnicity showed no significant association (p = 0.768), with Edo indigenes having 168 (96.0%) exposed and 7 (4.0%) not exposed, while non-Edo respondents had 100 (95.2%) exposed and 5 (4.8%) not exposed.

Occupation of the father was significantly associated with exposure to air pollution (p < 0.001). All respondents whose fathers were in skill levels 0 and 1 were exposed 3 (100.0%) and 46 (100.0%) respectively. Exposure was also high among skill level 2 [195 (97.0%)], but lower proportions were observed among higher skill levels, particularly skill level 3 [7 (77.8%) exposed, 2 (22.2%) not exposed] and skill level 4 [17 (81.0%) exposed, 4 (19.0%) not exposed].

Similarly, occupation of the mother showed a statistically significant association with exposure (p = 0.002). While all respondents in skill level 0 were exposed 3 (100.0%), lower exposure proportions were seen in higher skill levels, such as skill level 3 [6 (75.0%) exposed, 2 (25.0%) not exposed] and skill level 4 [31 (88.6%) exposed, 4 (11.4%) not exposed].

Family type was not significantly associated with exposure (p = 1.000), with nuclear families having 240 (95.6%) exposed and 11 (4.4%) not exposed, and extended families having 28 (96.6%) exposed and 1 (3.4%) not exposed.

Household size also showed no significant association (p = 1.000). All households with fewer than 4 members were exposed 20 (100.0%), while among those with ≥4 members, 248 (95.4%) were exposed and 12 (4.6%) not exposed.

Number of siblings was not significantly associated with exposure (p = 0.519). Households with fewer than 3 siblings had 187 (94.9%) exposed and 10 (5.1%) not exposed, while those with ≥3 siblings had 81 (97.6%) exposed and 2 (2.4%) not exposed.

Position of the child in the family was also not statistically significant (p = 0.070), although children with birth order <3 had a higher exposure 164 (97.6%) compared to those ≥3 [103 (92.8%)].

Informant type showed no significant association (p = 0.736), with fathers reporting 68 (97.1%) exposed and 2 (2.9%) not exposed, and mothers reporting 200 (95.2%) exposed and 10 (4.8%) not exposed.

Primary caregiver was not significantly associated with exposure (0.149, p = 1.000), with similar distributions between fathers [81 (96.4%) exposed, 3 (3.6%) not exposed] and mothers [187 (95.4%) exposed, 9 (4.6%) not exposed].

Table 4: Prevalence of respiratory symptoms among respondents

Variables	Frequency (n=280)	Percent
Cough in the past 2 weeks		
Yes	88	31.4
No	192	68.6
Duration of cough(n=88)		
<1 week	58	65.9
1–2 weeks	26	29.5
>2 weeks	4	4.5
wheezing or whistling sounds when breathing in the past 12 months?		
Yes	24	8.6
No	256	91.4
shortness of breath during play or activity?		
Yes	9	3.2
No	271	96.8
chest congestion or difficulty breathing?		
Yes	9	3.2
No	271	96.8
Respiratory illness diagnosed in the past 12 months		
Pneumonia	8	2.9
Asthma	6	2.1
Bronchitis	8	2.9
None	258	92.1
Has the child been absent from school/daycare due to respiratory illness?		
Yes	27	9.6
No	253	90.4

About one-third of the children had experienced cough in the past two weeks, accounting for 88 (31.4%), while the majority 192 (68.6%) had no cough. Among those who had cough (n = 88), most cases were short in duration, with 58 (65.9%) lasting less than one week, 26 (29.5%) lasting 1–2 weeks, and only 4 (4.5%) lasting more than two weeks.

A small proportion of respondents reported wheezing or whistling sounds during breathing in the past 12 months, 24 (8.6%), whereas the majority 256 (91.4%) did not. Similarly, very few children experienced shortness of breath during play or activity 9 (3.2%) or chest congestion/difficulty breathing 9 (3.2%), with most children not experiencing these symptoms.

In terms of diagnosed respiratory illnesses within the past 12 months, the vast majority had no diagnosis 258 (92.1%). Among those diagnosed, pneumonia and bronchitis were the most common, each reported in 8 (2.9%) of children, while asthma was reported in 6 (2.1%).

Regarding the impact on daily activities, 27 (9.6%) of children were absent from school or daycare due to respiratory illness, whereas 253 (90.4%) had not. Overall, respiratory symptoms and diagnosed illnesses were relatively low among the study population, with cough being the most reported symptom.

Table 5: Socio-demographic characteristics and prevalence of respiratory symptoms among respondents

Variables	Respiratory symptoms		Test statistic	p-value
	Yes n(%)	No n(%)		
Age			0.048	0.826
0–23 months	24 (38.1)	39 (61.9)		
24–59 months	86 (39.6)	131 (60.4)		
Sex of Child			0.796	0.372
Male	61 (41.8)	85 (58.2)		
Female	49 (36.6)	85 (63.4)		
Religion			5.054	**0.025**
Christianity	94 (37.0)	160 (63.0)		
Islam	15 (60.0)	10 (40.0)		
Ethnicity			0.196	0.658
Edo Indigene	67 (38.3)	108 (61.7)		
Non-Edo	43 (41.0)	62 (59.0)		
Occupation of Father				
Skill 0			5.998*	0.199
Skill 1	1 (33.3)	2 (66.7)		
Skill 2	23 (50.0)	23 (50.0)		
Skill 3	79 (39.3)	122 (60.7)		
Skill 4	3 (33.3)	6 (66.7)		
Occupation of Mother			2.493*	0.646
Skill 0	0 (0.0)	3 (100.0)		
Skill 1	31 (40.3)	46 (59.7)		
Skill 2	64 (40.8)	93 (59.2)		
Skill 3	3 (37.5)	5 (62.5)		
Skill 4	12 (34.3)	23 (65.7)		
Family Type			0.313	0.576
Nuclear	100 (39.8)	151 (60.2)		
Extended	10 (34.5)	19 (65.5)		
Household Size			1.843	0.175
<4 members	5 (25.0)	15 (75.0)		
≥4 members	105 (40.4)	155 (59.6)		
Number of Siblings			12.878	**<0.001**
<3	64 (32.5)	133 (67.5)		
≥3	46 (55.4)	37 (44.6)		
Position of Child			0.656	0.418
<3	63 (37.5)	105 (62.5)		
≥3	47 (42.3)	64 (57.7)		
Informant			1.617	0.203
Father	23 (32.9)	47 (67.1)		
Mother	87 (41.4)	123 (58.6)		
Primary caregiver			2.567	0.109
Father	27 (32.1)	57 (67.9)		
Mother	83 (42.3)	113 (57.7)		

Age group of the child was not significantly associated with respiratory symptoms ($p = 0.074$). However, all children aged 0–23 months had respiratory symptoms 63 (100.0%), while among those aged 24–59 months, 205 (94.5%) had symptoms and 12 (5.5%) did not.

Sex of the child showed similar distributions and was not statistically significant ($p = 0.661$). Male children had 139 (95.2%) with respiratory symptoms and 7 (4.8%) without, while females had 129 (96.3%) with symptoms and 5 (3.7%) without.

Religion was also not significantly associated with respiratory symptoms ($p = 0.609$). Among Christians, 242 (95.3%) had respiratory symptoms and 12 (4.7%) did not, whereas all respondents practicing Islam had respiratory symptoms 25 (100.0%).

Ethnicity showed no significant association ($p = 0.768$), with Edo indigenes having 168 (96.0%) with respiratory symptoms and 7 (4.0%) without, while non-Edo respondents had 100 (95.2%) with symptoms and 5 (4.8%) without.

Occupation of the father was significantly associated with respiratory symptoms ($p < 0.001$). All children whose fathers were in skill levels 0 and 1 had respiratory symptoms 3 (100.0%) and 46 (100.0%) respectively. Although prevalence remained high among skill level 2 [195 (97.0%)], lower proportions were observed in higher skill levels, particularly skill level 3 [7 (77.8%) with symptoms, 2 (22.2%) without] and skill level 4 [17 (81.0%) with symptoms, 4 (19.0%) without].

Similarly, occupation of the mother showed a statistically significant association with respiratory symptoms ($p = 0.002$). While all children in skill level 0 had symptoms 3 (100.0%), lower prevalence was observed in higher skill levels, such as skill level 3 [6 (75.0%) with symptoms, 2 (25.0%) without] and skill level 4 [31 (88.6%) with symptoms, 4 (11.4%) without].

Family type was not significantly associated with respiratory symptoms (p = 1.000), with nuclear families having 240 (95.6%) with symptoms and 11 (4.4%) without, and extended families having 28 (96.6%) with symptoms and 1 (3.4%) without.

Household size also showed no significant association (p = 1.000). All households with fewer than 4 members had children with respiratory symptoms 20 (100.0%), while among those with ≥4 members, 248 (95.4%) had symptoms and 12 (4.6%) did not.

Number of siblings was not significantly associated with respiratory symptoms (p = 0.519). Households with fewer than 3 siblings had 187 (94.9%) with symptoms and 10 (5.1%) without, while those with ≥3 siblings had 81 (97.6%) with symptoms and 2 (2.4%) without.

Position of the child in the family was also not statistically significant (p = 0.070), although children with birth order <3 had a slightly higher prevalence of symptoms 164 (97.6%) compared to those ≥3 [103 (92.8%) with symptoms and 8 (7.2%) without].

Informant type showed no significant association (p = 0.736), with fathers reporting 68 (97.1%) with respiratory symptoms and 2 (2.9%) without, and mothers reporting 200 (95.2%) with symptoms and 10 (4.8%) without.

Primary caregiver was not significantly associated with respiratory symptoms (p = 1.000), with similar distributions between fathers [81 (96.4%) with symptoms and 3 (3.6%) without] and mothers [187 (95.4%) with symptoms and 9 (4.6%) without].

Table 6: Air pollution and respiratory symptoms

Variables	Respiratory symptoms		Test statistic	p-value
	yes n(%)	no n(%)		
Fuel type			5.590	0.018
Clean fuel	75 (35.4)	137 (64.6)		
Unclean fuel	35 (51.5)	33 (48.5)		
Smoke outlet			1.942	0.163
No smoke outlet	94 (41.2)	134 (58.8)		
Smoke outlet present	16 (30.8)	36 (69.2)		
Ventilation			2.851	0.091
Not ventilated	9 (60.0)	6 (40.0)		
Ventilated	101 (38.1)	164 (61.9)		
Child near cooking area			31.972	**<0.001**
No	77 (32.4)	161 (67.6)		
Yes	33 (78.6)	9 (21.4)		
Indoor air pollution sources			17.543	**0.001**
None	83 (34.6)	157 (65.4)		
Mosquito coils	23 (63.9)	13 (36.1)		
Generator fumes	2 (100.0)	0 (0.0)		
Burning waste	2 (100.0)	0 (0.0)		
Place of cooking			18.613	**<0.001**
Inside a separate kitchen	73 (33.0)	148 (67.0)		
Inside the house (no separate kitchen)	14 (73.7)	5 (26.3)		
Outside the house	23 (57.5)	17 (42.5)		
Indoors tobacco smoking			9.592	**0.002**
No	102 (37.6)	169 (62.4)		
Yes	8 (88.9)	1 (11.1)		

Type of cooking fuel used was significantly associated with respiratory symptoms (p = 0.018). Respondents using unclean fuel had a higher proportion of respiratory symptoms, with 35 (51.5%) reporting symptoms and 33 (48.5%) without symptoms. In contrast, those using clean fuel had a lower prevalence, with 75 (35.4%) reporting symptoms and 137 (64.6%) without symptoms.

Presence of a smoke outlet was not significantly associated with respiratory symptoms (p = 0.163). Among households without a smoke outlet, 94 (41.2%) had respiratory symptoms while 134 (58.8%) did not. Conversely, households with a smoke outlet present had fewer cases of symptoms, with 16 (30.8%) reporting symptoms and 36 (69.2%) without.

Ventilation was also not significantly associated with respiratory symptoms ($p = 0.091$). However, a higher proportion of respiratory symptoms was observed in non-ventilated households, with 9 (60.0%) reporting symptoms compared to 6 (40.0%) without. In contrast, ventilated households had 101 (38.1%) with symptoms and 164 (61.9%) without symptoms.

Child being near the cooking area was significantly associated with respiratory symptoms ($p < 0.001$). Among children not near the cooking area, 77 (32.4%) had respiratory symptoms while 161 (67.6%) did not. In contrast, children exposed to the cooking area had a much higher prevalence of symptoms, with 33 (78.6%) affected and only 9 (21.4%) without symptoms.

Indoor air pollution sources were also significantly associated with respiratory symptoms ($p = 0.001$). Households with no indoor pollution sources had 83 (34.6%) children with symptoms and 157 (65.4%) without. However, higher proportions of symptoms were observed among households using mosquito coils [23 (63.9%)], generator fumes [2 (100.0%)], and burning waste [2 (100.0%)], compared to those with no source of indoor pollution.

Place of cooking was significantly associated with respiratory symptoms ($p < 0.001$). Cooking inside a separate kitchen was associated with fewer symptoms, with 73 (33.0%) affected and 148 (67.0%) not affected. In contrast, cooking inside the house without a separate kitchen showed a higher prevalence of symptoms, with 14 (73.7%) affected and 5 (26.3%) without symptoms, while cooking outside the house showed 23 (57.5%) with symptoms and 17 (42.5%) without. Household tobacco smoking indoors was also significantly associated with respiratory symptoms ($p = 0.002$). Among households without indoor smoking, 102 (37.6%) had respiratory symptoms and 169 (62.4%) did not. In contrast, households with indoor tobacco smoking had a much higher prevalence of symptoms, with 8 (88.9%) affected and only 1 (11.1%) without symptoms.

CHAPTER FIVE

DISCUSSION

Household air pollution arising from the use of solid fuels for cooking and other non-cooking sources is known to have adverse health effects, especially acute respiratory infection in under-fives and this study carried out in Ekosodin, Benin City profiles this.

This study revealed that majority of the households used cleaner cooking fuels, and this could be because most households' heads had gainful employment and hence had the financial capacity to afford cleaner cooking fuels like electricity and gas as opposed to some households that used charcoal, firewood, and kerosene. Use of cleaner cooking fuels is beneficial in the long run as it decreases the overall risk of exposure to household air pollutants which can contribute to morbidity and mortality.

This is similar to a study which showed that solid fuels were the main source of cooking fuels in developing countries. This could be due to the fact that poverty is a major constraint to move up the energy ladder as clean fuels are more costly and people generally move up the energy ladder as their socio-economic conditions improve.[28] Another study from Peru found that switching from cleaner fuel to polluting cooking fuels increased the chances of suffering a life-threatening respiratory illness.[29]

Another notable observation from this study was that most households had well-ventilated cooking areas with windows. This could be attributable to modern architectural designs that most present building patterns have followed over the past years. This is important because cooking in a separate kitchen helps reduce the spread of smoke within the indoor space and adequate ventilation helps decrease the concentration of the smoke inhaled which overall reduces the intensity and duration of exposure of under-fives as they are more vulnerable to air pollution because of their delicate lung tissue and easy susceptibility to infection. Despite a high proportion of households reporting adequate ventilation, the study showed that most kitchen areas did not have a designated smoke outlet like an air vent or exhaust fan, that primarily serve to convey pollutants such as smoke and dust away from the environment as windows and doors alone may not be sufficient enough to do the work efficiently, hence absence of these outlets lead to accumulation of air pollutants even with the presence of separate kitchens.

Children in households where cooking was done inside the house without a separate kitchen had more symptoms than those in households with separate kitchens. This is because when cooking is done inside living areas, smoke, which is culprit air pollutant, gets mixed with the normal air that's being taken in by the children, and this is very detrimental to their respiratory health. Even when clean fuels are used, poor cooking areas can increase exposure to smoke, fumes, and other indoor pollutants.

A study conducted in Uganda showed a different method of reducing smoke exposure was identified and that is the presence of the cooking area completely outside the living house, as children who lived in households where cooking was done inside their living house had an increased risk of coming down with respiratory symptoms.[30] This could be attributed to the fact that outside cooking is protective as it prevents pollutants accumulation from cooking fuels as smoke dissipates quickly reducing exposure and lowering the risk of respiratory problems. Another similar study showed that the odds of acute respiratory infection in children who lived in poorly ventilated houses was four times higher than those living in houses that had good ventilation.[31] This is because the numbers of doors and windows are pertinent in improving house ventilation and this further equates to less chance of exposure to indoor air pollutants.

Another finding from this study revealed that tobacco smoke, mosquito coils, generator fumes, and waste burning were other sources of indoor air pollutants identified. Mosquito coils ranked the most common and this is because it is widely used in many Nigerian homes to prevent mosquitoes, but they release smoke and chemical pollutants which have harmful effects on the respiratory system.

In West Africa, these are important public health problems mainly because of poor electricity, weak waste management system, high mosquito density due to malaria, poverty and lack of strict environmental health enforcement. Hence, most people settle for these methods because they are cheap, even though they are very harmful to their health.

A study done in suburban communities in Nigeria revealed the adverse respiratory health effects associated with chronic exposure to household generator fumes, with symptoms like chronic cough, shortness of breath and wheezing corelating strongly with both frequency and proximity of generator use.[32]

A salient finding noted in this study was reduced duration of time spent by under-fives near smoke sources like cooking areas. This is of great public health significance because children who stay near smoke sources directly inhale harmful emissions and because their lungs are still developing and highly sensitive, continuous inhalation weakens their natural defense mechanisms such as mucus lining and immune cells that normally help trap germs. Once this happens, microorganisms easily infect the respiratory tract hence leading to presence of respiratory symptoms.

This is similar with a study which showed that children carried by their mother or caregivers while cooking were more likely to have respiratory infections.[33] Another contrast study showed the odds of acute respiratory infection been higher in children who had been carried on the back while cooking than those who had never been carried while cooking.[31] Carrying child on the back of mothers while cooking is a deep rooted culture especially in Africa, where mothers are responsible for taking care of their children and preparing meal for the family but this can be resolved by teaching mothers or caregivers about the danger of smoke exposure to children and encouraging safer childcare practices during cooking like leaving the child with another adult or in a safe nearby space while cooking is ongoing, also choosing cooking time to coincide with sleep period of the child or creating a playdate with other kids to enable caregiver have time to cook.

Another finding from this study showed that cough was the most prevalent respiratory symptom among under-fives as opposed to other severe symptoms such as wheezing, shortness of breath, and asthma. A high rate of cough among under-fives shows that many are constantly exposed to air pollutants and this signals poor household air quality and a preventable cause of childhood illness and death mainly because of everyday practices such as cooking and use of harmful fuels indoors. Similar to this finding, a study showed that children living in environments with indoor air pollution experienced respiratory illnesses such as persistent night cough, nose irritation, wheezing and a smaller number of doctor diagnosed asthma cases.[34]

Overall, the study greatly demonstrates that children's respiratory health is closely linked to indoor air quality, cooking practices and exposure to household smoke pollutants. Cleaner fuels, proper cooking spaces, reduced indoor smoke sources and keeping children away from cooking areas appear important in reducing respiratory symptoms.

CONCLUSION

This study revealed that the common sources of household air pollution among households with under-five children in Ekosodin were mainly cooking-related and indoor combustion sources.

The study also revealed that the prevalence of respiratory symptoms among under-five children was moderate, with cough being the most reported symptom, the presence of respiratory symptoms among a considerable proportion of under-five children shows that household air pollution remains an important child health concern in the community.

This study also found a significant association between household air pollution and the occurrence of respiratory symptoms, demonstrating that unclean fuel types were independently associated with significantly higher acute respiratory infection prevalence.

RECOMMENDATIONS

1. The Federal Government, through the Ministry of Health and Ministry of Environment should strengthen policies that promote access to clean and affordable household energy sources, especially gas and electricity, in peri-urban communities.
2. The Edo State Government should support community-based clean cooking campaigns that educate households on the dangers of firewood, kerosene, charcoal, mosquito coils, burning waste, generator fumes, and indoor tobacco smoking.
3. The Ovia North-East Local Government Authority should collaborate with community leaders in Ekosodin to organize regular sensitization programmes on household air pollution and prevention of respiratory symptoms among under-five children.
4. Primary healthcare workers should educate caregivers during immunization clinics, antenatal clinics, and child welfare clinics on the importance of keeping children away from cooking areas while cooking is ongoing.
5. Caregivers should avoid using unclean fuels such as firewood, charcoal, and kerosene whenever cleaner alternatives are available and affordable.

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APPENDIX I

CONSENT FORM

TITLE OF STUDY: PREVALENCE OF HOUSEHOLD AIR POLLUTION AND RESPIRATORY SYMPTOMS AMONG UNDER FIVE CHILDREN IN EKOSODIN, BENIN CITY, EDO STATE, NIGERIA

INSTITUTION: Department of Public Health and Community Medicine, College of Medicine, University of Benin, Benin city, Edo state, Nigeria.

PRINCIPAL INVESTIGATORS: ERICA OBUZOME AND SONIA OGHRORO

SUPERVISOR: PROFESSOR A. R. ISARA

PARTICIPATION: Participation in this study is voluntary. Refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may discontinue your participation at any time without penalty or loss of benefits. The principal investigators may decide to withdraw from the study if we are unable to obtain the necessary information.

INTRODUCTION: We are interested in determining the Prevalence of Household Air Pollution and Respiratory Symptoms Among Under Five Children in Ekosodin, Benin City, Edo State, Nigeria.

PROCEDURES TO BE FOLLOWED

If respondents agree to participate, an interview-based online questionnaire will be used to obtain information from such respondents and this questionnaire will identify the common sources of household air pollution and the prevalence of respiratory symptoms among under-fives exposed to household air pollution among under-fives.

BENEFITS: Participants would contribute to important research that may help improve public health promotion strategies. The results obtained from this research work would help us identify the association between household air pollution exposure and the occurrence of respiratory symptoms with the aim of providing targeted health education campaigns, enhancing local policy design for clean-cooking fuel promotion and improved ventilation strategies.

COMPENSATION: Participants will not receive any compensation for their participation.

DURATION OF PARTICIPATION: This study only requires the questionnaire. There is no follow-up or further information needed.

WHO CAN PARTICIPATE IN THIS STUDY: The study focuses on caregivers of under-fives in Ekosodin, Benin City, Edo State.

ASSURANCE OF CONFIDENTIALITY OF VOLUNTEER'S IDENTITY: Records relating to your participation in the study will remain confidential. Your name will not be used in any report resulting in this study. All questionnaires, computerized records, and analysis of data will contain only a unique study number, not your name.

PERSONS AND PLACES FOR ANSWERS REGARDING YOUR RIGHTS AS A RESEARCH SUBJECT:

If during the course of this study you have questions concerning the nature of the research or you believe you have sustained a research-related injury or assault, you should contact;

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Nigeria.

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Ethics and Research Committee,

Email: ubthresearchethics@gmail.com

APPENDIX II

QUESTIONNAIRE

DEPARTMENT OF PUBLIC HEALTH AND COMMUNITY MEDICINE UNIVERSITY OF BENIN, BENIN CITY.

PREVALENCE OF HOUSEHOLD AIR POLLUTION AND RESPIRATORY SYMPTOMS AMONG UNDER FIVE CHILDREN IN EKOSODIN, BENIN CITY EDO STATE, NIGERIA.

Dear respondents, we are 600 Level medical students of the University of Benin interested in studying the **"Prevalence of Household Air Pollution and Respiratory Symptoms Among Under Five Children in Ekosodin**." This questionnaire will aid as a tool of data collection in this research. Your sincere response will be helpful, and the information given here will be appreciated and treated with utmost confidentiality.

Section A: Socio-Demographic Characteristics

1. Age: ____
2. Sex of the child: Male [ ] Female [ ]
3. Ethnicity: Benin [ ] Esan [ ] Etsako [ ] Igbo [ ] Yoruba [ ] Hausa [ ] Urhobo [ ] Others [ ] Specify: ____
4. Religion: Christianity [ ] Islam [ ] African Traditional Religion[ ] Others [ ]
Specify: ____
5. Size of Household: ____
6. Number of siblings: ____
7. Position of child in family: ____
8. Informant: Father [ ] Mother [ ] Sibling [ ] Others ____________________C
9. Primary Caregiver of child: Father [ ] Mother [ ] Sibling [ ] Others ____
_
10. Family type: Nuclear [ ] Extended [ ]

11. Occupation of father: ____

12. Occupation of mother: ____

Section B: Sources of Household Air Pollution

13. What is the main type of cooking fuel used in your household?

☐ Firewood ☐ Charcoal ☐ Kerosene ☐ Gas ☐ Electricity ☐ Others (specify):

____

14. Where is cooking usually done?

☐ Inside the house (no separate kitchen) ☐ Inside a separate kitchen ☐ Outside the house ☐Others (specify) ____

15. Does the cooking area have ventilation (windows/chimney)?

☐ Yes ☐ No

16. Is there a smoke outlet in the cooking area?

☐ Yes ☐ No

17. How often does smoke from cooking fill the house?

☐ Always ☐ Sometimes ☐ Rarely ☐ Never

18. Do household members smoke tobacco inside the house?

☐ Yes ☐ No

19. Are the following used indoors (sources of smoke)?

☐ Mosquito coils ☐ Generator ☐ Burning waste ☐ None ☐ Other (specify)

____

__

20. Does the child stay near the cooking area while cooking is ongoing?

☐ Yes ☐ No

21. Average hours of child exposure to indoor smoke per day:

☐ < 1 hour ☐ 1–3 hours ☐ > 3 hours

Section C: Respiratory Symptoms in Under-Five Children

22. Has the child had cough in the past 2 weeks?

☐ Yes ☐ No

23. If yes, how long did the cough last?

☐ < 1 week ☐ 1–2 weeks ☐ > 2 weeks

24. Has the child experienced wheezing or whistling sounds when breathing in the past 12 months?

☐ Yes ☐ No

25. Has the child had shortness of breath during play or activity?

☐ Yes ☐ No

26. Has the child had chest congestion or difficulty breathing?

☐ Yes ☐ No

27. Has the child been diagnosed with any respiratory illness in the past 12 months?

☐ Pneumonia ☐ Asthma ☐ Bronchitis ☐ None ☐ Other (specify) ______

28. Has the child been absent from school/daycare due to respiratory illness?

☐ Yes ☐ No

APPENDIX III

ETHICAL APPROVAL FROM HEALTH RESEARCH ETHICS COMMITTEE (HREC), UNIVERSITY OF BENIN TEACHING HOSPITAL, BENIN CITY, EDO STATE

HEALTH RESEARCH ETHICS COMMITTEE (HREC)

UNIVERSITY OF BENIN TEACHING HOSPITAL

P.M.B. 1111 BENIN CITY NIGERIA Telephone: 052-600418 Website: ubth.org

CHIEF MEDICAL DIRECTOR Prof. (Mrs) I.N Ize-Iyamu

DIRECTOR OF ADMINISTRATION Jim Uwadie, Esq

CHAIRMAN Prof. (Mrs.) Antoinette N. Ofili

HREC OFFICE:
Committee email: ubthresearchethics@gmail.com
Registration Number:
NHREC-UBTH-HREC/24/12/2022B

PROTOCOL NUMBER: ADM/E 22/A/VOL. VII/14865491272121

PROPOSAL TITLE: "PREVALENCE OF HOUSEHOLD AIR POLLUTION AND RESPIRATORY SYMPTOMS AMONG UNDER FIVE CHILDREN IN EKOSODIN, BENIN CITY, EDO STATE, NIGERIA"

PRINCIPAL INVESTIGATOR(S): ERICA ONYINYECHI OBUZOME, SONIA EFEMENA OGHRORO

DEPARTMENT/INSTITUTION: DEPARTMENT OF PUBLIC HEALTH AND COMMUNITY MEDICINE, SCHOOL OF MEDICINE, UNIVERSITY OF BENIN, BENIN CITY, EDO STATE, NIGERIA

DATE CONSIDERED: MARCH 31ST, 2026

DECISION OF THE COMMITTEE: APPROVED

THIS APPROVAL DATES 31/03/2026 TO 19/03/2027. IF THERE IS DELAY IN STARTING THE RESEARCH, PLEASE INFORM THE HREC SO THAT THE DATES OF APPROVAL CAN BE ADJUSTED ACCORDINGLY

REMARK:

CHAIRMAN: PROF. (MRS) A.N. OFILI SIGNATURE & DATE: 31/3/2026

UNIVERSITY OF BENIN TEACHING HOSPITAL ETHICS & RESEARCH COMMITTEE
Sign........
Date........
BENIN CITY P.M.B. 1111

SUPERVISOR (S): PROF. A. R ISARA

DECLARATION BY INVESTIGATOR(S):

PROTOCOL NUMBER (please quote in all enquiries):

Note that no participant accrual or activity related to this research may be conducted outside of these dates and you are to furnish the committee with the research activities at the completion of the study. All informed consent forms used in this study must carry the HREC assigned number and duration of HREC approval of the study. In multiyear research, endeavor to submit your annual report to the HREC early in order to obtain renewal of your approval and avoid disruption of your research. No changes are permitted in the research without prior approval by the HREC except in circumstances outlined in the Code. The HREC reserves the right to conduct compliance visit your research site without previous notification.

Signature & Date..............................

ubthresearchethics@gmail.com Registration Number: NHREC/24/01/2020

APPENDIX IV

RECEIPTS FOR PLAGIARISM TEST

INTELLECTUAL PROPERTY & TECHNOLOGY TRANSFER OFFICE (IPTTO)
Vice Chancellor's Office
University of Benin
PMB1154, Benin City, Nigeria

CLEARANCE FORM

DATE: 11/05/2026

NAME: ERICA ONYINYECHI OBUZOME

MATRIC NO: MED1807441

DEPARTMENT: MEDICINE

FACULTY: MEDICINE

SESSION OF GRADUATION: 2024/2025

DIRECTOR
DATE ....
IPTTO (VCO)
UNIBEN, BENIN CITY

Head Of Unit (IPTTO)

INTELLECTUAL PROPERTY & TECHNOLOGY TRANSFER OFFICE (IPTTO)
Vice Chancellor's Office
University of Benin
PMB1154, Benin City, Nigeria

CLEARANCE FORM

DATE: 11/05/2026

NAME: SONIA EFEMENA OGHRORO

MATRIC NO: MED1807449

DEPARTMENT: MEDICINE

FACULTY: MEDICINE

SESSION OF GRADUATION: 2024/2025

DIRECTOR
DATE ....
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UNIBEN, BENIN CITY