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Household Fuel Choice and Infant Mortality in Rivers State, Nigeria: A Retrospective Cross-sectional Study

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Abstract

Household air pollution primarily from unclean cooking fuel is a public health challenge that has been associated with increased morbidity and mortality among children. Studies have linked mothers' type of cooking fuel to child mortality. However, there is still a dearth of knowledge on household fuel choice and infant death in Nigeria. This study was designed to examine the association between household cooking fuel choice and infant death in Rivers State, Nigeria. Simple random sampling technique was used to select 354 respondents among women attending antenatal clinics from September 16, 2019, to October 9, 2019, in two randomly selected zonal hospitals in Rivers State. Copies structured self-administered questionnaire was used to collect data. Bivariate and multivariable logistic regression analyses were used to control for potential confounders of infant death at a 0.05 level of significance. Unclean household cooking fuel usage (COR: 2.43; 95% CI: 1.15, 5.12) was significantly associated with infant death at the bivariate model level. In the multivariate model, unclean household cooking fuel usage remains significantly associated with infant death (AOR: 3.81; 95% CI: 1.53, 9.45) even after adjusting for potential confounders. The study showed that women using unclean household cooking fuel are more likely to experience infant death. This calls for increased public awareness of the adverse health effects of polluting cooking fuel usage on young children. This will be effective in reducing preventable infant death. Also, the government and relevant stakeholders should promote interventions and policies that will make clean household cooking fuel more accessible and affordable.

Keywords:
Household cooking fuel;
Infant death;
Fuel choice;
Unclean fuel;
River State

Le choix du combustible des ménages et la mortalité infantile dans l'État de Rivers, au Nigeria : une étude transversale rétrospective

Résumé

La pollution de l'air domestique, principalement due à des combustibles impurs, est un problème de santé publique qui a été associé à une augmentation de la morbidité et de la mortalité chez les enfants. Des études ont établi un lien entre le type de combustibles utilisés pour faire la cuisine par des mères et la mortalité infantile. Cependant, il y a encore un manque de connaissances sur le choix des combustibles domestiques et la mortalité infantile au Nigeria. Cette étude a été conçue pour examiner l'association entre le choix du combustible des ménages et la mortalité infantile dans l'État de Rivers, au Nigeria. Une technique d'échantillonnage aléatoire simple a été utilisée pour sélectionner 354 répondantes parmi les femmes fréquentant des cliniques prénatales du 16 septembre 2019 au 9 octobre 2019, dans deux hôpitaux de zone sélectionnés au hasard dans l'État de Rivers. Un questionnaire auto-administré structuré a été utilisé pour collecter les données. Des analyses de régression logistique bi-variées et multivariées ont été utilisées pour contrôler les facteurs de confusion potentiels de la mortalité infantile à un niveau de signification de 0,05. L'utilisation de combustible de cuisine domestique

impur (COR : 2,43 ; IC à 95 % : 1,15, 5,12) était significativement associée à la mortalité infantile au niveau du modèle bi-varié. Dans le modèle multivarié, l'utilisation de combustibles de cuisine domestiques impurs reste significativement associée à la mortalité infantile (RCA : 3,81 ; IC à 95 % : 1,53, 9,45) même après ajustement pour les facteurs de confondus potentiels. L'étude montre que les femmes qui utilisent des combustibles de cuisine domestiques impurs sont plus susceptibles de connaître la mort infantile. Cela nécessite une sensibilisation accrue du public aux effets néfastes sur la santé de l'utilisation de combustibles de cuisine polluants sur les jeunes enfants. Cela sera efficace pour réduire la mortalité infantile évitable. En outre, le gouvernement et les parties prenantes concernées devraient promouvoir des interventions et des politiques qui rendront les combustibles domestiques propres pour la cuisine, plus accessibles et abordables.

Mots-clés:
Combustible de cuisine domestique ;
Mort infantile ;
Choix de carburant ;
Carburant impur ;
État de la rivière

Introduction

Globally, there is a consensus that by 2030, the number of preventable deaths from air pollution, particularly infant deaths (defined as death in the first year of life), would have reduced [1-2]. This reduction in air pollution death will influence progress toward several Sustainable Development Goals (SDGs): particularly SDG12 (Responsible consumption and production), SDG11 (Sustainable cities and communities), and SDG3 (Good Health and Well-being) directly or indirectly [1].

However, despite this conscientious effort, the majority of households in Sub-Saharan Africa continue to use polluting cooking fuel, resulting in rising air pollution [3]. In Nigeria, more than 60% of households use polluting cooking fuel as their principal source of domestic cooking fuel [4–6]. The incomplete combustion of polluting fuels (such as wood, crop waste, animal dung, coal and kerosene) for everyday cooking, lighting and heating is the primary cause of household air pollution, which has been linked to increased child mortality in sub-Saharan Africa [7]. In 2016, it was projected by World Health Organization that polluting cooking fuel use caused 3.8 million premature deaths as a result of household air pollution [8].

According to a report released by the World Health Organization [8-9], air pollution has a significant and negative influence on the health and survival of children. Around the world, 93 percent of all children live in areas where air pollution levels surpass World Health Organisation standards. Environmental pollution is directly or indirectly linked to more than one out of every four deaths of children under the age of five. In 2016, 543 000 children under the age of 5 died as a result of respiratory tract illnesses caused by both household and ambient air pollution [10]. About 41 percent of the world's population is exposed to household air pollution through the use of polluting household cooking fuel. However, the use of polluting household cooking fuel is almost primarily an issue in the low- and middle-income countries (LMICs), affecting 83 percent of the population of Africa [10]. Air pollution is responsible for more than half of all acute lower respiratory infection mortality in children under the age of five in LMICs. This makes it one of the world's silent killers of children especially in sub-Saharan Africa [10].

Women and their children are disproportionately affected by the adverse health effects of household air pollution [11]. Women and young children (particularly children under the age of five) are more vulnerable to household air pollution since they are mostly responsible for cooking and infants spend the majority of their time with their mothers in developing countries [3, 11].

Additionally, the growing organs of new-borns make them more vulnerable to absorbed and retained harmful substances from the household air pollution than adults [12, 13]. As a result, children exposed to household air pollution have a lower life expectancy [3].

Infant mortality is a serious public health concern around the world. In 2018, the United Nations International Children's Emergency Fund reported a 2.7 percent infant mortality rate in low-income countries, compared to 0.3 percent in high-income countries. According to the World Health Organisation report, the African Region's risk of infant death is more than six times that of the European Region [14]. Apart from socioeconomic constraints such as regional conflicts. poverty, and poor healthcare system; exposure to household air pollution play a significant role in the increased risk of infant death in sub-Saharan Africa like Nigeria [15]. The analysis of secondary data pooled from the Nigerian Demographic and Health Surveys showed that mothers' type of cooking fuel is a likely predictor of infant death (16). *Nevertheless, there is still a dearth of knowledge on household fuel choice and infant death in Nigeria.* This study was designed to examine the association between household cooking fuel choice and infant death in Rivers State, Nigeria.

Methods

Study Setting

The study was carried out in Rivers State located in Nigeria's oil-rich Niger Delta region. The state is bordered on the north by Abia and Imo states, on the east by Akwa Ibom state, on the west by oil-rich Bayelsa and Delta

states, and on the south by the Atlantic Ocean. There are 23 local government areas (LGAs) in the state, which encompass 37,000 square kilometres and have a population of 7,490,453 people [17]. With 20 ethnolinguistic groupings, the population is extremely diversified [17].

Based on terrain and access to major towns and communities, it is separated into riverine and upland districts. Agriculture and petty trading are the most common occupations in rural areas, while people in urban areas work in diverse fields of commerce and industry [17].

Rivers State is plagued by environmental issues ranging from air pollution caused by natural gas flaring activities to oil spills in bodies of water and land degradation caused by crude oil extraction activities. Furthermore, it has been reported that River State has approximately 83 percent energy poverty. A situation which forces a large portion of the population to rely on unclean household cooking fuels such as firewood and other forms of polluting cooking fuels (18). Finally, the State is in the South-south geopolitical region with the highest rate of infant death when compared to the other regions in the Southern Nigeria (2).

Study Design and Population

A retrospective cross-sectional study design was employed in this study. All the pregnant women aged between 18 to 45 years who visited public health institutions for antenatal care services in the selected zonal hospital facilities of Rivers State, Nigeria constituted the study population. We restricted the study to pregnant women at any gestation age who had previously given birth to a live baby in the last 12 months.

Sample Size and Sampling Procedure

The sample size of this study was calculated using the modified formula for estimating a single population proportion for rare diseases [19-20]. According to (21) in the study conducted in Niger Delta, the prevalence of infant death among women in high exposure areas to air pollution stood at 8.7%. Using this prevalence value of infant death at 8.7%, 95% confidence level, a total sample size of 161 was obtained. Thereafter, the calculated sample size was multiplied by 2 to increase its power and representativeness. Also, a non-response rate of 10% was added to give a final sample size of 354. The final sample size was equally allocated to the selected health facilities.

A simple random sampling technique was used to randomly select two zonal hospitals in Rivers state (Okrika and Bori Zonal hospitals). Lastly, a simple random sampling technique was used to select the study participants from the selected health facilities.

Data Collection

A structured self-administered questionnaire divided into two parts was used for data collection among randomly selected pregnant women attending antenatal clinics from 16 September 2019, to 9 October 2019, in selected zonal hospitals in Rivers State. The first part covered the socio-economic data of the respondents and the main source of household cooking fuel, while the second part of the questionnaire comprised obstetrics and infant death history. The main source of cooking fuel was categorised as 'clean' or 'unclean'. Women who used gas or electricity as their main source of household cooking fuel were classified as clean household cooking fuel users, while women that used crop residue, coal, firewood, kerosene, or sawdust as their main source of household cooking fuel were classified as unclean household fuel users or polluting household fuel users [22].

Socio-economic characteristics included the mother's age which was categorised as <25 years, 25-34 years and ≥ 35 years; marital status as married and unmarried; educational status as no formal education, primary, secondary and tertiary; religion as Christian and Muslim, monthly household income in naira as < 50,000 or ≥ 50,000; respondents' occupation categories into six groups; household size as 1-3persons, 4-6persons, and >6persons; Substance abuse as alcohol intake (yes or no) and smoking (yes or no). Respondents' obstetrics history included gravidity categorised as multigravida grand multigravida; parity as primiparity, multiparity and grand parity. Gravidity and parity categorisation were based on the inclusion criteria (only women who had previously given birth were included in the study). Infant death is defined as death that occurred before one year of life and was categorised as, Yes or No.

Validity and Reliability of Study Instrument

The study instrument was subjected to face and content validity. A pre-test was carried out by giving the questionnaire to women attending antenatal clinics at General Hospital in Bodo. The test-retest reliability index of 0.89 was obtained, signifying that the instrument met the appropriate psychometric requirements for data collection and was considered fit for the study.

Statistical Data Analysis

Data were entered, cleaned and analysed using SPSS (version 23.0; IBM) software. Descriptive statistics like frequencies and percentages were used to describe the respondents' characteristics and categorical data were compared using Pearson's chi-square test. Bivariate and multivariate logistic regression analyses were computed

to assess the association of infant death with the independent variables. Potential confounding factors either had been reported as a confounder in previous studies [22] or had a p-value less than 0.2 in the bivariate logistics regression [23]. Statistical significance was declared in the multivariate logistics regression when the p-value is less than 0.05.

Ethical Considerations

This study was carried out in compliance with the Declaration of Helsinki. Ethical approval was given by the Research Ethics Committee of Rivers State Hospital Management Board. Authorisation to use the selected health facilities was obtained from the head of each selected health facility. Written informed consent was obtained from each participant; after explaining the purpose of the study, benefits and risks. The right to participate or withdraw from participation was also made explicit to them to ensure that participation was voluntary and to make them feel free from coercion or pressure.

Results

The result of socio-economic characteristics and obstetrics history of the respondents as presented in Table 1 shows that more than half of the respondents used clean household cooking fuel 65.6% (n=160) and those using unclean household cooking fuel 62.1% (n=62.1) were between ages of 25 to 34 years old. Majority of the respondents using clean household cooking fuel 81.9%

Table 1: Socio-economic characteristics and obstetrics history of respondents

Variables	Items	Clean Household Cooking Fuel (n, %)	Unclean Household Cooking Fuel (n, %)	P-Value
Age (years)	< 25	61 (25)	24 (23.3)	0.375
	25 – 34	160 (65.6)	64 (62.1)	
	= 35	23 (9.4)	15 (14.6)	
Marital status	Unmarried	45 (18.4))	16(15.5))	0.515
	Married	199 (81.6)	87(84.5)	
Educational status	No formal education	4(1.6)	1(1)	0.575
	Primary	15(6.1)	9(8.7)	
	Secondary	154(63.1)	69(67)	
	Tertiary	71(29.1)	24(23.3)	
Religion	Christianity	239(98)	100(97.1)	0.624
	Islam	5(2)	3(2.9))	
Respondents' occupation	Artisan, small scale entrepreneur	147(60.2)	65(63.1)	0.563
	Civil servant	19(7.8)	8(7.8)	
	Fishing/farming	19(7.8)	13(12.6)	
	Fulltime housewife/unemployed	23(9.4)	7(6.8)	
	Oil and gas related occupation	14(5.7)	4(3.9)	
	Professional	22(9)	6(5.8)	
Household size	1-3 persons	125(51.2)	61(59.2)	0.028*
	4-6 persons	106(43.4)	31(30.1)	
	>6 persons	13(5.3)	11(10.7)	
Substance abuse	Alcohol intake	45 (18.4)	26(25.2)	0.151
	Cigarette smoking	14(5.7)	2(1.9)	0.123
Household income	< 50,000	56(23)	29(28.2)	0.303
	= 50,000	188(77)	74(71.8)	
#Gravidity	Multigravida	221(90.6)	97 (94.2)	0.268
	Grand multigravida	24(9.4)	6 (5.8)	
Parity	Primiparity	152(62.3)	75 (72.8)	0.168
	Multiparity	88 (36.1)	27 (26.2)	
	Grand multiparity	4 (1.6)	1 (1)	

#Current pregnancy was included measuring gravidity
*significant at $p < 0.05$, N=347

(n=199), 98% (n=239) and unclean household cooking fuel 84.5% (n=87), 97.1% (100) were married and professed Christianity respectively. Furthermore, the majority of respondents who used clean household cooking fuel and those who used unclean household cooking fuel had completed at least secondary school. More than half of the respondents had household income greater or equal to N50,000. Also, 5.3% of respondents using clean household energy had a household size greater than 6 persons compared to 10.7% of respondents using unclean household cooking fuel. On substance abuse, 18.4% and 5.7% of respondents using clean household cooking fuel agreed to alcohol consumption and cigarette smoking compared to 25.2% and 1.9% of respondents using unclean household cooking fuel who agreed to alcohol consumption and cigarette smoking respectively. The obstetrics history of respondents shows that a large proportion using clean household cooking fuel and unclean household cooking fuel were multigravida 90.6% and 94.2; and primipara 62.3% and 72.8% respectively.

Bivariate logistic regression result for infant death is presented in Table 2. The unadjusted model shows that unclean household cooking fuel usage shows a significant association with infant death (COR: 2.43; 95% CI: 1.15, 5.12). In the multivariate model presented in Table 3, unclean household fuel usage increases the odds of infant death (AOR: 3.81; 95% CI: 1.53, 9.45) after adjusting for mothers' age, education status, household income, household size, parity, alcohol intake and smoking.

Table 2: Unadjusted odd ratio of Infant Death by main Household cooking fuel

Dependent Variables	Clean Household Cooking Fuel (n, %)	Unclean Household Cooking Fuel (n, %)	cOR (95% CI)
Infant Death			
Yes	16 (6.6)	15 (14.6)	2.43 (1.15, 5.12) *
No	228 (93.4)	88 (85.4)	
Total	244 (100)	103 (100)	

cOR; Crude odd ratio
*significant at $p < 0.05$; N =347

Table 3: Adjusted odd ratio of infant death by main household cooking fuel

Variables		Infant Death aOR (95% CI)
Household cooking fuel	Clean	Reference
	Unclean	3.81 (1.53, 9.45) **
Age (years)	< 25	0.44 (0.10,1.94)
	25 – 34	0.70 (0.24, 2.09)
	= 35	Reference
Education	No formal education	0.00(0.00,0.00)
	Primary	1.77 (0.38, 8.19)
	Secondary	1.13 (0.42, 3.08)
	Tertiary	Reference
Parity	Primipara	0.11 (0.01,1.63) *
	Multipara	1.18 (0.10, 13.28)
	Grandpara	Reference
Household Income (Naira)	< 50,000	1.40 (0.54, 3.60)
	= 50,000	Reference
Household size	1-3 persons	2.35 (0.30,18.50)
	4-6 persons	2.85 (0.45, 17.84)
	>6 persons	Reference
Alcohol Intake	No	Reference
	Yes	1.86 (0.75,4.57)
Smoking	No	Reference
	Yes	0.00 (0.00, 0.00)

aOR: Adjusted odd ratio; *significant at $p < 0.05$; **significant at $p < 0.01$

Discussion

This study revealed no significant association in most of the socio-economic and obstetrics history of respondents using clean household cooking fuel and those using unclean household cooking fuel. However, household size was significantly associated with the choice of household cooking fuel usage. Respondents with higher household sizes are more likely to use unclean household cooking fuel than clean household cooking fuel. A possible explanation may be the increased demand for household cooking fuel for larger household sizes resulting in increased cost. Hence, women with larger household sizes may opt for unclean household cooking fuel because they are cheaper and easily accessible. This is in line with a recent study conducted in southern Ethiopia that reported that household size is a determinant of household energy use [24]. Interestingly, in this study, household income had no significant association with household fuel use. This implies that household income is not a determinant of household fuel choice in the study area. This observation is not in tandem with a previous study in Ghana [25] that reported low income to prevent the adoption of clean household cooking fuel.

This study showed significantly higher odds (3.81 times) of infant death among women using unclean household cooking fuel compared to women using clean household cooking fuel. This implies that women using unclean household cooking fuel are more likely to experience infant deaths. This is consistent with previous studies in India [3], Pakistan [27], and Nigeria [6, 16] that have reported increased risk for neonatal, post-neonatal and child mortality among polluting cooking fuel users. Polluting cooking fuels when burnt contain several air pollutants such as carbon monoxide, particulate matter and other toxic air pollutants which have been linked to increased infant death [21]. This result is in tandem with a Gambia study that reports that a significantly higher risk of mortality from acute lower respiratory infection among children often carried on their mother's back during cooking [6, 28-29]. A plausible explanation for this may be due to the increased intake of air among infants and their developing organs that make them more vulnerable to absorbed and retained harmful substances from the household air pollution than adults [12-13].

Furthermore, the indoor lifestyle of children under the age of five, particularly neonates and infants may contribute to increased levels of household air pollution exposure, resulting in the development of acute respiratory infection [30]. This assumption is biologically plausible because unclean cooking fuel comprises several hazardous pollutants such as carbon monoxide, nitrogen oxides, sulphur oxides, benzene formaldehyde, 1,3-butadiene, and polyaromatic compounds [31].

Limitations of the Study

The limitations of this study include misclassification bias as some households may be using a combination of different cooking fuels. However, the main household cooking fuel was used in the classification. Furthermore, because the analysis was based on a retrospective cross-sectional design, causal effects could not be quantified. In addition, the small sample size and recall bias as data on infant death were based on mothers' self-report. Finally, while our study could not control for all likely biases, being aware of them allowed for a thorough analysis of the data.

Conclusion and Recommendations

The study shows that women using unclean household cooking fuel are more likely to experience infant deaths. This call for increased public awareness on the adverse health effects of polluting cooking fuel usage on young children. This could be effective in reducing preventable infant deaths. Moreover, multi-sector collaboration, adequate investments and relevant government policies should be advocated to ensure the use of clean cooking fuel in every household. These interventions will make clean household cooking fuel more accessible and affordable. Thus, keeping our children healthy and the environment clean.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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