Household use of solid fuel for cooking and under-five mortality in Nigeria

Olugbemisola W. Samuel[1, 2], Gbolahan A. Oni[1], KC Samir[2], Marcus Wurzer[2] & Akanni I. Akinyemi[3]

[1]Demography and Social Statistics, Covenant University, Ota, Nigeria

[2]International Institute for Applied Systems Analysis, Laxenburg, Austria

[3]Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria

Email: gbemisola.samuel@covenantuniversity.edu.ng

Abstract

Background: Exposure to harmful smoke from household use of solid fuel had continuously contributed to childhood deaths in Nigeria.

Objective: This study examined the effects of cooking fuels used by households on childhood mortality in Nigeria. The study derives its relevance from the United Nations Sustainable Development Goals 1, 3 and 7, which focused on issues of poverty, good health, affordable and clean energy.

Methods: The 2013 Nigeria Demographic and Health Survey dataset was used for analysis with a selection of 10,983 households.

Results: The results show that level of education, wealth-status, place of residence and regional locations are factors influencing the use of solid fuel, and under-five mortality ($P<0.01$).

Conclusion: Therefore, improved level of education, economic conditions, availability and provision of cheap and clean fuel will assist the poor to reduce usage of solid fuel, minimize exposure of young children to dangerous smoke and reduce childhood mortality in Nigeria.

Keywords: Solid fuel; Cooking; Under-five Mortality; SDGs; Nigeria

Introduction

Globally, about 5.9 million children could not live to celebrate their fifth birthday in 2015 (UNICEF, 2016) and close to 80 percent of these deaths were reported to have occurred in South Asian and sub-Saharan African countries. Top on the list among countries with high risk of under-five mortality in these two regions was; Nigeria, India, Democratic Republic of Congo, Ethiopia, and Pakistan (UNICEF, 2016).

The rate of under-five deaths in Nigeria was 128 deaths per 1,000 live births as at 2013 (NPC and ICF, 2014); although, researchers have shown that some of these deaths are influenced by avoidable factors and illnesses (Abioye, Oyesomi, Ajiboye, Omidiora and Oyero, 2017; Oyero and Salawu, 2018; Solanke, Amoo and Idowu, 2018; UNICEF, 2011; 2012, 2013; 2016). Exposure to harmful biomass smoke (indoor air pollution) emanating from types of fuel used for cooking by the households subject children living in such homes to high risk of Lower Respiratory Infections (Akinyemi, Bamgboye and Ayeni, 2013; Samuel, Ayayi, Idowu and Ogundipe, 2016). About 74,604 deaths in 2012 among under-five children were attributed to household indoor air pollution in Nigeria (World Health Organization, 2015).

Reliance on solid fuel for cooking and meeting other energy needs is inevitable in many developing countries where sustainable energy falls far short of what is required to achieve energy access for all (Alege, Adediran and Ogundipe, 2016; Akinyemi, Alege, Ajayi, Amaghionyeodiwe and Ogundipe, 2015). It was estimated that in 2014, more than 1 billion people predominantly rural dwellers in sub-Saharan Africa do not have electricity and more than 3 billion, the majority from sub-Saharan Africa and Asia are still cooking without clean fuels and more efficient technologies (United Nations, 2017). It is indeed a paradox that Nigeria, a country blessed with so many natural resources, and abundant mineral resources such as crude oil, coal, renewable energy (i.e., wind, wood, hydropower, and solar) yet unable to satisfy the energy requirement of her people.

This paper, therefore, examined the effects of the use of solid fuel for cooking within the household on under-five mortality in Nigeria. The study derives its relevance from the United Nations Sustainable Development Goals (SDG) 1, 3 and 7, which focused on finding solutions to issues of poverty, good health and well-being, and affordable and clean energy respectively, in all countries of the world by the year 2030.

Literature review and analytical framework

Air contamination due to the burning of biomass or unclean fuels (i.e., animal dung, charcoal, wood, and keeping the home warm) remain a critical public health and environmental issues in developing

countries. Globally, more than 4 million people lose their lives due to sicknesses that can be related to pollution; about 534,000 of such mortality were children under the age of five years (Wusu and Amoo, 2014; 2016; Ezeh, Agho, Dibley, Hall and Page, 2014). Examples of such illness include; acute respiratory infection (also called pneumonia), cataracts, bronchitis, asthma, and impaired cognitive development.

Children suffer from Lower Respiratory Infections – Pneumonia, due to exposure to smoke from the use of solid fuel in the household (UNICEF, 2015; Samuel *et.al*, 2016). The 2016 Unicef Report on under-five mortality, revealed that pneumonia and diarrhea remain leading causes of death in South Asia and Central Africa, East and Western African regions. More than half of the Nigerian households use unclean fuel for cooking thereby increasing the risk of exposure of children living in those homes to emissions of unhealthy substance (Olisaekee, 2014; NPC and ICF international, 2014).

It is a common practice to find mothers carrying their young children at the back while doing house chores such as bathing, cooking in the kitchen, fetching water for drinking and washing dishes. Food preparation in the rural households is usually done on local stoves using coal, cow dung, firewood, and charcoal. Smokes emanating from this type of cooking fuel which is known as solid fuel contain harmful tiny particles and when inhaled over a long period, can damage the breathing process leading to severe health problems (Njoki, 2017).

Clean fuel, on the other hand, is non-solid fuel, the example of such fuel includes electricity, liquid petroleum gas (LPG) or kerosene (Rao and Pachauri, 2017). Globally, more than 80 percent people are exposed to harmful emissions which is above the level recommended by World Health Organization (WHO) and close to 4 million deaths can be attributed to household-related sources (Rao, Klimont, Smith, Dingenen, Dentener, Bouwman *et al*, 2016).

Hence, there is a need for more research focusing on the interrelationships between the choice of fuel used for preparing food in the household and its contributive effects to deaths of under-five children in Nigeria. Therefore, the objectives of this study are to identify the different types of cooking fuel used in the households in Nigeria, to determine the relationship between cooking fuel and under-five mortality; thirdly, to examine the socioeconomic factors influencing the use of solid/ biomass fuel in the household and lastly to measure the extent to which use of unclean fuel within the household had contributed to under-five mortality in Nigeria.

Analytical framework

The analytical framework for this study was derived from the conceptual framework of Mosley and Chen (1984). The framework (Figure 1) shows the links that exist in the process of operation, particularly between the socioeconomic factors and type of cooking fuel used in the household (i.e., the proximate determinant) in influencing under-five mortality. There is a direct relationship between the underlying factors and the proximate determinant which in turn have a direct link with under-five mortality. The outside (broken) arrow linking the underlying factors to the outcome variable was put there to acknowledge the fact that the proximate variable chosen in this study is not the only proximate determinant through which the socioeconomic factors could be impacting under-five mortality. Hence, some of the underlying factors used in the study may still indicate significant indirect effects on under-five mortality, despite the presence of the only proximate determinant in our study, since they may be channeling some of their effects on child mortality, through other proximate variables that were not considered in our study.

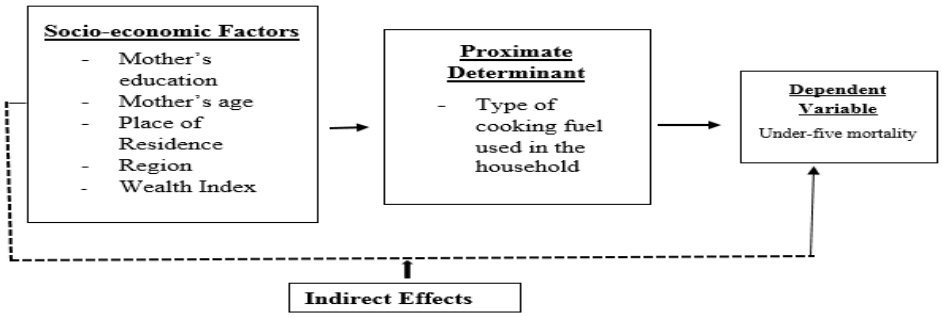

Figure 1: Analytical Framework showing the pathway through which the underlying factors operate through the proximate determinant to influence under-five mortality.

Note: *The broken line indicates the possible indirect effects of the socioeconomic variables on under-five mortality through some other proximate determinants not considered in this study.*

Data and methods

The 2013 Nigeria Demographic and Health Survey dataset was used in this study. The study sample consists of 10,983 households who have their kitchen location within the house. The use of solid fuel for cooking in kitchens located within the homes was used as a proxy for exposure to indoor air pollution in this study. The analyses were done using both descriptive and inferential statistics including charts, frequency distribution, and cross-tabulation methods. Multivariate analyses were carried out using Binary Logistic Regression analyses with the aid of Stata software (version 13.0).

Binary Logistic Regression analysis is a preferred method of multivariate analysis when the outcome (dependent) variable is a binary (dichotomous) variable (i.e., two possible outcomes; alive or dead; positive or negative, 1 or 0, etc.). It is expressed as shown below:

$$\text{Log}\left[\frac{\text{P}}{1-\text{P}}\right] = \alpha + \beta_1 \text{X}_1 + \beta_2 \text{X}_2 + \cdots + \beta_\text{k} \text{X}_\text{n} + \mu \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The model estimates the odds of under-five mortality, given the presence of some underlying (independent) variables. In this study, P is the probability of under-five death occurring, (1-P) is the probability of under-five death not occurring. While $X_1 \ldots X_n$ represents the explanatory (independent) variables and $\beta_1 \ldots \beta_k$ are the regression parameters; α is a constant that gives the value of under-five mortality when all the independent variables are absent in the model, and μ is the residual or random error term. $\text{Log}_e\left[\frac{\text{P}}{1-\text{P}}\right]$ is referred to as the logistic transformation of the probability of an event (i.e., under-five death) occurring. A binary regression model was used in this study to predict the odds of occurrence of under-five mortality within the different categories of the underlying factors in Nigeria as influenced by the underlying factors with or without adjusting for the proximate determinant.

Results

The result as depicted in Figure 2 shows the proportion of households who were using different types of cooking fuel. The following were considered to be solid fuel: wood, charcoal, and dung, while the non-solid fuel is electric, gas, and kerosene. The proportion using solid fuel was 71.3 percent while proportion using non-solid fuel was 28.7 percent.

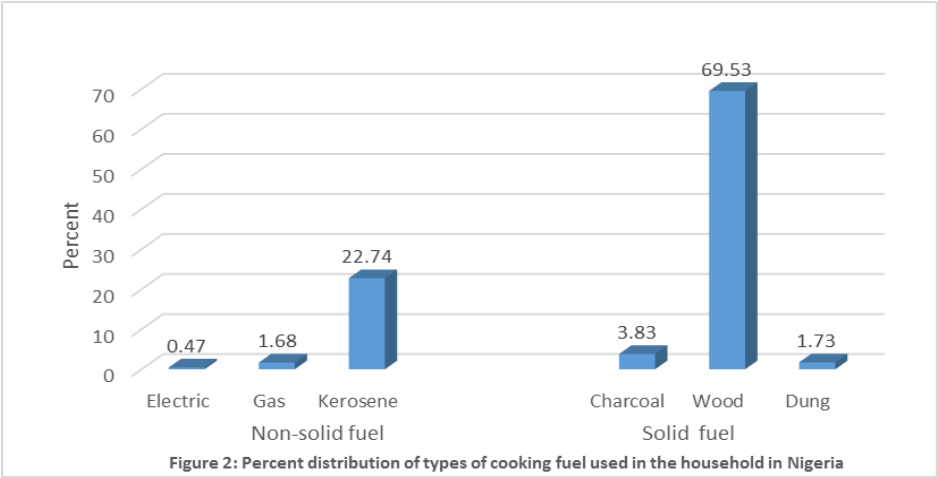

Figure 2: Percent distribution of types of cooking fuel used in the household in Nigeria

Bivariate analyses

Table 1a shows the bivariate relationship between the type of fuel used for preparing food and the deaths of children below age five years. The proportion of deaths was higher for children living in homes where solid fuel was used for cooking (9.53%) as compared to deaths among the children living in homes where non-solid fuel was used for cooking (5.52%). The test of significance indicates a significant association between types of cooking fuel used and under-five mortality (Chi-square = 42.29 on 1 d.f; P < 0.001).

Table 1a: Association between the use of solid fuel and under-five mortality

	Under-five Mortality			Pearson chi^2
Cooking fuel	Alive (%)	Dead (%)	Total (%)	
Non-solid fuel	2,584 (94.48%)	151 (5.52%)	2,735 (100%)	42.2932 on 1 d.f., P<0.001
Solid fuel	7,462 (90.47%)	786 (9.53%)	8, 248 (100%)	

Table 1b shows the bivariate association between all the selected socio-economic factors and under-five mortality. The results showed that the pattern of under-five mortality declined as mothers' wealth status increases. Similarly, there was a decline in the number of child's deaths as the level of education of mothers' increases. The proportion of childhood mortality was higher in the rural area than the urban centers. Further, mothers who practiced other religion reported deaths of their under-five children more than mothers who practiced Christianity. Finally, mothers living in the northern parts of Nigeria experienced more deaths of their under-five children than their counterparts who lived in the southern regions.

Table 1b: Association between the socio-economic factors and under-five mortality

Variables	Under-five Mortality		
	Alive (%)	Dead (%)	Chi-square; d.f;(P-value)
Wealth Status			
Poor	3275 (88.2%)	438 (11.8%)	78.88; 2; (<0.001)
Middle	2198 (92.0%)	191 (8.0%)	
Rich	4705 (93.5%)	325 (6.5%)	
Residence			
Urban	4272 (93.4%)	300 (6.6%)	39.93; 1; (<0.001)
Rural	5906 (90.0%)	654 (10%)	
Education			
No education	3121 (88.6%)	401 (11.4%)	69.57; 3; (<0.001)
Primary	2483 (91.1%)	244 (8.9%)	
Secondary	3751 (93.4%)	265 (6.6%)	
Higher	823 (94.9%)	44 (5.1%)	
Religion			
Christianity	5700 (92.6%)	458 (7.4%)	22.31; 1; (<0.001)
Other religion	4437 (90.0%)	491 (10.0%)	
Region			
North	4309 (89.7%)	497 (10.3%)	33.87; 1; (<0.001)
South	5869 (92.8%)	457 (7.2%)	

Multivariate analysis results

Before carrying out the binary logistic regression analysis, we carried out the test of multicollinearity among the independent (explanatory) variables. The results are shown in Table 2. None of the correlation coefficients was greater than 0.85 implying that there was no significant collinearity among the variables (Pallant, 2011; Oni, 1988). Hence, all the explanatory variables were used in the multivariate analyses.

Table 2: Collinearity test

Variables	Wealth	Education	Residence	Region	Cooking fuel
Wealth	1.000				
Education	0.6250	1.0000			
Residence	-0.4940	-0.3562	1.0000		
Region	0.4563	0.5271	-0.2189	1.0000	
Cooking fuel	-0.5459	0.4658	0.3958	-0.3461	1.0000

Table 3 shows the socio-economic determinants of the use of solid fuel in Nigerian households. The binary logistic regression parameters were used to estimate the relative risk (i.e., Odds Ratio) of using solid fuel for cooking against not using it, for each category of the different explanatory variables. For example, the use of solid/biomass fuel for preparing food declines as the level of mother's education increases. Mothers who had no education were more than 5 times more likely to use solid fuel for cooking compared with those mothers who had post-secondary (i.e., higher) education level. Rural households were about 3 times more likely to use solid fuel for cooking compared to urban households. More of the children whose mothers had a better standard of living used cleaner fuel than children whose mothers were of low socio-economic status. There were higher chances of using solid fuel for cooking among homes in the rural settlements than families residing in the urban units. The odds of using

solid energy to prepare meals was 4 times higher in most of the northern households compared to the southern households. Finally, poor households were about 170 times more likely to use solid fuel for cooking compared with wealthy (or rich) households.

Table 3: Socio-economic determinants of use of solid fuel in Nigerian households

Variables	Odds ratio	P-value	95% Confidence Interval
Residence			
Urban	**RC**		
Rural	2.94	0.00	2.60 – 3.33
Region			
North	3.71	0.00	3.18 – 4.32
South	**RC**		
Wealth Status			
Poor	169.01	0.00	75.34 – 379.14
Middle	11.41	0.00	9.39 – 13.86
Rich	**RC**		
Level of Education			
No education	5.17	0.00	3.91 - 6.83
Primary	3.96	0.00	3.23 – 4.86
Secondary	2.15	0.00	1.80 – 2.57
Higher	**RC**		
Constant	0.20	0.00	0.17 – 0.24

***RC = reference category; Log likelihood= -3510.852;**
Chi-square=5306.87; d.f = 7; P-value= 0.000

Table 4 examines the determinants of under-five mortality in Nigeria using two models. Model 4a examines the socioeconomic determinants of under-five mortality when no consideration is given to the use of solid fuel for making food by the households. Model 4b further adjusted the effects by considering the use of biomass energy for preparing food as additional proximate (or intervening) variable for the effects of socioeconomic variables on under-five mortality. The difference between the two models enables us to assess the extent to which the use of wood, coal, charcoal and animal dung for cooking explains the indirect effects of the socioeconomic variables on under-five mortality. The results from Model 4a show that place of residence, level of education and wealth status are strong determinants of under-five mortality in Nigeria. Under-five mortality was significantly higher in the rural areas than in urban areas (OR = 1.21, P < 0.05). Under-five mortality was significantly higher in poor households than in wealthy households (OR = 1.36; P < 0.001), and significantly higher among children born by illiterate women than among those born by women with higher education levels (OR = 1.63; P < 0.001). The results from Model 4b also show that when the use of solid fuel for cooking was considered in the model, only two of the socioeconomic factors retain their significant indirect relationship with under-five mortality. These are wealth status and mothers' education.

Table 4: Socio-economic determinants of under-five mortality

	Model 4a	Model 4b
Variables	**OR (95% CI)**	**OR (95% CI)**
Residence		
Rural	1.21 (1.02 – 1.43)*	1.17 (0.99 – 1.38)
Urban	RC	
Region		
North	1.05 (0.88 – 1.25)	1.05 (0.88 – 1.25)
South	**RC**	
Wealth Status		
Poor	1.38 (1.11 – 1.71) ***	1.28 (1.03 – 1.60)*
Middle	1.04 (0.85 – 1.28)	0.95 (0.77 – 1.19)
Rich	**RC**	**RC**
Level of Education		
No education	1.63 (1.13 – 2.36) ***	1.69 (1.15 – 2.48) ***

Primary	1.52 (1.07 – 2.14)*	1.55 (1.07 – 1.24)*
Secondary	1.23 (0.88 – 1.71)	1.27 (0.89 – 1.79)
Higher	**RC**	**RC**
Cooking fuel		
Non-solid fuel	-	**RC**
Solid fuel	-	1.23 (0.98 – 1.54)
Constant	0.05	0.05
Log likelihood	**-3207.30**	**-3150.88**
Chi-square value	**97.01; d.f. = 7; (p-value=0.000)**	**102.64; d.f. = 8; (p-value=0.000)**
Difference (Model Chi-square) = 56.42		
Likelihood Ratio Test	**Chi-square = 56.42; d.f. = 1; P < 0.001**	

- *RC is the reference category*
- *OR is the odds ratio*
- ****P<0.001; **P<0.01; *P<0.05*

The explanation for this is that inputting use of solid fuel variable in the model has helped to explain most of the indirect effects that place of residence and wealth status had on under-five mortality. Using the Likelihood Ratio (LR) test (Kleinbaum, 1994). Use of solid fuel for cooking was highly significant in explaining the effect of socioeconomic variables on under-five mortality (Chi-square value = 56.42 on 1 degree of freedom, P < 0.001). The result can also be explained thus: the use of solid fuel for cooking is a significant channel through which some of the socioeconomic variables influence under-five mortality. However, the fact that some variables such as education and wealth status still maintain their significant indirect relationship with under-five mortality is an indication that the use of solid fuel for cooking variable is not the only intermediate (or proximate) variable through which the socioeconomic variables are influencing under-five mortality. These other proximate variables were not included in our model so it (the model) could not fully explain the indirect relationship between the socioeconomic variables and under-five mortality. This fact was earlier indicated in the Analytical Framework in Figure 1.

The Synergy effect of education and wealth status on under-five mortality

In the results of the analysis of the determinants of under-five mortality shown in Table 4, we identified mother's level of education and her wealth status as the two major determinants of under-five mortality. Both have a negative association with under-five mortality. That is, the higher the level of each of the variables, the lower the level of under-five mortality. This means that the two variables can produce synergy effects on under-five mortality if operate together in a household. The under-five mortality rate for each category of education or wealth status can be considered as the probability of under-five death for that category. Since wealth status of a woman does not necessarily determine her education level and vice-versa, we consider the two variables as independent, and we can apply the rule of probability multiplication to estimate the combined effects of the two variables on under-five mortality. If A and B are two independent events which can occur simultaneously, the Probability of A and B occurring together, that is, P (A and B) = P (A) * P (B). We estimated from Table 2, the under-five mortality rate for each category of education and wealth status of mothers. For example, the death rate of children under-five years of age for mothers with no education, e_1 = 401/3522 * 1000 = 114 per 1000. Similarly, the under-five mortality rate for children of poor mothers is w_1 = 438/3713 * 1000 = 118 per 1000.

Table 5 below shows the estimated under-five mortality rate for each combination of education and wealth status of mothers in Nigeria. For example, mothers who had no education and are poor ($\boldsymbol{w_1e_1}$) had the highest under-five mortality rate of 134.5 per 1000. Mothers with post-secondary education and who were wealthy ($\boldsymbol{w_3e_4}$) had the least under-five mortality rate of 33.2 per 1000. The under-five mortality rates for other cell combinations fall between the two limits above. This result implies that the more favorable the combination of education and wealth status levels of a mother is, the lower the risk of losing her child before reaching age five.

Table 5: Matrix showing the combined Effects of Wealth status and Education on Under-five Mortality

	Level of Education			
Wealth Status	e_1	e_2	e_3	e_4
w_1	134.5	105.0	77.9	60.2
w_2	91.2	71.2	52.8	40.8
w_3	74.1	57.9	42.9	33.2

Discussion

The study establishes that education and wealth status are strong determinants of the use of wood, charcoal, coal and animal dung for cooking in Nigeria. This result supports the findings of Samuel *et al* (2016) and Ezeh *et al* (2014) that there is a strong relationship between the education and wealth status of mothers and under-five mortality in Nigeria. Hence, the chances of using solid fuel for preparing meals was higher among the poor households while the usage of cleaner energy was higher among the rich families (Olisaekee, 2014). The result in this study also shows that the use of biomass fuel was predominant in the rural areas than in the urban units. These findings tend to suggest that the rural areas are dominated by poor and uneducated households compared to the urban areas.

Poverty makes it impossible for most families in the rural areas to afford the use of cleaner fuel for their cooking, thereby, putting many young children at risk of dying as a result of exposure to smoke emanating from the use of biomass fuel. However, it is also true that most rural areas in Nigeria do not have electricity and so, are left with little or no alternative than to use solid fuel for cooking. Firewood is also in abundance in the rural areas. Our study also found that more of the households in the northern regions of the country used solid fuel for cooking than their counterparts in the southern regions. This can be attributed to the fact that the southern part of Nigeria is more developed than the northern regions. The south has better accessibility to cleaner fuel than the northern parts of Nigeria.

Lastly, the results from this study showed that the risk of under-five mortality increases as the level of education and wealth status of mother's decreases, and vice-versa. This confirms the findings of Ezeh *et al* (2014); Fayehun and Omololu, (2011); Antai (2011) and Caldwell (1979) that the region, wealth status and education attainments of mothers are significant determinants of under-five mortality.

Limitation of the study

One major limitation this study encountered was the unavailability of the variable on the specific cause of deaths of under-five children in the NDHS 2013 dataset. Secondly, there was no variable on indoor air pollution, hence, the authors had to use "location of the kitchen" within the home as a proxy for indoor air pollution.

Conclusion and recommendations

It is a reality that the poor are likely to use solid fuel, while the rich are more likely to use non-solid fuel. Level of education and wealth status can determine whether or not solid fuel is used in the households, as well as whether under-five mortality is high or low. These are also intrinsically linked to poverty. Provision of good education, particularly girl/woman education and essential amenities including sustainable energy such as electricity by the governments will go a long way in alleviating the level of poverty in the country. Similarly, government/ policymakers should provide kerosene as an alternative to use of coal and firewood in rural areas as a better source of cleaner fuel at a cheaper rate such that the poor homes would be able to afford it. In the meantime, we recommend that Nigerian women be sensitized on the importance of women's education for general up-lifting of women and its relationship to child survival. They must also be made aware of the possible link between air pollution from the use of solid fuel for cooking, and child morbidity and mortality Awareness/Campaign in local languages will be necessary in order to reach the mostly uneducated rural populations. There is also the need for policymakers to provide cleaner fuel at a cheaper cost to the people particularly those in the rural areas and in northern Nigeria. Therefore, to holistically address the problem of under-five mortality in relation to the type of cooking fuel used in the households in Nigeria, there is an urgent need to focus on the rural areas and northern parts of the country where a larger proportion of these deaths are coming from.

Acknowledgments

The authors appreciate the support of the Covenant University Centre for Research, Innovation, and Development (CUCRID), Covenant University, Ota, Nigeria for funding the publication of this research paper. The authors will like to appreciate Prof. Samir KC for championing the application for the Young Scientists Summer Programme, Laxenburg, Austria and for his mentorship role during the 3-months summer programme. Part of the research was developed in the Young Scientists Summer Program

at the International Institute for Applied Systems Analysis (IIASA), Laxenburg (Austria) with financial support from the IIASA Annual funds. Finally, the authors are grateful to ICF Macro Incorporation, USA for permission to access the Nigeria Demographic and Health Survey Datasets used in this study.

References

Abioye, T., Oyesomi, K., Ajiboye, E., Omidiora, S. & Oyero, O., 2017. Education, Gender, and Child-Rights: Salient Issues in SDGS Years in ADO-ODO/OTA Local Government Area of Ogun State, Nigeria in Okorie, N., Ojebuyi, B. & Salawu, A. (eds.) Impacts of the Media on African Socio-Economic Development. (pp. 141-154) Hershey PA, USA: IGI Global.

Adetoro, G.W. & Amoo, E.O., 2014. A statistical analysis of child mortality: evidence from Nigeria. *Journal of Demography and Social Statistics,* 1: 110 – 120. Obafemi Awolowo University Press.

Adedini, S.A., 2013. *Contextual Determinants of Infant and Child Mortality in Nigeria.* The University of the Witwatersrand, A Doctoral Thesis submitted to the Faculty of Humanities, Demography and Population Studies, Johannesburg.

Akinyemi, O., Alege, P. O., Ajayi, O. O., Amaghionyeodiwe, L. & Ogundipe, A. A. (2015). Fuel Subsidy Reform and Environmental Quality in Nigeria. International Journal of Energy Economics and Policy, 5(2):540-549

Akinyemi, J.O., Bamgboye, E.A. & Ayeni, O., 2013. New Trends in Under-five Mortality Determinants and their effects on Child Survival in Nigeria: A Review of Childhood Mortality Data from 1990 – 2008. *African Population Studies*, 27 (1). http://dx.doi.org/10.11564/27-1-5

Alege, P.O., Adediran, O.S & Ogundipe, A.A., 2016. Pollutant Emissions, Energy Consumption and Economic Growth in Nigeria.International Journal of Energy Economics and Policy, 6(2), 202-207.ISSN: 2146-4553. Available at http: www.econjournals.com

Antai, D., 2011. Regional inequalities in under-5 mortality in Nigeria: a population-based analysis of individual- and community-level determinants. *Population Health Metrics* 9: 6.

Caldwell, J.C., 1979. "Education as a Factor in Mortality Decline: An Examination of the Nigerian Data". *Population Studies*, 33(3): 395-413.

Ezeh O.K., Agho, K.E., Dibley, M.J., Hall, J.J. & Page, A.N., 2014. The Effect of Solid Fuel Use on Childhood Mortality in Nigeria: Evidence from the 2013 Cross-sectional Household Survey. *Environmental Health*, 13: 113.

Fayehun, O.A. & Omololu, O., 2009. Ethnic Differentials in Childhood Mortality in Nigeria. Paper presented at Detroit, Michigan, USA. April 30- May 2, 2009.

Ikamari, L. D.E., 2013. Regional Variation in Neonatal and Post-neonatal Mortality in Kenya. *African Population Studies*, 27 (1). http://dx.doi.org/10.11564/27-1-4

Kleinbaum, D.G., 1994. Statistics in the Health Sciences: Logistic Regression, A self-Learning Text. Springer, New York, p. 105.

National Population Commission (NPC) [Nigeria] & ICF International, 2014. *Nigeria Demographic and Health Survey 2013*. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF International.

Ogunjuyigbe, P.O., 2004.Under-Five Mortality in Nigeria: Perception and Attitudes of the Yorubas towards the Existence of "*Abiku*". *Demographic Research*. 11(2): 43-56.

Olisakee, G.O., 2014. Energy Poverty and Under-five Mortality in Nigeria: Is there a link? Nigeria/Africa.

Oni, G.A., 1996. Infant Feeding Practices, Socio-economic Conditions and Diarrhoeal Disease in a Traditional Area of Urban Ilorin, Nigeria. *East African Medical Journal,* 73(5): 283 – 288.

Oni, G.A., 1988. Child mortality in a Nigerian City: Its levels and socioeconomic differentials. *Social Science & Medicine*, 27(6): 607-614.

Oyero, O., & Salawu, A. 2018. Building media capacity for children sustainability in Africa: Educational and partnership imperatives. SAGE Open, 8(1), pp.1-10 doi: 10.1177/2158244018763930

Pallant, J., 2011. *SPSS Survival Manual - A Step-by-Step Guide to Data Analysis Using SPSS for Windows.* Fourth Edition, Mc-Graw Hill: Open University Press. ISBN: 978 1 74237 392 8.

Rao, N.D. & Pachauri, S., 2017. Energy access and living standards: Some Observations on Recent Trends. *Environmental Research Letter*, 12 025011. http://dx.doi.org/10.1088/1748-9326/aa5b0d.

Rao, S. Klimont, Z., Smith, S.J., Dingenen, R.V., Dentener, F., Bouwman, L., et al., 2016. Future air pollution in the Shared Socio-economic Pathways. *Global Environmental Change*,

Samuel G.W., 2017. Proximate Determinants: The Pathways of Influence of Underlying factors on Under-five Mortality in Nigeria. A Doctoral Thesis submitted to Demography and Social Statistics, Covenant University, Ota, Nigeria.

Samuel, G.W, Ajayi, M. P, Idowu, E. A. & Ogundipe, O. M., 2016. Levels and Trends in Household Source of Cooking Fuel in Nigeria: Implications on Under-five Mortality. *Health Science,* 10:4.

Solanke, B. L., Amoo, E. O., & Idowu, A. E. (2018). Improving postnatal checkups for mothers in West Africa: A multilevel analysis. Women & health, 58(2), 221-245. https://www.tandfonline.com/doi/abs/10.1080/03630242.2017.1292343

UNICEF, 2011. Levels and Trends in Child Mortality: Report 2013. Estimates Developed by the UN Inter-agency Group for Child Mortality Estimation.

UNICEF, 2012. Levels and Trends in Child Mortality: Report 2013. Estimates Developed by the UN Inter-agency Group for Child Mortality Estimation.

UNICEF, 2013. Levels and Trends in Child Mortality: Report 2013. Estimates Developed by the UN Inter-agency Group for Child Mortality Estimation. Available from:http://www.who.int/maternal_child_adolescent/documents/levels_trends_child_mortality_2013.pdf.

UNICEF, 2015. Levels and Trends in Child Mortality: Report 2013. Estimates Developed by the UN Inter-agency Group for Child Mortality Estimation.

UNICEF, 2016. Levels and Trends in Child Mortality: Report 2014. Estimates Developed by the UN Inter-agency Group for Child Mortality Estimation. Available from:https://www.unicef.org/media/files/Levels_and_Trends_in_Child_Mortality_2014.pdf.

United Nations, 2017. Sustainable Development Knowledge Platform – Progress of Goal 7 in 2017.*https://sustainabledevelopment.un.org/sdg7.*

WHO, 2016. Household Air Pollution and Health. *Fact sheet N°292.*

Wusu, O., & Amoo, E. O. (2014). 11 Sub-Saharan African Children and Adolescents. Continuity and change in sub-Saharan African demography, 192.

Wusu, Onipede, and Emmanuel O. Amoo (2016). Fertility Behaviour and Wealth Situation in Nigeria: Evidence from 2013 Demographic and Health Survey. Social Indicators Research, Vol. 128, No. 1 (2016): 1-14. https://link.springer.com/article/10.1007/s11205-015-1016-4