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HEALTH EFFECTS OF HOUSEHOLD COOKING FUEL CHOICE IN NIGERIA

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Abstract
This study investigates the health effects of household cooking fuel choice in Nigeria. Relying on data sourced from the Nigeria's General Household Survey (2015/2016), the study used Two Stage Least Square (2SLS) estimation techniques to obtain the estimates of the link between cooking fuels and household health status. The regression results show that smoke from solid cooking fuels has a negative effect on housewife health and that households who use solid fuels for cooking spend relatively more on healthcare expenditure since they are exposed to respiratory related illnesses and injuries. It is recommended that modern cooking fuels should also be made available and affordable for household consumption in order to reduce indoor air pollution and improve household health status.
Keywords: Fuel Choice; Household; Air pollution; Nigeria; Health outcome; Two stage least square

Introduction

The prevalent use of traditional fuels in Nigeria has been attracting serious concerns due to its link with health and environmental hazards. Despite several efforts to reduce these concerns by the Nigerian governments through policy interventions, use of traditional fuels has continued to increase thereby causing serious damage to human health, productivity and the environment. Burning of traditional fuels is associated with high emissions of carbon monoxide, hydrocarbons, sulfur oxide and particulate matter which when inhaled affect lungs and respiratory organs (Ogwumike, Ozughalu & Abiona, 2014; Gujba, Mulugetta & Azapagic, 2015; Buba, Abdu, Adamu & Usman, 2017). Air pollution from these fuels accounts for about 79,000 premature deaths in Nigeria annually while deaths from acute lower respiratory infection in children younger than five years account for about 90% of the total number of deaths from indoor pollution in Nigeria (World Bank, 2019). Indoor air pollution from traditional fuels also contributes to tuberculosis, respiratory tract infections, lung cancer and lung function decline in Nigeria (Malla & Timilsina, 2014; Emagbetere, Odia & Oreko, 2016). The health hazards from traditional fuels portend serious consequences in Nigeria because of the following reasons. Nigeria has one of the largest people lacking access to modern energy in the world. Over 75 percent of her population lives below poverty line and cannot afford basic energy needs (World Bank, 2018). Evidence abounds that energy consumption and energy access situations in Nigeria are far below the level of basic human needs, and despite the

country's endowed energy resources, meeting her citizens' energy needs has become a herculean task due to rising population, urbanization and ineffective energy infrastructure (Malla & Timilsina, 2014). Also, only about 45% of Nigeria's population is connected to the national grid with 90% rural dwellers having unreliable or no electricity supply (International Energy Agency, 2018). Firewood and animal wastes account for over 85% of the total energy used by the Nigerian household for cooking, and are expected to remain the dominant fuel sources for the foreseeable future (Ozoh, Okwor, Adetona, et al., 2017). Kerosene and other oil products account for about 10 percent with only 2.7 percent of Nigerian households relying on natural gas (LPG) for cooking (IEA, 2018).

Furthermore, a good number of Nigerian households are characterized by inefficient fueling practices. Many urban households customarily use traditional fuels and are reluctant to use clean fuels despite their availability and relative cheaper cost (Buba et al., 2017; Ozoh et al., 2017). The three stone stoves are common and prevalent in the rural areas and some urban areas of the country. Majority of Nigerian households are also exhibiting slow or stalled energy transition. Some families were reported to have reverted to cooking with firewood in response to economic hardship (Buba et al., 2017). The prevalent inefficient fueling practices have emerged as significant threats to the quality of life in the country, prompting the question: what effect does cooking with traditional or solid energy has on health? Although, several authors have examined health effects of cooking fuels (Ana, 2010; Olowoporoku, Longhurst & Barnes, 2012; Ubuoh & Nwajiobi, 2018), empirical studies on health effects of fuel choice in Nigeria is scanty. Handful indigenous studies on this area are mainly observational in nature and involve monitoring of household indoor air pollution. Accordingly, having a clear understanding of determinants of household cooking fuel choice and transition leads to well-informed energy decisions and how energy policy formulation should be pursued with a view to designing and implementing strategies that will not only ensure access to energy services but will also facilitate transition to modern fuels and address health problems associated with the use of traditional fuels. Thus, this study fills this gap and contributes to the empirics by modeling health impact of household cooking fuel choice. Hence, the objective of this study is to examine the health effects of households' cooking fuel choice in Nigeria.

Literature Review

Indoor air pollution and Health Outcomes

Health outcomes refer to the changes in health condition of households due to changes in some factors. These factors include interventions or programmes from policy makers, behavioural change and other policies change from environmental related activities, energy use and policies, etc. Household health outcomes can be seen from two perspectives: mortality (length of life) and morbidity (quality of life). Mortality measures how long people live. Among the indicators used to measure mortality are; life expectancy at birth, under-5 mortality rate, infant mortality. Morbidity, on the other hand, measures various diseases or illnesses affecting the quality of life. Indicators used to capture morbidity include anemia, diabetes, diarrhea, respiratory infection, etc. Health hazards arising from burning of fuels are numerous. These hazards encompass both mortality and morbidity. This is because excessive exposure to air pollution from solid fuels such as firewood and charcoal is associated with diseases that could trigger instant death. For instance, exposure to PM2.5 over a long period of time is associated with mortality due to cardiovascular disease (Hooch, Krishnan and Beelen, 2013). Substances released during the burning of biomass fuels that are harmful to respiratory health include, but are not limited to, carbon monoxide (CO), fine particulate matter ($PM_{2.5}$), sulfur oxides (SO), nitrogen oxides (NO), formaldehyde, etc.

Household air pollution from use of cooking fuels cause health problems such as high blood pressure, cardiovascular disease, chronic obstructive pulmonary disease, tuberculosis, pneumonia, asthma, and lung cancer (Smith 2000; McCracken, Wellenius, Bloomfield et al., 2012; Noubiap, Essouma & Bigna, 2015; Peña, Romero, Velazquez et al.,2015; Van Gemert Kirenga, Chavannes et al., 2015).

Empirical Review of the Health impact of Fuel Choice

Studies on health impact of households' fuel choice can be categorized into three. The first category consists of descriptive and theoretical studies that seek to explain the relationship between households' fuel use and health outcomes (Ana, 2010; De Longueville, Hountondji & Henry, 2010; Ibem, 2011; Olowoporoku, Longhurst & Barnes, 2012; Erickson & Jennings, 2017). The second category of studies in this area is observational. Studies in this category simply monitored the level of particulate matter existing in a cooking area before and after intervention programmes such as introduction of improved cookstoves, liquefied petroleum gas (LPG) intervention etc. For instance, Bautista, Correa, Baumgartner, Breysse and Matanoski (2008), Onabowale & Owoade (2015), Mbanya and Sridhar (2017), Tumwesige, Okello, Semple and Smith (2017), Jung and Huxham (2018) and Ubuoh and Nwajiobi (2018) all conducted observational studies which involve monitoring household indoor air pollution. Some of the interesting findings of these studies are that the levels of particulate matter concentration reduce significantly after intervention programmes; firewood followed by charcoal emitted high particulate matter (PM_{10}); and that household air pollution contributes breathing problems, eyes and skin irritations, acute lower respiratory infection in children and mothers and also facilitate high blood pressure. The third category employed econometric techniques to establish negative effect of household energy use on some health outcomes indicators such as acute lower respiratory infections (ALRI) among children, under 5 mortality, lower lung capacity or lung function decrement, upper Respiratory Tract Infections (URTI), asthma, tuberculosis, and stunted growth. For example, Mishra et al. (2007) used data from the National Family Health Survey (NFHS) in Pakistan (1998-1999) to investigate the relationship between household solid fuel use and anemia and child stunting in Indian children. Through a multivariate logistic regression approach, they found that child stunting was significant and more common among children from households that used solid fuels. Balietti et al. (2017) also used data from the National Family Health Survey (NFHS) in India (2005-2006) and corrected an endogeneity issue between the child stunting and the household fuel choice by using an instrumental variables approach. The authors establish a strong causal link between pollution from solid fuels and the likelihood of being stunted or severely stunted in Indian children. However, Machisa et al., (2013) did not find any significant negative effect of solid fuel use on stunting in children from Swaziland after adjusting for child characteristics or controlled variables such as birth weight, age, sex and preceding birth interval.

While the effect of household air pollution from solid fuels on stunted height is mixed, most studies established a negative effect of solid fuel use on respiratory illness among children and mothers. Using multinomial approach and instrumental variable technique, Pitt, Rosenzweig and Hassan (2006) found that among Bangladeshi households who are exposed to smoke through greater cooking time are more likely to experience respiratory illness. Gajate-Garrido (2013) also found similar result for Peruvian children. The author used a two-wave panel survey of Peruvian children younger than six years old and correct for individual fixed effects and various confounding variables. Her result revealed that children who live in a house where firewood is used as cooking fuel are more likely to report respiratory illnesses. Wichmann and Voyi (2006) also investigate the relationship between traditional fuels and respiratory illness in children in South African. They employed the 1998 South African Demographic and Health Survey and found that children who

lived in households where traditional fuels are used were 1.27 times more likely to experience respiratory disorder. Silwal and McKay's (2014) empirical analysis also shows that people living in households that cook with firewood have 11.2 per cent lower lung capacity than those that cook with cleaner fuels.

Recent study by Buthelezi, Kapwata, Wernecke, Webster, et al. (2019) also established a negative relationship between traditional fuels and respiratory disorder. The study categorized fuels into electric and non-electric and examined their effect alongside some confounding factors on upper and lower respiratory tract Infections among 245 households in low income South African coastal community. Their results revealed significant effects of non-electric sources for heating and cooking on prevalence of upper respiratory tract infections. Their results, however, failed to establish a negative significant relationship between electric or non-electric fuel use type for cooking and lower respiratory tract infections. Using different health outcome: infant mortality Nazi, Page and Agho (2017) investigated the link between air pollution from cooking fuel and under-five mortality in Pakistan. Applying multinomial logistic regression models on data collected from the 2013 Pakistan Demographic and Health Survey (PDHS), their results shows that use of cooking fuel has weak relationship with total under-five mortality. The study, however, found a stronger link between cooking fuel and mortality for sub-group analyses of children aged 12±59 months. Imelda (2017) examined the effect of fuel switching on under -5 mortality rate in Indonesia. The study motivation came from the fact that Indonesian government introduced LPG to Kerosene conversion program aimed at inducing household switch to LPG. The author found that the infant mortality rate fell by 30 percent post intervention.

Focusing on five categories of health outcomes (cardiopulmonary, respiratory, neurologic, eye health, and burns) Das, Jagger and Yeatts (2017) investigated the association between fuel use and health outcomes for a cross-sectional sample of 655 households in Malawi. Their results showed that; cooking with firewood or crop residue has significant relationship with odds of having difficulty breathing, shortness of breath, chest pains, night phlegm, dizziness, forgetfulness, and dry irritated eyes. It was also found that cooking in rural areas compared with cooking in urban areas comes with higher odds of experiencing persistent cough, shortness of breath, and phlegm, and also associated with lower probability of forgetfulness, burns, and phlegm. From this review, it could be seen that inferential studies of health effects of households' cooking fuels in Nigeria is scanty. Furthermore, while majority of studies in this area focus mainly on health outputs, limited attention is given to indoor air pollution associated with cooking fuels on health inputs, especially, on healthcare expenditure. Thus, this study fills these gaps.

Model Specification

Empirical studies on health impact always start with health production function;

$$H = f(M, X) \text{ ---------- } 1$$

The health production function describes the relationship between combinations of medical (M) and non-medical (X) inputs and the resulting health output. The non-medical inputs include economic, social and physical condition of household. Given scanty of data on household medical attributes and our interest in non-medical attributes of household, health equation used by Silwal and Mckay (2017) is adapted. The model is stated as;

$$y_i = \beta_0 + \beta_1 X_i + \beta_i C_i + \xi_i \text{ ---------- } 2$$

Where y represents two health indicators; health outcome measured by binary response whether or not a household head spouse (in this case housewife) is suffering from an air pollution related illness or injury[1] and household's healthcare expenditure; X_i is the categories of cooking fuel choice (here cooking fuel choice is categorized into solid and non-solid fuels), and C is a vector of covariates that could also affect human health. It consists of socio-economic attributes of household such as household size, income, educational level of spouse (housewife), etc. In this study, it is assumed that fuel quality is a proximate cause of exposure to household air pollution, which in turn affects health status, hence β_1 is the coefficient of interest. It is expected to be positive since the higher use of solid fuels increases the amount of indoor air pollution related illness, injury and healthcare expenditure. Thus, the explicit health equation is written as;

$$H_{ij} = \beta_0 + \beta_1 FU_{ij} + \beta_2 Y_{ij} + \beta_3 N_{ij} + \beta_4 AG_{ij} + \beta_5 ED_{ij} + \beta_6 AC_{ij} + \beta_7 CW + \beta_8 KT_{ij} + \beta_9 UR_{ij} + \mu_{ij} \ldots \quad 3$$

Where;
Y= income of households
FU= choice of cooking fuels
N= household size
AG= age of household head
ED= level of education of household head
AC= access to electricity
CW= Access to clean water
KT= location of kitchen
UR= place of residence (urban/rural areas)
μ = error term
Other variables remain as defined above.

Apriori Expectation

It expected that the use of solid or traditional cooking fuels, through indoor air pollution, will negatively affect maternal health, and positively impact on household healthcare expenditure. Similarly, it is expected that those households residing in urban area, and those having access to electricity and clean water are more likely to have less maternal health problems and healthcare expenditure. It is also expected that educational level of household head and housewives correlates negatively with the maternal health problem and healthcare expenditure. The effects of household size and age of household head on maternal health are inconclusive, but it is envisaged that these variables would have positive impact on healthcare expenditure.

Estimation Technique

The major problem with equation 3 is the presence of endogeneity. This is because fuel choice is not randomly distributed across household. It is affected by other factors such as income, better health information or health concern (Silwal & McKay, 2014). For instance, households with better health information may decide to choose and use only modern fuel or mix limited

traditional fuels with modern ones. In these cases, the normal logit binary response technique is invalid as estimates that will be derived from equation 3 through this method will be biased and inconsistent. To deal with the problems of endogeneity, an instrumental variable procedure will be used to estimate equation 3. To do this a variable that affect the fuel choice but do not otherwise affect health outcome will be needed. Some of the variables that have been used to instrument fuel choice include; predominant road type in the community (Silwal and Mckay, 2017), fuel availability proxied by the share of houses that uses solid fuel as main cooking fuel (Balietti & Datta, 2017), and agricultural land ownership (Basu, et al., 2020). This study follows Basu et al. (2020)'s by using agricultural land ownership. According to these authors, this instrument highly correlates with fuel choice and is less likely to associate with health status. That is, ownership of agricultural land could influence the choice of traditional cooking fuels but does not determine how healthy an individual is. Two-stage least squares was used to estimate the instrumental variable model through these steps. Firstly, fuel choice was regressed on the instrument variable (agricultural land ownership) and on social, economic and cultural attribute of households. In the second stage, health indicator (maternal health and healthcare expenditure) was regressed on the predicted value of fuel choice and on social and economic attributes of households.

Source of Data

The study used data from the Nigeria's General Household Survey (GHS) collected by the National Bureau of Statistics, Nigeria in collaboration with the World Bank. This survey was conducted between 2015 and 2016 and data released for public use in 2018. The World Bank emphasizes collection of these basic data to promote Living Standard Measurement Study (LSMS) surveys in developing countries. The Household survey was a nation-wide survey which collected detailed information on a variety of topics including demographic characteristics of the household, education, health, income, energy, infrastructure, expenditure, economic activity, housing conditions, access to social amenities, asset ownership, violence, and other subjective issues among others. A multi-stage and stratified sample design sampling techniques was used to collect data from 4,581 households across 60 enumeration areas chosen from the 36 states in Nigeria, including capital state, Abuja. The raw data from this survey was used to analyze health impact of household cooking fuel choice in Nigeria.

Empirical Result

Table 1 presents the estimation results of the effect of fuel choice on housewife respiratory health and households' healthcare expenditure in Nigeria.

In the results, it is found that the use of solid cooking fuels such as firewood and charcoal significantly increases the incidence of respiratory infections among housewives. This implies that in households where solid fuels (traditional fuels) are the main cooking fuels, housewives face the risk of respiratory diseases and are more likely to get sick or suffered injury. This result satisfies a priori expectation of a positive relationship between health outcomes and emissions from burning solid fuels. This is in line with the findings of Gajate-Garrido (2013) for Peru, Buthelezi et al., for South Africa and Das et al., (2017) for Malawi. They all found that cooking with solid fuels has significant relationship with odds of experiencing respiratory illness, difficulty breathing, chest pains, shortness of breath, night phlegm, forgetfulness, dizziness, and dry irritated eyes. Etc. Also, the results show that households using solid fuels for cooking face increase in healthcare expenditure compared with those using non-solid fuels. Furthermore, households living in urban areas are less likely to have respiratory infection, sickness or eyes

injury compared to those residing in rural areas. This result is in consonance with a prior expectation since households in rural areas are predominant solid fuels users who are susceptible to indoor air pollution coming from carbon emission. Also, most rural dwellers lack adequate medical facilities. However, it was found that households in urban areas are more likely to spend more on healthcare than those in rural areas.

Table 1: Regression results of health impact of fuel choice

Dependent variable:	Housewife respiratory health	Healthcare expenditure
	Coefficient	Coefficient
Constant	0.683** (-3.576)	6.661** (12.374)
Fuel (Solid)	1.657** (3.712)	0.948** (3.711)
Urbanisation	-0.538** (-3.747)	0.216** (2.572)
Household size	0.032** 2.671	0.033 (1.013)
Age of housewife	0.375** (6.615)	
Age of household head		0.216** (7.518)
Marital Status	0.020 (0.665)	-0.044 (-0.506)
Location of Kitchen (outside)	-0.175** (-2.805)	-0.255 -1.369
Access to Electricity	-0.312** (-3.050)	0.269 0.915
Access to clean water	-0.188** (-2.113)	-0.365** (-4.113)
Educational attainment (Primary)	0.511 (1.398)	-0.372 (-1.253)
Educational attainment (Secondary)	-0.281 (-0.330)	-0.238** (-3.434)
Educational attainment (tertiary)	-0.394** (-3.116)	0.186** (2.134)
Education of mother (Primary)	0.879 (0.987)	
Education of Mother (Secondary)	-1.879 (-1.792)	
Education of Mother (tertiary)	-1.786** (-2.604)	
Household income	-0.102** (3.712)	0.312** (4.771)
F-statistic Prob(F-statistic)	8.575 (0.000)	8.209 (0.000)
Instrument Orthogonality C-test Test: Difference in J-stats	7.758 (0.005)	5.076 (0.012)
Endogeity test: Difference in J-stats	1.331 (0.169)	1.663 (0.657)
Weak Instrument Diagnostics: Cragg-Donald F-stat	10.639	12.294
Breusch Pagan test: F-statistic	8.801 (0.074)	1.459 (0.148)

t-statistic test are enclosed in parentheses. ** indicates significance at 5% critical level.

The results show that housewives in households with access to electricity and clean water are less likely to have respiratory infections, sickness and eye injury. Though, household healthcare expenditure is not significantly influenced by access to electricity, it is affected by access to clean water. In the results, the probability of housewives suffering from respiratory infections, sickness and eye injury increases with age of housewives. A positive relationship was also found between age of household head and household healthcare expenditure. While location of kitchen outside the dwelling unit reduces the incidence of housewives contacting respiratory infections, getting sickness or having eyes injury, it, however, does not play any significant role in determining household healthcare expenditure. Lastly, the higher the education levels of household head and housewife are, the lesser the probability of them having respiratory related sickness and injury. That is, housewives with higher education are less likely to fall sick or have injury. It was also revealed that higher income promotes better health status. The coefficient of household income is negative and statistically significant at 5 percent critical level for maternal health function, and it is positive and statistically significant at 5 percent level for healthcare expenditure function. This implies that housewives in households with higher income are less likely to contact respiratory infection, get sick and experienced eyes' injury compared to housewives in households with lower income. However, healthcare expenditure tends to rise with the level of income.

Conclusion

The assessment of energy transition and health impact of household cooking fuel choice in Nigeria is essential to the country's push for achievement of clean and affordable modern energy for all (SDG-7) as well as climate protection (SDG-12). From the results, it is confirmed that health challenges persist due to the widespread use of traditional cooking fuels- households who use traditional fuels for cooking spend relatively more on healthcare expenditure since they are exposed to respiratory related illnesses and injuries. Lastly, it was also found that access to electricity, household head income, and educated spouse of household head promote housewives health status in Nigeria. It is, therefore, recommended that the Nigeria's government needs to provide reliable power supply for household consumption at affordable price. LPG should also be made available and affordable for household consumption. This will ultimately lead to reduction in indoor air pollution and improve household health status.

References

Ana, G.R. (2010). Air pollution in the Niger Delta: Scope, Challenges and Remedies. Retrieved from:https://www.intechopen.com/books/the-impact-of-air-pollution-on-health-economy-environment-and-agricultural-sources/air-pollution-in-niger-delta-area-scope-chanleges-and-remedies

Balietti, A. and Datta, S. (2017). The impact of indoor solid fuel use on the stunting of Indian children. Working Paper www.ancabalietti.net/wp-content/uploads/2017/04/Datta_Balietti_March2017.pdf

Bautista L. E., Correa, A., Baumgartner, J., Breysse, P., & Matanoski, G. (2008). Original contribution indoor charcoal smoke and acute respiratory infections in young children in the Dominican Republic. *American Journal of Epidemiology, 169* (5), 572–580.

Buba, A., Abdu, M., Adamu, I. & Usman, Y.I. (2017). Socio-economic determinants of households fuel consumption in Nigeria. *International Journal of Research – Granthaalayah, 5*(10), 348-

360.

Buthelezi, S. A., Kapwata, T., Wernecke, B., Webster C., Mathee A. & Yael Wright, C. (2019). Household fuel use for heating and cooking and respiratory health in a low-income, south African coastal community. *International Journal of Environmental Research and Public Health,* 16, 1-12

Das, I., Jagger, P. & Yeatts, K. (2017) Biomass cooking fuels and health outcomes for women in Malawi. *Ecohealth, 14*(1), 7–19.

De Longueville F., Hountondji, Y., Henry Ozer, P. S. What do we know about effects of desert dust on air quality and human health in West Africa compared to other regions? Review Article. *Science of The Total Environment*, *409* (1), 2010, 1-8.

Emagbetere, E., Odia, J. & Oreko, B. U. (2016). Assessment of household energy utilized for cooking in Ikeja, Lagos State, Nigeria. *Nigerian Journal of Technology, 35*(4), 796 – 804.

Erickson, L. E. & Jennings, M. (2017). Energy, transportation, air quality, climate change, health nexus: sustainable energy is good for our health, *AIMS Public Health*, *4* (1), 47-61

Gajate-Garrido, G. (2013). The impact of indoor air pollution on the incidence of life threatening respiratory illness:evidence from young children in Peru. *Journal of Development Studies, 49(*4), 500-515

Gujba, H., Mulugetta, Y. & Azapagic, A. (2015). The household cooking sector in Nigeria: environmental and economic sustainability assessment, *Resources*, *4*, 412-433.

Hoek, G., Krishnan, R., Beelen, R., Peters, A., Ostro, B. Brnekreef, B. & Kaufman, J. D. (2013). Long-term air pollution exposure and cardio-respiratory mortality: a review. *Environmental Health, 12:43,* https://doi.org/10.1186/1476-069X-12-43

Ibem, E.O. (2011). Challenges of disaster vulnerability reduction in Lagos Megacity Area, Nigeria. *Disaster Prevention and Management*. *20*(1), 27-40.

Imelda (2017). Fuel switching and infant health: evidence from LPG conversion program in Indonesia, *Selected Paper prepared for presentation at the 2017 Agricultural & Applied Economics Association Annual Meeting, Chicago, Illinois, July 30-August 1*

International Energy Agency (IEA), (2018). World Energy Outlook 2018. IEA, Paris

Jung, J. & Huxham, M. (2018) Firewood usage and indoor air pollution from traditional cooking fires in Gazi Bay, Kenya, *Bioscience Horizons*, *11*,1-12

Malla S. & Timilsina G., (2014). *Household cooking fuel choice and adoption of improved cook stoves in developing countries: A review*. Policy Research Working Paper 6903. World Bank.

Machisa, M., Wichmann, J., and Nyasulu, P. S. (2013). Biomass fuel use for household cooking in swaziland: is there an association with anaemia and stunting in children aged 6–36 months? *Transactions of the Royal Society of Tropical Medicine and Hygiene*, *107*(9), 535–544.

Mbanya, V.N. & Sridhar, M.K.C. (2017). PM_{10} Emissions from cooking fuels in Nigerian households and their Impact on Women and Children. *Health, 9,* 1721-1733.

Mishra, V. & Retherford, R. D. (2007). Does biofuel smoke contribute to anaemia and stunting in early childhood? *International Journal of Epidemiology*, 36(1),117–129.

Noubiap J.J.N., Essouma M., & Bigna J.J.R. (2015). Targeting household air pollution for curbing the cardiovascular disease burden: a health priority in Sub-Saharan Africa. *The Journal of Clinical Hypertension. 17*,825–829.

Ogwumike, F. O., Ozughalu U. M. & Abiona, G. A. (2014). Household energy use and determinants: evidence from Nigeria. *International Journal of Energy Economics and Policy, 4*(2), 248-262.

Olowoporoku, A. O., Longhurst, J. W. S. & Barnes, J. H. (2012). Framing air pollution as a major health risk in Lagos, Nigeria. *Air Pollution*, *20*, 479-486.

Onabowale, M.K. & Owoade, O.K. (2015). Assessment of residential indoor-outdoor airborne particulate matter in Ibadan, Southwestern Nigeria. *Donnish Journal of Physical Sciences*, *1*, 001-007.

Ozoh O. B., Okwor T. J., Adetona O., Akinkugbe, A.O., Amadi C. E., Esezobor C., Mortimer K. (2018): Cooking fuels in Lagos, Nigeria: factors associated with household choice of kerosene or liquefied petroleum gas (LPG). *International Journal of Environmental Research and Public Health, 15*(4), 1-13.

Pitt, M. M., Rosenzweig, M. R. & Hassan M. N. (2006). Sharing the burden of disease: Gender, the household division of labour and the health effects of indoor air pollution in Bangladesh and India. Retrieved from https://www.researchgate.net/publication/237423021_Sharing_the_Burden_of_Disease_Gender_the_household_Division_of_Labor_and_the_Health_Effects_of_Indoor_Air_Pollution_in_Bangladesh_and_India

Silwal A. R. & McKay, A. (2017). *The Impact of cooking with firewood on respiratory health: evidence from Indonesia.* University of Sussex Economics Working Paper Series No. 72-2014

Smith, K. R. (2000). National burden of disease in India from indoor air pollution. *Proceedings of the National Academy of Sciences, 97*(24),13286–13293.

Tumwesige, V., Okello, G., Semple, S., & Smith, J. (2017). Impact of partial fuel switch on household air pollutants in sub-Sahara Africa. *Environmental Pollution 231,* 1021-1029.

Ubuoh, E. A. & Nwajiobi, B. (2018). Implications of different household cooking energy on indoor air quality in urban and semi-urban settlements in Imo, South Eastern Nigeria. *Journal of Applied Science and Environmental Management, 22* (5) 725 – 729

Van Gemert F, Kirenga B, Chavannes N, Kamya M, Luzige S, Musinguzi P, Turyagaruka J, Jones R, Tsiligianni I, Williams S, & De Jong C. 2015; Prevalence of chronic obstructive pulmonary disease and associated risk factors in Uganda (FRESH AIR Uganda): a prospective cross-sectional observational study. *The Lancet Global Health. 3*, 44–51.

Wichmann, J. & Voyi, K.V.V. (2006a) Impact of cooking and heating fuel use on acute respiratory health of preschool children in South Africa. *The Southern African Journal of Epidemiology and Infection 21*, 48- 54.

World Bank (2019). *World Bank Development Indicators.* http://datacatalog.worldbank.org/dataset/world-development-indicators

Yeh, E. (2004). *Indoor air pollution in developing countries: household use of traditional biomass fuels and the impact on mortality.* University of California, Berkeley