International Journal of Economics, Commerce and Management
United Kingdom ISSN 2348 0386 Vol. VIII, Issue 6, June 2020

http://ijecm.co.uk/

EFFECT OF FOOD PRODUCTION FLUCTUATION AND CARBON DIOXIDE EMISSION ON CHILD HEALTH IN SUB-SAHARA AFRICA

Kemi Funlayo AKEJU
Department of Economics, Faculty of the Social Sciences
Ekiti State University, Ado-Ekiti, Ekiti State, Nigeria
kemi.akeju@eksu.edu.ng; akf126@yahoo.com

Dayo Benedict OLANIPEKUN
Department of Economics, Faculty of the Social Sciences
Ekiti State University, Ado-Ekiti, Ekiti State, Nigeria
dayo626@yahoo.com; dayo.olanipekun@eksu.edu.ng

Abstract

Climatic changes affect food production leading to upsurge high price of household food items which can affect the choice and preference of cooking energy at household. As households struggles to source food with available income, usage of biomass energy from wood, charcoal and waste increases as an affordable alternative source of energy for cooking in predominantly poor households in Sub Sahara Africa. This paper examined how fluctuations on food production and emission from household energy resources affect the quality of child health and its outcome. Using data from the World Development Index database this paper explores the interaction of shocks on an index of food production and that of pollution from energy resources on child mortality. Findings revealed that CO2 emission raises child mortality and food production index has a significant negative impact on child mortality, thus calling for households to use appropriate cooking energy to reduce CO2 emission which contributes to factors affecting child health and it outcomes.

Keywords: Food production, cooking energy, Household, Energy pollution, Child mortality

INTRODUCTION

Sub Saharan Africa is the poorest region in the world and has remained challenged with how to improve child health outcomes and performances. Less progress has been recorded on combating the death of under-five children in the region where many households are constraint with low income and incessant shock to the price of food items due to a high level of food insecurity raised by climatic events of droughts and flooding affecting food production in the region. Wheeler and von Braun (2013) identified that extreme droughts and floods do not only affect food production but also the health conditions and disease environment that further interacts with the food system. The Sustainable Development Goals (SDGs) of the post-2015 development agenda give food and nutrition security a high priority. Despite the efforts of governments and international organizations, the number of people affected by food and nutrition insecurity remains high, with 780 million people undernourished and about two billion malnourished (FAO, 2015).

An observed shock in food production has affected many households in accessing adequate nutrition for children in African. Malnutrition affects under-five children and results in stunted growth. Low improvement in child health outcomes needs to be observed along with its many causes. Many works on child health outcomes focused on Mosley and Chen's 1984 analytical framework of proximate determinants; maternal factors, nutrients deficiency, injury, illness, and environmental factors with strong inference on the role of nutrients, food supplement and immunization. However, a growing literature considers household energy as a potential determinant of child health with claims of 3.5 million deaths and 4.3% of global disability-adjusted life years attributed to household air pollution (Lim et al. 2010, Smith et al 2014).

Although carbon dioxide and other greenhouse emission gases are known to contribute to the radioactive force of climate change (IPCC, 2007) yet much has not been done on the effect of a large amount of air pollutant generated from household cooking and home heating with coal and biomass fuels (wood, charcoal, residues) on the health of under-five children in Africa, where the provision of electricity is by far the greatest infrastructure challenge which has become a scenario leading Sub-Saharan Africa with the lowest rates of energy access, capacity per capita and electricity consumption per year. Statistics from World Development Index show that electrics power consumption(Kwh per capita) of Sub-Sahara Africa in 2014 stood at 480.32 with Electricity production from hydroelectric sources (% of total) being 21.17, Electricity production from coal sources (% of total) at 51.43.

Child health outcome is modelled using child mortality as a dependent variable of interest. Child mortality in Sub Saharan Africa is the largest across regions of the world with a record of 78 per 1,000 lives in 2016. Trends across its sub-region based on a report from World

Bank database 2017 indicates Eastern Africa had made steady growth but out of the 46 countries in sub-Saharan Africa, only Cape Verde, Eritrea, Mauritius, and Seychelles made highly consistent progress; thus indicating that progress is urgently required to achieve the Sustainable Development Goal (SDG 3)target on child survival, particularly in high mortality countries of sub-Saharan Africa who could not meet the MDG 4 due to low pace of progress. WHO (2012) reports indicate that one in eight of total global deaths is a result of air pollution exposure; thus indicating that reducing air pollution could save millions of lives. A recent report in 2018 by WHO also indicates that 3 billion people cook using open fires, simple stoves fuelled by kerosene, biomass and coal with up to 4 million premature death attributed to household air pollution from this cooking practices and close to half of the deaths due to pneumonia among children under 5 years of age caused by particulate matter (soot) inhaled from household air pollution.

Up to 2.5 billion people worldwide lack access to clean energy for cooking and heating and nearly 730 million people in sub-Saharan Africa rely on the traditional use of solid biomass (mainly fuelwood, charcoal, and dung) for cooking, typically with inefficient stoves or simple three-stone fires, in poorly ventilated spaces (IEA, 2014; WHO, 2017). Access to modern energy services remains limited; more than 620 million people have no electricity. In 42 countries, more than half the population relies on solid biomass for cooking, and in 23, the share is above 90%.

Rural households are particularly dependent on traditional biomass, but many urban households cook with it as well, mainly in the form of charcoal. The usage of biomass at homes has consequences on the health of people especially under-five children who are often prone to diseases in early life. Across households in Sub Sahara Africa, poor women with children pay heavy prices spending much of their time at home breathing in smoke from coal and wood cook stoves as a result of conventional cooking methods. Unexpected changes in energy prices, including prices for gasoline and heating fuel (natural gas and electricity), often raise usage of conventional cooking methods and affect food access at the household level (Charlotte, Tuttle, & Timothy, 2017).

An observed shock in food production has affected many in accessing adequate nutrition for children in African households. This study finds the linkage between low food production and usage of biomass energy for cooking in households as household's source for alternative energy with income spread on food and energy in poor households. In this study, the question asked is does the index of food production and emission from CO2 have a significant impact on child health in sub-Sahara Africa in the face of its slow pace of other explanatory variables of

access to sanitation, improved water, immunization of DPT and reduction in the prevalence of anemia due to health expenditure level in the region.

An investigation of the effect of fluctuation in food production and emission of carbon dioxide (CO2) on child mortality in Sub Saharan Africa is done using a panel linear regression to access the interaction of CO2 and food production index on child mortality and also ascertain the long term effect of its use on child mortality in the region. Though air pollution affects everybody but children have the greatest susceptibility. Their bodies perform a metabolic activity and their immune systems are weak so they are less able to metabolize to remove pollutants like adults. Children, also, have greater surface-to-volume ratios than adults as they play on the ground and engage in oral exploratory behaviour. This increases their skin's potential exposure, potential ingestion of contaminants in the soil and dust, and exposure through respiration by inhaling air closer to the ground than adults do. In the case of infant death, the link between cause and effect is immediate, whereas for adults diseases today may reflect pollution exposure that occurred many years ago.

Because their respiratory systems are under-developed, infants breathe more air per body weight than adults and also engage in a lot of mouth breathing. The mouth breathing, which bypasses the filter of the nose, may pull air pollutants deeper into infants respiratory system thus making the effect of air pollution to be suffocation and death or Sudden Infant Death Syndrome (SIDS i.e. an unexplained and unexpected death of an apparently healthy infant) (Cao et al., 2007; Pickett and Bell, 2011). An indirect susceptibility of infants to air pollution has been argued to be through the health of pregnant mothers. The weakening of her immune system when exposed to air pollution could be detrimental to her foetus.

Since 2005, a series of unfavourable weather episodes in major producing countries have combined with a low level of infrastructure and transformation in agriculture to generate a sudden reduction in food production. The international price of food item rose rapidly putting a constraint on the local prices and increases in non-food uses of cereals, such as the use of cereal feedstock in the fuel ethanol sector, have put additional pressure on prices, while creating incentives to increase production. A higher cost of imported food also leads to trade deficits that depress the level of activity in the economy leading to unemployment and lower government revenues. In all cases, real incomes and welfare of the population, especially the poor, are affected. With high import dependency in Sub Sahara Africa, a rise in world prices often raises domestic prices with the transmission of the world to local prices depending on whether the commodity is an exportable good suitable for yielding revenue for the government at larger produce. While these shocks affect the household demand directly, we also assume that the children under-five are still in the care of the household adults and consider that

household's ability to provide health care for its children contributes significantly to the child survival.

Notable works on traditional biomass energy identified its effect on household food production in numerous ways. Qiu Chen and Alisher Mirzabaev (2016) found that the time spent on collecting straw and firewood may create a burden on rural household, as it could reduce the available labour inputs for agricultural production, which in turn, possibly brings negative impact on food security. Health effect was identified by WHO on the increased rate of acute lower respiratory infection in children, Bruce, Smith, Balakrishnan and Adair-Rohani et. al (2014) asserted it increases the risk of adverse pregnancy outcome and impairs cognitive development in children. Lim et al (2012) claimed exposure to smoke from traditional biomass cooking stoves caused almost 600,000 deaths in Sub Sahara Africa in 2012.

Onanuga (2014) on the impact of carbon dioxide emission on infant mortality in sub-Sahara Africa with a panel FGLS and GMM for period 1990-2012 identified a positive relationship between carbon dioxide emission and infant mortality. The study incorporated food production index along with other proximate and underlying factors of access to water and sanitation and found that food production index has a significant negative impact on infant mortality rate. This study considered an incessant change in the price of food items in the past few years 2010-2017 and considered the implication of changes in household food price on a choice of cooking energy relative to the low per capita income in the period on child mortality.

This study considered two specifications of child mortality considering various efforts on health and environmental situation of Sub Sahara Africa. First, it considered the specification of child mortality as determined by proximate factors of access to sanitation, access to improved water, the rate of DPT immunization, and prevalence of anaemia in under-five children in the region and observe that low rate and slow growth in these variables raises child mortality. Second, it considered an alternative specification of child mortality by accounting for the log of food production index and the impact of energy pollution using CO2 emission. The effect of observed worsening of food security in most parts of sub-Saharan Africa notably in situations of conflict compounded by droughts or floods is measured and household cooking emission effect is considered to have a significant impact on child mortality. We asked if the causality from changing food production index and usage of biomass cooking energy is an intermediating channel to a high rate of child mortality in Sub Sahara Africa with consideration on other social and health factors. Findings from this study relate with other studies that link household energy pollution to increase death in children (Onanuga, 2014; Sanglimsuwan, 2013).

ESTIMATION STRATEGY

Underlying and proximate determinants of child mortality in SSA

Studies have shown that under-five mortality is influenced and determined by various social, economic, demographic, environmental, cultural or behavioural factors. Some of these factors influence under-five mortality directly and others affect it indirectly (Antai, 2010; Black, 2008; Mosley and Chen, 1984). Those factors that have indirect effects on under-five mortality are referred to as the underlying (or background) factors. Examples include mother's education, wealth status, etc. While, those factors that have direct effects on under-five mortality are called proximate determinants examples of such variables include immunization, source of drinking water, etc.'

The estimating model focus on child mortality as being determined by vector of components of health system, and socio economic factors involving rate of prevalence of anaemia, access to sanitation, rate of immunization DPT and access to improved water. Improvements have been recorded on immunization of DPT on children within 12 -23 months and these directly contribute to boosting immunity in children in Sub Saharan Africa. Despite improvement made on water and sanitation system, sufficient access to improved water and sanitation remains a mirage in Sub Saharan Africa. The lack of groundwater is already causing significant ecological damage, including declining water quality, depleted rivers, and receding land—all of which will likely be intensified by population growth and climate change and at least one in five people still rely on surface water in Angola, Kenya, Madagascar, Sierra Leone, and South Sudan. These variables are essential to child health outcomes. The equation for estimation is written as:

$$lnCM_{it} = \beta_0 + \beta_1 lnPa_{it} + \beta_2 lnSs_{it} + \beta_3 lnImdpt_{it} + \beta_4 lnIw_{it} + U_{it} \ldots (1)$$

Where, CM is child mortality, Pa is rate of prevalence of anaemia, Ss is access to sanitation, Imm is rate of immunization of DPT and Iw is the access to improved water.

Impact of food price shock and Household Energy Emission on child mortality in SSA

To estimate the impact of recent upsurge in food price and CO_2 emission in household on child mortality, we incorporate the variables as regressors compounding factors affecting child mortality to test their robustness and significant impact. The model becomes:

$$lnCM_{it} = \beta_0 + \beta_1 lnPa_{it} + \beta_2 lnSs_{it} + \beta_3 lnImdpt_{it} + \beta_4 lnIw_{it} + \beta_5 ln\, CO_{2it} + \beta_6 ln\, Cpi_{it} + U_{it} \ldots\ldots (2)$$

Equation 2 specifies a panel model where CO_2 is the emission of carbon dioxide and Cpi is the consumer price index. To attain uniformity, the log of the variables are employed towards measuring the fluctuations in child mortality rate expected to come from shocks in food availability due to price and that of carbon dioxide emission. Global energy related carbon dioxide emission has been on the increase recently in Sub Saharan Africa as current energy system are failing to meet the needs of the world's poor which predominantly depends on traditional biomass for cooking. Countries in Sub Saharan Africa is caught between recessed economic system and rising inflationary pressures which are compounded with shocks to food production raising prices of food items. For many developing countries, the recent food, commodities, and oil price shocks are already having severe implications particularly among the poorest.

RESEARCH METHODOLOGY

Data Source and Description

Data used for the study on 46 countries in Sub Saharan Africa were sourced from World Bank, World Development Index 2017).

Child Mortality (CM): Child mortality also known as Under-five mortality rate is the probability per 1,000 that a new-born baby will die before reaching age five, if subject to current age-specific mortality rates.

Rate of Prevalence of Anaemia (pae): Prevalence of anaemia, children under age 5, is the percentage of children under age 5 whose haemoglobin level is less than 110 grams per litter at sea level.

Rate of Immunization DPT (imdpt): Child immunization, DPT, measures the percentage of children ages 12-23 months who received DPT vaccinations before 12 months or at any time before the survey. A child is considered adequately immunized against diphtheria, pertussis (or whooping cough), and tetanus (DPT) after receiving three doses of vaccine.

Access to Improved sanitation facilities (Ss): This is the percentage of people using at least basic sanitation services, that is, improved sanitation facilities that are not shared with other households. This indicator encompasses both people using basic sanitation services as well as those using safely managed sanitation services. Improved sanitation facilities include flush/pour

flush to piped sewer systems, septic tanks or pit latrines; ventilated improved pit latrines, compositing toilets or pit latrines with slabs.

Access to Improved Water (Iw): This is the percentage of people using drinking water from an improved source that is accessible on premises, available when needed and free from faecal and priority chemical contamination. Improved water sources include piped water, boreholes or tube-wells, protected dug wells, protected springs, and packaged or delivered water.

Carbon dioxide Emission (CO_2): Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

Food Production Index (Fpi): Food production index covers food crops that are considered edible and that contain nutrients. Coffee and tea are excluded because, although edible, they have no nutritive value. The commodities covered in the computation of indices of agricultural production are all crops and livestock products originating in each country.

Estimation Strategy

Drivers of child mortality were observed with two models. One with basic ideas of immunization, and environmental effect of water and sanitation and the other based on the effect of shock on food production and household energy emission on child mortality in Sub Saharan Africa with the use of the linear regression and fixed effect technique on panel data on 46 Sub Saharan Africa countries. Usage of fixed effects regression allows the control of time-invariant unobserved individual characteristics which can be correlated with the observed independent variables.

Econometric Model Specification

From the determinants of child mortality discussed above, the two models are constructed as;

$$lnCM_{it} = \beta_0 + \beta_1 lnPa_{it} + \beta_2 lnSs_{it} + \beta_3 lnImdpt_{it} + \beta_4 lnIw_{it} + U_{it}. \quad (1)$$

$$lnCM_{it} = \beta_0 + \beta_1 lnPa_{it} + \beta_2 lnSs_{it} + \beta_3 lnImdpt_{it} + \beta_4 lnIw_{it} + \beta_5 ln\, CO_{2it} + \beta_6 ln\, Fpi_{it} + U_{it} \ldots\ldots (2).$$

RESULTS AND DISCUSSION

Table 1 reports regressions of determinants factors of child mortality in Sub Saharan Africa countries using the two models.

Table 1: Least-squares regression

The dependent variable is the log of child mortality.		
Variables	Model 1	Model 2
imdpt	-0.0320***	-0.3706***
	(0.034)	(0.0429)
lpw	-0.2373***	-0.3696***
	(0.0548)	(0.0513)
Pae	1.8161****	1.2008***
	(0.0561)	(0.0713)
lpss	0.0311	-0.0197
	(0.0297)	(0.0275)
Fpi	-0.1496**	
	(0.0662)	
Co2emiss	0.064***	
	(0.0006)	
_cons	-2.0290***	3.3016***
	(0.1355)	(0.4810)
Adjusted R-sqd	0.9742	0.9784
R-sqd	0.9744	0.9786
F-Statistics.	0.0000	0.0000

Notes: data covers 46 Sub Saharan Africa countries. Model 2 add the interaction of consumer price index and co2 emission to determinants of child mortality modelled in model 1. The two models report coefficient estimate and its robust standard errors presented in parenthesis. *, ** and *** represent significance level of estimates at p-values of <0.1, 0.05 and 0.01 respectively.

Result presented in table 1 revealed that in model 1; immunization of DPT and access to improved water has a negative relationship with child mortality in SSA while prevalence of anaemia and access to sanitation has positive effect on child mortality. All the variables except access to sanitation is statistically significant at 1 % level. This result indicates that a unit increase in access to immunization of DPT on children at early lives and that of access to improved water reduces child mortality by 0.03 and 0.2. Prevalence of anaemia and access to improved sanitation raises child mortality although that of sanitation is not significant but prevalence of anaemia in children which reflect low level of haemoglobin has significant impact on child mortality. A unit increase in prevalence of anaemia raise child mortality by 1.8 while a unit increase in access to improved sanitation raises child mortality by 0.03.From this result we observed that the proportion of people with access to adequate sanitation is low to have improvement on child mortality. This result signifies that much is needed in terms of immunization, access to improved water and sanitation to make great impact on reduction of child mortality. On the prevalence of anaemia, food nutrient rich in providing haemoglobin is needed to fight child mortality. The R-Squared statistics of 0.9744 indicates that the independent variables are sufficient to indicate the interactions between the dependent variable and the independent variables.

Model 2; provides the effect of interaction of index of food production and co2 emission on child mortality. The result indicates that child mortality has negative relationship with all the variables except prevalence of anaemia and c02 emission. With the interaction of food production, effect of a unit increase in prevalence of anaemia on child mortality dropped from 1.8 to 1.2, an indication that food supplement from adequate food production can help reduce prevalence of anaemia and a unit increase in food production reduce child mortality by 0.14. $C0_2$ emission raises child mortality by 0.06. we observe that all the variables except access to adequate sanitation has significant relationship with child mortality and this indicates that interaction of these variables serves as drivers of child mortality in Sub Sahara Africa. The unit of index of food production has the potential of reducing child mortality by 0.15,thus increasing food production is essential in the provision of adequate nutrients for child survival. The R-Squared statistics of 0.9786 indicates that the independent variables are sufficient to indicate the interactions between the dependent variable and the independent variables.

To further account for potential correlation between child mortality with household, food production and co2 emission due to energy choice decisions, we employ a fixed effect model. The result is presented in table 2:

Table 2: fixed effect regression estimate

The dependent variable is the log of child mortality.		
Variables	Model 1	Model 2
lmdpt	-0.1005 ***	-0.0915***
	(0.0299)	(0.0303)
lw	-0.4587***	-0.4990***
	(0.0525)	(0.0545)
Pa	2.3009***	1.7849***
	(0.0497)	(0.0720)
Ss	0.0621**	0.0668***
	(0.0296)	(0.0269)
Fpi	-0.4273***	
	(0.0370)	
CO_2emiss	0.0051***	
	(0.0004)	
_cons	-2.9374***	1.2619
	(0.1156)	(0.4193)
R-sqd(overall)	0.9711	0.9759
F-Statistics	0.000	0.000

Notes: data covers 46 Sub Saharan Africa countries. Model 2 add the interaction of food price index and co2 emission to determinants of child mortality modelled in model 1. The two models report coefficient estimate and its robust standard errors presented in parenthesis. *, ** and *** represent significance level of estimates at p-values of <0.1, 0.05 and 0.01 respectively.

Findings in Table 2 using fixed-effect regression estimates revealed that in model one; only immunization and improved water have a negative significant relationship with child mortality. Prevalence of anaemia and the percentage of people with access to sanitation relates positively to child mortality. In model two; the prevalence of anaemia, CO2 emission and percentage of people with access to sanitation raises child mortality Examination for the effect of CO2

emission on child mortality includes the high population of households using biomass energy for cooking in Sub Sahara Africa and with under-five children clinging to mothers who predominantly spend most time cooking, children are at higher risk of inhaling of CO2 emission. A unit increase in food production index leads to 0.43 reductions in child mortality thus signifying the importance of food security to child survival in the region.

CONCLUSION

This paper considers driving forces of child mortality and observed that food production, immunization and access to improved water is essential in reducing child mortality. Effect of emission from CO2 was also found to raise child mortality in Sub Sahara Africa. This paper contributes to the debate on the role of agriculture transformation in the development process as an engine to reduce poverty and improve the general wellbeing of children through better access to nutrients in Africa. It also indicates that for the burden of undernourishment, malnutrition and prevalence of anaemia to be reduced in Sub Sahara Africa, there is need to intensify efforts on food production through the usage of improved technologies to reduce losses in biodiversity and limit carbon emissions from agriculture. The emission of carbon dioxide was also observed to have a contributory effect on the rise of child mortality in Sub Sahara Africa. Children deserve to live in a world free from the life-threatening effects of climate change. Given the overwhelming scientific evidence on the dangers and causes of climate change, failing to take action is an injustice to all children.

WAY FORWARD

To promote child development and growth, food security must be ensured to fight hunger and malnutrition in under five children. Household living environment must be made clean from high emission of carbon dioxide. Research work on factors that promote child development must be engaged towards reducing child mortality.

REFERENCES

Antai, D. (2010). Migration and child immunization in Nigeria: Individual and community-level contexts. BMC Public Health, 10 (1). http://dx.doi.org/10.1186/1471-2458-10-116

Black, R. E., Lindsay H. Allen, Zulfiqar A. Bhutta, and Juan Rivera for the Maternal and Child Undernutrition Study Group. (2008). Maternal and child undernutrition: Global and regional exposures and health consequences. The Lancet 371 (9608): 243–260.

Smith K., Bruce N, Balakrishnan K, Adair-Rohani H, Balmes J, Chafe Z et al.(2014). Millions dead: How do we know and what does it mean? Methods used in the comparative risk assessment of household air pollution. Annu. Rev. Public Health.Volume35(http://www.annualreviews.org/doi/abs/10.1146/annurevpubl health-032013-182356).

Cao, H., Hsu, T., Ativanichayaphong, J., Stephanou. H., and Chiao, J.C. (2007). An infant monitoring system using CO2 sensor. IEEE International Conference on RFID Gaylord Texan Resort, Grapevine, TX, USA

Tuttle, Charlotte and Beatty, Timothy K. M., (2017). The effects of energy price shocks on household food security in Low-Income households. Economic Research Report 260484, United States Department of Agriculture, Economic Research Service.

FAO, IFAD and WFP. (2015). The state of food insecurity in the World 2015. Meeting the 2015 international hunger targets: Taking stock of uneven progress. Rome, FAO.

International Energy Agency. (2014). Energy climate change and environment. 2014 insights.

IPCC. (2007). Climate Change 2007: The physical science basis. In S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H.L. Miller (Eds.), Contribution of working group I to the fourth assessment report of the intergovernmental panel on climate change. Cambridge: Cambridge University Press.

Lim, S. S. et al., 2012. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990- 2010: a systematic analysis for the Global Burden of Disease Study 2010. The Lancet, 380(9859), pp. 2224-2260.

Mosley, W. H., and Chen, L. C. (1984). An Analytical Framework for the Study of Child Survival in Developing Countries. Population and Development Review, 10, 25-45. Retrieved from http://www.jstor.org/stable/2807954.

Mosley, W. H. (2006). Mortality and morbidity trends and differentials: Determinants and implications for the future. Johns Hopkins University. Retrieved from http://ocw.jhsph.edu/courses/population change/PDFs/Lecture7.pdf.

Onanuga, O. and Onanuga, A. (2014). Economics of the environment and infant mortality in Sub-Saharan Africa. Munich Personal RePEc Archive. Online at https://mpra.ub.uni-muenchen.de/83323/

Pickett, A.R. and Bell, M.L. (2011). Assessment of indoor air pollution in homes with infants. International Journal of Environmental Research and Public Health, 8: 4502- 4520.

Maternal and Child Nutrition Study Group. (2013). Executive summary of the Lancet Maternal and Child Nutrition Series. Oxford, UK: Elsevier. http://download.thelancet.com/flatcontentassets/pdfs/nutrition-eng.pdf.

Chen, Qiu & Mirzabaev, Alisher, (2016). "Evaluating the impacts of traditional biomass energy use on agricultural production in Sichuan, China," Discussion Papers 250213, University of Bonn, Centre for Development Research (ZEF).

Sanglimsuwan, K., (2013). Environmental health economics: Evidence at cross country analysis. School of Economics, Bangkok University.

Smith, K., Bruce, N., Balakrishnan, K., Adair-Rohani, H., Chafe, Z, (2014). Millions dead: how do we know and what does it mean? Methods used in the comparative risk assessment of household air pollution. Annual Review of Public Health, 35, 185-206. doi: 10.1146/ annurev-publhealth-032013-182356.

Wheeler, T. and von-Braun, J. (2013). Climate change impacts on global food security. Science, 341, 508-513. http://dx.doi.org/10.1126/science.1239402

World Health Organization. (2012). WHO guidelines for indoor air quality: Household fuel combustion. Geneva: World Health Organization.

WHO (2018). Household air pollution and health. World Health Organization.

World Bank, (2018). Tracking SDG7: The Energy Progress Report 2018, Washington DC: International Bank for Reconstruction and Development / The World Bank.

WEO-2017 Special Report: Energy Access Outlook, International Energy Agency, (https://webstore.iea.org/weo-2017-special-report-energy-access-outlook)

World Development Indicators (2017). https://datacatalog.worldbank.org/dataset.