ELECTRICITY CONSUMPTION AND HEALTH OUTCOMES IN SUB-SAHARAN AFRICA

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ABSTRACT

Electricity is a source of clean energy and its use is expected to advance better population health. Thus, the low level of electricity consumption in sub-Saharan Africa is alarming, as a greater percentage of member country populations would have little or no experience of electricity usage. The health hazards associated with alternative sources of energy or fuel including traditional solid fuels cannot be underestimated. This study examined the effect of electricity consumption on some health outcomes in sub-Saharan Africa. Estimating a panel model and accounting for potential endogeneity, electricity consumption per capita was found to have no significant effect on the infant and under-five mortality rates. However, where it was significant, it was found to reduce life expectancy at birth. An aggressive effort towards enhancing availability and affordability is paramount towards increasing electricity consumption and the consequential health gains.

Keywords: Electricity consumption, Health, Sub-Saharan Africa, Endogeneity

JEL Classification: I19, Q42, Q53

1. Introduction

Health outcomes in sub-Saharan Africa (SSA) are generally low as shown by the high mortality rate among children, mothers and adults as well as the low life expectancy at birth. Child and maternal mortality rates in SSA are relatively high and still constitute a great challenge in most countries in SSA and moving from the MDGs to SDGs, the reduction of both rates remain a struggle. The highest mortality rates in the world are found in the African continent (Deaton and Tortora, 2015). As shown by the World Development Indicators 2016, has the highest infant, under-five and adult mortality rates can be found in sub-Saharan Africa relative to other regions of the world. Infectious diseases also still cause large numbers of deaths.

Electricity is a necessary good for individuals, households, and firms but in SSA it has become a luxury good because it is one infrastructure seriously lacking and unaffordable by many. Electricity improves the environmental sanitation in households thus improving health; it prevents the health hazards caused by air pollution from the use of traditional sources of fuel, precisely solid fuel (including coal, firewood, animal dung. However, uninformed and particularly poor households are exposed to the consequential health effects.

According to the International Energy Agency (IEA) World Energy Outlook 2014 Fact book, two thirds of SSA population cannot access electricity for their use; and of the total energy demand, 60% are for charcoal and fuel wood. "Each year nearly 600, 000 premature deaths in Africa are caused by household air pollution as a result of the use of solid fuels, such as fuel wood and charcoal" (IEA World Energy Outlook 2014 Fact book).

Despite the energy resources abounding in SSA, the lingering challenge has been harnessing the abundant renewable energy including the rich solar and water sources. The high cost of the technology used for electricity supply and the generally low income earning population worsens the affordability of electricity tariff. Increased access to electricity and greater affordability would improve the sanitation experience of households and reduction in

air pollution. As shown by the IEA World Energy Outlook 2014 Fact book, two-thirds of the population in SSA are without access to electricity and the average consumption per capita for electricity in residences is around half of the average obtainable in China. The IEA World Energy Outlook 2014 Fact book also states that cooking with solid biomass is relied on by nearly 730 million.

Diseases contracted due to household air pollution from solid fuels and ambient particulate matter pollution include cancer in adults, cardiovascular and circulatory diseases, chronic respiratory diseases, diarrhoea, lower respiratory infection, and other common infectious diseases (Cohen 2013). Household air pollution from solid fuels was the second leading cause of death in India while ambient particulate matter pollution was the sixth (Cohen 2013, p. 38). Women and children are more exposed to the toxic waste from solid fuel related air pollution and cooking is the major form of consuming solid fuel (Gordon et al., 2014).

2. Literature Review

Poloamina and Umoh (2013) showed that while household income had a positive effect, rural residence, transmission and distribution process as well as effective government policy increased access to electricity in sub-Saharan Africa. Ahlborg (2015) empirically revealed that the presence of democracy and quality institutions significantly improve the consumption of electricity by households in Africa. Thus the characteristic high level of political instability, the disregard for the rule of law and corruption in Africa explain the low electricity consumption in most African countries. The long hours of relative darkness in homes, the lack of electricity to power fans and air conditioners so as to reduce the heat level, and the hazards from traditional alternative sources (such as firewood, candlelight, kerosene lamps) have negative health implications. Sub-Saharan Africa is one region with a relatively low per capita household electricity consumption. Precisely, it has the lowest compared to other regions of the world. Does this have any link to the health outcomes in SSA countries?

Several studies have found evidence of positive electricity effects on economic growth (Polemis and Dagoumas 2013, Bildirici 2013, Pempetzoglou 2014). The need for more contributions on the health effects of electricity use remains glaring. Examining the effect of electricity use on air pollution, Barron and Torero (2015) found that reduction in kerosene use improved the health of household members shown by reduction in the incidence of acute respiratory infections among children under six years of age. Singh (2013) found that reductions in neonatal death in rural India was explained by improvement in access to electricity in households.

Examining the impact of high pollution fuels on fetal and infant health, Epstein et al. (2013) found that household fuel such as coal, kerosene and biomass significantly increase the risk of low birth weight and neonatal death in India. Explaining the negative health impact of using solid fuels rather than electricity by households. For instance, Lakshmi et al. (2014) also found that women who cook with firewood and kerosene were more likely to experience stillbirth than those who use liquid petroleum gas or electricity in India. They also found stillbirth to be associated with the use of kerosene lamp compared to electric light. Thus the poor availability and low affordability of electricity in SSA surely have health impacts, which deserves to be examined.

Markandya and Wilkinson (2007) showed that though there are health benefits arising from the use of electricity, the actual generation of electricity comes with some health costs that vary across the

different generation methods. However, they say these costs are smaller compared with the health burden or cost of indoor air pollution from burning fuels. Using the Demographic Health Surveys of 60 low income countries from 1990 to 1999, Wang (2002) showed that at the national level, electricity access reduced both infant mortality and under-five mortality and the electricity effect on mortality was large and independent of income; it was the only significant determinant of health in urban areas.

Emphasizing on more reliable measures of health outcomes especially in industralised countries, Or (2000) used a premature mortality measure (potential years of life lost) rather than the standardised mortality rates of child mortality that generally has been overcome by industralised countries.

3. Methodology

The health outcome model follows the Mosley and Chen (1984) framework of child mortality, which emphasizes a broader approach of incorporating both biological or proximate and socioeconomic factors that affect child health. The health outcomes considered are infant mortality, under-five mortality and life expectancy at birth. The independent variable is the electricity consumption per capita. The study controls for vaccination use including DPT and measles, sanitation and nutrition factors including access to clean drinking water and prevalence of undernourishment, and healthcare expenditure categorized into total healthcare expenditure and public healthcare expenditure. The health outcome model for infant mortality, under-five mortality and life expectancy at birth is presented as equation one below.

$$HO_{it} = \delta_{1it} + \delta_2 ECPC_{it} + \delta_3 X_{it} + U_{it} + \varepsilon_{it} \quad (1)$$

Where health outcomes is given as a function of electricity consumption per capita ($ECPC_{it}$) and some control variables (X_{it}); U_{it} is the individual level effect and ε_{it} is the overall error term. Two regression models were estimated for each of the health outcome indicator. The first regression model assumes the exogeneity of all explanatory variables. Thus, based on a Hausman test, the fixed effect or random effect estimator was employed. The second regression however accounts for the potential endogeneity of total and public healthcare expenditures hence; a panel instrumental variable technique was thus used.

4. Data

The sample size is 16 sun-Saharan African countries based on data availability and data was obtained from the World Development Indicator 2016. The mean electricity consumption per capita is 712.13 with the highest value obtained in South Africa while Ethiopia has the least. Life expectancy at birth in the region is 55.50 with Mauritius having the highest of 72.62 while Zimbabwe has the lowest value of 45.55. The infant mortality rate in the region is approximately 63, with Angola having as high as 116.72 while Mauritius records the lowest of 13.89. The under-five mortality rate is 97.01 and Angola still records the highest of 195.54 while Mauritius also still recods the lowest of 15.78. The summary of some key variables used are presented by country in Table 1.

Table 1 Summary of Key Variables by Country

Country	Electricity consumption per capita	Infant Mortality Rate	Under-five Mortality Rate	Life Expectancy at Birth
Sub-Saharan Africa	712.13	62.68	97.01	55.50
Angola	155.98	116.72	195.54	48.96
Botswana	1407.2	44.93	65.26	57.09
Cameroon	220.06	75	120.14	52.77
Congo	140.98	55.96	84.99	55.56
Cote d'ivoire	196.23	85.23	122.7	48.63
Ethiopia	39.36	64.79	100.66	57.77
Ghana	292.10	54.98	83.21	59.21
Gabon	988.52	47.59	71.85	60.70
Kenya	138.35	51.15	78.98	55.35
Mauritius	1767.36	13.89	15.78	72.63
Mozambique	385.19	85.52	125.36	51.52
Nigeria	120.35	92.27	150.29	49.50
Senegal	164.54	54.19	89.06	61.59
South Africa	4600.35	46.81	66.54	53.72
Tanzania	76.68	55.41	86.11	57.43
Zimbabwe	700.86	58.47	95.7	45.55

Source: World Development Indicator 2016

5. Results

Infant Mortality Rate

The fixed effect estimator was found to be appropriate based on a Hausman test and the estimates are presented under regression 1 in Table 2. Electricity consumption per capita was found to be insignificant in explaining the infant mortality rate. However, while total health expenditure significantly reduced infant death, public health expenditure increased the infant death rate significantly. An increase in the percentage of children immunized against measles significantly reduced infant mortality but DPT vaccination was insignificant. Increasing the percentage of the population with access to improved source of drinking water and better sanitation or toilet facilities significantly reduced the rate of infant death in the SSA region. The prevalence of undernourishment was not significant. Accounting for the potential endogeneity of both total and public healthcare expenditure, regression 2 was obtained using the panel instrumental variable technique and the endogenous total healthcare expenditure and public expenditure variables were instrumented using the total net flows on external debt and the share of gross capital formation to the GDP. Employing the generalized two stage least squares random effect estimator, electricity consumption per capita was insignificant to explain changes in the infant mortality rate. All other variables were also insignificant except for access to improved drinking

water source. Generally, there was no improvement in the results when endogeneity bias was controlled for.

Table 2 Estimates for the Infant Mortality Rate Equation

Variables	**Fixed Effect Estimate Regression 1**	**G2SLS random-effects IV Estimates Regression 2**
Electricity	0.001(0.27)	0.010(1.01)
GDP per capita	0.002(1.27)	-0.003(-0.35)
Total health expenditure	-0.023(-2.68)*	0.074(0.40)
Public health expenditure	1.815(2.63)*	-33.596(-1.39)
DPT Vaccine	-0.054(-0.85)	0.060(0.14)
Measles Vaccine	-0.184(-2.44)**	0.185(0.56)
Water	-1.676(-10.43)*	-0.868(-3.22)*
Sanitation	-0.561(-2.11)**	-0.395(-0.89)
Undernourishment	0.148(0.98)	0.857(1.38)
Constant	209.52(12.51)*	162.63(5.48)*
F statistic	68.27	-
Prob (F statistic)	0.0000	-
rho	0.97	0.18
Wald Chi2	-	63.59
Prob Chi2	-	0.0000

Note: t statistic in parentheses; * & ** denote significance at 1% and 5% respectively

Under-five Mortality

As seen in Table 3, the fixed effect estimates obtained from regression 1 showed that electricity consumption per capita did not significantly explain the under-five death rate. This was also observed for the GDP per capita. While an increase in total health expenditure significantly reduced the rate of under-five death, the more the health expenditures made by the government, the greater the under-five deaths. The under-five mortality rate significantly reduced as the percentage of children immunized against measles increased. Improvement in drinking water source was also significant in under-five mortality rate reduction. An increasing prevalence of undernourishment significantly increased the number of under-five deaths. From regression 2, all the estimates obtained after controlling for possible endogeneity were insignificant. Thus accounting for endogeneity did not necessarily improve the results.

Table 3 Estimates for the Under-five Mortality Rate Equation

Variables	**Fixed Effect Estimate Regression 1**	**G2SLS Random Effect IV Estimates Regression 2**
Electricity	0.001(0.10)	0.013(0.41)
GDP per capita	0.005(1.69)	-0.010(-0.06)
Total health expenditure	-0.045(-2.93)*	0.157(0.07)
Public health expenditure	3.123(2.55)**	-82.116(-0.19)
DPT Vaccine	-0.085(-0.75)	0.397(0.09)
Measles Vaccine	-0.426(-3.18)*	-0.260(-0.30)
Water	-2.806(-9.86)*	-0.828(-0.09)
Sanitation	-0.807(-1.71)	-1.449(-0.20)
Undernourishment	0.560(2.10)**	-
Constant	336.95(11.36)*	369.29(0.97)
F statistic	77.13	-
Prob (F statistic)	0.0000	-
rho	0.97	0.79
Wald Chi2	-	26.35
Prob Chi2	-	0.0009

Note: t and z statistic in parentheses; * & ** denote significance at 1% and 5% respectively

Life Expectancy at Birth

The effect of electricity consumption per capita was negatively significant as shown in Table 4. The random effect estimate showed that increasing electricity consumption still reduced the life expectancy at birth. Thus it did not as a matter of fact improve the population health status. Total health expenditure was highly significant in improving population health. Public health expenditure on the other hand was rather insignificant. An increase in the proportion of children vaccinated for measles significantly increased the life expectancy at birth. An increasing prevalence of undernourishment significantly reduced the life expectancy at birth. Accounting for endogeneity bias as shown in regression 2, electricity consumption per capita as well as all other variables were insignificant except for the prevalence of undernourishment which was negatively significant.

Table 4 Estimates for the Life Expectancy at Birth Equation

Variables	Random Effect Estimates Regression 1	G2SLS Random Effect IV Estimates Regression 2
Electricity	-0.003(-2.16)**	-0.004(-0.79)
GDP per capita	-0.001(-1.93)	0.004(1.09)
Total health expenditure	0.016(5.07)*	-0.092(-0.96)
Public health expenditure	-0.458(-1.64)	20.394(1.87)
DPT Vaccine	0.006(0.22)	-0.166(-0.75)
Measles Vaccine	0.084(2.81)*	-0.077(-0.42)
Water	0.113(1.95)	0.111(0.73)
Sanitation	0.123(1.67)	0.378(1.73)
Undernourishment	-0.164(-3.31)*	-0.633(-2.15)**
Constant	42.647(8.12)*	31.479(2.05)**
Wald Chi2	271.23	20.14
Prob Chi2	0.0000	0.0171
rho	0.90	0.10

Note: z statistic in parentheses; * & ** denote significance at 1% and 5% respectively

6 Discussions

The level of electricity consumption in the SSA is minute compared to the population that needs to be catered for. This could explain why any so called increase was generally insignificant to explain both infant mortality and under-five mortality. However, where it was significant it worsened health outcomes, precisely life expectancy at birth. It could also be due to the high tariff burden associated with the minute increase. The vulnerable population becomes even more impoverished, leading to poorer healthcare affordability and status and consequently a reduced life expectancy at birth. There is therefore the need to increase the amount of electricity available for consumption (electricity production) so that electricity consumption per capita can be significant enough to impact health.

Public health expenditure significantly increased both infant and under-five death rates indicating that government spending on health is grossly inadequate and lack direct target on health outcomes as well as the avoidance of diversions in the implementation process. It had no significant effect on the life expectancy at birth. The lack of measles immunization among children; poor drinking water sources and the prevalence of undernourishment have significantly contributed to the high level of under-five deaths in the region. Infant deaths was significantly reduced by measles vaccination among children as well as improved drinking water source and toilet facilities in households. Life expectancy at birth was significantly reduced by measles vaccination and reduced levels of undernourishment. Thus better hygiene and sanitation conditions including vaccination use and toilet type proved significant in improving health outcomes. Not accounting for endogeneity bias did not generally underestimate the results. Rather, there was no improvement in the estimates as most of the variables were insignificant.

7. Conclusions

Electricity consumption per capita has no significant effect on health outcomes in sub-Saharan Africa. In fact, when it is significant it rather reduces the life expectancy at birth. Thus the gross inadequateness and unavailability as well as unaffordability of electricity call for serious health concerns in the region. This is because a greater percentage of the population would have to resort to the alternative traditional but unsafe energy sources, which constitute serious health hazards. An aggressive effort towards enhancing availability and affordability is paramount towards increasing electricity consumption and the consequential health gains.

The population health status of sub-Saharan Africa greatly depends on improvements in the vaccination of children especially against measles and the equipment of households with adequate better sources of drinking water and sanitation facilities to enhance hygiene levels. Efforts towards improving the nutritional intake of households, towards drastically reducing the prevailing undernourishment level remain paramount. The poor attitude of government towards healthcare financing policies and implementation as shown by the insignificance of public healthcare expenditure is still a matter of concern. This re-emphasizes the importance of good governance in the sun-Saharan African region.

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