African Review of Economics and Finance

African Review of Economics and Finance | ISSN 2042-1478 | Volume 9 | Issue 1 | June 2017

Health expenditure and child health outcomes in Sub-Saharan Africa

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Abstract

This study sought to understand the relationship between child health outcomes and health spending while investigating lagged effects. The study employed panel data from 45 Sub-Saharan African countries between 1995 and 2011 obtained from the World Bank's World Development Indicators. Fixed and Random effect models were estimated. Under-five, infant and neonatal mortality were used as child health outcomes while total health spending was disaggregated into public and private spending. The effects of one and two period lags of expenditure were estimated. The results show a positive and significant relationship between health expenditure and child health outcomes with elasticities of -0.11 for infant mortality, -0.15 (under-five mortality) and -0.08 (neonatal mortality). Public health expenditure was found to be relatively more significant than private expenditure. Positive and significant lagged effects were also estimated between health expenditure and child health. The findings suggest that, while health expenditure is crucial for the improvement of child health, it is equally important for this expenditure to be sustainable as it also has delayed effects.

Keywords: Health expenditure; Child health outcomes; Lag effects; SSA.

1. Introduction

Economic theory has over the years identified human capital as a catalyst to economic growth and development at the macro and micro levels (Wilson and Briscoe, 2004, Becker, 1964). Specifically, health capital development contributes to growth through increase in healthy time for both market and non-market activities (Grossman, 1972, Muurinen, 1982). Improving health capital, therefore, remains principal on the development agenda of several governments over the world.

In spite of this, adequate and sustained levels of health resources needed to develop health capital in Sub-Saharan Africa (SSA) are largely limited (Tandon and Cashin, 2010). The Abuja Declaration of 2001 was intended to improve public expenditure on health in SSA with the aim of improving population health. However, very few countries in the region are close to the target of 15 percent of government budget (Tandon and Cashin, 2010). In 2011, exactly ten years after the declaration, only six countries had achieved this target. These countries include Rwanda (23 percent), Liberia (18.9 percent), Malawi (18.5 percent), Madagascar (15.5 percent), Togo (15.4 percent) and Zambia (16.0 percent) (World Bank, 2012).

Further, per capita expenditure on health is lowest in the SSA region, relative to all other regions of the world. Per capita expenditure on health in the region increased from US$ 79.4 in 2000 to US$ 154.6 in 2011. This was significantly less than the world average of US$ 1026.5 in 2011. Also, health financing in the SSA region are mostly from private sources and largely made up of catastrophic out of pocket (OOP) expenditure. The WHO estimates that up to 10 percent of the population in these countries suffer this type of financial catastrophe each year, with up to 4 percent pushed down the poverty line (WHO, 2012). Similarly, other health related inputs in the SSA region have continually performed poorly over the years relative to other regions of the world. For instance, physician, nurse/midwife and dentistry density per 10,000 population was estimated to be 2.2, 9.0 and 0.4, respectively in 2010, relative to the world average of 14.2, 28.1 and 2.2, respectively (WHO, 2012).

Population health status in SSA also requires substantial improvements to meet set targets such as the Millennium Development Goals (MDGs), especially among children. Countries in the region continue to face high disease burdens and poor performance in terms of child health outcomes. It is reported that the Africa region lags behind in achieving the child health-related MDG targets with most countries in the region unlikely to achieve these targets. The WHO (2012) also showed that only eight countries were on track to achieve the health related MDGs. Majority of the countries in the region were achieving less than 50percent of what is expected to reach the target in 2015.

In light of the afore discussions, recent empirical studies (Martin *et al*. 2011, Husain, 2010, Farage *et al*., 2012) have attempted to identify the exact relationship that exist between increased health expenditure and health outcomes. Not only have the findings of these studies been inconclusive[1] but also neglected the possible lagged effects that may exist in this relationship. In this regard, this study sought to examine the relationship between health expenditure and health outcomes (with particular emphasis on child health outcomes) and examine the lagged effects of health expenditure on child health outcomes.

It was found that health expenditure significantly determines child health outcomes measured by infant, under five and neonatal mortality rates. These findings corroborate existing theoretical and empirical studies. It was also found that child health outcomes relate positively and statistically significant with the lags of health expenditure. This implies that health expenditure has a delayed effect on child health outcomes.

The rest of the paper proceeds as follows; section two presents a brief review of the literature. Section three presents methods including data used in the analysis while section four presents the results. In section five, the results are discussed with various policy implications. The summary and conclusions are briefly presented in section six.

2. Literature review

Empirical analyses around macro level health expenditure have focused on three broad themes over the years. Some studies analysed the effects of per capita income on health expenditure (Baltagi and Mascone, 2010, Martin *et al*., 2011, Jack and Lewis, 2009, Murthy and Okunade, 2009, Jaunky and Khadaroo, 2008, Husain, 2010, Farag *et al*., 2012). Another group of studies has focused on estimating the relationship between health expenditure and aggregate population health (Babazono and Hillman, 1994, Berger and Messer, 2002, Bokhari *et al*., 2007, Lawanson, 2012). A final set of studies in recent years has concentrated on the relationship between health aid and health outcomes at the macro level (Mallaye and Yogo, 2012, Mukherjee and Kizhakethalackal, 2012, Williamson, 2008, Wilson *et al*., 2009).

[1] Further discussion of this is presented in the literature review section of the paper.

With regards to the focus of the current study, the last two sets of empirical studies were reviewed. Consequently, the review suggested that there exists a plethora of studies that estimate the relationship between health care expenditure and health outcomes at the macro level in developed regions with little attention on developing regions. Studies that have focused on developing regions with emphasis on SSA include Lawanson (2012), Anyanwu and Erhijakpor (2009), Akinkugbe and Mohanoe (2009) and Kamiya (2010) with all of these studies focusing on public health care expenditure and population health, including child health.

In general, there seem to be some level of inconsistency in the exact relationship that exist between health care expenditure and health outcomes. Some studies have shown that public health expenditure has no impact on health outcomes. For instance, Kamiya (2010) found that government spending on health do not lead to reduction in mortality in developing countries. Also, Filmer and Pritchett (1999) found that the most important determinant of child mortality outcomes was not public spending on health. Musgrove (1996) concluded that health care expenditure has no significant influence on child mortality. Much recently, in terms of health aid and health outcomes, Mukherjee and Kizhakethalackal (2012), Wilson *et al*. (2009) and Williamson (2008) all showed in their empirical studies that the relationship between health aid and reducing infant mortality rate was not significant.

In contrast, studies such as, Bokhari *et al*. (2007), Gupta *et al*. (2002) and Cremieux *et al*. (1999) found strong positive relationships between health spending and childhood mortality. Other studies like, Lawanson (2012), Anyanwu and Erhijakpor (2009) Murthy and Okunade (2009) have all established that public health expenditure significantly improves life expectancy, reduces under five mortality and infant mortality rates. Other studies that found positive relationship between health aid and health outcomes include Mallaye and Yogo (2012) and Mishra and Newhouse (2009) for the case of SSA. For instance, in the case of SSA, Lawanson (2012) estimated the effects of public health expenditure on health outcomes, measured by infant mortality, under-five mortality, crude death rate and life expectancy. Using panel data between 2003 and 2007 across 45 SSA countries with two-stage least squares and fixed effects estimates, the results showed that the relationship between public health expenditures and health outcomes was negative for mortality rates but positive for life expectancy. In an earlier study, Anyanwu and Erhijakpor (2007) examined the effectiveness of total and public health expenditure on two health outcome measures, namely under-five mortality and infant mortality rates across African countries. Their study employed panel data and two-stage ordinary least squares estimation and found that both total health expenditure and per capita public health expenditure significantly influenced under-five and infant mortality rates in Africa. Their results showed that increasing per capita total health expenditure by 10 percent reduced under-five mortality by 21 percent and infant mortality by 22 percent while a 10 percent increase in per capita public health expenditure reduced under-five and infant mortality by 25 percent and 21 percent, respectively. Using time series data from Lesotho, Akinkugbe and Mohanoe (2009) employed an error correction model (ECM) and found that in addition to public health care expenditure, the availability of physicians, female literacy and child immunization significantly influenced health outcomes. Farag *et al*. (2013) provided a more recent empirical investigation into the relationship between country health spending and selected health outcomes, measured by infant and child mortality. Using data from 133 low and middle income countries for the years 1995, 2000, 2005 and 2006, the study showed a significant impact of health spending on reducing infant and under five mortality rates with elasticities from 0.13 to 0.33 for infant mortality and 0.15 to 0.38 for under five mortality rates. The study also found that the level of good governance determined the magnitude of the impact of government health spending on infant and under five mortality rates for each country. Countries with higher levels of good governance showed higher impact of government health spending on health outcomes.

Rhee (2012) performed a single country analysis of the effects of health care expenditure on infant mortality rate and life expectancy at birth in Korea. The study used time series data from 1985 to 2010. The results of the study indicate that there exists a significant and positive relationship between health care expenditure and the two measures of health outcomes with elasticities ranging from 0.01 to 0.02. Using the number of physicians and number of hospital beds as health inputs, the results showed significant relationship with elasticities ranging from 0.04 to 0.13. Rhee (2012) concluded that health care expenditure tends to be effective in the long run while the number of physicians and hospital beds are effective in the short run due to the magnitude of variation in the elasticities of the two sets of inputs. Bokhari *et al*. (2007) estimated the relationship between health care expenditure, per capita income and health outcomes nexus using under five mortality and maternal mortality as health outcome measures. The study found elasticities for under five mortality ranging from -0.25 to -0.42 and maternal mortality ranging from -0.42 to -0.52, with respect to health care expenditure. An interesting implication of the results however suggests that economic growth is a more important contributor to health outcomes relative to government health expenditure for developing countries.

In a similar study for 15 European Union countries over the period 1980-1995, Nixon and Ulmann (2006) applied fixed effects model to panel data to estimate the relationship between health care expenditure and two measures of health outcomes (infant mortality and life expectancy). The results showed that increase in health care expenditure significantly influence infant mortality but only marginally in relation to life expectancy. Using mortality rates per 1000 population with data from 20 OECD countries from 1960 to 1992, Berger and Messer (2002) showed that health care expenditure have a significant negative relationship with mortality rates. Cremieux *et al.* (2005) used gender specific infant mortality and gender specific life expectancy at birth and at age 65 as measures of health outcomes. Panel data analysis from Canadian provinces showed that both public and private drug spending were significant for all the health outcome measures. Cremieux (1999) also investigated the impact of total health care spending (including both public and private sources) on gender specific infant mortality and life expectancy at birth using panel data from Canadian provinces over the period of 1978-1992, the study showed that health expenditure was significant for all outcomes with elasticity of -0.4 and -0.6 for male and female infant mortality, respectively; 0.05 and 0.024 for male and female life expectancy, respectively. Babazono and Hillman (1994) estimated the relationship between health care spending and health outputs measured by perinatal mortality, infant mortality, life expectancy at birth for both males and females and life expectancy at 80 years. Using data from 21 OECD countries for 1988 and multiple linear regression with stepwise analysis, they found that only female life expectancy at birth was significantly affected by health care expenditure with elasticity of 0.38. Hiltiris and Possnett (1992) also employed panel data from 20 OECD countries between 1960 and 1987. The results show that health expenditure had a negative impact on mortality with elasticity of -0.08.

With regards to health aid and health outcomes, Mukherjee and Kizhakethalackel (2012) investigated the impact of health aid on infant mortality rate and examine the role of education in understanding this nexus. The authors also investigated this nexus by disaggregating health aid into infectious disease control and nutrition health aids. Using data from poor developing countries, the results showed that education always lowers infant mortality rate but the overall effect of health aid remains insignificant. In terms of disaggregated health aid, the study also found that total health aid and nutrition aid may lower infant mortality rate only after education exceeds a threshold level.

An important gap in the literature is the fact that previous studies have ignored the possibility of lag effects in estimating this relationship. For instance, Gupta and Verhoeven (2001) acknowledged that there could be lags between spending and its effects on outcomes, however, they failed to address this problem. The current study therefore contributes to existing studies by introducing lag effects in the estimation of the relationship between health spending and child health outcomes. Public and private differences in these relationships were also explored.

3. Methodology

3.1. Theoretical framework

The theoretical framework adopted in this study follows Fayissa and Gutena (2008) who developed a macro level health production function based on the Grossman (Grossman, 1972) model. Like Grossman (1972), Fayissa and Gutena (2008) treated social, economic and environmental factors as inputs in the health production system. At the micro level the theoretical formulation can be simply expressed as follows

$$H = F(x) \tag{1}$$

Where H is health output and x is a vector of individual inputs to the health production function, F. The elements of the vector of inputs include nutrient intake, income, consumption of public goods, education, time devoted to health-related procedures, initial health stock and the environment.

While the above model analyses health production at the individual level, the current study seeks to analyse health production at the level of the health sector as a whole. Without loss of theoretical ground, Fayissa and Gutena (2008) presented a macro level specification of equation (1) by representing the elements of the vector x by per capita variables and regrouped into sub-sectors of economic, social and environmental factors. This specification is shown in the expression in equation (2) below

$$h = F(Y, S, V) \tag{2}$$

Where h is aggregated child health outcome, Y is a vector of per capita economic variables, S is a vector of per capita social variables and V is a vector of per capita environmental factors.
Equation (2) can be re-written in its scalar form as follows

$$h = f(y_1, y_2, \ldots, y_n; s_1, s_2, \ldots, s_m; v_1, v_2, \ldots, v_l) \tag{3}$$

Where h is child health outcome, ($y1, y2,\ldots,yn$) = Y; ($s1, s2,\ldots,sm$) = S; ($v1, v2,\ldots,$

vl) = *V* and *n*, *m* and *l* are number of variables in each sub-group, respectively. Assuming a Cobb-Douglas production technology relating the inputs and outputs, then equation (3) can be transformed as

$$h = \Omega \Pi_{yi}^{\alpha i} \Pi_{sj}^{\beta j} \Pi_{vl}^{\gamma k} \tag{4}$$

Where αi, βj and γk are elasticities. The term Ω in equation (4) estimates the initial health stock and measures the health status that would have been observed if there was no depreciation in health or health improvement due to changes in social, economic and environmental factors used in the production process. In a similar way $(\Pi_{yi}^{\alpha i} \Pi_{sj}^{\beta j} \Pi_{vl}^{\gamma k} - 1)x100\%$ estimates the percentage change in child health status due to socioeconomic and environmental factors.

Taking the logarithmic transformation of equation (4) and rearranging yields equation (5) below

$$\ln h = \ln \Omega + \sum \alpha_i (\ln y_i) + \sum \beta_j (\ln s_j) + \sum \gamma_k (\ln v_k) \tag{5}$$

Where $i = 1,...,n$; $j = 1,....,m$ and $k = 1,....,l$

Equation (5) also corresponds to the additive logarithm health production function derived by Koc (2004). According to Fayissa and Gutena (2008), the economic inputs in the health production function may include the total health care expenditure per capita in a particular country. This can further be disaggregated into private and public components of health expenditure.

3.2. Empirical model

Following Baltagi (2008), the starting point for the estimation of the relationship between health expenditure and child health outcomes in a panel regression model is specified as follows;

$$y_{it} = \alpha + X_{it}^{'} \beta + u_{it} \qquad i = 1,..., N \qquad t = 1,...,T \tag{6}$$

Where *i* and *t* denote countries (cross section units) and time (time series dimension) respectively. α is a scalar, β is $Kx1$ vector and X_{it} is the *it*th observation on K^{th} explanatory variables.

For the purposes of estimation, the following reduced form health production model was employed

$$HS_{it}^{j} = \alpha_i + \beta_1 THE_{it} + \beta_2 Y_{it} + \beta_3 \text{Im} m_{it} + \beta_4 Educ_{it} + \beta_5 THE_{it-l} + \beta_6 S_{it} + \beta_7 HIV_{it} + \beta_8 U_{it} + \sum_n \beta_n POP_{nit} + \varepsilon_{it} \tag{7}$$

$$HS_{it}^{j} = \alpha_i + \beta_1 THE_{it} + \beta_2 Y_{it} + \beta_3 \text{Im} m_{it} + \beta_4 Educ_{it} + \beta_5 THE_{it-l} + \beta_6 S_{it} + \beta_7 HIV_{it} + \beta_8 U_{it} + \sum_n \beta_n POP_{nit} + \varepsilon_{it} \tag{8}$$

$$HS_{it}^{j} = \varphi_i + \theta_1 \Pr HE_{it} + \theta_2 Y_{it} + \theta_3 \text{Im} m_{it} + \theta_4 Educ_{it} + \theta_5 \Pr HE_{it-l} + \theta_6 S_{it} + \theta_7 HIV_{it} + \theta_8 U_{it} + \sum_n \theta_n POP_{nit} + \varepsilon_{it} \tag{9}$$

Where *j* in each equation represents different child health outcome measures as dependent variable and *n* represents different population brackets in terms of the explanatory variables. All variables were transformed and used in natural logarithms. Equation (7), (8) and (9) estimates the effect of total, public and private health expenditure on health outcomes, respectively. This allows for an understanding of the separate effect of each of these variables on the health outcomes of a population. The variables in the equations are further described in Appendix 1. All data used in the study was obtained from the World Bank's World Development Indicators (WDI) over the period 2005-2011 for 45 SSA countries[2]. The choice of sample period was justified by data availability.

To estimate the equations above, the fixed and random effect panel data models were used. As is the case in most panel data analysis, there was the need to test for random effects or panel effects in the model. As suggested by Baltagi (2008), the Breuch-Pagan Lagrange Multiplier (LM) test was used to make a decision between random effects regression and simple OLS regression. Secondly, the Hausman's specification test was employed to compare estimates from the random effects and the fixed effects models. Panel data analysis also raises the issue of heteroskedasticity when the regression disturbances are not with the same variances across time and cross sectional units. Robust standard errors were therefore computed to correct for the presence of heteroskedasticity as suggested by Baltagi (2008).

4. Results

4.1. Health care expenditure and infant mortality rate

The regression results for the effects of disaggregated health care expenditure on infant mortality rate with lag effects are presented in Table 1. The overall performance of the various regression models suggests that the models are well behaved. This can be observed from the probability values of the Wald chi square test and F-test for the fixed and random effects models, respectively. The various R-square statistics are also generally acceptable. The Hausman specification test generally seems to confirm the fixed effects model over the random effects model (Table 2). Both models were, however, reported to allow for robustness.

[2] The countries were : Angola, Benin, Burkina Faso, Botswana, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo Demographic Republic, Congo, Cote d'Ivoire, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Ghana, Guinea, Guinea Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, South Africa, Sao Tome, Senegal, Seychelles, Sierra Leone, Sudan, Swaziland, Tanzania, The Gambia, Togo, Uganda and Zambia.

Moreover, a close observation of the models suggests not much difference. The Wald chi-square test strongly confirms the presence of heteroskedasticity in the fixed effects models. Robust standard errors were, therefore, estimated and reported in all the models to ensure consistent standard errors and unbiased estimates. The Breusch-Pagan lagrangian multiplier test also showed support for the random effects model over OLS estimations (Table 2).

The estimation results presented in Table 1 suggest that health expenditure is an important determinant of infant mortality in SSA. Total health expenditure (THE) showed negative and significant (at 1 percent level) relationship with infant mortality rate. The estimated elasticity for this relationship suggests that infant mortality will be reduced by approximately 1.1 percent when THE increases by 10 percent. Similar results were reported in both the fixed and random effects models.

The one and two-period lags of THE included in the regressions also showed negative and statistically significant relationship with infant mortality rate. The relationship was significant at 10 percent for the one-period lag and 1 percent for the two-period lag. This relationship was observed for both fixed and random effects models. The estimated elasticities suggest that a 10 percent increase in THE one year back reduces current year infant mortality by 0.80 percent in the fixed effects model and 0.70 percent in the random effects model. Similarly, a 10 percent increase in THE two years earlier reduces infant mortality by approximately 1.4 percent and 1.3 percent in fixed and random effects models respectively.

The effect of disaggregated health care expenditure on infant mortality shows that a 10 percent increase in public health spending reduces infant mortality rate by approximately 0.60 percent in both the fixed and random effects models with statistical significance at 1 percent level. The one-period lag of public health spending showed negative but insignificant relationship with infant mortality. A much significant relationship was portrayed by the two-period lag of public health spending (at 1 percent level of significance). The relationship was consistent in both the fixed and random effects models.

Education, real GDP per capita, sanitation, HIV prevalence were also found to be important factors influencing infant mortality. Improved education, real GDP per capita and sanitation are likely to reduce infant mortality while increased HIV prevalence is likely to increase infant mortality. The relationships were consistent in both models.

4.2. Health care expenditure and under-five mortality

The regression results for the effects of disaggregated health care expenditure on under-five mortality are reported in Table 3. The joint significance of the model is confirmed by the probability values of the Wald chi-square test and F-test statistics for the fixed and random effects models. The within, between and overall R-squared values for both models also suggests the models have fits that can be trusted. Again, as in the previous analysis, the Hausman chi-square specification tests presented in Table 4 shows that results from models 1 and 2 are better with the fixed effects model while model 3 is better specified in the random effects model. Results from both fixed and random effects specifications were, however, reported for all models. The BPLM test for random effects also confirmed that, relative to the OLS analysis, there were panel effects and hence the random effect specification should be used.

The estimated results show that all the explanatory variables had expected signs. Also, a general observation suggests that there exists a strong relationship between health care expenditure and under-five mortality in SSA. The relationship between THE and under-five mortality was estimated to be negative and statistically significant at 5 percent level. The results indicate that a 10 percent rise in the level of THE is likely to reduce under-five mortality with estimated elasticities of approximately 1.1 percent for the fixed and random effects models. The one-period lag of THE was negative and statistically significant at 5 percent level in both models. This indicate that THE in the previous year impacts on under-five mortality negatively. Public health spending showed strongly significant (at 1 percent level) influence on under-five mortality in both models. The negative sign with an estimated elasticity of about -0.09 suggest that a 10 percent increase in PuHE leads to a reduction in under-five mortality by 0.90 percent. The one-period lag of PuHE showed a negative and significant relationship with under-five mortality with estimated elasticity of approximately -0.1. Unlike public health care spending, private health care spending did not show statistical significance, even though the expected sign was observed. Education showed negative relationship with under-five mortality at 1 percent significance level. HIV prevalence was positively associated with under-five mortality, even though the relationship was only significant in the random effects model. Access to improved sanitation facilities showed negative relationship with under-five mortality at 10percent significance level.

TABLE 1: RESULTS OF HEALTH CARE EXPENDITURE AND INFANT MORTALITY

	Fixed Effect Models			Random Effect Models		
Variable	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
LnTHE	-0.1146*** (0.03726)			-0.10680*** (0.03908)		
LnRGDPpc	-0.22299** (0.10434)	-0.26012** (0.11075)	-0.21273* (0.10953)	-0.15924** (0.07163)	-0.12831** (0.06264)	-0.13882* (0.07294)
LnUrban	0.06385 (0.04919)	0.0658 (0.06627)	0.06941 (0.05912)	0.07269 (0.05518)	0.07795 (0.07359)	0.07664 (0.06249)
LnImmDPT	0.02911 (0.04301)	-0.02763 (0.05023)	0.05246 (0.05226)	-0.02008 (0.04422)	-0.07879 (0.05277)	0.01396 (0.04968)
LnSanitation	-0.27696** (0.12655)	-0.24528* (0.14349)	-0.24710* (0.12892)	-0.10867 (0.07135)	-0.07492 (0.06698)	-0.10901 (0.07430)
LnPop<14	0.44825 (0.37260)	0.71240** (0.33213)	0.43672 (0.35930)	0.61535* (0.35868)	0.88317*** (0.32457)	0.58914* (0.35679)
LnPop65>	-0.13502 (0.22038)	-0.14743 (0.29527)	-0.1058 (0.25297)	-0.17505 (0.18606)	-0.11949 (0.24062)	-0.12669 (0.21844)
LnHIV	0.03241 (0.05912)	0.06883 (0.07280)	0.03283 (0.05644)	0.08280** (0.03718)	0.09042*** (0.03463)	0.07358** (0.03650)
LnTHE(-1)	-0.08114* (0.04028)			-0.06873* (0.04171)		
LnTHE(-2)	-0.1435*** (0.04598)			-0.12532*** (0.04697)		
LnEduc	-0.11382** (0.05379)	-0.1395*** (0.05073)	-0.1493*** (0.04870)	-0.15996*** (0.04426)	-0.2042*** (0.03885)	-0.187*** (0.04302)
LnPrHCE		-0.04764 (0.04155)			-0.04181 (0.03879)	
LnPrHE(-1)		-0.0309 (0.02767)			-0.01431 (0.02827)	
LnPrHE(-2)		-0.04654 (0.03508)			-0.00741 (0.03526)	
LnPuHE			-0.0605*** (0.02089)			-0.059*** (0.02181)
LnPuHE(-1)			-0.03145 (0.02310)			-0.02485 (0.02377)
LnPuHE(-2)			-0.0977*** (0.03131)			-0.100*** (0.03316)
Constant	5.95365*** (1.91868)	4.98367*** (1.66924)	5.39489*** (1.87888)	4.62679*** (1.72541)	3.16627** (1.43973)	4.12143** (1.69969)
Within R2	0.73458	0.63901	0.71519	0.72297	0.61854	0.70599
Between R2	0.30386	0.38234	0.39545	0.42053	0.52819	0.51714
Overall R2	0.40701	0.47153	0.48092	0.54333	0.60749	0.60344
Prob.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
No. of Obs.	315	315	315	315	315	315
No. of Groups	45	45	45	45	45	45

Source: Author's computation

Notes: ***significant at 1%; **significant at 5%; *significant at 10%. Standard errors are reported in parenthesis. (1) is model with total health expenditure as percent of GDP. (2) is model with private health expenditure as percent of GDP. (3) is model with private health expenditure as percent of GDP.

TABLE 2: DIAGNOSTIC TESTS FOR INFANT MORTALITY REGRESSION

	Fixed Effects			Random Effects		
Test	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Wald test (Chi2)	1.4e+30***	1.2e+28***	6.7e+24***			
BPLM test (Chibar2)				1068.30***	885.83***	1279.60***
Hausman (Chi2)	5.09	1209.22***	21.82**	5.09	1209.22***	21.82**

Source: Author's computation

Notes: *** shows significance at 5%

TABLE 3: RESULTS OF HEALTH CARE EXPENDITURE AND UNDER-FIVE MORTALITY

	Fixed Effect Models			Random Effect Models		
Variable	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
LnTHE	-0.14784**			-0.13512**		
	(0.05619)			(0.05576)		
LnRGDPpc	-0.20118	-0.23463*	-0.20838	-0.13700*	-0.0908	-0.12553
	(0.12237)	(0.13097)	(0.13001)	(0.07602)	(0.06825)	(0.08045)
LnUrban	0.04517	0.05174	0.05415	0.05979	0.07238	0.06561
	(0.05422)	(0.07478)	(0.06502)	(0.06161)	(0.08419)	(0.06910)
LnImmDPT	-0.02031	-0.05875	0.00285	-0.06198	-0.10747	-0.02877
	(0.05538)	(0.06976)	(0.06450)	(0.05536)	(0.06792)	(0.05972)
LnSanitation	-0.22641*	-0.25374*	-0.19599	-0.10739*	-0.10311*	-0.10182
	(0.13301)	(0.13683)	(0.13604)	(0.06085)	(0.05662)	(0.06813)
LnPop<14	0.28884	0.52001	0.24936	0.52228	0.79088**	0.45569
	(0.54142)	(0.45493)	(0.52308)	(0.46906)	(0.40114)	(0.47079)
LnPop65>	-0.12165	-0.10597	-0.10929	-0.22864	-0.17044	-0.18234
	(0.26141)	(0.34658)	(0.29451)	(0.21742)	(0.27502)	(0.24611)
LnHIV	0.04612	0.05889	0.05851	0.08879*	0.08697**	0.08824*
	(0.07481)	(0.08526)	(0.07253)	(0.04540)	(0.04232)	(0.04530)
LnTHE(-1)	-0.19452**			-0.16359**		
	(0.08116)			(0.08276)		
LnEduc	-0.19352***	-0.2206***	-0.2170***	-0.2393***	-0.2898***	-0.255***
	(0.05747)	(0.06023)	(0.05432)	(0.04573)	(0.04854)	(0.04408)
LnPrHE		-0.03965			-0.02348	
		(0.06584)			(0.05554)	
LnPrHE(-1)		-0.05424			-0.00641	
		(0.04820)			(0.04973)	
LnPuHE			-0.0869***			-0.087***
			(0.03171)			(0.03209)
LnPuHE(-1)			-0.11387**			-0.1107**
			(0.04979)			(0.05063)
Constant	7.16082***	6.35539***	6.80035***	5.77046***	4.22271**	5.43562**
	(2.50719)	(2.22083)	(2.49219)	(2.14772)	(1.83146)	(2.16239)
Within R2	0.68097	0.5984	0.67274	0.67161	0.57975	0.66629
Between R2	0.38777	0.45113	0.48355	0.5119	0.61889	0.59263
Overall R2	0.49441	0.53432	0.57111	0.61628	0.67853	0.66907
Prob.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
No. of Obs.	315	315	315	315	315	315
No. of Groups	45	45	45	45	45	45

Source: Author's computation

Notes: ***significant at 1%; **significant at 5%; *significant at 10%. Standard errors are reported in parenthesis. (1) is model with total health expenditure as percent of GDP. (2) is model with private health expenditure as percent of GDP. (3) is model with private health expenditure as percent of GDP.

Table 4: Diagnostic tests for Under-five Mortality Regression

Test	Fixed Effects			Random Effects		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Wald test (Chi2)	16731.51***	26764.17***	59928.29***			
BPLM test (Chibar2)				1008.46***	802.90***	1264.48***
Hausman (Chi2)	22.36***	96.98***	32.19	22.36***	96.98***	32.19

Source: Author's computation

Notes: *** shows significance at 1%, ** shows significance at 5%

4.3. Health expenditure and neonatal mortality

Table 5 shows regression results of the relationship between health care spending and neonatal mortality in SSA. Judging from the R-square values, the models exhibit acceptable goodness of fit. The joint significance of the model was also confirmed with a probability value less than 0.01.

Diagnostic tests performed on the regression models suggest that the random effects model is preferable, relative to the fixed effects models. This is evident from the insignificant Hausman chi-square tests reported in Table 6. The Breusch-Pagan lagrangian multiplier test for random effects also provides highly significant evidence in support of the random effects model, relative to the OLS. The Wald test also, strongly, confirmed the presence of heteroskedasticity. To remedy the problem of heteroskedasticity, robust standard errors were estimated and reported.

Similar to the findings presented earlier, health care spending was generally significant in influencing neonatal mortality. Total health spending showed negative and significant (at 1 percent level) impact on neonatal mortality with estimated elasticities of approximately -0.08 in both the fixed and random effects models. The one-period lag of total health spending also exhibited a significant (at 5 percent level) impact on neonatal mortality. The relationship showed estimated elasticities of -0.07 in the fixed effects model and -0.08 in the random effects model.

The results also showed an expected negative relationship between private health care spending and neonatal mortality. This relationship was, however, not significant at the statistically acceptable levels in both the fixed and random effects models. The one-period lag of private health spending was also not significant even though it showed the expected negative sign. Contrary to this, public spending on health showed the expected negative sign and also significant at the 5percent level. The negative relationship with estimated elasticities of approximately -0.04 in both the fixed and random effects models suggest that a 10percent increase in PuHE is likely to reduce neonatal mortality by about 0.4percent. The one-period lag of the variable showed significant negative relationship with neonatal mortality with estimated elasticities of about -0.04 in both models.

Other control variables that showed statistical significance in influencing neonatal mortality include education and sanitation. Education showed negative and significant (at 1 percent level) relationship across all the models. Access to sanitation facilities also showed similar inverse relationship with the dependent variable even though the level of significance was inconsistent across the models.

TABLE 5: RESULTS OF HEALTH CARE EXPENDITURE AND NEONATAL MORTALITY

	Fixed Effect Models			Random Effect Models		
Variable	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
LnTHE	-0.08257***			-0.0807***		
	(0.02532)			(0.02534)		
LnRGDPpc	-0.11076	-0.13031*	-0.11628	-0.09368*	-0.09475*	-0.09227
	(0.06754)	(0.06775)	(0.07404)	(0.05656)	(0.05430)	(0.06005)
LnUrban	0.05716*	0.0569	0.06148	0.05976*	0.06163	0.06371*
	(0.03182)	(0.03837)	(0.03803)	(0.03294)	(0.04047)	(0.03846)
LnImmDPT	-0.00921	-0.02825	-0.0006	-0.02075	-0.0417	-0.01057
	(0.02951)	(0.03327)	(0.03438)	(0.02928)	(0.03345)	(0.03329)
LnSanitation	-0.12758*	-0.14809**	-0.11404	-0.08937**	-0.09544**	-0.08065*
	(0.06737)	(0.06949)	(0.06779)	(0.04326)	(0.04163)	(0.04456)
LnPop<14	0.27295	0.40045	0.26096	0.34236	0.47567	0.32673
	(0.37859)	(0.31651)	(0.36570)	(0.35390)	(0.29210)	(0.34750)
LnPop65>	-0.1185	-0.10763	-0.11306	-0.12916	-0.10727	-0.11535
	(0.14560)	(0.16445)	(0.16354)	(0.12591)	(0.14619)	(0.14534)
LnHIV	-0.01044	-0.00765	-0.00447	0.0063	0.01046	0.00881
	(0.04417)	(0.04738)	(0.04453)	(0.03454)	(0.03497)	(0.03486)
LnTHE(-1)	-0.07563**			-0.06871**		
	(0.03328)			(0.03294)		
LnEduc	-0.1125***	-0.11511***	-0.1239***	-0.1247***	-0.1354***	-0.1348***
	(0.03407)	(0.03553)	(0.03340)	(0.02939)	(0.03065)	(0.02917)
LnPrHE		-0.04933			-0.04343	
		(0.02969)			(0.02837)	
LnPrHE(-1)		-0.03317			-0.02004	
		(0.03000)			(0.03042)	
LnPuHE			-0.04277**			-0.04365**
			(0.01787)			(0.01775)
LnPuHE(-1)			-0.04341*			-0.04301*
			(0.02388)			(0.02364)
Constant	4.45136**	4.07218***	4.28369**	4.02890**	3.46481***	3.83794**
	(1.68413)	(1.45834)	(1.66958)	(1.58396)	(1.32135)	(1.56758)
Within R2	0.69656	0.65154	0.68281	0.69388	0.64599	0.68048
Between R2	0.37277	0.37643	0.43272	0.41868	0.43928	0.477
Overall R2	0.43927	0.44361	0.4914	0.48221	0.49906	0.52811
Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
No. of Obs.	315	315	315	315	315	315
No. of Groups	45	45	45	45	45	45

Source: Author's computation

Notes: ***significant at 1%; **significant at 5%; *significant at 10%. Standard errors are reported in parenthesis. (1) is model with total health expenditure as percent of GDP. (2) is model with private health expenditure as percent of GDP. (3) is model with private health expenditure as percent of GDP.

TABLE 6: DIAGNOSTIC TESTS FOR NEONATAL MORTALITY REGRESSION

	Fixed Effects			Random Effects		
Test	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Wald test	87176.15**	18486.37**	2.2e+05**			
(Chi2)	*	*	*			
BPLM test				1643.07**	1491.98**	1862.80**
(Chibar2)				*	*	*
Hausman	47.04	52.46	120.21	47.04	52.46	120.21
(Chi2)						

Source: Author's computation

Notes: *** shows significance at 1%, ** shows significance at 5%

5. Discussion

The results suggest that, in general, health expenditure had significant and positive influence on child health outcomes in SSA. The relationship was consistent and significant for all the various model specifications employed in the analysis. Health spending was associated with reduced infant, neonatal and under five mortality rates. A disaggregation of health expenditure suggests that public health expenditure was significant determinant of child health outcomes, relative to private health expenditure. The results conform with some earlier studies on the relationship that health spending have significant positive impact on health outcomes (Lawanson, 2012, Anyanwu and Erhijakpor, 2009). This implies that further investment in the health system of countries in SSA is needed to improve population health, especially among children. While many countries in the region face significant resource limitations, it has been suggested that there could still be additional revenue generated if resources are well managed (Mclntyre and Meheus, 2014).

Aside the direct effects of health spending on health outcomes in SSA, the findings also suggest that there are lagged effects in the relationship. The one and two period lags introduced in the models were mostly significant. This suggests that investments in health may not have immediate impact on health status but the impact may be delayed with some time dimensions. This also implies that investments in the health system should not be one-off but continuous if the general objective of improved child health outcomes is to be achieved.

It is worth noting that the policy recommendation to increase resources committed to the health sector has been on the agenda of governments and various international partners. In fact, some targets, such as the Abuja Declaration of 2001, have been set to fulfil this recommendation and a close assessment suggests that there is still the need for strong commitments. The slow pace of progress across SSA countries in achieving the now defunct MDGs on health provides enough justification for this policy recommendation. Most countries in the region are faced with major health system challenges including poor access to health care, significant inequalities in health service utilization, lack of health care infrastructure and workforce. A sure way to ameliorate this situation is for governments to increase health sector resources.

Up to this point, the discussions have focused on the state as the major actor in strengthening health systems across the SSA region. While this has been a popular view and considered to be a sustainable way to improve the health sector, some recent views have argued for a change in focus. For instance, Obeng-Odoom (2012) argued that an alternative approach to tackling the health sector challenges in developing countries is to shift focus from the state spending directly in the health sector to reducing poverty and inequality. The author argued that most of the health sector impediments in developing countries are exogenous and are closely related to wide-spread poverty and inequality. Effective population health improving policies should therefore not only focus on investing into the health sector but also reducing poverty and bridging the gap between the rich and poor.

The study was limited in a number of ways. First, unavailability of data limited the extent to which analysis could be performed in the study. While the available data was used to achieve the objectives of explaining health spending in SSA, a more holistic analysis required that health spending be disaggregated into specific components such as spending on treatment, prevention, health system capital inputs and health workforce. Access to such data was however difficult. Also, the short time dimension of the health expenditure variables used in the study posed some limitations to the analysis. Owing to the above limitation on the length of time series, the econometric analysis employed in the study were also limited largely due to loss of degrees of freedom. For instance, the number of lags included in the models to capture the delayed effects of health spending on health outcomes was limited. There is also the possibility of endogeneity arising between the dependent variable and health expenditure. This was, however, not tested or addressed in the current paper due to our inability to identify a good instrument for this purpose.

Finally, the health outcome variables used in the analysis were limited to mortality indicators of population health status. A more encompassing analysis required variables that consider both mortality and morbidity (longevity) indicators. Examples of such variables include disability adjusted life years (DALYs) and health-adjusted life expectancy (HALE). Information on these variables were hardly available for SSA countries. Future studies may consider these limitations as channels for improvement.

6. Conclusion

The study sought to examine the relationship between health expenditure and child health outcomes in SSA. The lag effect of the relationship was also investigated. A panel sample of 45 countries over the period of 1995-2011 was employed in the analysis. The findings suggest that health expenditure (both public and private) impacts positively on child health outcomes. Public expenditure was, however, identified to be more significant. Evidence of delayed effects was also established in the health expenditure – health outcome nexus. The findings suggest that while health expenditure is crucial for the improvement of child health, it is equally important for this expenditure to be sustainable as it also has delayed effects. Effective and sustainable health policies should also tackle poverty and inequality.

Biographical Notes

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Acknowledgements

We are grateful to the editors and the two anonymous reviewers who provided constructive comments to help shape this paper.

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Appendix 1: Variable description

Variables	Description
Health status (HS)	Represents child health outcome measures including, neonatal mortality, Infant mortality and under-5 mortality
Neonatal mortality rate (NMR)	Number of deaths during the first 28 completed days of life per1000 live births in a given year
Under-five mortality rate (U5M)	The probability of a child born in a specific year or period dying before reaching the age of five
Infant mortality rate (IMR)	The probability of a child born in a specific year or period dying before reaching the age of one
Total health expenditure (THE)	Total health expenditure expressed as a percentage of gross domestic product (GDP). Covers spending on preventive and curative health services, family planning activities etc.
Public health expenditure (PuHE)	Level of public spending on health expressed as percent of GDP. Includes spending from government budgets, external borrowing, grants and social health insurance funds
Private health Expenditure (PrHE)	Level of private expenditure on health expressed as a percentage of GDP. Includes direct household (out-of-pocket) spending, private insurance, charitable donations and direct service payments by private corporations
Real GDP per capita (RGDPpc) (Y)	Real GDP per capita measured in constant 2005 international dollars
DPT Immunization (Imm)	Percentage of children ages 12-23 months who received DPT immunization before 12 months
Education (Educ)	Secondary school enrolment as percentage of gross school enrolment
Sanitation (S)	Percentage of population using an improved sanitation facility
HIV prevalence rate (HIV)	Estimated number of adults aged 15-49 years with HIV infection expressed as percent of total population in that age group
Urbanization (Urban) (U)	Percentage of population living in areas classified as urban according to the criteria used by each country
Population aged 14 years and below (Pop1)	Population age group below or equal to 14 years expressed as percentage of total population
Population 15-64 years (Pop2)	Population age group between 15 and 64 years expressed as percentage of total population
Population 65 years and above (Pop3)	Population age group above 65 years expressed as percentage of total population

Source: Author's compilation