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Impact of Public Health Expenditure on Infant and Under-five Mortality in Tanzania (1995-2013): An Application of Bayesian Approach.

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Abstract

The main purpose of this study was to examine the impact of public health expenditure on health outcomes (infant and under five mortality rate) in Tanzania over the period 1995 to 2013. Per capital GDP as an indicator of income level and improved sanitation facilities were used as explanatory variables. A full Bayesian time series approach based on Markov Chain Monte Carlo (MCMC) was used to estimate the impact of public health expenditure on health outcomes (infant and under five mortality). The results shows that, despite changing patterns on government health expenditure over the period 1995 to 2013, still government health expenditure had no impact on health outcomes (infant and under five mortality) in Tanzania. The results further shows that, the mean for income levels represented by (GDP per capital) had positive significant effect on both infant and under-five mortality decline. The failure to bring impact on health outcomes (infant and under five mortality) was probably due to its low level of public health spending. The paper recommends the policy that aim to increase GDP per capital and public health expenditure. Since public health expenditure is still low, re-prioritisation is also needed in the public expenditure system for resource allocation during budgeting to favour health budget to be given first priority.

Keywords: Bayesian Approach, Health Outcomes, Government Health Expenditure

1. Introduction

Health care is a core component of human capital investment, which in turn rising its spending also raises quality of life, prolonged life expectancy, reducing morbidity and mortality rates (Murthya & Okunadeb, 2009). On other hand, health outcomes symbolize how healthy a country is and assesses the quality of health care in the country (Deluna & Peralta, 2014). Thus, infant and under-five mortality are known to be the most important indicators for early childhood development and health status of population for given countries (Hassen, 2014, Deluna & Peralta, 2014).

Tanzania is a country that experiences a changing pattern of public health expenditure. Its total health expenditure (private and public) as a percentage of gross domestic products (GDP) for years 1995 and 2013 was 3.6% and 7.3%, respectively. There was also an increase in public health expenditure as percentage share of GDP and per capital health spending from 1.53% in 1995 to 2.65% in 2013 and from US $6.38 in 1995 to US $49.32 in 2013 respectively. Despite changing patterns on health expenditure, still the public expenditure on health as percentage of gross domestic product (GDP) is lowest compared amongst the developing countries like Malawi and Uganda. These two countries have low per capital income but spends more public fund in health than Tanzania (See Table 1).

In different countries, some governments spend less than 1% of their gross domestic product (GDP) on both preventative and intervention health services (Rajkyman & Swaroop, 2007). It also differs in public health expenditure depending on their level of developments. For instances, per capital health expenditure during the year 2001 was $29 in Sub-Saharan Africa and $ 4887 for the U.S. In the same year the average GDP percent devoted for health in Sub-Saharan Africa was 6% and almost 14% in the U.S (Murthya & Okunadeb, 2009).

Countries with high level of public health spending have secured better health outcomes compared to countries with low level of public health spending (CMH, 2005). This means that, the size of the public fund in health sector matters for better health outcomes. Similarly, (Issa & Quattara, 2005) found that at low levels of development public health expenditure has stronger effect on mortality rates compared with private expenditure while a country at high development levels the opposite is true. The given evidence in this regard shows a wide variation of per capital health expenditure and public health expenditure within and between different countries in the world according to their levels of development.

In most developing countries, public health expenditure has failed to translate into better health status due to inherent difficulties of monitoring and controlling the behaviour of public health employees (Yaqub et al., 2010; Filmer et al., 2000). These difficulties have been contributed by the existence of large externalities in the control of many infectious diseases that are mostly addressed by standard public health interventions, and not providing

proper incentives to public employees to fulfil their duties due to the nature of the service (Filmer et al., 2000). With this view, it's important for policy makers in Tanzania to know how government health expenditure in the past years has affected the health outcomes of Tanzanian children and infants.

Like many other countries in Africa, the government of Tanzania through the Ministry of Health adopted free health care provision by abolishes user charges in government health in the early 1990. However, the burden of providing free health care for all became evident amidst rising health care costs and a struggling economy (Musau, et al., 2011). Thereafter, the central government reforms the health sector and introduced private financing in the form of user fees in public facilities and private health insurance schemes (Musau, et al., 2011). As a result of this to date, Tanzanian households above five years have been increasingly facing financial difficulties in paying for compulsory health services except for children less than five years and adults above 60 years which get free health care services in government health facilities. This paper concentrates with free health services for children less than five years believing that, government health expenditures could bring social changes particularly for improving health outcomes indicators (infant and under five mortality). The said free health services are important to the poor because are more likely to obtain health care from public facilities (Gupta et al., 2003; Amaghionyeodiwe, 2009).

A number of empirical studies examined the link between public health expenditure and health outcomes as it affects the mortality of infants and children under age five. However, the relationship remains unclear resolved due to the fact that, there is no relationship between public health expenditure and health outcomes (Filmer & Pritchett, 1999; Burnside & Dollar, 1998, Yaqub et al., 2010 Ssozi & Amlani, 2015; Deluna & Peralta 2014; Musgrove, 1996). Other studies suggest that public health expenditures and its financial investments leads to improve health outcomes (Emamgholipour & Asemane, 2016; Boachie & Ramu, 2016; Meshkani et al., 2015; Erwin et al., 2012; Mays & Smith, 2010; Schenk, 2013; Remington et al., 2008; Akachi et al., 2011; Issa & Quattara, 2015; Kim & Lane, 2013; and Singh, 2014).

Results of previous studies on the same topic had limitations that varied depending on the methodologies and examined time periods. For instances, Erwin et al., (2012) and Singh, (2014); found most studies limited to cross-sectional designs that covers a short time period; thus leading to inadequate conclusions drawn. Moreover, for similar studies conducted over a shorter time period, it's difficult to detect changes in other mortality that occur over a longer period of time apart from infant mortality (Schenck, et al., 2014). Other limitation includes the presence of time lags between greater spending and improved outcomes when financial resources are spent and when improved population outcomes are achieved (Singh, 2014). It is also noted that, previous papers on the impact of public health expenditure on health outcomes face problems of endogeneity in regression estimation, thus requiring instrumental variables (IV) technique to solve the problem (Akinci et al., 2014, Barenberg et al., 2015). The said problem arises due to government health expenditure to be endogenous (i.e. the variable is correlated with error term) in nature leading to bias and inconsistency of parameter estimates. In principles, the IV technique involves identification of exogenous variable that is correlated with endogenous variable of interest and uncorrelated with the error term in the main regression equation.

The weak results of the effects of public health expenditure on health outcomes could be the presence of simultaneity bias that's why many studies failed to address the problem of endogeneity by reporting insignificant effects of public health expenditure on health outcomes (Barenberg et al., 2015). In turn, most previous literature finds a weak link between public health expenditures and health outcomes despite the backdrop of the surge in health expenditure since 2000 (Ssozi & Amlani, 2015).

This paper studies the impact of public health expenditure on health outcomes (infant and under five mortality) in Tanzania using Bayesian analysis to get reliable estimation results when researcher doubts about endogeneity problem and also tackle existing limitation with previous studies that focused on classical regression model (Murthya & Okunadeb, 2009; Deluna &Peralta, 2014; Yaqub et al., 2010; Barenberg et al., 2015; Akinci et al., 2014; Cevik & Tasar, 2013).

Bayesian approach has several advantages compared with classical approach. Among them, despite used in previous research, they are not widely used in medical literature (Pullenayegum et al., 2012). Second, it allows much more regressors in equation than the convectional approach based on Ordinary Least Square (OLS) method (Mehrara & Sujoudi, 2015). Third, the posterior distribution from Bayesian analysis is a fixed entity based on observed data and highlights explicitly the uncertainty in the estimation of each parameter. It can also be used regardless of the overall sample size meaning that, the sample size does not affect inference method (Kruschke et al., 2012). Finally, a Markov Chain Monte Carlo (MCMC) based on Bayesian approach is extremely good in terms of implementation, flexibility and interpretation providing the result with posterior distribution for all parameters (Hay& Nipettitt, 2001).

Our aim was to examine whether government health expenditure had an impact on infant and under-five mortality rate in Tanzania over the period between the years 1995 to 2013. The whole paper is built to attempt answer the question: - do the current public health spending had impact on health performance indicators (infant and under five mortality)? The analysis of this paper will help to answer such question. To the best of our knowledge, no paper has been undertaken in Tanzania to address this question.

1.2 Framework for Analyzing Impact of Public Health Spending

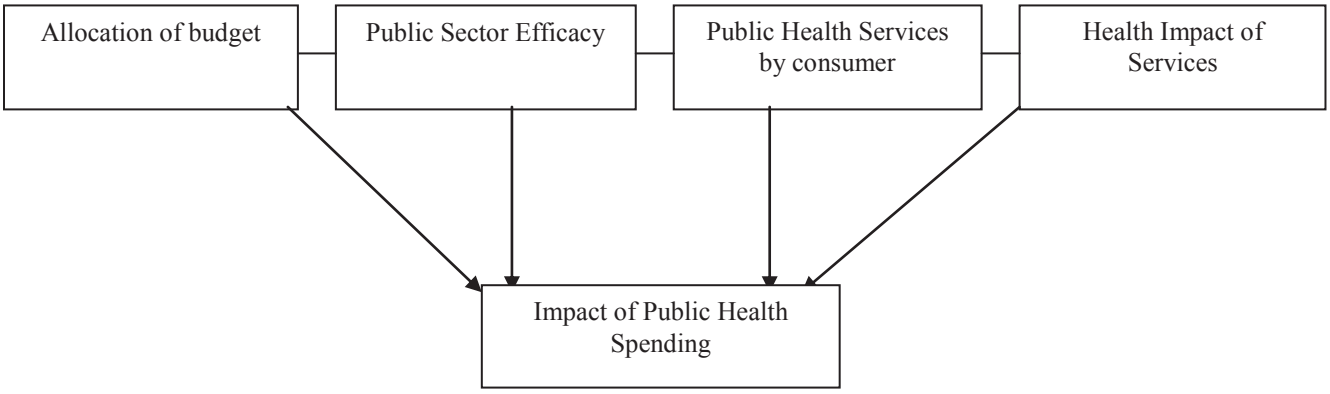

Figure1: Framework for Analyzing Impact of Public Health Spending

Source**:** (Adapted from Filmer et al., 1997).

The impact of public spending is the product of allocation of the budget, public sector efficacy, consumer demand for services and health impact of services (Filmer et al., 1997).Government health spending can bring impact on health outcomes depending on the composition of public spending allocated across health input during budget process. Health inputs are allocated to all activities related to health sectors. For instances, when government increases budget in building dispensary or health centre, it may lead to more or less effective spending into supply of services. The money spent on building dispensary or health centre whether it creates effective health services or not depends on the public sector efficacy. Similarly, the consumers will be willing to make choice on the type of health services provided depending on the price of public and private health services providers, quality of services offered and travel time. If the kind of medical treatment offered by private or public is effective in eliminating a certain kind of diseases it will have impact on health services provided. In general, Filmer et al. (1997) stated that; **"**If any one of the above frameworks is low, total impact will be low".

2. Materials and Methods

2.1 Data Sources

This paper used secondary data obtained from free access databases reported for the period 1995-2013 as categorised by the World Bank 2015 development indicators. The World Bank data limitation on health expenditure in Tanzania allows us to consider the period starting from 1995 to 2013. All variables are expressed in percentages, except infant and under-five mortality which are expressed in number of deaths per 1000 live births.

2.2 Model Specification

We selected two explanatory variables (GDP per capita at constant 2005 US$ and improved sanitation facilities), to capture the dynamics of public health expenditure on health outcomes in Tanzania. In mode building, we incorporate three components which are likelihood, prior and given data set to yield final results which are posterior distributions. According to (Ntzoufras, 2009) the likelihood part of the multiple linear regression models can be viewed as

$y_i \sim N(\mu_i, \tau)$, where $\mu_i = X'_i \beta$, $i = 1\ldots, n$ and $\tau = \frac{1}{\sigma 2}$

Where y_i = *dependent variables for mortality rate* (infant and under five)

X'_i = *vector of explanatory variables* (Public health expenditure, GDP per capital & improved sanitation facilities)

β = *Coefficient of unknown parameter to be estimated*

The prior distribution assumed is

$$p(\beta,\tau) = \prod_{j=0}^{k} p(\beta_j)p(\tau)$$

Where $\beta_j \sim N(\mu_{\beta_j}, c_j^2)$ and $\tau \sim gamma(a,b)$.

The resulting posterior density is given by: p (β_0, β_i, τ|y) $\propto$ p (y|β_0, β_i, τ) $p(\beta,\tau)$

Where β_0, β_i, represents the set of unknown parameter, *y* represents the data; p (β) is the prior density of the parameter which is derived from theoretical or other prior knowledge.

p (y|β_0, β_i, τ) is the likelihood function which describes data *y* given unknown parameter β_0, β_i, . p (β_0, β_i, τ|y) represents the posterior density which is the density of parameter β_0, β_i, given the data y.

Since the model involves two dependent variables as health outcomes (infant and under age-five mortality) two different Bayesian models were analysed.

2.3 Data Analysis

We used full Bayesian time series approach based on Markov Chain Monte Carlo (MCMC) methods in WinBUG1.4 statistical package to examine the impact of public health expenditure on health outcomes (infant and under-five mortality). The MCMC utilizes time series because; it's set up contains all information to time t and for time t-1. The Metropolis-Hasting algorithm enables a wide class of time series models to be estimated by Metropolis-Hasting Markov Chain Monte Carlo (Quintana and Nason, 2012).

The dataset was drawn with a normal distribution of mean, *mu* and precision *tau*. *Mu* is given a normal prior with mean 0 and precision 0.001, and tau is given a gamma (0.0, 0.01). The estimation method was based on Markov Chain Monte Carlo (MCMC) simulation to get posterior distribution. We run 10,000 iterations sample with a burn in of 1000 and 1 thinning parameter. The iteration was important to observe stationary distribution (convergences). Similarly, thinning is done to reduce autocorrelations which is common in time series data. To see whether the model was appropriate, diagnosis test performed based on MCMC post estimation through history plots, autocorrelation plots and kernel density. Kernel density is done to observe normal distribution of the parameters. All the models were free from autocorrelation, showed normal distribution and convergence to equilibrium, thus ready for interpretation.

3. Results

Figure 2&3 shows the trends of GDP per capital and public health expenditure as a share of GDP on health outcomes (infant and under-five mortality) in Tanzania over the period 1995 to 2013. Figure 2 shows a slightly growth increase in GDP per capital over the examined period. GDP per capital describes the quality of life of the people for a given country (Asiedu et al., 2015). The increase in GDP per capital from the year 1995 to 2013 corresponds with the decrease in health outcomes (infant and under five mortality), implying that higher income improves welfare for individuals or nations, which in turn lead to improvements in the health status (infant and under five mortality rate).

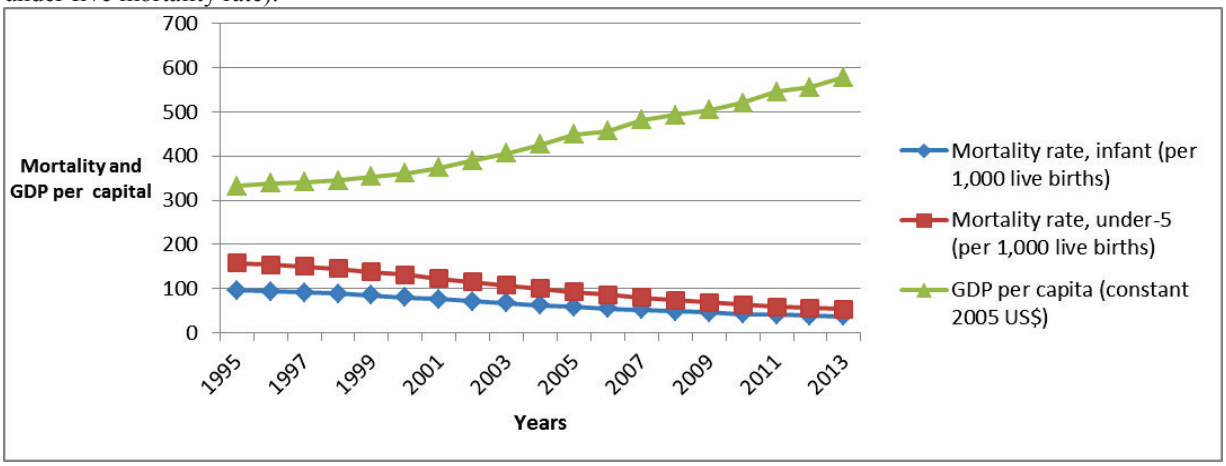

Figure 2: Trend of GDP per Capital and Health Outcomes (Under-five & infant Mortality).

For a given trends over time, public spending on health has not gone beyond 3.8% of GDP (Figure 3). Between 1995 and 2013, public health expenditure has averaged 2.22 percent as a share of GDP annually. Similarly,

public health expenditure on health has reduced significantly from 3.6% in the year 2009 to 2.6% in 2013. Generally, after international financial crisis in the year 2009, the trends in health expenditure was not appear convincing, implying that any change in macroeconomic condition can have diverse impact on allocation of public fund, particularly health sector. The trend of continuous decline of public health expenditure may result in government failure in providing health facilities (e.g. medical coverage, hospital infrastructures).

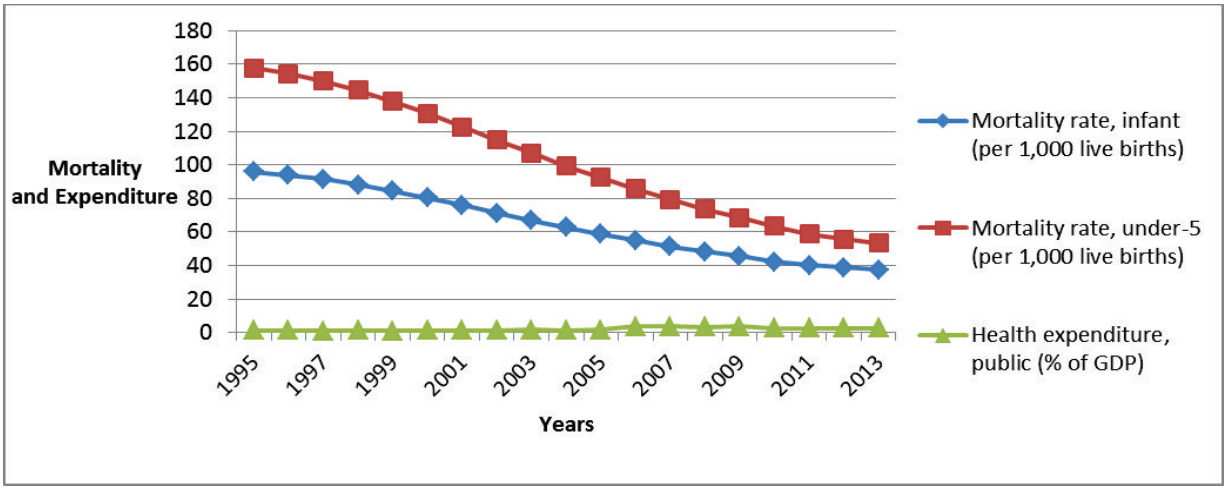

Figure 3: Trend of Public Health Expenditure and Health Outcomes
Source: (World Bank Indicators, 2015).

Table (2 & 3) shows the result from Bayesian modeling estimates for impact of public health expenditure on health outcomes (infant and under five mortality) in Tanzania over 1995 to 2013.

Diagnostic test based on MCMC post estimation for two models shows normal distribution of the parameters, no autocorrelation and the posterior distribution has been convergence to equilibrium.

Table 2: Summary of Bayesian Posterior Results for Under-Five Mortality

			95 %Credible intervals	
Parameter	**Mean**	**SD**	**2.5%**	**97.5%**
Model				
β_0(intercept)	14.39	2.191	10.01	18.64
β_1(Per capital GDP)	-1.409	0.5573	-2.491	-0.2951
β_2(Public health expenditure)	0.0020	0.05183	-0.09877	0.1062
β_3(Improved sanitation facilities)	-0.546	0.5075	-1.558	0.4344

Source: Authors Estimates

The results of the Bayesian model (Table 2) are interpreted within the credible intervals and the association between explanatory variables and dependent variables is observed on the signs of the posterior summaries (mean, 2.5% and 97.5% percentiles). If the sign of posterior summaries are all positive or negative, the corresponding association can be concluded.

The result from (Table 2& 3) implies that, the mean for income levels represented by (GDP per capital) had a good effect on both infant and under-five mortality decline. The negative coefficient signs of GDP per capital on health outcome (infant and under five mortality) shows a unit increase of GDP per capital decrease both infant and under five mortality. In contrast, there were no evidence that access to improved sanitation facilities and public health had an effect on infant and under-five mortality (See Table 2 & 3).

Table 3: Bayesian Posterior Results for Infant Mortality.

			95 %Credible intervals	
Parameter	**Mean**	**SD**	**2.5%**	**97.5%**
Model				
β_0(intercept)	11.99	2.029	7.937	15.93
β_1(Per capital GDP)	-1.062	0.5161	-2.064	-0.03105
β_2(Public health expenditure)	-0.0200	0.04799	-0.1133	0.07663
β_3(Improved sanitation facilities)	-0.6033	0.4699	-1.54	0.3075

Source: Authors Estimates

4. Discussion of Results

Tanzania is among the low income countries in Sub Sahara Africa where we expect public health spending, income and health facilities impact stronger health outcomes(infant and under five mortality rates). Different studies show that public health spending has strong impact not only on components of health services used by the poor but also on vital indicators such as infant mortality, access to safe water or sanitation in low income countries (Cevik and Tasar, 2013). The result findings (Table 2&3) show that, there was no evidence that improved sanitation facilities have an impact on infant and under-five mortality under examined time period.

Public health spending is also a key determinant of health in the middle income and less developed countries though these countries have small public spending on health care and spent limited resources badly in such a way that public health spending goes to expensive and non-essential services rather than essential health services which have strong impact on mortality rates (Cevik and Tasar, 2013). The result findings (Table 2&3) show the failure of government health expenditure in Tanzania to bring impact on health outcomes (infant and under five mortality) probably due to its low level of health spending and misuse of health resources in Tanzania (e.g. building dispensaries and health centres without providing necessary health facilities tools and health personnel). These provide implication that, not only size of public spending but also composition and scope matters to improve health outcomes (Cevik and Tasar, 2013).

Filmer and Pritchett (1997) on studying relationship between public health spending and child mortality suggests that, public spending on health is not the dominant drive of child mortality outcome. Income inequality, female education and cultural factors (e.g. degree of ethno linguistic fractionalization) explain practically all the variation in child mortality across countries. They emphasized policy that encourage economic growth, reduce poverty and income inequality and increase female education would do more for attaining child mortality reductions than increasing public spending on health.

In the same vein, Filmer and Pritchett (1999) found insignificant results that government health expenditure accounts for less than one seventh of one percent variation in under-five mortality across country. They conclude that 95 percent variation in under-five mortality can be explained by factors such as country per capital income, female educational attainment and choice of region. The findings of this study (Table 2&3) show that public health expenditure as shares of GDP have no impact on under-five and infant mortality. The findings are consistence with (Ssozi & Amlani, 2015; Deluna & Peralta 2014, Musgrove, 1996; Filmer & Pritchett, 1999; Filmer & Pritchett 1997; Burnside & Dollar 1998). Therefore, during the period 1995 to 2013, any variation in government health expenditure had no impact on health outcomes (infant and under five mortality) in Tanzania.

On the other hand, income per capital represents the summary of economic conditions in a country (Asiedu et al., 2015). That's why a large body of literature on the determinants of health outcomes typically includes GDP per capital as one of the explanatory variables that may have significant effect on health outcomes (Asiedu et al., 2015). Income can also affect health status in different channels, among them is through access to food and health care services (Gwatkin et al., 2007). The results in (Table 2 & 3) show that, income levels represented by (GDP per capital) have positive impact on health outcomes (infant and under five mortality) meaning that an increase in income per capital improves health outcomes (mortality rate of children). Similarly, the graph in (Figure 2) shows that per capital income increased substantially from 1995 to 2013 and at the same time there was a significant reduction in both infant and under five mortality rates. For example from 1995-2013, GDP per capital increased by about 43% while infant and under five mortality rate declined by 44% and 66% respectively. This evidence still shows that GDP per capital have positive impact on reducing health outcomes (infant and under five mortality rates). Similarly, Holmes et al. (2015) on studying the extent of progress between 1990 to

2014 in reproductive, maternal, newborn, and child health to inform priorities for post-2015 in Tanzania found that economic growth was associated with reductions in child mortality.

The result findings of this study confirms GDP per capital to be one of the determinants of health outcomes (infant and under five mortality) declines in Tanzania. In contrast, Asiedu et al. (2015) on studying the impact of income per capital on health outcomes in Sub Sahara Africa and outside Sub Sahara Africa found that an increase in GDP per capital significantly reduces mortality rates for children and increases adult life expectancy. Moreover, Cutler et al. (2006) argued that people with lower income live shorter lives than high income people in a given country implying a positive relationship between income and health within countries to exist.

Similar study showed the effects of GDP per capital on infant mortality using panel data from 83 developing countries over a period of 40 years, found economic growth broadly decreases infant mortality in developing countries, but its impact differ during the period of economic booms and slumps (Nishiyama, 2011). Such kind of evidence was also supported by Pritchett and Summers (1996) who found raising GDP per capital reduces infant mortality. In turn, Emamgholipour and Asemane (2016) study the effects of governance indicators on child mortality rate in 27 OECD (Organization for Economic Cooperation and Development) countries found that, increase in GDP per capital decreases child mortality rate in OECD countries. Therefore, the findings of our study are consistent with other previous studies that found income to have a greater impact on health outcomes (Alijanzadeh, et al., 2016; Asiedu et al., 2015; Meshkani et al., 2015; Bokhari et al., 2007; Filmer and Pritchett, 1999; Musgrove, 1996, Jourmand et al., 2008; Afonso & Aubyn 2006; Issa & Quattara, 2005).

5. Conclusion

The findings of this study showed that public health expenditure as a share of GDP has no impact on under-five and infant mortality in Tanzania over examined time period. This suggests that free health services offered by the government especially for children less than five years do not meet their health needs. Even though government health expenditure has no impact on health outcomes, it should not ignore its expenditure on medical goods and services. This is important because government spending on health is necessary but not sufficient condition to improve health outcomes (infant and under five mortality). On other hand, the failure of government health expenditure to bring impact on health outcomes (infant and under five mortality) is probably due to its low level of health spending that is relatively less than 3.8% of its GDP over the period 1995 to 2013. The failure could also be due to misuse of health resources in Tanzania (e.g. building dispensaries and health centres without providing necessary health facilities tools and health personnel). Given that public health expenditure is still low, re-prioritisation is also needed in the public expenditure system for resource allocation during budgeting to favour health budget to be given first priority. The findings of the result are important to policy makers in Tanzania where government health expenditure fluctuate irrespective of its low public health expenditure.

The paper recommends the policy that aim to increase and sustain public health expenditure without ignoring proper resource allocation and good management of public fund. In turn, the paper also recommends policies that continue to rise GDP per capital in Tanzania since the income levels (GDP per capital) matters for improving health outcomes (infant and under five mortality).

On reviewing previous literature on public health spending nexus health outcomes, the findings of this paper present lessons to be learnt on investigating the relationship between public health expenditure and health outcomes that, government health expenditure is necessary whatever different level of health spending but not sufficient condition to improve health outcomes (infant and under five mortality).

The findings of this study have got some limitations. First, the result described in this study does not generalize the conclusion drawn to other setting due to different geographical location and different level of health spending and health outcomes. Second, the results may also be affected by data limitations due to the fact that, the data sourced from World Bank Development Indicators (2015) may be subject to personal measurement errors. Third, the study neglect governance variable such as corruption index that is important indicators to explain effectiveness of public health expenditure and health outcomes relationship. However, the said limitation does not invalidate the results of this study.

Authors Contributions

This study was part of the first author's thesis for a doctoral dissertation with the school of Medicine, at the University of Zambia. Mwoya Byaro and Patrick Musonda were involved in the critical analysis of this study. Mwoya Byaro conducted the literature review, carried out the analysis and drafted the manuscript. All authors read and approved the manuscript.

Conflict of Interest

Mwoya Byaro and Patrick Musonda have no conflicts of interest to declare.

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(Supporting Information) for Impact of Public Health Expenditure on Health Outcomes

Table 1: Health Expenditure: An International Comparison

Country	Total exp. On health as % of GDP 2012	Public health exp. as % of GDP 2012	Public exp. on health as % of total exp on health 2012	Public exp.on health as % of total govt exp. 2012	GDP per capita (constant 2005 US$)	Mortality rate, under-5 (per 1,000 live births) in 2012	Mortality rate, infant (per 1,000 live births) in 2012	Total Population in Millions,2014
US	17.09	8.00	46.95	20.02	45,008.61	7.1	6.1	318,857,056.00
Germany	11.26	8.64	76.71	19.34	39,274.36	4	3.3	80,889,505.00
Australia	9.35	6.28	67.17	18.66	45,008.61	4.3	3.6	23,490,736.00
UK	9.23	7.78	83.97	16.17	39,793.39	4.8	4.1	64,510,376.00
Tanzania	7.13	2.78	39.04	11.16	556.05	55.7	38.8	51,822,621.00
South Africa	8.92	4.31	48.36	14.02	6051.31	47.7	36.8	54,001,953.00
Zambia	4.75	2.56	53.86	12.57	970.76	74.4	49	15,721,343.00
Kenya	4.45	1.82	40.88	19.34	624.00	55.6	39.2	44,863,583.00
Malawi	9.19	5.16	56.12	22.09	262.35	77.3	50.2	16,695,253.00
Uganda	9.75	4.19	42.96	24.17	429.40	64.1	42.5	37,782,971.00

Source: World Bank Indicators (2015)