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Determinants of Public Health Expenditure in Sudan

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Boosting health care expenditures is becoming a priority and a major health policy concern almost worldwide. To achieve solving that concern, it is crucial to know the main factors that underlie the growth in health care expenditures. This will help in supporting decision-makers to find best policies to manage health care costs. Here in this study, our aim is to examine the determinants of health care spending in Sudan over the period (1990-2018).Data used in this study have been collected from different sources that are mentioned in the text when come by. Variables included in this study include per capita GDP, number of physicians, population age structure variables; (population under 15 and/or over 65), infant mortality rate (IMR), population growth and lagged health expenditure. These variables have been singled out by this study as the key determinants of health care expenditure. Variables have been displayed in their descriptive formats to check for their minimum, maximum, range, mean, standard deviation and coefficient of variation. A correlation matrix was produced to check for relationships between the variables. A stepwise regression method was adopted to described determine the factors that most affect and determine health care expenditure in Sudan. Our study findings revealed that the GDP per capita and the lagged health care expenditures (i.e. per capita health expenditure of the previous year) are the major two factors that affect health care expenditure levels. Together, the two variables are responsible for 93.3% of the variations in the per capita health care expenditure. The regression model excluded all of the remaining variables because of the fact that they are statistically insignificant and do not fit with the model at a (0.05) level of significance. They do not contribute significantly to the explanation of the per capita health care spending variation. These variables are number of physicians, annual population growth rate, percent of the population aged 65 years and older, percent of the population under 15 years and infant mortality rate.

Keywords: GDP, Physicians, Regression, Hospitals, Hospital-beds, IMR.

INTRODUCTION

Determinants of healthcare expenditure vary across countries. However, the literature review shows that there are common variables which have a direct and indirect effect on public health care expenditure, which is in this research, refers to expenditure incurred by the Sudanese government on health care services.

In the Sudan, healthcare services have improved significantly in term of quantity and quality during the past decades due to the adoption of policies and measures that meet the increasing demand for healthcare services and the growing costs of these services. So the government of Sudan makes every effort to provide high-quality healthcare services to the public, which lead to achieving substantial improvements in health care system. (Almalki, Fitzgerald and Clark, 2011).

The number of the physician has been increasing during the 1980s up to early 1990s and has been increasing piercingly, similar to the trends of per capita health expenditure and GDP. The trend of the annual population percent change has been fluctuating with a sharp downward trend from the 1980s to mid-1990s and then the trend changed to upward till 2003 and then a downward trend again. This fluctuation may attribute to the number of non-nationals working in Sudan Arabia. The percent of the population aged 65 years or older has been increasing slowly with little fluctuations over the study period. The percent of population under 15 years shows a downward trend during the study period. Whereas the trend of infant mortality rate has been sharply declining, the rate declined from 75 in 1980 to 14 per 1000 live births. At a distance from advancements in social and health care services, the improved statistics of infant and child mortality rates mostly attributed to the compulsory

childhood vaccination program implemented by the government since 1980 (Aldossary A, While A, Barriball L 2008). This exceptional growth will increase the demand for necessary services and facilities including health care, ultimately creating new economic opportunities (Almalki, Fitzgerald and Clark, 2011).

The rest of this article is organized as follows: Section 3 the determinants of public healthcare expenditures model which includes (model variables, data sources and model specification). Section 4 reports the major empirical results. Finally, the last section (5) for the summary of finding.

MATERIALS AND METHODS

The main aim of this research is to identify the most important determinants of health care expenditure in Sudan. The specific objectives are to determine the most important factors affecting health expenditures and to recommend proposals that would activate and promote the role of existing providers of health services in Sudan.

Methods: In this approach, the study would try to estimate the effect of various factors on healthcare expenditures depending on levels of expenditure on health services, using the Autoregressive Distributed Lag (ARDL) method.

The health expenditures data collected for all States of Sudan, and the sources were the Central Bureau of Statistics, Ministry of Health, Ministry of Finance and Ministry of Planning and National Economy. Based on the theoretical framework of the endogenous growth model, the distributed slow-down autoregressive methodology is applied to estimate the long-term equilibrium parameters along with the error-correcting model to estimate the short-term dynamics of the parameters simultaneously.

The Autoregressive Distributed Lag (ARDL) method would be used to estimate and analyze the effect of various factors on per capita healthcare expenditures in Sudan in the period 1990 – 2018 for all states of Sudan.

In similar studies of healthcare expenditures for developed nations, per capita GDP accounts for the largest portion of change in healthcare expenditures. Mettao (2003) used per capita gross state product in his study of the United States; similarly, this same variable would be used to measure the effects of per capita personal income on per capita healthcare expenditures in this study. Administrative areas with higher incomes are expected to spend more on personal healthcare. Studies have been done to estimate the elasticity of healthcare expenditures with respect to GDP in developed nations. Newhouse (1977) found that income elasticity relative to healthcare was close to 1. This suggests that healthcare is a normal service. However, Sen, & Anindya (2005) found that income elasticity with respect to healthcare expenditures to be less than 1 suggesting that healthcare is an inelastic service. There was some disagreement as to how much income explains health expenditures, but its positive effect can be seen in many research findings on this subject.

The variables Age 65 and Age -15 increase the demand for healthcare. Theory suggests that age is a driving factor for the increase in healthcare expenditures. All of the studies mentioned above used age variables as determining factors in the demand for healthcare. In this study both proportions of the population above the age of 65 and below the age of 15 would be used in the model, expecting them to have great impact on healthcare expenditure levels more than any variables. Matteo (2003) used age variables, and obtained a result that conforms to that of previous literature and revealed that healthcare expenditures for the elderly and young are greater than those of middle-aged people. In this study, and in addition to age variables, infant mortality rate would be used as an indicator of the demand for healthcare in each state.

On the other side, variables of physicians per 100,000 people, hospitals per 100,000 people, hospital beds per 100,000 people and life expectancy at birth are used to account for the supply of healthcare. It is difficult to determine the effect these variables would have on healthcare expenditures because they shift the supply curve of healthcare. Shifting the supply of healthcare has the effect of lowering the price of healthcare while raising the quantity of healthcare provided. It is not definite that this study would determine how much this supply shift would affect both price and quantity, but would try to check whether it would increase or decrease healthcare expenditures.

Most statistical tests and models rely upon certain assumptions about the variables used in the analysis. When these assumptions are not met the results may not be trustworthy, resulting in a Type I or Type II error, or over- or under-estimation of significance. This Autoregressive Distributed Lag (ARDL) model suggested to be used here is no exception. It has been examined for the existence of a relationship between variables in levels which is applicable irrespective of whether the underlay in repressors are purely I_0, purely I_1 or mutually co-integrated. The statistic underlying this procedure is the familiar Wald or *F*-statistic in a generalized Dicky–Fuller type regression used to test the significance of lagged levels of the variables under consideration in a *conditional* unrestricted equilibrium correction model (ECM).Itisshownthattheasymptoticdistributionsofbothstatisticsarenon-standard under the null hypothesis that the preexists no relationship in levels between the included variables, irrespective of whether the regresses are purely I_0, purely I_1 or mutually co-integrated.

This study employed nine explanatory variables as follow

Healthcare expenditures per capita (in SDG),

The following figure illustrates the per capita health expenditure for the period of 1990 to 2018 which showed that there was a gradual increase in the per capita healthcare expenditure in the period from 1990 to 2005, and after that there was a jump in the following two years, after which there was stability with some fluctuations until 2014. In 2018, there was a significant drop in per capita healthcare expenditure, due to the decrease in national income.(in figure1)

GDP per capita (SR) Gross domestic product (GDP)

The following figure illustrates the GDP per capita for the period of 1990 to 2018 which showed that there was a gradual increase in the per capita spending in health care facilities in the period from 1990 to 2010. In 2018, there was a significant drop in GDP per capita. (figur2)

and Number of Physicians per 1000 population in figure 3.

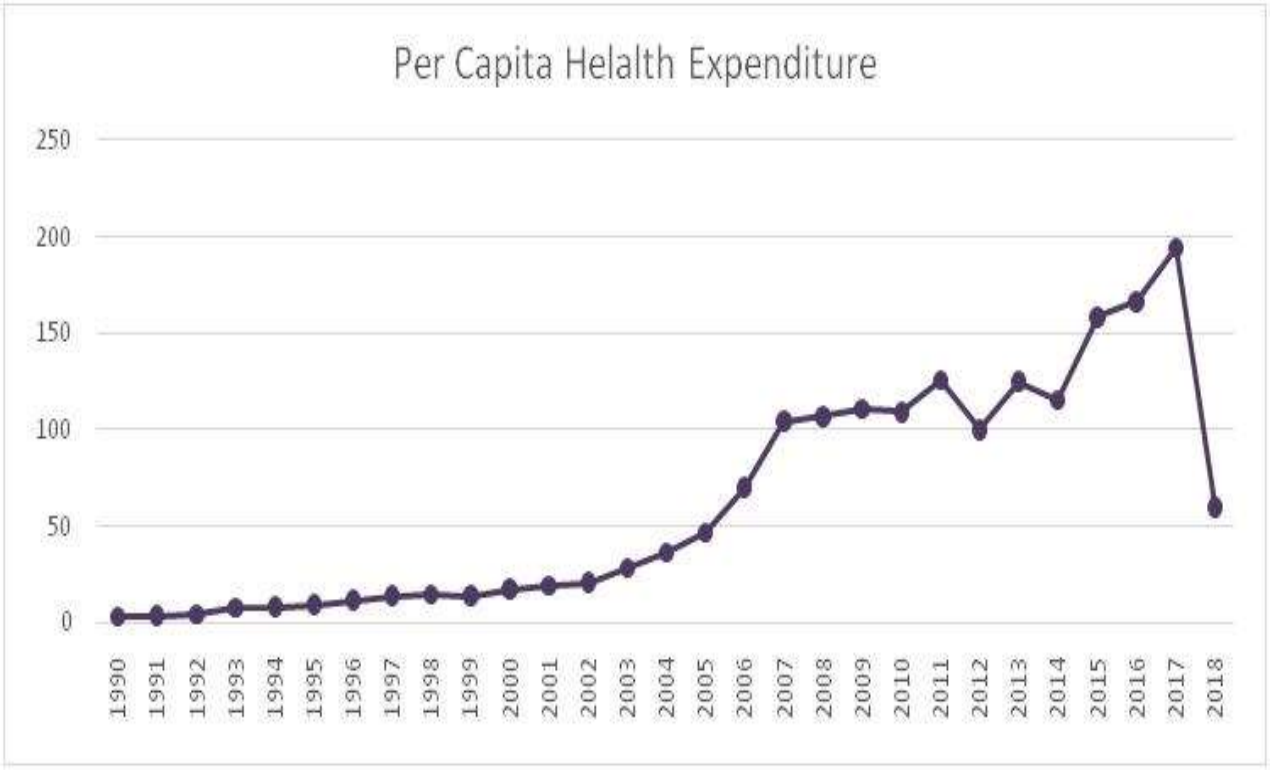


Figure 1: Healthcare expenditures per capita (in SDG)

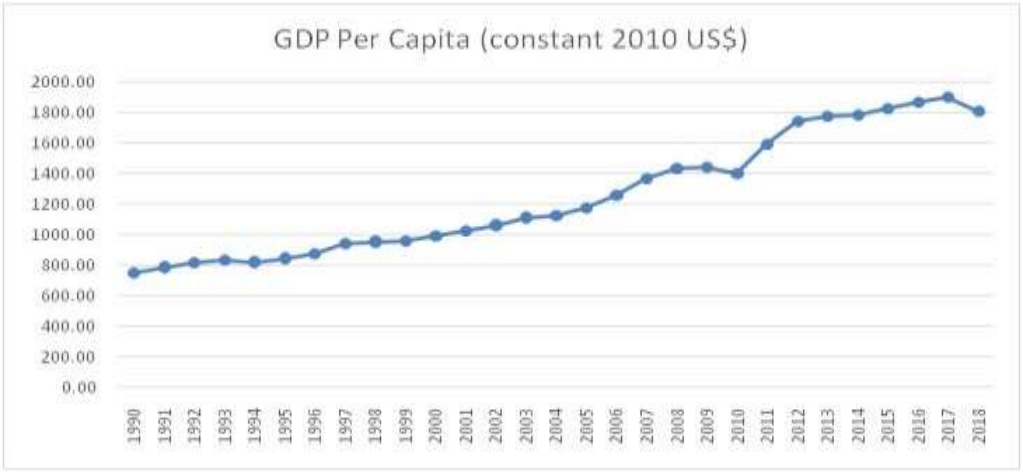


Figure 2: GDP per capita (SR) Gross domestic product (GDP)

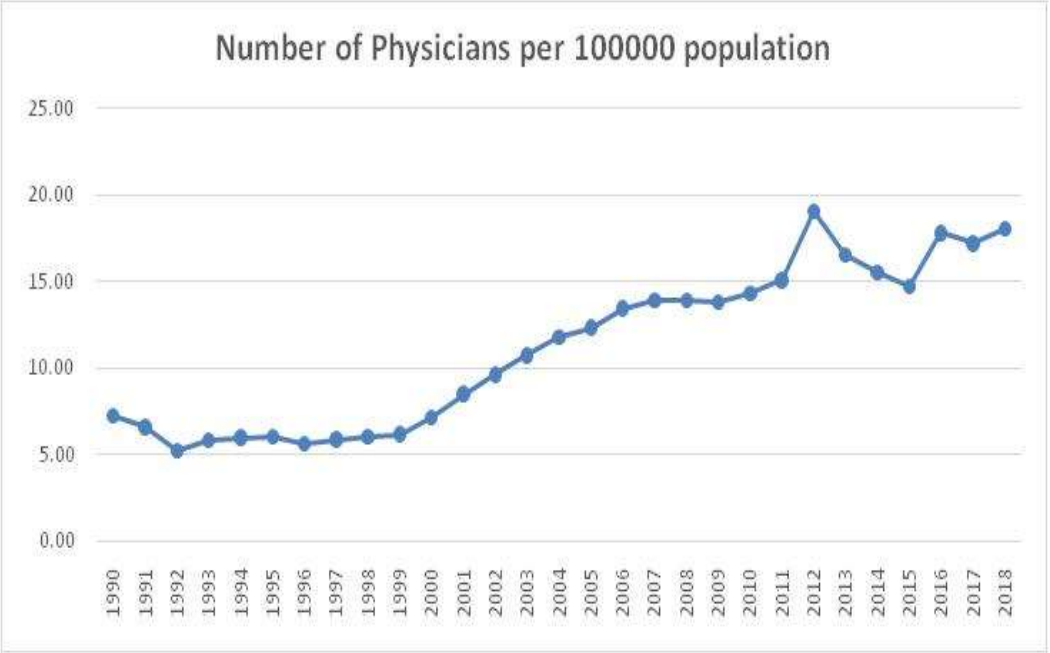


Figure 3:Number of Physicians per 1000 population

Total population. For missing population estimates, the population was projected by the researcher using different growth rates assuming inter-census growth rates to project populations of each year within that period.

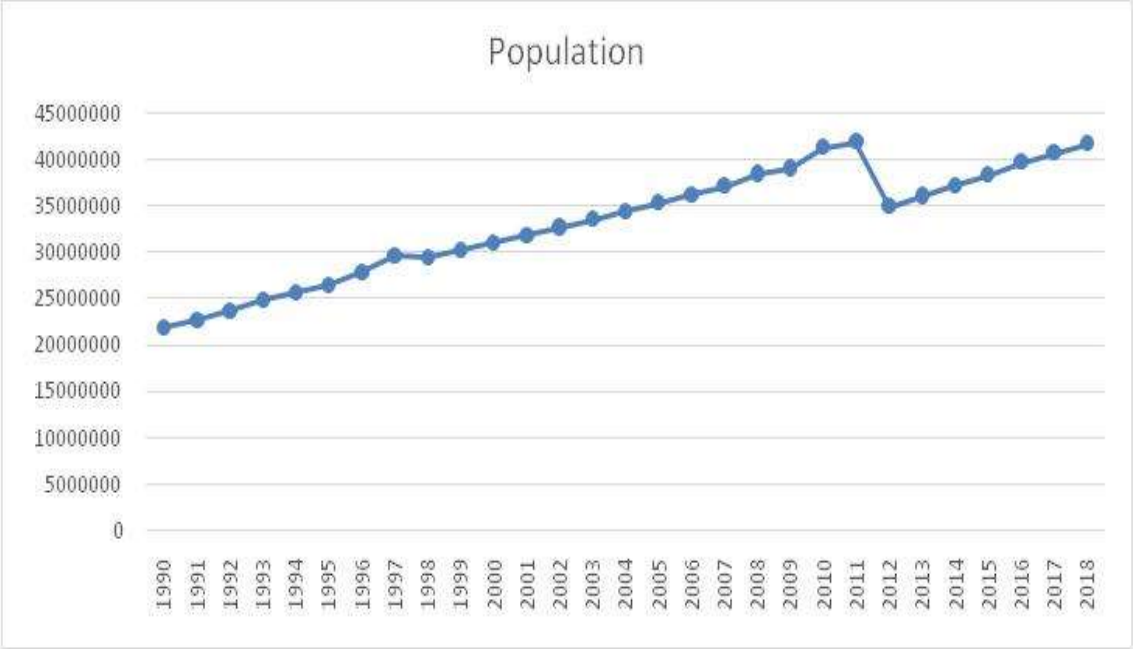


Figure 4: Total population for missing population estimates, using different growth rates assuming inter-census growth rates

Population growth rate

is the annual average rate of change of population size, for a given country, territory, or geographic area, during a specified period. It expresses the ratio between the annual increase in the population size and the total population for that year, usually multiplied by 100.

Percent of population under 15

It includes infancy and comprehensive schooling age population. A researcher will obtain the estimates of this variable from WHO and World Bank database, (http://data.worldbank.org/).

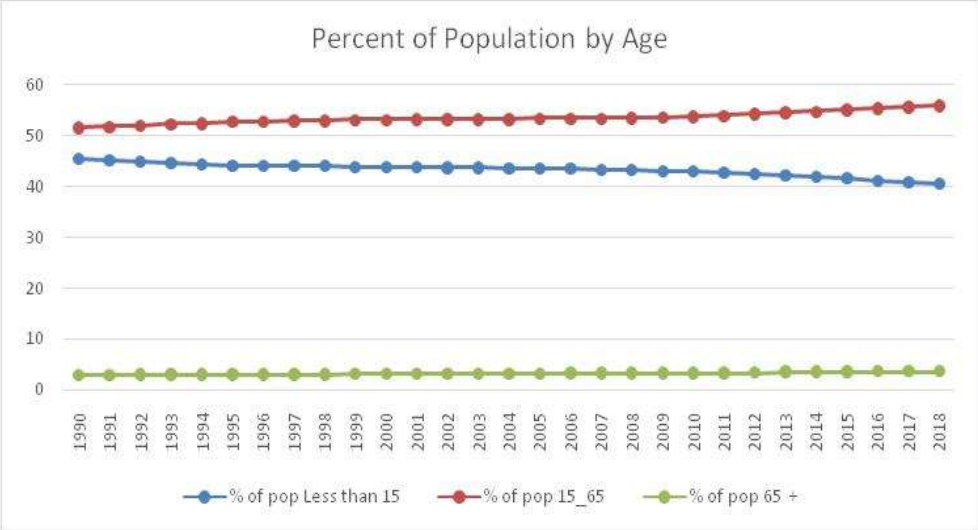


Figure 5: percentage of population by age

:

Percent of population aged 65+:

This variable indicates total population aged 65 and above as a percentage of the total population. Widely but not unanimously, this variable is accepted as a definition of 'elderly' or older person. According to the WHO, this definition does not adapt well to the situation in Africa, for example. While this definition is somewhat arbitrary, it is many times associated with the age at which one can begin to receive pension benefits. A researcher will obtain the estimates of this variable from WHO and World Bank database, (http://data.worldbank.org/).

Percent of population aged 15 – 65:

The annual average rate of change of population size, for a given country, territory, or geographic area, during a specified period. It expresses the ratio between the annual increase in the population size and the total population for that year, usually multiplied by 100

Infant mortality rate:

(probability of dying between birth and age 1 per 1000 live births) Infant mortality rate is the probability of a child born in a specific year or period dying before reaching the age of one, given that he or she has been subjected to age specific mortality rates prevailing during that period. It is a probability of death derived from a life table and expressed as a rate per 1000 live births. The data will be use here are estimates generated by the UN Inter-agency Group for Child Mortality Estimation (IGME) in 2015, (http://data.unicef.org/).

Under 5 Mortality Rate:

(probability of dying before reaching age 5 per 1000 live births) The probability of a child born in a specific year or period dying before reaching the age of five if being subjected to age-specific mortality rates of that period. Statistics for this variable are estimates and were found in the previous website. The data will be use here are estimates generated by the UN Inter-agency Group for Child Mortality Estimation (IGME) in 2015, (http://data.unicef.org/).

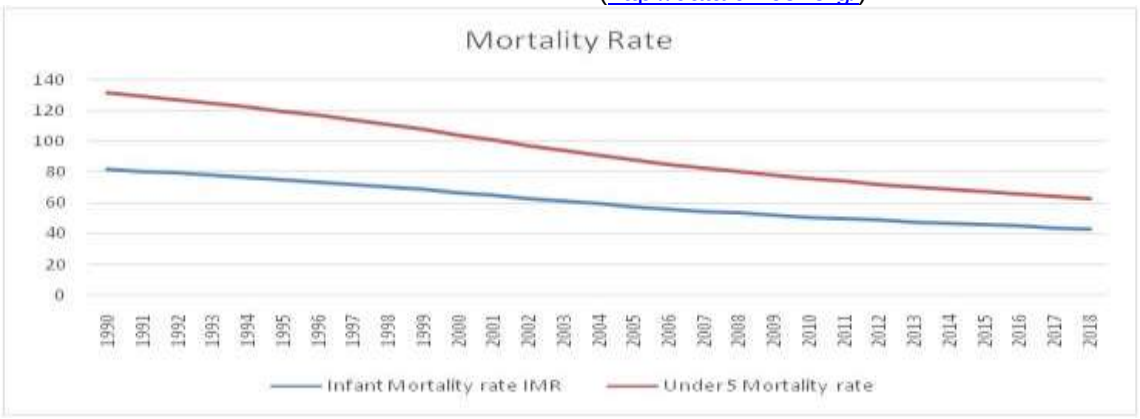


Figure 6:Under 5 Mortality Rate

Hospitals per 100,000 Population:

a hospital is a health care institution that provides patient treatment with specialized staff and equipment. Data for this variable will be from the Annual Health Statistical Reports published by the National Center for Health Information, under the Sudan Ministry of Health (covering the period **1990 to 2018**). Hospitals per 100,000 are the ratio of total hospitals of the Sudan divided by its total population and multiplied by (100,000).

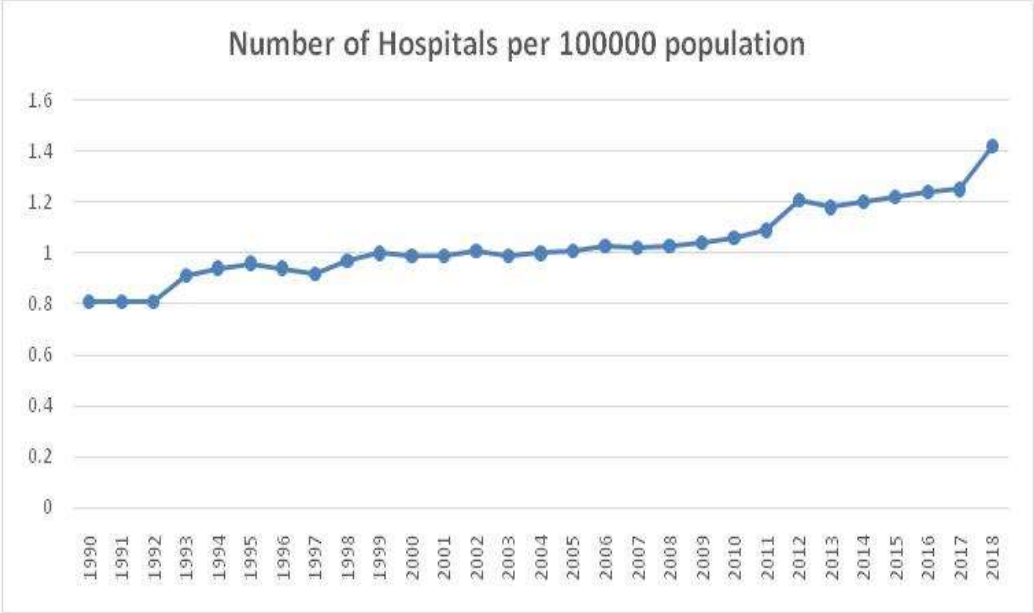


Figure 7: Hospitals per 100,000 Population

Hospital beds

Data for this variable will be from the Annual Health Statistical Reports published by the National Center for Health Information, under the Sudan Ministry of Health (covering the period 2000 – 2010). Hospital beds per 10000 are ratios. Authors used these ratios to indicate the number of hospital beds in the public sector available per 10000 inhabitants of the area.

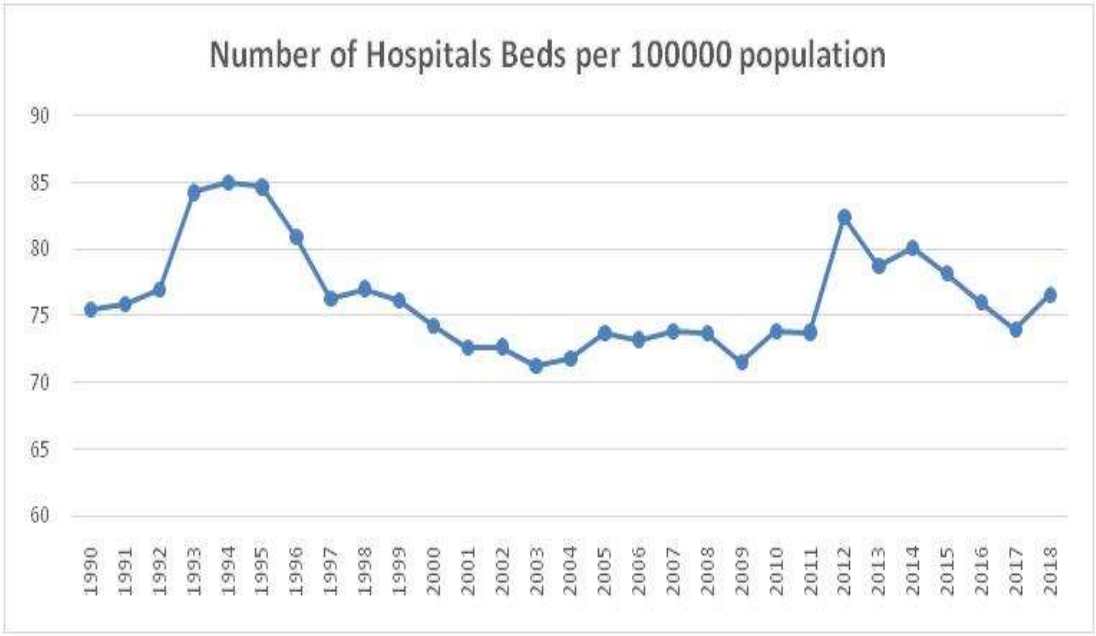


Figure 8: number of hospital beds per 100,000 population

RESULTS AND DISCUSSION

The following table shows the results of the stability test of the dependent variable series, which settled after taking the first differences of the logarithm series, where the Dickey Feller statistical value (-2.432511) is higher than the levels of significance (5% and 10%)

Table 1: Hypothesis testing

Null Hypothesis: D(LY) has a unit root				
Exogenous: None				
Lag Length: 0 (Automatic – based on SIC, maxlag=6)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-2.432511	0.0171
Test critical values:	1% level		-2.653401	
	5% level		-1.953858	
	10% level		-1.609571	
*MacKinnon (1996) one-sided p-values.				

The following table shows the estimates of the chosen model: The following estimated model is the model in which all the coefficients of the independent variables were significant, and these variables are (the populations is less than five years, the population is less than fifteen years, and the infant mortality rate). We note from the estimates that the infant mortality rate is related Inverse with the dependent variable unlike the other two variables

The following figure shows the graph of the real and estimated data for the dependent variable by the model in addition to the residuals or errors of the model

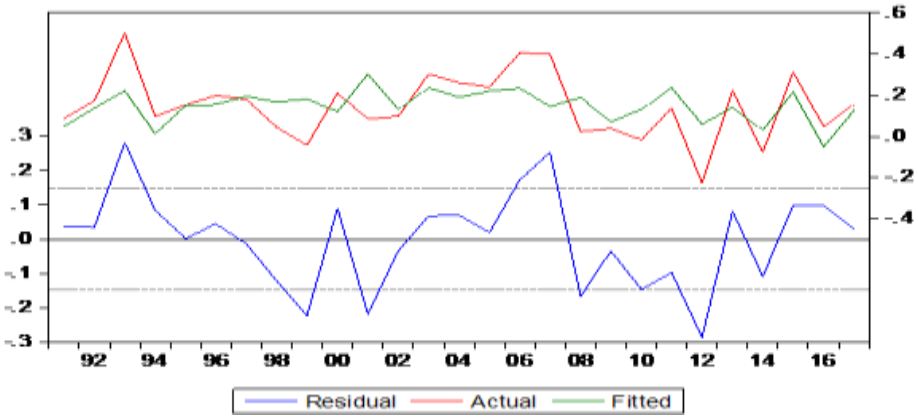
Model 1

Dependent Variable: D(LY)				
Method: Least Squares				
Sample (adjusted): 1991 2017				
Included observations: 27 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(PL 15))	38.74227	16.76807	2.310478	0.0298
D(LOG(PL15 - 65))	46.29545	22.93500	2.018550	0.0548
D(LOG (IMR))	-7.564138	1.742036	-4.342125	0.0002
R-squared	0.223483	Mean dependent var		0.148879
Adjusted R-squared	0.158773	S.D. dependent var		0.158953
S.E. of regression	0.145789	Akaike info criterion		-0.908871
Sum squared resid	0.510108	Schwarz criterion		-0.764889
Log likelihood	15.26976	Hannan-Quinn criter.		-0.866058
Durbin-Watson stat	1.789943			

Figure 9: the real and estimated data for the dependent variable

Model 2

Dependent Variable: D(LY)				
Method: Least Squares				
Sample (adjusted): 1991 2017				
Included observations: 27 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(PL5))	39.22019	16.90682	2.319785	0.0296
D(LOG(PL15))	46.27469	23.11029	2.002341	0.0572
D(LOG(IMR))	-6.658392	2.090084	-3.185706	0.0041
D(LOG(GDP))	0.686217	0.859564	0.798332	0.4328
R-squared	0.244420	Mean dependent var		0.148879
Adjusted R-squared	0.145866	S.D. dependent var		0.158953
S.E. of regression	0.146903	Akaike info criterion		-0.862130
Sum squared resid	0.496354	Schwarz criterion		-0.670154
Log likelihood	15.63876	Hannan-Quinn criter.		-0.805046
Durbin-Watson stat	1.743942			



The two variables, previous per capita health expenditure and GDP per capita, explain 92.8 percent of the annual variation in the per capita health expenditure. The results show that as GDP per capita goes up by 1 percent, on average the per capita health expenditure goes up by .456% percent holding the previous year spending on health constant. Similarly, as previous per capita health expenditures increase by 1 percent the per capita health expenditure of the current year increases by 0.57 percent. Moreover, the elasticity of GDP per capita is less than 1 which implies that health is a necessity in Sudan and not a luxury good (Antonides, 2008). These results go in line with the results of many studies.

CONCLUSION

The highest variation is scored by the variable infant mortality rate (58.2%), followed by GDP per capita (46.7%), and per capita health expenditures (46.1%).

There is a high significant positive correlation between health expenditure per capita and GDP per capita. Spending on health depends primarily on GDP and previous spending values. One percent increase in GDP leads to 0.456% increase in health expenditure.

The two variables, per capita health expenditure and GDP per capita, explain 92.8 percent of the annual variation in the per capita health expenditure.

Elasticity less than 1 implies that health care is a necessity in the Kingdom.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

AUTHOR CONTRIBUTIONS

All authors contributed equally in this study

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