International Journal of Applied Research 2018; 4(3): 527-535

ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2018; 4(3): 527-535
www.allresearchjournal.com
Received: 16-01-2018
Accepted: 25-02-2018

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Health expenditure, human development and economic growth for BRICS countries: Testing for co-integration and causality

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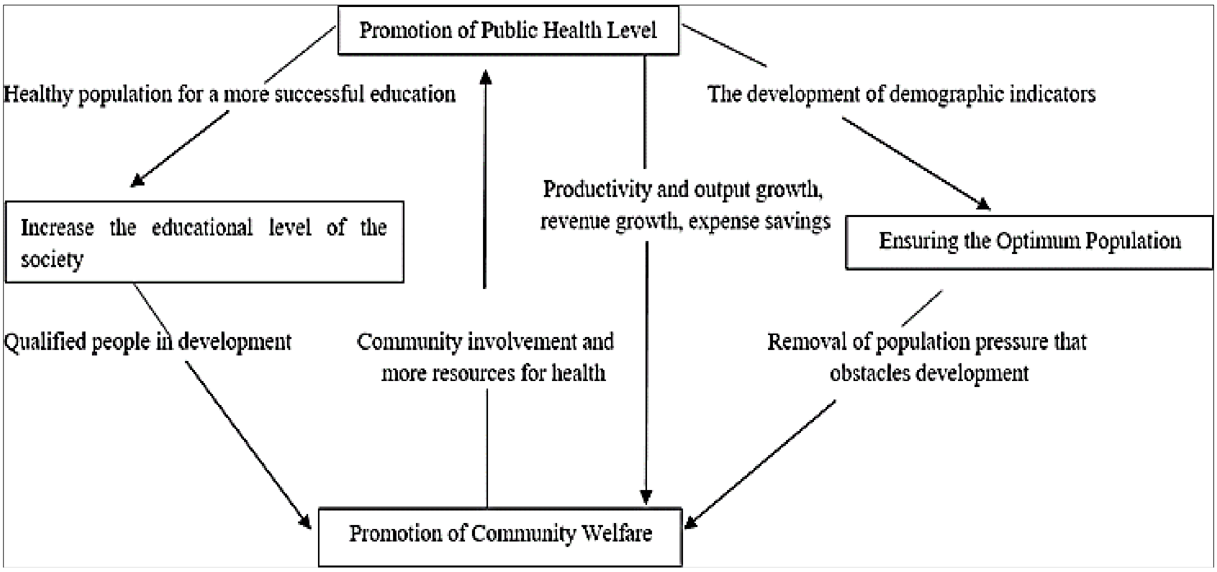
Abstract
The linkage between health indicators, population growth and economic growth and human development is attempted to investigate in this study in BRICS countries for the period 2000-2017. The panel co-integration, panel Fully-Modified Ordinary Least Squares (FMOLS) model and Granger's Causality tests are used to identify the long-run relationship and direction of causality amongst the variables. The empirical results depict long-run relationship amongst the variables. Panel FMOLS provides evidence of positive and significant impact on the economic growth and Human well-being of the countries. Panel Granger's Causality test depicts bi-directional causality between economic growth and health expenditure in the short-run. Thus, economic growth enables advancement of health care facilities and the better health indicators can allow higher economic growth. The study provides empirical evidence of short-run uni-directional causality from human development to health expenditure. Therefore, better human development conditions leads to higher health care expenditure.

Keywords: Panel co integration, BRICS countries, economic growth, human development index.

Introduction
The significance of health expenditure is one of key aspect of economic and social wellbeing individuals and nations. The increasing health expenditure is recognized as a core strategy to improve population health in the Global Economy. Cole and Neumayer (2006) [11] states that poor health has a negative impact on productivity, and health is a key factor in explaining the prevalence of underdevelopment in many countries around." There is an increasing trend in the healthcare spending of countries across the world. The increased health care spending leads to economic growth as the increased spending provides a better access to health care facilities and leads to improved health status. Healthier persons in the country are more productive and thus an economy has better income status. There are direct and indirect impact of better health situation on productivity level and economic progress of the country. Persons with good health conditions are more efficient and tend to be more creative, skillful and show better learning outcomes. The better health situation motivates the person to continue education, acquire greater skill and enhances learning capability which has the direct impact on the productivity levels. The enhancement of health status also reduces mortality rates and increases life expectancy which allows the greater labor participation and increased savings. The increased savings improves physical capital formation and spurs economic growth. According to World Health Organization, 2001, "extending the coverage of crucial health services to the world's poor could save millions of lives each year, reduce poverty, spur economic development and promote global security."
The economic growth improves the possibility of the spending the higher amount of resources on health care. The higher income implies higher amount of money available for spending. "A large body of research within health economics indicates that variation in per capita health care expenditure could be mostly explained by variations in per capita GDP (Gerdtham and Jonsson, 2000) [19]. GDP leads to better health standards through various channels such as nutrition, education, sanitation and housing (Caldwell, 1986; Musgrove, 1996) [8, 31]. There could exist a mutual relationship between Health expenditures and economic growth indicators in each country based on theoretical principles and experimental observations (Beheshti and Sajoudi, 2008, p: 116) [5]. Therefore, "the policies for better

health, poverty reduction, and less inequality throughout the world require thorough understanding of both the processes and causal paths that underlie the intricate relationship between health and income. This is deemed difficult, contingent and only partially understood**.** (Muhammad Jami Husain (2009); p:01) [39].

The relationship between health level and economic growth of society can be depicted through the Chart 1. The health expenditure of the country as a proxy for availability of health services will have an important role in raising the health situation of society and contributing to economic and social progress. The progress in health situation improves country's health indicators (such as improved life expectancy and reduced Infant Mortality Rate) and other socio-economic indicators that allow population to reach an optimum level and the retarding effects of population pressure disappears. This provides momentum to the economic and social development of the country and increases productivity level and speeds up income growth. The surge in the economic growth increases expenditure, savings and economic and social development, and thus accordingly the level of welfare increases.



Source: Ismail Mazgit, "Ekonomik Kalkınma Surecinde Turkiye'de Saglık Sektorunun Yeniden Yapılanması", Unpublished phd thesis, Dokuz Eylül University, Izmir, 1998, p. 109.

Fig 1: Economic development and health status

The present study aims to investigate the effect of health expenditure on economic growth and Human Development Index (HDI) of BRICS countries using the data from 2000-2017. The study attempts to provide empirical evidence for direction of causation between health expenditure and economic growth and human development and to verify the presence of co-integration and the estimates of the long-run relationships amongst the variables of the study. The empirical procedure involves the use of panel co integration techniques, test for causality between health expenditure and economic growth and HDI and estimating panel fully modified ordinary least squares (FMOLS) to analyze the long-run relationship between GDP per capita growth and health expenditure. BRICS (constitutes Brazil, Russia, India, China and South Africa) is a group of countries that have similar characteristics of emerging economies. According to estimates by the International Monetary Fund, the contribution of the BRIC countries to global economic growth was about 60% in 2016. The study will provide useful insights for effective policies framework and contributes to debate of health and economic growth linkage in developing nations.

The paper proceeds in five sections including Section 1 as introduction; Section 2 provides the review of relevant empirical literature on economic growth and health; Section 3 gives insights into Data and Research Methods; Section 4 reports the empirical results with Section 5 presents the summary and policy implications.

Section 2: **Review of literature**

There are plethora of research studies that evaluate the relationship between health indicators and economic development in developing and developed countries of the World. There is a lack of general conclusion in the research studies on the economic Growth and health relationship.

Dilrukshini, W. (2002) [13] applies time-series Granger's causality and co integration test using the data for 1952-2002 of Sri Lankan economy and found "no empirical support for long-term relationship between public health expenditure and economic growth". Meer *et al*. (2003) [29] shows that "the unidirectional causality running form economic wealth to health is not very strong. Wealth has positive and significant effect on health but of a small magnitude." Dreger and Reimers (2005) [14] use panel co-integration to "explain the long term relationship between health care expenditure and economic growth for a sample of 21 OECD countries during 1975-2001. The study found a long run association between the variables". Akram (2009) [1] finds positive influence of health indicator on per capita GDP in the long run in Pakistan for." the period of 1972-2006 but no significant impact of health indicators was noticed on "per capita GDP in the short run". Erdi and Yetkiner (2009) [17] examine "the real per capita health expenditure and real per capita GDP for the low and high-income countries. The uni-directional causality from income to health expenditure was found for low-income countries and from health expenditure to income was found for high-income countries". Baltagi and Moscone (2010) [3] analysis indicates non-stationary behavior of health care expenditure of the panel data of twenty OECD countries during the period 1971-2004. The study found long-run linkage between health care expenditure and income levels. Cetin and Ecevit (2010) [10] concluded no significant relationship between "health expenditure and economic growth for the period 1990-2006 by applying panel regression estimates using annual data of 15 OECD countries". Nkwaton Sevitenyi L. (2012) [32] also found similar results of no long term relationship between health expenditure and income levels. Elmi and Sadeghi (2012) [16] by "using panel co-integration causality vector error correction model (VECM) verified the long term association between GDP and health expenditure in a sample of developing countries from 1990 to 2009. The study found short-run uni-directional relationship with GDP granger cause health expenditure. In the long run the bidirectional relationship between the variables was found". Selim *et al*. (2014) [38] performs panel data analysis for "27 EU Member Countries and also Turkey during the period 2001-2011 for the data on per capita health expenditure and economic growth and shows positive relationship in short-run as well as long-run". Mandiefe and Tieguhong (2015) [28] evaluates annual time series data Cameroon of public health investments and economic growth by using Vector Error Correction Model (VECM) and found public health investment leads to "economic growth in long-run only through efficient allocation of resources". Sahbudak and Sahin (2015) [37] investigate the relationship between health indicators and economic growth for BRICS countries. It was found that the health indicators of health expenditure as % of GDP and life expectancy at birth have positive effect on economic growth and infant mortality rate negatively impact the economic growth". Eggoh *et al* (2015) [15] validates "negative effects of public health expenditure on economic growth after investigating 49 less developed African countries". Esra CEBECİ & Ahmet AY (2016) uses panel data analysis and found significant positive effects of "health expenditure and economic growth for BRICS countries and Turkey during the period 2000-2014". Badri and Badri (2016) [2] analyses data on the health expenditures of selected 24 OECD countries and uses dynamic panel data analysis for the period during 2006-2013 and found "positive effects of health expenditure on economic growth".

Section 3: Data

The data on the BRICS countries namely Brazil, China, India, Russia and South Africa has been applied to explore the linkage of health expenditure, infant mortality rate, population growth and economic growth and human development. The variables used in the study are presented in the Table1. The GDPPCG show the annual percentage growth rate of GDP per capita based on constant 2010 U.S. dollars of each country.

Table 1: Description for the data used

Variables	Symbols	Period	Description	Source
Human Development Index	HDI	2000-2017	UNDP HDI	World Bank
Health Expenditure	HE	2000-2017	Health Expenditure as % of GDP	World Bank
Economic Growth	GDPPCG	2000-2017	Annual growth of GDP Per Capita ($)	World Bank
"Infant Mortality Rate"	IMR	2000-2017	"Infant Mortality rate, (per 1,000 live births)"	World Bank
PopulationGrowth	POPG	2000-2017	Population Growth (Annual, %)	World Bank

Source: Authors' compilation

Health expenditure (HE) is expressed as a percentage of GDP. The infant mortality rate (IMR) is used as the health indicator and denotes the number of infants dying before reaching one year of age and expressed in number per 1,000 live births in the year. Population (POP) is the annual population growth rate for the year t and country i. Human Development Index (HDI) measures key dimensions of human development estimates provided by UNDP. The annual data of all variables for the period 2000-2017 has been extracted from World Development Indicators dataset of World Bank. The variables are used in natural logarithm.

The selected health indicators in BRICS countries during 2000-2017 are depicted through Table2. China shows the higher per capita GDP growth followed by India. The per capita healthcare expenditure for Brazil is highest with $ 1080 followed by Russia and South Africa. India spends the least per capita on health. The Health expenditure as percentage of GDP is also lowest for India with only 3.68% of GDP is spent on Healthcare. The health indicator in terms of Infant mortality rate (IMR) is lowest for Russia followed by China and Brazil. India has the highest IMR. The life expectancy is around 66 years for India just above South Africa.

Table 2: Health-related indicators in BRICS countries (2000-2017)

Country	Brazil	China	India	Russia	South Africa
GDP Per Capita, Growth (Annual %)	1.457012	8.696525	5.124364	3.92388	1.457375
Health Expenditure Per Capita, PPP (Constant 2010 International $)	1079.652	386.9123	151.2843	940.1926	806.1539
Healthcare Expenditure, Total (% of GDP)	8.346689	4.399214	3.683651	5.082111	7.311529
Healthcare Expenditure, Public (% of GDP)	3.590603	1.937904	0.837455	3.066124	3.488406
Infant Mortality Rate	19.51111	16.75	48.49444	10.36667	38.3
Life Expectancy at Birth, Total (Years)	72.98828	73.98394	65.97611	68.23217	57.51028

Source: Compiled by Author from World Development Indicators (WDI), World Bank. Figures denote the average during the period.

Methods

The long-run linkage between health expenditure, infant mortality rate, population growth and economic growth and human development is analyzed using panel co-integration tests. The following two models are used to investigate the relationship:

$$\text{lnGDPPCG}_{it} = \alpha_{it} + \beta_{1i} InHE_{it} + \beta_{2i}\text{lnIMR}_t + \beta_{3i}\text{lNPOP}_{it} + \varepsilon_{it} \qquad \text{(Model 1)}$$

$$\text{lnHDI}_{it} = \alpha_{it} + \beta_{1i} InHE_{it} + \beta_{2i}\text{lnIMR}_t + \beta_{3i}\text{lNPOP}_{it} + \varepsilon_{it} \qquad \text{(Model 2)}$$

The relationship amongst variables is analyzed using the Panel Co-integration method and panel fully modified ordinary least squares model. The following steps are involved for the empirical estimations of the above equations:

Panel unit root test

As the first step, the stationary properties of the variables used is analyzed using panel unit root test. The stability of the variables are examined using panel unit root tests. "Taylor and Sarno 1998 [39] states that Panel unit root tests are more powerful than standard time-series unit root tests because the variation across countries adds a great deal of information to the variation across time, resulting in potentially more precise parameter estimates." IHS (2013) [21] "Theoretically, these tests are simply multiple-series unit root tests that have been applied to panel data structures. The present study uses Levin, Lin and Chu (2002) [25] (LLC), Im, Pesaran and Shin (2003) [22] (IPS), ADF-Fisher Chi-square (ADF) and PP-Fisher (PP) tests to evaluate the presence of unit root in the variables".

IHS (2013) [21] "The LLC procedure involves pooling the t-statistic of the estimator to evaluate the hypothesis that every individual time series contains a unit root against the alternative hypothesis that every individual time series is stationary. Thus, LLC assume homogeneous autoregressive coefficients for all individuals, i.e. pi= p for all I, and test the hypotheses as

$$H_0: \rho = 0 \; ; H_a: \rho < 0 \;\;,,$$

IHS (2013) [21] "IPS is an alternative testing method based on the augmented Dickey-Fuller test statistics averaged across the panels. The null and alternative hypotheses are:

$$H0: \rho i = \rho = 0$$
$$Ha: \rho i < 0 \text{ for } i= 1, 2, 3 \ldots N1$$
$$\rho i = 0 \text{ for } i=N1+1, N1+2 \ldots N\text{"}$$

This method allows ρ_i to vary across groups and so is less restrictive test than LLC method.

IHS (2013) [21] "The Fisher-ADF and PP tests allow for individual unit root processes so that pi may vary across cross-sections. The tests are characterized by the combining of individual unit root tests to derive a panel-specific result. The null and alternate hypotheses are same as for IPS."

Panel co - integration

The existence of co-integration and the long-run relationships between the variables of the study is verified using Pedroni, Kao and Johansen Fisher Panel Co-integration tests. The panel co integration test is essentially a test of unit roots in the estimated residuals of the panel. In the presence of a co integrating relation; the residuals are expected to be stationary. The tests are implemented on the residuals obtained from the regression equations mentioned as Model 1 and Model 2. "Pedroni (1999) **[33, 34]** test extended the Engle and Granger tests to estimate panel co integrated test". The test analyzed whether the order of co integration of residual term is I(0) or I(1). Specifically, seven panel co integration statistics are derived and heterogeneous panel and heterogeneous group mean panel co integration statistics are calculated. "The first category of four statistics is defined as within-dimension-based statistics and includes a variance ratio statistic, a non-parametric Phillips and Perron type ρ statistic, a non-parametric Phillips and Perron type *t*-statistic and a DF type *t*-statistic. The second category of three panel co integration statistics is defined as between-dimension-based statistics and is based on a group mean approach (Bildirici M; 2004a, 2004b) [6, 7]. The null hypothesis of no co integration for all units of the panel is tested in both kinds of tests against the alternative hypothesis of existence of co-integration for all units of the panel.

The Kao co-integration tests the null hypothesis of no co-integration between variables against the alternative hypothesis of co-integration between variables using ADF-type test. "The test is based on the Engle-Granger two-step procedure, and imposes homogeneity on the members in the panel (Kao, 1999) [23].

The third test is the "Fisher's test which aggregates the p-values of the individual Johansen maximum likelihood co-integration test statistics. The Fisher test is a non-parametric test that does not assume homogeneity in the coefficients (Maddala and Kim, 1998; Maddala and Wu, 1999) [26, 27].

Estimation of long-run relationship (Panel FMOLS) and short –run causality

The presence of panel co-integration is analyzed using panel co integration tests mentioned above and it shows if the long-run relationship exists between but these tests don't indicate the direction of causality and the coefficient estimates of variables.

In the presence of co-integration amongst variables, the spurious results will be produced using regression based on variable in levels. **"**Phillips and Hansen (1990) [35] suggested the estimation of panel fully modified ordinary least squares model (FMOLS) to estimate the relationship in the long run". Panel FMOLS generate long run estimates for the co integrated panel and avoids endogeneity and serial correlation and provides consistent parameters. Model 1 and Model 2 are estimated using panel FMOLS to evaluate the effect of health expenditure on GDPPC growth and human development index in BRICS countries.

The Panel Stacked Granger Causality Test is applied to investigate the direction of causality amongst the variables. The panel stacked grange causality method treats the panel data as one large stacked set of data and the granger causality test is performed in the standard way. HIS (2013) the bivariate regressions are computed to perform Granger's Causality tests. The bivariate regression takes the following forms:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \ldots\ldots.. + \alpha_1 y_{t-1} + \beta_1 x_{t-1} + \ldots\ldots + \beta_l x_{t-l} + \varepsilon_t \qquad (3)$$

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \ldots\ldots.. + \alpha_1 x_{t-1} + \beta_1 y_{t-1} + \ldots\ldots + \beta_l y_{t-l} + \mu_t \qquad (4)$$

for all possible pairs of (x,y) series in the group.

The reported F-statistics are Wald statistics for the joint hypothesis:

$$\beta_1 = \beta_1 = \ldots\ldots\ldots\ldots \beta_1 = 0 \text{ for each equation}$$

IHS (2013) [21] "It is assumed that all coefficients are same across all cross-sections. The null hypothesis is that x does not Granger-cause y in the equation 3 and that y does not Granger-cause in the equation 4".

Section 4: Empirical results

Descriptive statistics

The descriptive statistics of the variables for the relevant period of 2000-2017 is depicted in the Table 3. The variations of IMR is highest. The highest maximum value is seen in INHE and the lowest in the INGDPPC growth.

Table 3: Descriptive statistics

Variables	Mean	Median	Maximum	Minimum	Std. Dev.	N
lnHDI	-0.394	-0.367	-0.196	-0.699	0.120	90
lnHE	5.349	5.713	6.932	2.921	1.153	90
lnGDPPCG	2.499	2.566	3.111	-3.6E	0.409	90
lnIMR	3.088	3.128	4.200	1.774	0.648	90
InPOPG	0.800	0.891	1.171	0.000	0.307	90

Source: Authors' Calculations

Correlation matrix

The correlation matrix in table 4 shows that the health expenditure has positive correlation with HDI and GDPPC growth and negative correlation is found between IMR and health expenditure. Therefore health indicators improves with higher health care spending.

Table 4: Correlation statistics

Variables	lnHDI	lnHE	lnGDPPCG	lnIMR	InPOPG
lnHDI	1				
lnHE	0.837346	1			
lnGDPPCG	-0.31581	0.41202	1		
lnIMR	-0.32522	-0.61754	0.082177	1	
InPOPG	0.074718	-0.2271	-0.1475	0.748055	1

Source: Authors' Calculations

Panel unit root test results

The results of panel unit root tests based on LLC, IPS, Fisher-ADF and PP approaches with constant and trend method are presented in the Table 5.

Table 5: Unit root test results

Variables	Test	Level		Variables	Test	First difference	
		t-statistics	p-value			t-statistics	p-value
lnHDI	LLC	1.36435	0.9138	Δ lnHDI	LLC	-2.42663	0.0076
	IPS	1.49528	0.9326		IPS	-2.09806	0.0179
	ADF	5.63239	0.8451		ADF	22.4455	0.013
	PP	13.4796	0.1981		PP	55.8067	0.000
lnHE	LLC	0.11149	0.5444	Δ lnHE	LLC	-4.50481	0.000
	IPS	1.1915	0.8833		IPS	-3.46576	0.0003
	ADF	3.73699	0.9584		ADF	30.6112	0.0007
	PP	2.35016	0.9929		PP	33.01	0.0003
InGDPPC Growth	LLC	-0.85645	0.1865	Δ lnGDPPC Growth	LLC	-7.17919	0
	IPS	2.26912	0.8994		IPS	-5.6752	0
	ADF	15.5864	0.1334		ADF	44.5638	0
	PP	2.9483	0.9877		PP	96.7162	0
lnIMR	LLC	-0.85433	0.1965	Δ lnIMR	LLC	2.78558	0.9973
	IPS	2.27104	0.9884		IPS	1.26904	0.8978
	ADF	15.6596	0.1098		ADF	6.12889	0.8043
	PP	2.91548	0.9833		PP	34.2628	0.0002
POP	LLC	-4.68152	0	Δ POP	LLC	-5.5907	0
	IPS	-2.26573	0.0117		IPS	-3.81093	0.0001
	ADF	27.2561	0.0024		ADF	31.8799	0.0004
	PP	2.59805	0.9894		PP	19.7623	0.0316

Source: Authors' Calculations In shows the natural logarithms.

The reported results of GDP per Capita growth, Health expenditure, IMR, population growth and human development index are not stationary at levels. All the variables were found to be stationery at first difference at 5% level of significance for all methods i.e. the variables of the study are integrated of order one.

Panel co-integration results

After the determination of the stability of variables, the co-integration amongst variables is evaluated. The within and between dimension results of Pedroni's panel co-integration test are examined for this purpose. The co integration relationship according to Panel v, Panel ADF and Group ADF tests in constant and trend model are summarized in Table 6. The results show that 8 out of 11 statistics in Model 1 and 6 out of 11statistics in Model 2 are significant at 5 % level of significance. So, the null hypothesis of no co integration can strongly be rejected for both the models

Table 6: Pedroni co-integration test results

Model I			Model II		
Method	Test statistic	Probability	Method	Test statistic	Probability
Panel v-Statistic	-0.930714	0.8240	Panel v-Statistic	5.756494	0.000*
Panel rho-Statistic	-0.457157	0.3238	Panel rho-Statistic	-0.749426	0.2268
Panel PP-Statistic	-5.545595	0.000*	Panel PP-Statistic	-7.269653	0.000*
Panel ADF-Statistic	-4.680772	0.000*	Panel ADF-Statistic	-1.762593	0.0390**
Group rho-Statistic	0.701772	0.7586	Group rho-Statistic	1.209272	0.8867
Group PP-Statistic	-4.469712	0.000*	Group PP-Statistic	-9.443892	0.000*
Group ADF-Statistic	-3.858131	0.0001*	Group ADF-Statistic	-3.985297	0.000*

Notes: (*) (**) (***) represents the significance of test statistic according to 1%, 5% and 10% significance level. Source: Authors' Calculations

Table 7: Kao co-integration test results

	Model I		Model II	
Method	Test Statistic	Probability	Test Statistic	Probability
ADF	-0.795889	0.213	-3.288754	0.0000*
Residual Variance	0.186587		0.0000771	
HAC Variance	0.018347		0.00011	

Notes: (*) represents the significance of the test statistic according to the 1% significance level. Source: Authors' Calculations

The results of Kao panel co integration are presented in Table 7 corroborate the existence of co integration amongst variables in Model 2. The test results show that the null hypothesis of no co integration relationship amongst variables in Model 2 is rejected at 1 percent level of significance. However, the results are contradictory for Model 1. The Kao (1999) [23] residual panel co integration tests accept the null hypothesis of no long term relationship in Model 1.

Given the contradiction in the test results, study uses Johansen-Fisher panel co integration test and the results are presented in Table 8 & Table 9. The Johansen-Fisher test uses maximum Eigen value and trace value to analyze the existence of co-integration amongst variables.

The results show that the trace statistic and Max-Eigen statistic of null hypothesis of none co integration equation is strongly rejected for both models with GDPPC growth and HDI as dependent variables at 1% level of significance. So, it can be concluded that there exists long term co integration relation amongst variables HDI, Health expenditure, and infant mortality rate and population growth in the BRICS countries.

Table 8: Johansen fisher panel co- integration test results (model I)

Hypothesized No. of CE(s)	Fisher stat (from trace test)	Probability	Fisher stat (Max Eigen Test)	Probability
None	173.6	0 *	116.9	0 *
At most 1	79.01	0 *	49.23	0 *
At most 2	42.54	0 *	39.94	0 *
At most 3	15.64	0.1103	15.64	0.1103

Notes: (*) (**) represents the significance of the test statistic according to the significance level of 1% and 5%. Source: Authors's Calculations

Table 9: Johansen fisher panel co-integration test results (model II)

Hypothesised No. of CE(s)	Fisher stat (from trace test)	Probability	Fisher stat (Max Eigen Test)	Probability
At most 1	100.7	0*	59.77	0*
At most 2	61.11	0*	52.12	0*
At most 3	26.53	0.0031**	26.53	0.0031**

Notes: (*) (**) represents the significance of the test statistic according to the significance level of 1% and 5%. Source: Authors's Calculations

Granger causality test results

The Panel Stacked Granger Causality Test Results for the variables included in two models with specification of two lags are presented in Table 10 and Table 11.

Table 10: Panel stacked granger causality test results (model 1)

Null Hypothesis	Obs	F-Statistic	Prob.	Results
LNHE does not cause LNGDPPCG	85	13.427	0.0004	GDPPCG □ HE
d LNGDPPCG does not Granger Cause LNHE		3.64242	0.05	
LNIMR does not Granger Cause LNGDPPCG	85	0.58217	0.4477	$GDPPC \rightarrow IMR$
LNGDPPCG does not Granger Cause LNIMR		9.3456	0.003	
LNPOPG does not Granger Cause LNGDPPCG	85	0.24574	0.6214	-
LNGDPPCG does not Granger Cause LNPOPG		0.07299	0.7877	
LNIMR does not Granger Cause LNHE	85	3.87837	0.0523	*IMR* □ *HE*
LNHE does not Granger Cause LNIMR		12.8642	0.0006	
LNPOPG does not Granger Cause LNHE	85	10.2192	0.002	*POPG* □ *HE*
LNHE does not Granger Cause LNPOPG		4.59227	0.0351	
LNPOPG does not Granger Cause LNIMR	85	1.64066	0.2038	-
LNIMR does not Granger Cause LNPOPG		0.11721	0.733	

Source: Authors's Calculations (***)(**) represents the significance of the test statistic according to the significance level of 1% & 5%

The test is used to identify the direction of causality amongst variables in the panel of BRICS countries. The results of causality test between GDP growth and health expenditure rejects the null hypothesis which means Health expenditure Granger's cause GDP per growth and GDP per capita growth Granger's causes increased health expenditure. Thus, there exists bi-directional causality between Health expenditure and GDP per capital growth. The economic growth enables the advancement of healthcare facilities and improved healthcare facilities allows better health status of the nation which allows higher productivity, savings and entrepreneurial activities leading for higher economic growth. The IMR has unidirectional causality from GDP per capita i.e. GDP per capita growth causes IMR to fall. It means that in order to achieve good health standards the income growth is desirable.

The variables IMR and health expenditure and population growth and health expenditure have shown bi-directional causality. Thus the higher health care spending allows for reduction of infant mortality rate and thus better health conditions and also countries with good health situations have higher health spending. The test results indicate that the population growth variable fail to reject the null hypothesis of no causality with health expenditure. The bidirectional causality is found. The higher population growth level necessitates higher health expenditure as a percentage of GDP and vice versa.

Table 11: Panel stacked granger causality test results model II

Null Hypothesis	Obs	F-Statistic	Prob.	Direction of Causality
LNHE does not Granger Cause LNHDI	80	1.71769	0.1865	HDI → HE
LNHDI does not Granger Cause LNHE	80	2.75016	0.050	
LNIMR does not Granger Cause LNHDI	80	0.43368	0.6497	-
LNHDI does not Granger Cause LNIMR	80	0.42126	0.6578	
LNPOPG does not Granger Cause LNHDI	80	2.67109	0.0758	*POPG* → HDI
LNHDI does not Granger Cause LNPOPG	80	0.10313	0.9021	
LNIMR does not Granger Cause LNHE	80	1.01499	0.3673	
LNHE does not Granger Cause LNIMR	80	1.26545	0.2881	-
LNPOPG does not Granger Cause LNHE	80	2.30234	0.05	*POPG* □ HE
d LNHE oes not Granger Cause LNPOPG	80	2.39857	0.0478	
LNPOPG does not Granger Cause LNIMR	80	1.50797	0.228	IMR → *POPG*
LNIMR does not Granger Cause LNPOPG	80	2.37318	0.0501	

Source: Authors's Calculations (**) represents the significance of the test statistic according to the significance level of 5%.

The panel Granger's test results of Model 2 show unidirectional causality between HDI and Health expenditure. The null hypothesis of no causality from HDI to health expenditure is rejected at 5% level of significance but health expenditure doesn't Granger's causes HDI is accepted. The increase health expenditure automatically will not lead to human welfare rather other factors such as education should complement higher health spending to achieve human development. Population growth and HDI were found to have unidirectional causality with Population growth granger causes HDI at 5 % level of significance. IMR is found to granger cause the population growth at 10% level of significance. The population growth and health expenditure were found to have bi directional causality at 10% level of significance. IMR has unidirectional causality to population growth. The test results of other variables in Model 2 fail to reject the null hypothesis at conventional level of significance and therefore no causality between IMR and HDI and IMR and health expenditure.

In summary, the principle of Healthier is Wealthier and Wealthier is Healthier is found to be corroborated by the empirical results of Panel Granger's Causality Test of the study. The direction of causality goes from health expenditure to economic growth and from economic growth to Health expenditure as well. But the improved health expenditure may not necessarily cause the improved HDI. The other factors such as literacy rates should complement higher health spending to improve human welfare. The nations with better HDI scores are found to have higher Health care spending.

Panel FMOLS estimates

In the next step estimations of the long run relationship amongst variables are evaluated. Table 12 summarizes results of panel FMOLS estimates for the two models used in the study. The health expenditure has statistically positive impact on GDP per capita income in the long run. The coefficient is 0.011 which means that 1% increase in health expenditure will spur the GDPP growth by 0.011%. The coefficient of health expenditure in Model 2 with HDI as dependent variable is also significantly positive with the value of 0.32. It means that one unit increase in the health expenditure will improve the Human development index by 0.31 units. It is to be noted the effect of health expenditure is greater for improving human well-being of the countries. Thus the results indicate that an increase of expenditure on health is an important channel to improve the human well-being and economic growth. The results are in consonance with the empirical results of Hashmati (2001) that showed "positive relationship between health expenditure and economic growth for Organisation for Economic Co-operation and Development (OECD) countries". Eryiğit *et al*. (2012) [18] found the positive association between health expenditure and economic growth. From 1950 to 2005 in Turkey. The increase of health expenditure results into better health levels and improves the quality of the community for all nations. "These factors have direct and positive bearing on the better human well-being and spur the economic growth process of the economy in the long run".

Table 12: Panel FMOLS Estimates (Model 1 & Model 2)

	Model 1		Model 2	
Variable	Coefficient	Prob.	Coefficient	Prob.
LNHE	0.315851** (0.158554)	0.05	0.011493 (0.010869)	0.2936
LNPOPG	-2.96705*** (1.177198)	0.013	-0.07771** (0.025203)	0.0028
LNIMR	-0.06757 (0.514837)	0.896	-0.1722*** (0.022312)	0
R-squared	0.499212	2.493296	0.971694	-0.3892
Adjusted R-squared	0.415748	0.416461	0.969121	0.118125
S.E. of regression	0.318328	7.295945	0.020758	0.033177

The panel FMOLS results show the significant negative impact of population growth on economic growth and Human development index. The population growth increases consumption expenditure and results into low saving and reduction of investments and thus likely to slow down the economic growth process. The coefficient of IMR as health indicator with respect to economic growth and human development is found to be negative for both the models. The coefficient of IMR is significantly negative in the Model 2 with HDI as dependent variable indicating that 1 unit of fall in IMR will lead to 0.17 units fall in Human welfare. The results corroborate the findings of "Sahbudak and Sahin (2015) [37] of negative relationship between IMR and economic growth". However, the coefficient of IMR is negative but statistically insignificant in Model 1. So it can be concluded that the increased health expenditure with fall in IMR and population growth have positive impact on the long term economic growth and human welfare.

Conclusions

The study investigates the long-run and short-run relationship between selected health indicators (i.e. health expenditure, infant mortality rate) and economic growth and human development index using panel co-integration, Panel FMOLS and Panel Granger's Causality using panel data of BRICS countries using data from 2000-2017. The initial analysis shows the positive correlation between health expenditure as percentage of GDP and growth in GDP per capita and Human Development index. The co-integration tests reveal long-run relationship between health expenditure, IMR, population growth and economic growth and human development. The panel FMOLS provides the estimates in the presence of co integration amongst variables. The empirical results show the expenditure on health has significantly positive impact on the GDP per capita growth and HDI in BRICS countries. The study shows 1% increase in health expenditure will spur the GDPP growth by 0.011% and human development by 0.32 %. IMR and population growth are found to be negatively associated with development indicators (i.e. GDP per capita and HDI). The bi-directional causality is found between health expenditure and economic growth. It means wealthier nations can allow high level of health care spending and higher health expenditure is also significant for the economic growth trajectory of a nation. Improved economic growth helps in the advancement of healthcare facilities and fall of infant mortality rate. The unidirectional causality from HDI to health expenditure shows that a human development improvement causes improvement of health expenditure. The study provides the empirical evidence that the health expenditure spurs economic growth through human development and reduced health related risk. However, the impact of high health expenditure on economic growth is not automatic for developing nations. It (i.e. higher health expenditure) has to be complemented with improved other indicators of human well-being (HDI) such as education, per capita indicators, reduced health risk. Therefore, policies should be framed to increase health expenditure and promotion of Human development indicators such as education must be reinforced by the countries to stimulate economic growth.

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