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Social Environment Determinants of Life Expectancy in Developing Countries: A Panel Data Analysis

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Abstract

Despite remarkable improvements in health over the past 50 years, there still remain a great number of health challenges around the world. This study examined the relationship between life expectancy rate (as a proxy for health status) with health expenditure, gross domestic product, education index, improved water coverage, and improved sanitation facilities in 108 selected developing countries using annual panel data within the period of 2006–2010. The empirical results from using the panel data approach showed a positive relationship between life expectancy rate and all of those explanatory variables. The relationship between life expectancy with education index and gross domestic product were significant at 1% and 5% significance levels, respectively. Furthermore, the causality finding showed that there is no short-run causality between life expectancy and its determinants. There is a unidirectional causality running from the independent variables of health expenditure, education index, improved water, and improved sanitation to life expectancy at birth. On the other hand, bidirectional causality exists between life expectancy and income in the long-run by employing VECM test. These independent variables can be considered as important determinants for investment in health status in the long-run. This study could be used as a guideline and may be significant for future researchers and policy makers who aim to improve the life expectancy in developing countries.

Keywords: life expectancy rate, health, panel data, developing countries

1. Introduction

Even though there have been incredible improvements in global health over the past 50 years, an increasing number of health care challenges still need to be addressed. Globally, more than one billion people are unable to access health care systems; there are 36 million deaths a year from non-communicable diseases and over 7.5 million children under the age of five died from malnutrition or infectious diseases, such as AIDS or HIV, tuberculosis, malaria, and so forth. People in developing countries with higher poverty levels that could threaten their health status are more likely to get sick or suffer chronic illness, injuries of greater severity, emotional and attitude problems, and many other physical and mental health problems. Health issues have become critical because they are now perceived as crucial inputs for economic growth, reducing poverty, and achieving long-term economic development (Asafu-Adjaye, 2007; Smith, 1999).

Besides medical inputs such as the availability of general practitioners and the number of nurses, beds, and other medical inputs, the non-medical determinants of health such as income, health expenditure, education, personal health practice, and social and environmental issues are also crucial in maintaining good health and they might also directly affect the health of individuals. These non-medical factors are related to the way people are raised, their lifestyle, and how they overcome difficulties and unbearable circumstances that affect people of all ages including children, youths, and adults. People save money for future investment such as their health by taking medical insurance for its benefits. Thus, facilities such as hospital buildings and medical equipment alone cannot be assumed to be the determinants of health, whereas health care delivery system is also important to sustain health condition in some countries such as Canada (Clark et al., 1997). Life expectancy is widely used to gauge the health status of populations. It is a core social determinant in measuring the quality of life.

According to the Organization for Economic Co-operation and Development (2011), the life expectancy at birth is the predominant approach for measuring the health status of a population as well as evaluating the improvement in health status in each country. Countries with higher life expectancy tend to be associated with a better pattern of growth. In 2008, the country with the greatest life expectancy was Japan, followed by Hong Kong, Australia, Macao, Singapore, and New Zealand; the life expectancy in all these countries exceeded 80 years. In general, East Asian countries such as China, Japan, and Korea experienced greater life expectancies at birth compared to Southeast Asian countries such as Cambodia, Indonesia, Malaysia, Philippines, Vietnam, and Thailand, and South Asian countries such as India, Pakistan, and Bangladesh (OECD, 2011). The life expectancy varies greatly between the different countries around the world. Ususally, greater life expectancy is associated with higher income per capita, but this is not always the case as demonstrated in Figure 1, which shows that the association is less pronounced at higher levels of national gross domestic product (GDP) per capita. For instance, Sweden, Japan, and Great Britain have lower life expectancies than their GDP per capita. At individual level, both theoretical and empirical reasoning accepted the fact that richer residents have better health because they can afford better medical care, nutrition, sanitation, and housing to nurture good health.

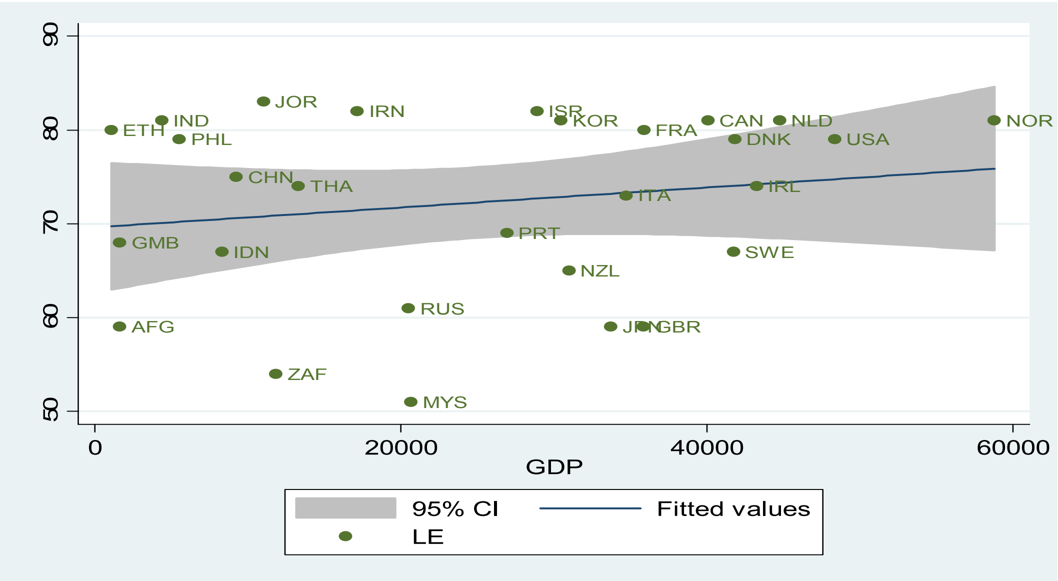

Figure 1. Scatter Plots of Life expectancy at Birth (Years) and GDP Per Capita (US Dollar Purchasing Power Parity) in 2010

Note. LE is life expectancy at birth, GDP is GDP per capita, and CI is confidence intervals. Retrieved data from World Bank (2013).

However, the relationship between life expectancy and per capita income is certainly not assured at aggregate level in comparison to developing countries such as Costa Rica and Cuba, which are considered to have high health status. Conversely, the USA is among the industrialized countries besides being the wealthiest country in terms of GDP per capita, but it was ranked to have lower health outcomes compared to many others (Starfield, 2000; Asafu-Adjaye, 2007). The considerable variation in life expectancy for a given level of income suggests that life expectancy may be influenced by other determinants. Thus, this study is interested to investigate the foremost factor that influences life expectancy, whether it is income, health expenditure, education, or improved water and sanitation.

Previous studies have found mixed results on the effects of population-level income, health expenditure, education, improved water, and sanitation on the health outcome across the countries. In low-income countries, Burnside and Dollar (1998) found that there was no significant association between health spending and change relating infant mortality. McCarthy et al. (2000) found that health expenditure had a negative effect on life expectancy in Africa. Preston (2007) found that the increase in income per capita was strongly associated with the increase in life expectancy as a proxy for health in poor countries. However, he also found that this relationship was weak or nonexistent when these poor countries achieved a higher level of income per capita. Thus, the relationship between health and income varies according to the level of development in the situation where people in poor countries are less healthy than those in richer countries.

In general, the investments in developing countries on improving water and sanitation are weak and inadequate compared to developed countries as they give more investments and have more sophisticated technology to sustain a good environment. This has resulted the drawbacks in the investment and innovation in water supply systems and sanitation facilities in these developing countries. Kumar and Vollmer (2012) reported that improved sanitation could reduce the risk of contracting diarrhea. However, there was heterogeneity in this association; the results showed that the effects of treatment were not statistically significant for girls or children with low or middle socioeconomic status. It has been recognized that rich countries with high income and health expenditure also have subgroups of the population with lower life expectancies e.g. Aboriginal Australians. Therefore, social issues and health literacy could also play a role.

This concern has raised two questions relevant to this study:

i) Is there any relationship between life expectancy and income, health expenditure, education, and improved water and sanitation in developing countries? If so, what is the directional causality?

ii) What are the major determinants that affect life expectancy in different regions?

Thus, the objectives of this study are as the following: 1) to analyze the relationship and causality between life expectancy (as an indicator of health status) and income, health expenditure, education, and improvements in water and sanitation; and 2) to ascertain the main factor that influences life expectancy rate at birth. This data were analysed by a panel data approach, and obtained from 108 selected developing countries over the period of 2006 until 2010.

The remainder of this paper is structured as the following: 1) Section 2 briefly presents the existing empirical literature on the topic; 2) Section 3 reviews the theoretical framework and describes the panel data analysis and data used; 3) Section 4 discusses the empirical results; and 5) Section 5 draws the conclusions, discusses the limitations, and offers recommendations for future research.

2. Literature Review

Numerous previous studies have shown interest in contemporaneous health factors by conducting a vast number of experiments to clarify this field.

Only a small handful of studies that have examined the socio-economic determinants of health including environmental factors, and most of these studies either focused on one factor or discussed the factors separately. For instance, Kabir (2008) attempted to analyze the socio-economic determinants of life expectancy for 91 developing countries by using multiple regression and probit regression model which are commonly used to analyze binary variables. He found that almost all independent variables such as per capita income, education, health expenditure, access to safe water, and urbanization, ended up being statistically insignificant, which indicated that pertinent socio-economic factors are not always significant in determining the life expectancy of the people in the selected developing countries. Consequently, the present study utilized a different methodology by using panel data analysis to determine the importance of income, education, health expenditure, improved water, and improved sanitation in influencing health status.

As discussed earlier, residents of rich countries with high income and health expenditure have a higher quality of life than residents of poor countries. According to Kirkwood (2008), there is a strong positive correlation between life expectancy and income in developed countries. Bulled and Sosis (2010) found a positive correlation between life expectancy and GDP globally. For that reason, it is reasonable that income should be an important determinant of demand for health in developing countries as well.

Inequity in health care financing systems is also a problem as there is the tendency for variation in health spending between rich and poor countries. The disparity becomes a problem when this indicator shows a trend between different countries in influencing health. Many previous studies have used child mortality and mortality rate indicator as a proxy for health. Anyanwu and Erhijakpor (2007) found that health expenditure had a significant effect on infant mortality and there were less than five mortality in 47 selected African countries between 1999 and 2004. In contrast, some studies that analyzed health expenditure did not find any impact on health indicators after adjusting other factors; for example, Musgrove et al. (2005) found that the total spending on health did not affect the mortality rates. In contrast to those studies, the present study utilized life expectancy as an indicator of health outcomes.

Education and health are the two most important investments in human capital. Education has been recognized for its basic role in health status via its investment in human capital, which can induce changes in societies as well as promote the development of reform in many countries. Many economic findings have shown a strong positive relationship between health and education; this is consistent with studies by Chen and Li (2009), Lange (2011), and Tenn et al. (2010). Bulled and Sosis (2010) studied the relationship between life expectancy, reproduction, and educational attainment in 193 countries according to UNESCO world regions. Grossman (1975) found that education was also seen as helpful in increasing the efficiency of health production. Groot and Brink (2007) also have found that individuals' level of education, which is also described in terms of the number of years of education, has a positive association with health status. However, most of these studies were conducted in richer countries rather than lower income countries.

The access to safe drinking water and sanitation are crucial in most countries. In general, investment in developing countries in improving water and sanitation remains low and inadequate compared to developed countries which have higher investment and more sophisticated technology to sustain a good environment. This has resulted the drawbacks in investment and innovation of the water supply system and sanitation facilities in these developing countries. Water and sanitation have played an important role in health status in Khorezm and Uzbekistan; This is because, contamination in drinking water and lack of awareness about sanitation as well as the lack of hygiene in this area have led to health problems such as fecal-oral diseases and diarrheal disease in particular (Herbst et al., 2012). Checkley et al. (2004) discovered that a better water coverage is associated with a higher level of improved sanitation, which could lead to a fully improved condition of health. The improvement of both water and sanitation can reduce fecal contamination. Howard and Bartram (2003), Kumar and Vollmer (2012), and Peter (2010) have all noted the importance of good water supply, sanitation, and hygienic environment in the societies.

The reviews of several previous studies have suggested that only a few researchers argued that education, income, health expenditure, improved water coverage, and improved sanitation would have an impact on health across different countries. The relationship may be weak or insignificant compared to these determinants of health. The reason that the empirical evidence for the determinants of health has provided conflicting results may be due to the different methodologies used. With regard to the developing regions, most studies did not have to look far to discover evidence for a variety of social environmental determinants of health in less-developed countries jointly, rather than focusing on individual countries separately. For that reason, this study intended to contribute by establishing the main determinant that influences life expectancy across 108 developing countries and identifying the exact relationship. Ultimately, the results will help future researchers regarding all the health care challenges encountered by developing countries.

3. Data and Methodology

3.1 Theory Review on the Concept of Demand for Health Capital

The demand for the health model was developed by Michael Grossman (1972) as an explanation of the demand for health and health care. He constructed a model of the demand for health in terms of better health and solved the complex problems concerning the optimization of the health lifecycle, the gross investment for each period, and the consumption of health care, which are seen as derived demands for health. His model concentrated more on health and investment in health, enabling a thorough understanding on the role of several variables such as age, education, and income in health production through the demand for health capital.

In Grossman's model, health is treated as an endogenous variable that people could improve through consumption and production. In addition, health is also considered to be a capital stock because it depends on time or the age of an individual and it is said to depreciate as people age. In the concept of health, the production function is health inputs such as health care, diet, environment, income, time, and other variables together with health capital stock over time in order to produce good health.

In the present study, the model is based on an example of Grossman's health model in producing health investment and other inputs of health. Thus, in this paper, the production function of health is related to the function of health expenditure, income, education, improved water, and improved sanitation which are laid out in Grossman's original health model in producing health investment and other home goods such as leisure activities and entertainments. In his model, Grossman found an increase in wage rates and education; the outcome of healthy days increased with higher optimal health stock. Similarly, when the determinants included in the present study–

education, income, health expenditures and the two environmental factors of improved water and sanitation–are considered as an investment in health. Conceptually, the increase in these explanatory variables will lead to the increase in life expectancy rate as health stock. This implies that the level of health is greater with a greater income, higher education level, increased health expenditure, greater availability of clean water, and better sanitation, which lead to the improvement of efficiency in health production.

3.2 Theoretical Model Specification

By applying Grossman's health model (1972) in producing health investment, the present study attempted to include two environmental factors (improved water coverage and sanitation) together with the other socioeconomic factors (income, education, and health spending) that may influence life expectancy, which are used to indicate health status. Asafu-Adjaye (2007) stated that an individual's health is determined not solely by his/her income, but also by income inequality in the population. Thus, the present study considered the following to be the generalized health production function:

$$LE_t = I_t\ (GDP_t,\ EDUC_t,\ HE_t,\ IWC_t,\ ISF_t \tag{1}$$

Where, LE_t indicates the life expectancy at time t, I_t is the investment in health, GDP_t is the gross domestic product, $EDUC_t$ is the education index, HE_t indicates health expenditure, IWC_t is improved water coverage, and ISF_t is improved sanitation facilities. All these variables were estimated in the following section for the period 2006 to 2010.

The natural logarithm (l) of this multiplicative form is used to stabilize the value of the time series data from the equation (1), the model can be expressed as in this form:

$$lle = \beta_0 + \beta_1 lhe + \beta_2 lgdp + \beta_3 leduc + \beta_4 liwc + \beta_5 lisf + \varepsilon_t \tag{2}$$

β_0 refers to the intercept of the regression line and β_1 to β_5 are the coefficients for each variable and ε_t indicates the residual. The natural logarithm transformation of the series also effectively linearizes the exponential trend. As the effect, the model implies a log-normal and not a normal distribution. The rationale behind the transformation into the natural log model is that this transformation compresses the scale so that the difference between the two values is smaller than the original values, thereby reducing heteroscedasticity.

3.3 Data Sources

In this study, the data used were life expectancy rate at birth, health expenditure, education index, gross domestic product, improved water coverage, and improved sanitation. This study has analysed the annual data for the period of five years from 2006 until 2010 in 108 selected developing countries that were chosen due to the disparities in social environmental factors between these countries and also the availability of the required data.

These secondary data were collected from various sources such as the data for life expectancy rate at birth (years), health expenditure per capita (current U.S. dollar), and gross domestic product per capita (Note 1) provided by the World Bank's website. Improved water coverage (%) and improved sanitation facilities (%) data were obtained from the WHO/UNICEF Joint Monitoring Program (JMP) website. The education index data (Note 2) were obtained from the Human Development Index (HDI) website.

3.4 Panel Data Analysis

To meet the objectives of this study, the large cross-sectional data were obtained using the panel data methodology. The estimation of panel data models is generally considered to be an efficient inferential method of handling a combination of cross-sectional and time series data. Panel data analysis has become popular among social science researchers because it allows the enclosure of a sample for N cross-sectional units such as countries, households, firms or individuals, with T different time periods such as yearly, monthly, and quarterly. The association of panel data consists of time series of each cross-sectional member in the dataset, proposing a variety of estimation methods. A principle specification panel data model can be modeled as the following:

$$lle_{it} = \alpha + \beta_1 lhe_{it} + \beta_2 lgdp_{it} + \beta_3 leduc_{it} + \beta_4 liwc_{it} + \beta_5 lisf_{it} + u_{it} \tag{3}$$

$$u_{it} = \mu_i + v_{it} \tag{4}$$

$$lle_{it} = \alpha + \beta_1 lhe_{it} + \beta_2 lgdp_{it} + \beta_3 leduc_{it} + \beta_4 liwc_{it} + \beta_5 lisf_{it} + \mu_i + v_{it} \tag{5}$$

i is the cross-sectional dimension or unit of observation such as households, firms, and countries ($i = 1, 2, \ldots, N$), t refers to the time series dimension ($t = 1, 2, \ldots, T$), and μ_i denotes individual specific unobservable effects. This is constant across individuals, which means that, if μ_i is correlated with any explanatory variable, the regression could estimate a dependent variable, LE_{it} with any explanatory variables, whether HE_{it}, GDP_{it}, $EDUC_{it}$, IWC_{it}, and ISF_{it}, will be a constraint on heterogeneity bias. v_{it} denotes remainder or idiosyncratic disturbances, and u_{it} denotes a composite error term. The coefficients and intercept do not have *i* or *t* subscripts, which mean that they are assumed to be the same for all individuals in all-time series and do not allow the possibility of heterogeneity among individuals.

3.5 Granger Causality Test

This method is used to examine the causal links between the life expectancy rate at birth with health expenditure, gross domestic product, education index, improved water coverage, and improved sanitation facilities by applying Vector Error Correction Model (VECM) and Wald Test in panel data. This study used panel unit root tests, Kao Residual Cointegration test, Vector Error Correction Model, and Wald Test to allow a cross-sectional dependence among the panel data. Panel unit root test is needed at the first step to identify whether all the variables are stationary. In this paper, we conducted ADF & PP Fisher, and Levin, Lin, and Chu test by using the EViews 9. After that, we applied Johansen Fisher Panel Cointegration to test the existence of cointegratio. Hereafter, based on the existence of a cointegration relationship result, the direction causality between dependent and independent variables can be determined by Vector Error correction (VECM). The coefficient, that is indicated as C(1) in Error Correction Term (ECT) should be negatively significant to determine if there is long-run causality between dependent and independent variables. Finally, Wald test can be used to analyse short-run causality.

4. Results and Discussion

4.1 Descriptive Statistic Analysis

Based on the statistic test results obtained from Table 1, the six variables were logged in the analysis of variance test to stabilize the value of the time series data. The mean value indicates the average for each variable. Overall, the highest mean was improved water coverage (8.9336), followed by improved sanitation facilities (8.4937), gross domestic product (8.175), health expenditure (4.7273), and life expectancy (4.1646); the education index had a negative value of −0.6585. The chi-square test (X^2) is a statistical test to check for deviations of observed frequencies from expected frequencies. The *p*-value for the chi-square test was 0.000 ($< \alpha = 0.01$) for some variables such as life expectancy indicator, health expenditure, and education index. This chi-square value also reflected the contribution of these independent variables to the dependent variable, i.e., life expectancy.

Table 1. Descriptive Statistics

Characteristics	**lle**	**lhe**	**lgdp**	**leduc**	**liwc**	**lisf**
Mean	4.1646	4.7273	8.175	−0.6585	8.9336	8.4937
Maximum	4.3915	7.4408	11.1534	−0.0683	14.016	13.6699
Minimum	3.7975	2.1198	5.6497	−1.8971	4.625	3.6376
Standard deviation	0.1559	1.2416	1.108	0.3791	1.7115	1.8014
Skewness	0.0000***	0.0286**	0.0526*	0.0000***	0.1327	0.2233
Kurtosis	0.0000***	0.0000***	0.0208**	0.3027	0.0258**	0.9097
Adjusted chi^2	66.81	68.50	8.62	43.72	7.08	1.50
p-value for chi^2	0.0000***	0.0000***	0.0134**	0.0000***	0.0290**	0.4722
Observation	540	540	540	540	540	540

Note. lle = ln life expectancy; lhe = ln health expenditure per capita; lgdp = ln gross domestic product per capita; leduc = ln years of schooling; liwc = ln improved water coverage and lisf = ln improved sanitation facilities. The asterisks *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

The *p*-value for the gross domestic product variable was 0.0134 ($< \alpha = 0.05$ significance level, i.e., at 95% confidence level) and 0.0290 ($< \alpha = 0.05$ significance level) for improved water coverage. The descriptive statistical analysis test of the skewness of variables showed that all the variables – life expectancy, health expenditure per capita, gross domestic product per capita, education, improved water coverage, and improved sanitation had positive values, and they were skewed to the right.

4.2 Empirical Approach Analysis

4.2.1 Panel Analysis

The estimation results in Table 2 were obtained in order to fulfil the objectives of this study. The estimation model for the relationship between life expectancy (lle) and health expenditure (lhe), gross domestic product (lgdp), years of schooling (leduc), improved water coverage (liwc), and improved sanitation facilities (lisf) can be estimated as the following:

Table 2. Summary of the results for pooled ordinary least squares (ols), random effects, and fixed effect robust models

Variables/Tests	**Pooled OLS**	**Random Effects**	**Fixed Effects Robust**
Constant	3.762	3.69	3.221
lhe	−0.024	0.008	0.004
lgdp	0.076	0.037	0.036
leduc	0.132	0.182	0.136
liwc	−0.06	−0.003	0.064
lisf	0.061	0.033	0.017
Breusch–Pagan LM test	1059.55***		-
Hausman test	-	56.06***	
Observations, *N*	540	540	540
Number of countries, *i*	108	108	108
Wald Test for Heteroscedasticity	-	-	1.5e+05***
Prob > F(5,107)	-	-	63.72***

Note. N is 108 countries and T is 5 years (2006–2010). The asterisks *** indicate the p-value was significant at the 1% level.

Table 3. Results of the Fixed Effects Robust Estimation

$$\underset{\substack{(0.223)\\[14.46]^{**}}}{\text{lle} = 3.221} + \underset{\substack{(0.004)\\[1.19]}}{0.004\text{lhe}} + \underset{\substack{(0.013)\\[2.88]^{*}}}{0.036\text{lgdp}} + \underset{\substack{(0.031)\\[4.35]^{**}}}{0.136\text{leduc}} + \underset{\substack{(0.042)\\[1.54]}}{0.064\text{liwc}} + \underset{\substack{(0.031)\\[0.54]}}{0.017\text{lisf}}$$

Note. lle = ln of life expectancy, lhe = ln of health expenditure per capita, lgdp = ln of gross domestic product per capita, leduc = ln of years of schooling, liwc = ln of improved water and lisf = ln of improved sanitation. Values in parentheses ( ) show robust standard error. Values in square brackets [ ] refer to t statistics. The asterisks * and ** denote the significance at the 5% and 1% levels, respectively.

Table 3 shows the results for the estimation of the fixed effects model after adjusting for the robustness of the model involving life expectancy at birth as the dependent variable with the function of the independent variables for health expenditure per capita, gross domestic product per capita, years of schooling, total improved water coverage, and total improved sanitation facilities. All variables were in the natural log form, allowing analysis of changes in explanatory variables to the changes in a dependent variable. This means that these coefficient variables have been log-transformed to indicate elasticity values.

The estimation of a regression model is referred as a deterministic model, where the value of the constant coefficient β_0 is the y-intercept of the model; this value was positive, which has no viable economic interpretation. As expected, the estimated coefficients β_1 to β_5 were positive, indicating that the increase in the corresponding explanatory variables will lead to the increase in life expectancy at birth. However, the t statistic values showed that only two variables, years of schooling and gross domestic product, were statistically significant at the 1% and 5% levels, respectively. The remaining variables (health expenditure, and improved water and sanitation) were statistically insignificant, indicating that these factors were not consistently dominant in influencing life expectancy in developing countries.

In order to decide whether to choose the pooled ordinary least squares (OLS) or random effects model, the Breusch and Pagan Lagrangian Multiplier (LM) test were used to test the existence of random effects underlying the pooled OLS model. The pooled OLS model assumed that there was no correlation between the error terms, and there was no difference between the cross-sectional and time series.

H_0: $\sigma^2_\lambda = 0$ (pooled OLS model is preferred)

H_a: $\sigma^2_\lambda > 0$ (random effect is preferred)

As shown in Table 2, the null hypothesis could be rejected because the *p*-value of 0.0000 was less than the 1% significance level. In conclusion, the random effects model was more appropriate than the pooled OLS model, indicating that there was variation between or within countries in the error term and it also showed highly significant differences between countries.

The Hausman test was used to address the country-specific effects.

H_0: Cov $(\lambda_i, X_{it}) = 0$ Random effects model is preferred

H_a: Cov $(\lambda_i, X_{it}) \neq 0$ Fixed effects model is preferred

According to this result, the null hypothesis can be rejected because the *p*-value of 0.0000 is less than the 1% significance level. In conclusion, the fixed effects model is the most appropriate model to be accepted rather than the random effects model. The chi-square test gave highly significant results. The null hypothesis showed that there was no correlation between the error term and all the regressors. In this case, the null hypothesis was rejected when the chi-square value was significant at the 1% level (or at a confidence level of 99%), with the *p*-value of 0.000, being less than 0.01.

From the results in Table 2, the null hypothesis was rejected because the *p*-value of 0.0000 was highly significant, and less than the value of significance of 0.01. As a conclusion, there was a heteroscedasticity problem in the model, or it could be said that the model was not homoscedastic. To correct the heteroscedasticity within this model, the robust test was used in the fixed effects model. The final test for the robustness of the fixed effect results concerning the impact of unobservable heterogeneity such as the impact of time preferences, the effect on life expectancy of health expenditure, gross domestic product, education index, and improved water and sanitation.

4.2.2 Causality Test

Table 4. Panel unit root test at level and first different

Variables	**Unit Root Test (ADF & PP Chi-square)**	
	Level, I(0)	First Difference, I(1)
lle	1.0000	0.0000***
lhe	1.0000	0.0000***
lgdp	1.0000	0.0000***
leduc	1.0000	0.0000***
liwc	1.0000	0.0000***
lisf	1.0000	0.0000***

Note. The asterisks *** denote the significance at the 1% levels.

Table 5. Panel cointegration, short-run, and long-run causality test

Model	Causality Direction		Kao Residual Cointegration Test	Short-Run Causality	Long-Run Causality (ECT)	
	Dependent Variable	Independent Variable	H_0: No Cointegration	(Wald Test) C(4) = C(5) = 0	Coefficient, C(1)	Prob.
1	D(lle)	D(lhe)	0.0471*	0.3351	-0.0061	0.0000**
2	D(lhe)	D(lle)	0.0000**	0.0681	-7.26E-05	0.9480
3	D(lle)	D(lgdp)	0.0304*	0.7583	-0.0047	0.0000**
4	D(lgdp)	D(lle)	0.0000**	0.7541	-0.0033	0.0222*
5	D(lle)	D(leduc)	0.0000**	0.9795	-0.0075	0.0000**
6	D(leduc)	D(lle)	0.0000**	0.5680	-8.11E-05	0.7771
7	D(lle)	D(liwc)	0.0000**	0.5587	-0.0071	0.0000**
8	D(liwc)	D(lle)	0.0000**	0.4254	7.48E-05	0.3695
9	D(lle)	D(lisf)	0.0000**	0.7929	-0.0075	0.0000**
10	D(lisf)	D(lle)	0.0000**	0.6575	-0.0001	0.1834

Note. The asterisks * and ** denote the significance at the 5% and 1% levels, respectively.

Table 4 and 5 present the results of panel unit root test data, Kao Residual Cointegration test, and VECM causality analysis, respectively. The results reported that all variables are stationary at first difference, and cointegrated at significant at the 5% and 1% level, respectively. Therefore, VECM can be run in order to find long-run causality between dependent variables and independent variables from coefficient, C(1) or also known as Error Correction Test (ECT). The findings showed that there is long-run causality for most of the models (except for model 2, 6, 8, and 10). This means that all health determinants are granger cause to life expectancy in the long-run, and there would be the speed of adjustment toward long-run equilibrium. When assigning lhe, leduc, liwc and lisf as dependent variables, there is no long-run causality running from the life expectancy as the independent variable to these dependent variables. In this regard, life expectancy does not granger cause to all factors (except GDP) in the long-run. In the case of determining the short-run causality, Wald test was adopted. The result displayed that there is no short-run causality for all models.

5. Conclusion

In conclusion, the estimated results revealed that all the explanatory variables representing health expenditure, gross domestic product, education index, improved water coverage, and improved sanitation in the 108 developing countries had positive coefficients, which indicated that all these variables have a positive relationship with life expectancy. The results are consistent with the theory and in line with most of the earlier studies such as Grossman (1975), Corman and Grossman (1985), Gilmore et al. (2002), Grundy and Sloggett (2002), Wildman (2003), Lleras-Muney (2005), and Adams (2002), which produced compelling results in observing a causal relation between education and health. Furthermore, the fixed effects robust estimation results of the present study showed that the major determinant of life expectancy in developing countries was an education index measured as years of schooling with high statistical significance at the 1% level. This was followed by gross domestic product as a proxy for income, that have a highly significant effect on life expectancy at the 5% level. These results suggested that both the education index and gross domestic product can be considered to be important for investment in health. The results also suggested that an individual will spend according to what they can afford and what they know and acknowledge as the best for their health. Silles (2009) found a strong positive relationship between health and years of schooling. Kemptner et al. (2011) found a strong causal effect for years of schooling on long-term illness as a proxy for health among men.

In addition, many parents in the developing countries do not have enough money and have small budgets to buy and provide adequate nutrition to their family members, which resulted them to suffer from poor diet for short or long term. The level of income is not just a factor for good health, but it is also indicated for other determinants such as high self-esteem and a positive outlook on life, which can both affect an individual's life. Swift (2010) stated that both total GDP and GDP per capita showed significant effects on life expectancy for most countries, indicating that an increase in income will lead to improvement in health. On the other hand, the empirical findings in this study showed that health expenditure and improved water and sanitation did not have a significant impact on life expectancy at birth. Thus, those three variables are not important to be included in this model, and they are not important to be considered as determinants of demand for health. The result of the relationship between health expenditure as an investment in health and life expectancy was consistent with the previous studies where there was a positive but statistically insignificant relationship between health spending and health outcomes (Filmer and Pritchett, 1999), and (Thornton, 2002). Savedoff (2007) found that health status was not strongly related to the level of health spending when other kinds of spending were considered. Kabir (2008) showed that access to safe water turned out to be insignificant. The empirical findings also showed the long-run unidirectional causality running from independent variables of health expenditure, education index, improved water and improved sanitation to life expectancy, and long-run bidirectional causality between life expectancy and income.

5.1 Limitations and Policy Implications

This study has some limitations that should be considered. It was limited by the data sample. The period for the time series data was constrained as several data for some countries were missing variables over long periods. The data from the World Bank, UNDP, and WHO/UNICEF did not seem to have long periods for all variables; in fact, the data on health expenditure and GDP per capita were available without missing variables from 1995 to 2011 for most developing countries except Sudan and Myanmar. However, the data for education index and improved water and sanitation were not fully available with many missing variables for most developing countries, especially Africa. Hence, the data for all variables without many missing points were only between 2005 and 2010. This issue could affect the estimations and result to be poor in terms of accuracy and findings.

Another limitation was the estimation equations by utilizing data from many countries by assuming similar health production functions across the developing countries. However, this assumption may not be appropriate for all countries chosen in the sample because some countries have shown rapid increase for the growth of these determinants over time. Although some countries showed similar patterns in health expenditure per capita, income, years of schooling, improved water, and improved sanitation, there were variations found on the factor that actually leads to the improvement in health status at the country level. Future studies could consider employing a combination of qualitative and quantitative methodology to observe the behavior of future trends besides improving the current study.

This study was also unable to include some important factors that determine better health such as individuals' behavior on nutrition, health care input, age, and other determinants due to the unavailability of these data in terms of time series data. This limitation could be seen when the fixed effects robust estimation model showed an intercept value that was highly significant. The high significance of the constant value in the model implies that other important determinants have not been included in the model. Hence, future research could improve this study by including other important variables that influence health status by obtaining the data through surveys. The limited time of the present study has made it impossible to conduct such a survey to obtain more accurate data. In the future, other methodology such as qualitative approach could be considered to estimate non-numerical variables.

Relating the policy implications, this study has discovered a number of important implications for future practice. More research is necessary to fully understand the interactions between proxies for health and factors that lead to health investments. Undoubtedly, a clearer understanding of these issues can also improve the design of economic, health, and environmental policies in promoting health in the long-run. More information on nurturing behaviors to promote adult and child health and nutritional well-being are also needed, particularly for low-income environments. Additionally, when people can gain better income from better education, they can use their income to spend on health care. Mushkin and Weisbrod (1963) and Grossman (1972) stated that health is a human capital when the investment in health could lead to better economic growth for one country especially for developing countries that are categorized as underdevelopment of economy.

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Competing Interests Statement

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Notes

Note 1. Converted to international dollars (base year is 2005) and measured based on purchasing power parity (PPP)

Note 2. Measured using mean and expected years of schooling among adults and children.

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