

Impact of Life Expectancy on Economics Growth and Health Care Expenditures: A Case of Bangladesh

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Abstract Life expectancy is one of the major key indicators of population health and economic development of a country. The main objective of this study was to determine the impact of life expectancy on changes of economic growth and health care expenditure. We also examined trend of life expectancy according to the sex difference. We used multiple regression models to estimate the impact of life expectancy on economic growth and health care expenditure. Elasticity of life expectancy on health care expenditure and economic growth is also estimated. Results show greater life expectancy of females compared with the males over the past 15 years. The higher Gross Domestic Product (GDP) per capita was observed in a longer life expectancy. i.e., one US Dollar (USD) increment in GDP per capita will increase in an average of life expectancy by 33 days. Similarly, increased one unit of per person Health Expenditure Per Capita (HEPC) will increase the life expectancy in an average of 8 days in a year. The higher proportion of total expenditure on health as a percentage of GDP and direct personal expenditure on health by household as a share of private expenditure on health results in also longer life span. We conclude that the increased life expectancy has direct impact on increased per capita real income and higher expenditure on health. This study has some policy implications for Bangladesh, in particular the needs for increased per capita real income and planning for future health and population policies/programs. Therefore, political stability, adequate and suitable social sector policies and government interventions are required to increase life expectancy and economic growth in the country. There is also a need for involvement of health human force in macro and micro policy-makings and critically examine other determinants of health care expenditure.

Keywords Life Expectancy, GDP, HEPC and Regression Analysis

Life expectancy is one of the major key indicators of population health condition and economic development of a country. In most countries worldwide, the life expectancy of people at birth has increased over the last few decades. Evidence shows that improvement in health and welfare increases life expectancy. According to the World Bank report 2011, Life expectancy of Bangladeshi population ranks 103th for males and 128th for females out of 193 countries in the world [1]. People of countries with poor health and development indicators live shorter s than those of the rich nations [2]. Among the developed countries variations in the average life expectancies are not so high, but there are differences that cannot easily be explained by reference to economic prosperity. People of developed regions in general have higher life expectancies than people of low and middle income countries. By sex, females in general have longer life expectancies than men. For example, in United State, the female life expectancy increased from 78.0 years in 1985 to 80.9 years in 2010, while male life expectancy increased from 71.0 years in 1985 to 76.3 years during the same duration [3]. Currently, people of Japan have the longest life expectancy at birth worldwide. In upper middle income countries like South Africa, the life expectancy at birth is 60 years. As such a newborn living in upper middle income countries can expect to live 44 years free from disability, which is 31 years less than the one in Japan. To the best of our knowledge, there are limited number of studies that have been conducted in Bangladesh, which examined the impact of life expectancy at birth on the economic change and health care expenditure. Some studies assigned to consider potential determinants of life expectancy. The previous studies of the cross country analyses have demonstrated that health condition leads to economic growth [4-6].

The study by Acemoglu & Johnson (2007) showed relationship between increased life expectancy and improvement in economic growth (measured through Gross Domestic Product (GDP)/capita), controlling for country fixed effects [7]. The Researchers' estimations are evident for only a minor (but statistically insignificant) downward

1. Introduction

trend between life expectancy and GDP per capita, indicating that countries with greater declines in mortality (hence increased in life expectancy) may have a slight decrease in GDP per capita.

A previous study conducted in Bangladesh, Husain (2002), examined that most of the important determinants of life expectancy which look at cross-section determinants within multiple Ordinary Least Square (OLS) regression structure both in linear and log-linear models [8]. This study showed most of the study variables statistically significant, both in linear and log-linear models. The available literature suggests that the leading determinant of the life expectancy is economic growth (income level). The data available from the World Bank [9] showed that there was a strong association between real terms of income predicted by GDP per capita and life expectancy among the people of under developed countries. It observed that the lower per capita GDP, the shorter life expectancy. But on the other hand, a study by Wilkinson et al. suggested that once countries attain some threshold level of income, such as increase in per capita GDP can no longer be associated with the increased life expectancy [10]. A study by Rogers et al. (2000), which examined a theoretical framework of the association between economic growth and life expectancy in developed region identified that the life expectancy rises at a declining rate as income increases [11]. Similarly, a study by Kambiz et. (2011), which evaluated means of time series data over 2001-2009 found the relationship between health and economic growth in Organization Islamic Conference member states [12]. This study established increased life expectancy led to the economic growth in the member countries.

The impact of life expectancy on economic growth and health care determinant has been well established at the individual level. From a theoretical perspective, there are multiple channels through which life expectancy affects economic growth [13]. Firstly, healthier individuals increase their incomes by being more productive, physically more energetic and mentally more robust. A second mechanism for improved economic development is through increased saving. As people live longer, they will tend to invest more in their retirement. For example, a 10 year increase in longevity is shown to lead to a 4.5% rise in savings [5]. Thirdly, the improved health status of people can lead to increased economic growth through increased education levels. The healthier people tend to invest more in their skills development in order to earn higher wages than the less healthy people. In addition, a healthier child can attend school, learn more and have higher cognition than the non-healthier one.

Having discussed the evidence available and the gaps identified in terms of life expectancy and health care as a potential determinant, in this study, we examine the impact of life expectancy on changes in economic level and health care expenditure. We also examine the trend of life expectancy according to the sex difference over the study period of 1995-2011.

2. Methods

In this study, we intend to estimate at what magnitude of life expectancy change as a response to changes in determinants of health care expenditure. Average association and elasticity of life expectancy on health care expenditure and economic growth is therefore estimated using multiple regression analyses. Data and estimation techniques are explained below.

2.1. Data and Variable

This study analyzed annual time data from Bangladesh during the period of 1995 - 2011. This provides complete set of information to meet the objective of this study. The data on determinants of health care expenditure used in this analysis were sourced from the World Development Indicators [14]. In this study, life expectancy was predicted by national income (per capita GDP at US dollar and at constant price), GDP per capita, PPP (constant 2005 international US\$), health expenditure per capita, PPP (constant 2005 international \$), public health expenditure (% of GDP), total health expenditure (% of GDP), public health expenditure (% of government expenditure), public health expenditure (% of total health expenditure), out-of-pocket health expenditure (% of total expenditure on health) and out-of-pocket health expenditure (% of private expenditure on health). The analysis was performed using Stata statistical software, version- 12 [15].

2.2. The Estimation Strategy

To examine the relationship between life expectancy at birth on determinants of health care expenditure, multiple regression analysis was utilized. The underlying multiple linear regression models corresponding to each variables

$$y = \alpha + \beta_i x_i + \varepsilon \quad (1)$$

where y is the response variable (life expectancy at birth), x_i ($i= 1, 2, 3, \dots, k$) are the predictor variables (inter parameter measurements), β is the regression coefficients, and ε is the error term with an $N(0, \sigma^2)$.

3. Results

The descriptive statistics such as average, standard deviation (SD), and number of observations (on the basis of which the statistics were calculated) are presented in Table 1.

The average life expectancy was about 65.88 years (SD 2.167 years). The health expenditure per person and GDP Per capita were about US\$36.64 (SD US\$15.28) and US\$1102.43(SD US\$230.87) respectively. Also, the averages of public health expenditure as a share of GDP were about 1.22 % (SD 0.087%).

3.1. Trend Analysis

Figure 1 shows the relationship between income level and life expectancy over the study period. The GDP Per capita was exponentially increasing tendency and also slightly increasing life expectancy. Figure 2 shows difference in the trend of life expectancy by sex. The female life expectancy in Bangladesh increased from 62.01 years in 1995 to 69.68 years in 2011, while male life expectancy increased from 62.23 years to 68.23 years during the same period. The average of public health expenditure as a share of government expenditure and total health expenditure were about 8.37% (SD 0.616 %) and 37.73% (SD 2.25%) respectively. Average GDP per capita (constant 2005 US

dollar) was also about US\$ 1102.429 (SD US\$ 230.87). The average out-of-pocket health expenditure as a share of private expenditure on health and total expenditure on health were about 96.11 % (SD 0.403%) and 59.85% (SD 2.298%) respectively. The male life expectancy was more than female in 1995 to 1997 but after 1999, the reverse figure was observed, hence, female life expectancy continued longer than male. The gap between male and female was 0.22 years in 1995, narrowing to 1.45 years in 2011. By years, the distance of gap was continuously larger. The slower rate of yearly improvement in female life expectancy by 0.4777 times, total by 0.4272 times and male by 0.3791 times but female was 0.0986 times more than males.

Table 1. Results of Descriptive Statistics

Variables	Mean	Std. Dev.	95 % CI for Mean		Minimum	Maximum
			Lower bound	Upper Bound		
Total Life Expectancy	65.88	2.167	63.88	67.95	62.123	68.94
GDP Per Capita , PPP (Int. \$ 2005)	1102.43	230.87	1100.32	1530.65	813.35	1544.80
Health expenditure per capita, PPP (constant 2005 int. \$)	36.64	15.22	35.24	61.52	20.421	67.27
Public Health expenditure (% of GDP)	1.22	0.09	1.05	1.35	1.098	1.36
public Health expenditure (% of government expenditure)	8.37	0.62	8.12	8.95	7.352	9.67
Public Health expenditure (% of total health expenditure)	37.73	2.25	36.21	39.85	34.389	42.30
Total Health Expenditure (% of GDP)	3.24	0.35	3.11	3.67	2.734	3.72
Out-of-pocket health expenditure (% of private expenditure on health)	96.11	0.40	93.56	96.52	95.128	96.62
Out-of-pocket health expenditure (% of total expenditure on health)	59.85	2.29	52.36	61.52	55.396	63.33

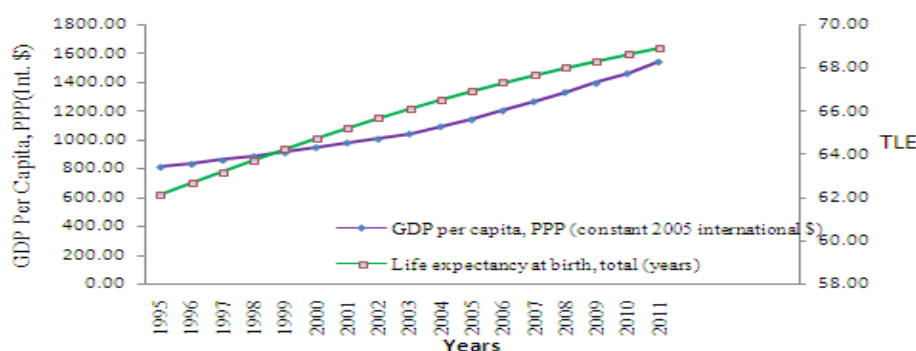


Figure 1. Change in economics level and corresponding change of total life expectancy

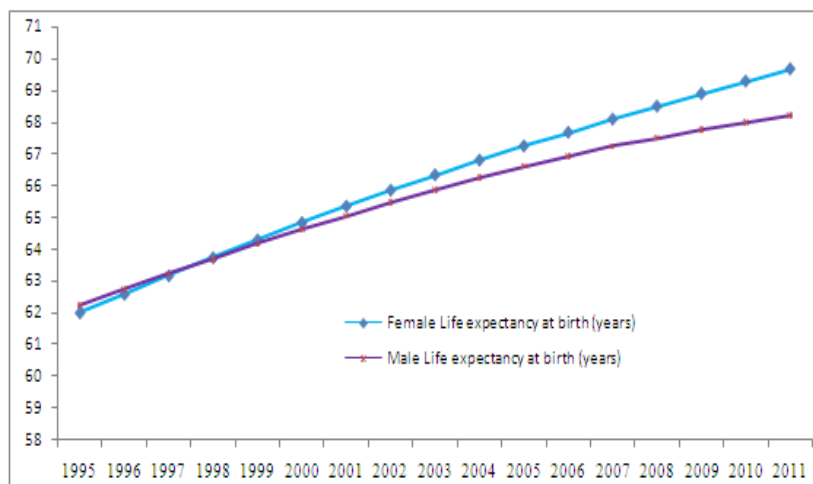


Figure 2. Trend of life expectancy at bir

Table 2. Result of Trend analysis

Variable Name	Equation	Coefficient	R ² -value	P-value
Total Life Expectancy (TLE)	$TLE = 62.04 + 0.4272 * year$	0.4272**	0.9913	0.053
Life Expectancy for Male (LEM)	$LEM = 62.22 + 0.3791 * year$	0.3791***	0.9859	0.025
Life Expectancy for Female (LEF)	$LEF = 61.85 + 0.4777 * year$	0.4777***	0.9948	0.001
GDP Per Capita (GDP)	$GDP = 69.85 + 0.4488 * year$	0.4488***	0.9635	0.051

NB: ***, ** and * are 1%, 5% and 10% level of significant.

3.2. Regression Estimation

Table 3 shows results of variables that were examined through both the linear and log-linear models for life expectancy. For model diagnostics, Ramsey’s [16] RESET test for model specification, Bruesch-Pagan [17] test for heteroskedasticity, variance inflation factor (VIF) and pairwise correlation for multicollinearity, and Jarque-Bera [18] test for normality of residuals have been performed. The computed test statistic for model specification and heteroskedasticity follow a chi-square distribution with one degree of freedom, while the normality test statistic follows chi-square distribution with 2 degrees of freedom. None of the diagnostic tests indicate the problems with modeling and estimation of the determinants. The estimated GDP Per capita, health expenditure per capita (HEPC), total health expenditure as a share of GDP and out-of-pocket expenditure on health as a share of private expenditure were influence life expectancy of these citizens. In the present study, positively support that there was significant evidence to claim that higher GDP per capita results in a longer life expectancy. i.e., one dollar increasing in GDP per capita by 33 days will also increase life expectancy by one year on average, for HEPC by 8 days. If the higher of total expenditure on health as a percentage of GDP and direct personal expenditure on health by household as a share of private expenditure on health results in also longer life span. These results are also significant that increased percentage

of total expenditure on health as a percentage of GDP and direct personal expenditure on health by household as a share of private expenditure on health by 8 and 13 days respectively will also increase life expectancy by one year in an average. The estimated linear model can explain more than 95 percent variation in life expectancy and also log-linear model can explain by 97 percent. The regression results clearly demonstrate that majority of the explanatory variables incorporated in the analysis appear to be statistically insignificant.

3.3. Elasticity Estimation

The study also examined elasticity of life expectancy with respect to the regressors to determine their marginal influence over life expectancy. The results on elasticity estimates using the linear and log-linear models have been presented in Table 4. This shows that the income had nearly impacted on life expectancy. The income-elasticity of life expectancy, i.e. one percent point increase in GDP per capita increases life expectancy by 0.023%. The single unit increases in HEPC increases the life expectancy by 0.021%. On the other hand, out-of pocket health expenditure as a share of private expenditure on health is an important influence on life expectancy. A 0.015 percent increase in the variables lead to about 1 percent increase in life expectancy. Other variables also had important influence on life expectancy.

Table 3. Result of regression analysis for Total Life Expectancy

Independent Variable	Linear Model		Log-Linear Model	
	Coefficient (Std. Err)	P-value	Coefficient (Std. Err)	P-value
GDP Per capita, PPP(Int. \$ 2005)	0.0289** (0.223)	0.053	0.0856*** (0.0451)	0.001
Health expenditure per capita	0.0228*** (0.0089)	0.007	0.0158*** (0.0059)	0.028
Public Health expenditure (% of GDP)	-0.0975 (4.792)	0.253	-0.0316 (.0299)	0.322
Public Health expenditure (% of GE)	0.0100 (0.153)	0.534	-0.00005(0.0013)	0.994
Public Health expenditure (% of THE)	-0.0432 (2.664)	0.144	-0.1241 (0.235)	0.152
Total Health Expenditure (% of GDP)	0.0242** (0.050)	0.045	0.0464 (0.0337)	0.207
Out-of-pocket health expenditure (% of PHE)	0.0235*** (0.012)	0.0014	0.0519*** (0.048)	0.0025
Out-of-pocket health expenditure (% of THE)	-0.0451 (2.902)	0.146	-0.05022 (0.0496)	0.341
R ²	0.9552		0.9752	
Adj. R ²	0.8926		0.9368	
Root MSE	0.02215		0.00022	
F- statistic	45.29		65.26	
Heteroscedasticity [$\chi^2(1)$]	0.056		0.000	
Model Specification [$\chi^2(1)$]	1.06		0.23	
Normality [$\chi^2(1)$]	0.503		0.029	

NB: ***, ** and * are 1%, 5% and 10% level of significant

Table 4. Result of Elasticity Estimation

Indicators	Linear Model	Log-linear model
GDP Per Capita	0.023	0.095
Health expenditure per capita	0.002	0.048
Public Health expenditure(% of GDP)	0.001	0.003
public Health expenditure(% of GE)	0.025	0.030
Public Health expenditure(% of THE)	0.023	0.052
Total Health Expenditure(% of GDP)	0.021	0.064
Out-of-pocket health expenditure (% of Pvt.HE)	0.015	0.032
Out-of-pocket health expenditure (% of THE)	0.012	0.032

4. Discussion

Our study findings show the relationships between life expectancy at birth and economic level in Bangladesh. For developing countries like Bangladesh, people are striving earnestly for achieving socio-economic progress through investing significantly on social sectors such as: health, education, sanitation, environmental management and sustainability, social safety nets and etc. As shown in our study the trend of life expectancy at birth for both males and females is increasing over the past few decades. During

1995 to 1997, the males were more likely to enjoy increased life expectancy than females, but after 1999 the trend has been reverse with females showing increased life expectancy than those of males. The gap of increased life expectancy (between males and females) was continuously larger than the males since 1999. For example, the gap between male and female was 0.22 years in 1995, narrowing down to 1.45 years in 2011. In the trend analysis, the results suggested that the yearly improvement of life expectancy for female by 0.4777 times, total by 0.4272 times and male by 0.3791 times, but female was 0.0986

times more than male (Table 3). The annual GDP per capita increased by 0.4488 times over the study period. There was increasing trend of income level and positive changes in life expectancy in Bangladesh. The reasons for the difference between male and female life expectancy are not yet fully established. While some reasons include improvement in primary school enrollment rate and increased labor force in the country. According to the Global Development Report, 2012, Bangladesh has shown improved primary school enrollment rate, where girls possess 89.9 percent and boys 82.9 percent [21]. On the other hand, during the last 30 years, 552 million female joined the labor force, which is the increased rate of 58.7 percent in 2009 from 56.5 percent in 1980. In previous study, Rosenberg (2007) suggested that the reasons for more life expectancy of female while some conflict female are biologically greater to men and thus live longer [19]. Others argue that males are employed in more hazardous occupations (factories, military service, etc). In addition, males generally quite often drive, smoke and drink alcohol more than females [19].

In our study, GDP Per capita, health expenditure per capita (HEPC), total health expenditure as a share of GDP and out-of-pocket expenditure on health as a share of private expenditure were statistically significant and positively response in both linear and log-linear models. Our study findings suggested that, one USD increase in GDP per capita will increase the life expectancy in an average by 33 days per year. In addition, one unit increase in per person expenditure on health will increase average life expectancy by 8 days per year. The increased total expenditure on health as a percentage of gross domestic products will improve expected years of by 8 days. Further, one unit increase of direct personal expenditure on health by household as a share of private expenditure on health, will increase the life expectancy approximately by 13 days annually. The regression results clearly demonstrate that majority of the explanatory variables incorporated in the analysis appear to be statistically insignificant.

The main reason for this linear relationship is because people consume both needs and wants [20]. People consume needs in order to survive. Once a person's needs are satisfied, they could then spend the rest of their money on non-necessities. If everyone's needs are satisfied, then any increase in GDP would barely affect life expectancy. The GDP per capita is not the only thing that affects life expectancy. Government intervention can also affect it. A nation could be rich, but if its' government ignores the plight of the poor, it can lower the life expectancy. Some poor nations have high life expectancies because their governments' strongly prioritize needs over wants. Cuba is a good example of this. Despite having a very low GDP per capita (largely due to non-market economic activity and USA's economic blockade), the life expectancy in Cuba is close to 77 years (USA's life expectancy is only slightly higher) [21]. Another reason for the wide variation in the life expectancies for countries with low GDP per capita would be due to the level of non-market economic activity

[22]. For example, if there is a lot of subsistence farming, people could be working and have enough food to eat, but wouldn't be contributing much to the nation's GDP because they wouldn't be buying the food they eat, or selling the food they grow i.e. no exchange of money. The longer life expectancy and GDP per capita are not always linearly related each other. Some countries' GDP per capita may be very high but the life expectancy may be low. For example, Saudi-Arab, which has high per capita GDP, but relatively low life expectancy [20].

Kabir (2008) examined the context of cross-country investigation in developing countries at the beginning of the twenty-first century [20]. His findings suggested that there was no guarantee in the improvements in terms of per capita income, education, per capita health expenditure, and urbanization would lead to higher life expectancy among the developing countries. This is because over the last ten years many of these countries have witnessed gains in these areas but demonstrated decrease in life expectancy. However, in many developing countries, Sub-Saharan Africa in particular, the life expectancy has been decreasing. In some countries, although the income and health expenditure have increased, the life expectancy is decreasing. In lower middle income countries, like South Africa has shorter life expectancy than other similar countries. Unfortunately, HIV AIDS has taken its toll in Africa, Asia and even Latin America by reducing life expectancy in 34 different countries (26 of them in Africa). Africa is home to the world's lowest life expectancies with Swaziland (33.2 years), Botswana (33.9 years) and Lesotho (34.5 years) rounding out the bottom. Between 1998 and 2000, 44 different countries had a change of two years or more of their life expectancies from birth and 23 countries increased in life expectancy while 21 countries had a drop [19].

In the twentieth century, life expectancy rose rapidly due to improvements in public health, nutrition and medicine. It is likely that life expectancy of the most developed countries will slowly advance will then reach a peak in the range of the mid-80s. Currently, microstates Andorra, San Marino, and Singapore along with Japan have the World's longest life expectancies. In our study, income-elasticity of life expectancy suggested that one percent point increase in GDP per capita and HEPC increases life expectancy by 0.023% and 0.021% respectively. On the other hand, out-of-pocket health expenditure as a share of private expenditure on health has an important influence on life expectancy, which increases in an average of 0.015 % in life expectancy. The analyses, however, suggest that life expectancy in Bangladesh could be improved if attention is given to increase economic growth, per person expenditure on health, human force for health in macro and micro policy planning, and other determinant of health care expenditure such as..... In general, individuals with higher educational level have better health status, as a result it has led to greater productivity and higher income [12]. In a same way, the people with high income can have greater level of

investment for obtaining better health outcomes [12]. Greater emphasis on education, such as increased level of knowledge and skills among mothers can enhance women's work output and their active participation in the labor market. Further, total fertility rate can be reduced in the societies, which also will ultimately lead to the better health status of the women. The lower life expectancy can be improved if nutritional status of the poor children and mothers in particular, could be raised through appropriate nutritional policies of the countries, particularly in developing nations. Therefore, political stability, adequate and suitable social sector policies, good governance [20] and effective interventions to address these issues are required to improve life expectancy in countries like Bangladesh.

5. Conclusion

This study explored determinants of life expectancy in Bangladesh, using multiple regression models. Eight widely used variables were used as regressors to examine their significance in determining life expectancy. The results suggested that most of the variables traditionally considered as influential turned out to be insignificant in comparison with the findings of previous studies. Appropriate diagnostic tests have also been performed to examine robustness of the models in this study. Heteroskedasticity and non-normality of error terms were absent in the models. Goodness of fit tests also confirmed appropriateness of the regression frameworks. In the multiple regression, elasticity estimates of the variables found to be important other than the GDP Per capita and HPEC. These results have some policy implications for Bangladesh, in particular to develop and implement effective policy interventions to increase per capita real income and higher expenditure on health, population planning and these are undoubtedly important for overall wellbeing and social development.

Conflict of Interest

None declared.

Author's Contributions

Corresponding author conceptualized the study. All authors contributed in the development of the study and participated in the manuscript writing. Main author wrote the first draft while other authors reviewed the manuscript and approved the final version.

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