Original Article

The socioeconomic and political determinants of life expectancy in selected countries of the world

Fatemeh Yari [1], Lotfali Agheli [2*], Hossein Sadeghi [1], Sajjad Faraji Dizaji [1]

[1] Department of Economic Development and Planning, Tarbiat Modares University, Tehran, Iran.

[2] Economic Research Institute, Tarbiat Modares University, Tehran, Iran.

Corresponding author and reprints: Lotfali Agheli, Associate Professor of Economics, Economic Research Institute, Tarbiat Modares University, Tehran, Iran.

Email: aghelik@modares.ac.ir

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Abstract

Background: Increasing life expectancy has been considered as an evident indicator of demographic change, and most countries have experienced a significant increase in life expectancy. This study aimed to identify the economic, social, and political determinants of life expectancy and to estimate their related effects.

Methods: Based on the theoretical background and Grossman health production function, the econometric model is specified to investigate the effects of economic, social and political factors on life expectancy at birth. In this regard, Panel data of 98 selected countries obtained from World Bank during 2000-2016 is used and GLS approach is applied. Estimations are conducted by software Stata 16.

Results: The econometric results show that GDP per capita, literacy rate, health expenditure per capita and democracy impact the life expectancy positively. Reversely, GDP per capita squared (in logarithm) influence life expectancy negatively. The results indicate at the per capita income of equivalent to 20000 US$, 1% increase in GDP per capita causes 0.205%, 0.207% and 0.209% increase in life expectancy for total population, males and females, respectively.

Conclusion: Positive effect of economic variables of GDP per capita and health expenditure per capita on life expectancy conducts the adoption of policies and interventions to improve economic status on a global scale, especially in poor and low-income countries. Also, the provision of educational opportunities, especially in low-income countries, and the transition from autocratic political systems to democratic societies may result in longevity and increase the supply of labor in the long run.

Keywords: Democracy; Gross Domestic Product; Health expenditure; Life expectancy; Literacy.

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Introduction

Longevity as a measure of human and economic development is evaluated in terms of life expectancy at birth. Life expectancy reflects differences in mortality quite well, but it is insensitive to the age structure of the population, changes in birth rates, and other demographic phenomena (1). It helps to assess the general health status of societies. In a health system, if the life expectancy of a country is higher than the other countries with the same resources, it means that this country's health system is better than the others and also its population is healthier (2).

In addition, in the absence of wars, new epidemics, or substantial economic reforms, a lack of improvement in life expectancy gains are viewed as a cause for concern, and actual declines in life expectancy are particularly alarming (3). Increasing life expectancy is one of the most important demographic changes since the mid-twentieth century, and most countries around the world have experienced a significant increase in life expectancy. Between 2000 and 2016, global life expectancy at birth increased by 5.5 years, from 66.5 to 72.0 years (4). Life expectancy and mortality rates are broad measures of the nation's health status, which is an outcome of several economic, social and environmental factors (5).

There is a positive association between income and health (6). In explaining the relationship between health and income, the Preston curve demonstrates a cross-sectional relationship between life expectancy at birth and per capita income (7). It indicates a dramatic increase in the low levels of per capita income, however, as per capita income increases, the curve becomes flat. The positive effect of GDP (Gross Domestic Product) and per capita GDP on life expectancy has been affirmed in numerous studies. Miladinov (2020) concluded that GDP per capita increases the life expectancy at birth through increasing economic growth and thus leads to the prolongation of longevity in five EU accession candidate countries (Macedonia, Serbia, Bosnia and Herzegovina, Montenegro, and Albania) (8).

Health spending is also an important indicator of healthcare quality and population health. Empirical studies have established a significant relationship between life expectancy and health expenditure (9). The increasing health spending in countries with low life expectancy has important returns on life expectancy and significantly diminished global inequalities in longevity (10).

The socioeconomic determinants of health consist of a wide range of variables such as years of education, lifestyle, i.e. alcohol consumption (11), marital status, employment/unemployment, household income and expenditure (12), income inequality, and segregation (13), and social influences (14). Education development significantly improves life expectancy (15). Strong associations between education and overall population health, i.e. life expectancy, have been found in Italy, Denmark, and the USA (16). A substantial gap in partial life expectancy between people with low and high levels of education has been verified in all European countries (17).

Regarding the role of political regimes in the health system, a strong correlation between life expectancy and democracy has been established (18). Among other political factors influencing life expectancy, good governance, political stability, and control of armed conflict have positively affected life expectancy (19).

The main goal of public health care policies is to maintain and improve health status. Therefore, assessing and understanding the factors affecting population health and demographic change is a vital issue that can provide useful information for making appropriate decisions and policies. Since Life expectancy is one of the main indicators in explaining the public health of countries, identification, and analysis of the factors affecting life expectancy help policy-makers to redesign or plan appropriate policies on retirement regulation, public health provision, employment and labor force, economic growth, production and consumption, environment and sustainable development. Knowledge and awareness of the factors that determine the longevity of people are still not enough and further study is needed. In this regard, this study aims to identify the life expectancy predictors and to estimate their effects in 98 selected countries over the period 2000-2016. Based on the literature review the most important and comprehensive factors are chosen as explanatory variables. This research also tries to examine the possibility of nonlinear relationships between variables.

Methods

This study contains 98 countries[1] (according to the World Bank classification, including 31 high-income, 52 middle-income, and 15 low-income countries). The time span is limited to 2000 – 2016 due to data availability. The dependent variable is life expectancy at birth, and explanatory variables are GDP per capita, GDP per capita squared, and health expenditure per capita, as economic factors; literacy rate, as a social factor, and democracy index, as a political factor. These factors are chosen for investigation based on a review of related literature. Econometric tools are used for analyzing the data which is a common method for the estimation of statistical relationships. The summary statistics of the variables employed in the analysis are presented in table 1.

The data on life expectancy at birth (years), GDP per capita (in PPP current USD), current health expenditure per capita (in PPP current USD), and the literacy rate of people aged 15 and above are derived from the *World Bank* website.

Table 1. Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
LE	70.05971	9.5224	44	83.98488
LEM	67.63889	9.202786	41.927	81.7
LEF	72.56222	9.999811	45.345	87.14
LIT	82.99117	20.75106	17.9787	99.99486
LITM	86.52418	16.85035	24.7165	99.99487
LITF	79.65327	24.55783	12.1336	99.99587
HE	1261.212	1596.381	11.4246	9877.871
DEM	0.4625588	0.2763778	0.0192587	0.9034218
Y	17518.94	19948.35	478.3107	141634.7

Notes: LE, LEM, and LEF denote life expectancy of total population, male and female respectively. Similarly, LIT, LITM and LITF denote literacy rates of total population, male and female. HE denotes current health expenditure per capita, Y means GDP per capita, and DEM indicates democracy index

The data on the liberal democracy index is collected from the *Our World in Data* website. In our sample, there is a positive and strong relationship between life expectancy at birth and the global literacy rate during 2000-2016 (see Figure 1).

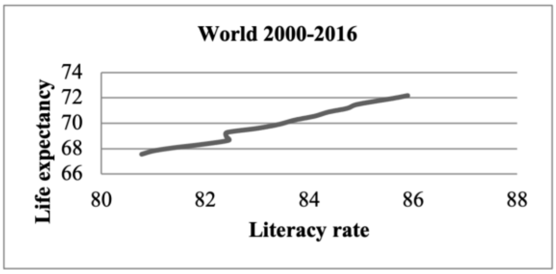

Figure 1. Life Expectancy versus literacy rate

Figure 2 shows the cross-sectional relationship between democracy and life expectancy for selected countries in 2015. It generally displays a positive relationship; however, it encompasses some countries with low democracy index and high life expectancy and vice versa.

The average life expectancy across 98 countries is about 67.63 for men and 72.56 years for women, which denotes about 5 years gap in average life expectancy between the two groups.

[1] Algeria, Argentina, Armenia, Australia, Austria, Azerbaijan, Bangladesh, Belarus, Belgium, Benin, Bolivia, Brazil, Burkina Faso, Burundi, Cameroon, Canada, Central African Republic, Chad, Chile, China, Colombia, Comoros, Costa Rica, Cote d'Ivoire, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Ethiopia, Fiji, Finland, France, Gabon, Germany, Ghana, Haiti, Iceland, India, Indonesia, Iran, Islamic Rep., Ireland, Italy, Japan, Jordan, Kazakhstan, Kenya, Korea, Rep., Kyrgyz Republic, Latvia, Liberia, Luxembourg, Madagascar, Malaysia, Maldives, Mali, Mauritania, Mauritius, Mexico, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, Netherlands, New Zealand, Nigeria, Norway, Pakistan, Panama, Paraguay, Peru, Portugal, Qatar, Romania, Russian Federation, Rwanda, Saudi Arabia, Senegal, Seychelles, Singapore, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Thailand, Turkey, Uganda, United Kingdom, United States, Uruguay, Uzbekistan, Vanuatu, Vietnam, Zambia.

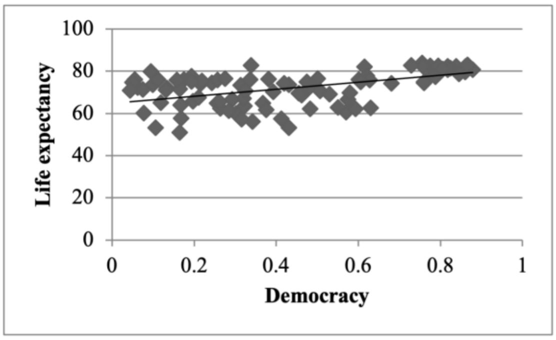

Figure 2. Life Expectancy versus democracy level

The average literacy rate is 86.48% for men and 79.65% for women which represents more education opportunities for men worldwide. Health expenditure per capita is 1261, on average. The MIN. and MAX. of GDP per capita (in PPP) are 478 and 141634 for Mozambique and Qatar, respectively. These figures indicate substantial income inequality in the world.

In health economics, when researchers would like to explain the health status of populations, they usually apply a health production function. It describes the relationship between health inputs and outputs. Health output is measured by various indicators such as life expectancy and mortality rates, but health inputs take different variables like per capita income, education level, medical expenditure, lifestyle, nutrition, genetics, age, gender, living places, and environmental quality.

Grossman's (1972) health model is of high relevance in conceptualizing the health production function and factors affecting health. A simple theoretical Grossman health model is defined as follows:

$$H = f(X) \qquad (1)$$

Where *H* is an output measure for health, and *X* is a vector of health inputs. This vector has different components, because of the individual preferences and goals of researches while including them in the health production function.

In this study life expectancy (*LE*) indicates health status, and health determinants are categorized in economic, social, and political factors. These factors are represented by *ECO*, *SOC*, and *POL*, respectively. Thus, vector *X* can be rewritten as equation 2:

$$H = f(ECO, SOC, POL) \qquad (2)$$

Economic factors include health expenditure per capita (*HE*), *GDP* per capita (*Y*), and its squared form (for examining the nonlinear relationship between life expectancy and per capita income). The literacy rate (*LIT*) for people aged 15 and above is a proxy for social factors. Also, the democracy (*DEM*) index summarizes political factors.

Based on theoretical background and Grossman health production function, the econometric model is specified as follows:

$$LLE_{it} = \beta_0 + \beta_1 LHE_{it} + \beta_2 LY_{it} + \beta_3 (LY)^2{}_{it} + \beta_4 LLIT_{it} + \beta_5 DEM_{it} + +u_{it} \qquad (3)$$

$$u_{it} = \mu_i + v_{it} \qquad (4)$$

Where *L* is the logarithm. Subscripts *t* and *i* represent time and country, respectively. μ_i denotes individual specific unobservable effects. v_{it} denotes residuals or idiosyncratic disturbances, and u_{it} indicates a composite error term with independent and identically distribution (*i.i.d*), where:

$$\mu i \sim iid\ (0,\ \sigma_\mu^2\ ), and\ vit \sim iid\ (0\ ,\ \sigma_v^2), t = 2000, \dots, 2016, i = 1,2, \dots 98 \qquad (5)$$

It should be noted that three versions of equation (3) were estimated for three different groups i.e., total population, males, and females.

In the estimation phase, we recognized that the model cannot account for all factors in a specific country that could affect life expectancy. Hence, we used a random effect model to include the unobserved country-specific factors, not correlated with independent variables. To achieve research objectives the model was estimated in panel data of selected countries using Stata 16 software.

Results

The first step in estimating panel data models is to test the stationary of variables. The stationary data are of statistical desired properties, such as constant mean and variance over time. In this case, estimation outputs are reliable statistically. In other words, we do not face a spurious regression.

In this study, the number of panels is higher than the time periods. Thus, we use the Harris-Tzavalis test to examine whether the panels contain a unit root, as the null hypothesis. It assumes that the number of panels tends to infinity while the number of time periods is fixed. The results are presented in Table 2. Except for *DEM* which is integrated in level [I(0)], the remaining variables are stationary at the first difference [I(1)].

Because of different degrees of integration in panels, Kao (1999) cointegration test is used to check for the presence of long-run relationships among variables under study. The results in Table 3 indicate the rejection of the no cointegration hypothesis. Leamer (1983) test is used for choosing between panel or pool data models. In this test, the null hypothesis is based on the pooled data specification. If the null hypothesis is rejected, the panel data model is preferred to the pooled data model. Table 3 reports the results of the Leamer test too and indicates the selection of the panel data model against the pooled data one.

Table 4 displays the estimation results. As expected, the estimated coefficients of *Log(Y)*, *Log(LIT)*, *Log(HE)*, and *DEM* are positive; indicating that increase in the corresponding explanatory variables will lead to higher life expectancy at birth. However, the *t*- statistic values show that three variables, i.e., the logarithm of literacy rate, logarithm of health expenditure per capita, and logarithm of GDP per capita, are statistically highly significant. The estimated coefficient of $[Log(Y)]^2$ is negative and highly significant.

Discussion

The relation between LE and Y is nonlinear (quadratic form). Therefore, the function has a slop at every point. The effect on LE of 1% change in Y depends on the value of Y and the marginal effect of Y is not constant.

$$\frac{\partial Log(LE)}{\partial Log(Y)} = \beta_2 + 2\beta_3 Log(Y) \qquad (6)$$

The general rule to interpret the coefficients is to compute effects by comparing different cases as it is reported in table 5. LE and Y are in logarithmic form. The estimated coefficient of Log(Y) indicates the elasticity of Log(LE) to Log(Y).The elasticity presents the percentage of change in LE, for one percent change in Y. For example, if we assume Y=50000, by a 1% increase in Y, we get a 0.193% increase in total life expectancy (LE) with β_2=0.3334 and β_3=-0.0149; 0.195% increase in male life expectancy (LEM) with β_2=0.3328 and β_3=-0.0146; and 0.196% increase in female life expectancy (LEF) with β_2=0.3459 and β_3=-0.0159.

Table 2. Results of Harris-Tzavalis unit root test

	Level			First Difference		
Variable	rho	z-statistic	p-value	rho	z-statistic	p-value
Log(LE)	0.988	8.9131	1.0000	0.3987	-23.1643	0.0000
Log(LEM)	0.987	8.8521	1.0000	0.1993	-34.0330	0.0000
Log(LEF)	0.9938	9.2457	1.0000	0.2344	-32.1195	0.0000
Log(LIT)	0.9437	6.3616	1.0000	0.1508	-36.6793	0.0000
Log(LITM)	0.9278	5.4454	1.0000	0.1814	-35.0108	0.0000
Log(LITF)	0.9507	6.7612	1.0000	0.2599	-30.7303	0.0000
Log(HE)	0.9344	5.8262	1.0000	-0.0776	-49.1302	0.0000
DEM	0.7775	-3.2196	0.0006		-	
Log(Y)	0.9552	7.0245	1.0000	0.238	-31.8869	0.0000
$(Log(Y))^2$	0.9592	7.2518	1.0000	0.245	-31.5275	0.0000

Table 3. Results of Kao Test for co-integration and Leamer test for choosing between panel and pooled data models

	Kao test		Leamer test	
	Kao-ADF Statistic	p-value	F-statistic	p-value
Model 1 (Total)	2.1868	0.0144	F(97,1563)=158.97	0.000
Model 2 (Male)	3.0923	0.0010	F(97,1563)=165.43	0.000
Model 3 (Female)	3.1982	0.0007	F(97,1563)=157.53	0.000

In a similar calculation if y=20000 one percent increase in GDP per capita is associated with approximately 0.205%, 0.207%, and 0.209% increase in life expectancy in models 1, 2, and 3, respectively. Table 5 reports the partial derivatives of Log(LE) to Log(Y).

Since the coefficient of the square of *Log(Y)* is negative and highly significant in three models, the nonlinear relationship between GDP per capita and life expectancy is confirmed. This finding reconfirms the Preston curve in a certain interval of GDP per capita. This also is consistent with the findings of Clark (2011) (21). An increase in income normally leads to improvement in health through expanding health-related behaviors, such as a healthy lifestyle, appropriate nutrition, non-smoking, physical exercise, routine clinical check-up, and so forth. A study by Khang et al. (2019) also suggests income-based inequality in life expectancy among the Korean population (22). However, beyond some threshold level of affluence, higher income may no longer imply lower mortality or improved life expectancy and may lead to a stressful and unhealthy lifestyle that could affect the health status of the population adversely (23).

Furthermore, a one percent increase in literacy rate is associated with a 0.11%, 0.10%, and 0.08% increase in life expectancy in models 1 to 3, respectively. Adults with higher educational attainment live healthier and longer, compared with their less educated peers. In other words, more schooling is linked with better health and longer life (24). Moreover, the impact of literacy rate on life expectancy is greater for men compared to women.

Table 4. Estimation results of random effects GLS regression

Variable	Model 1 (Total)	Model 2 (Male)	Model 3 (Female)
constant	1.8729***(0.081)	1.8128***(0.0906)	1.9824***(0.0789)
Log(HE)	0.0153***(0.0036)	0.0166***(0.0037)	0.0149***(0.0035)
Log(Y)	0.3334***(0.0191)	0.3328***(0.0192)	0.3459***(0.0193)
$[Log(Y)]^2$	-0.0149***(0.001)	-0.0146***(0.001)	-0.0159***(0.001)
Log(LIT)	0.1121***(0.0107)	0.1088***(0.0133)	0.0893***(0.0082)
DEM	0.0197*(0.011)	0.0178(0.0115)	0.0211*(0.0109)
Wald test	*P*<0.0000	*P*<0.0000	*P*<0.0000
Sigma_u (within countries)	0.07149	0.0755	0.0704
Sigma_e (between countries)	0.0229	0.0238	0.02269

Notes: **** significant at 0/1% (p<0.001), ** significant at 1% (p<0.01); * significant at 5% (p<0.05)*

Table 5. Partial derivatives of Log(LE) to Log(Y)

	Model 1 (Total)	Model 2 (Male)	Model 3 (Female)
Y	∂Log(LE)/∂Log(Y)	∂Log(LE)/∂Log(Y)	∂Log(LE)/∂Log(Y)
10,000	0.2142	0.216	0.2187
20,000	0.2052	0.2072	0.2091
50,000	0.1933	0.1955	0.1964
100,000	0.1844	0.1868	0.1869

One percent increase in health expenditure per capita leads to a 0.015%, 0.014%, and 0.016% increase in life expectancy in models 1 to 3, respectively. The result is consistent with that of similar studies (25).

The democracy index is statistically significant in the first and third models while it is not significant in model 2. One unit increase in the democracy index is related to a 0.019%, 0.017%, and 0.021% increase in life expectancy in models 1 to 3, respectively. Likewise, democratic experience matters for global health (26). In a similar study, life expectancy has been higher in democratically governed states than in authoritarian states throughout the 20th century (27).

The positive effect of economic variables of GDP per capita and health expenditure per capita on life expectancy conducts to adopt policies and interventions to improve economic status on a global scale, especially in poor and low-income countries. Also, the positive effect of literacy rate on life expectancy highlights the important role of social factors in health promotion. Therefore, policies for resolving educational attainment limitations in regions with low literacy rates are suggested to be given priority. Furthermore, the effectiveness of political conditions on health should not be ignored. Transitioning from autocratic rule to democracy would have benefits for population health. Generally, these policies would promote and maximize potential health.

This study provided evidence for 98 countries. Further research can be conducted for each country or geographical region to understand the effect of variables such as environmental factors which are not included in our specification. Moreover, the possible interaction between variables can be investigated.

This study faced some limitations. First, there might be other control variables, which could explain the variation in life expectancy across countries more accurately; however, relevant data were not accessible for all sample countries such as environmental factors.

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Author’s contribution

Yari F and Agheli L developed the study concept and design; Yari F acquired the data and prepared the first draft of the manuscript. Agheli L, Sadeghi H and Faraji dizaji S contributed to the intellectual content and manuscript editing. All authors read and approved the final manuscript.

Ethical considerations

This study was approved by the Ethics Committee of University (Code:1399.147).

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Conflict of interest

The authors declared no conflict of interest.

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