

Final Year Project SM 4290 – Research Project (Statistics)

Title: Statistical Analysis on the correlation of Socioeconomy on Life Expectancy

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INTRODUCTION

In life not everyone has the same living conditions, life might be kind towards them and provides them with various benefits and opportunity to succeed, whereas life might be cruel, giving them little chances to have a happy and fulfilling life. And where life gives, life also takes away, death is an unavoidable fate that possibly every living creature will eventually face, death could come to anyone at any time without bias, a healthy person living their best life could potentially expire the day after, much like how a deathly ill person could. But on average, most people are expected survive until a certain age, this measurement is called the Life Expectancy. There are various possibilities as to what could affect the life expectancy; such as diseases, environment, and culture. For this research, the Socioeconomic factors will be used to determine how they could have an impact on the country's life expectancy. In theory a country with a better overall socio-economy would have the opportunity to raise the country's average life expectancy compared to a country with poor socio-economy.

Fortunately, the world has experienced several advancements in science to allow the global population to experience a longer life span. Research done on OECD countries have shown that the life expectancy has risen since 1960. And according to The World Bank, the average global Life Expectancy has increased from 53 years to 73 years from 1960 to 2019



Figure 1. Life Expectancy at birth from 1960 to 2015 of OECD Countries



Rise of Life Expectancy over Time from 1960 to 2019

Figure 2: The global Life Expectancy according to The World Bank

This report aims to analyze how the country's socioeconomic status could affect the life expectancy by finding their correlation through the use of a linear regression model. Through the model an estimate could be formed to allow for a prediction on what could happen to the life expectancy when a variable either increases or decreases by one unit.

In addition to finding the rate of change of the life expectancy, this report also analyzes why and how each of the variables used can affect a country's life expectancy, for example how the average income of the country can increase or decrease the country's life expectancy.

This report aims to provide a better understanding on how the socioeconomic status affects the life expectancy, in hopes even a struggling country could increase their life expectancy and provide the population with a better and longer life.

LITERATURE REVIEW

Based on a study conducted by Kabir (2008), there appears to have a positive relationship between primary health care spending and health status, indicating that income is one of the determining factors that effects the life expectancy, as well as data from World Bank (1997) which pointed out that the life expectancy have a strong positive relationship with income per capita in case of developing countries.

Hill and King (1995) and Gulis (2000) conducted that education, especially within females play an important role in improving the overall life expectancy, Williamson and Boehmer (1997) conducted a study based on 97 cross-sections, the study indicated that the education status improve the female life expectancy significantly, he mentioned that education impacts health both directly and indirectly as education enhance the productivity of labor which in turn increases the income and attainments for female which further effects the health of their child. He also found that rising education improves the health of women inside and outside of the home which help them improve the health of their family and child survival.

According to John M. Last, Socioeconomic status (SES) is a descriptive term used for people in society. The SES is a combination of occupational, economic, and educational criteria expressed in ordered categories. Though there are other categories under the SES, they are closely related to income, occupation and education level (Last, 2007).

The Human Development Index (HDI) is the summary measure of the average achievements in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living ("Human Development Index (HDI) | Human Development Reports", 2021). The HDI can be used as a measurement of the population's income composition, from the Gross National Income (GNI), the Income index of a country can be calculated.

The formula for Income Index according to the Human Development Report

Income Index (II) = $\frac{\ln(GNIpc) - \ln 100}{\ln(75000) - \ln (100)}$

A study was conducted in 2016 to observe the relationship between income and life expectancy. Data for the study was obtained from 1.4 billion deidentified tax records of the US population between 1999 to 2014, the mortality data were obtained from Social Security Administration death records and are used to evaluate the factors associated with the differences in life expectancy. According to the study, between 2001 and 2014, a higher income was linked to a greater longevity, and the differences in life expectancy across income groups increased over time (Chetty et al., 2016).

According to the HDI, the measure for Education is called the Education Index (EI). As of 2010, the Education Index is measured by the mean years of schooling for adults aged 25 years and more and the expected years of schooling for children of school entering age ("Human Development Index (HDI) | Human Development Reports", 2021).



The formula for Education Index 2010 onwards according to the Human Development Report

A study was conducted in 2020 to determine if there was an influence education has towards health. The study uses empirical data from the Organization for Economic Co-operation and Development (OECD) and the World Bank for 26 OECD countries during 1995 to 2015. The study found that adults with a higher educational attainment have better health and lifespans compared to their less-educated peers, as the tertiary education is critical in influencing infant mortality, life expectancy, child vaccination, and enrollment rates (V. Raghupathi & W. Raghupathi, 2020).

In 2017, an article shows the connection between employment level and the health conditions of Americans from 1986 to 2011. According to the article, the health gained by employment is conditional on one's race, gender, and education level; individuals with lower education gain less from employment than highly educated people (Assari, 2017)

Data

The data used for this research are obtained from The World Bank and the Human Development Reports from the United Nations Development Programme. The data covers 188 countries in total from 2000 to 2015. The Data used are the Gross National Income (GNI) per capita, the Mean Years of Schooling (Adults), the Expected Years of Schooling (Children), the Life Expectancy and the Unemployment Rates.

The Life Expectancy is the statistical age that a person is expected to live until, the Minimum, Median, Mean, and Maximum of the Life Expectancy are 39.44, 71.79, 69.25, and 84.28 respectively, the 1st Quartile is 63.26, and the 3rd Quartile is 75.84. The minimum Life Expectancy comes from Sierra Leone in 2000 and the maximum comes from Hong Kong in 2015

According to the Human Development Report, we can calculate the Income Index of a country from the country's GNI per capita and the Education Index can be calculated from the country's Expected Years of Schooling and the country's Mean Years of Schooling.

The Gross National Income per capita is the GNI converted into international dollars using purchasing power parity rates. GNI is the sum of value added by all resident producers plus any product taxes not included in the valuation of output plus net receipts of primary income ("Indicator Metadata Registry Details", 2021). The GNI should reflect the average income of a country's citizen before tax.

For this research, the GNI is converted into Income Index using the formula given by the Human Development Report. The Income Index for this report has: Minimum, Median, Mean, and Maximum of 0.21, 0.68, 0.67, and 1.09 respectively, the 1st Quartile is 0.52, and 3rd Quartile is 0.81; the minimum Index comes from The Democratic Republic of Congo in 2001 and the maximum Index comes from Qatar in 2012.

The Mean Years of Schooling, calculated in years, refers to the average number of years of education received by people ages 25 and older, converted from education attainment levels using official durations of each level ("Human Development Reports", 2021), and the Expected Years of Schooling refers to the number of years of schooling that a child of school entrance age can expect to receive if prevailing patterns of age specific enrolment rates persist throughout the child's life("Human Development Reports", 2021)

Both The Mean Years of Schooling and the Expected Years of Schooling are necessary to calculate the Education Index of the country in the given year according to the formula given by the Human Development Report. For this research, the Minimum, Median, Mean and Maximum value of the Education Index are 0.116, 0.626, 0.5996, 0.934, respectively, the 1st Quartile at 0.456, and the 3rd Quartile at 0.739. The minimum Index comes from Niger in 2000 and the Maximum comes from Germany in 2015

The last Variable used for the report is the Unemployment Rate of the country. The unemployment rate is the percentage of the labor force that is jobless. According to Investopedia, the unemployment rate is a lagging indicator, meaning that it rises or falls in the wake of a changing economic condition, instead of anticipating them. When the economy is in a poor shape and jobs are scarce, the unemployment rate is expected to rise, and when the economy is growing at a healthy rate and jobs are plentiful, it can be expected to fall ("Unemployment Rate Definition", 2021). In this report, the Minimum, Median, Mean and Maximum value of the Unemployment Rate are 0.17, 6.66, 8.275, 37.25, the 1st Quartile at 3.81, and the 3rd Quartile at 10.93. The minimum rate is from Qatar in 2015 and the maximum rate is from North Macedonia in 2005

Results

Linear Regression Model

To Analyze the correlation of Life Expectancy with the Socioeconomic factors a linear regression model would be helpful:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3$$

Where; Y is the measure of the country's life expectancy, x_1 stands for the income index of the population, x_2 stands for the population's education index, and x_3 for the population's unemployment rate

Life Expectancy = $\beta_0 + \beta_1$ (Income Index) + β_2 (Education Index) + β_3 (Unemployment Rate)					
Residuals					
Minimum	1 st Quartile	Median	3 rd Quartile	Maximum	
-18.75	-2.36	0.58	3.25	10.84	
Coefficients					
	β	Std. Error	T value	P value	
(Intercept)	41.07	0.37	109.63	$< 2 \times 10^{-16}$	
Income Index	24.51	0.90	27.15	$< 2 \times 10^{-16}$	
Education Index	21.24	0.91	23.32	$< 2 \times 10^{-16}$	
Unemployment Rate	-0.11	0.02	-7.06	2.18×10^{-12}	

$Y = 41.07 + 24.51x_1 + 21.24x_2 - 0.11x_3$

From the model above, we can predict the changes on Life expectancy when the variables are increased by one unit. The Life Expectancy increases by 24.51 when the Income Index increases by 1. The Life Expectancy increases by 21.24 when the Education Index increases by 1, and the Life Expectancy decreases by 0.11 when the Unemployment Rate increases by 1; to make an accurate prediction when a variable increases, all other variables must remain constant. From this model we can see that the studies done by Kabir, Hill and King, Gulis, and Williamson and Boehmer are accurate, the Income status of the population and the education does correlate positively with Life Expectancy.

Correlations

As stated by Kabir, and the World Bank, the average income of the population has a positive correlation with health. The reason for this correlation is that people with a higher income have more access to health care and health promoting assets, and in turn this will allow them to have a better and healthier life. And according to The Health Foundation (2021) health also affects income, a better health allows people to gain and sustain employment, can reduce the costs they face from ill-health and allows them to have more options such as a more active life



People with lower incomes are more likely to report their health as 'bad' or 'very bad' Self-rated health and employment rate by household income, adults aged 55 years and under: UK, 2018/19

Graphical representation of correlation between health and net household income

The figure above is obtained from The Health Foundation (2021) that shows how income has an effect on the health conditions of individuals. A decreasing pattern can be observed in the graph as the net household income increases from 2.5% reporting to be in "Very bad" condition to 1.1% reporting to be in "Very bad" condition. Therefore, to increase the average life expectancy, and increase in the income of the population.



GNI against LIfe Expectancy

The figure above represents the effect of the higher value of GNI on the Life Expectancy from the data used to generate the linear model. The figure shows an increasing trend, the average life expectancy increases as the GNI of the country increases which proves that the statement made by The Health Foundation was correct. However the rise in life expectancy decreases after \$20000, this is might be because at \$20000 the individual's needs are fully met and any further increase in GNI does not affect the life expectancy drastically

Income Inequality and Wealth

Income Inequality refers to how unevenly income is distributed throughout a population. The less equal the distribution, the higher income inequality is. Populations can be divided up in different ways to show different levels and forms of income inequality such as by sex or by race. Different measures such as the GINI coefficient can be used to analyze the level of income inequality in a population ("How Income Inequality Works", 2021). Income inequality is responsible for the worsening of the wealth of poor people and improving the wealth of the rich



Distribution of Family Wealth, 1963-2016

Source: Urban Institute calculations from Survey of Financial Characteristics of Consumers 1962 (December 31), Survey of Changes in Family Finances 1963, and Survey of Consumer Finances 1983-2016. Note: 2016 dollars.

The figure above illustrates a region with high income inequality in America from 1963 to 2016. The poorest 10% of Americans went from having zero assets to being \$1000 in debt; Middleincome families more than doubled their prior average wealth; Families in the top 10% had more than five times their prior wealth and Families in the top 1% had more than seven times their prior wealth. Within the United States, the lowest GINI value is 0.386 in 1986 and had risen to 0.489 in 2020 according to the Federal Reserve Bank of St. Louis

However, wealth and income are similar yet they are different. Income refers to the money earned as a return for work or investments, and wealth refers to the money or assets accumulated by a person during their life. Though they are different, higher income levels can contribute to the family's wealth more than lower income levels and a hence a higher wealth level can also show a positive correlation to good health as well as higher income

Education Gap

The relationship between education and income is strong. Education is often referred to as an investment in human capital. In general, those with more education earn higher income than with lower education (Wolla & Sullivan, 2021).

Education	Percentage of Families	Median Income (2013)	Median Wealth (2013)
No High School Diploma	12%	\$37,766	\$37,766
High School Diploma	50%	\$41,190	\$95,072
Two- or Four-year Degree	25%	\$76,293	\$273,488
Advanced Degree	13%	\$116,265	\$689,100

Family Financial Outcomes Based on Education according to the Federal Reserve Bank of St. Louis

The effect of Education on GNI



The relationship between education and wealth is also strong. A higher income makes saving easer, and saving is necessary to build wealth. Those with lower income have a flatter income pattern,

making paying debt and saving more difficult, and those with more education tend to make financial decisions that contribute to building wealth, such as: having liquid assets, diversifying and keeping debt relatively low to assets

Education on Life Expectancy

As the study conducted by Williamson and Boehmer suggests, Education does in fact play a positive role in Life Expectancy, and this conclusion is further supported by the model generated by this report, where the Education index of a country positively correlates with the life expectancy. A higher education level not only provides the means to improve the socioeconomic conditions in which people live and work, but also promote the adoption of healthier lifestyles and facilities access to appropriate health care ("Life expectancy by sex and education level", 2017).



The effect of Education on Life Expectancy



Education on Employment Rate

Education has a substantial impact on employment prospects. On average, over 80% of the population with tertiary education is employed. The average falls to over 70% for people with upper or post-secondary non-tertiary education and to less than 60% for those without an upper secondary education within the OECD countries. The probability of working full time also increases with the level of education. Some 64% of employed adults with below upper secondary level of education work full time, compared with 74% of the employed with a tertiary education ("How does education affect employment rates?", 2014) Within the United States, the overall unemployment rate was 4.6% in 2016, however the unemployment rate for college graduates was 2.3% while those with less than a high school diploma was 7.9% (Wolla & Sullivan, 2021).



NOTE: In November 2016, the overall U.S. unemployment rate was 4.6 percent, but level of education matters. The unemployment rate for college graduates was 2.3 percent, while that for those with less than a high school diploma was 7.9 percent. SOURCE: FRED®, Federal Reserve Bank of St. Louis. Accessed December 21, 2016; https://fred.stlouisfed.org/graph/?g=8ds7.



The effect of Education on Unemployment Rate

However, from the figure above, using the data used to generate the linear model, it appears that the data does not seem to support the previous statement made by the Federal Reserve Bank, this may indicate that Education alone might not be enough to form a concrete conclusion that it has a positive or negative effect on the unemployment rate, as the skills of the individual or the demographic of the population might be also be a leading factor to the changes on the Unemployment Rate.

Limitations to the Research

For the relationship among education, income, and wealth. It is more complicated than simply more education yielding a higher income and more wealth. Factors such as natural ability and family background also impact both income and wealth and are not caused by having more education (Wolla & Sullivan, 2021), these factors are not included in the data used for the formation of the model.

Conclusion - Summary

The research was based on international data from 2000 to 2015 for the life expectancy, income index, education index, and the unemployment rate to determine if there are any correlations between life expectancy and the variables as well as how strongly they correlate. The lowest recorded life expectancy was in Sierra Leone with an average of 39.44 years, with Income Index of 0.29, Education Index of 0.27, and Unemployment Rate of 3.44%, and the highest recorded value of life expectancy was in Hong Kong with an average of 84.28 years, with Income Index of 0.96, Education Index of 0.85, however the unemployment rate was missing within the research

Based on the model, Income and Education have a positive correlation with the life expectancy, where a higher income or education will lead to a higher life expectancy, and the unemployment rate has a negative correlation with life expectancy, where a lower unemployment rate will lead to a higher life expectancy. Though they all correlate significantly to life expectancy, the income is a large factor which alters the life expectancy with 24.51 unit increase in life expectancy for every 1 unit increase in income, Education alters the life expectancy less than income, the life expectancy increases by 21.24 unit for every 1 unit increase in education, and the unemployment rate is less impactful to life expectancy but is still significant, for every 1 unit increase of unemployment rate, life expectancy decreases by 0.11.

The income level, Education level and the unemployment not only correlates with the life expectancy but also correlates with each other, the education can provide opportunity for a higher income and provides better chances for employment, hence improving the employment rate and the income index, a lower unemployment rate would provide a higher average income in the country due to more population earns income and with a higher income, the access to higher education is more open in addition to easier access to health care facilities and health care assets.

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