Life Expectancy from WHO Dataset

Shi Tang

21/04/2022

Introduction

What aspect(s) should be considered in order to increase life expectancy?

A person's life expectancy is a statistical measure of the average time is expected to live, based on several factors such as birth, age, and other demographic factors. Indeed, the United Nations estimates a global average life expectancy of 72.6 years for 2019 – which is higher than in any country back in 1950. Therefore, I am interested to find the factor(s) contributing to the increase in life expectancy using predictive model.

The data was from Kaggle https://www.kaggle.com/kumarajarshi/life-expectancy-who. The data contains information related to life expectancy, health, economic and other factors for 193 countries from year 2000 to 2015. The original data related to life expectancy, health factors for 193 countries have been collected from `WHO` data repository website and its corresponding economic data was collected from `United Nation` website.

Methods

First, we need to import the data-set. The data-set consists of 22 columns and 2938 rows.

The following table shows all factors and their corresponding missing values count and percentage:

Factors	missing (count)	missing (%)
Country	0	0.000
Year	0	0.000
Status	0	0.000
Life expectancy	10	0.340
Adult Mortality	10	0.340
infant deaths	0	0.000
Alcohol	194	6.603
percentage expenditure	0	0.000
Hepatitis B	553	18.822
Measles	0	0.000
BMI	34	1.157
under-five deaths	0	0.000
Polio	19	0.647
Total expenditure	226	7.692
Diphtheria	19	0.647
HIV/AIDS	0	0.000
GDP	448	15.248
Population	652	22.192
thinness 1-19 years	34	1.157
thinness 5-9 years	34	1.157
Income composition of resources	167	5.684
Schooling	163	5.548

From the above table, most of the columns have missing values. We also observed that some columns have naming issues. We will rename all the columns by removing white spaces and replace missing values with mean value.

Factors	missing (count)
Country	0
Year	0
Status	0
Life_expectancy	0
Adult_Mortality	0
infant_deaths	0
Alcohol	0
percentage_expenditure	0
Hepatitis_B	0
Measles	0
BMI	0
under_five_deaths	0
Polio	0
Total_expenditure	0
Diphtheria	0
HIV_or_AID	0
GDP	0
Population	0
thinness_1_19_years	0
thinness_5_9_years	0
Income_composition_of_resources	0
Schooling	0

Looking closer into every factor, the factor `Status` is the country status according to WHO standards, `Developed` or `Developing`, which is non-numerical. We will transform it into a new binary numerical variable called `developed`, so that developed country is 1 and developing country is 0.

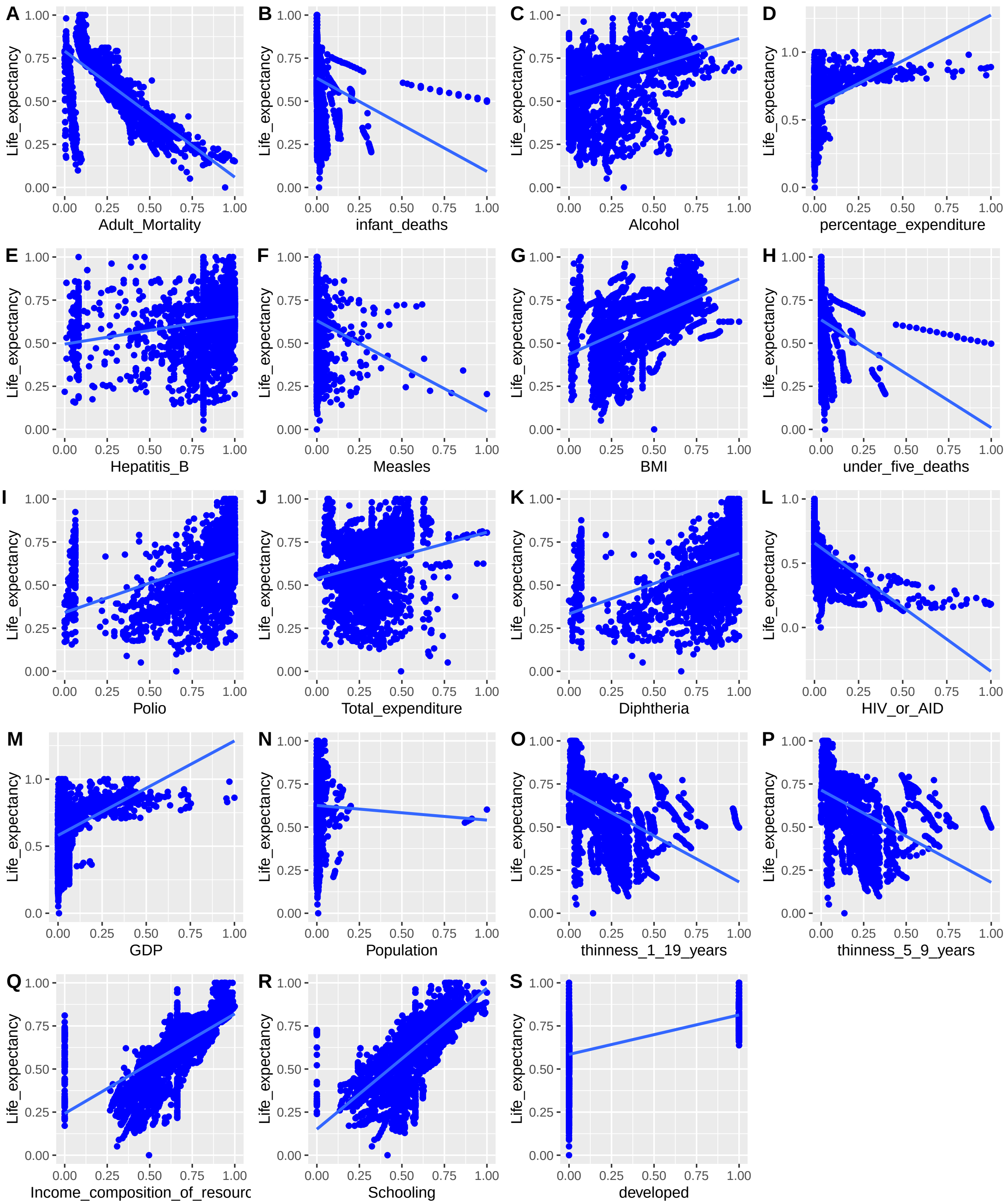
Also, we need to perform data normalization for each numeric columns in the dataset to a common scale, without distorting differences in the ranges of values, therefore, we will choose min-max normalization technique to do so:

$$\text{Min-Max Normalization} = \frac{(X - min(X))}{(max(X) - min(X))}$$

Since we are interested in life expectancy, we will check the distribution of it. Below is the histogram of life expectancy, and it is normally distributed and thus fitting a linear regression is appropriate.

There are also interactive histograms for every factor, please check the visualization on the website.

Now, lets visualize the distribution of life expectancy against all variables.



There are also interactive scatter plots that correspond to the above section, please check the visualization on the website.

From the above scatter plots, we can quickly tell that factors `Measles`, `under_five_deaths`, `Polio` and `Population` have no significant linear relationship with life expectancy. We will double check that by fitting a linear model for each variable with life expectancy.

Variable	Adjusted R Squared
Adult_Mortality	0.4847
infant_deaths	0.03827
Alcohol	0.1531
percentage_expenditure	0.1455
Hepatitis_B	0.0412
Measles	0.0245
BMI	0.3125
under_five_deaths	0.04918
Polio	0.2128
Total_expenditure	0.04293
Diphtheria	0.2258
HIV_or_AID	0.3094
GDP	0.185
Population	4.55e-05
thinness_1_19_years	0.2227
thinness_5_9_years	0.2175
Income_composition_of_resources	0.4793
Schooling	0.5111
developed	0.232

The above table shows the adjusted R squared for the linear model, and we will only consider the factors with adjusted R squared higher than 0.15. Therefore, we will drop factors `infant_deaths`, `Alcohol`, `percentage_expenditure`, `Hepatitis_B`, `Measles`, `under_five_deaths`, `Total_expenditure`, `GDP` and `Population`.

Results

After dropping factors not required, we fit a linear regression using the rest of factors. The table below shows the summary table of each factor, and it can be seen that the p-values for factors `thinness_1_19_years` and `thinness_5_9_years` are considerable large, meaning that these two factors are not significant in this linear regression.

Characteristic	**Beta**	**95% CI**	**p-value**
Adult_Mortality	-0.28	-0.30, -0.26	<0.001
BMI	0.08	0.06, 0.09	<0.001
Polio	0.06	0.04, 0.07	<0.001
Diphtheria	0.08	0.06, 0.09	<0.001
HIV_or_AID	-0.45	-0.49, -0.42	<0.001
thinness_1_19_years	-0.06	-0.11, -0.01	0.027
thinness_5_9_years	0.01	-0.05, 0.06	0.8
Income_composition_of_resources	0.12	0.10, 0.15	<0.001
Schooling	0.28	0.25, 0.31	<0.001
developed	0.04	0.03, 0.05	<0.001

Therefore, we will drop factors `thinness_1_19_years` and `thinness_5_9_years` and construct a new linear regression.

Characteristic	**Beta**	**95% CI**	**p-value**
Adult_Mortality	-0.28	-0.30, -0.26	<0.001
BMI	0.09	0.08, 0.11	<0.001

Characteristic	Beta	95% CI	p-value
Polio	0.06	0.04, 0.07	<0.001
Diphtheria	0.08	0.06, 0.09	<0.001
HIV_or_AID	-0.46	-0.49, -0.42	<0.001
Income_composition_of_resources	0.12	0.10, 0.15	<0.001
Schooling	0.29	0.25, 0.32	<0.001
developed	0.04	0.04, 0.05	<0.001

In order to evaluate our model, we will split the dataset into training and testing set into 75% of training data and 25% of testing data. The mean squared error of testing set is 0.0061, which is quite small, we can conclude that the model is considerably appropriate.

Conclusions and Summary

In conclusion, from the linear regression model, in order to increase the life expectancy, we should increase the vaccination coverage of Polio and Diphtheria. Also, reduce the risks of adult mortality and HIV/AIDS. Measures should be taken to provide better education, country development and health care.