China's Aging Population and Government Healthcare

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Abstract: China is currently the most populated countries in the world, and its population will continue to age rapidly throughout 2050, thereby creating one of the largest elderly populations in the entire world. Unfortunately, the country also has a poor healthcare system, as many people have inadequate access to quality healthcare, and therefore cannot seek sufficient medical treatment or afford their medical bills. Consequently, healthcare is a major issue that needs to be addressed. In this project, we experimented with Jupyter Notebook to look at multiple data sets that reflected various population, healthcare, and government expenditure metrics of China. Specifically, using numpy, pandas and matplotlib, we gathered, cleaned, and modified, and visualized the datasets to best express our findings. In our visualization, we used various types of graphs that would best display and explain our observations, and also included a heat map created through the Basemap toolkit in matplotlib. Regarding future endeavors, we wish to collect more specific and relevant datasets pertaining to China to reach, as large datasets related to China are difficult to find in the United States. With these data sets, we can perform a deeper level of analysis.

I. China Healthcare Understanding

Prior to 2016, China's healthcare system was composed of three major health insurance programs: Urban Employment-Based Basic Medical Insurance, Urban Resident Basic Medical Insurance, and Rural New Cooperative Medical Scheme. These three insurance programs covered 283.3 million, 314.5 million, and 736 million people, respectively. In 2016, the government merged the URBMI and RNCMS programs. It has been widely understood that China has been failing to provide adequate healthcare to many of its citizens, especially the elderly, as there are multiple limitations regarding China's social security system. First, the RNCMS program has not increased inpatient or outpatient expenditures, as one would normally see with the support of an insurance program. Moreover, many medications are not readily available in local rural communities, and when travelling to urban areas, the elderly find out their insurance does not cover the medications provided. In regards to providing for the elderly, the government is lacking as well. In 2014, income failed to cover the expenditure on pensions in 22 out of 30 mainland provinces, forcing all levels of government in those provinces to subsidize the pensions. In all provinces, population aging is gradually becoming more noticeable, and the growth in the number of retirees insured is higher than the number of contributors. Furthermore, in rural areas many people are lacking the necessary medical resources.

This project aims to bring awareness regarding the rising urgency of the aging population issue in China. While the government intends to increase its healthcare expenditures to 6.5-7% of its GDP by 2020, we would like to emphasize how more effort and spending is needed to address this healthcare issue. To do so, we will analyze the projected changes associated with population shifts, and examine China's government healthcare system in terms spending, and compare it to the rest of the world. Furthermore, we will display our

analysis regarding the relationship between government expenditure and health levels across the world. Through our findings, we hope the government and other organizations will see the need to help the Chinese elderly population and take action as well.

II. Data Understanding

We downloaded the majority of our data sets from the World Bank website, as the site contains multiple datasets covering health and economic indicators, including those pertaining to China. Particularly, we used Google Data Explorer to scan for relevant data sets and extracted those datasets through links that led us to the World Bank website. We also gathered data from various research papers, including those that had data regarding the projection of China's population and the situation of the elderly population.

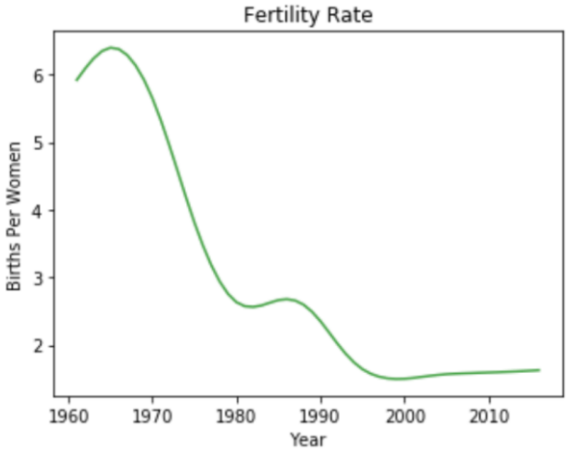
III. Data Preparation

Much of the data we compiled was either poorly formatted or contained unnecessary information, so naturally our first step was to condense the data. The data was downloaded as CSV files, so we first read the necessary CSV files on to Python as DataFrames and began the cleaning process using the pandas package. We dropped null values to avoid errors, and also dropped unnecessary columns. We filtered through the data to find countries of interest (e.g. US, Germany, France) and formatted the dataframes to be plotted. For some information, we used slicing and merging to mine through the data and further condense it, so that we were left with all relevant information. To plot the data, we used the matplotlib package, and plotted line graphs and scatter plots.

IV. Causes of Population Shift

The first step in examining the population shift is to see what the causes are. In the middle of the 20th century, it was very common for families in China to have multiple kids so that there were more people to support the growth of the family. This pattern was especially prominent in rural areas, as farmers depended on their kids to help out on the field as well. However, with the rise in technology and urbanization, we have seen a shift in the desirable number of kids. To examine this trend, we gathered fertility rate data in China through the World Bank Data website and created a line graph, plotting years against number of births per woman.

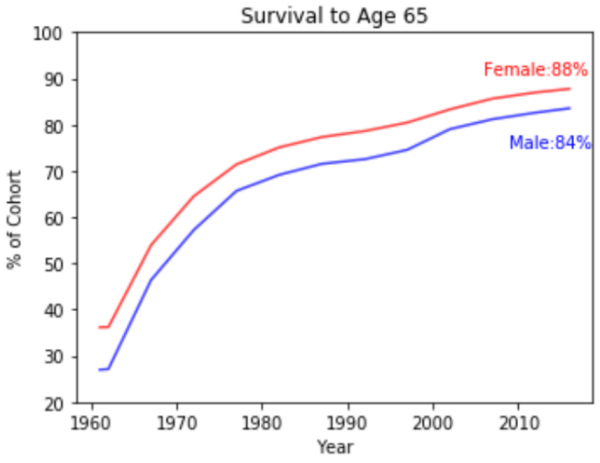
Figure 1: China's Fertility Rate



From *figure 1*, we can clearly see that over time, the fertility rate has significantly decreased since the mid-1960s, and plateaued around 1.5 kids per woman (most likely due to the enforcement of the one child policy). In 2015, the one child policy was repealed, so it will be interesting to see if the fertility rate increased.

Furthermore, there is another variable of interest: life expectancy. Aside from the increase in fertility rates during the mid-20th century, life expectancy also plays a critical role in determining the age structure in a population. With the rise of modern medicine, it is believed that life expectancy has increased across the world, and we wished to examine the trend in China. If life expectancy increases, that means the elderly population will increase as the elderly will stay alive longer. While looking for data metrics to measure life expectancy, we came across the metric, "survival to age 65 (% of cohort)." In other words, the metric essentially indicates the percentage of babies that will survive to age 65. We believed this metric would be a fantastic measurement of life expectancy. That said, we gathered data again from the World Bank and created a line graph for the chances of survival to age 65 for both males and females.

Figure 2: Life Expectancy



In the graph, we see that over the past five decades, the chance of surviving to age 65 has increased nearly ~55% (males increase from ~25% to 84% and females increase from ~35% to 88%).

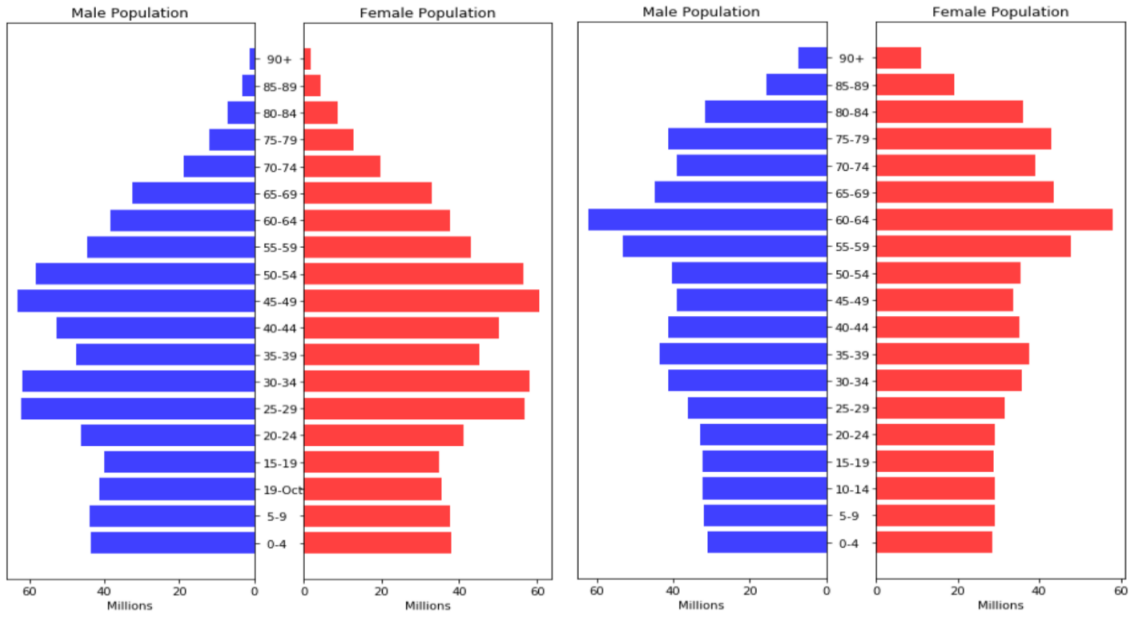
Ultimately, we see that that fertility rates have been decreasing and life expectancy has increased over the past five decades, as shown by data from the world bank. While fertility rates have seemed to flatten out lately, life expectancy continues to increase, and with the continual development of new pharmaceuticals and biotechnologies, it may continue increasing for the next couple decades.

V. Effects of Population Shift

Though our initial theory was that the elderly population was going to grow significantly, we wanted to confirm the belief. As such, we researched for data displaying the population breakdown of China's male and female population by age group in 2018. Additionally, we looked for data displaying the projected population breakdown of China's male and female population in the future. Taking a look at *figure 3*, we see China's current age structure on the left. The majority of the population lies in the 25-54 age range, creating a shape that spikes out near the center of the bar graph. On the right, we displayed China's projected age structure in 2050. Here, we can see there has been a shift in age groups. The majority of the population now lies above the 55 age mark instead of the 25-54 age group, creating a somewhat inverted pyramid shape in the graph.

Now that we have confirmed the projected age population is going to weighted heavily in the older age group, we would have liked to see the population distribution of theelderly population (65+) across the different areas of China. To examine the potential effects, we found a new dataset that

Figure 3: Elderly Population Across China



took the elderly population of each province in China, as well as the projected elderly population in 2030 for each province. To demonstrate the change in population across the province, we created a double bar graph with the provinces laid out on the x axis (see figure 4). From an initial look, we see that the 2030 bar is higher than the 2010 bar in all provinces. To conduct a more detailed analysis, we modified the data set to create a percentage change column for all the provinces and took the five-number summary *(see figure 5).* Unsurprisingly, we see that across all provinces, the median for population change is a 78.5% increase and the mean is an 84% increase. The minimum and maximum percent changes are still significant, standing at ~42% and 211%, respectively. Other statistics included a 25 percentile of 68% and 75 percentile of 95%.

Figure 4: Elderly Population Across China

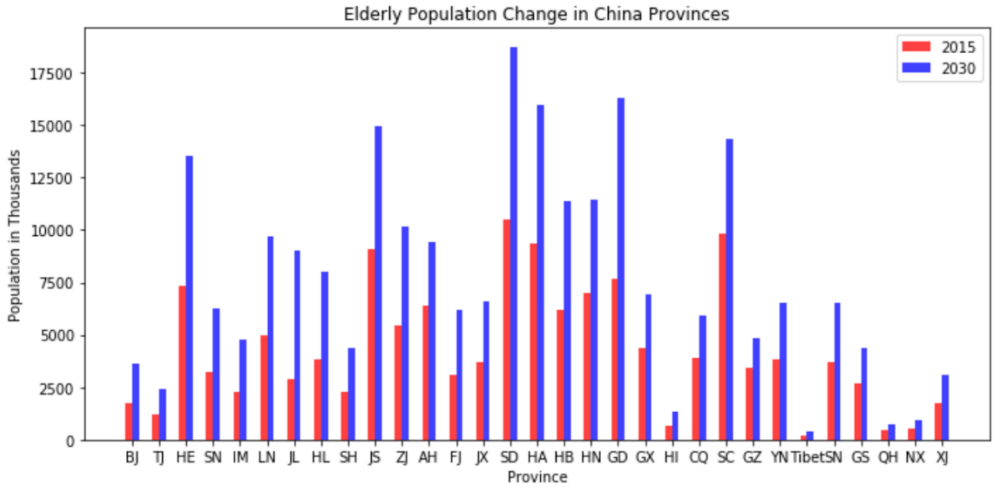
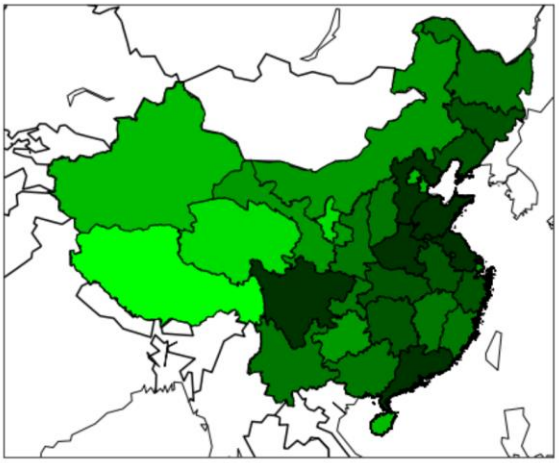


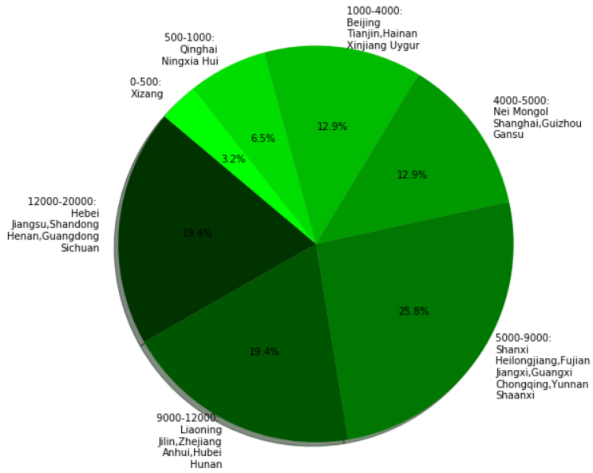
Figure 5: Population Statistics

	% change
mean	83.974825
std	30.465180
min	42.330211
25%	67.748280
50%	78.497110
75%	95.013054
max	211.134092

Furthermore, we projected this change in age structure across China through a heat map. To create these maps, we used Basemap, located in matplotlib's toolkits. This allowed us to create a visualization of China's map. Since Basemap does not have the information to draw the province lines in China, we had to download the information from a third party website, save it into the same directory as Jupyter notebook, and then draw the province lines. Additionally, the colors represent the population density of the elderly population in each province. This data is the same as the 2030 projected population in the double bar graph. The pie graph below the heat map organizes the provinces into population increase by number in millions. From the map, we can see that both rural and urban areas have a significant increase in the elderly population size (rural areas are generally more inland and urban areas lie more towards the coast). While the urban area elderly population increases are as expected, it's interesting to see that the rural population does not lag far behind, and therefore may pose a serious issue for the Chinese government to handle moving into the future. Essentially, only the extremely western regions have very little population growth.

Figure 6: China 2030 Population by Province

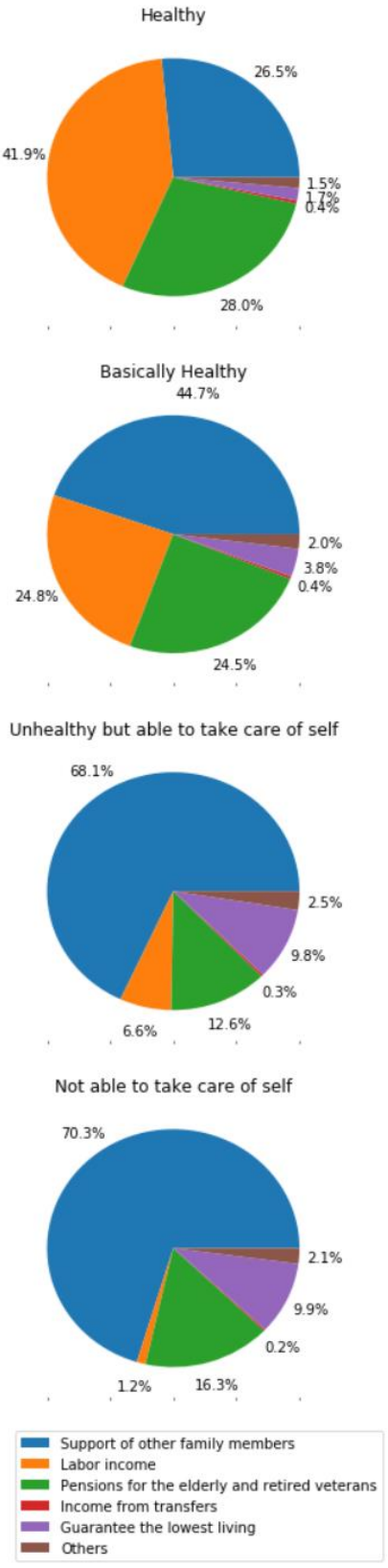




VI. Elderly Dependency

After establishing the causes and effects of the growing elderly population, we will now analyze our findings with the effects on healthcare. First, we looked at how the elderly receive money in China. The dataset we found splits up the elderly population into four groups: healthy, basically health, unhealthy but able to take care of self, and unable to take care of self. We created a pie chart of the distribution of income sources for each group and essentially found that regardless of group classification, a significant portion of the elderly population relies on family for income.

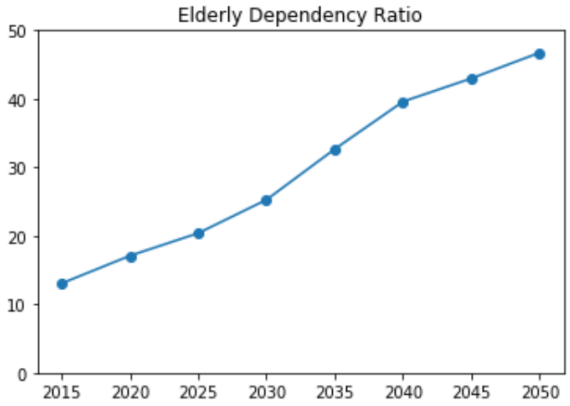
Figure 7: Elderly Income Distribution



Taking into account the number of elderly in each group, of the entire elderly population, 40.72% depend on support of other family members for income. This is problematic because as we found out earlier, life expectancy is increasing and fertility is decreasing. Consequently, the elderly will need support for a longer period of time, as they live for longer, and they will have less forms of support, as families commonly have less kids now.

Additionally, we examined the elderly dependency ratio. As people get older, they begin retiring and the new generation of workers replaces them.

Figure 8: Elderly Dependence ratio



The elderly dependency ratio measures the ratio of the elderly with those in the labor force, and measures pressure productivity. For instance, if the elderly dependency ratio is 13, that means there are 7.69 workers per elderly adult in China. However, as we have seen with the elderly population projected to increase and the labor force projected to be a smaller portion of the population, we find to no surprise that the elderly dependency ratio increases to 46.74 in 2050 *(see figure 6)*, meaning that there will only be 2.14 workers per elderly adult.

Pensions also account for a fair amount of elderly as a source of income, and when there are less workers, there is less money going into pensions. In fact, 22 out of 30 provinces in 2014 could not cover their pensions through income, and governments of all levels had to subsidize them.

VII. Government Healthcare Expenditure

The next step in our analysis is to see how much the government is currently spending on its healthcare programs. It is important to see how much the government places importance on healthcare, and see if the government should be increasing its expenditure. We looked at health expenditure as a % of GDP and health expenditure per capita by country for China. Then, we took China's numbers and compared them to other countries with similar economic and development statuses across the world *(see figure 9)*. In both categories, we see that China is spending a significantly smaller amount than all other countries in the graph. In 2015, when looking at health expenditure relative to GDP, China spent 4.6% less than the average. Additionally, in regards to health expenditure per capita, China is spending significantly less than other developed countries, and even lower than the global average of $1,002, which includes developing countries. We must note that the government plans to raise its healthcare expenditure to 6.5-7.0% of GDP by 2020, but this is only a 0.5% increase. Therefore, on a comparable basis, we believe it is reasonable for China to increase its healthcare expenditure to a greater portion of its GDP, as 7% is still lower than all other countries. Although it may take time for China to catch up, it should increase its urgency to do so.

Figure 9: China Healthcare Expenditure

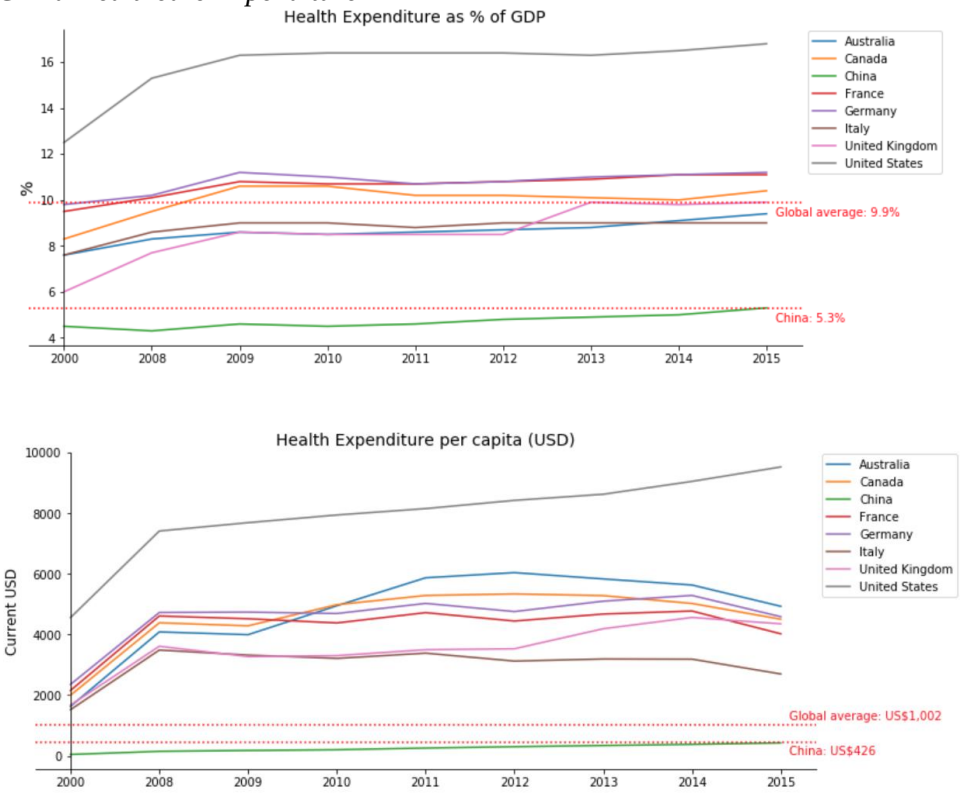
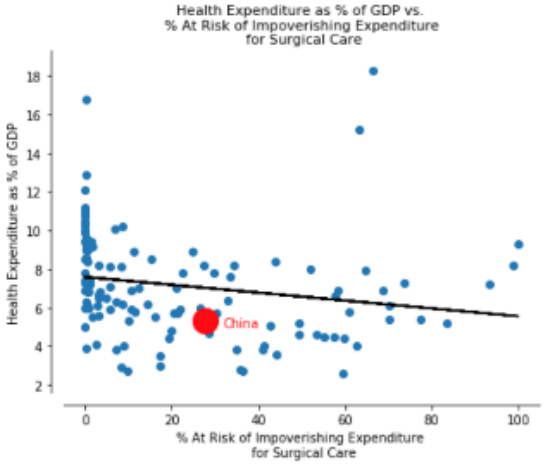


Figure 10 : Healthcare Expenditure Correlations



VIII. Healthcare Expenditure and Country Health Relationship

The last step of our analysis was seeing if there is a relationship between government spending and health levels of a country. We chose to use health expenditure as a % of GDP as our independent variable, and % at risk of impoverishing expenditure for surgical care and life expectancy as our dependent variables. As we can see from *figure 10*, there are some implications for the health of a nation regarding how much it invests in its healthcare. From the graph on the left, we can see that health expenditure as a percentage of GDP is inversely correlated (-0.194) with the percentage of people at risk of impoverishing expenditure for surgical care. While this is a weak correlation, we can clearly see that countries who spend less on health tend to disadvantage their citizens by forcing them to bear the burden of costly healthcare. It also illustrates the relationship between a nation's health expenditure and the income of its citizens. China sits below the trendline (y = -0.02x + 7.59), highlighting that health expenditure needs to be increased for China to match its comparable peers and to lessen the financial burden on its citizens.

The graph on the right further explains the relationship between health expenditure and the wellbeing of a nation's citizens. Life expectancy is positively correlated with health expenditure as a percentage of GDP (0.29), indicating that a nation's citizens live longer as their government invests more of the budget in healthcare. China sits in a promising area below the trendline (y = 0.1x - 0.46), indicating that its people tend to live for as long as other comparable nations that invest more in health. However, we can clearly see that there is a large cluster of nations above the trendline and to the right of the graph. These countries are largely Western nations who are also tackling the issue of an aging population, and their tendency to invest significant sums of money in their healthcare indicates that China likely needs to follow suit. China also lags behind Western peers (Australia, Canada, France, Germany, Italy, the UK and US) by 5.27 years in life expectancy.

IX. Conclusion and Future Work

From our analysis, we've observed that fertility rates were extremely high in the mid-20th century and have significantly decreased overtime. Additionally, life expectancy has increased. That said, we believe these two metrics are significant factors in the increasing elderly population. Furthermore, we see that the elderly population is going to increase in all areas of China, both urban and rural. Through an analysis of the elderly dependency ratio, we can see that the labor force is decreasing and therefore each member in the labor force will have to support a larger number of retired citizens. In terms of government healthcare expenditure, it is clear that China is lagging behind other developed countries and has room to step up its funding. We see that there are some positive relationships between the healthcare expenditures of a country and its citizen's health levels. Moving forward, we would like to gather more data sets relating to China, as data sets pertaining to China are difficult to find and may be limited in the United States.

X. Appendix

Ferenc, L.T., & Gui-Ying, C.., & Hizsnyik, E., (2008). Regional Population Projections for China

"Population Pyramids of the World from 1950 to 2100." *PopulationPyramid.net*, www.populationpyramid.net/china/2018/.

Quanbao, J., & Shucai, Y., & Sanchez-Barricarte, J.J., (2016). Can China Afford Rapid Aging?

World Bank, www.worldbank.org/.

Code is located at:
https://github.com/ml720/data_bootcamp_final_project.git

or

https://github.com/benteoh09/data_bootcamp_final_project.git