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How Hospital Bed Density Affects Life Expectancy

Introduction:

A myriad of factors come into play when discussing the factors behind the number of years a person is expected to spend on this planet. I would like to study the relationship between a peculiar indicator of life expectancy - hospital beds. Hospital beds are an interesting phenomena to study compared with the regular study of infrastructure through the number of doctors or hospital buildings present in conventional data analysis. I believe that the number of hospital beds provides an insight into the treatment capacity of a country unlike other variables. Studying the effects of a working health infrastructure provides a good indicator of the standard of living of its citizens. I would like to find patterns among countries that have similar life expectancies. I examine global data on the number of hospital beds per 10,000 people collected by the WHO. My findings reinforce the commonly held belief that hospital bed density has a positive correlation with the life expectancy of a country. I seek to identify and understand how these patterns have changed from 2010 to 2015. This examination is relevant in today's day and age as the global populus struggles to grasp the reality of a pandemic that has ripped through our social fabric. There is rampant inequality on the planet on account of the varying degrees of preparedness for an increase in patients.

This study analyzes the inequality in our capacity to care for people in the years leading up to the pandemic in the hopes of showing us a more equal way forward.

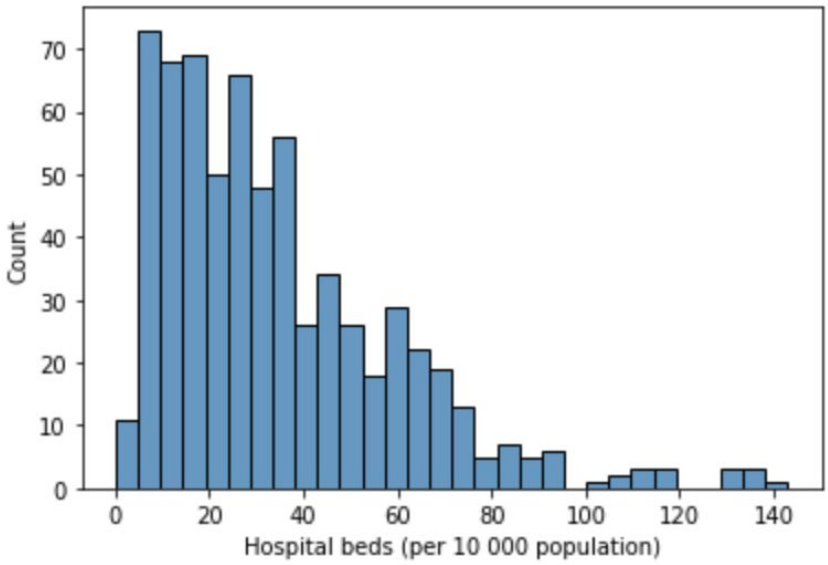
The literature surrounding life expectancy shows that a lot of studies on life expectancies assess macro trends such as GDP per capita (Erdil) and unemployment rates (McAvinchey). The studies by Erdil and McAvinchey were conducted to find correlation between the economic wellbeing of a country and its citizens life expectancy. Other factors such as inflation rates in economies on the Belt and Road initiative are also discussed (Bai). The Belt and Road countries are an interesting subgroup of the international landscape as they are mostly developing economies with unstable inflation rates. The aforementioned studies took a holistic view of the drivers behind life expectancy rates around the planet and in particular geographic regions. However, not all of the literature on life expectancy is centered around country level statistics. A large number of reports also focus on micro factors and assess the effect of healthy habits such as physical activity and consuming more fruits/vegetables and their impact on life expectancy (Reimers). These studies are important as they shift the focus to the individual consumer and how their habits affect their life. Along with macro and microeconomic factors, there is some literature on the role our natural environment plays on the declining life expectancy rates in some countries as pollution affects quality of life (Mariani). Rising global air pollution due to climate change might make this an increasingly pertinent topic in the coming years. The impact of government expenditure on healthcare in relation to life expectancy is also well documented for a number of countries (Self). Most literature revolves around finding the impact of certain variables

on life expectancy through correlation and implied causality. No existing literature seeks to identify patterns in existing health infrastructure and life expectancy.

Data:

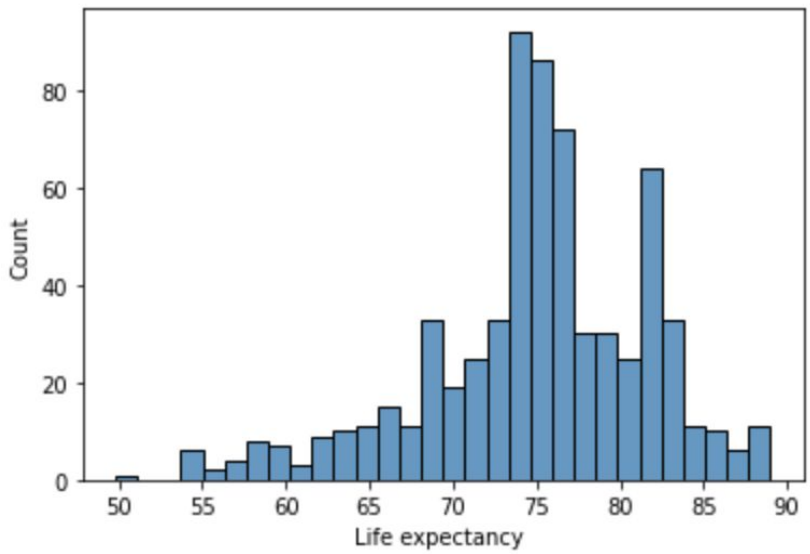
The data I am currently analysing belongs to the United Nations World Health Organization. I used data collected from 178 countries on the number of hospital beds per 10,000 people. This Data was compiled from the WHO Regional offices and modified to standardize the unit of measure per 10,000 population. Regional and global estimates are based on population-weighted averages weighted by the total population. These estimates are presented only if available data cover at least 50% of total population in the regional or global groupings. Hospital beds are used to indicate the availability of inpatient services. There is no global norm for the density of hospital beds in relation to total population. As seen in Figure 1, data for hospital beds was positively skewed, which showed that more countries around the world have fewer hospital beds.

Figure 1.



The second dataset I used was obtained from Kaggle. The user that posted this dataset to Kaggle, however, obtained this dataset from the WHO website and it is believed to be accurate for life expectancies. The dataset contains information on a number of statistics, ranging from Hepatitis cases to alcohol consumption but I am only interested in obtaining life expectancy numbers. Life expectancy at birth reflects the overall mortality level of a population. Final estimates of mortality rates for years were used to compute abridged life tables for 183 countries with populations of 90,000 or greater. There might be some inaccuracies in the data as a lack of complete and reliable mortality data, especially for low income countries forces WHO to apply modelling (based on data from other populations) to estimate life expectancy. I merged the two datasets to make the analysis more seamless. As the datasets belong to WHO, a reliable international resource, it is expected to be free of errors. As evidenced by Figure 2, life expectancy data was negatively skewed, as expected, as the average lifespan has continued to grow with scientific advancements over the last few decades.

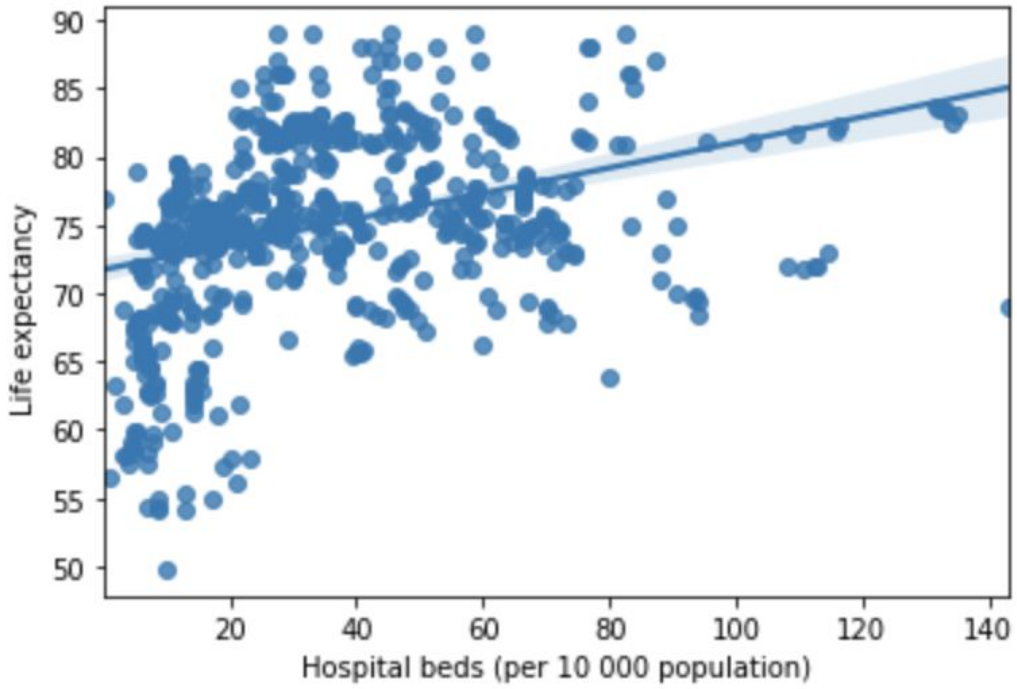
Figure 2.



Methods and Results:

I checked to see if there was a linear relationship between hospital beds and life expectancy in case supervised regression analysis might be considered. Figure 3 showcases a positive correlation between life expectancy and hospital beds. Although Figure 3 shows a positive correlation between hospital beds and life expectancy, the linear effect was not strong enough to warrant supervised regression analysis.

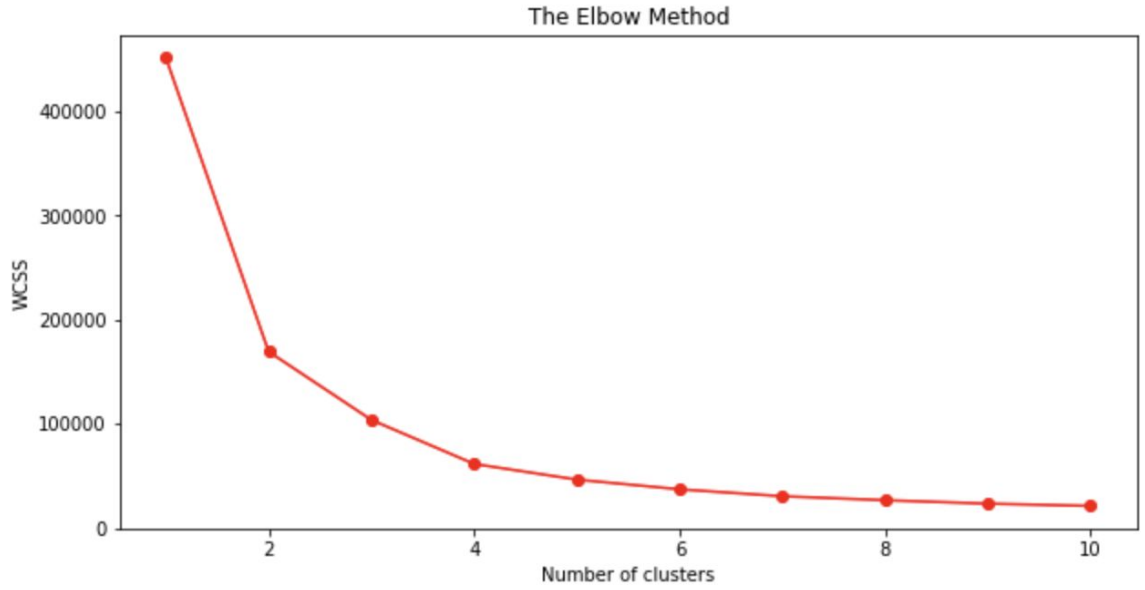
Figure 3.



I decided against regression analysis since there was not a lot of variation in the life expectancy statistics as it had a standard deviation of only 6.68. I conducted k-means clustering on data from the years 2010 to 2015 to study any patterns within the data. I picked the years 2010 to 2015 because it contained the most amount of data. I identified the number of clusters to use with a parameter known as WCSS. WCSS

stands for Within Cluster Sum of Squares. The Elbow Method is then used to choose the best K value. In Figure 4, we can see that after 4 there's no significant decrease in WCSS so 4 is the best choice. Therefore there's an elbow shape that forms and it is usually a good idea to pick the number where this elbow is formed.

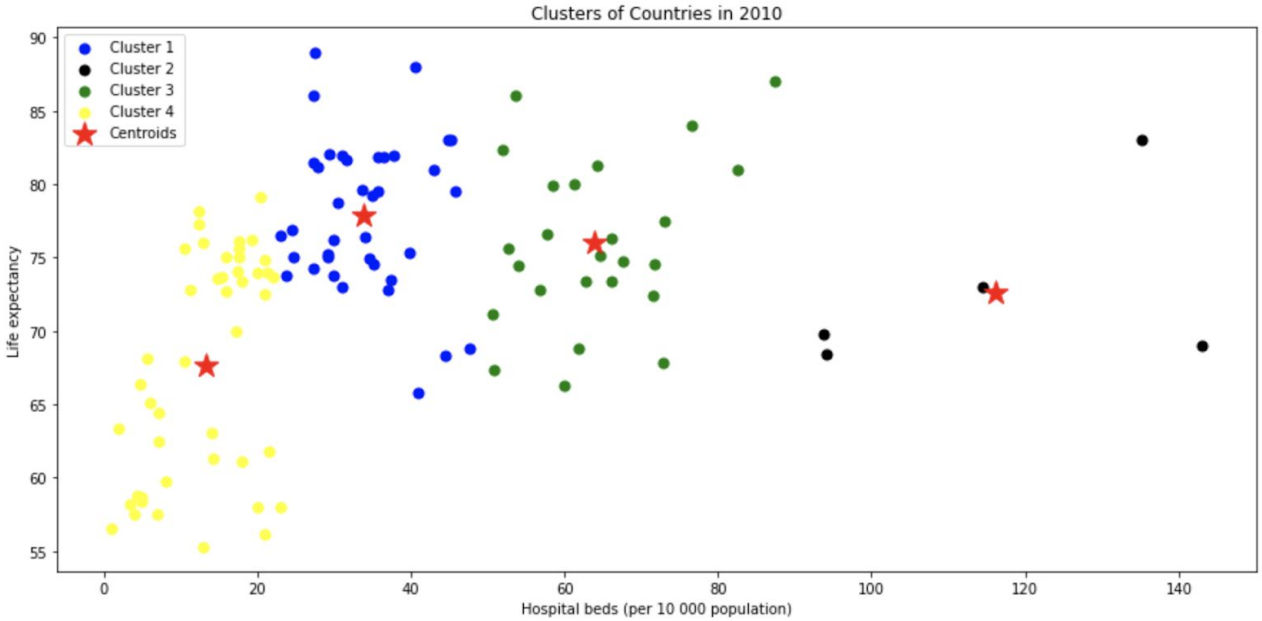
Figure 4.



The K-means clustering algorithm was used to find groups which have not been explicitly labeled in the data. This method was used to identify how the number of hospital beds provided by countries has increased over the years and whether there were any groups in the data. The algorithm was run and each country was assigned to a cluster with which it had the most similarities. Once the algorithm had been run and the groups were defined, any new data was easily assigned to the correct group. In my analysis, I plotted 113 countries included in the 2010 data with no missing data. As seen in Figure 6, the data consisted of 4 clusters with centroids indicated. Countries were

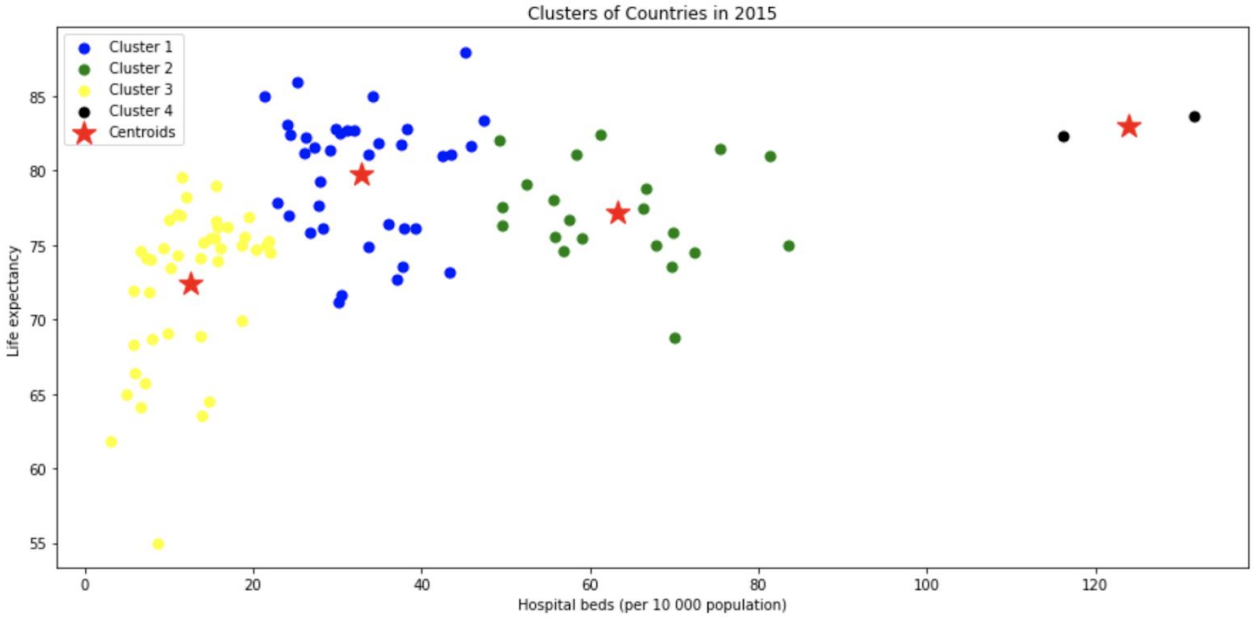
divided amongst the four clusters with 38 countries in cluster 1, 5 countries in cluster 2, 25 countries in cluster 3, and 45 countries in cluster 4.

Figure 6.



I conducted the same k-means clustering method with data from 2015. 103 countries were plotted in 2015 due to missing data for a few countries. Figure 7 shows that the data consisted of 4 clusters with centroids indicated. Countries were divided amongst the four clusters with 37 countries in cluster 1, 21 countries in cluster 2, 43 countries in cluster 3, and 2 countries in cluster 4.

Figure 7.



Discussion:

In Figure 6, it can be seen that in 2010, countries with the highest life expectancy did not necessarily have the highest number of hospital beds per 10,000 people. The highest placed centroid - indicating higher life expectancy - belonged to the cluster with the second lowest hospital beds number. Countries with the highest number of hospital beds were surprisingly worse off than two groups of countries with fewer hospital beds. In Figure 7, it can be seen that two countries became isolated from the rest of the world in terms of the number of hospital beds. These countries also ended up having the highest life expectancy, which was a far cry from the results seen in 2010. The largest number of countries stayed in the cluster closest to the origin. This shows that a huge chunk of the countries around the world have a lower life expectancy and health resources. Our analysis showcases that the discrepancy between the life expectancy of

presumably wealthier nations and developing nations did not decrease in the 5 years between 2010 and 2015. There was not a significant horizontal movement seen by the centroids except for the movement by the black cluster towards more hospital beds per 10,000 people. The movement of the black cluster shows that wealthy countries have been able to accumulate more wealth and prosperity for their citizens. All four centroids moved in an upward direction, indicating that global health standards rose from 2010 to 2015.

Our analysis is limited however, in the sense that it analyzes snapshots of data in time at 2010 and 2015 instead of a continuous study of how the data changed across the years. Our analysis also incorporates a single variable affecting life expectancy which is specific to hospital capacity. There might be a number of confounding variables or external factors to be considered, variables that have been touched upon by other literature. Our study has uncovered patterns of inequality among countries in terms of their life expectancy and hospital beds as there has been a prevalence of a small number of countries in a cluster doing significantly better than the rest.

Conclusion:

This research has analyzed the patterns prevalent between hospital bed density and life expectancy around the world. Our findings have concluded that, according to the k-means clustering method for WHO data, the variable hospital bed density positively affects the variable “life expectancy”. This research also showcases the rampant economic inequality that has subjected a significant portion of the global population to a life that is expected to be shorter than their more affluent counterparts.

This study is aimed at contributing to the progress of research on patterns of global health and inequality. An advantage of our analysis is that we have incorporated data from around the globe and explained how global inequality among health systems has grown. Differences between life expectancies based on a person's country of birth have grown too.

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