A STUDY ON THE MORTALITY PROFILE OF INDIA WITH RESPECT TO HOSPITAL STRENGTH OVER THE STATES

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1: INTRODUCTION :

In the early 20th century, India was under the British Rule. At that time, there were many causes for death. Some of them are war, famine, drought, flood, epidemic and many more. Later in that century, when India got freedom, there was many problems arisen. For this, number of deaths did not decrease that much. But slowly and steadily, those problems was solved. One of those problems was poor quality of Healthcare system which is improving day by day. There is some information given below about the growth, population size and death.

The story of mortality transition in India is truly a remarkable one. Mortality, which was high during the 19th century, started declining since the beginning of the 20th Century doubling the life expectancy at birth in the 20th century. It has reached 61.3 years for males and 63.0 years for females by 1997-2001. Recently, Chaurasia (2006) has made an attempt to study the mortality trends in the urban areas covering the period 1971-2002 and concluded that rate of decline in urban male mortality has been slower than that of urban female mortality in India. In their study of patterns of mortality at adult ages, Krishnaji & James (2002) concluded that gender differentials and rural urban differentials have narrowed down over the period from 1970s. However, their analysis was confined to adult mortality and that too only up to 1997. Further, a concern was raised with regard to the slower decline or stagnation in infant and child mortality in late 1990s, departing from the long-term trend observed in India since 1981. Mortality across British India was strikingly high in this period. The average life expectancy at birth during 1881-1920 was around 25 years- 25.3 years for males and 25.6 years for females during 1901-11- signifying very heavy mortality during the late 19th and early 20th century. Infant mortality rates outreached 200 in the country with high fluctuations. At higher ages, mortality fluctuation was nominal, despite its high level. The relative contribution of infant mortality over total mortality rate was higher. However, Bhat (1989) argued that India's high mortality regime during late 19th and early 20th century was characterized by extraordinarily heavy adult mortality. Mortality was high in India during the colonial period 1872-1947. Average life expectancy at birth during the period 1872-1921 was around 25 years. The high mortality regime was also characterized by extraordinarily heavy adult mortality. The high level of mortality during this period was mainly due to famine, plague, smallpox and influenza. After 1921, a marginal decline in adult mortality was observed, but mortality seems to have stagnated at high levels up to 1950. In the period of 1920-1947, efforts were made to reduce famine deaths and diseases of hunger. However, the impact of these efforts was not highly visible throughout the country. Mortality declined rapidly after independence. India's crude death rate declined from around 32 deaths per 1000 population during the mid-1940s to about 21 by the mid-1960s. The life expectancy at birth increased by around 14 years between 1951-61 and 1971-81. Though overall mortality was disadvantageous to females, Bhat (1987) has observed that the decline in mortality among female adults was relatively rapid during this period. Mortality in India declined rapidly after 1970s, and the life expectancy at birth of both males and females increased in all the states in the rural and urban areas (see appendix tables). Improvement

In life expectancy was more favourable to females than males. The increase in life expectancy of males and females were 11.2 and 14.5 years respectively in rural areas and 7.2 and 9.8 years respectively in the urban areas during 1971-2001. However, these improvements were below the standard set by the United Nations for a given mortality level. #

Health is a state subject as per the constitution of India. It is the responsibility of every state to make efforts for raising the health standard and standard of living of the targeted population and the advancement of public health as its primary function. Access to health care depends on how health care is provided. In India, the healthcare sector shows a tremendous improvement, since last few decades. This can be illustrated by the notable improvement in health indicators such as infant mortality, maternal mortality, and life expectancy at birth etc. Despite these improvements, India still faces many issues and gaps in the healthcare delivery system. Healthcare is one of the largest service sectors in India. However, healthcare sector can be viewed as a glass half empty or a glass half full. The healthcare system faces some challenges that are, reduction in mortality rates, improved infrastructure, availability of health personnel, etc. There is a considerable shortage of hospitals, hospital beds, and trained medical staff such as doctors and nurses, and so the accessibility among the public is not so good. The rural-urban imbalance also hampers access to health care services. In rural areas, the accessibility is significantly lower as compared to urban areas. Children and women are under-represented in the health care workforce. The majority of the Indian population lives in rural areas below the poverty line and they even don't have enough resources to finance their healthcare expenditure. The public health care sector is very poor and responsible for such health status of Indians. The private healthcare sector is mainly responsible for the majority of healthcare in our country. Out of total expenses on health, most of the expenses are paid out of pocket by patients and their relatives. According to NFHS-3, the private healthcare sector still remains the primary source of healthcare for almost 70 per cent of urban households and 63 percent of rural households. Almost 44 percent of all children are under-nutrition and maternal and child mortality rates are significantly higher, despite the big efforts by the government. Today, India is the third largest economy in terms of Gross National Income (GNI) in terms of Purchasing Power Parity (PPP) and has the capacity to grow more quickly and equitably to emerge as one of the developed nation. Against the strong economic growth and increased public health spending on healthcare in the country, it is about 4.1 percent of GDP in the 11th five-year plan. From the experience of the developed nation, it is observed that unless a nation spends at least 5-6 percent of its GDP on health care and the larger portion of it is from the government expenditure, the basic health care needs of the country are rarely met. The government healthcare spending in India is only 1.04 percent of GDP. The government has decided to increase the spending on health care to 2-3 percent through the pronouncement of many policies such as National Health Policy 2002, and the National Rural Health Mission (NRHM). Investment in healthcare rose very high in the beginning periods of NRHM. But at the peak of NRHM performance, investment in health care started stagnating at about 1.04 percent of GDP. The result of such stagnation is felt at the failure of

 # Source-
https://www.researchgate.net/publication/273461759_Mortality_Trends_and_Patterns_in_India_Historical_and_Contemporary_Perspectives

the health care delivery system to the people who need most and to expand the workforce in healthcare, even to train and retain the existing health care workforce. The disinclination or unwilling to provide for regular employment harms the service delivery system, management function, research and development functions of the government. The biggest constraint that the Indian healthcare system faces is the failure in attaining minimum levels of public expenditure in healthcare facilities and infrastructure. Experience from the international economies shows that health outcomes are closely related to the government health expenditure. From the BRIC countries, only Brazil and China show better performance and is considered to achieve the universal health coverage. Brazil spends 9.5 % of its GDP on health, but of this 9.5 %, the government expenditure on health constitute 47.5 % of GDP (Almost 45.7 % of total health expenditure). South Africa spends 8.9 % of its GDP on health, but of this percentage, the share of government Health expenditure as the percentage of total health expenditure is 48.4, China spends 5.4 % of its GDP, which is 56.0 percent of total health expenditure spend by the government. Russia spends 6.5 % of its GDP on health, out of this 51.1 % is spent by government as a percentage of total health expenditure. India spends only 3.8 per cent of its GDP on health, which is almost less than half as compared to other BRIC countries. Out of total health expenditure as a percentage of GDP, government expenditure on health constitutes only 30.5 % of this 3.8 % of total health expenditure of GDP. Today, India possess advanced technologies and knowledge to prevent diseases and to provide a proper health care for its people, yet the number of unhealthy people is still very high and other indicators of health such as CBR, MMR, IMR, TFR are also very high. Today, India has all the resources to intervene and to provide better health care to those in greatest need, but the existing intervention and resources did not match the power of the health system to deliver in a better way and on an adequate scale. From the table 2, we can say, that the health expenditure in India is relatively very low as compared to developed and some developing countries. [##]

In this project an attempt has been made to find, if there is any impact of Number of Hospitals on the CDR in India on the basis of 2011 census data.

2: OBJECTIVES :

The study has been conducted with a view to fulfil the following objectives: -

1: To analysis the data of the state wise CDR and Number of Hospitals to get an idea through graphical representation.

2: To analysis the data of state-wise CDR and Number of Hospitals to get an idea whether the total number of hospitals is dependent of CDR.

3: To fit a linear regression model to the data, if there exists a linear association between them.

Source-> *http://shodhganga.inflibnet.ac.in/bitstream/10603/186490/10/09%20chapter%202.pdf*

4: To extend the analysis in order to find the variation in dependency, between CDR and Number of Hospitals over the various regions in India, if exists.

5: To test the effect of the different hospital strength on the variability of the CDR over the states in India.

3: SUMMARY OF THE DATA SET:

Here we have the data on CDR and Number of Hospitals for each state in India from the census report 2011.Before the analysis, we define the two variables belongs to our study-

3.1: Crude Death Rate (CDR):

The Crude Death Rate (CDR) indicates the number of deaths occurring during the year, per 1, 000 population estimated at midyear. Subtracting the Crude Death Rate from the Crude Birth Rate provides the rate of natural increase, which is equal to the rate of population change in the absence of migration. Primary source of data for births and deaths is the registration of births and deaths under Civil Registration System (CRS) of the Office of Registrar General, India (ORGI). Since the reporting of deaths under CRS is not Complete, ORGI estates CDR annually through Sample Registration System, a large scale demographic survey conducted by them.

In this project, Crude Death Rate (CDR) is described as –

$$\text{Crude Death Rate} = \frac{\text{Total number of Deaths on a certain region on a certain time}}{\text{Total number of population on a certain region on a certain time}} \times 1000$$

3.2: Number of Hospitals:

Number of Hospitals is obtained from the addition of the numbers of Sub Divisional and District Hospitals. Here we are considering a hospital which has more than 30 beds. Here, for calculation purpose in ANOVA, we divided the Total number of hospitals into three levels and naming as a Hospital Strength. The levels are given below:

Level A -> Low Hospital Strength ->Number of Total Hospitals is 0 to 50

Level B -> Moderate Hospital Strength-> Number of Total Hospitals is 51 to 100

Level C -> High Hospital Strength ->Number of Total Hospitals is above 100

Table I: State Wise CDR and Number of Hospitals with Several Levels over Different Regions in India in 2011

Region	States	CDR	Sub Divisional Hospitals	District Hospitals*	Total Hospitals	Hospital Levels**
Eastern	Odisha	8.5	26	32	58	B
	Bihar	6.7	40	36	76	B
	West Bengal	6.2	45	16	61	B
	Jharkhand	6.9	10	21	31	A
Central	Chhattisgarh	7.9	17	17	34	A
	Madhya Pradesh	8.2	56	50	106	C
Northern	Delhi	4.3	49	9	58	B
	Haryana	6.5	25	21	46	A
	Himachal Pradesh	6.7	36	12	48	A
	Jammu & Kashmir	5.5	0	22	22	A
	Punjab	6.8	35	20	55	B
	Uttar Pradesh	7.9	0	72	72	B
	Uttarakhand	6.2	20	18	38	A
Western	Goa	6.7	0	2	2	A
	Gujarat	6.7	26	24	50	A
	Maharashtra	6.3	81	23	104	C
	Rajasthan	6.7	12	34	46	A
Southern	Andhra Pradesh	7.5	58	17	75	B
	Karnataka	7.1	146	31	177	C
	Kerala	7	43	14	57	B
	Tamil Nadu	7.4	231	30	261	C
North Eastern	Arunachal Pradesh	5.8	0	14	14	A
	Assam	8	13	24	37	A
	Manipur	4.1	1	7	8	A
	Meghalaya	7.8	1	10	11	A
	Mizoram	4.4	2	8	10	A
	Nagaland	3.3	0	11	11	A
	Sikkim	5.6	0	4	4	A
	Tripura	5	11	2	13	A

Source of CDR Data - https://data.gov.in/resources/state-wise-crude-death-rate-cdr-india-1971-2012

Source of Hospitals Data - https://data.gov.in/catalog/sub-divisional-hospitals-district-hospitals-and-mobile-medical-units-functioning-0

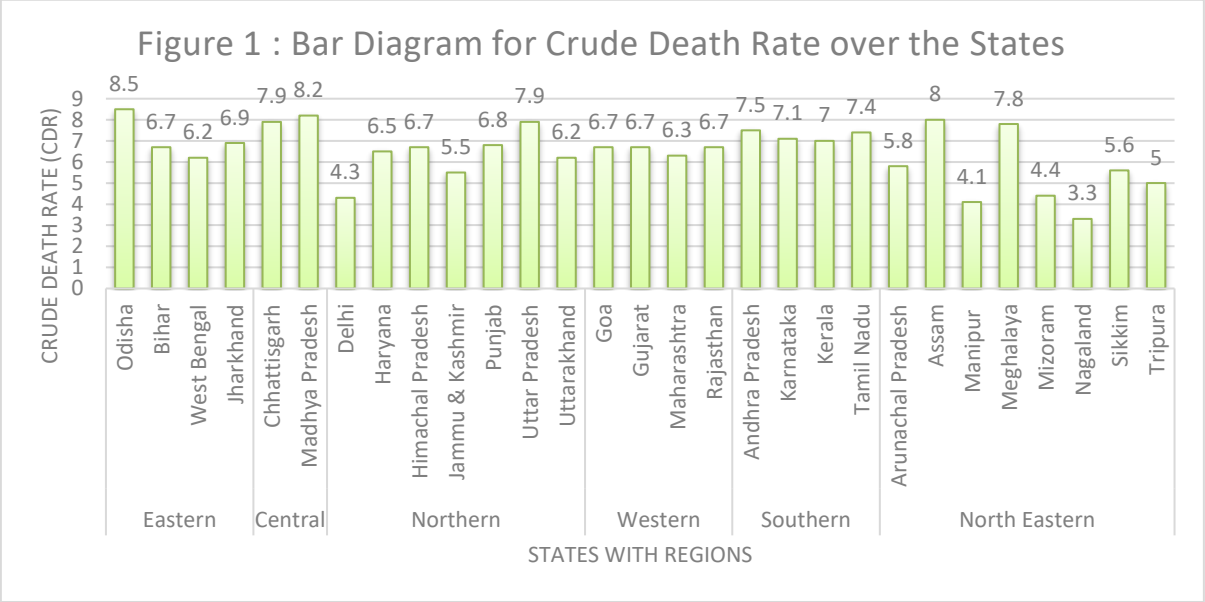
**Data for District Hospital taken from National Rural Health Mission State Data Fact Sheet for March, 2011 for some states*

Note: For insufficiency of the data and calculation purpose, some states and Union of Territories of India are omitted.

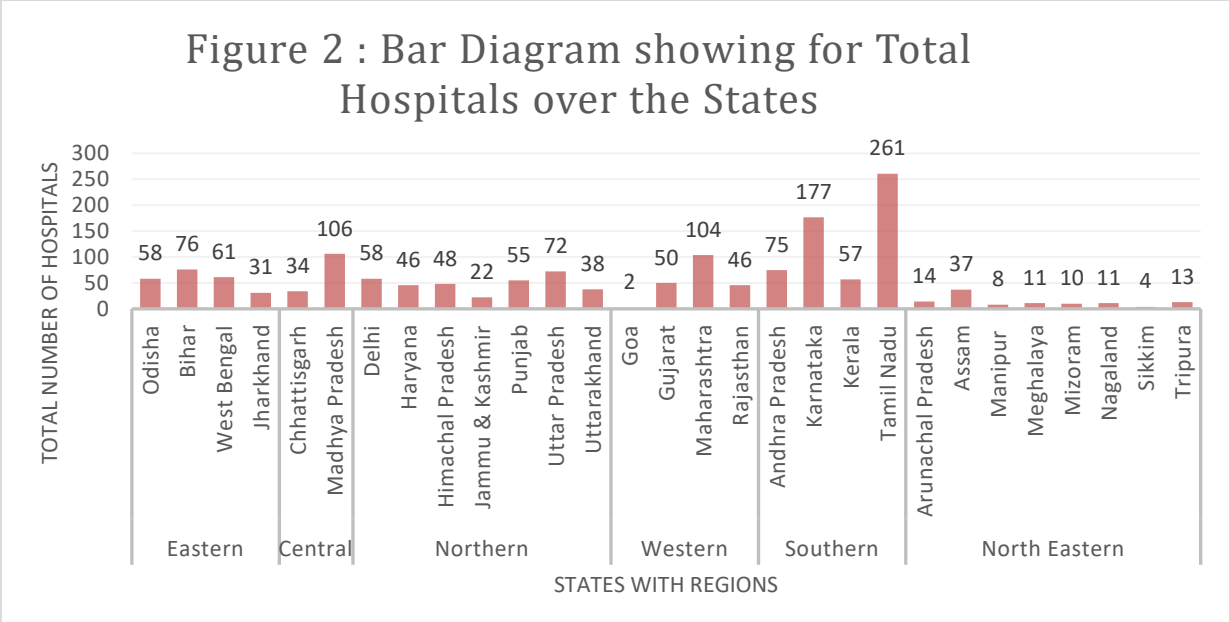
4: METHODOLOGY AND ANALYSIS:

4.1: Analysis for Objective 1:

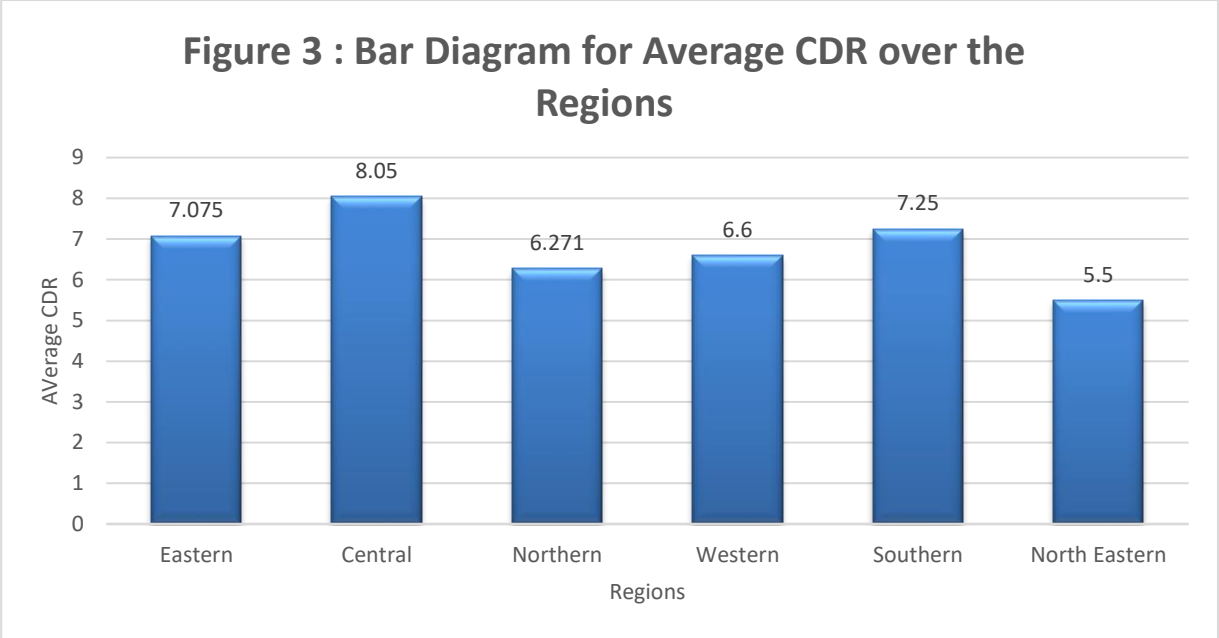
At first we represent a graphical visualization of the given data using Microsoft Excel and Minitab as given below:-



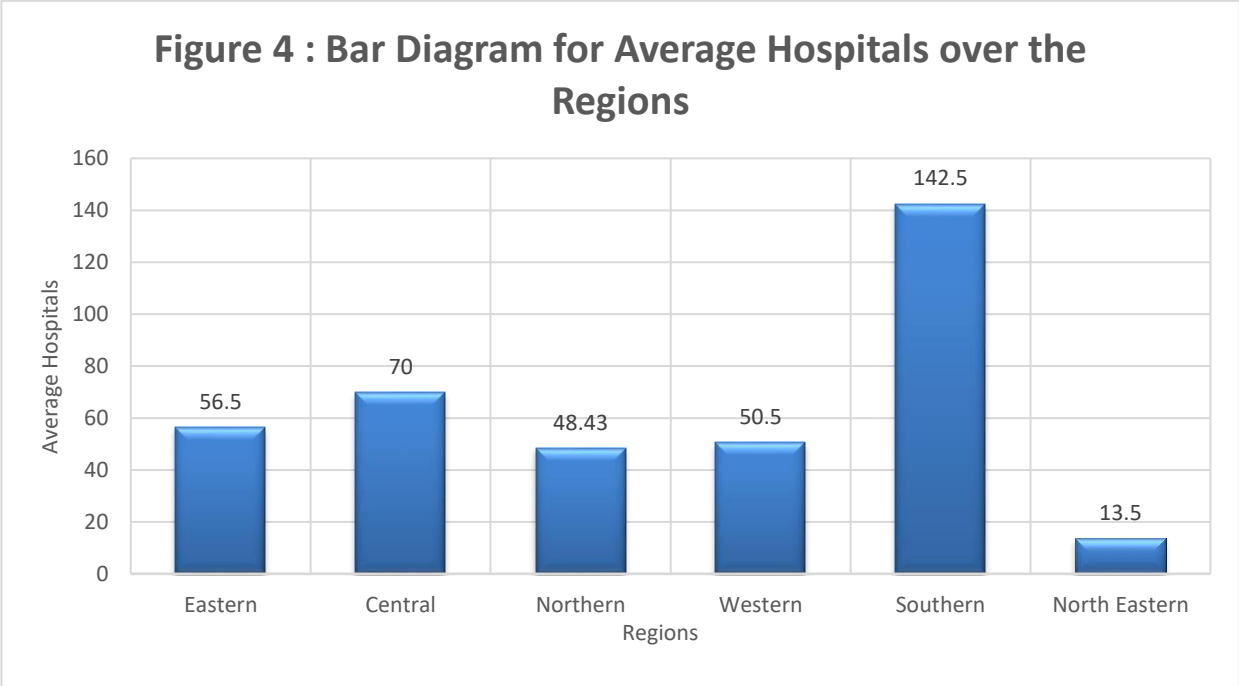
From the Figure 1, we see that CDR is moderately same over the sates except for few states. We see that Odisha, Madhya Pradesh and Assam have most CDR where Delhi, Manipur and Nagaland have the lowest CDR.



From the Figure 2, we see that in Tamil Nadu, Karnataka and Madhya Pradesh have the highest hospitals whereas Goa, Sikkim and Manipur has the lowest number of hospitals .In case for other states , number of hospitals are moderately same.

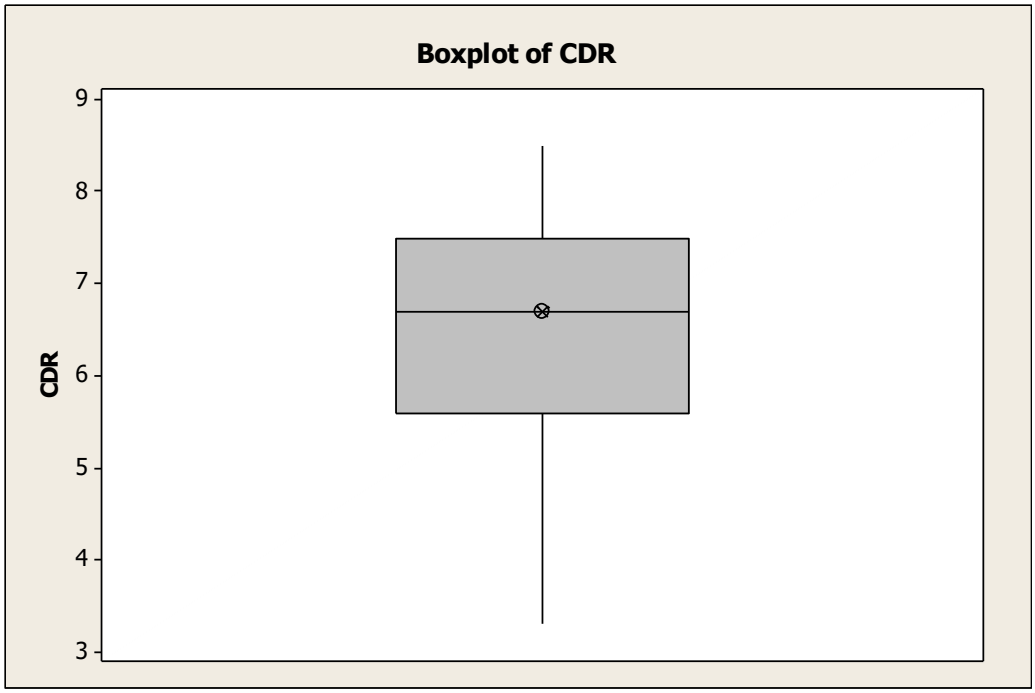


In the Figure 3, we see that there is no such greater variation in CDR over the states.



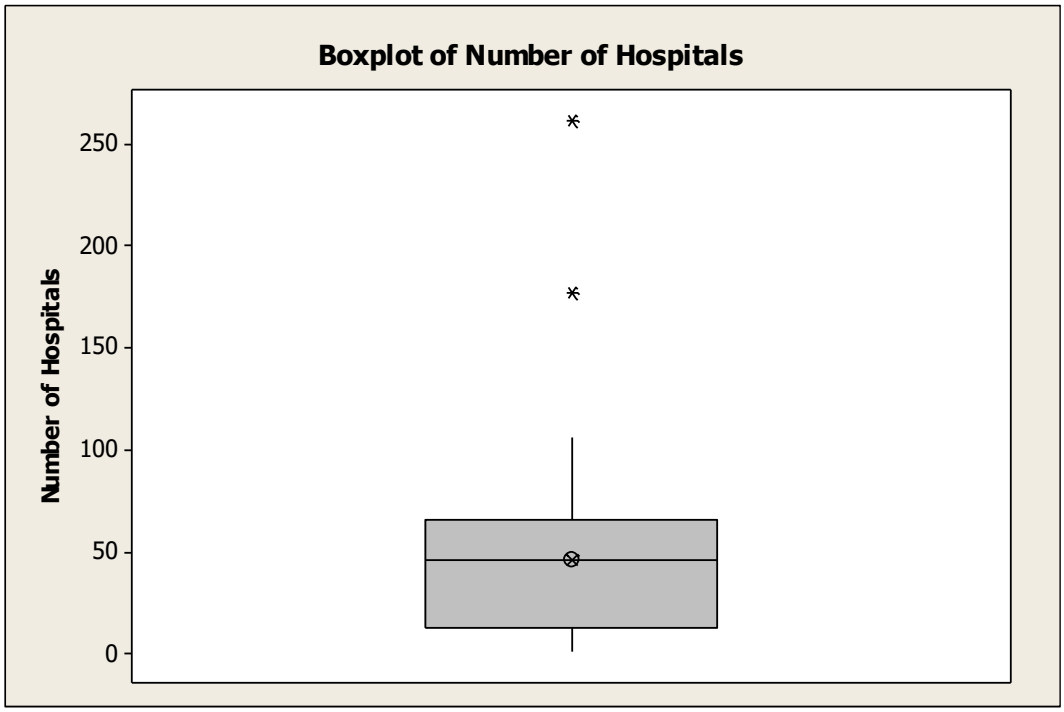
In the Figure 4, we see that in the Southern Region has the highest number of hospitals where North Eastern has lowest number of Hospitals.

Figure 5 : Box Plot for Crude Death Rate over the states in India



In the figure 5, we see that there no outliers in CDR and median is around 6.75

Figure 6: Box Plot for Number of Hospitals over the states in India



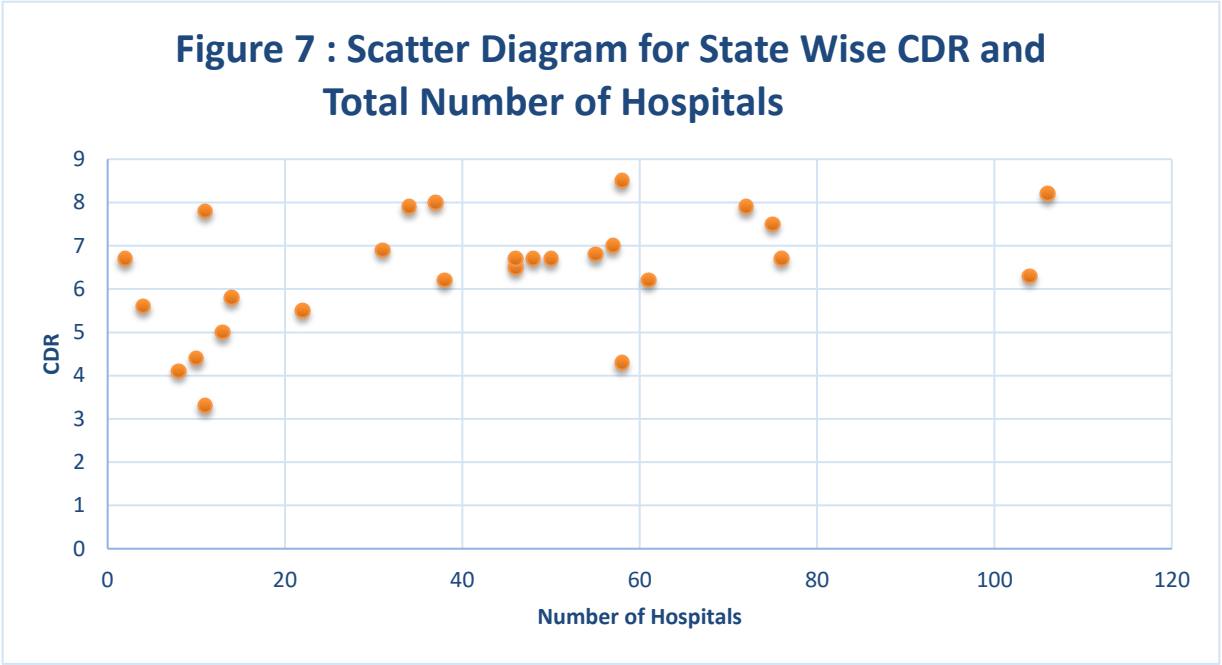
In the figure 6, we see that Karnataka and Tamil Nadu are the outliers and median is around 50

Now to fulfil our next objectives, we use some statistical methods to analyse our data. The step and the methods which are applied are mentioned in the next page.

4.2: Analysis for Objective 2:

In the figure 6, we see that Karnataka and Tamil Nadu are outliers in number of hospitals. So, for our objective 2 and 3, we exclude those two states and their values to do our analysis.

To get an idea, whether the CDR is dependent on number of hospitals or not, we have plotted the given bivariate data in a scatter diagram using Microsoft Excel and it is shown below:



From the Figure 7, we can see that there is no significant association between CDR and number of hospitals over the states in India.

So, we cannot make any clear comment that there is dependency is present or not over the states in India.

Now to conclude a strong decision for the dependency of CDR on number of hospitals over the states, w compute the Pearson Correlation Coefficient between them and test the hypothesis:

$H_{0:}$ CDR and the number of hospitals are uncorrelated

Against, H_1: they are not uncorrelated.

We test the hypothesis for both at 1% and 5 % level of significance using p-value testing, i.e. we reject the H_0 if the p-value of the corresponding test is less than the chosen level of significance, and otherwise we accept it.

For testing and calculating correlation coefficient, we use the statistical software Minitab. The results from this software are shown below:

Correlation: Total Hospitals, CDR

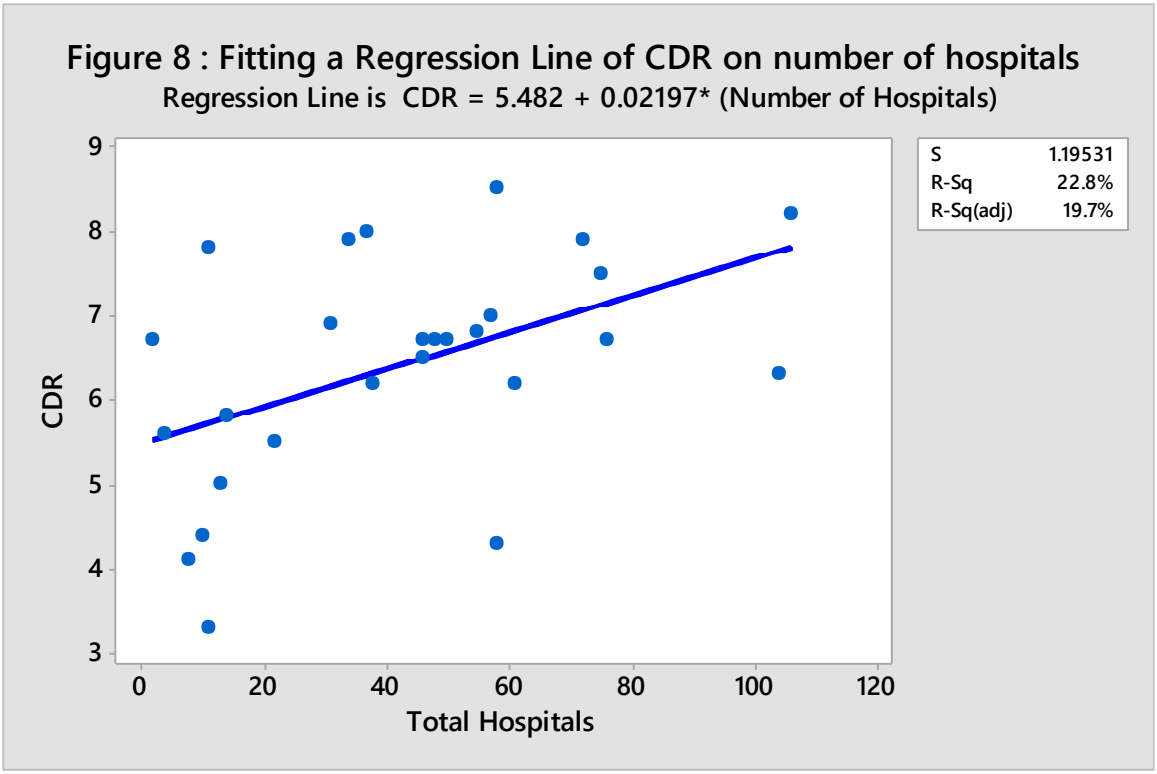
Correlations

Pearson correlation	0.478
P-value	0.012

From the above result, we can see that calculated p-value is slightly greater than .01 i.e. it is less than .05 .So we can say that we can reject our hypothesis i.e. CDR and number of hospitals are uncorrelated over the states.

4.3: Analysis for Objective 3:

From objective 2, we can see that there is a correlation between CDR and number of hospitals. For this, in this objective we fit a regression line of CDR on number of hospitals. Now for calculation and fitting for regression, we use Minitab and the results are shown below:



Now we see that from our regression line as the number of hospitals increases CDR increases but R–Square is not high (22.8%) ,we can say that above regression equation that is fitted to the data is not much efficient.

4.4: Analysis for Objective 4:

To extend the analysis, in order to find the variation in dependency, between CDR and number of hospitals, over various regions in India, we at first plot the data for the individual regions in different scatter diagrams, except the Central region as in that region, there is only two states and it is meaningless to do scatter plot on that region. The scatter diagrams are drawn using Microsoft Excel as shown below:

Figure 9 : Scatter Diagram for Eastern Region

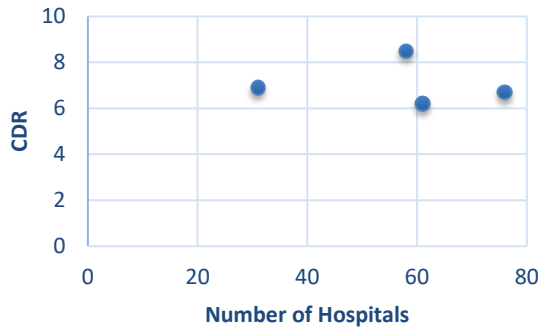


Figure 10 : Scatter Diagram for Northern Region

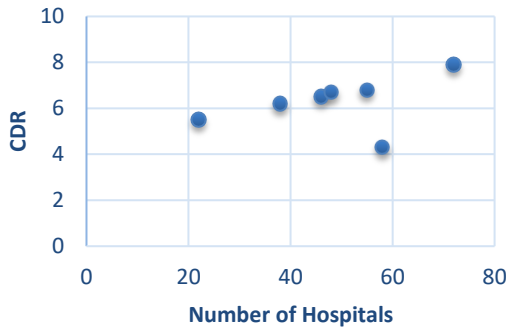


Figure 11 : Scatter Diagram for Western Region

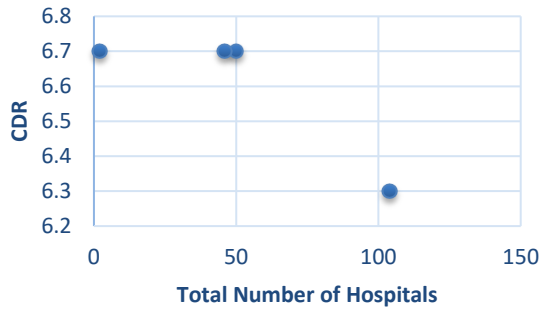


Figure 12 : Scatter Diagram for Southern Region

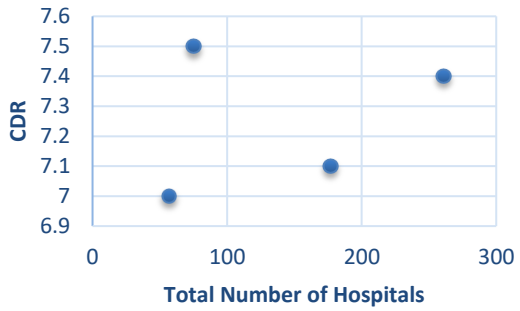
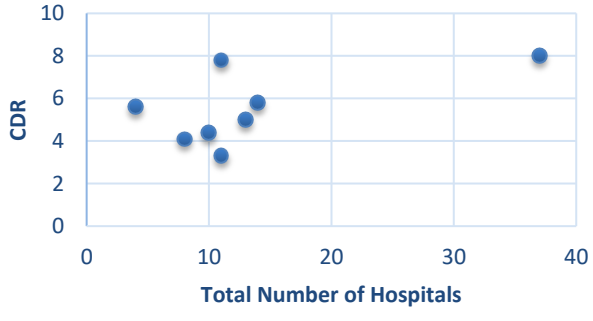


Figure 13 : Scatter Diagram for North Eastern Region



From the above scatter diagrams, we can say few things for various conditions. For Eastern region, if we ignore Odisha state, we can say that CDR does not change that much and we can say same things for western region if we ignore Maharashtra. In case of Northern region, if we ignore Delhi state, we can say that CDR increases as number of hospitals increases. Same things can be comment for southern region if we ignore Andhra Pradesh state. But for North Eastern region, we can say that there is no correlation between CDR and number of hospitals.

Now to conclude a strong decision for the dependency of CDR and number of hospitals for different regions in India, we consider a general hypothesis which will be tested further:

H_0: CDR and number of hospitals for the region are uncorrelated

Against H_1: They are not uncorrelated.

We test the hypothesis for both at 1% and 5 % level of significance using p-value testing, i.e. we reject the H_0 if the p-value of the corresponding test is less than the chosen level of significance, and otherwise we accept it.

For testing and calculating correlation coefficient, we use the statistical software Minitab. The results from this software are shown below:

Table 2 : Region wise Result on Testing for Correlation between CDR and Number of Hospitals

Region	Pearson's Correlation Coefficient	p-value	Decision		Remark
			At 5% Level	At 10% Level	
Eastern	-0.083	0.917	H_0 is accepted	H_0 is accepted	CDR and Number of Hospitals are uncorrelated
Northern	0.404	0.368	H_0 is accepted	H_0 is accepted	CDR and Number of Hospitals are uncorrelated
Western	0.854	0.146	H_0 is accepted	H_0 is accepted	CDR and Number of Hospitals are uncorrelated
Southern	0.252	0.748	H_0 is accepted	H_0 is accepted	CDR and Number of Hospitals are uncorrelated
North Eastern	0.590	0.124	H_0 is accepted	H_0 is accepted	CDR and Number of Hospitals are uncorrelated

4.5: Analysis for Objective 5:

To test the homogeneity of the effects of the several levels of the number of hospitals of CDR for each state of India, we use one way fixed effect Analysis of Variance (ANOVA) model.

ANOVA Model:

Our one way fixed ANOVA Model is:-

$$y_{ij} = \mu + \alpha_i + e_{ij} \; and \; e_{ij} \sim N(0, \sigma^2)$$

where,

y_{ij} represents CDR of the j[th] state belongs to the i[th] level of the factor i.e. number of hospitals

Here, in the analysis, we have i = 1, 2, 3 and j = 1(1)n_i, where,

n_i represents the states falling in the i[th] level of number of hospitals.

μ denotes the general effect.

α_i denotes the additional fixed effect corresponding to the i[th] level of number of hospitals

e_{ij} denotes the random errors.

Here we have to test the hypothesis H_0: $\alpha_1 = \alpha_2 = \alpha_3 = 0$ against H_1: at least one inequality occurs in H_o.

We test the hypothesis for 5 % level of significance using p-value testing, i.e. we reject the H_0 if the p-value of the corresponding test is less than the chosen level of significance, and otherwise we accept it.

For ANOVA, we use the statistical software Minitab. The **ANOVA Table** is shown below:

Table 3: One Way ANOVA for the effects of the three levels of the factor (Number of Hospitals) on CDR

Analysis of Variance

Source	Degrees of Freedom	Adjusted SS	Adjusted MS	F-value	p-value
Hospital Strength	2	5.920	2.960	1.85	0.178
Error	26	41.698	1.604		
Total	28	47.618			

From the ANOVA table, we can see that the calculated p-value is greater than 0.05, the chosen level of significance. So, we accept H_0, i.e. the effects of the three levels of the factor- number of hospitals on CDR is equal and equals to zero. Hence there is no significant effect of number of hospitals on CDR over the states in India

5. Conclusion:

Throughout the entire project work, our main objective was to find if there exists any dependency of CDR on number of hospitals and for this we approach various methods. At first we saw that there is a dependency of CDR on number of hospitals over the states in India from scatter diagram and fitted a linear regression line which is showing us that if number of hospitals increases then CDR also increases but we also see that that line is not a good fit for the data. When we search our dependency of CDR on number of hospitals over the regions in India, we see that for few regions, there is a dependency (upward) if certain values are omitted from scatter diagram. Although we cannot say that strongly as there is no such dependency from our applied statistical methods. When we applied ANOVA method to find that there is any additional effect was present or not over the states, we see that there is no additional effect of hospital strength on CDR over the states. So, we conclude that there is no strong effect of number of hospitals on CDR over the different states of India in 2011 according to our data.

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