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QUANTIFICATION OF REGIONAL DEPRIVATION IN HEALTH SERVICE INSTITUTIONS IN BANGLADESH

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ABSTRACT

One of the major challenges in public health sector is to provide homogeneous medical facilities to all over the country. Uniformity in the distribution of medical facilities will lead to be a consistent development in the public health scenario in a society. This study focuses on the construction of a comparative index to assess the availability of district level institutional medical facilities in Bangladesh. The number of health care service providing institutions in all districts has been used to get available medical facilities (MFA) per 1000 population, and then the Index of Available Medical Facilities (IMFA) has been computed based on the secondary data. After obtaining the IMFA for 64 districts, the most and the least deprived districts in each division has been identified. To support the probabilistic inference, the form of distribution of IMFA (Beta distribution) has been used to facilitate classification of districts on the basis of available medical facilities. Among the 64 districts just 19 districts fall into the low deprived category, 23 districts belong to the high deprived category and remaining 22 districts are in the moderately deprived category. The divisional districts enjoy in better position than other districts in each division. The northern part as well as the coastal region in Bangladesh has comparatively lower medical facilities than other region of the country. The findings of the study will be helpful for allocating public health budget to

different districts so as to minimize the gaps of providing medical facilities among the Bangladeshi citizens.

Key-words: Health service facilities, deprivation, Composite Index, Beta Distribution.

Introduction

Bangladesh is a developing country with colossal health problems. Demand for health research in this nation is constantly increasing. In order to ensure the development of a country it is essential to ensure good health of all people, because human capital is more important than any others resources. The government of Bangladesh is constitutionally committed to ensure health facilities of all citizens. The Ministry of Health and Family Welfare (MOHFW) is responsible for making policy and planning of the health sector, although there are other ministries having health care responsibilities and infrastructures. The health infrastructure of the country has been built on the country's general administrative pattern, which follows the national government, divisional administration, district administration, upazila (sub-district) administration, union administration, and ward administration. Bangladesh is a non-federal state having no province. The country has 7 divisions, 64 districts, 485 upazilas 4,562 unions and 40,482 wards (BBS, 2012). The MOHFW still follows the older system to deploy community health workers and organize community health services. The MOHFW implements its policies through several executive authorities.

Poverty and variations in facilities makes the sense of deprivation. It is a multi-dimensional concept. The relative deprivation can be measured with developing deprivation index. Different types of deprivation indices are available in the literatures (Sen, 1997; Bhatty, 1998; Chakrabarty and Mukharjee, 1999; Layte *et al*, 2001; Jensen *et al*, 2002; Srinivasan and Mohanty, 2004; Cappelari and Jenkins, 2006). The present work is mainly motivated by the works of Das, Nath (2007) and Bhattacharjee and Wang (2011) where deprivation indices were developed to measure the relative deprivation socio-economic and health facilities among different regions in the North-eastern part of India.

Health is one of the basic needs of people as stated by the Constitute of the People's Republic of Bangladesh. The Government of Bangladesh is constitutionally committed to "the supply of basic medical requirements to all levels of the people in the society" and the "improvement of nutrition status of the people and public health status" (Bangladesh Constitution, Article-18). It is a basic requirement to improve the quality of life. A national economic and social

development largely depends on the state of health. A large number of Bangladesh's people, particularly in rural areas, remained with no or little access to health care service. Availability of health facilities is not similar to all over the country. The numbers of hospitals or health care centres can play a positive rule in health service system. But the distribution of health service providing institutions is not same all over the country. This variation also makes the scenes of deprivation. The deprivation in basic facilities creates a sense of neglect in the mind of the citizens of the deprived areas towards the government. This may sometimes prove to be very hazardous in a democratic setup like Bangladesh. So assessing the deprivation is not only crucial for the regional concern, but also important for establishment of equity toward balanced development across the nation. The main objective of study is to examine the district wise variations of medical facilities, mainly number of hospitals and clinics, of the country and to identify the least and the most deprived districts on the basis of value of deprivation index. The outcomes of this work will put some input for public health budget to reduce the gap in the medical service facilities among the different areas of the country.

Data and Methods

The key information in this study is the number of government and non-government hospitals and clinics (district hospital, medical college hospital, other specialized hospital, upazilas health complex and all other privet hospitals and clinics) in each district of Bangladesh. The required information has taken from two website www.hsmdghs-bd.org and www.digitalinfobd.org (available in the early 2013).

Medical facility for the citizen of a country depends on several parameters e.g. number of hospital, clinic, diagnostic centre, and health care complex; number of bed, doctor, nurse etc. For this, a mega data set is needed to measure the spatial disparity in available medical facilities of a nation. Unfortunately, district wise updated information for all these parameters is incomplete in Bangladesh. In this study, we consider only one indicator (number of hospitals and clinics per thousand population in each district) to get a preliminary idea about the regional inequality in available medical facilities in our country.

Availability of medical facilities has been obtained per thousand population as follows:

Available medical facilities per 1000 population (MFA) is

$$\text{MFA}= \frac{Total\ number\ \ of\ (Hospitals\ \ and\ \ clinics\ )in\ a\ district}{Total\ \ population\ \ \ in\ this\ district} \times 1000$$

Ten the index of the available medical facilities (IMFA) is obtained for all districts with the following formula:

$$\text{IMFA}= \frac{Max.\ MFA - Observed\ \ MFA}{Max.MFA - Min.MFA}$$

That is after calculating the MFA we have to find out the district with the maximum and minimum MFA, then using above expression IMFA for 64 districts can be obtained.

Three groups of districts (least, moderate and most deprived) has been formed based the Beta distribution of the index of available medical facilities. The details are presented in the related section.

Results

District-wise position of medical facilities and Index of Available Medical Facilities (IMFA) are represented in the following table. The values of (IMFA) indicate the status of deprivation in a district in terms medical facilities. A score of IMFA near to zero (0) is an indicator of the best availability of facilities i.e. the least deprivation or very low level of deprivation and a value of one (1) is an indicator of poor availability of facilities i.e. high level of deprivation.

Table 1: District wise IMFA values

District	IMFA	District	IMFA	District	IMFA
1. Dhaka	0.000	23. Pirojpur	0.626	45. Khagrachhari	0.820
2. Khulna	0.044	24. Faridpur	0.630	46. Sirajganj	0.822
3. Jhenaidah	0.171	25. Nawabganj	0.651	47. Chandpur	0.823
4. Kushtia	0.193	26. Comilla	0.651	48.Chittagong	0.832
5. Satkhira	0.242	27. Narayanganj	0.652	49.Lakshmipur	0.835
6. Chuadanga	0.259	28. Sylhet	0.663	50. Shariatpur	0.836
7. Magura	0.303	29. Jaipurhat	0.674	51.Lalmonirhat	0.842
8. Meherpur	0.408	30. Noakhali	0.674	52. Habiganj	0.864
9. Narail	0.417	31. Rangamati	0.676	53. Cox's bazar	0.869
10. Natore	0.442	32. Munshiganj	0.697	54. Jamalpur	0.878
11. Bagerhat	0.459	33. Tangail	0.707	55.Kishoreganj	0.880
12. Rajshahi	0.471	34. Dinajpur	0.718	56. Kurigram	0.881
13. Pabna	0.508	35. Rajbari	0.731	57. Patuakhali	0.905
14. Gopalganj	0.513	36. Narshingdi	0.735	58. Barguna	0.912
15. Jessor	0.518	37. Thakurgaon	0.738	59. Nilphamari	0.917
16. Feni	0.527	38. Barisal	0.751	60. Gaibandha	0.937
17. Manikganj	0.536	39. Bandarban	0.752	61. Sherpur	0.967
18. Bogra	0.559	40. Brahmanbaria	0.753	62. Bhola	0.979
19. Naogaon	0.564	41. Jhalakathi	0.790	63. Netrakona	0.980
20. Gazipur	0.584	42. Madaripur	0.804	64.Sunamganj	1.000
21. Rangpur	0.591	43. Panchagarh	0.809		
22. Mymensingh	0.622	44. Maulvibazar	0.810		

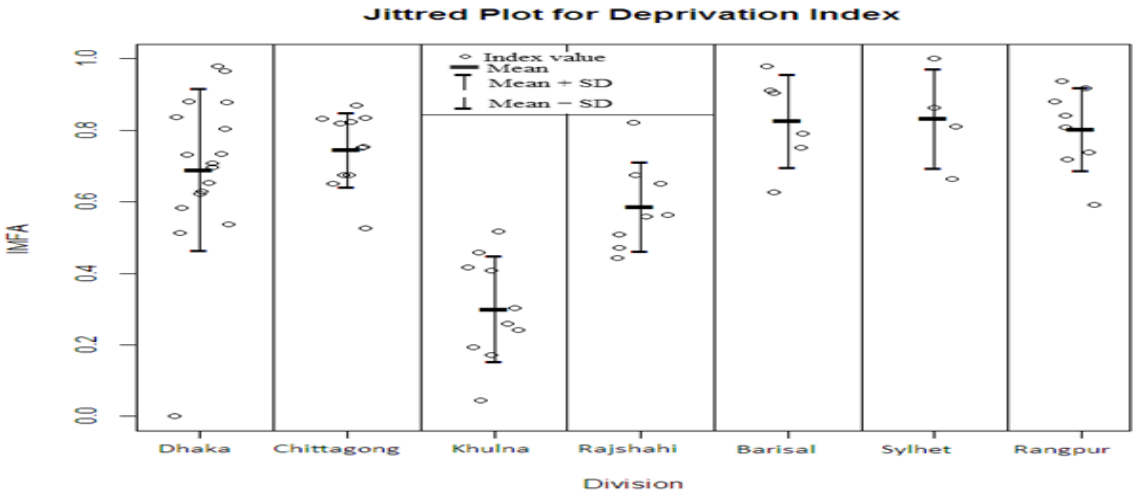
In above table the IMFA arranged in ascending order and the MFA in descending order. That is the availability of medical facility decrease as we move top to down. The availability of medical facility is the highest in Dhaka district; Khulna, Jhenaidah, Kushtia and Satkhira are some other districts with good medical facility. Sunamganj district has the lowest medical facility as its IMFA is 1.00. Some other much deprived districts are Netrakona, Bhola, Sherpur and Gaibandha.

Table 2: Most and least deprived district of different divisions

Division	No. of districts	Districts		Average IMFA of division
		Least Deprived	Most Deprived	
1. Khulna	10	Khulna (0.044)	Jessor (0.518)	0.301
2. Rajshahi	8	Natore (0.442)	Sirajganj (0.822)	0.586
3. Dhaka	17	Dhaka (0.00)	Netrakona (0.980)	0.691
4. Chittagong	11	Feni (0.527)	Cox's bazaar (0.869)	0.747
5. Rangpur	8	Rangpur (0.591)	Gaibandha (0.937)	0.804
6. Barisal	6	Pirojpur (0.626)	Bhola (0.979)	0.827
7. Sylhet	4	Sylhet (0.663)	Sunamganj (1.00)	0.834

Among the seven divisions of our country, the maximum average IMFA is located in Sylhet division followed by Barisal division and the minimum average IMFA is found in Khulna division followed by Rajshahi division (Table 2 and Figure 1). It is observed that in Dhaka division Dhaka district is the least deprived and Netrakona district is the most deprived. In Chittagong division, Feni district is the least deprived and Cox's bazar district is the most deprived. In Khulna division, Khulna district is the least deprived and Jessor district is the most deprived. In Rajshahi division, Natore is the least deprived and Sirajganj district is the most deprived. Similarly Pirojpur, Sylhet, Rangpur are the least deprived districts and Bhola, Sunamganj and Gaibandha districts are the most deprived in the Barisal, Sylhet and Rangpur divisions respectively.

Figure 1: The Jittered plot for the IMFA of all the districts classified by divisions



Source: Data in table 1.

Footnote: The graph is created with R, an open source environment and language for statistical computing and graphics <http://cran.r-project.org/>. (For code see Appendix I)

Distribution of IMFA

Index of Available Medical Facilities (IMFA) takes any values between the ranges 0 to 1, so it follows continuous distribution. The IMFA has been obtained for 64 districts and we found that, there is huge variation among the values of IMFA. To support the probabilistic inference, distribution of the IMFA should be examined to facilitate classification of the districts on the basis of the extent of deprivation. Similar study is available based on Beta (Iyengar and Sudarshan, 1982) and Normal distribution (Vidwan, 1983). Hence, the assumed distribution played a crucial role in obtaining the empirical outcomes (Navaneetham and Saxena, 1999).

For testing the hypothetical distribution of the IMFA, one may use the chi-square test of goodness of fit. To model the empirical frequency, the range [0, 1] can be divided into non-overlapping class intervals, and the chi-square test of goodness of fit can be conducted after obtaining the frequency within each class interval. The observed frequency can be compared with the theoretical frequencies expected under the hypothetical distribution. Although the interval setting could be arbitrary and converting the scale from continuous to discrete might have reduced the precision, the approach outlined above has been commonly used in practice (Kotz and Johnson, 1983).

The Kolmogorov Smirnov (K-S) test statistic could also be applied in this case as the indices are continuous in nature. Different authors have proved that the K-S statistic is more appropriate for continuous data compared to the chi-square test of goodness of fit (Keeping, 1962; Pal, 1998) . The test statistic is given by,

$$D_n = \max | S_n(x) - F(x) | \qquad (1)$$

where $S_n(x)$ and $F(x)$ are empirical and theoretical distribution functions respectively. However, for performing the K-S statistic the theoretical distribution needs to be completely specified i.e. the valued of the parameters needs to be known. In this exercise the parameters are estimated form data. The critical value of D_n for α level of significance depends on the number of observations and may be denoted by $D_{\alpha,n}$. If the number of observations are over 35, as the case here, the critical value at 5 percent level of significance ($D_{0.05,n}$) is $1.36/\sqrt{n}$. Thus, D_n value greater than $1.36/\sqrt{n}$, will indicate that the fitted distribution is significantly different from the theoretical distribution.

After deciding about the probability distribution of *IMFA,* it is important to find two real numbers $c, d \in [0, 1]$ to divide three linear intervals namely $[0, c]$, $[c, d]$ and $[d, 1]$ with the same probability weight of 33.33%, i.e.,

$P[0 \le IMFA \le c] = 0.3333$ …(2)

And, $P[0 \le IMFA \le d] = 0.6666$ … (3)

Thus, $P[c \le IMFA \le d] = 0.3333$ using (2) and (3)

These intervals have been used in this study to characterize the various stages of deprivation as follows:

(i) Low Deprivation if $0 \le IMFA \le c$

(ii) Moderate Deprivation if $c \le IMFA \le d$

(iii) High Deprivation if $d \le IMFA \le 1$

Since the values of ADI lies between 0 and 1, one may select the two parameter beta distribution of type I as a probable distribution. The beta distribution is generally a skewed distribution and its probability density function is

$$f(x) = \frac{1}{\beta(a,b)} x^{a-1}(1-x)^{b-1},\ 0 < x < 1 \text{ and } a, b > 0 \quad (4)$$

$= 0$, otherwise

Here, $\beta(a,b) = \int_0^1 x^{a-1}(1-x)^{b-1} dx$ (5)

Based on the values of IMFA for all districts, the estimated values of a and b are obtained using the method of maximum likelihood (Johnson and Kotz, 1970). The estimated values are,

$$\hat{a} = m_1\left[\frac{m_1(1-m_1)}{m_2} - 1\right] \quad (6)$$

And

$$\hat{b} = (1-m_1)\left[\frac{m_1(1-m_1)}{m_2} - 1\right] \quad (7)$$

Here,

m_1 = mean of all IMFAs and

m_2 = variance of all IMFAs

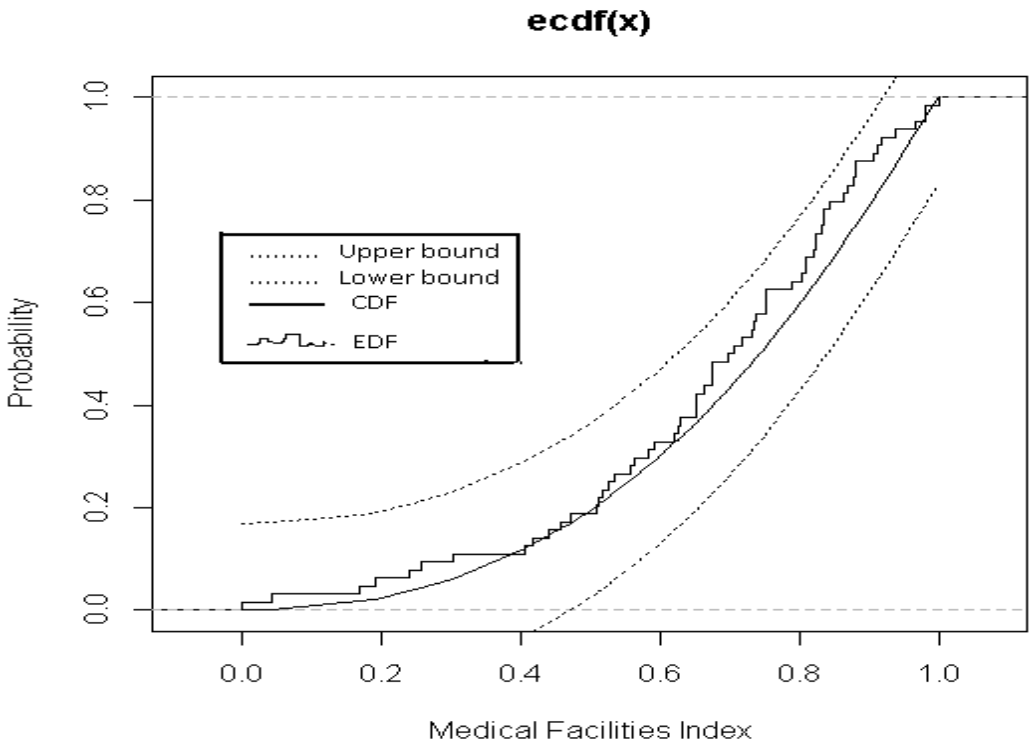
Based on the empirical data for this investigation, the estimated model parameters are $\hat{a} = 2.132$ and $\hat{b} = 1.084$.

The *K-S* test used to test if the IMFA values fit to the beta distribution specified by the parameters already estimated from the data. The value of the statistic,

$D_n = \max |S_n(x) - F(x)| = 0.0815$

which is insignificant (*p* value 0.7884, see R-code for K-S test in appendix II). This numerical test of goodness of fit test as well as graphical presentation of K-S test (Figure 2) supports the use of $\beta_I(2.132,1.084)$ to describe the values of IMFA in this investigation.

Figure 2: Graphical presentation of K-S test



Source: Based on values of the IMFA for different districts (Table 1)

Footnote: The graph is drawn with R, an open source environment and language for statistical computing and graphics <http://cran.r-project.org/>. (For code see Appendix II)

Based on (2),

$P[0 \le ADI \le c] = 0.3333$

$$\Rightarrow \int_0^c \frac{1}{\beta(2.132,1.084)} x^{1.132}(1-x)^{0.084}\,dx = 0.3333$$

$\Rightarrow c = 0.575$ (Using regularized incomplete beta function calculator)

Similarly, (3) leads to $P[0 \le ADI \le d] = 0.6666$

$$\Rightarrow \int_0^d \frac{1}{\beta(2.132,1.084)} x^{1.132}(1-x)^{0.084}\,dx = 0.6666$$

$\Rightarrow d = 0.807$ (Using regularized incomplete beta function calculator)

The values of *c* and *d* thus obtained are needed to classify the IMFA values into the following three stages of deprivation.

Stage of deprivation classified by the value of IMFA

According to the above calculation districts can be categorized into following level of deprivation:

Stage of deprivation	Values of IMFA
Low Deprivation	Less than 0.575
Moderate Deprivation	Between 0.575 to 0.807 but less than 0.807
High Deprivation	0.807 or higher

Table 3: Classification of the districts into different deprivation groups

Division	Type of deprivation	Districts
Dhaka	Low Deprivation	Dhaka, Gopalganj, Manikganj
	Moderate Deprivation	Faridpur, Narayanganj, Narsingdi, Tangail, Munshiganj, Mymensingh, Gazipur, Rajbari
	High Deprivation	Madaripur, Netrakona, Sherpur, Shariatpur, Jamalpur, Kishoreganj
Chittagong	Low Deprivation	Feni,
	Moderate Deprivation	Brahmanbaria, Rangamati, Bandarban, Comilla, Noakhali
	High Deprivation	Chandpur, Chittagong, Cox's bazar, Khagrachhari, Lakshmipur
Khulna	Low Deprivation	Khulna, Kushtia, Bagarhat, Satkhira, Chuadanga, Jessore, Jhenaidah, Narail, Meherpur, Magura
	Moderate Deprivation	
	High Deprivation	
Rajshahi	Low Deprivation	Naogaon, Pabna, Rajshahi, Bogra, Natore
	Moderate Deprivation	C.Nawabganj, Jaipurhat,
	High Deprivation	Sirajganj
Barisal	Low Deprivation	
	Moderate Deprivation	Barisal, Pirojpur, Jhalakathi
	High Deprivation	Bhola, Patuakhali, Barguna
Sylhet	Low Deprivation	
	Moderate Deprivation	Sylhet
	High Deprivation	Maulvibazar, Habiganj, Sunamganj
Rangpur	Low Deprivation	
	Moderate Deprivation	Rangpur, Dinajpur, Thakurgaon
	High Deprivation	Panchagarh, Kurigram, Lalmonirhat, Nilphamari, Gaibandha

Among the 64 districts just 19 districts fall into the Low deprived category, 23 districts fall into the High deprived category and remaining 22 districts fall into the Moderate deprived category.

Discussion

Deprivation in medical facilities might be due to unequal distribution of service providing hospitals or clinics over the country or even within the division. The reasons of unequal distribution of medical facilities arise due to lack of poor implementation of government policies and may depend on powerful person in some areas. Lack of proper demand-supply information is also another cause of regional deprivation. Popular demands for local government, boundary changes, and new division and districts continue to proliferate. Thus, it is important to investigate if the dispersion in medical facility deprivation arises from the inefficiency of local government.

In the previous section it is found that from the 64 districts considered in the study 23 of them are highly deprived. Out of which Rangpur, Sylhet and Barisal are the worst sufferers. None of the district of these divisions falls in the low deprived category. These three are the newly formed divisions in the country. On the other hand Khulna is the only divisions where all districts fall in the low deprived category. Dhaka, Rajshahi and Chittagong divisions are in the moderate position. The divisional districts are in a better position than other districts except for Chittagong division.

Sylhet is one of the smallest divisions in Bangladesh. Its socio-cultural traditions are slightly different than other areas. It is lagging behind with respect to some indicators especially in education. The literacy rate is far below the national level. According to this study it is found that there are three districts out of fours fall in the highly deprived group. Rangpur, a north Bengal division, is another deprived area. About two-third districts fall in the highly deprived groups and the rest of them belong to the moderate deprived group. The highly deprived districts under this division have a boarder with the neighbour country. There are fifty percent districts of Barisal division fall in the High deprived category. All of them are situated in the coastal area.

A mixed mode of deprivation has been observed in Dhaka, Chittagong and Rajshahi divisions. In Dhaka division, none of the district belongs to greater Dhaka district fall in the high deprived category. On the other hand almost all the highly deprived districts in this division were the part of greater Mymensingh district. Chittagong is the only division where the headquarter districts under this division falls in the highly deprived group. In this division, five out of 11 districts are highly deprived. Like Barisal division majority of these are coastal districts. Rajshahi division has a comparatively better position than Dhaka and Chittagong division. It has only one highly deprived district. Khulna division enjoys the best position as all districts fall in the least deprived group.

Dhaka is the least and Sunamganj is the worst sufferer districts in Bangladesh. Almost all of the top ten (least deprived) districts belong to Dhaka and Khulna. Similarly most of the bottom ten (most deprived) districts are under the Dhaka, Barisal and Rangpur divisions. Interestingly, Dhaka divisions fall both the best and worst groups. One of the possible reasons for spatial deprivation is the distance from the capital as well as from the divisional headquarters. Another reason may the coastal and hilly areas as majority of these districts fall in the worst sufferer group. Regional development is associated with socio-economic and health awareness of the people. The more aware people can raise their demands for better facilities. The study also found a moderate degree of negative association ($r = - 0.434$) between index of available medical facilities and literacy rate of the districts. This indicates that people in high literacy area can manage comparatively better medical facilities than those of having low literacy rate. Therefore, socio-economic development should get top priority for reducing the regional gap in medical facilities of the country. A meaningful and trustworthy coordination between government and local government is necessary especially budgetary allocation and implementation in public health projects.

Conclusion

Health is a basic right of human being. It is not less important at all, because human capital is more important than any others resources. In order to ensure the development of a country it is essential to ensure a healthy nation. This study has elaborately discussed about the availability of medical facilities in all districts and is devoted to identify the worst sufferer districts and divisions. It has been observed that over one-third districts belong to the most deprived group of which most of them are predominantly rural. Two-third coastal districts are the worst sufferers. This article is a primary step for quantifying regional deprivation in the medical service providing institutions. Here, the number of hospitals and clinics are considered for the unit of analysis with an assumption of homogeneous in size. It is a serious limitation of this research works. An in-depth study considering the size in terms of number of beds in hospitals or clinics, number of doctors and nurses per thousand populations in each district will be more meaningful to conduct such research work. The findings of the study will be helpful for allocating public health budget to the different districts to minimize the gaps of providing medical facilities among the Bangladeshi citizens.

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Appendix 1

R code for drawing the jittered plot

```
s1<-seq(1,1,length=17)+runif(17,min= -.2,max=.2)
dha<-c(0.00,0.630,0.584,0.513,0.878,
0.880, 0.804, 0.536, 0.697, 0.622, 0.652, 0.735, 0.980, 0.731, 0.707, 0.967, 0.836)
s2<-seq(2,2,length=11)+runif(11,min= -.2,max=.2)
cta<-c(0.752, 0.753, 0.823, 0.832, 0.651, 0.869, 0.527, 0.820, 0.835, 0.674, 0.676)
s3<-seq(3,3,length=10)+runif(10,min= -.2,max=.2)
kha<-c(0.459, 0.259, 0.518, 0.171, 0.044, 0.193, 0.303, 0.408, 0.417, 0.242)
s4<-seq(4,4,length=8)+runif(8,min= -.2,max=.2)
raj<-c(0.559, 0.651, 0.674, 0.564, 0.442, 0.508, 0.471, 0.822)
s5<-seq(5,5, length=6)+runif(6,min= -.2,max=.2)
bar<-c(0.912, 0.751, 0.979, 0.790, 0.905, 0.626)
s6<-seq(6,6,length=4)+runif(4,min= -.2,max=.2)
syl<-c(0.663, 0.864, 0.810, 1.00)
s7<-seq(7,7,length=8)+runif(8,min= -.2,max=.2)
rag<-c(0.718, 0.937, 0.881, 0.842, 0.917, 0.809, 0.591, 0.738)
x<-c(s1,s2,s3,s4,s5,s6,s7)
y<-c(dha,cta,kha,raj,bar,syl,rag)
plot(x,y,main="Jittred Plot for Deprivation Index",xlab="Division",ylab="IMFA ")
s<-seq(1.5,7.5,length=7)
abline(v=s)
avg<-c(mean(dha),mean(cta),mean(kha),mean(raj),mean(bar),mean(syl),mean(rag))
points(seq(1,7,length=7),avg,pch="--",col=1,cex=3.5)
sd<-c(sd(dha),sd(cta),sd(kha),sd(raj),sd(bar),sd(syl),sd(rag))
up<-avg+sd
```

```
lo<-avg-sd
points(seq(1,7,length=7),up,pch="--",col=1,cex=2)
points(seq(1,7,length=7),lo,pch="--",col=1,cex=2)
segments(seq(1,7,length=7),up,seq(1,7,length=7),lo)
```

Appendix 2

R code for K-S test

```
x1<-c(0.00, 0.630, 0.584, 0.513, 0.878, 0.880, 0.804, 0.536, 0.697, 0.622, 0.652, 0.735,
0.980, 0.731, 0.707, 0.967, 0.836, 0.752, 0.753, 0.823, 0.832, 0.651, 0.869, 0.527, 0.820,
0.835, 0.674, 0.676, 0.459, 0.259, 0.518, 0.171, 0.044, 0.193, 0.303, 0.408, 0.417, 0.242,
0.559, 0.651, 0.674, 0.564, 0.442, 0.508, 0.471, 0.822, 0.912, 0.751, 0.979, 0.790, 0.905,
0.626, 0.663, 0.864, 0.810, 1.00, 0.718, 0.937, 0.881, 0.842, 0.917, 0.809, 0.591, 0.738)
#include index of available medical facilities (IMFA) of 64 districts
x<-sort(x1)
n<-length(x)
ks.test(x,pbeta,2.132,1.084)
```