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Analysis of Spatial Distribution of Health Centres in Koch Bihar District, West Bengal

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Abstract

Inequality in the distribution of healthcare services has become a prime concern especially in the developing countries of the Third World. Equality in the distribution of healthcare services and equal access to such services are the pillars of the health systems of a nation. Therefore, understanding the geographical distribution of healthcare resources, equal access to such resources and improvement of them may lead to better planning to make health services accessible to all. This research paper tries to analyze correlation and inequality in the distribution of the health facility centers (Health Sub-Centres & Primary Health Centres) and the population of Koch Bihar district by applying various statistical techniques. The concentration of both primary health center (PHC) and health sub-center (HSC) is very high in Haldibari block compared to the other blocks of Koch Bihar district. Pearson's correlation coefficient shows that there is a positive correlation between population and health facility centers. Howevera a huge inequality was observed in the entire region between population and health centers with the help of the Lorenz curve and Gini coefficient. Chi-Square value revealed that there is a huge difference in observed and expected health centers in the entire district. The study suggests that more PHCs and HSCs are to be set up to reduce the disparity and to better health services in the district.

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Introduction

Healthcare is a program of service that provides all facilities of health and related services necessary to strengthen and maintain the health of mind and body. Healthcare resources include professionals such as physicians, nurses, health maintenance organizations, etc. The availability of healthcare resources has traditionally been measured using indicators such as the number of doctors or hospital beds per unit of population. Healthcare in India is handicapped because it has to face serious crises in cost, quality of care and equitable distribution of modes and standards of service to the population as a whole (Mandal & Sinha, 1980).

Spatial analysis is the geographical approach to understand inequalities in healthcare services. An important issue of equitable service distribution is the contrast between the need for services and demand for them (Meade &Earickson,2000). Access to healthcare requires that there is an adequate supply of health services available to the population. The access should be distinguished between two components; initiation and continuation (Donabedian, 1972). An important distinction exists between access to treatment and receipt of treatment (Mooney, 1983). Access depends on opportunities while receipt of treatment depends both on these opportunities and whether individuals have availed themselves of them (Wagstaff & Doorslaer, 2000). The literature typically defines access to mean "Receipt of treatment". Access is, therefore, a complex concept and it is widely recognized in the literature that access is a function of more than just the time and money costs in seeking health service. It includes income, specifying services, quality, personal inconvenience, cost and information (Goddard & Smith, 2001).

Distribution of health facilities, population and transport facilities leads to the disparity in access to health centers (Delamater, 2012). The quality of healthcare in rural areas with predominantly low income and minority populations largely depends on geographical access and the distance to the health care facility is highly sensitive in making health care choices. Geographical accessibility is defined as the ability to obtain health care resources that meet the health demands of the population. It infers that a community has healthcare accessibility if the resources meet specific characteristics such

as geographic location; affordability that fit with patients' needs (Levesque, Harris & Russell, 2013). The relationships between social disadvantages and the availability of the quality and quantity of General Practice services, the geographical access to healthcare services were relatively equal across socioeconomic groups. However, the residents of deprived areas are facing difficulty in obtaining evening and same-day appointments. They conclude that services were available but more travel time and inadequate quality of services for some underprivileged populations (Hyndman & Holman, 2001). For the assessment of supply, demand and spatial arrangement of health care centers the accessibility was measured based on Euclidian distance and health facility population ratio. The study aimed to compute the ratio between population and health facilities to measure the spatial accessibility. It revealed the disparities in the health care system with very less percent of population availing good health services (Jamtsho & Coner, 2014).

Inequality in health services distribution has become a concern of challenge among different countries (Mackenbach, 2008). Equality in the distribution of health services and equal access to such services has become a major principle in most health systems (Horev, 2004). Therefore, understanding the geographical distribution of health resources, equal access to such resources and improvement of them may lead to better planning to make health services accessible to all. The equal and fair distribution of resources in the health sector is one of the most important goals to be achieved by health systems in every country all over the world. It is usually considered to be one of the main challenges and concerns of policymakers and managers in the health sector.

Objectives

The study puts forward the following objectives:

i) To measure the spatial concentration of health centers.
ii) To measure the inequality in the distribution of health centers.
iii) To make an attempt to study a relationship between health centers and population size. sis on doctors, paramedical staff, other supporting staffs and other.

The Study Area

The Koch Bihar district is located in the northeastern part of the state of West Bengal. Geographically, the district is surrounded by district Jalpaiguri and Alipurduar to the North and West, state of Assam (Kokrajhar and Dhubri districts) to the east and international boundary with Bangladesh towards south, south-east and south-west. The location of the district is spread over from 26°32'20" N to 25°57'40" N latitudes and 89º54'35"E to 88º47' 40"E longitudes. According to the 2011 census, it has a population of 2,822,780, roughly equal to the nation of Jamaica. This gives it a ranking of 136th in India (out of a total of 640). The district has a population density of 833/sq km. Its population growth rate over the decade 2001-2011 was 13.86%. It has a sex ratio of 942 females for every 1000 males, and a literacy rate of 75.49%.

Topographically, the entire district belongs to a plain terrain with an average elevation of 52m (the highest elevation of 93m is found in the northwestern part and the lowest elevation of 10m is found in the southeast part of the district). Annual temperature varies from 15°C to 35°C and the average annual rainfall is about 3201 mm.

According to 2011census, the district comprises of 12 Community Development Blocks and 6 Statutory Towns. There is a total of 1194 villages and 12 Census Towns in the district. As per Census 2011, about 10.3% of population live in urban areas while 89.7% live in rural areas. The district has a maximum proportion of child population (0-6 years) among all the districts in the State i.e. 12% and hence the primary healthcare centers and sub-centers lay a crucial role to cater basic health services to the population especially on the maternal and child care.

Methodology

For the present study, mainly secondary data has been used. This study attempts to analyze the statistical correlation and inequality between the health facility centers and the population of Koch Bihar district by applying different statistical techniques such as Location Quotient, Lorenz Curve, Gini's Coefficient, Pearson's Correlation and finally the Chi-Square values. Gini coefficient and Lorenz curve help to understand the nature of accessibility to healthcare services and assist in reducing the inequality in the distribution of healthcare resources in Koch Bihar district. The study eventually will help the people as well as the planners to determine the medical needs which will, in turn, enhance the optimal utilization of resources (Ahmad, et al., 2017). The techniques used are as follows:

Location Quotient: It is a simple technique used to determine the spatial distribution of amenities or phenomena in a block or district compared to the entire region in respect of the population. It is applied to show the variation in the concentration of health centers among the blocks of Koch Bihar district. It is computed as :

$$LQ \quad \frac{hb}{pb} \Big/ \frac{Hd}{Pd}$$

Where, LQ = location quotient, hb = No. of health centres in particular block, pb = population of the concerned block, Hd = total number of health centres in the district, Pd = Total population of the district.

If the LQ is equals to 1, it indicates that the health centres are equally distributed. If the value of the quotient exceeds 1 for a particular block, that means the concentration exceeds the district average. When the value is lesser than 1 that indicates the deficiency in the service, while a value is equal to 1 or close to 1 which indicates self -sufficiency.

Lorenz Curve and Gini's Coefficient: In order to have a clear idea about the index of spatial disparity with respect to the healthcare centers (PHC and HSC), the Lorenz curve and Gini's coefficient (developed by statistician Corrado Gini, 1912) have been used. It puts forth an idea of inequality in the distribution of PHCs over the blocks. But to measure the exact value of inequality, Gini coefficient has been computed as follows:

$$G = \frac{\sum x_i . y_{i+1} - \sum x_{i+1} . i}{100 \times 100}$$

The Gini coefficient ranges from 0 to 1, where 0 represents the perfect equality and 1, the perfect inequality.

Pearson's Correlation Coefficient: Pearson's correlation coefficient measures the linear correlation between two sets of variables: dependent (y) and independent (x). The following formula is used:

$$r = \frac{n[\sum(x.y) - (\sum x.\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

Chi-Square: Basically, the Chi-Square test is intended to test how likely it is that an observed distribution is due to chance, and that's why it is also called the "Goodness of fit" statistic. It is a non-parametric test and is computed as follows:

$$\chi^2 = \sum \frac{(Observed - Expected)^2}{Expected}$$

Results and Analysis

Spatial Distribution of Health Centers

The location quotient method has been used to analyze the variation in the spatial concentration of health centers in the blocks compared to the entire region in respect of the population. Table 1 delineates that the Primary Health Centres (PHCs) vary at the block level. The degree of LQ of PHCs is very high in Haldibari block (1.691), Sitai Block (1.593), Dinhata II Block (1.440) and Mathabhanga I Block (1.208) which indicates number of PHCs are available to its population in respect of other blocks. There are excess PHCs in compared to the other blocks. Mathabhanga II and Mekhliganj block having the LQ values of 1.159 and 1.132 respectively also consist of excess facilities of PHCs. Tufanganj I (1.061), Coochbehar II (1.022), Sitalkuchi (0.948), Tufanganj II (0.941) having very close value to 1, indicates that the facilities are sufficient to the population and equally distributed, while Cooch Behar I (0.538) and Dinhata I (0.307) having the much lesser values from 1 delineate that the facilities are deficit to the population compared to the other blocks.

The map of the adequacy of PHCs in Fig.1 put forth the variant adequacy in the distribution of PHCs among the blocks of Koch Bihar district. The map reveals almost the same fact as the above table describes. Haldibari, Mathabhanga I, Sitai and Dinhata II having high degree of LQ values belongs to the group of over adequacy of PHCs, Mekhliganj and Mathabhanga I have high adequacy consisting greater values of LQ from 1, simultaneously Cooch Behar I, Sitalkuchi, Tufanganj I and Tufanganj II belong to the group of decent adequacy in consequence of very near LQ values to 1, while Cooch Behar I and Dinhata I belong to the group of very low adequacy having much lesser values of LQ from 1.

Table -2 depicts that the Health Sub-Centres (HSC) are also not equally distributed at the block level. If we notice the LQ column and the Fig.2, Mekhliganj, Sitai, Dinhata II, Cooch Behar I, Cooch Behar II, Mathabhanga I, Mathabhanga II consist the LQ values close to 1, that delineate the HSCs are approximately equally distributed and decently adequate in respect of population compared to the other blocks, while in consequence of greater values of LQ from 1 Tufanganj I, Tufanganj II, Sitalkuchi and Haldibari and Dinhata I Block have excess number of HSCs to the population and belong to the group of high adequacy.

Inequality in Distribution of Health Centres

The Lorenz curve compares the distributions of a given variable with the uniform distribution shown by a diagonal line. In this curve, the horizontal axis (x) represents the cumulative percentage of population and vertical axis (y) illustrates the cumulative percentage of health centers of Koch Bihar District. The Gini's Coefficient value of serving the population of PHCs of block-level is 0.2038 which indicates that the PHCs are 20.38% unequally distributed. If we take a look at the Lorenz Curve and the line of equality of HSCs, it can be noticed that there is a very little gap between the two lines, which indicates that inequality is not very significant for the distribution of HSCs in respect to the population. Gini's Coefficient value for HSCs is 0.0425 that depicts there are only 4.25% inequality.

Relation Between the Health Centres and the Population

To investigate the relationship between the number of health centers and the population, Pearson's Correlation Coefficient technique has been applied. From the correlation table of PHCs (Table-5), we find the r value for the PHCs is 0.348 with 0.267 of significance which indicates there are only 34.80% of positive relation of PHCs with the increasing population rate in the district and only 0.121 of R-square value delineates only about 12.1% of variance in healthcare facilities. As the value of significance is greater than 0.05 or 5%, the null hypothesis is accepted which is predicting there is no such relation of the number of PHCs with increasing population rate. What this result portends is that the distribution of PHCs is not entirely based on population.

Now if we notice at the correlation table of HSCs (Table- 6) and the regression line in the above figure of HSCs, the value of r i.e. 0.932, proves there is 93.2% highly positive correlation between the number of HSCs and the population of the district. The value of significance is less than 0.05 or 5% with 95% confidence rejects the null hypothesis and accepts the alternative. The R-square value which is 0.869 depicts there is 86.9% of the variance in health facilities (HSC) due to the population of the district.

Distribution of Health Centres from the Perspective of National Rural Health Mission or NRHM Norms

As per the norms of National Rural Health Mission (NRHM) the population norms for the provision of HSCs and PHCs and BPHCs are suggested 5000, 30000 and 1,20,000 people respectively in plain areas.Considering the above norms of NRHM if we pay attention to the district, there are 30 PHCs in the district, and it is estimated that in an average each PHCs in the district is serving 87,887 persons, which is 2.93 times excess to the centers.

Table-5 and fig.4 reveals that all the PHCs of the particular blocks are suffering from overpopulation pressure and sometimes the pressure exceeds 5 to 9 times. For example, Dinhata-I and Cooch Behar-I are remarkable. Dinhata-I has the facility-population ratio of 1:286269 which should be 1:30000. PHCs of Dinhata-I block is suffering from tremendous pressure of excess population. The pressure is 9.54 times more. Cooch

Behar-I having the PHC-population ratio of 1:163279, deals with 5.44 times overpopulation pressure. Except for these two blocks, each PHCs of Tufanganj-II, Sitalkuchi, Coochbehar-II, Tufanganj-I, Mekliganj, Mathabhanga-I and II, Dinhata-II, Sitai and Haldibari is tackling 50,000 to approximately 1,00,000 population while the PHC-population ratio should be 1:30000.

As suggested by NRHM is a case of HSC for the rural areas the facility and the population ratio should be 1:5000, while in the district the ratio is 1:6957 having 406 HSCs. Therefore, the HSCs deal with 1.30time's excess population pressure. Table 6 and Figure 5 denote that each and every block of the district is suffering from high overpopulation pressure. HSCs off Mathabhanga-I deal with the maximum population having a ratio of 1:7173. The block is suffering from 1.45 time's excess population. Cooch Behar-I consisting of 46 HSCs, deals with 1.42 times more population pressure having the facility-population ratio of 1:7099. By the same way, Mathabhanga-II deals with 1.38 times excess population pressure having the facility-population ratio of 1:6891. Dinhata-II faces 1.36 times excess population pressure having the ratio of 1:7793. Tufanganj-II suffers from 1.39 times excess population pressure having the ratio of 1:6780. Cooch Behar-II having the facility-population ratio of 1:6613 tolerates 1.32 times excess population pressure, rest of the blocks.

Sitai, Mekliganj, Sitalkuchi, Dinhata-I, Tufanganj-I and II, and Haldibari blocks are tackling with 1.35 to 1.16 time's excess population pressure. From figure 5, it is clear that the ratio of 1:6891 tolerates 1.38 times excess population pressure. Rest of the blocks i.e. Cooch Behar-II, Dinhata-I, Sitai, Mekliganj, Tufanganj-I, Sitalkuchi and Haldibari blocks are tackling with 1.30 to 1.16 times excess population pressure. From the figure 5, it is clear that HSCs of Cooch Behar-I, Dinhata-II and Mathabhanga-I are suffering from high population pressure compared to the other blocks. Haldibari block having the HSCs population ratio of 1:5776 that is lower than district ratio consists of lesser disparity compared to the other blocks.

In Table-7 and 8 the expected numbers of PHCs and HSCs have been calculated by dividing the existing population by the suggested population as mentioned in NRHM norms. In this manner, in Cooch Behar-Ithere are only 2 PHCs to serve the existing population of 326558, while the requirement of PHCs are 11. Cooch Behar-II requires 11 PHCs while there are only 4 PHCs exists. Dinhata-I has a requirement of at least 10 PHCs to produce the ratio 1:30000, while it has only 1 PHC. Thus, Dinhata-II needs 8 PHCs, Haldibari needs 3, Mathabhanga-I needs 7, Mathabhanga-II requires 8 and so on so forth as mentioned in the table. Similarly, in respect of HSCs, Cooch Behar-I requires at least 65 HSCs to achieve the suggested ratio i.e. 1:5000, while it has only 46 HSCs for serving 326558 population and Cooch Behar-II requires 69 HSCs over the existing 52, Dinhata-I needs 57 over the existing 47 and so on so forth as mentioned in the table. The total requirements of PHCs are 88 over the existing 30 PHCs and the total requirement of HSCs is 527 while the availability is only 406.

In Table-7), Chi-Square method had been applied to measure how well the observed distribution of facilities fit with the distribution that is expected. By applying the formula, it returns a value of 38.13 with (12 - 1) or 11 degrees of freedom and a p-value is 0.000042 or the significance level is only 0.004%, which is much less than the 0.01 or 1% of significance level and the calculated value is much greater than the tabled value in respect of 1% significance level that constrains to reject the null hypothesis and accept the alternative which denotes there is huge variation in observed and expected facilities (PHCs) and much more requirement of PHCs to achieve the suggested ratio. Similarly, the calculated value for the HSCs as mentioned on the table i.e. 27.91 is much greater than the tabled value at1 percent significant level also reject the null hypothesis and accepting the alternative hypothesis proves the necessity of much more HSCs to serve the huge population with the suggested facility-population ratio.

Conclusion

The district health system not only determines but also implements various health policies, delivery of healthcare and management of health services for a specific geographical area. It is an integrated service allotted to each district for the welfare of the people, irrespective of caste, class, and religion, living in it. Every district, large or small, should have a district hospital systematically linked with the public hospitals/health centers down below the district such as sub-district/sub-divisional hospitals, Community Health Centres, Primary Health Centres and Sub-centres etc. that spread out gradually towards the fringe from the center. The District hospital is, therefore, the terminal point of the pyramid-shaped District Health System. Though it functions as a secondary level of healthcare and provides curative, preventive and promotive healthcare services to the people in the district, the other component parts in the base of the pyramid-shaped system are the Primary Health Centres and Sub-centres. The excellence of services provided in different Primary Health Centres and Sub-centres would ultimately reduce the pressure on the district hospital because these (the Primary Health Centres and Sub-centres) are the cornerstones of rural health services. This study tends to give the priority about nature of dispersal of the Primary Health Care system (PHC) and Health Sub-centres in Cooch Behar district situated in different tehsils & gram panchayats. In this analysis, it has been observed that Location Quotient (LQ) value is not equally distributed in this entire region and there is a huge difference in the distribution of PHCs and HSCs. The concentration of PHCs is very high in the Haldibari block and very low in Dinhata I block. Where the concentration of HSCs is very high in Haldibari and very low in Mathabhanga I block. The values of Gini's Coefficient and Lorenz curve have clarified that there is not an even distribution in population and health centers both Primary and Sub-centers. There is huge inequality in the spatial distribution of health centers and area wise total number of population. Pearson's Correlation Coefficient denotes a strong positive correlation between HSC and population and weak correlation between PHC and number of population. Requirements of PHCs is 88 and HSC is 527 whereas the district has only 30 numbers of PHCs and 406 number of HSCs. It is therefore, suggested that the required number of PHCs and HSCs as mentioned above are to be set up to reduce the disparity and better health services in the district.

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Table-1: Location Quotient of PHCs

Id	Block Name	Population	% of Population	PHC	% of PHC	LQ of PHC
1	Cooch Behar I	326558	12.39	2	6.67	0.538
2	Cooch Behar II	343901	13.04	4	13.33	1.022
3	Dinhata I	286269	10.86	1	3.33	0.307
4	Dinhata II	244066	9.26	4	13.33	1.440
5	Haldibari	103969	3.94	2	6.67	1.691
6	Mathabhanga I	218191	8.28	3	10.00	1.208
7	Mathabhanga II	227397	8.62	3	10.00	1.159
8	Mekligunj	155250	5.89	2	6.67	1.132
9	Sitai	110333	4.18	2	6.67	1.593
10	Sitaikuchi	185353	7.03	2	6.67	0.948
11	Tufanganj I	248595	9.43	3	10.00	1.061
12	Tufanganj II	186726	7.08	2	6.67	0.941
	Total	2636608	100.00	30	100.00	SD = 0.396

Source: Data collected from coochbehar.nic.in, and LQ computed by authors

Table-2: Location Quotient of HSCs

Id	Block Name	Population	% of Population	HSC	% of HSC	LQ of HSC
1	Cooch Behar I	326558	12.39	46	12.14	0.980
2	Cooch Behar II	343901	13.04	52	13.72	1.052
3	Dinhata I	286269	10.86	47	12.40	1.142
4	Dinhata II	244066	9.26	36	9.50	1.026
5	Haldibari	103969	3.94	18	4.75	1.204
6	Mathabhanga I	218191	8.28	30	7.92	0.957
7	Mathabhanga II	227397	8.62	33	8.71	1.010
8	Mekligunj	155250	5.89	24	6.33	1.075
9	Sitai	110333	4.18	17	4.49	1.072
10	Sitaikuchi	185353	7.03	30	7.92	1.126
11	Tufanganj I	248595	9.43	41	10.82	1.147
12	Tufanganj II	186726	7.08	32	8.44	1.192
	Total	2636608	100.00	406	107.12	SD = 0.812

Source: Data collected from coochbehar.nic.in, and LQ computed by authors

Table-3: Computation of Lorenz Curve and Gini's Coefficient for PHCs

ID	Block	Population (Ai)	PHC (Bi)	% of PHC to Population (Bi/Ai)100	Rank (D)	% of Population Distribution	% of PHC Distribution	Cumulative % of Population (Xi)	Cumulative % of PHC (Yi)	$XiYi_{+1}$	$YiXi_{+1}$
1	Haldibari	103969	2	0.00192	12	3.94	6.67	3.94	6.67	52.55	54.19
2	Sitai	110333	2	0.00181	11	4.18	6.67	8.12	13.34	216.68	231.81
3	Dinhata II	244066	4	0.00164	10	9.26	13.33	17.38	26.67	637.38	684.27
4	Mathabhanga I	218191	3	0.00137	9	8.28	10.00	25.66	36.67	1197.41	1257.10
5	Mathabhanga II	227397	3	0.00132	8	8.62	10.00	34.28	46.67	1828.46	1874.72
6	Mekligunj	155250	2	0.00129	7	5.89	6.67	40.17	53.34	2544.22	2645.41
7	Tufanganj I	248595	3	0.00121	6	9.43	10.00	49.60	63.34	3802.71	3967.51
8	Cooch Behar II	343901	4	0.00116	5	13.04	13.33	62.64	76.67	5220.35	5341.73
9	Sitaikuchi	185353	2	0.00108	4	7.03	6.67	69.67	83.34	6270.68	6396.40
10	Tufanganj II	186726	2	0.00107	3	7.08	6.67	76.75	90.00	7419.78	8022.83
11	Cooch Behar I	326558	2	0.00061	2	12.39	6.67	89.14	96.67	8914.22	9666.68
12	Dinhata I	286269	1	0.00035	1	10.86	3.33	100.00	100.00		
	Total	2636608	30							38104.44	40142.66
		? Ai	? Bi							? XiYi	? YiXi

Source: Compute by authors

Table 4: Calculation of Lorenz Curve and Gini's Coefficient for HSCs

ID	Block	Population (Ai)	HSC (Bi)	% of HSC to Population (Bi/Ai)100	Rank (Descending)	% of Population Distribution	% of HSC Distribution	Cumulative % of Population (Xi)	Cumulative % of HSC (Yi)	$XiYi_{+1}$	$YiXi_{+1}$
1	Cooch Behar I	326558	46	0.01409	12	12.39	11.33	12.39	9.76	230.788	211.272
4	Dinhata II	244066	36	0.01475	11	9.26	8.87	21.65	18.63	563.167	557.361
6	Mathabhanga I	218191	30	0.01375	10	8.28	7.39	29.92	26.02	1014.302	962.710
12	Tufanganj II	186726	32	0.01714	9	7.08	7.88	37.00	33.90	1555.143	1546.726
7	Mathabhanga II	227397	33	0.01451	8	8.62	8.13	45.63	42.03	2502.011	2465.759
2	Cooch Behar II	343901	52	0.01512	7	13.04	12.81	58.67	54.83	3896.437	3812.584
3	Dinhata I	286269	47	0.01642	6	10.86	11.58	69.53	66.41	4908.618	4895.388
9	Sitai	110333	17	0.01541	5	4.18	4.19	73.71	70.60	5639.794	5619.740
8	Mekligunj	155250	24	0.01546	4	5.89	5.91	79.60	76.51	6894.166	6811.667
11	Tufanganj I	248595	41	0.01649	3	9.43	10.10	89.03	86.61	8368.616	8319.598
10	Sitaikuchi	185353	30	0.01619	2	7.03	7.39	96.06	94.00	9455.297	9400.065
5	Haldibari	103969	18	0.01731	1	3.94	4.43	100.00	98.43		
	Total	2636608	406		N12	100	100.00			45028.3447	44602.875
										? XiYi	? YiXi

Source: Compute by authors

Table 5: Correlation Table of Population &PHC

		Population	PHC
Population	Pearson Correlation	1	.348
	Sig. (2-tailed)		.267
	N	12	12
PHC	Pearson Correlation	.348	1
	Sig. (2-tailed)	.267	
	N	12	12

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.348[a]	.121	.034	.889

a. Predictors: (Constant), POPULATION

Source: Computed by the author

Table 6: Correlation Table of Population & HSC

		Population	HSC
Population	Pearson Correlation	1	.932**
	Sig. (2-tailed)		.000
	N	12	12
HSC	Pearson Correlation	.932**	1
	Sig. (2-tailed)	.000	
	N	12	12

**. Correlation is significant at the 0.01 level (2-tailed).

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.932[a]	.869	.856	3.801

a. Predictors: (Constant), Population

Source: Computed by the authors

Table-7: Population served by PHCs (in descending order)

Id	Block Name	POPULATION	PHC	Ratio	Spare of Population	% of excess	Times Excess	Required PHC (TOTAL)
1	Dinhata I	286269	1	286269	256269	854.23	9.54	10
2	Cooch Behar I	326558	2	163279	133279	444.26	5.44	11
3	Tufanganj II	186726	2	93363	63363	211.21	3.11	6
4	Sitaikuchi	185353	2	92677	62677	208.92	3.09	6
5	Cooch Behar II	343901	4	85975	55975	186.58	2.87	11
6	Tufanganj I	248595	3	82865	52865	176.22	2.76	8
7	Mekligunj	155250	2	77625	47625	158.75	2.59	5
8	Mathabhanga II	227397	3	75799	45799	152.66	2.53	8
9	Mathabhanga I	218191	3	72730	42730	142.43	2.42	7
10	Dinhata II	244066	4	61017	31017	103.39	2.03	8
11	Sitai	110333	2	55167	25167	83.89	1.84	4
12	Haldibari	103969	2	51985	21985	73.28	1.73	3
	Total	2636608	30	87887	57887	192.96	2.93	88

Source: Data collected from coochbehar.nic.in, and LQ computed by authors

Table-8: Population served by HSCs (in descending order)

Id	Block Name	POPULATION	HSC	Ratio	Spare of Population	% of excess	Times Excess	Required HSC
1	Dinhata I	218191	30	7273	2273	45.46	1.45	44
2	Cooch Behar I	326558	46	7099	2099	41.98	1.42	65
3	Tufanganj II	227397	33	6891	1891	37.82	1.38	45
4	Sitaikuchi	244066	36	6780	1780	35.59	1.36	49
5	Cooch Behar II	343901	52	6613	1613	32.27	1.32	69
6	Tufanganj I	110333	17	6490	1490	29.80	1.30	22
7	Mekligunj	155250	24	6469	1469	29.38	1.29	31
8	Mathabhanga II	185353	30	6178	1178	23.57	1.24	37
9	Mathabhanga I	286269	47	6091	1091	21.82	1.22	57
10	Dinhata II	248595	41	6063	1063	21.27	1.21	50
11	Sitai	186726	32	5835	835	16.70	1.17	37
12	Haldibari	103969	18	5776	776	15.52	1.16	21
	Total	2636608	406	6494	1494	29.88	1.30	527

Source: Data collected from CoochBehar.nic.in, and LQ computed by authors

Table-9: Blockwise Observed and Expected distribution of PHCs

Id	Block Name	POPULATION	PHC (Observed)	Required PHC (Expected)	(O-E)^2	{(O-E)^2}/E
1	Dinhata I	326558	2	11	78.95	7.25
2	Cooch Behar I	343901	4	11	55.70	4.86
3	Tufanganj II	286269	1	10	72.97	7.65
4	Sitaikuchi	244066	4	8	17.10	2.10
5	Cooch Behar II	103969	2	3	2.15	0.62
6	Tufanganj I	218191	3	7	18.26	2.51
7	Mekligunj	227397	3	8	20.98	2.77
8	Mathabhanga II	155250	2	5	10.08	1.95
9	Mathabhanga I	110333	2	4	2.81	0.77
10	Dinhata II	185353	2	6	17.46	2.83
11	Sitai	248595	3	8	27.95	3.37
12	Haldibari	186726	2	6	17.84	2.87
	Total	2636608	30	88	3350.90	38.13

Source: Data collected from coochbehar.nic.in, and LQ computed by authors

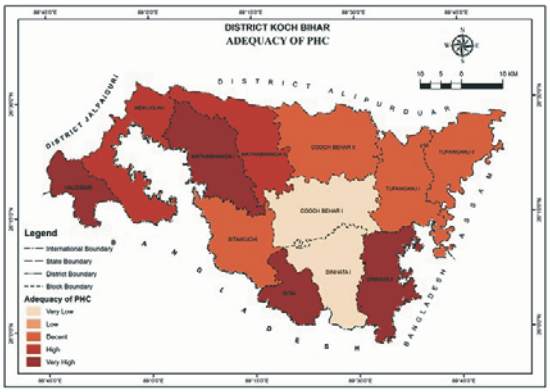

Fig. 2: Adequacy of PHCs

Table-10: Blockwise Observed and Expected distribution of HSCs

Id	Block Name	POPULATION	HSC (Observed)	Required HSC (Expected)	(O-E)^2	{(O-E)^2}/E
1	Dinhata I	326558	46	65	372.94	5.71
2	Cooch Behar I	343901	52	69	281.58	4.09
3	Tufanganj II	286269	47	57	105.14	1.84
4	Sitaikuchi	244066	36	49	164.18	3.36
5	Cooch Behar II	103969	18	21	7.81	0.38
6	Tufanganj I	218191	30	44	186.00	4.26
7	Mekligunj	227397	33	45	155.74	3.42
8	Mathabhanga II	155250	24	31	49.70	1.60
9	Mathabhanga I	110333	17	22	25.67	1.16
10	Dinhata II	185353	30	37	49.99	1.35
11	Sitai	248595	41	50	76.02	1.53
12	Haldibari	186726	32	37	28.57	0.77
	Total	2636608	406	527	14718.93	27.91

Source: Data collected from coochbehar.nic.in, and LQ computed by authors

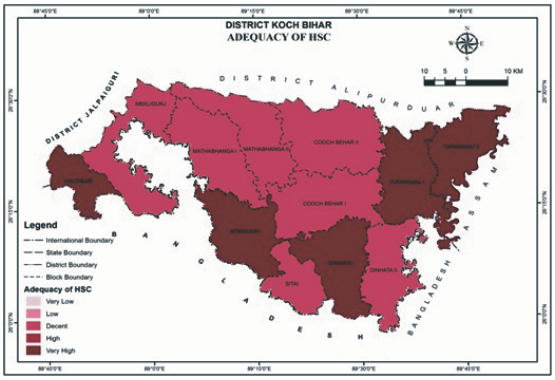

Fig. 3: Adequacy of HSCs

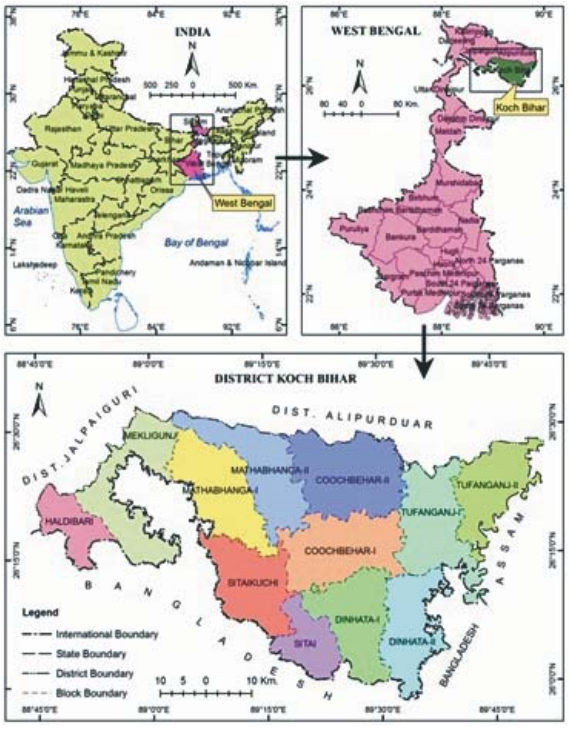

Fig 1: Location of the Study Area

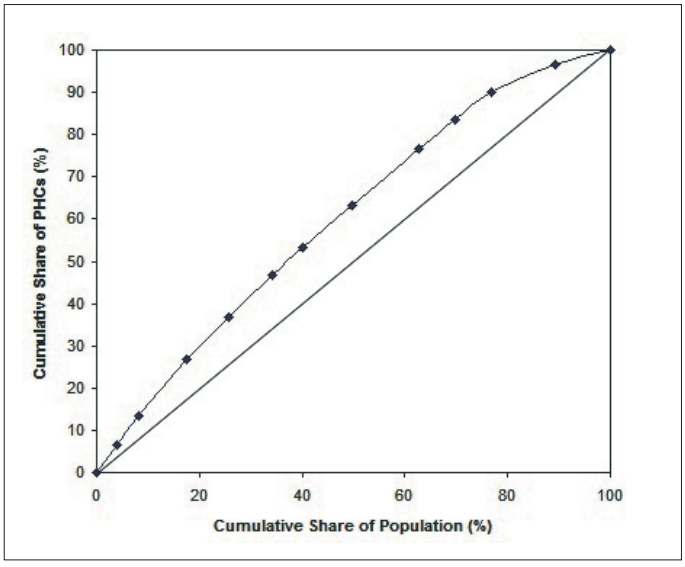

Fig 4: Lorenz Curve showing the inequality in distribution of PHCs

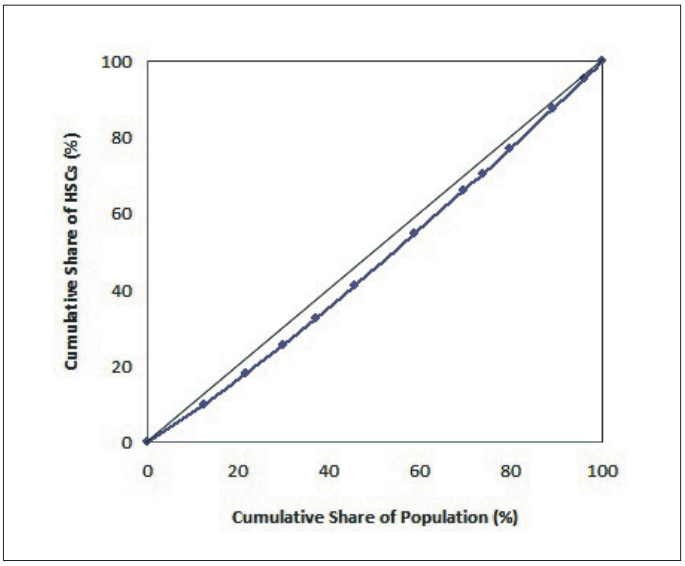

Fig 4b: Lorenz Curve showing the inequality in distribution of HSCs

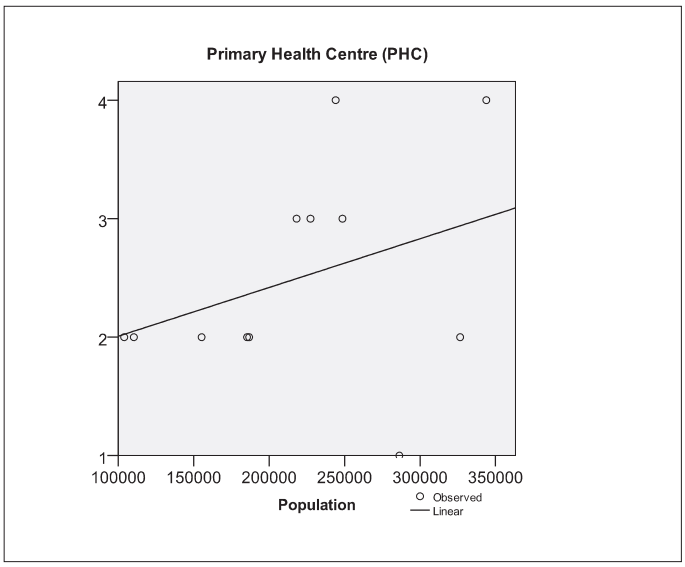

Fig.6: Linear relationship of Population and No. of PSCs

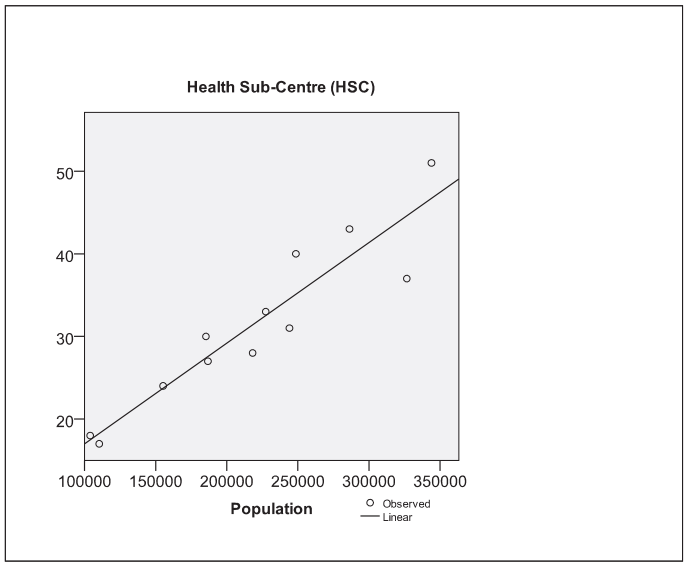

Fig.6: Linear relationship of Population and No. of HSCs

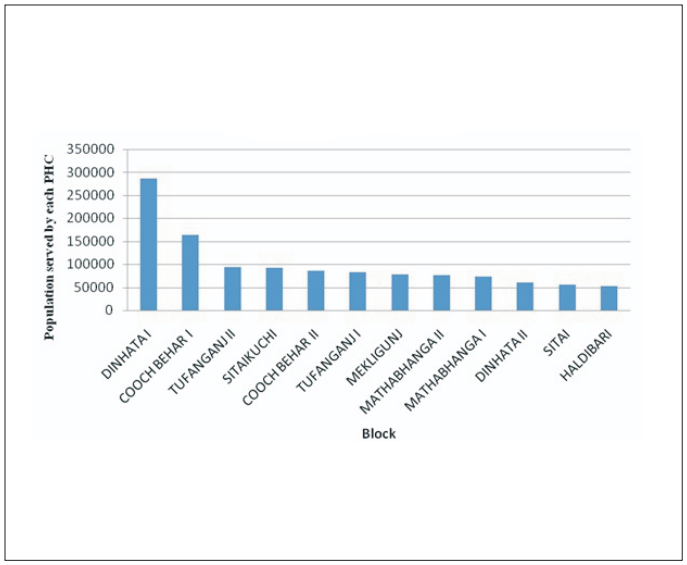

Fig.7: Population served by each PHC

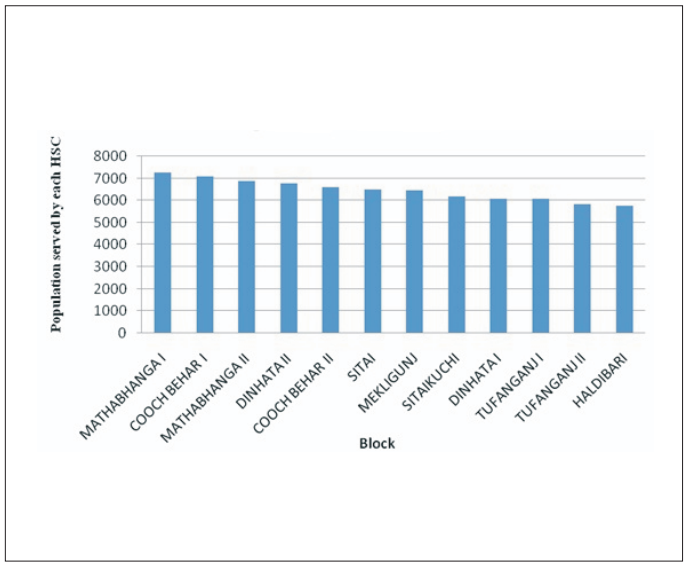

Fig.8: Population served by each HSC

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