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Spatio-temporal inequalities in healthcare facilities: A case study in undivided Medinipur District, West Bengal, India

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Abstract

The quality and quantity of health infrastructure are essential elements for the overall human development of a nation. But as per the report of WHO & World Bank (2017), at least half of the world's population cannot obtain essential health services. Keeping in mind the above-mentioned notation, the present study focuses on the spatio-temporal disparities in healthcare infrastructure among fifty-four blocks under the undivided Medinipur district, by computing Health Infrastructure Index (HII) on the basis of thirteen selected indicators using the Deprivation Index Method, for two temporal scales i.e. for the year 2001 and 2011. The study found that there exists inter-block disparity within the region regarding the availability and accessibility of basic healthcare infrastructure with respect to the population pressure of that region. The study argued for policy implementation by the local government for improving the underdeveloped pockets within the study area.

Keywords: Health Infrastructure Index; Deprivation Index Method; Spatio-temporal disparities; Health infrastructure

1. Introduction

The World Health Organization (WHO) constitute that "*health is a state of complete physical, mental and social well-being and not merely the* absence of disease or infirmity''. The World Bank (1993) found that health is considered as one of the most basic needs of human being for increasing productivity and economic growth of a nation. Health is an essential component of economic development which has a strong correlation with the social well-being of the people (Meher & Patro, 2014). Therefore, achieving socio-economic growth of a nation can be done by enhancing the national health infrastructure (Kaur et al., 2023).

The development is a multi-dimensional process in terms of quality of life, healthcare standards, educational facilities, economic growth and social sector improvement (De, 2017; Guo et al., 2022; Jedrzejczak-Gas et al., 2021; Majumder, 2021). The United Nations' Sustainable Development Goal (SDG) 3 depicts good health and well-being to "ensure healthy lives and promotion of wellbeing for all at all ages". The quality and quantity of health infrastructure is essential elements for overall human development. The social objectives like economic growth and poverty alleviation can be achieved by creating adequate health infrastructure (Pradhan et al., 2011). Kumar and Singh (2020) pointed that socio-economic development can be achieved by improving the health conditions of the people, which depends upon the health infrastructure facilities in that region. Therefore, Governments attempt should be improve to strengthen healthcare facilities to provide preventive and curative healthcare facilities to its citizens (Koka and Mir, 2018). Furthermore, government should take initiatives to promote equitable distribution of health services in different district within the state (Saikia & Bhattacharjee, 2011).

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The report of World Health Organization and World Bank (2017) found that at least half of the world's population cannot obtain essential health services. In India, there exists a regional, intra-regional and even micro-level inequality in socio-economic facilities (Parveen, 2016). Numbers of study observed that the inter-state and intra-state inequality in health among the number of large state like Uttar Pradesh, Bihar, Madhya Pradesh, Rajasthan etc. remains a matter of deep concern (Kumari and Raman 2011). The study of George & Sharma (2023) found higher inequalities in public health sector in India, more remarkable in the state of Madhya Pradesh due to disparities in access to health care facilities. The study of Meher & Patro (2014) depicted that wide variation exist in public health status and public health care services between and within different states of India. Their study assessed inequalities based on deprivation method as followed in the Human Development Report 1990 (UNDP 1990). In their study, Kaur et al. (2023) examined the inter-district health infrastructure disparities in the newly created Union Territory (UT) of Jammu and Kashmir, by developing a district level health infrastructure index (HII) using principal component analysis. Rout (2007) shows the inter-district inequality in healthcare infrastructure based on computed composite index value in respect to the state of Orrisa (Odisha). Kumari and Raman (2011) made an attempt to examine inter-district level of inequality in respect to education and health facilities for two temporal scales i.e. 1990-91 and 2007-08 in the state of Uttar Pradesh.

In consideration to the district of West Bengal, Sheet and Roy (2013) found considerable block-level disparity in health infrastructure within the district of Birbhum. Majumder (2021) examined inter-block regional disparity among different blocks under Jalpaiguri Administrative Division (JAD) including five dimensions namely, health, education, economy, socio-demography and transport by constructing a multi-dimensional approach-based index. The study of Barman & Roy (2018) found block-level healthcare facilities in respect to public health infrastructure in the Koch Bihar district, using health infrastructure index and health inequality index. Mandal (2017) found inter-block inequality in health services in the south 24 Parganas district in the state of West Bengal.

In consideration to the above mention scenario, the present work is focused on the inter-block disparity in healthcare facilities for the year 2001 and 2011 under the undivided Medinipur district in the state of West Bengal. The study also focuses on the most vulnerable blocks for which special attention is needed. The study also suggested possible policy implementation for the improvement of health facilities at the underdeveloped and deprived region for the balanced development of the people.

Objectives of the Study

The main objectives of the study are as follows:

- To examine the inter-block disparities in health infrastructure facilities under the Undivided Medinipur district for two temporal scales i.e. 2001 and 2011.
- To identify the most backward region for which special planning is needed by government initiative.

2. Material and methods

2.1. Study area

Prior to the division, the Undivided Medinipur district was one of the largest district of West Bengal, which was partitioned in the year 2002 and 2017 respectively into Purba Medinipur, Paschim Medinipur and Jhargram districts, to facilitate suitable administration and better functioning of development initiatives. It is located between 21°36'35"N - 22°57'10"N latitudes and between 86°35'50"E - 88°12'40"E longitudes (Census, 2001). The Western part of the study area is a fringe of the Chotonagpur Plateau and consists of a hard laterite zone, whereas the Eastern portion has been formed out of the alluvial deposits, borne by the river Hooghly and its tributaries, and coastal influences.

The study includes fifty-four blocks under the study area to assess regional imbalances in health facilities. Within fifty-four blocks, eight blocks included under the newly formed Jhargram district, twenty-one is included in the jurisdiction of Paschim Medinipur district, and remain twenty-five blocks fall under the jurisdiction of the divided Purba Medinipur district. The detail of the study area has shown in figure 1.

2.2. Data Source

The study has been done primarily based on secondary data collected from District Census Handbook, Midnapore district (2001), District Census Handbook, Paschim Medinipur district (2011), District Census Handbook, Purba Medinipur district (2011), District Statistical Hand Book, Medinipur district (2001), District Statistical Hand Book,

Paschim Medinipur district (2010 & 2011 Combined), District Statistical Hand Book, Purba Medinipur district (2010 & 2011 Combined). Due to the unavailability of the census 2021, the study focuses on the 2001 and 2011 census data.

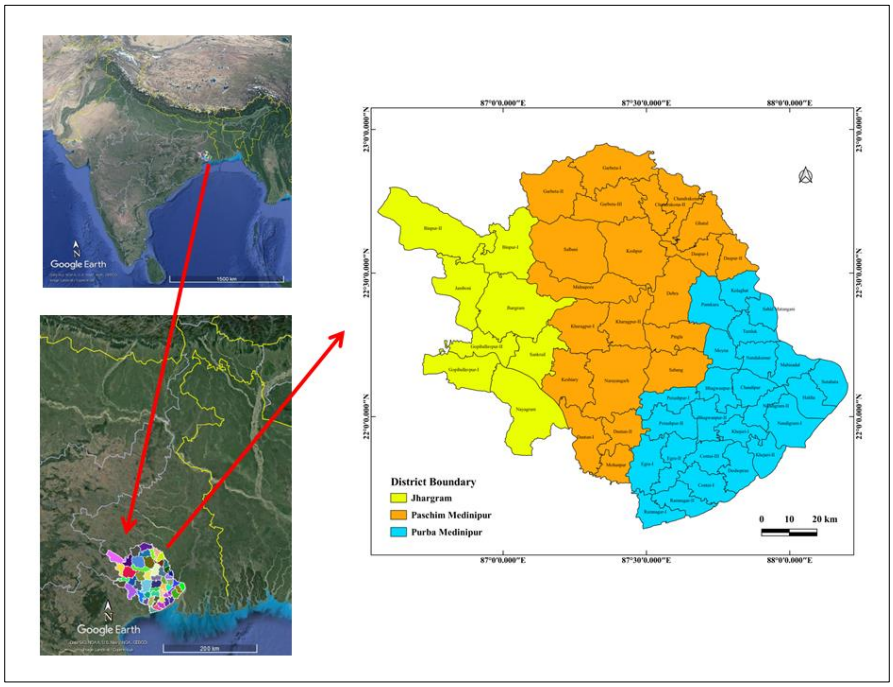


Figure 1 Location map of the study area including three newly formed districts with block boundary

2.3. Selection of indicators

Table 1 Selected Indicators, their relation with development and calculated CV for 2001 & 2011

Variable ID	Variable Explanation	Relationship with Development	CV (2001)	CV (2011)
X1	Percentage of village having Medical facilities	Positive	57.56	41.27
X2	Number of Primary Health Centre per 10,000 population	Positive	41.91	45.87
X3	Number of Health Sub-Centres per 10,000 population	Positive	27.54	14.72
X4	Number of Maternity & Child Welfare Centre per 10,000 population	Positive	167.17	95.98
X5	Number of Family Welfare Centre per 10,000 population	Positive	135.78	106.81
X6	Number of Hospital beds per 10,000 population	Positive	140.28	93.39
X7	Number of registered doctors in health centres per 10,000 population	Positive	46.20	40.09
X8	Registered Private Medical Practitioner per 10,000 population	Positive	82.93	86.04
X9	Community Health Worker (ASHA) per 10,000 population	Positive	70.62	55.37
X10	Achievement in Universal Immunization Programme per 10,000 population	Positive	25.94	8.64
X11	Number of Patient treated in govt. health centres per 10,000 population	Positive	43.12	38.05
X12	Number of Animal Development Aid Centre per 10,000 cattle	Positive	97.88	46.87
X13	Number of Veterinary personnel per 10,000 cattle	Positive	60.64	38.82

The socio-economic development should be measured based on several relevant and feasible variables (Majumder, 2021). The accessibility of physical healthcare infrastructure includes primary health centres, family welfare centres, hospital beds, doctors in the health centres etc. directly impacts on people's health (Armenta et al., 2018; Lakshmi & Sahoo, 2013; Shaw & Sahoo, 2020). The choice of indicators also depends on the availability and accessibility of the relevant data (Kumar and Rani, 2019). The present study used thirteen health indicators for the construction of the Health Infrastructure Index (HII). The selected variables are summarized in Table 1.

2.4. Choice of methods of Analysis

In the methodological arena researcher like- Meher & Patro, 2014; Sheet & Roy, 2013; Barman & Roy, 2018; Bishnoi and Aneja, 2008 etc. have used Deprivation Index Method to compute composite index. In other side, another group of researcher like,- Kumari & Raman, 2022; George & Sharma, 2023; Kumar and Singh, 2020; Kaur et al., 2023 utilized Principal Component Analysis (PCA) to formulate composite indices of health inequalities.

In the present study, all the selected thirteen variables have been computed by assign them equal weight, to aggregate the selected variables, to compute Health Infrastructure Index (HII) using Deprivation Index Method, following the methodology used in UNDP's Human Development Index. All the fifty-four blocks have been classified into five categories (i. e. Very low, Low, Moderate, High and Very high) according to the computed values. The lowest value of the calculated index is termed as very low level of development and vice versa, in respect to health facilities. The details methodology involved in the study is described below:

The first step involves the identification and selection of related variables. In this study, thirteen variables have been selected. The second step follows the methodology used in UNDP's Human Development Index (HDI) to normalize the selected indicators. The equations (1&2) are:

$$Sji = (xij - x_{min}i) / (x_{max}i - x_{min}i) \text{ (for Positive relationship)} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

$$Sji = (x_{max}i - xij) / (x_{max}i - x_{min}i) \text{ (for Negative relationship)} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Where, Sji denotes the standardized score of ith variable at jth unit of study. $x_{max}i$ and $x_{min}i$ represents the maximum and minimum values of ith variable in the study area respectively. xij represents the actual value of ith variable at jth units of study.

The next step involves a simple average of standardized scores, as equal weightage is considered for all the variables to get the average Deprivation Index (DPIj) of each individual block using the following equation (3).

$$DPIj = \Sigma Sji / n \quad \ldots\ldots\ldots\ldots\ldots (3)$$

(Where, DPIj denotes the average Deprivation Index of jth units of study and Sji denotes the standardized score of each indicator.)

In the final stage, calculation of the development index in respect to health infrastructure or Health Infrastructure Index (HII) has been done using the follow equation (4) for every block in the study area.

$$HII = (1- DPIj) \quad \ldots\ldots\ldots\ldots\ldots (4)$$

(Where, HII denotes the Health Infrastructure Index, and DPIj denotes the average deprivation index of jth units of study.)

For understanding the health condition, the block with highest calculated index value has been considered as the block with very high health facility, whereas lowest value indicates very low health infrastructure condition under different blocks. All the blocks have been classified into five classes to identify the block-level inequality situation for two temporal scales i.e. for the year 2001 and 2011.

2.5. Correlation analysis

Pearson correlation coefficient was calculated to show the relationships among various indicators incorporated in the study, and also their interrelation with health infrastructure index, based on the following equation (5):

$$r = \frac{N\Sigma xy-(\Sigma x)(\Sigma y)}{\sqrt{[N\Sigma x^2-(\Sigma x)^2][N\Sigma y^2-(\Sigma y)^2]}} \quad \text{..... (5)}$$

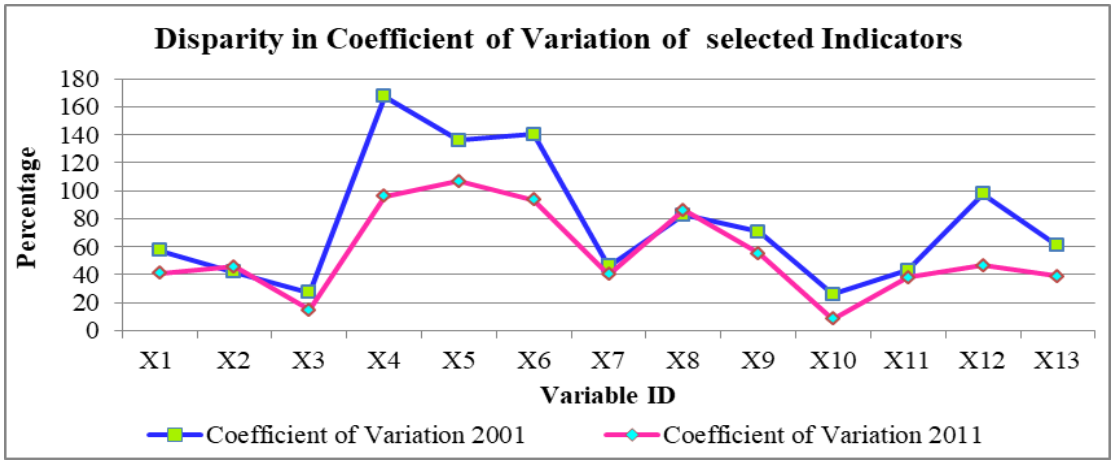
Where, r = Pearson correlation coefficient; N = the number of pairs of scores; Σxy = the sum of the products of paired scores; Σx = the sum of x scores; Σy = the sum of y scores; Σx^2 = the sum of squared x scores; Σy^2 = sum of squared y scores respectively.

3. Result and Discussion

3.1. Selected Indicators and their relative disparity:

For understanding the level of health infrastructure facilities among fifty-four blocks under undivided Medinipur district, thirteen indicators have been selected. The raw data for the year 2001 and 2011 have been analyzed basis on the mean, standard deviation, variance and coefficient of variation. The calculated coefficient of variation (in table 1) shows different CV values which indicate that each indicator has their imbalanced distribution among different blocks within the study area. This is responsible for different health infrastructure condition among blocks. The other consideration is that how far their values differ from one another is indicates their magnitude of disparity among regions. The higher the coefficient of variation (CV) values indicates higher the level of dispersion exists around the mean, i.e. greater the degree of variation exists within the blocks and vice versa.

The results indicate that there has uneven distribution of the facilities in respect to health indicators within the blocks which collective responsible for generating imbalances among blocks regarding the health infrastructure facilities. It is also observed that the disparities have been reduced relatively form the year 2001 to 2011 in respect to maximum of the indicators (Figure 2). Maximum variation is shown regarding the i) Number of Maternity & Child Welfare Centre per 10,000 population, ii) Number of Family Welfare Centre per 10,000 population and iii) Number of Hospital beds per 10,000 population, whereas, minimum block level disparity found regarding i) Achievement in Universal Immunization Programme per 10,000 population and ii) Number of Health Sub-Centres per 10,000 population.



(Source: Prepared by the author)

Figure 2 Level and pattern of disparity in coefficient of variation for the year 2001&2011

3.2. Level of Health Facilities

For understanding the health infrastructure, thirteen indicators have been aggregated with equal weightage following the methodology mentioned above for the year 2001 and 2011. The highest the index value considered as better health situation, and rank 1 has been assign to it, while lowest value represents worst health facilities with rank 54, within the study area. The table 2 shows Health Infrastructure Index (HII), their relative rank and their relative level of development among different blocks within the study area.

For the year 2001, highest values is found in the block of Nayagram (0.48) with rank 1, while lowest value found in the block Bhagwanpur-I (0.16) with rank 54. In the year 2011, the situation changed, where highest value observed in the block Chandrakona-II (0.53) with rank 1 and lowest value observed in the block kharagpur-I (0.21) having the rank 54 (Table 2).

Table 2 Block-wise computed score of HII, Rank & Level of Development

		2001			2011		
Sl	**C D Block**	**HII**	**Rank**	**Level**	**HII**	**Rank**	**Level**
1	Jhargram	0.21	45	L	0.42	9	H
2	Binpur-I	0.34	13	H	0.5	2	V H
3	Binpur-II	0.41	5	V H	0.44	8	H
4	Jamboni	0.33	18	H	0.46	5	V H
5	Nayagram	0.48	1	V H	0.34	29	M
6	Sankrail	0.38	8	H	0.37	19	M
7	Gopiballavpur-I	0.4	6	H	0.5	3	V H
8	Gopiballavpur-II	0.33	19	H	0.45	7	H
9	Salbani	0.31	23	M	0.42	10	H
10	Keshpur	0.27	33	M	0.29	45	L
11	Garbeta-I	0.31	24	M	0.28	47	L
12	Garbeta-II	0.31	26	M	0.29	46	L
13	Garbeta-III	0.45	2	V H	0.33	32	M
14	Mednapore	0.19	48	L	0.39	11	H
15	Debra	0.19	47	L	0.37	20	M
16	Pingla	0.25	38	M	0.3	41	L
17	Keshiary	0.33	14	H	0.37	17	M
18	Dantan-I	0.31	25	M	0.26	51	L
19	Dantan-II	0.3	29	M	0.38	15	M
20	Narayangarh	0.24	43	L	0.3	43	L
21	Mohanpur	0.33	20	H	0.38	14	M
22	Sabang	0.37	9	H	0.3	44	L
23	Kharagpur-I	0.2	46	L	0.21	54	V L
24	Kharagpur-II	0.24	40	L	0.26	49	L
25	Chandrakona-I	0.33	21	H	0.45	6	H
26	Chandrakona-II	0.28	31	M	0.53	1	V H
27	Ghatal	0.35	11	H	0.25	52	L
28	Daspur-I	0.41	4	V H	0.35	23	M
29	Daspur-II	0.34	12	H	0.31	38	L
30	Tamluk	0.25	36	M	0.35	25	M
31	Sahid Matangini	0.33	22	H	0.33	34	M

32	Panskura	0.17	52	V L	0.35	28	M
33	Kolaghat	0.33	15	H	0.33	35	M
34	Moyna	0.18	50	L	0.36	22	M
35	Nandakumar	0.16	53	V L	0.34	30	M
36	Chandipur	0.24	41	L	0.39	12	H
37	Mahisadal	0.24	42	L	0.35	27	M
38	Nandigram-I	0.29	30	M	0.35	26	M
39	Nandigram-II	0.39	7	H	0.37	18	M
40	Sutahata	0.3	27	M	0.46	4	V H
41	Haldia	0.42	3	V H	0.36	21	M
42	Potashpur-I	0.27	32	M	0.27	48	L
43	Potashpur-II	0.18	49	L	0.23	53	V L
44	Bhagwanpur-I	0.16	54	V L	0.31	37	L
45	Egra-I	0.22	44	L	0.26	50	L
46	Egra-II	0.25	37	M	0.35	24	M
47	Khejuri-I	0.37	10	H	0.32	36	M
48	Khejuri-II	0.17	51	V L	0.34	31	M
49	Bhagwanpur-II	0.33	17	H	0.3	40	L
50	Ramnagar-I	0.25	35	M	0.38	16	M
51	Ramnagar-II	0.24	39	L	0.38	13	M
52	Contai-I	0.27	34	M	0.31	39	L
53	Deshopran	0.3	28	M	0.33	33	M
54	Contai-III	0.33	16	H	0.3	42	L

(VH=Very High, H=High, M=Medium, L=Low and VL=Very Low) Source: Calculated by the author

3.3. Temporal pattern of Health Facilities

The temporal pattern shows the changing scenario of the health facility index from the year 2001 to 2011. It shows a fluctuating condition of their relative position whereas condition of few blocks degraded considerably. It is found that though maximum blocks improved their healthcare facilities in the year 2011, there still exist imbalances among blocks in respect to their availability of healthcare infrastructure within the study area. The block Nayagram, Garbeta-III, Ghatal, Daspur-I, Haldia, Sabang and Khejuri-I show their degrading condition regarding availability of healthcare facilities. In contrary, the blocks namely, Jhargram, Midnapore, Chandrokona-I, Chandrakona-II, Chandipur and Sutahata shows an improvement condition within the study area (Figure 3).

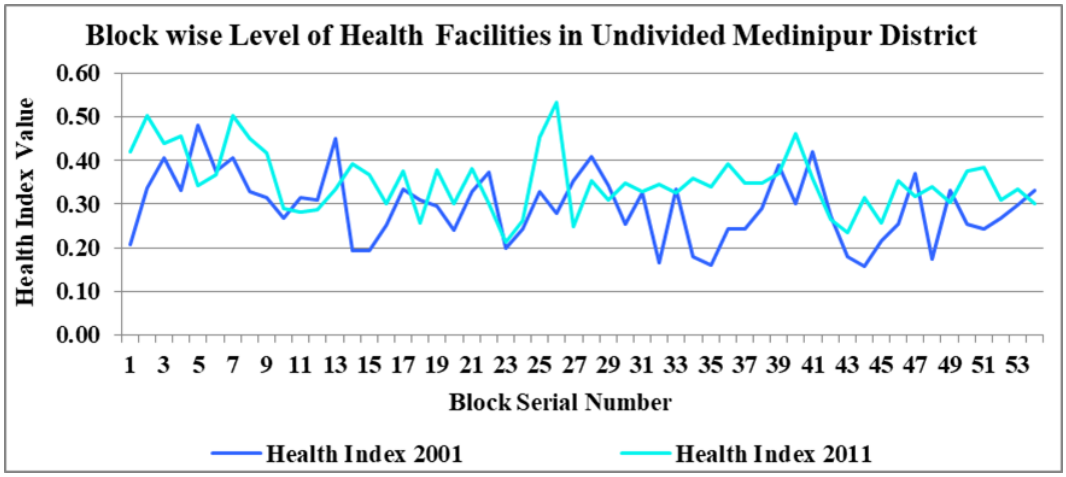


Figure 3 Temporal pattern of level of health facility in 2001 & 2011. (Source: Prepared by the author)

3.4. Spatial pattern of Health Facilities

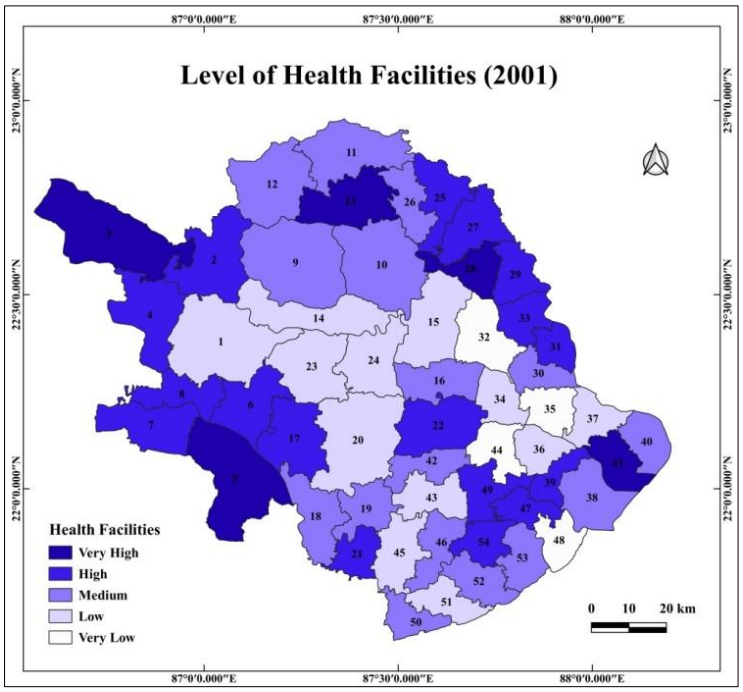
Accessibility and availability of healthcare facilities and infrastructure plays a crucial role in the development of a region. But in real world these are not evenly distributed (Majumder, 2021), rather it is often seen that modern healthcare facilities have concentrated around the urban centres. Health worker also be insufficient in the rural area. Therefore, rural areas suffer more and the people intended to migrate towards the periphery of the urban centres for accessing the proper socio-economic facilitates including health, education etc.

In the present study, an attempt has been taken to assess the spatial pattern of inter-block healthcare facilities in the year 2001 and 2011. For that, fifty-four blocks has been classified into five development classes. The study found that only five blocks falls in very high category of health facilities for both the years. It is remarkable that the number of blocks in high category is reduced from 17 to 7 from the year 2001 to 2011, whereas medium categories of block increased from 16 to 24 in the same period. In contrary, the very low category block reduced from 4 to 2 in that time period (Table 3).

Table 3 Number of Blocks in different Level of Health Facilities

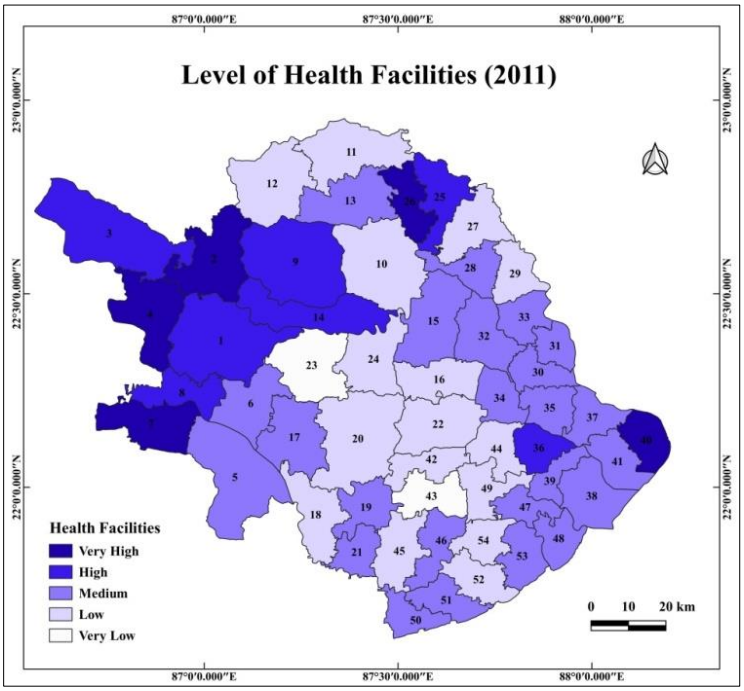
Level of Health Facilities		**2001**	**2011**
> (Mean + 1.5 Standard Deviation)	Very High	5	5
(Mean + 0.5 SD) - (Mean + 1.5 SD)	High	17	7
(Mean - 0.5 SD) - (Mean + 0.5 SD)	Medium	16	24
(Mean - 1.5 SD) - (Mean - 0.5 SD)	Low	12	16
< (Mean - 1.5 Standard Deviation)	Very Low	4	2

Source: Prepared by the author



Source: Prepared by the author

Figure 4 Inter-block spatial pattern of level of health facility in 2001



Source: Prepared by the author

Figure 5 Inter-block spatial pattern of level of health facility in 2011

The figure 4 and 5 shows the block-level spatial pattern of availability of health infrastructure facilities under the undivided Medinipur district. It is found that western blocks show the availability of very high level of health facilities in respect to the total population, whereas, eastern blocks show low to medium condition of the availability of health infrastructure facility in consideration to the total population of those area. It is remarkable that as the western part of the study area, including the blocks of Jhargram district shows very low population density in comparison to the eastern area, their health infrastructure seems to be sufficient for serving the total population. In contrary, the eastern blocks are very thickly populated and that's why their available healthcare infrastructure facilities are not sufficient to meet

the needs of the inhabitants of the region. In the central part of the study area, few block shows very low level of health infrastructure facilities for both the years (Figure 4 & 5). The table 4 shows top five high level and low level blocks regarding the health infrastructure facilities in the study area for the year 2001 and 2011.

Table 4 Best and worst blocks in respect to health facilities

Top 5 blocks in High Level of Health Facilities		**Top 5 blocks in Low Level of Health Facilities**	
2001	**2011**	**2001**	**2011**
Nayagram	Chandrakona-II	Bhagwanpur-I	Kharagpur-I
Garbeta-III	Binpur-I	Nandakumar	Potashpur-II
Haldia	Gopiballavpur-I	Panskura	Ghatal
Daspur-I	Sutahata	Khejuri-II	Dantan-I
Binpur-II	Jamboni	Moyna	Egra-I

3.5. Relative share of Area and Population under different Level of health facilities:

For policy implementation and proper planning, it is very important to calculate the percentage of area and population falls under the different level of development categories. The table 5 shows percentage share of blocks, area and population present under different development classes, based on availability of health infrastructure facilities within the study area. It also helps to analyze their relative improvement or degradation of the above situation from the year 2001 to 2011.

Table 5 Number of Blocks, Area & Population in different Level of Health Facilities

Level of Health Facilities	**2001**	**2011**
Percentage of Blocks included in different Level of Health Facilities		
Very High	9.26	9.26
High	31.48	12.96
Medium	29.63	44.44
Low	22.22	29.63
Very Low	7.41	3.70
Percentage of Area included in different Level of Health Facilities		
Very High	11.58	8.39
High	25.23	17.75
Medium	27.10	32.31
Low	23.09	29.91
Very Low	5.14	3.59
Percentage of Population included in different Level of Health Facilities		
Very High	7.00	5.67
High	25.71	10.39
Medium	26.98	39.99
Low	22.93	30.82
Very Low	8.78	3.93

Source: Calculated by the author

The table shows that the maximum of blocks, area and population falls under the medium category of development class which also increased from the year 2001 to 2011. In contrary, the least percentage of blocks, area and population falls under very low and very high development classes respectively. It is considerable that while the percentage share of block, area and population increased in low-level development categories from the year 2001 to 2011, it shows a decreasing condition for the high-level development categories. The entire scenario indicates that the area shows a relatively decreasing trend of its percentage share in very high and high level development classes, whereas percentage share increased in the medium and low level of development categories for the year 2001 to 2011. It implies that the region suffers from less accessibility of healthcare infrastructure form the year 2001 to 2011 due to increasing population pressure of the region.

3.6. Inter-Relationship among different indicators of health facilities

It is necessary to investigate the relationship of the indicators with the calculated composite index and among themselves. The table 6 and 7 shows pearson's correlation coefficient of the indicators and HII for the year 2001 and 2011. It is found that except indicators X1 and X8 all the indicators are positively correlated with the HII. The relationship between indicators and the calculated HII shows a positive moderate to high correlation within the study.

Table 6 Pearson Correlation Coefficient of selected indicators in 2001

	X1	***X2***	***X3***	***X4***	***X5***	***X6***	***X7***	***X8***	***X9***	***X10***	***X11***	***X12***	***X13***	***HII***
X1	1.000													
X2	-0.268	1.000												
X3	-0.182	0.368	1.000											
X4	-0.099	0.158	0.243	1.000										
X5	0.089	0.061	0.094	0.257	1.000									
X6	-0.129	0.088	-0.008	0.001	0.249	1.000								
X7	-0.197	0.527	0.154	0.106	0.291	0.629	1.000							
X8	0.639	-0.143	-0.181	-0.107	-0.026	-0.146	-0.189	1.000						
X9	0.640	-0.261	-0.130	-0.182	0.214	0.091	-0.065	0.363	1.000					
X10	-0.251	0.403	0.277	0.055	0.216	0.021	0.142	-0.074	-0.056	1.000				
X11	-0.078	0.270	0.229	0.125	0.018	0.164	0.390	-0.035	-0.121	0.261	1.000			
X12	-0.033	0.010	-0.040	-0.105	0.069	0.013	0.056	-0.057	0.080	0.125	-0.037	1.000		
X13	0.077	0.027	-0.055	-0.187	-0.048	0.063	0.082	-0.049	0.078	0.070	-0.007	0.896	1.000	
HII	0.374	0.397	0.323	0.212	0.539	0.326	0.499	0.321	0.452	0.452	0.386	0.302	0.293	1.000

Source: Computed by the author

Table 7 Pearson Correlation Coefficient of selected indicators in 2011

	X1	***X2***	***X3***	***X4***	***X5***	***X6***	***X7***	***X8***	***X9***	***X10***	***X11***	***X12***	***X13***	***HII***
X1	1.000													
X2	-0.444	1.000												
X3	-0.501	0.632	1.000											
X4	0.052	0.046	0.217	1.000										
X5	0.040	0.084	0.157	0.424	1.000									
X6	-0.353	0.195	0.041	-0.023	0.047	1.000								
X7	-0.523	0.705	0.489	0.034	0.054	0.522	1.000							

X8	0.286	-0.226	-0.346	0.101	0.202	-0.175	-0.283	1.000						
X9	-0.834	0.436	0.651	0.072	-0.023	0.146	0.458	-0.260	1.000					
X10	0.163	-0.045	0.039	0.236	0.158	-0.180	-0.065	0.055	-0.147	1.000				
X11	0.316	0.048	0.121	0.366	0.143	-0.225	-0.042	-0.124	-0.333	0.448	1.000			
X12	-0.347	0.368	0.371	-0.225	-0.104	0.095	0.288	-0.052	0.398	-0.349	-0.465	1.000		
X13	-0.066	0.173	0.051	-0.152	-0.140	-0.136	0.104	0.045	0.004	-0.041	0.122	0.396	1.000	
HII	-0.200	0.672	0.659	0.483	0.454	0.149	0.606	-0.007	0.302	0.291	0.392	0.277	0.325	1.000

Source: Computed by the author

4. Conclusion

In this study, fifty-four blocks have been analyzed based on the calculated HII. The spatio-temporal pattern of inequality among blocks has been shown using graphs and calculated index values. The study concluded that wide disparity exists among different blocks in the study area regarding the availability of healthcare infrastructure in comparison to the population pressure of that region. The study found inequality between the eastern and western regions under the study area. The western region shows a relatively high level of availability of health facilities in comparison to the total population, as this region has less population pressure. In contrary, the eastern region is composed of huge population pressure, and thus the availability of healthcare facilities per population is negligible. Therefore, improvement in public health infrastructure is very urgent in the eastern blocks of the study area to meet the requirements of the population. Furthermore, strengthening the local human resources is very helpful for mitigating the imbalanced situation in a considerable manner. New public health infrastructure should be developed and it is necessary to strengthen the existing health infrastructure facilities by physical improvement and recruitment of required health service human resources into the health institutions. Government should take proper initiatives to improve the public health infrastructure of the vulnerable pockets for balanced development of that region.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest with any personal, organizational or financial relationship related to the material in the study.

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