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HUMAN CAPITAL AND HEALTH: AN INTER-DISTRICT STUDY OF WEST BENGAL, INDIA

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Abstract: The present study examines the disparity in health based on health indicators across the districts in West Bengal, India. The disparities are considered to infer about human capital across the districts. The study has employed Principal Component Analysis (PCA) and accordingly formulated health indices in three domains: Health Infrastructure (HII), Accessibility and Affordability (AAI), and Nutrition and Health (NHI). A composite health index, grounded on the aggregate of the three indices, was constructed. The composite index highlights the overall disparity across the districts, while the domain-specific index reveals disparity within the district. The findings reveal wide variations both in the composite index and the domain-specific indices. There seems to exist inequality in the health component of human capital across the districts. Thus, the study recommends that concrete steps must be taken to improve the health indicators in the districts lagging behind. This will facilitate addressing the regional variations and strengthening the health component, eventually contributing to an improved human capital across districts and consequently in the state of West Bengal, India.

Keywords: Disparity, West Bengal, Health Indicators, Health Index, Human Capital.

JEL Classification: C38, I14 & J24

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I. INTRODUCTION

The notion behind incorporating health as an integral part of human capital was highlighted most prominently by Grossman in 1972. He was the first person to construct a model for the demand for health by applying human capital theory (Shurcke *et al.*, 2005; Becker, 2007; Bloom & Canning, 2008). Human capital, considered as a productive investment and investments embodied in humans, incorporates knowledge, abilities, health, and locations, typically resulting from expenditures on education, on-the-job training programs, and medical aid (Todaro & Smith, 2012). Health is thus a vital component of human capital that helps explain labour productivity at the micro level and the economy's performance at the macro level. Accordingly, the need was felt to incorporate economic growth theory that would capture health effects and their factors as determinants of economic growth and convergence (Poças, 2014).

The World Health Organisation (WHO) defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition" (WHO, 2020, p. 1). Furthermore, among the 17 Sustainable Development Goals (SDGs), SDG 3, "Good Health and Well-Being", relates to health. It is to ensure healthy lives and promote well-being for all at all ages.[1] Thus, the objective and the promotion of the healthy well-being of the population is a priority across the globe. It is because individuals who are both educated and healthy contribute positively to the nation's growth through enhanced productivity. However, enhanced productivity and growth are possible only through investments made in health. These investments can range from early investments in a child to continuous investments throughout life. Alongside this, "a long life correlates closely with adequate nutrition, good health and education and other valued achievements" (UNDP, 1990, p. 11). Health investments thus constitute one of the major categories of human capital and its accumulation, investments in education being the other category. Health improvements for most of history have also been the consequences of increased resources that allow for more investments. This, in turn, facilitates more consumption of calories and protein and, thus, more nutritious food. Therefore, investments in improved nutrition improve human health capital (Goldin, 2016). Also, prevention of early childhood diseases, proper nutrition, and a continuing adequate diet in adulthood ought to make adults more productive workers (Schultz, 1994). Furthermore, poor health in the early days due to malnourishment also affects the growth and development of children and, hence, adult health (Lutter *et al.*, 1989; Ahmed *et al.*, 1999). This can lead to some severe social and economic losses. It is therefore advocated that nations, especially developing nations, invest in the health of the general population, and women and children in particular, to accrue long-term social and economic benefits channelled through healthier and productive adults (Hoddinott *et al.*, 2008; Stenberg *et al.*, 2014). Thus, population health is crucial, for any (dis)investments in health can have a (negative) positive impact on human capital, labour productivity and hence economic growth of a nation or any region. Population health, on the other hand, is determined by the health system of a nation.

In this direction, the data on various health indicators in West Bengal, such as crude birth rate, crude death rate, infant mortality rate (IMR), maternal mortality ratio (MMR), etc., portray an improvement in population health over the years. For instance, the crude birth rate (CBR)[2] in West Bengal declined from 20.6 in 2001 to 15.2 in 2020; the crude death rate (CDR)[3] declined from 7.0 to 5.8 for the same period. The Infant Mortality Rate (IMR) in West Bengal in 2001 was 51 per 1000 live births; it declined to 25 in 2016 in West Bengal. Finally, the Maternal Mortality Rate (MMR)[4] in West Bengal declined from 14.8 in 2001 to 5.5 in 2016 (GoWB, 2005-06, 2011-12, 2016-17 & 2017-18). However, there exists considerable variation across the districts in West Bengal. The variations exist in terms of health infrastructure, accessibility, affordability and nutrition. As population health depends on the aforementioned factors, the variations across the districts can have a detrimental effect on the population's health and thereby on the state. Therefore, understanding the various factors that determine public health is central to interventions and improving health outcomes.

II. OBJECTIVES OF THE STUDY

Against this backdrop, this paper is an attempt to examine health disparities and suggest ways to enhance health and health outcomes at the district level in West Bengal, India. The objective is twofold: firstly, to examine the inter-district disparities based on various health indicators; and secondly, rank the districts according to the regional variations. Ranking the districts will allow for effective policy formulation in the districts that lag behind the better-performing districts.

III. STUDY AREA

According to the Census of India (2011), West Bengal, with a population of over 91 million, is the fourth most populous Indian state. Furthermore, according to the Economic Survey, Government of India, 2024-25, West Bengal ranked fifth in terms of literacy rate in 1951 among the States and Union Territories. The state's rank declined to 19th in 2011. West Bengal currently comprises 23 districts (Figure 1), but for the present study, only 19 districts have been taken into consideration. As few districts were formed post 2014 and due to data limitations, these districts have not been incorporated in this study. Among the districts in West Bengal, South 24-Parganas is the largest district in terms of area, and the district with the least area is Kolkata (see Table 1). While North 24-Parganas is the most populated district, Dakshin Dinajpur is the least populated district. Kolkata, with 24,306 persons per square km, is the most densely populated district, and Purulia is the least densely populated district with 468 persons per sq. km. The district with the highest literacy rate is Purba Medinipur with 87 per cent, and the least literate district is Uttar Dinajpur with 59.07 per cent. While Kolkata district has the lowest sex ratio with 908 females per 1000 males, Darjeeling district has the highest sex ratio with 970 females per 1000 males (DCHB, GoWB, 2011).

Table 1: Characteristic Description of Districts in West Bengal, India

Sl. No.	*District*	*Area (sq. km.)*	*Population*	*Population Density (per sq. km.)*	*Literacy Rate (%)*	*Sex Ratio (females per 1000 males)*
1.	Bankura	6,882	3,596,674	523	70.26	957
2.	Barddhaman	7,024	7,717,563	1,099	76.21	945
3.	Birbhum	4,545	3,502,404	771	70.68	956
4.	Coochbehar	3,387	2,819,086	832	74.78	942
5.	Dakshin Dinajpur	2,219	1,676,276	755	72.82	956
6.	Darjeeling	3,149	1,846,823	586	79.56	970
7.	Hugli	3,149	5,519,145	1,753	81.80	961

Sl. No.	District	Area (sq. km.)	Population	Population Density (per sq. km.)	Literacy Rate (%)	Sex Ratio (females per 1000 males)
8.	Howrah	1,467	4,850,029	3,306	83.31	939
9.	Jalpaiguri	6,227	3,872,846	622	73.25	953
10.	Kolkata	185	4,496,694	24,306	86.31	908
11.	Maldah	3,733	3,988,845	1,069	61.73	944
12.	Murshidabad	5,324	7,103,807	1,334	66.59	958
13.	Nadia	3,927	5,167,600	1,316	74.97	947
14.	North 24-Parganas	4,094	10,009,781	2,445	84.06	955
15..	Paschim Medinipur	9,368	5,913,457	631	78.00	966
16.	Purba Medinipur	4,713	5,095,875	1,081	87.02	938
17.	Purulia	6,259	2,930,115	468	64.48	957
18.	South 24-Parganas	9,960	8,161,961	819	77.51	956
19.	Uttar Dinajpur	3,140	3,007,134	958	59.07	939
	West Bengal	88,752	91,276,115	1,028	76.26	950
Source: Census of India, 2011.						

Furthermore, several studies and reports (WBHDR, 2004; Raychaudhuri & Haldar, 2004; Sengupta & Ghosh, 2013; Banu & Rawal, 2015; Biswas, 2016; Sengupta & Chakrabarti, 2024) in West Bengal have revealed inter-district disparities in literacy rate, education, sex ratio, income, infrastructure and so on. For instance, the West Bengal Human Development Report (2004) revealed wide variations across the districts in terms of Human Development Index (HDI). Kolkata, with an HDI value of 0.78, ranked first, followed by Howrah and North 24-Parganas with the HDI values of 0.68 and 0.66, respectively. Murshidabad, Purulia and Maldah were placed in the bottom three with the HDI values of 0.46, 0.45 and 0.44, respectively. In the case of urbanisation, which is the percentage of the urban population, wide differences exist across the districts. The top three urbanised districts are Kolkata (100%), Howrah (63.38%) and North 24-Pargana (57.27%); in the bottom three are Purba Medinipur (11.63%), Coochbehar (10.27%) and Bankura (8.33%) (DCHB, 2011). Alongside this, the data on District Domestic Product (DDP) from 2005-06 to 2013-14 at constant prices (2004-05) also highlighted considerable disparity across the districts. While the growth rates of the top three districts, namely, North 24-Parganas, Barddhaman and Kolkata in 2005-06 were 12.24, 10.35 and 9.83 per cent respectively, the growth rates in the bottom three districts, namely, Purulia, Uttar Dinajpur and Dakshin Dinajpur were 2.28, 1.93 and 1.45 per cent respectively. In 2013-14, North 24-Parganas, Barddhaman and Kolkata districts retained the top three ranks with the growth rates of 12.92, 10.47 and 9.69 per cent respectively, and in the bottom three were Coochbehar, Uttar Dinajpur and Dakshin Dinajpur districts with the growth rates of 2.12, 1.84 and 1.33 per cent respectively (GoWB, 2015). These findings confirm the existence of intra-state disparities in West Bengal, India.

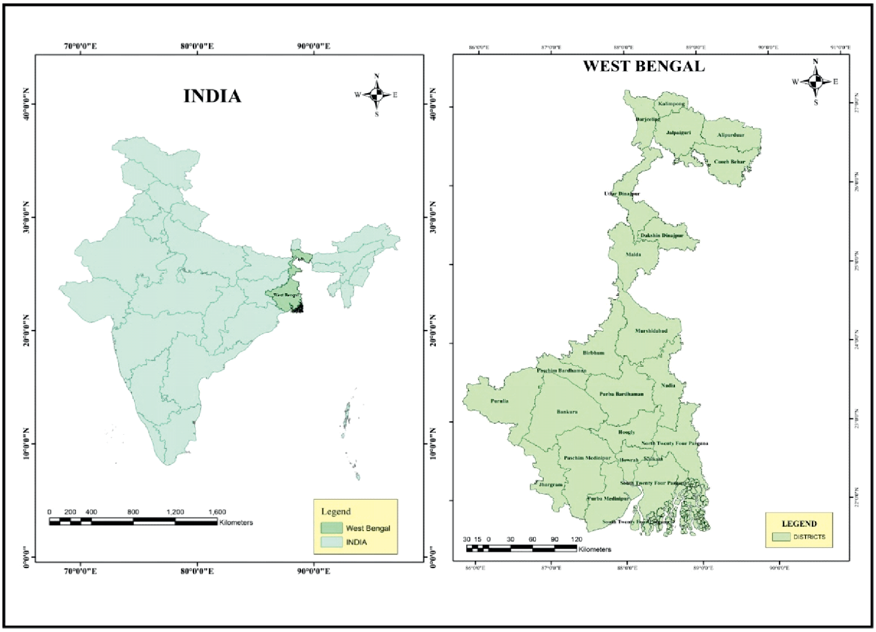

Figure 1: Map of the Study Area

Source: Author's creation in Arc GIS 10.8 through point source from Google Earth

IV. DATA SOURCE AND METHODOLOGY

Since the study is based on secondary sources, the data used for the study were compiled from the District Statistical Handbook (2011), National Family Health Survey (NFHS-4, 2015-16; NFHS-5, 2019-20) and West Bengal Health Survey (2016-17 and 2017-18 combined).

To prepare an Index, the study has employed the method of principal components. The method has been considered suitable because it allowed for a considerable data reduction. Data reduction was important because the data considered several health indicators for all 19 districts in West Bengal, leaving the newly formed districts out due to data limitations. Before employing the method of Principal Component Analysis (PCA) to construct an index, the variables' raw data were normalised. Normalisation helped to convert the raw data in different units into an identical range of 0 to 1.

The variables were normalised using the following technique:

$$NSV_{ij} = \left(\frac{X_i - X_{\min}}{X_{\max} - X_{\min}} \right) \quad \text{(i)}$$

where NSV_{ij} is the normalised standardised value for the i^{th} variable and j^{th} district; x_i is the unstandardised value of the variable for the j^{th} district; and x_{min} and x_{max} are the minimum and maximum values of the variables for the j^{th} district.

Once the data were normalised, PCA was applied. In PCA, the maximum variance in the data is accounted for by fewer components. Furthermore, it helps to overcome multicollinearity problems by producing uncorrelated components with one another. In principal component analysis, many interrelated variables (original variables) are transformed into a smaller set of variables, P, called the 'principal components'. In order to extract fewer principal components, the eigenvalues corresponding to each principal component are identified, and only those principal components for which the eigenvalue is greater than one are retained. The eigen values represents the amount of variation explained by a component, and a value greater than one denotes a substantial amount of variation. Finally, these 'principal components' are uncorrelated and linear combinations of the original variables and account for the maximum proportion of variation in the original X_j's. Hence, the first principal component accounts for maximum variance in X_j's, the second principal component accounts for the remaining variation and so on. The aim of applying PCA is to extract fewer principal component variables (P_j's) that are linear combinations of X_k's (k = 1,2, …, n) such that:

$$P_i = a_{j1} X_1 + a_{j2} X_2 + \ldots + a_{jn} X_n \quad \text{(ii)}$$

where the coefficients a_{j1} (j = 1,2, … , n) are the factor loadings or weights.

In the case of standardised values of the variables, z_i (i = 1,2, …, n), the principal component, P_i, can be written as,

$$P_i = a_{j1} Z_1 + a_{j2} Z_2 + \ldots + a_{jn} Z_n \quad \text{(iii)}$$

Once the PCA results were obtained, the weights of individual variables were calculated, followed by the construction of the three health indices viz., Health and Infrastructure Index (HII), Affordability and Accessibility Index (AAI), Nutrition and Health Index (NHI). The various indicators under each domain are presented in Table 3. The weights were calculated by multiplying the first eigenvalue by the first extracted component column, the second eigenvalue by the second extracted component column and so on. In calculating the weights, only the absolute values were considered, i.e., the negative values are treated as positive. Thus, the formula for the weight determination of individual variables is $WV = \Sigma L_{ij}.E_j$, where L_{ij} is the factor loading of the i^{th} variable on the j^{th} factor; E_j is the eigenvalue of the jth factor.

The domain-specific index given below was constructed using the formula given by Raychaudhuri & Haldar (2009) and Sengupta & Chakrabarti (2024), which is as follows:

$I_j = \frac{\Sigma_{i=1} x_i (\Sigma_{j=1} L_{ij}.E_j)}{\Sigma_{i=1} (\Sigma_{j=1} L_{ij}.E_j)}$, where j in I_j = 1 to 3 (three indices, namely, HII, AAI and NHI) and I is the domain-specific index, x_i is the i^{th} Indicator; L_{ij} is the factor loading of the i^{th} variable on the j^{th} factor; E_j is the eigenvalue of the j^{th} factor

Finally, a Composite Health Index (CHI) was constructed, the average of the above three indices. The composite index is constructed as follows:

$CHI = \frac{1}{N} \Sigma_{j=1}^{3} I_j$, where I_j is the domain-specific index, and N is the number of indices in the study.

V. RESULTS AND DISCUSSION

This section presents the discussion on the results obtained from PCA and is based on the health indices on three domains and the composite index inter-district variations. The analysis considered separate variables for each index and accordingly extracted the principal components based on the earlier criteria. Before proceeding with the PCA analysis, the Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity have been considered. The value of KMO varies between 0 and 1. The value of 0 indicates factor analysis is inappropriate due to diffuse correlations between variables. The value close to 1 indicates compact correlations, indicating factor analysis to be appropriate. A KMO value of more than 0.5 is acceptable for PCA. Bartlett's test indicates whether the correlation matrix differs significantly from an identity matrix. Therefore, if it is significant ($p < 0.05$), then it means that the correlations between variables included are (overall) significantly different from zero, and hence PCA is appropriate. PCA's appropriateness leads to extracting distinct and reliable principal components (Field, 2009; Haak & Pagilla, 2020; Kumari & Raman, 2021). In this study, PCA has been applied separately to construct each index, and hence, the results have separate KMO and Bartlett's test of sphericity for each index. For all three indices calculated, the value of KMO is above the recommended and acceptable value of 0.5. Bartlett's test of sphericity is also found to be significant ($p < 0.05$) for all three indices calculated (Table 2). This confirmed that PCA is appropriate for the study.

Table 2: KMO and Bartlett's Test of Sphericity

		HII	*AAI*	*NHI*
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.535	0.543	0.725
Bartlett's Test of Sphericity	Approx. Chi-Square	77.475	18.783	55.928
	df	21	10	21
	Sig.	0.000	0.043	0.000

Source: Author's calculation

The rotated component matrix for the three indices with factor loadings is shown in Table 3. The elements or loadings in the rotated component matrix indicate the correlation between the variables and the corresponding principal components. The loadings that constitute each component are marked in bold in the table. These loadings are used to calculate weights, as mentioned in the methodology section and only for the NHI emerged three principal component factors, as eigenvalues differ from data about HII to NHI data. In the case of both HII and AAI, there emerged two components emerged, and it was only for NHI, three components emerged. Only those components for which the eigenvalues are more than or equal to one are retained. This is also shown through the scree plot in Figure 2. As shown in the figure, in the case of HII and AAI, the eigenvalue after the second component declines and is less than one. For NHI, it is after the third component.

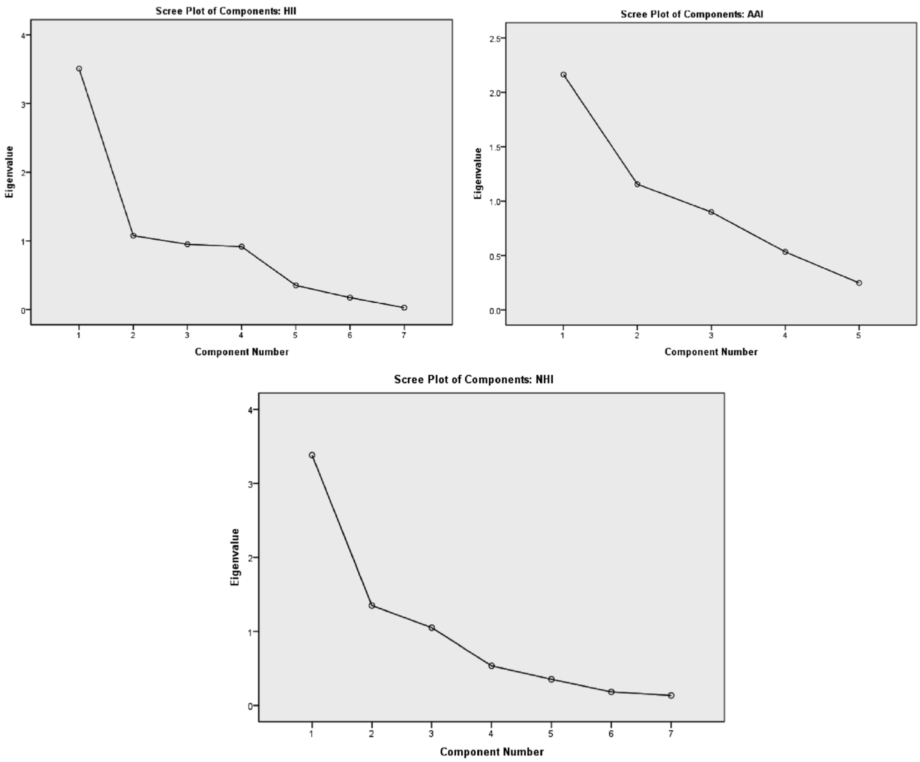

Figure 2: Scree plot showing the number of components retained in the case of HII, AAI and NHI

Source: Author's work

Table 3: Rotated Component Matrix

	Component				
Domain	*Indicators*	*1*	*2*	*3*	*Weights*
HII	Rural Hospitals	0.824	0.234	-	3.14
	Primary Health Centre	0.877	0.148	-	3.24
	Sub Centre	**0.924**	0.084	-	3.33
	Beds per 1000 pop	-0.237	**-0.443**	-	1.31
	Block Primary Health Centre	**0.794**	0.102	-	2.89
	District Hospitals	-0.095	**0.839**	-	0.57
	Sub-Divisional Hospitals	**0.692**	-0.336	-	2.79
AAI	Health Insurance	**0.871**	0.107	-	2.01
	Inst. Births in Public Facilities	**0.833**	0.110	-	1.93
	Avg. Out-of-Pocket Expense in Public Facility	**-0.601**	-0.007	-	1.31
	Institutional Delivery	-0.118	**0.907**	-	1.30
	Antenatal Care	0.418	**0.685**	-	1.70

	Component				*Weights*
Domain	*Indicators*	*1*	*2*	*3*	
NHI	Alcohol Consumption in Women	-0.065	-0.042	**0.964**	1.29
	Nutritional Status of Children Wasted	0.140	**0.909**	0.065	1.77
	Nutritional Status of Children Underweight	0.542	**0.762**	0.111	2.98
	Nutritional Status of Women	**0.887**	0.303	0.035	3.45
	Children Immunised	0.070	**0.869**	-0.193	1.61
	Anaemic Women	**0.776**	0.013	-0.312	2.97
	HH Using Iodised Salt	**0.842**	0.164	0.056	3.13

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalisation.

Note: Since for HII and AAI only two principal components emerged, it has been labelled dash (-) in the table.

Source: Author's calculation

Table 4 shows that the two principal components in the case of HII explain 65.484 per cent of the variation in the dataset. In the case of AAI, the two components explain 66.371 per cent of the variation, while in the case of NHI, the three components explain 82.663 per cent of the total variance in the data. The individual weights of the variables determined from the loadings of the component matrix and the eigenvalues are shown in the last column of Table 3.

Table 4: Total Variance Explained by HII, AAI and NHI Indicators

Domain	*Component*	*Initial Eigenvalues*			*Rotation Sums of Squared Loadings*		
		Total	*% of variance*	*Cumulative %*	*Total*	*% of variance*	*Cumulative %*
HII	1	3.509	50.122	50.122	3.477	49.675	49.675
	2	1.075	15.362	65.484	1.107	15.809	65.484
AAI	1	2.163	43.263	43.263	2.003	40.06	40.06
	2	1.155	23.108	66.371	1.316	26.31	66.371
NHI	1	3.384	48.339	48.339	2.42	34.568	34.568
	2	1.352	19.309	67.647	2.281	32.591	67.159
	3	1.051	15.016	82.663	1.085	15.504	82.663

Extraction Method: Principal Component Analysis

Source: Author's calculation

The domain-specific indices viz., HII, AAI and NHI, along with the districts' Composite Health Index (CHI) and subsequent ranks are presented in Table 5. The districts are arranged region-wise, i.e., northern and southern districts of West Bengal (see Figure 1). While the northern region comprises the districts in the Himalayan and the sub-Himalayan areas, the southern region comprises the districts lying in the Gangetic plain[5]. The ranks of the districts in Table 5 are assigned according to the score achieved and are in descending order, i.e., the district with the highest score is assigned rank one and so on. In the context of the available indicators, Barddhaman district, with 0.757, recorded the highest value in HII and accordingly ranked first among the districts. The lowest value for HII was recorded in Dakshin Dinajpur (0.065)[6] and accordingly ranked last among all the districts. Darjeeling, the only district with hill and plain terrain, recorded a value of 0.208 and ranked 16th among the 19 districts. Thus, in the case of HII, the southern districts are seen to perform better than the northern districts. The northern districts, namely Darjeeling, Maldah, Uttar Dinajpur and Dakshin Dinajpur, are placed in the bottom five (see rank in Table 5) in the case of HII. In the case of AAI, Bankura district recorded the highest value of 0.810, while Uttar Dinajpur recorded the lowest value with 0.196. Darjeeling district recorded a value of 0.606 and ranked seventh among the 19 districts. In case of the top five performing districts in AAI, three districts, Bankura, North 24-Parganas, and South 24-Parganas, fall in the southern region and two districts in the northern region, namely Jalpaiguri and Coochbehar. In case of NHI, North 24-Parganas with 0.925 recorded the highest value, while Purulia with 0.187 recorded the lowest value. Darjeeling district recorded a value of 0.743 and ranked fifth among the 19 districts accordingly. Again, three southern districts, namely, North 24-Parganas, Howrah and Nadia, and two northern districts, namely, Coochbehar and Darjeeling, occupy the top five places in the case of NHI. Finally, in the case of CHI, North 24-Parganas with 0.717 recorded the highest value and ranked first, while Uttar Dinajpur with 0.282 recorded the lowest value and ranked last amongst all the districts. Darjeeling district recorded a value of 0.519 in the case of CHI and ranked eighth across the 19 districts. In case of CHI, three southern districts, namely North 24-Parganas, South 24-Parganas and Barddhaman, and two northern districts, namely Coochbehar and Jalpaiguri, are the top five performing districts according to the CHI scores. The domain-specific indices and the composite index are also shown graphically in Figure 3, which shows disparity both within and across the districts.

A further glance at Table 5 shows a huge variation in each index and, accordingly, in the final composite index. For instance, in the case of HII, the variation between the first and the last performing district ranges between 0.757 and 0.065. Similarly, in the case of AAI, the variation ranges between 0.810 and 0.196, and in the case of NHI, it ranges between 0.925 and 0.187. These domain-specific variations not only reveal the inter-district variations but also highlight the fact that while some districts seem to be doing better in some health indicators and accordingly health indices, the same districts may not do well in the case of other health indicators/indices. For instance, in the case of the Health Infrastructure Index (HII), which includes hospitals, health centers and beds per thousand population, districts such as Maldah, Uttar Dinajpur and Dakshin Dinajpur are seen to be placed at the bottom. This reveals that these districts are in a disadvantaged position to cater to the population when in need because the availability of health centres and hospital beds is necessary for maintaining public health. However, the same districts, namely, Maldah and Dakshin Dinajpur, are also found to be doing fairly better in other domains, such as the Accessibility and Affordability Index (AAI) and the Nutrition and Health Index (NHI), as compared to HII. A similar disparity is visible in the case of other domain-specific indicators. For instance, institutional delivery under the AAI was found to be highest in Darjeeling (98.4%)[7], which ranked seventh in the overall accessibility and affordability index and lowest in Uttar Dinajpur (76.9%), which ranked last, i.e., 19th in the overall accessibility and affordability index. This shows a difference of 21.5 percentage points between the highest and lowest in the case of institutional delivery. Institutional delivery is central not just for delivery but also for maternal and child health. Neglecting this part of health can have profound implications on maternal and child health, which can translate into (poor) adult health (Sajedinejad et. al., 2015).

Table 5: District-Wise Values of HII, AAI, NHI and CHI Along with Ranking (PCA Result)

Region	*District*	*HII*	*Rank*	*AAI*	*Rank*	*NHI*	*Rank*	*CHI*	*Rank*
North	Coochbehar	0.293	11	0.685	5	0.744	4	0.574	3
	Dakshin Dinajpur	0.065	19	0.603	8	0.582	10	0.417	16
	Darjeeling	0.208	16	0.606	7	0.743	5	0.519	8
	Jalpaiguri	0.263	14	0.774	2	0.648	8	0.562	5
	Maldah	0.190	17	0.544	11	0.626	9	0.453	13
	Uttar Dinajpur	0.068	18	0.196	19	0.582	10	0.282	18
South	Bankura	0.381	8	0.810	1	0.267	17	0.486	11
	Barddhaman	0.757	1	0.478	12	0.469	14	0.568	4
	Birbhum	0.314	10	0.565	9	0.373	15	0.417	16
	Hugli	0.443	7	0.633	6	0.556	12	0.544	6
	Howrah	0.236	15	0.336	18	0.768	2	0.447	14
	Kolkata	0.268	13	0.410	16	0.734	7	0.471	12
	Murshidabad	0.636	3	0.428	13	0.535	13	0.533	7
	Nadia	0.323	9	0.393	17	0.756	3	0.491	10
	North 24-Parganas	0.524	6	0.701	3	0.925	1	0.717	1
	Paschim Medinipur	0.593	4	0.421	14	0.319	16	0.444	15
	Purba Medinipur	0.555	5	0.412	15	0.571	11	0.512	9
	Purulia	0.273	12	0.547	10	0.187	18	0.335	17
	South 24-Parganas	0.672	2	0.695	4	0.738	6	0.702	2

Source: Author's calculation

Note: Districts with the same score are assigned equivalent ranks. HII is the Health Infrastructure Index, AAI is the Accessibility and Affordability Index, and NHI is the Nutrition and Health Index.

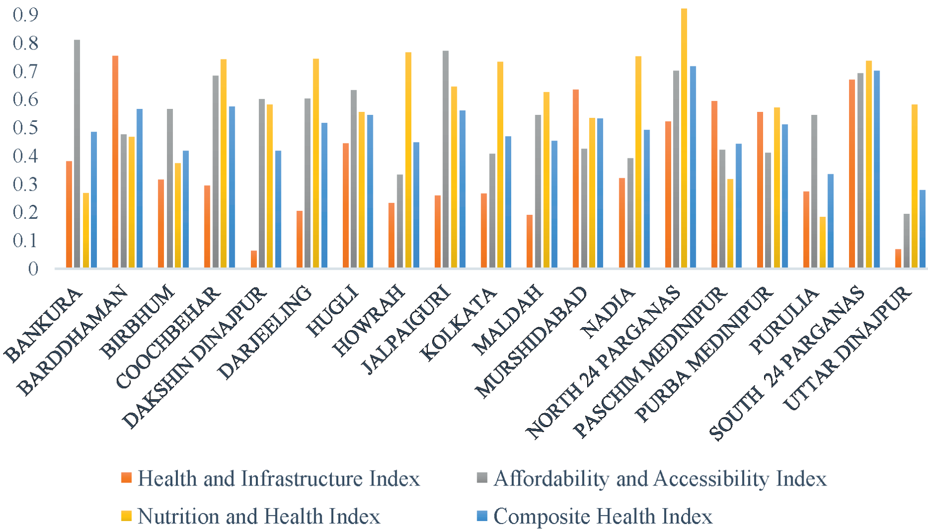

Figure 3: Inter-District Health Disparity in West Bengal

Source: Author's work

Furthermore, regarding the nutritional status of children under 5 years in terms of NHI, the study found that the percentage of children wasted, i.e., low weight for height, was lowest in North 24-Parganas (13.3%) and highest in Paschim Medinipur (30%). Accordingly, the districts ranked 1st and 16th in NHI, respectively. Since children wasted is a negative indicator, the less it is, the better the district is in its performance. Regarding underweight children, i.e., low weight for age, the best-performing district was Coochbehar (22.5%), and the worst-performing district was Purulia (46.3%). Purulia also featured as the worst-performing district in terms of the nutritional status of women's health aged 15-49 years[8], with 33.7 per cent of the women in Purulia facing a nutritional crisis. The best-performing district was North 24-Parganas, which has only 6.5 per cent of women experiencing malnutrition issues. In North 24-Parganas, women's health and maternal health were also found to be better. Women's health can be assessed with indicators such as body mass index (BMI) and anaemia. In this district, the percentage of women whose BMI was less than normal was found to be the least (6.5%) in 2019-21. Additionally, the percentage of anaemic women was also found to be lower (65.3%) as compared to other districts. It was also found that in this district, there was better child health with the lowest percentage of anaemia in children under

5 years (57.9%). Furthermore, another child health indicator, i.e., wasted and underweight children, was found to be better in the district in 2019-21 (NFHS-5, 2019-21). Thus, the important correlation between maternal health and child health can be established as found in prior studies (Gortmaker, 1979; Jain et. al., 2012; Kuhnt & Vollmer, 2017; Vishwakarma et. al., 2019).

VI. CONCLUSION

In this study, an attempt was made to understand several health indicators across the districts in West Bengal through PCA. This was then considered to infer about the human capital through the component of health. Understanding and examining the health indicators allowed for index construction. Based on this, districts were ranked according to the index score, which helped in comparing inter-district disparity. The study found alarming disparities in several health indicators in all the districts. It was also found that some districts, such as Bankura, Barddhaman, Coochbehar, Darjeeling, and Howrah (see Table 5), performed better in some health indicators, while not the same in other health indicators (see Figure 3). This was noticed in the case of domain-specific health indices.

On the other hand, the composite health index revealed the overall picture of the district in the case of the health indicators considered for the study. However, the domain-specific health indices revealed the actual scenario of the districts in West Bengal. Thus, if health indicators under domain-specific are considered and policies are formulated for improvement, the districts might improve and do better in the future. For instance, expansion in the number of health centres and beds in the hospitals can strengthen the infrastructure in the backward districts such as Howrah, Kolkata, and the districts in the north. Kolkata, the only urbanised district in the State, features as the worst-performing district in terms of available beds per thousand population. It has 7.73 beds per thousand population and is above the State's average of 1.46 beds per thousand population. It is followed by Darjeeling with the availability of 3.26 beds per thousand population. These are higher than the proposal made by the Indian Public Health Standards (IPHS), which proposes one bed per thousand population as an 'Essential' norm for every district and two beds per thousand population as a desirable target (IPHS, GoI, 2022). In addition to it, an increase in the percentage of antenatal care, institutional births (in the districts where the percentage of institutional births is lower), and higher coverage of health insurance can improve accessibility and affordability in districts such as Murshidabad, Paschim Medinipur, Purba Medinipur, Kolkata, Nadia, Howrah and Uttar Dinajpur. For instance, in the case of institutional births, an important indicator of maternal and child health, West Bengal's performance in relation to the nation has shown improvement between 2015-16 and 2019-21 according to NFHS data. The percentage of institutional births in the State in 2015-16 was 75.2 lower than the national percentage of 78.9 per cent. It increased to 91.7 per cent in 2019-21 and was higher than the national percentage of 88.6 per cent. This is accounted for by the increase in institutional births in the districts of West Bengal. However, Uttar Dinajpur, with 76.9 per cent, still features as the worst-performing district among all the districts in the case of institutional births and is way below the state and the nation's performance. It is followed by Murshidabad, which follows the same trend. Therefore, the awareness regarding the importance of antenatal care and institutional births needs to be raised to further improve the health indicators in the aforementioned districts. Alongside this, nutrition and health can be escalated if steps are taken in the poor-performing districts in the case of NHI to improve malnutrition issues. These districts are Bardhaman, Bankura, Paschim Medinipur, and Purulia. Purulia and Barddhaman also show poor performance in the case of children who are stunted, with the percentage of such children being 36.9 and 36.2 per cent, respectively. It is higher than the State (33.8%) and the nation (35.5%). Bankura and Purulia are also among the poor districts in the State as per the growth rates of DDP. The lowest percentage of stunted children is seen in Purba Medinipur (25.8%), which also ranked one in the case of literacy rate as per the Census of 2011. Districts such as Purulia, Paschim Medinipur, and Bankura also has higher proportion of women who consume tobacco. Purulia has 26.5 per cent, Bankura has 21.5 per cent, and Paschim Medinipur has 18.8 per cent of women who consume tobacco. This is above the State's percentage of 10.8 as well as the nation's percentage of 8.9 per cent. Although Darjeeling performs well in other indicators of NHI, it has the highest percentage of women who consume alcohol. The percentage of such women in the district is 5.8 per cent. It is higher than the State (1.1%) and the national average (18.8%). The lowest is seen in both Coochbehar and Maldah, which have only 0.3 per cent of women in each district who consume alcohol. Policies such as those recommended by the United Nations Decade of Action on Nutrition, led by the World Health Organisation and the Food and Agriculture Organisation of the United Nations, can help overcome nutritional crises in the districts. Some of these policy actions that can be incorporated are nutrition-related education for all, the alignment of health systems and nutrition-needs, universal coverage of essential nutrition interventions, and promoting nutrition governance and accountability to a larger extent.

Unless the disparities across the districts are addressed, the disparities may continue to lead to several health issues, such as frequent illness, inability or prolonged duration to recover from illness, bedridden health issues, and so on. This ultimately may weaken the population's health and, hence, impact the human capital or derail the process for improving the human capital. Thus, this calls for serious steps to be undertaken to not only narrow the disparities in the districts but also to improve several health indicators, mainly in the backward districts (as per the scores and ranks achieved). Unless this is done, the aim of improving human capital through the health component in the districts and eventually in the state will remain an unrealised accomplishment. Therefore, it is of utmost importance to strengthen health and health systems by addressing inter-district disparities through targeted interventions grounded in local needs in the state of West Bengal. This will be a step forward to ensure equitable health outcomes and enhance the human capital through the health component, further contributing towards achieving the SDGs, particularly SDG-3, i.e. Good Health and Well-Being.

Notes

1. Please visit https://sdgs.un.org/goals/goal3 for further details.
2. CBR is annual number of live births per 1000 population
3. CDR is the annual number of deaths per 1000 population
4. MMR is the annual number of deaths of women related to pregnancy and childbirth per 100,000 live births
5. https://wb.gov.in/about-west-bengal-facts-figures.aspx
6. The number in parentheses represents the score achieved in domain-specific indices.
7. Please refer NFHS-5, 2019-21 for further information and other related indicators
8. NFHS-5 accessed the nutritional status of women in case of Body Mass Index (BMI) below normal. A BMI less than $18.5 kg/m^2$ is below normal.

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