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Quantifying basic health care facilities in Assam: where do the districts stand?

Hemanta Saikia and Dibyojyoti Bhattacharjee

Department of Business Administration, Jawaharlal Nehru School of Management, Assam University, Silchar-788011.

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ABSTRACT

Health services are seen as one of the most decisive dimension to measure the development of a region. The present study is an empirical approach to measure the health facilities available in the different districts of Assam through some indicators of health services supported by current literature. A composite index called as MPI (Mazziotta-Pareto Index), is used for this purpose. The different indicators considered for health facility development are normalized to eliminate the unit of measurement and its variability. The distributional pattern of the composite index is recognized to ease the classification of the districts based on the health services. Finally, the low development districts of Assam are identified and the responsible indicators of such low level of development are discussed. The Government of Assam has made one year rural posting mandatory for those doctors who want to go for post-graduate studies from the government medical colleges from 2009. This study will provide a quantification of the district level scenario on health conditions before the implementation of such a welcome scheme on public interest. A similar study followed after a gap of few years would reflect the impact of such scheme on health facilities of the state.

Introduction

Every human being has a desire for a healthier and better environment. In an era of reforms in health sector, health systems deserve the highest priority in any endeavor to improve public health facilities. Since 1990, the United Nations annually ranks all the member countries in the world on the basis of health, education and income, the three essential aspects of human development. The Human Development Index (HDI) decides the relative rank of a country's achievement in the above mentioned aspects in a concise manner which helps to locate the countries immediate concerns as well as prioritize the relevant policy areas globally (Sen 1985, 1992, 1999). However, a combined HDI using education and incomes along with health indicators failed to take account of differences in health care endowment and their efficient use (Murray and Frenk 2001). The fact is that much of the variation in the health outcomes of different health indicators was not properly examined. The World Health Organization (WHO 2000) has rightly pointed out that the primary goal of a health system should provide better health services in a responsive manner. But how well a health system accomplishes this goal that actually is reflected in terms of actual outcomes related to health.

In India, the 73rd and 74th amendments of the constitution and reproductive child health approach have emphasized the need of decentralization; therefore, district becomes the focus of planning and program implementation (Ministry of Health and Family Welfare 2005). In this context, the assessments of the current states health facilities along with overall human development of the districts of India are essential. It is needless to articulate that not only inter-state differentials are substantial, but within a state, district also may vary considerably in the context of health facilities.

Assam is the biggest state of northeast India which at present comprises of 27 districts. The population of the state is 26.6 million and is scattered over 23 districts, 125 towns and 26,247 villages (Census 2001). The state has the highest population density amongst the northeastern states, that is, 339 per square km (Census 2001). The death rate of the state is 8.6 in the year 2008 which has decreased compared to 9.1 in the year 2003 (Sample Registration Bulletin RGI 2009). Recently, the health services of the state have seen developing enormously. The National Rural Health Mission (NRHM) that was launched in the year 2005 is seen as commitment of the present government to improve the delivery of public health services (Baru 2005). Though initially NRHM was to focus only on states with poor demographic profiles but gradually it was opened for civil society. In 2009, the Government of Assam has made one year rural posting mandatory for those doctors who want to go for post-graduate studies from the government medical colleges. Therefore, this study will provide a quantification of the district level scenario on health conditions before the implementation of such a welcome scheme on public interest.

However, the main purpose of the present study is to determine the status of health facilities of different district of Assam. Therefore, a number of indicators related to the enhancement of health facilities are considered supported by available literature. These selected indicators will help to identify the backward districts of Assam. A composite index called as Mazziotta-Pareto Index (MPI), developed by Mazziotta and Pareto (2007), is used to quantify the district wise health facilities of Assam.

Section two of the paper provides a review of current available literature and sets the specific health related indicators of the study. As the paper attains its objectives (provided in section three) by means of a composite index called as MPI, so the section four give attention to the methodology of the study. The fifth section provides empirical outcomes of the study based on the results of MPI by fitting appropriate statistical distribution and hence identifying those districts of the state

Tele: +91-9954154094, +91-9435170253

E-mail addresses: h.saikia456@gmail.com, djb.stat@gmail.com

which has poor health facilities. In the last section, a discussion is forwarded about the responsible indicators that might have lead to the poor show in health facilities in those districts.

Review of literature

Various indicators are needed at different levels to measure the services of health system. Measures of any service delivery output include basically access, utilization and coverage which indicate whether people are receiving the services as they need (WHO 2008). Data on the population distribution of health service resources are required to estimate physical access and estimates of types of services rendered need to be reported by facilities (WHO 2008).

The WHO *Toolkit on Monitoring Health System Strengthening* includes a list of draft indicators for health service delivery (WHO 2008) which focuses on availability and utilization of indicators on number of health center, number of hospital beds, number of health workers, access to safe drinking water, sanitation, safe motherhood, family planning, HIV/AIDS disease control, children immunization, etc. The distribution of health indicators should be measured in terms of 1,000 people (Kruk and Freedman 2008). This was also supported by the articulation of Kathuria and Sankar (2005), they opined that since population and area vary across states (or districts) therefore various indicators that are considered to determine the status of health facilities ought to be set in terms of per thousand populations. Antony, Rao and Balakrishna (2001), examined the validity of the Human Development Index (HDI) which is widely used to measure health inquiry and standard of living. Different health indicators they considered for the study are prevalence of contraceptive use (percent), availability of sanitation (percent), health services and safe drinking water (percent) and prevalence of underweight children of less than four years. According to the Kumar et al. (2008), the dimensions of deprivation can be due to lack of access to basic health services, drinking water, sanitation etc.

In India, several studies have highlighted the persistent of health within the country, both inter-state as well as intra-state. An examination of the development of healthcare facilities in India following the recommendation of Bhore Committee (1946) indicates that lack of availability of trained healthcare person in rural areas and poor quality of care is the focal weakness in the healthcare system. The Human Development Report (HDR) (Government of India 2001), assessing the health status of people across different Indian states using a Human Development Index (HDI). To explore the performance of intra district health system level, Alag et al. (2001) ranks the districts on the basis of a few reproductive and child health indictors. Various prime skills as regards to health facilities in front of the health researchers and policy makers are discussed by Halfon and Hochstein (2002) framework paper. Srinivasan and Mohanty (2004) studied the utilization of health care services and levels of deprivation in major states of India. Based on National Family Health Survey (NFHS) data, Acharaya (2005) examines socio-economic determinants of Infant Mortality Rate (IMR) in India by applying multiple regression as well as correlation and finds that among the different development factors household sanitation condition and safe drinking water facility plays an important role in reducing IMR. Benerji (2005) discussed some strategies concerning health service development in India. A crucial statement was given by Maheshwari, Bhat and Saha, (2005) that though state governments in India have been successful in creating impressive networks of health facilities, the overall achievement of health goal has not been remarkable, especially in rural areas because of low commitment of doctors. Baru (2005) discussed some of the critical issues on implementation of National Rural Health Mission (NRHM). A case study of recurring flood disasters and its impact on health consequences was prepared by Roy (2007).

Based on the above literature survey the parameters like number of health centers (per 1000 people), number of hospital beds (per 1000 people), number of doctors available (per 1000 people), percentage of households having safe drinking water, percentage of households having basic sanitation facilities, average percentage of achievement of family welfare program and average percentage of achievement of immunization program have been considered to quantify the status of district wise health facilities of Assam. Though the parameter number of health center considered as a single variable but it contains actually various sub-indicators viz. number of hospitals, Sub-Divisional Civil Hospitals (SDCH), Primary Health Centers (PHC), dispensaries, Community Health Centers (CHC) and Sub-centers (SC) for each district. Similarly, the parameter achievement of family welfare program set in terms of percentage which comprises of sterilization, Intra Uterine Device (IUD) insertion, Cervical Caps (CC) users and OP users. Yet again, the coverage of BCG, DPT-3, OPV-3, Measles and TT injections are considered under the parameter average percentage of achievement of immunization program. All these parameters are also the vital components of National Rural Health Mission (NRHM).

Objective of the study

The main objectives of the study are as follows:

- To quantify the health facilities available in different districts of Assam in terms of some health related indicators.
- To classify the districts based on the values of the composite index MPI derived from the heath indicators.

Data and methodology

Data

The information about relevant data for the study is collected from "Statistical Hand Book, Assam, 2009" a report published by Directorate of Economics and Statistics, Government of Assam, Guwahati. The report provides a wide range of up-to-date factual data on diverse aspects of socio-economic trend of Assam. Efforts have been made to present the latest available data covering up to 2008-2009, but for the Chirang, Baksa and Udalguri districts, the information for the indicators viz. number of hospital beds, number of doctors available, sanitation, average achievement of family welfare program and average achievement of immunization program are not available. As a result, the researchers try to estimate the missing data using appropriate data imputation method for the districts Chirang, Baksa and Udalguri. Moreover, the former Kamrup district was recently divided into two separate districts as Kamrup Rural and Kamrup Metro. But, through-out the study the two districts are considered together as Kamrup (R+M).

Estimation of missing data

Missing data are present in almost all the case studies of composite indicators (Nardo et al. 2005). One of the most suitable methods is that the missing values are substituted by estimated values obtained from a multiple regression equation. In order that the dependent variable of the regression is the indicator hosting the missing value and the regress variables are the indicators, those are showing a strong relationship with the

dependent variable. Accordingly, the multiple regression is used to estimate the values of different indicators that are missing, as the case may be, viz. number of hospital beds, number of doctors available, sanitation, average achievement of family welfare program (percent) and average achievement of immunization program (percent) for the districts Chirang, Baksa and Udalguri.

Let y_{ij} (where $i = 1, 2, \ldots, n$ and $j = 1, 2, \ldots, m$) be a set of m health enhancement indicators for n districts. Now suppose that out of m indicators only $m-1$ indicators are fully observed and an indicator k ($< m$) only observed for r districts but missing for the remaining $n-r$ districts. The multiple regression technique computes the regression of y_k on ($y_{i1}, y_{i2}, \ldots, y_{im-1}$) using r complete observations and estimate the missing values as prediction (Nardo et al. 2005) from the following equation.

$$\hat{y}_{ik} = \hat{\beta}_0 + \sum_{j=1}^{m-1} \hat{\beta}_j y_{ij}, \quad i = 1, 2, \ldots, n\text{-}r \qquad \ldots (1)$$

The Mazziotta-Pareto Index (MPI)

Composite indices are increasingly recognized as a useful tool for policy making and public communications in conveying information on countries performance in various fields of development (Nardo et al. 2005). A composite indicator is the mathematical combination of individual indicators that represent different dimensions of a concept whose description is the objective of the analysis (Saisana and Tarantola 2002). Here Mazziotta-Pareto index is used to quantify the health facilities available in the districts because for each districts, the indicators variability in relation to its mean value is measured by the coefficient of variation, allows to obtain a robust measure and less influenced by outliers.

Let $\{x_{ij}\}$ be the matrix of n rows and m columns where rows represents the districts and column represents the health enhancement indicators that are considered for the study. Let us suppose that $\bar{x}_j$ and S_j denote the mean and standard deviation of the j^{th} health indicator where

$$\bar{x}_j = \frac{\sum_{i=1}^{n} x_{ij}}{n} \quad \text{and} \quad S_j = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(x_{ij} - \bar{x}_j\right)^2}$$

Now, the normalization matrix $\{z_{ij}\}$ is defined as follows

$$z_{ij} = 100 \pm \frac{\left(x_{ij} - \bar{x}_j\right)}{S_j} \times 10 \qquad \ldots (2)$$

where the sign "$\pm$" depends on the relation of the j^{th} indicators with the phenomenon to be measured (i.e. "+" if the individual indicator represents a dimension considered positive for *e.g.* 'number of health centers' and "-" if it represents the dimension negative for *e.g.* 'death rate'). Also, the distribution of different indicators, measured in different way, can be compared by the transformation in standardized deviations. Thus, it is possible to convert the individual indicators to a common scale with mean 100 and standard deviation 10 and so they have the same mean and variability (see Appendix-A).

Again, let cv_i be the coefficient of variation for the i^{th} district and it can be calculated as

$$cv_i = \frac{S_i}{\bar{z}_i} \qquad \ldots (3)$$

where $\bar{z}_i = \dfrac{\sum_{j-1}^{m} z_{ij}}{m}$ and

$$S_i = \sqrt{\frac{1}{n}\sum_{j=1}^{m}\left(z_{ij} - \bar{z}_i\right)^2}$$

then the composite index MPI is given by

$$\text{MPI}_i = \bar{z}_i\left(1 - cv_i^2\right) = \bar{z}_i - \left(S_i \times cv_i\right) \qquad \ldots (4)$$

Thus, the value of MPI is indicating the status of development in a district for all the indicators of health taken together. Higher the value of MPI more developed is the respective district in the available health facility and vice-versa.

Distribution of the MPI

To support the probabilistic inference, distribution of the MPI should be examined to facilitate the classification of the district on the basis of the extent of deprivation (Navaneetham and Saxena 1999). For testing the hypothetical distribution of the MPI, chi-square test of goodness of fit or the Kolmogorov-Smirnov test is commonly used. But, different authors commented that Kolmogorov-Smirnov test statistics is more appropriate for continuous data compared to the chi-square test of goodness of fit (Keeping 1962; Pal 1998). The Kolmogorov-Smirnov test statistics is given by,

$$D_{\alpha,n} = max\,|S_n(x) - F(x)| \qquad \ldots (5)$$

where $S_n(x)$ and $F(x)$ are empirical and theoretical distribution function respectively. However, for performing the Kolmogorov-Smirnov test, the theoretical distribution needs to be completely specified (i.e. the values of the parameters should be known) in this case the parameters are estimated from the data. The critical value of D_n for α level of significance depends on the number of observations and may be denoted by $D_{\alpha,n}$. The interval $[F(x) - D_{\alpha,n}, F(x) + D_{\alpha,n}]$ provides the 100(1-α)% confidence band for $F(x)$ that can be used to visualize the goodness of fit of $F(x)$.

However, a more meaningful characterization of the different stages of development would be in terms of suitable classification from an assumed distribution (Basavaraj 2009). After deciding about the probability distribution of MPI it is important to find two real numbers $c, d \in [0, 1]$ to divide the three linear intervals namely $[0, c]$, $[0, d]$ and $[d, 1]$ with the same probability weight of 33.33% (Bhattacharjee, 2011) i.e.,

$$P[0 \le MPI_i \le c] = 0.3333 \qquad \ldots (6) \text{ and}$$

$$P[0 \le MPI_i \le d] = 0.6666 \qquad \ldots (7)$$

Thus, $P[c \le MPI_i \le d] = 0.3333$ using (6) and (7) Hence, the following intervals have been used to classify the various stages of the development in health facilities in different district of Assam.

a) Low development, if $0 \le MPI_i \le c$
b) Moderate development, if $c \le MPI_i \le d$
c) High development, if $d \le MPI_i \le 1$

Analysis and result

Since the values of MPIs are positive (i.e. $\text{MPI}_i \ge 0$), one probable distribution may be the two parameter gamma distribution. The probability density function of which is given by,

$$f(x) = \frac{1}{\lambda^{\alpha}\Gamma\alpha}\left(\frac{x}{\lambda}\right)^{\alpha-1} e^{-\frac{x}{\lambda}}, \alpha > 0, \lambda > 0; 0 < x < \infty \qquad \ldots (8)$$

where $\Gamma\alpha = \int_0^\infty e^{-x} x^{\lambda-1} dx$ … (9)

Based on the MPI values of all districts (see Appendix – B), the estimated value of λ (scale parameter) and α (shape parameter) are obtained using maximum likelihood estimation (MLE) procedure (Johnson and Kotz 1970) and is given by,

$$\hat{\lambda} = \frac{\sigma^2}{\overline{M}} \text{ and } \hat{\alpha} = \left(\frac{\overline{M}}{\sigma}\right)^2 \quad \ldots (10)$$

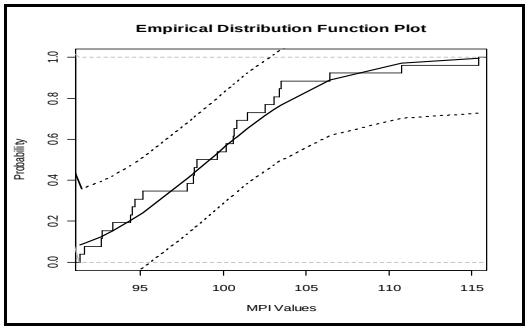
where, $\overline{M}$ and σ^2 be the mean and variance of the generated MPI values from equation (4).

Now, the estimated value of the parameters $\hat{\lambda} = 0.3431$ and $\hat{\alpha} = 289.335$ are obtained from district wise calculated MPI values. The corresponding value of the Kolmogorov-Smirnov test statistic of goodness of fit test is,

$D_{\alpha,n} = max\,|S_n(x) - F(x)| = 0.12139$ … (11)

The table value of Kolmogorov-Smirnov test statistics with 26 degrees of freedom at 5 percent level of significance is given by 0.23320, providing sufficient evidence that the MPI values can be considered to follow the two-parameter gamma distribution as in (8). One can also visualize the empirical distribution function (EDF) to the theoretical CDF curve, in the following graphical depiction, along with the confidence bounds. As the EDF lies within the upper and lower confidence bounds, that also corroborates the fitting of empirical data to the theoretical distribution.

Figure 1: Goodness of fit of MPI values to gamma distribution



Source: Based on calculated values of the MPI (see table in Appendix –B)[1]

The classification table provided below is derived from using the equation (6) and (7) and classifies the various stages of the development as regards to health facilities.

On the basis of above mentioned categorization, the different levels of development regarding health facilities of different districts of Assam can be revealed in the following table.

Based on the above classification table it is seen that out of 26 districts of Assam, pertaining to health facilities, 9 of them descend to the low development category. Therefore, some probable reasons of low development of health facilities in such districts are discussed below.

Responsible indicators for low development

In the earlier sections, it has been seen that 9 districts are plummeting into the low development category in terms of health care facilities viz. Bongaigaon, Dhemaji, Morigaon, Tinsukia, NC Hills, Hailakandi, Chirang, Baksa and Udalguri. Several reasons may be responsible for low development of health facilities in the above mentioned districts. Low development might be in consequence of unequal distribution of health services within the state. However, in course of the study a number of health enhancement indicators were considered therefore a relook at the normalized values of all these indicators, for low developed districts might reveal some clues of their development.

We can move row wise in the Table 3 above and understand the indicator wise health status of the low development districts under consideration. In any given row of the table, if the value of the normalized quantities under a given indicator is less than its mean value (i.e. 100) then that particular district requires improvement corresponding to that indicator. For example, in case of Dhemaji district, all the health enhancement indicators are enormously less than 100 and hence all of them are responsible to the status of its low development. However, in Hailakandi district number of health centers, number of doctors available, safe drinking water are much below the average while sanitation facility and achievement of family welfare program are better than average. All the districts considered in Table 3 are performing poorly in the number of health centers, number of hospital beds and number of doctors available.

Human health is to a great extent dependent on access to the healthy environment. For healthy environment, every individual should have to access safe drinking water, sanitation and primary health care. Lack of access to safe drinking water and basic sanitation creates obstacle in people's health and livelihood. A look at the above table expose the fact that access to safe drinking water need to be enhanced for the districts of Hailakandi, Dhemaji, Morigaon, Tinsukia, Chirang, Udalguri and NC Hills. Also, though the NRHM which was launched by the government in 2005, make an effort to improve the health services but it had failed to keep its promise on account of unequal distribution of primary health care facilities. Hence, it is essential to improve the indicators especially related to available medical facilities as well, like, number of health centers, number of hospital bed, number doctors available for all these low development districts.

Natural disasters are regular occurrence in Assam especially flood is an annual event. Brahmaputra and Barak, the two most important rivers in the state are responsible for floods in Assam during the rainy season. Amongst the districts currently under consideration except Tinsukia and NC Hills, the other districts viz. Hailakandi, Dhemaji, Morigaon, Bongaigaon, Chirang, Baksa and Udalguri are heavily affected due to floods in every year. Therefore, there always remains a possibility of the outbreak of water borne disease due to the consumption of unpurified water during and after flood.

Conclusion and area for future research

In order to quantify the district wise health facilities of Assam, the study has considered different health indicators. All these indicators are aggregated using a composite index which is called as Mazziotta-Pareto Index (MPI).

The distributional pattern of composite index is recognized to ease classification of the districts based on the health services. The composite index, MPI, can also be extended by including some other health indicators in the study. The different indicators that are considered can be weighted based on their relative importance.

The outcome of the study reflects that the low development of health facilities in some of the districts crop up mainly because of the unequal distribution of health services. Therefore, in an era of reforms in the health sector, the state government

should take the initiative to promote equal distribution of health services in the districts to the extent possible.

Though the state is making swift reforms in the health sector during last couple of years but the lack of MBBS doctors below the PHC level was a major concern for the state (NRHM, Govt. of Assam 2009). Therefore, Government of Assam decided to enforce bond for MBBS doctors, by an order of the Govt. Vide HLB/400/2009/06 dated August 28, 2009 for government service of five years and in lieu thereof one year rural service as per "The Medical Colleges of Assam and Regional Dental College (Regulation of admission of under graduate students) Rules, 1996" (NRHM, Govt. of Assam 2009). However, the student who does not want to receive the offer of five years government service or one year rural service, will have to pay an amount of compensation as mentioned in the bond and then he/she will be allowed to take admission in post-graduate course. This one year rural posting is mandatory for those doctors who want to do post-graduate studies. Thus, posting of MBBS doctors in rural areas shall provide some hopes to better health care facilities in remote areas of the districts.

This new scheme of the Govt. of Assam is seen as a major audacious step to improving the health care services of Assam. Hence, the present study is essential, as it mostly quantify the status of health facilities in different districts of Assam before the implementation of the scheme. Once the scheme is on for few years, a similar study can reflect the impact of such a scheme on the health status of the state. Both the Ministry of Health of the state and the people of Assam must be hoping this scheme shall put an end to the unhealthy shape of health affairs especially in the rural areas. Along with the proposed scheme, which seems to be a welcome idea, it is also the responsibility of the public to cooperate with the health workers, mainly doctors, and participate in the health care and immunization programs to achieve better health outcomes. The success of such a model can set an example to improve the health scenario in the other states of the country.

References

- Alag V, Kapilashrami MC, Tiwari KN, Talwar PP. Reproductive and Child Health Needs: Prioritization of District in India. New Delhi: National Institute of Health and Family Welfare Report; 2001.
- Antony GM, Visweswara KR, Balakrishna N. Suitability of HDI for Assessing Health and Nutritional Status. Economic and Political Weekly. 2001; 36(8): 2976-2979.
- Acharya SS. Socio-economic Determinants of Infant and Child Mortality in India: Illustrations from NFHS. Journal of Health & Development. 2005; 1(1): 47-56.
- Baru VR. The National Rural Health Mission and Public-private Partnerships. Journal of Health & Development. 2005; 1(4): 19-22.
- Banerji D. A Forgotten Path to Health Service Development. Journal of Health & Development. 2005; 1(2): 7-11.
- Basavaraj B. Status of Regional Disparity in Karnataka- A Comparative District Level Analysis. Sinhgad Business Review. 2009; 1(1): 21-26.
- Bhattacharjee D. Classifying Districts of North East India by Level of Deprivation in Basic Facilities, Southern Economist Golden Jubilee Publication. 1 May, 2011; 113-131.
- Bhore J. Health Survey and Development Committee Report. Vol-II. New Delhi: Government of India; 1946.
- Govt. of India. India: National Human Development Report 2001. New Delhi: Oxford University Press for the Planning Commission; 2002.
- Halfon N, Hochstein M. Life Course Health Development: An Integrated Framework for Developing Health, Policy and Research. The Milbank Quarterly. 2002; 80(3): 433-479.
- Johnson NL, Kotz S. Continuous Univariate Distributions. Singapore: John Wiley and Sons Inc; 1970.
- Keeping ES. Introduction to Statistical Inference. Princeton, New Jersey: D. Van Nostrand Co. Inc; 1962.
- Kaplan RM, Bush JW, Berry CC. Health Status Index: Category Rating versus Magnitude Estimation for Measuring Levels of Well–being. Medical Care. 1979; 7(5): 501-525.
- Kathuria V, Sankar D. Inter-state Disparities in Health Outcomes in Rural India: An Analysis Using a Stochastic Production Frontier Approach. Development Policy Review. 2005; 23(2): 145-163.
- Kumar TK, Holla J, Guha P. Engel Curve Method for Measuring Poverty. Economic and Political Weekly. 2008; 7: 115-123.
- Kruk M, Freedman L. Assessing Health System Performance in Developing Countries: A Review of the Literature. Health Policy. 2008; 85(3): 263-276.
- Mazziotta PM, Pareto A. Composite Indices for Multidimensional Development and Poverty: An Application to MDG Indictors. Paper presented in CREI Seminar, University of Roma Tre: Roma; 2007.
- Maheshwari S, Bhat R, Saha S. Directions for Reforms in the Health Sector: Lessons from a State in India. Journal of Health & Development. 2005; 1(3): 33-51.
- Murray CJL, Frenk J. World Health Report 2000: A Step Towards Evidence-based Health Policy. The Lancet. 2001; 357: 1698-1700.
- Ministry of Health and Family Welfare Report. New Delhi: Government of India; 2005.
- Navaneetham K, Saxena PC. Multivariate Graphical Methods for Characterizing Development: An Application of Chernoff-type Faces. Demography India. 1999; 28(1): 111-122.
- Nardo M, Saisana M, Saltelli A and Tarantola, S. Tools for Composite Indicators Building. EUR 21682 EN, Italy: European Commission-JRC; 2005.
- National Rural Health Mission. The Way Forward through Innovations in Healthcare- Assam. Department of Health and Family Welfare, Guwahati: Government of Assam; 2009.
- Pal SK. Statistics for Geoscientists: Techniques and Applications. New Delhi: Concept Publishing Company; 1998.
- Roy S. Recurring Flood Disasters and Health Consequences: A Case Study of Murshidabad District in West Bengal. Journal of Health and Development. 2007; 2(4): 135-145.
- Report of the Scientific Peer Review Group on Health Systems Performance Assessment. Geneva: World Health Organization; 2002.
- Sen A. Commodities and Capabilities. New York: North-Holland; 1985.
- Sen A. Inequality reexamined. New York: Russell Sage Foundation; 1992.
- Sen A. Development as freedom. Oxford: Oxford University Press; 1999.
- Srinivasan K, Mohanty SK. Health Care Utilization by Source and Levels of Deprivation in Major States of India. Demography India. 2004; 33(2): 107-126.

- Statistical Hand Book of Assam. Directorate of Economics and Statistics, Guwahati: Government of Assam; 2009.
- Saisana M, Tarantola S. State-of-the-art Report on Current Methodologies and Practices for Composite Indicator Development. EUR20408EN, Italy: European Commission-JRC; 2002.
- The World Health Report 2000: Health Systems Improving Performance. Geneva: World Health Organization; 2000.
- Toolkit on Monitoring Health Systems Strengthening [electronic document]. World Health Organization, Geneva, [cited 2011, February 9] URL: http://www.who.int/healthinfo/statistics/toolkit_hss/ en/index; 2008.

Table 1: Classification of development through MPI

Development Category	Values of MPI
Low Development	Less than 96.669
Moderate Development	Between 96.669 to 101.693
High Development	Greater than 101.693

Table 2: District-wise classification of development

Development Category	Districts of Assam
Low Development	Bongaigaon, Dhemaji, Morigaon, Chirang, Tinsukia, NC Hills, Baksa, Hailakandi, Udalguri
Moderate Development	Kokrajhar, Goalpara, Barpeta, Nalbari, Darrang, Lakhimpur, Golaghat, Sibsagar, Dibrugarh, Karbi-Anglong, Karimganj
High Development	Dhubri, Kamrup (M+R), Sonitpur, Nagaon, Jorhat, Cachar

Table 3: Normalized values of health indicators for the low developed districts of Assam

	Normalized values obtained using eq. (2)						
District	No. of health center (‘000)	No. of hospital beds (‘000)	No. of doctors available (‘000)	Safe drinking water (%)	Sanitation (%)	Achievement of family welfare programme (%)	Achievement of immunization programme (%)
Bongaigaon	87.940	93.460	90.943	104.399	93.271	90.288	94.851
Dhemaji	90.134	95.328	91.508	90.637	85.540	88.704	98.845
Morigaon	94.423	90.775	92.826	87.359	95.756	105.353	102.224
Tinsukia	97.016	98.246	96.592	90.694	100.657	89.082	89.996
NC Hills	85.746	90.775	89.813	83.334	100.311	109.911	112.512
Hailakandi	89.835	91.826	88.119	80.498	114.668	101.362	91.420
Chirang	86.844	89.570	89.607	96.100	104.453	95.572	83.044
Baksa	96.470	85.292	83.966	102.386	89.288	86.312	113.168
Udalguri	93.170	90.878	90.883	99.863	90.524	90.579	109.245

Appendix – A
District wise authentic values along with mean and standard deviation of the indicators

District	No of Health center Per 1000 population	No of beds per 1000 population	No of doctors per 1000 population	Drinking water	Sanitation	Average % of achievement of family welfare programme	Average % of achievement of Immunization programme
Dhubri	55.94	52.61	54	53.15	49.7	49.24	103.33
Kokrajhar	43.45	33.99	38	78.61	25.3	58.82	96.77
Bongaigaon	19.02	27.47	23	50.10	51.4	39.81	85.20
Goalpara	36.92	40.74	37	31.71	64	74.85	98.41
Barpeta	58.92	52.84	56	35.87	72.7	36.68	85.30
Nalbari	34.87	63.08	60	44.56	52.9	62.63	68.84
Kamrup(M+R)	89.13	107.31	94	60.63	71.7	79.31	91.04
Darrang	38.41	55.17	42	41.98	49.1	46.97	88.85
Sonitpur	63.96	51.68	57	60.10	59.8	60.82	81.25
Lakhimpur	36.17	43.30	45	40.19	57.7	88.55	86.52
Dhemaji	23.12	31.19	25	29.04	40.2	36.71	89.16
Morigaon	31.14	22.11	27	24.02	55	69.29	92.51
Nagaon	84.84	68.67	72	68.67	77	47.18	95.78
Golaghat	36.17	38.18	60	51.66	64.5	49.67	81.36
Jorhat	36.92	49.81	49	43.94	65.5	112.38	104.62
Sibsagar	48.67	47.02	37	43.50	72	63.00	79.38
Dibrugarh	52.21	28.17	37	63.24	78.1	38.28	102.54
Tinsukia	35.99	37.01	34	29.13	62.1	37.45	80.38
Karbi-Anglong	30.77	47.25	49	39.51	49.2	85.83	99.66
NC Hills	14.92	22.11	21	17.86	61.6	78.21	102.71
Karimganj	49.41	25.84	27	30.36	86.3	62.19	84.87
Hailakandi	22.56	24.21	18	13.52	82.4	61.48	81.80
Cachar	56.50	30.26	38	48.63	81	67.26	91.27
Chirang[1]	16.97	19.71	20.94	37.40	67.60	50.15	73.49
Baksa[1]	34.97	11.18	10.29	47.02	45.63	32.03	103.36
Udalguri[1]	28.80	22.32	23.35	43.16	47.42	40.38	99.47
Mean	41.57	40.51	40.56	43.37	61.15	58.81	90.30
SD	18.69756	19.94081	18.87969	15.30414	14.48768	19.56878	9.915718

Appendix-B
District wise MPI values along with mean, standard deviation and coefficient of variation after normalization

District	Mean	SD	CV	MPI
Dhubri	103.9201	7.489055	0.072065	103.3804
Kokrajhar	100.173	14.13313	0.141087	98.17895
Bongaigaon	93.59361	5.297245	0.056598	93.2938
Goalpara	100.9207	5.769654	0.05717	100.5909
Barpeta	101.493	8.347835	0.08225	100.8063
Nalbari	99.06592	11.15945	0.112647	97.80884
Kamrup (M+R)	116.7065	12.26648	0.105105	115.4172
Darrang	98.49569	5.001793	0.050782	98.24169
Sonitpur	104.0172	7.542157	0.072509	103.4704
Lakhimpur	101.0967	6.612086	0.065404	100.6643
Dhemaji	91.5285	4.369222	0.047736	91.31993
Morigaon	95.53135	6.314772	0.066102	95.11393
Nagaon	111.5523	9.43123	0.084545	110.7549
Golaghat	100.0463	6.510677	0.065077	99.62259
Jorhat	107.4368	10.24413	0.09535	106.4601
Sibsagar	100.5254	5.908769	0.058779	100.178
Dibrugarh	103.4214	9.670799	0.093509	102.5171
Tinsukia	94.61221	4.59486	0.048565	94.38906
Karbi-Anglong	102.1107	8.05914	0.078926	101.4746
NC Hills	96.05815	11.66086	0.121394	94.6426
Karimganj	99.28003	9.341244	0.09409	98.40112
Hailakandi	93.96161	11.00758	0.11715	92.67207
Cachar	103.421	6.181015	0.059766	103.0516
Chirang	92.17033	7.104812	0.077084	91.62267
Baksa	93.84072	10.81238	0.115221	92.59491
Udalguri	95.02086	7.111197	0.074838	94.48867