Research Article

Assessment of health-related development indicators and classification of Indian states based on composite indices

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ABSTRACT

Background: There exists large interstate variation in health indicators related to demography, family planning, maternal care, immunization, health infrastructure, and other associated factors. **Objectives:** This study envisages to assess the range of variation in health-related indicators across states and also the classification of states based on composite indices (CIs) of states as the combined effect of all these indicators. **Materials and Methods:** The study is based on latest state level secondary data related to health indicators published by the Ministry of Health and Family Welfare, Government of India, and other official sources. The statistical procedure for the estimation of composite index is similar to the one developed by statisticians to classify Indian states/districts using CIs based on a set of positive (pushing factors) and negative(pulling factors) indicators. The CIs would lie between "0" and "1." The states with the value of indices close to "0" would be top performers and those close to "1" bottom performers. **Results:** The top states according to the level of development in health-related indices are Goa, Kerala, Mizoram, Tripura, Tamil Nadu, Himachal Pradesh, Karnataka, and Manipur, the middle-level states are Andhra Pradesh, West Bengal, Maharashtra, Odisha, Meghalaya, Uttarakhand, Assam, Gujarat, Chhattisgarh, Sikkim, Madhya Pradesh, and Punjab, and bottom states are Jharkhand, Nagaland, Rajasthan, Delhi, Uttar Pradesh, Jammu and Kashmir, Haryana, Bihar, and Arunachal Pradesh. **Conclusions:** Those states falling in top, middle, and bottom have been appearing in those classes many times for individual indicators also. Unless, the states make concerted efforts to come up for each of the indicators, cannot change the position or classes for health-related overall development.

KEY WORDS: Health Indicators; Composite Indices; Classification of Indian States

INTRODUCTION

Health and education are the two crucial social components for sustainable and stable life of any person or a society in a developing country. India is no exception to this reality. Ever since planned development started in India, prime importance was being given for developing these two sectors. As a result, tremendous progress has been achieved in all related spheres, especially in health and family welfare sector.

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The UN General Assembly in its Millennium Submit in 2000 at New York endorsed to achieve a set of Millennium Developmental Goals (MDGs) including health-related goals by 2015. The set goals included eradication of extreme poverty and hunger, achievement of universal primary education, promotion of gender equity and empowerment of women, reduction in childhood mortality, improvement of maternal health, combating of HIV/AIDS malaria and tuberculosis, sustainability of environment, access to safe drinking water, and development of global partnership for development. Remarkably, all these goals have a direct or indirect bearing on human health.[1] The reduction in under five mortality rate (UNDER5MR) from

125 deaths per 1000 live births in 1990 to the target figure of 42/1000 live births by 2015 was almost achieved by India. Similarly, infant mortality rate (IMR) could be brought down from 80/1000 live births in 1990 to 39/1000 live births in 2015 against the target of 27/1000 live births also is a remarkable achievement. The share of immunization of 1-year-old children against measles has gone up from 42% in 1992 to 74% in 2009. To reduce morbidity and mortality of children, a large number of initiatives were launched at the national level.[2]

The global sustainable development goals (SDGs) were aimed to push up the MDGs goals set to be achieved by 2025. The agenda of SDGs included 17 goals and 169 targets to be achieved by 2030. The SDGs included goals such as eradication of poverty and hunger, good health, gender equity, clean water, and sanitation, which have direct bearing on health.[1]

The WHO launched the global immunization program in 1974 as "expanded program of immunization" for prevention and control of six major fatal diseases causing morbidity and mortality of children. The Government of India also launched the same program in 1978, and the same is in operation in all the states of the country.[1]

The National Health Mission having two broad sub missions of rural health and urban health was aimed to strengthen health system for achieving universal access to equitable, affordable, and quality health-care services which are responsible to the needs of the people. A large number of central and state sponsored health programs focusing on different segments of the population were launched in different states of India. As a result, remarkable achievements have been made by various states over the period in health and social development sectors.[2] However, the rate of progress made over the years by different states has not been uniform in the process of development. Even for the same state, the level of health development of male and female population is different. The intertemporal and interspatial variations in health-related parameters are a matter of great concern.

The studies have been conducted by researchers to delineate states according to general development indicators. Many studies are available on the classification of states according to individual health-related indicators. The Indian Institute of Management, Ahmedabad, has recently made a study to classify Indian major states as high performers, middle performers, strugglers, and poorest performers based on mortality, infrastructure, workforce, and utilization variables related to health sector.[3]

Very few studies are available for classifying states or districts based on composite indices (CIs) as the combined effect of many individual indicators related to health sector. The present study is an attempt to assess interstate variations in health-related indicators and also to classify the states as top, middle, and bottom based on CIs which are derived as combined effect of available health-related/associated indicators on demography, family planning, maternal health, child health, and health and other infrastructure.

The specific objectives of the study are as follows:

i. To assess the range of variation of health-related indicators across states in India
ii. To classify Indian states according to values of CIs worked out based on all these indicators.

MATERIALS AND METHODS

The study is based on state level secondary data (Union Territory not included) related to health indicators published by the Ministry of Health and Family Welfare, Government of India, and other official sources.[4-6] The statistical procedure for the estimation of composite index is similar to that developed by Prem et al.[7] To classify districts based on social development indicators which are summarized as follows:

Let $[X_{ij}]$ denotes the data matrix representing the health-related indicators of states

$i = 1, 2,\ldots\ldots, n$ states and $j = 1, 2,\ldots., k$ indicators.

As $[X_{ij}]$ denotes different indicators in different units of measurement, these are not additive as such to get the required composite index. Hence, the $[X_{ij}]$ is transformed to $[Z_{ij}]$ as follows:

$$\left[Z_{ij}\right] = \frac{X_{ij} - \bar{X}_j}{S_j}$$

Where

$\bar{X}_j$ = Mean of j^{th} indicator,
S_j = Standard deviation of j^{th} indicators across states,
$[Z_{ij}]$ = The matrix of standardized indicators.

$[Z_{ij}]$ identifies the best value of each indicator. In the case of positive (pushing factors) indicators, the best value can be the maximum state value, and in the case of negative (pulling factors) indicators, it can be the minimum state value, depending on the direction of the impact of indicator on the level of development. Let Z_{0j} denotes the best value of j^{th} indicator. To get the pattern of development, calculate first P_{ij}

Where,

$$P_{ij} = (Z_{ij} - Z_{0j})^2$$

The pattern of development C_i is given as follows:

$$C_i \quad \left[\sum P_{ij} / (C.V.)_j\right]^{1/2}$$

Where $(C.V.)_j$ is the coefficient of variation of j^{th} indicator in matrix X_{ij}.

Composite index D_i is given as follows:

$D_i = C_i/C$, where $\overline{C} = C + 3S_{Di}$

$\overline{C}$ = Mean of C_i and S_{Di} = Standard deviation of $C_{i.}$

A smaller value of D_i will indicate high level of development, and higher value of D_i will indicate a low level of development as deviation of standardized indicator from the best state standardized value (maximum/minimum) is taken to calculate the CIs.

In all, 26 health-related indicators were included in the present study. These cover demographic (12), family planning (1), maternal health care (3), immunization of children (8), and health and other infrastructure facilities (2). The following are the group-wise indicators considered to work out the composite indicators for each state based on all the 26 indicators.

Demographic

Demographic indicators include share of slum population to urban population, population density, population growth rate, total literacy rate, female literacy rate, population sex ratio, child sex ratio, dependency ratio, total fertility rate (TFR), crude birth rate (CBR), crude death rate (CDR) and infant mortality rate (IMR).

Family Planning

The current use of contraceptive by any method.

Maternal Health

Tetanus for expectant mothers, IFA full course, and share of institutional delivery.

Immunization

Diphtheria, pertussis, and tetanus toxoids (DPT) immunization for children, polio, Bacillus Calmette Guerin (BCG), measles, DT/DPT5, TT 10 year, prophylaxis against blindness (below 1 year), and prophylaxis against blindness (under 5 years) were used.

Health and Other Infrastructure Facility

Share of primary health care (PHC) working 24 × 7, share of latrine facility within premises of houses.

The value of CIs would lie between "0" and "1." The states with value of indices close to "0" are top performers and those close to "1" are bottom performers. In the present study, the value of CIs <0.5 was considered as top perfumers, the value between 0.51 and 0.69 was treated as middle performers, and the value 0.7 or more was considered as bottom performers.

RESULTS

When the best performing states for individual indicators are considered, Kerala tops in lowest slum population, highest literacy rate, female literacy, sex ratio, and share of households with latrine facility. It stands second in lowest population growth, TFR, and share of institutional delivery to total delivery. For infant mortality, it stands at third lowest position after Manipur and Goa. Similarly, Goa has the distinction of being first in minimum dependency ratio, second in minimum slum population, as well as good coverage of prophylaxis of IFA to prevent nutritional anemia, immunization coverage to children (polio and DPT3 dose), and third in minimum population growth, maximum total literacy rate and female literacy rate, institutional delivery of children, and immunization coverage of children (measles, DPT5 dose, and Vitamin A prophylaxis for below 1 year). The smaller states of north eastern region such as Arunachal Pradesh, Mizoram, Sikkim, Nagaland, Meghalaya, and Manipur have best desirable state value related to demographic indicators such as density of population, decennial growth rate of population, female literacy, child sex ratio, TFR, CDR, CBR, and IMR and also in immunization coverage. Himachal Pradesh, Andhra Pradesh, and Punjab stand in the fore front for the use of contraceptive by any method. Tamil Nadu is among the first three states having best state indicators in sex ratio, dependency ratio, share of institutional delivery, and coverage in prophylaxis against blindness due to Vitamin A deficiency. The state of Rajasthan, followed by West Bengal and Jharkhand, has the distinction in percentage coverage of PHC working the whole day (Table 1).

When the least performing states for individual indicators are considered, Andhra Pradesh, Chhattisgarh, and Madhya Pradesh have the highest share of slum population in urban areas. The highest density of population in Delhi poses challenges in health management. Delhi stands in the bottom three states for indicators such as sex ratio, immunization coverage of infants against measles, DPT5, and TT for 10-year-old children. The state of Bihar has the second highest density of population, third highest population growth rate, lowest female literacy, highest dependency ratio, highest TFR, second highest CBR, second lowest polio coverage, third lowest DPT immunization coverage, second lowest TT immunization coverage for 10-year-old children, and third lowest coverage of latrine in house premises. The state of Rajasthan is among the least performing states for indicators such as population and female literacy, and Arunachal Pradesh stands in the bottom three states for

Table 1: Top three states with best state value for each indicator

Indicator	Best value (Max/Min)	Best state value	Top three state
Demographic indicator			
% of total slum population to urban population	Minimum	1.3	Kerala, Goa, Assam
Density per square km	Minimum	17	Arunachal Pradesh, Mizoram, Sikkim
Decennial growth rate of population (percent)	Minimum	-0.6	Nagaland, Kerala, Goa
Population literacy rate (%)	Maximum	94	Kerala, Mizoram, Goa
Female literacy rate (%)	Maximum	92.1	Kerala, Mizoram, Goa
Sex ratio	Maximum	1084	Kerala, Tamil Nadu, Andhra Pradesh
Child sex ratio	Maximum	972	Andhra Pradesh, Meghalaya, Mizoram
Dependency ratio (Census 2001)	Minimum	494	Goa, Tamil Nadu, Kerala
TFR (NFHS 4)	Minimum	1.2	Sikkim, Kerala, Punjab
CBR	Minimum	14.3	Manipur, Rajasthan, Uttar Pradesh
CDR	Minimum	3.3	Meghalaya, West Bengal, Madhya Pradesh
IMR	Minimum	11	Manipur, Goa, Kerala
Family planning			
Current use of contraceptive by any method (DLHS III)	Maximum	68.1	Himachal Pradesh, Andhra Pradesh, Punjab
Maternal health			
Tetanus immunization for expectant mothers (ii+booster)	Maximum	100.6	Mizoram, Karnataka, Andhra Pradesh
Prophylaxis against nutritional anemia among women (IFA full course completed)	Maximum	139	Delhi, Goa, Jammu and Kashmir
% of institutional delivery to total	Maximum	99.8	Tamil Nadu, Kerala, Goa
Child health			
% Coverage - DPT immunization for children (iii dose)	Maximum	122	Manipur, Goa, Mizoram
% Coverage - Polio (iii dose)	Maximum	121.8	Manipur, Goa, Mizoram
% Coverage - BCG (below 1 year)	Maximum	102.7	Manipur, Meghalaya, Mizoram
% Coverage - Measles (below 1 year)	Maximum	120.2	Manipur, Mizoram, Goa
% Coverage - DT/DPT5 immunization for children	Maximum	102.7	Mizoram, Sikkim, Goa
% Coverage - TT 10 year	Maximum	118.1	Sikkim, Maharashtra, Odisha
% Coverage - Prophylaxis against blindness due to Vitamin A deficiency - Ist dose (<1 year)	Maximum	183.5	Tamil Nadu, Goa, Odisha
% Coverage - Prophylaxis against blindness due to Vitamin A deficiency - 9th dose (<5 years)	Maximum	161.4	Tamil Nadu, Jharkhand, Gujarat
Infrastructure			
PHC working 24*7	Maximum	95.7	Rajasthan, West Bengal, Jharkhand
Latrine facility available within premises	Maximum	95.2	Kerala, Mizoram, Delhi

PHC: Primary health center, DPT: Diphtheria, pertussis, and tetanus toxoids, BCG: Bacillus Calmette Guerin, TFR: Total fertility rate, CBR: Crude birth rate, CDR: Crude death rate, IMR: Infant mortality rate

indicators such as population literacy, tetanus immunization of expectant mothers, prophylaxis against nutritional anemia, DPT, polio, BCG, and measles immunization of children as well as Vitamin A prophylaxis for children. The state of Odisha has the lowest share of latrine in house premises, third lowest coverage of PHC working full day, second highest IMR, and third highest CBR. Haryana, Punjab, and Jammu and Kashmir stand at the bottom for population and child sex ratio which poses severe challenges for gender equity. The family planning adoption rates are the lowest in the north eastern states of Meghalaya, Nagaland, and Manipur. The state of Jharkhand also stands at the bottom three states for most of the immunization indicators as well as coverage of houses with latrine facilities within premises (Table 2).

Using all these, 26 indicators representing demography, family planning, maternal care, immunization, and health infrastructure the CIs were worked out. The value of CIs would lie between "0" and "1." The states with CI close to "0" are top performers, and those close to "1" are bottom performers. Accordingly based on these indices, the states are divided into three classes as top (<0.5), middle (0.51-0.69), and bottom (0.7 or more), which are as follows:

- Top: Goa, Kerala, Mizoram, Tripura, Tamil Nadu, Himachal Pradesh, Karnataka, and Manipur

Table 2: Bottom three states with actual lowest value of indicators

Indicator	Best value (Max/Min)	Best state value	Bottom three states
Demographic indicators			
% of total slum population to urban population	Maximum	36.1	Andhra Pradesh, Chhattisgarh, Madhya Pradesh
Density per square km	Maximum	11320	Delhi, Bihar, West Bengal
Decennial growth rate of population (%)	Maximum	27.9	Meghalaya, Andhra Pradesh, Bihar
Population literacy rate (%)	Minimum	61.8	Bihar, Arunachal Pradesh, Rajasthan
Female literacy rate (%)	Minimum	51.5	Bihar, Rajasthan, Jharkhand
Sex ratio	Minimum	868	Delhi, Haryana, Jammu and Kashmir
Child sex ratio	Minimum	834	Haryana, Punjab, Jammu and Kashmir
Dependency ratio (Census 2001)	Maximum	951	Bihar, Uttar Pradesh, Meghalaya
TFR (NFHS 4)	Maximum	3.4	Bihar, Meghalaya, Uttarakhand
CBR	Maximum	27.8	Mizoram, Bihar, Odisha
CDR	Maximum	8.5	Mizoram, Karnataka, Assam
IMR	Maximum	59	Madhya Pradesh, Odisha, Uttar Pradesh
Family planning			
Current use of contraceptive by any method (DLHS III)	Minimum	16.8	Meghalaya, Nagaland, Manipur
Maternal health			
Tetanus immunization for expectant mothers (ii + booster)	Minimum	35.8	Arunachal Pradesh, Nagaland, Jharkhand
Prophylaxis against nutritional anemia among women (IFA full course completed)	Minimum	24.4	Arunachal Pradesh, Nagaland, Jharkhand
% of institutional delivery to total	Minimum	44.8	Meghalaya, Chhattisgarh, Uttar Pradesh
Child health			
% Coverage - DPT immunization for children (iii dose)	Minimum	51.1	Arunachal Pradesh, Nagaland, Bihar
% Coverage - Polio (iii dose)	Minimum	50.7	Arunachal Pradesh, Bihar, Jharkhand
% Coverage - BCG (below 1 year)	Minimum	60.8	Arunachal Pradesh, Nagaland, MP
% Coverage - Measles (below 1 year)	Minimum	51.5	Arunachal Pradesh, Nagaland, Delhi
% Coverage - DT/DPT5 immunization for children	Minimum	4.5	Bihar, Delhi, Jharkhand
% Coverage - TT 10 year	Minimum	13.4	Delhi, Bihar, Arunachal Pradesh
% Coverage - Prophylaxis against blindness due to Vitamin A deficiency - Ist dose (below 1 year)	Minimum	13.8	Arunachal Pradesh, Uttarakhand, Delhi
% Coverage - Prophylaxis against blindness due to Vitamin A deficiency - 9th dose (under 5 years)	Minimum	6.3	Arunachal Pradesh, Tripura, Bihar
Infrastructure			
PHC working 24*7	Minimum	10.3	Kerala, Manipur, Odisha
Latrine facility available within premises	Minimum	22	Odisha, Jharkhand, Bihar

PHC: Primary health center, DPT: Diphtheria, pertussis and tetanus toxoids, BCG: Bacillus Calmette Guerin, TFR: Total fertility rate, CBR: Crude birth rate, CDR: Crude death rate, IMR: Infant mortality rate

- Middle: Andhra Pradesh, West Bengal, Maharashtra, Odisha, Meghalaya, Uttarakhand, Assam, Gujarat, Chhattisgarh, Sikkim Madhya Pradesh, and Punjab
- Bottom: Jharkhand, Nagaland, Rajasthan, Delhi, Uttar Pradesh, Jammu and Kashmir, Haryana, Bihar, and Arunachal Pradesh (Table 3).

DISCUSSION

Based on 26 health-related indicators, the top performing states are Goa, Kerala, Mizoram, Tripura, Tamil Nadu, Himachal Pradesh, Karnataka, and Manipur; medium performing states are Andhra Pradesh, West Bengal, Maharashtra, Odisha, Meghalaya, Uttarakhand, Assam, Gujarat, Chhattisgarh, Sikkim, Madhya Pradesh, and Punjab; and bottom performing states are Jharkhand, Nagaland, Rajasthan, Delhi, Uttar Pradesh, Jammu and Kashmir, Haryana, Bihar, and Arunachal Pradesh in the given order of its names. In this study, the CIs varied from 0.3825 to 0.8541. Goa followed by Kerala and Mizoram remained at the top in terms of health-related indicators. Incidentally, these states stood in the first three top positions for indicators

Table 3: Composite index values (ascending order) of various states

States	Indices value
Goa	0.3825
Kerala	0.3929
Mizoram	0.4521
Tripura	0.4765
Tamil Nadu	0.4780
Himachal	0.4827
Karnataka	0.4865
Manipur	0.4878
Andhra Pradesh	0.5118
West Bengal	0.5122
Maharashtra	0.5616
Odisha	0.5649
Meghalaya	0.5781
Uttarakhand	0.5998
Assam	0.6082
Gujarat	0.6110
Chhattisgarh	0.6186
Sikkim	0.6396
Madhya Pradesh	0.6792
Punjab	0.6891
Jharkhand	0.7111
Nagaland	0.7275
Rajasthan	0.7477
Delhi	0.7513
Uttar Pradesh	0.7515
Jammu and Kashmir	0.7524
Haryana	0.7555
Bihar	0.8269
Arunachal Pradesh	0.8541

related to demography, immunization, and maternal health. As per the composite index, the bottom states were Bihar and Arunachal Pradesh which remained at bottom in terms of individual indicators related to demography, family planning, maternal health and immunization. The indicators which pulled down Delhi and Haryana as less performing statesinclude factors like density of population, sex ratio, child sex ratio, and so on.

According to the National Institute of Public Cooperation and Child Development New Delhi, in 2012-13, the percentage of mothers consumed IFA tablets for 100 days or more was the highest for Odisha (31.2%), followed by Chhattisgarh (28.1%), Assam (23.1%), Uttarakhand(21.4%), Madhya Pradesh (19.5%), Jharkhand (16.9%), Bihar and Rajasthan (12.7% each), and Uttar Pradesh (9.7%).[8,9] The percentage of mothers who had availed full antenatal checkup in 2012-13 was the highest in Odisha at 27.8%. It was abysmally low in Bihar (7.8%) and Uttar Pradesh (6.8%).[9] As far as institutional delivery at the state level is concerned, most of the southern states and Maharashtra present a better situation.[10] Singh and Sheera revealed that health facilities play a very important role in enhancing the level of development in the state. With respect to these facilities, the state of Gujarat was ranked first, and the state of Odisha was ranked last. The CIs varied from 0.414 to 0.890 for different states.[11] The research study by Kumar et al. of IIM Ahmedabad, placed Maharashtra, Tamil Nadu, and Kerala as the high-performing states and Uttarakhand, Assam and Odisha as the poor-performing states in terms of available resources.[3]

The states falling in the three mutually exclusive classes of top, middle, and bottom are the resultant of combined effect of all the 26 indicators considered for the study. Those states falling in top, middle, and bottom have been appearing in those classes many a times for individual indicators also. Besides, for the same indicator and for the same state, the values can be different for different years. The classification of the states based on the combined effect of 26 health-related indicators in this study gives a better logical support as compared to classification based on individual indicator. Some of the facts are also to be kept in mind while using such secondary data for composite index based research. The state level data are generated and compiled by state level agencies identified for such work. All state level agencies may not be working with uniform efficiency level. The working system, especially, the availability of human resources also may not be uniform across the states which in turn affect the indicator based performance to a great extent.

A large number of central and state sponsored health programs focusing on different segments of population have been launched in different states of India. As a result, remarkable achievements have been made by various states over the period in health and social development sectors. However, the rate of progress made over the years by different states has not been uniform in the process of development. Studies have been conducted by researchers to delineate states according to general development indicators. Many studies are available on the classification of states according to individual health-related indicators. This study was aimed to assess the range of variation of health-related indicators across states in India and to classify Indian states according to values of CIs worked out based on all these indicators. The top states according to the level of development in health-related indices included Goa, Kerala, and Mizoram, and bottom states included Bihar and Arunachal Pradesh. Unless the states make concerted efforts to come up for each of the indicators, it cannot change the position or classes for health-related development. In any case, state level concurrent assessment on the performance of each of the health-related indicators is important so as to improve the performance of the health sector. The interstate comparison for individual as well as combined effect may be taken as a step to improve

the working system of the health sector by each state so as to achieve the goal of "health for all."

CONCLUSIONS

Those states falling in top, middle, and bottom have been appearing in those classes many times for individual indicators also. Unless the states make concerted efforts to come up for each of the indicators, it cannot change the position or classes for health-related overall development.

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