Development of a Health Index of Indian States

Prof. Piyush Kumar Sinha
Prof. Arvind Sahay
Dr. Surabhi Koul
Indian Institute of Management Ahmedabad (IIMA)

Development of a Health Index of Indian States

Prof. Piyush Kumar Sinha
Prof. Arvind Sahay

Dr. Surabhi Koul
Indian Institute of Management Ahmedabad (IIMA)

Facilitated by

OPPI

Organisation of Pharmaceutical Producers of India

Table of Contents

Acknowledgments

Abstract

Development of a Health Index of Indian States

The current study analyses the performance of India states with regard to health of their populace. It constructs an index for the health performance using multiple parameters. The variables selected for the study were divided under outcome and input measures. Using factor analysis weights were attached to each of the parameters for arriving at a summated score for outcome and input dimensions. Using these scores the states were ranked. The results showed that the states performed very differently on the two dimensions. The analysis showed very low correlation between outcome and input variables. Assuming orthogonality between them an Outcome – Input matrix was plotted. Based on median score of the two dimensions, the four quadrants were identified. Maharashtra and Tamil Nadu were found amongst the best performers while Assam, Uttaranchal and Uttar Pradesh were lowest performers. States like Kerala, Himachal Pradesh, Delhi and J&K performed well. The study brought out clearly that besides building the resources and infrastructure for delivery of healthcare services, there is a need to develop innovative and participative approached to achieve the objectives by building dynamic capabilities using people, systems, infrastructure and technology.

Keywords: Factor Analysis, Health Index, Input Measure, Outcome Measure, Sates of India

1. Introduction

A country or state's performance depends a lot on the heath of its populace. Not only does it improve efficiency but it is also an indicator of an all-round performance of the nation. Policy makers cannot ignore its importance in economic development as well as happiness and human development of the nation. Health has been made one of the most important dimensions of the millennium development goals set for country. Four of the eighteen development goals adopted by the General assembly of the United Nations in September 2000 relate to health and well-being of the population of the country. The focus of the Indian government to develop 'a holistic care system that is universally accessible, affordable and effective' is an indication of a national focus aligned to the UN goals. The country and the states have injected resources into institutions, hospitals, partnerships and initiatives to progress in this domain. Leading pharmaceutical and healthcare companies have

also played a significant role by collaborating with the global health community to address the needs of the country.

IIMA was approached by OPPI to study this phenomenon and explore the possibility of looking at the states based on their performance of the health of their populace. The study involved collecting and purifying the data from reliable sources and developing an index which could capture the variances in the state and also give direction for a developing policies, strategies and action plans for each of the states.

2. Measurement of the Status of Health

Measuring the status of health of a country or a state is a complex process. It is a multi – faceted phenomenon which has been difficult to model and estimate. It becomes further complicated due to disparities among various states of India. There are many studies conducted by private as well as government agencies to study issues at state level.[1] Most of these have used the outcome variable as the indicators. While important these are negative indicators in the sense that reduction in these indicates better health status.[2] One such study has tried to bring in some of the initiatives into determining the score and a ranking of states based on these scores.[3]Comparison of countries with regard to health is also presented in WHO report which considers largely outcome variables only. It is also noted that different countries have used different dimensions

[1]Gudwani A, Mitra P, Puri A and Vaidya Mandar (2012), "India Healthcare: Inspiring Possibilities: Challenging Journey", Mckinsey & Company

[2]Sengupta Keya (2016), "Determinants of Health Status in India", Springer, New Delhi

[3]Bhandari Pranjul (2012), "Refining State Level Comparisons in India", Planning Commission, Government of India, Working Paper Series

for defining health performance. This makes comparison difficult and unusable for drawing any policy implications. More importantly, the comparison is at country level.

For a country like India, it is important that the study provides a path for each of the State due to wide variation in terms of economic, geographic, social, cultural and political canvas.

Table – 1: Indian States

Sr. No	State	Area (Sq. km.)	Population (Lakh)	SGDP (Lakh)	Per Capita Health Expenditure (Lakh)
1	Andhra Pradesh	275045	84665533	42710	144
2	Assam	78438	31169272	22956	116
3	Bihar	94163	103804637	15268	73
4	Chhattisgarh	135192	25540196	29635	88
5	Delhi	1483	16753235	334915	114
6	Gujarat	196244	60383628	64316	120
7	Haryana	44212	25353081	63045	149
8	Himachal Pradesh	55673	6856509	49817	135
9	Jammu & Kashmir	222236	12548926	28932	116
10	Jharkhand	79716	32966238	22902	103
11	Karnataka	191791	61130704	41545	137
12	Kerala	38852	33387677	53427	275
13	Madhya Pradesh	308252	72597565	22382	125
14	Maharashtra	307713	112372972	62729	129
15	Orissa	155707	41947358	26900	39
16	Punjab	50362	27704236	46688	197
17	Rajasthan	342239	68621012	25616	92
18	Tamil Nadu	130060	72138958	56461	149
19	Uttar Pradesh	240928	199581477	18103	127
20	Uttaranchal	53483	10116752	47831	84
21	West Bengal	88752	91347736	34229	193

3. The Approach

Several researchers have compared countries and states using several health parameters. In order to generate a generic list of variables the study started with looking at how indexes have been developed in other countries. Three approaches were developed:

Approach – 1: The Health Spectrum

The idea was to develop a spectrum with the country with highest performance and the country with lowest performance as the two end points. Indian states would find a place on this spectrum based on the scores of the health parameters. This would not only provide a relative position for each of the sates but also chart out journey that they would need to undertake to achieve excellence. However, it was found that these countries used parameters and definitions which were very different and non-comparable. This method was not pursued further. It was decided to use the variables available for each of the Indian states only and develop an appropriate method to arrive at the scores.

Approach – 2: Outcomes as Performance

The study started with collecting the list of variables most commonly referred. It was found that most studies have used the parameters used by WHO to assess the performance. These included Infant Mortality Rate (IMR), Under 5 Mortality Rate (U5MR), Neo Natal Mortality Rate (NNMR), Maternal Mortality Rate (MMR), Deaths due to HIV, Deaths Due to TB and Deaths due Malaria. It was also found that WHO also uses a list of 47 diseases under the classification of communicable and non-communicable. A list of all these diseases was prepared. It was also found that some studies had used other factors like sanitation methods and vaccination. Taking a cue from these studies, a list of diseases was prepared. This formed the outcomes which could be used to understand relative position of states.

Approach – 3: Input::Output Association

Health is a state subject and also the states differed in their expanse and population characteristic. Each of the states also develops separate plans for themselves based on their priorities and any national agenda in line with the millennium goals. A list of input variables consisted of infrastructure, manpower and economic factors. Based on the discussion within the team members, another dimension of utilisation of the service was added. The list of identified items is given in **Table – 2**.

Table - 2: Items Identified for Analysis

Outcome measures (MDGs)	Life expectancy at birth
	Under five mortality rate
	Neonatal mortality rate
	Maternal mortality ratio
	Deaths due to HIV/AIDS
	Deaths due to malaria
	Deaths due to tuberculosis among HIV negative people
Disease Incidence	
Communicable Diseases	Acute diarrhoeal diseases
	Malaria
	Acute respiratory infection
	Japanese encephalitis
	Viral hepatitis
	Acute encephalitis syndrome
	Dengue
	Cholera
	Typhoid
	Tetanus neonatal
	Diphtheria
	Whooping cough
	Measles

Communicable Diseases	Rabies
	Polio
	Pneumonia
	Meningococcal meningitis
	Syphilis
	Gonococcal infection
	Pulmonary tuberculosis
	Leprosy
	Kala azar
	Swine flu
	Chikungunya fever
	Acute flacid paralysis (AFP)
	Gonococcal infection
Non Communicable Diseases	Coronary heart disease
	Ischemic heart diseases
	Burden of ischemic heart diseases
	Burden of stroke
	Diabetes
	Hypertension
	Incidences of blindness
	Cancer
Infrastructure	State-wise PHCs, CHCs and aanganwadi functioning
	State-wise building position for SCs
	State-wise building position for PHCs
	State-wise building position for CHCs
	State-wise HW(F)/ANM at SCs & PHCs
	State-wise doctors at PHCs
	State-wise total specialists at CHCs
	State-wise radiographers at CHCs

Infrastructure	State-wise pharmacists at PHCs &CHCs
	State-wise laboratory technicians at PHCs &CHCs
	State-wise nursing staff at PHCs &CHCs
Status of Facilities Available	Facilities available at sub centres
	Facilities available at primary health centres
	Facilities available at community health centres
Utilisation of health services (WHO Annual report)	Contraceptive prevalence
	Antenatal care
	Births attended by skilled health personal
	Immunisation
	Smear positive TB treatment success.
Economic	GSDP
	State health expenditure
	Per capita heath expenditure

4. Data Collection and Preparation

The study collected data from several sources. It used the resources available in the libraries and reports and databases as available from websites of government departments, development organisations and research and consulting companies. The effort was to collect data on as many items as possible for each state for the last five year. This step became critical in choosing the items for further analysis. Several sources were used to collect the data. Three factors were considered in choosing the sources and extent of data: (a) the data is available for each state, (b) it is available for five years and (c) the source is credible and acceptable to the stakeholders. Under these three conditions, some of the items were dropped. Diseases which had low incidences (less than 1000 per lakh population) were removed.

The final list of variables used in the study is given in **Table – 3**. A similar method was used to select the states. In the final analysis, 21 states were chosen.

Table - 3: Variables Used in the Study

Dimension	Factors	Items	Source	Year
Outcome	Mortality	Infant Mortality Rate	Census of India, SRS Bulletin	2009 - 13
		Under 5 Mortality Rate	Census of India, SRS Bulletin	2009 - 13
		Neo Natal Mortality Rate	Census of India, SRS Bulletin	2009 - 13
		Maternity Mortality Rate	Census of India, SRS Bulletin	2009 - 13
		Deaths due to HIV	Indiastat (2016a), Central Bureau of Health Intelligence, MoHFW, GoI	2008 - 12
		Deaths due to TB	Central Bureau of Health Intelligence, MoHFW, GoI	2008 - 12
		Deaths due to Pneumonia	Central Bureau of Health Intelligence, MoHFW, GoI	2008 - 12
		Deaths due to Acute Diarrohrial Diseases	Central Bureau of Health Intelligence, MoHFW, GoI	2008 - 12
Input	Infrastructure	No. of PHCs	Indiastat (2016b), MoHFW, GoI	2008 - 12
		No. of CHCs	Indiastat (2016c), MoHFW, GoI	2008 - 12
		No. of SCs	Indiastat (2016d), MoHFW, GoI	2008 - 12
		No. of Hospitals (Private & Public)	Family Health Plans (New India Assurance Co. Ltd., National Insurance Co. Ltd., United India Insurance Co Ltd.)	2012
	Manpower	No. of Registered Medical Practitioners	Indiastat (2016e), Registrar General, Govt. of India & Bureau of Applied Economics & Statistics and Directorate of Health Services, Government of India	2008 - 12
		No. of Nurses in PHC's and CHC's	Indiastat (2016f), Indian Nursing Council	2008 - 12
		No. of Aganwadi Workers	Indiastat (2016g), NHRM	2008 - 12
		No .of ASHA workers	IndiaStat(2016h), NHRM	2008 - 12
	Utilisation	No. of Children Immunized	Indiastat(2016i), National Immunization Program, GoI	2008 - 12

The data so obtained was further cleaned for accuracy and units. A small set of missing data was filled in relation to the proximous state identified on the basis of SGDP. The final number was arrived based on a coefficient derived based on health expenditure. Data was collected for five years. A one year lag was considered for the outcome data. Thus the data for input items was collected for the year 2008 – 12, whereas, data for outcome items was collected for 2009 – 13. In a further refinement, children mortality was indicated by number of deaths under the age of 5 years as other measures in the category were included in this number. According to WHO, infant are defined as young children who are less than 1 year of age. Under 5 mortality rate is determined by the number of children under five years of age dying in a given year. Maternal Mortality is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes. MMR has been considered as the number of women dying of pregnancy-related causes in a given year.[4] All data was converted to per lakh of population. It was then normalised using mean and standard deviation.

[4](N. D.) 2016, Humanitarian Health Action, World Health Organisation. http://www.who.int/hac/about/definitions/en/

5. Data Analysis

Two methods were applied to arrive at the scores for each of the states. In the first case a regression analysis was used. Outcome variables were considered as dependent variables. Child mortality was chosen as the variable. When regressed on input variables, the results did not indicate any clear direction. When a correlation matrix was generated, it was found that only a few of the input variables were correlated to the outcome. There were also incidences of multi-collinearity. It was also felt that the economic variables may create a nested situation since the inputs created by the state would be a function of the budget allocated for health. Hence, this method was not pursued.

Most methods of developing an index have used a weighted sum approach. The second method followed this approach. It applied factor analysis to arrive at the weights. Factor analysis helps to reduce the number of observed variables into smaller number of variables which account for the most of the variance in the observed variables.[5] Analysis was carried out with all variables put together. The results were jumbled up and seemed confounded. The findings clearly hinted at the problem as was faced during the regression method. It was decided to carry out factor analysis separately for input and outcome. We applied Factor analysis to assign weights to each of the variables on the normalised data set. SPSS-22 was used for the same. The analysis was carried out at two stages. In the first stage, weights of each of the items were determined based on the factor loadings of each item. Using the normalised scores and these weights, a summated weighted score was arrived for each of the input factors. A second level factor analysis was carried out using the weighted scores for each factor for that dimensions. The factor loading so arrived was used to arrive at a summated score for the input dimension.

[5]Young, G. and Pearse, S (2013), A Beginner's Guide to Factor Analysis: Focusing on Exploratory Factor Analysis", *Tutorials in Quantitative Methods for Psychology,* Vol. 9(2), p. 79-94.

6. Findings

Outcome Measures:

The normalised values and weights arrived from factor analysis of items of child and maternity mortality rate (IMR, MMR, NMR, U5MR) a weighted summated score for the first parameter was arrived.

Table – 4: Rotated Component Matrix for Outcome Measure

Variable	Factor Loading
Child and Maternal Mortality Rate	0.7
Deaths due to other diseases	0.7

Similarly for the values and the weights of the items of deaths due to other diseases (death due to HIV, TB, Pneumonia, and Acute Diahorrial Disease) a summated to score was obtained for the second parameter of outcome. Later, Factor analysis was conducted on these two f to attain the weights (Factor Loadings). The rotated component matrix resulted in weight of 0.70 for each of the parameters **(Table – 4)**.

Table-5: State Ranking For Outcome Varibles

State	Weighted Score	Rank
Kerala	114	1
Maharashtra	162	2
Tamil Nadu	168	3
Jammu & Kashmir	204	4
Delhi	212	5
Andhra Pradesh	239	6
Himachal Pradesh	243	7
West Bengal	247	8
Gujarat	268	9

State	Weighted Score	Rank
Punjab	275	10
Karnataka	276	11
Haryana	295	12
Bihar	422	13
Jharkhand	423	14
Chhattisgarh	457	15
Orissa	473	16
Madhya Pradesh	480	17
Rajasthan	485	18
Uttaranchal	526	19
Uttar Pradesh	558	20
Assam	595	21

These weights were used to arrive at a weighted score for the states for each of the five years. Based on the weighted score for the year 2013, the final scores weights were arranged in ascending order to arrive he relative ranks of all the states as given in **Table - 5**.

Table-6: Rotated Component Matrix

Variable	Factor Loadings
Infrastructure	0.295
Manpower	0.74
Utlisation	0.595

Input Measures:

Similar to the above analysis, the normalised values of the items under parameters Infrastructure, Manpower and Utilisation were summated to attain a score of the input dimension. The summated score of all 5 years for each indictor were taken. Then factor analysis was conducted on these three parameters to attain the weights **(Table – 6)**.

Table-7: State Ranking for Input Variables

States	Weighted Score	Rank
Uttar Pradesh	4732917.348	1
Bihar	2264611.500	2
Maharashtra	2117093.247	3
Andhra Pradesh	1851103.656	4
West Bengal	1623936.541	5
Madhya Pradesh	1568440.624	6
Rajasthan	1469035.452	7
Karnataka	1358895.708	8
Gujarat	1335106.476	9
Tamil Nadu	1233721.149	10
Orissa	896492.113	11
Jharkhand	719330.424	12
Assam	711057.677	13
Kerala	646282.026	14
Chhattisgarh	635797.714	15
Haryana	587470.179	16
Delhi	567263.076	17
Punjab	545670.040	18
Jammu & Kashmir	299311.718	19
Uttaranchal	235443.417	20
Himachal Pradesh	199774.039	21

In the second stage weighted values of each item within each indicator were added which resulted in a summated weighted scores all 5 years for each of the states. Based on the weighted score for the year 2012, states were arranged in descending order as a higher score would indicate a better position of the state (**Table – 7**).

Outcome :: Input Map:

The study found that that there is a low degree of association between the input and outcome. Hence, the two ranks could not be compared or combined. It was decided to consider them orthogonal. Using them as the two axes, an Outcome – Input matrix was created. Median of the dimensions was used to create the high and low quadrants (**Figure – 1**)[6].

Figure – 1: Outcome:: Input Matrix
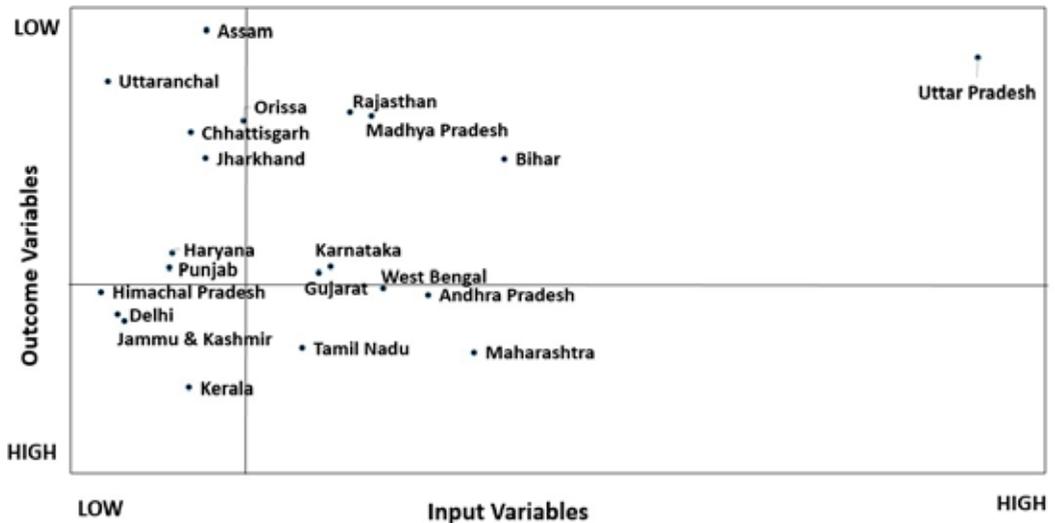
Since all ranking systems across the world use outcome measure for arriving at the scores, it was given higher importance as compared to the input measures. The states

[6]**Note:** (i) Outcome: Lower the better; Input : Higher the better
(ii) Outcome considered more important than input

were then ranked accordingly. The final ranking of the states based on the quadrant mapping can be seen in **Table – 8**.

Table – 8: Relative Position of States on Outcome – Input Matrix

State	Rank
Maharashtra	1
Tamil Nadu	2
Andhra Pradesh	3
West Bengal	4
Kerala	5
Jammu & Kashmir	6
Delhi	7
Himachal Pradesh	8
Gujarat	9
Karnataka	10
Punjab	11
Haryana	12
Bihar	13
Jharkhand	14
Madhya Pradesh	15
Orissa	16
Rajasthan	17
Uttar Pradesh	18
Chhattisgarh	19
Uttaranchal	20
Assam	21

7. Classification of States

The input::outcome matrix divided the states in 4 quadrants. It indicated that while resources are important, implementation of the initiatives to achieve the desired outcome is equally important. It also brings out that states and their policies need to be developed as suitable for the each of the states. It is expected that such segmentation would help in developing more focussed policies as well as fine tuning health policies for states and also at a level of cluster of states. The states could be divided into four classes:

High performers:

Maharashtra, Tamil Nadu and Kerala are high performing states. These states are performing well with respect to the inputs made available or created in the state. Kerala scores highest in outcome but falls to a lower rank due to resources.

Middling Performers:

Jammu and Kashmir, Delhi, Andhra Pradesh, West Bengal, Himachal Pradesh, Gujarat, Punjab, Haryana and Karnataka and lie in the low input and high outcome quadrant. Their performance falls in the middle range.

Strugglers:

Jharkhand, Bihar, Chhattisgarh, Orissa, Madhya Pradesh, Rajasthan, Uttar Pradesh, Uttaranchal and Assam are making efforts to come on the higher outcome performance. Of these states, Uttaranchal, Assam and Orissa are the poorest in terms of the resources available to them as well as lag behind in terms of come.

A time series based research was conducted to track the performance of the state on individual basis. Five year performance based on the outcome: input matrix can be seen in **Figure – 2.**

Figure – 2: Movement of States over 2009 – 13
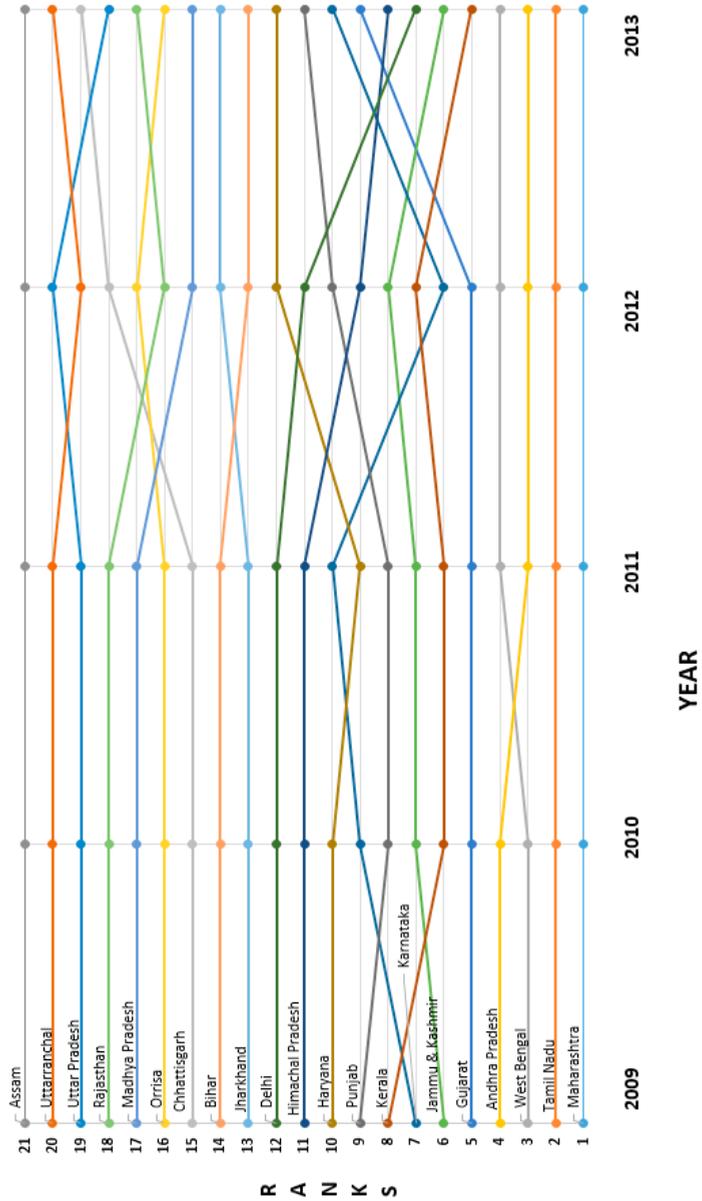
8. Conclusion

The study uses a unique outcome-input matrix that throws some valuable insights. Not only does it help in showing relative status of states, it also indicates as to which states are performing better with limited resources and which are not utilising the resources to the maximum level. There are some states which are performing low because the resources available to them are limited. Very few states are performing well. This study can be used by the government to analyse the current position of the states and identify focussed policies to be worked upon.

The current research has an enormous scope for further research in analysing the performance of the states. Since the data was not available for all the states; more updated and adequate data can be incorporated in further research. Some new variables can be included in the outcome and input parameters depending upon the availability of the data on the secondary sources.

9. Data Sources

1. Census of India (2009). *SRS Bulletin, Sample registration System*, Vol 44, No.1. Retrieved From: http://censusindia.gov.in

2. Census of India (2010). *SRS Bulletin, Sample registration System*, Vol 45, No.1. Retrieved From: http://www.censusindia.gov.in

3. Census of India (2011). *SRS Bulletin, Sample registration System*, Vol 46, No.1. Retrieved from: http://www.censusindia.gov.in

4. Census of India (2012). *SRS Bulletin, Sample registration System,* Vol 47, No.1. Retrieved From: http://www.censusindia.gov.in

5. Census of India (2013). *SRS Bulletin, Sample registration System*, Vol 48, No.2. Retrieved From:http://planningcommission.nic.in

6. Family Health Plan (2015). Retrieved from: https://www.fhpl.net

7. Indiastat.com (2016a). Retrieved from: http://www.indiastat.com

8. Indiastat.com (2016b). Retrieved from: http://www.indiastat.com

9. Indiastat.com (2016c). Retrieved from: http://www.indiastat.com

10. Indiastat.com (2016d). Retrieved from: http://www.indiastat.com

11. Indiastat.com (2016e). Retrieved from: http://www.indiastat.com

12. Indiastat.com (2016f). Retrieved from: http://www.indiastat.com

13. Indiastat.com (2016g). Retrieved from: http://www.indiastat.com

14. Indiastat.com (2016h). Retrieved from: http://www.indiastat.com