DEGREE AND PATTERN OF REGIONAL HETEROGENEITY IN CHILD HEALTH IN INDIA: A PRINCIPAL COMPONENT ANALYSIS APPROACH

By: Nadeem Ahmad
Research Scholar, Centre for International Trade and Development, School of International Studies, Jawaharlal Nehru University, New Delhi,
azmi2884@gmail.com.

We claim that every child, no matter to whom or where they are born, have equal right to survive. But this argument is never existed in reality in India. Despite the recent socio-economic improvement, child health status does not improve sufficiently and the fruits of these developments in the form of health have not reached equally to each and every section of the society. The overall aim of this paper is to contribute an understanding about the recent child health status, analyze the pattern and trends of improvement across the states in India. This paper attempts to review the heterogeneity of child health survival status across the states and over the period of time. It will apply Principle Component Analysis (PCA) model. The extracted data from all three rounds of NFHS are used. This paper answers the two important questions. First, what is the position of each state in case of child health status in each round of NFHS? Second, what is the relative trend of improvement of the each state during first round to third round of NFHS? Results of this analysis provided the evidence that not adequate improvement in child health status has found in last two decades. Furthermore, even little improving trends established, the fruits of this achievement were not distributed equally to all. In this analysis we are found that the only some states were experiencing the clear pattern of improvement in child health status over the time, while most others are worsening or stagnant.

Key Words: Rural Development, Socio-economic Status, Child Health Survival Index, Principal Component Analysis, NFHS.

INTRODUCTION

We have witnessed that over the last couple of decades; India has experienced economic growth, and to a large extent has been able to improve the standard of living. However, the development of social sectors has faced some bottlenecks (Dreze and Sen, 2013). There have been problems of poverty, poor health, inequality and the absence social of economic opportunities which have dragged the economy away from sustainable development (Todaro and Smith, 2011). Considering these social issues, it is observed that in the recent time period health is the priorities apart from other issues (Dreze and Sen, 2013; Fenske *et al*, 2013). A state on the path of growth trajectory cannot overlook the importance of the social sector. Health sector being a part of this social sector must be highlighted.

As developing country like India, it requires a large pool of capital as well as skilled human resources in form of better health. Good health is a basic requirement and essential for the survival and overall development of all human beings, and better child health are the key sources for the survival for all human beings (Som *et al*, 2007; Patra, 2008; Regina *et al*, 2010). In this regard, better child health is the only means to produce it.

Child health is a crucial merit good with high positive externalities, which is essential for progress of human capital and economic development of any particular country (Ettinger, 2004; Som *et al*, 2007). The adequate nutritional status of children in initial period from birth to three or five years of age is imperative for child's optimal growth of health, which is critical in developing countries like India (Mehrotra, 2006; Regina *et al*, 2010). In this period, children in India are predominantly vulnerable to growth beginning, malnutrition, common childhood illness and micronutrient deficiencies because of low dietary intake, lack of appropriate care and infectious diseases (IIPS, 2007; Patra, 2008; Arnold *et al*, 2009; Regina *et al*, 2010).

Despite the some recent improvement in child health and decline in the mortality rates among children, the fruits of these achievements of child health have not reached equally to each and every section of the society (IIPS, 2007; Arokiasamy, 2004; Kanjilal *et al*, 2010). This means that the status of child health is not identical in the whole country in India, but it varies with demographic and socioeconomic conditions across the states (Tiwari, 2013; Pathak and Singh, 2011; Joe *et al*, 2008; Arnold, 2009).

The best method to measure the child health status is the condition of child health care and child health outcomes. Thus, child health care in the form of immunization coverage, breastfeeding, nutritional foods, medical treatments, as well as child health outcomes like birth weight, nutritional status, prevalence of anemia and other diseases are used in this analysis that has a wider range of fluctuation across the socioeconomic indicators of the states in India (Pande and Yazbeck, 2003; Shin, 2007; Joe *et al*, 2008; Poel *et al*, 2008; Tiwari, 2013; Pathak and Singh, 2011). Hence, we need to look at pattern and trends of the child health in terms of child health care and child health outcome condition across the states of India and over the time.

In this consideration, regional inequality in child health care and child health outcomes are the most important obstruction for betterment of child health as a whole (Pande and Yazbeck, 2003; Onis *et al*, 2004; Mehrotra, 2006; Joe *et al*, 2008). Furthermore, regional heterogeneity in child health is very important issue as it contributes to the poor health status for all and it will be perpetuated across the generations (Hazarika, 2000;

Mishra, 2004). To study the degree and pattern of regional differences in child health across the state over the time is also important because its negative effects can come to appear in another dimension that adversely affects the human development after a long time (Basu, 1993; Li, 2004; Kishor and Gupta, 2009; Kabeer, 2010).

Moreover, it is the sustainable health care coverage as well as better health outcomes that are important for India today. Therefore, the area of health requires urgent study for three important reasons as mentioned: poor status of child health care and child health outcomes, inadequate improvement in child health outcomes, and inequality in health care and child health outcomes. Thus, we need to study the degree and pattern of regional differences in child health status further in detail and need to construct the composite child health index for each state. Hence, this paper will address some of these gaps in analysis of overall regional heterogeneity in child health- child health care and child health outcome indicators, across all the states of India as well as over the time.

Thus, here with the help of selected indicators, it is going to construct a health index for the children under the age of three years using principle component analysis model across all the states of India for all three round of NFHS. On the basis of this index, we are going to answer the two important questions. First, what is the rank and position of each state as compare to other state in the case of child health status in each round of NFHS? Second, what is the relative trend of improvement of the each state in the case of child health situation during the first round to third round of NFHS?

2. A Brief Review of Literature:

Data reveals that the extent of the child health problem is enormous in India. Approximately 50%, 20% and 43% of the children under age five are stunted, wasted and underweight, respectively. Anemia is a major problem among children in India; there are almost 70% children are anemic, which includes 26% are mildly, 40% are moderately, and 3% are severely anemic. In addition, under age of five years, 15%, 9% children reported to suffer from fever, diarrhea in last two weeks before the survey and only around half of them were taken to a health facility. Regarding the child health care, less than half of the children under the age of 23 months are fully vaccinated. Only 46% children under the age of 6 months are exclusively breastfed, and most of them are not continuously get breastfeeding till recommended age (NFHS-3 survey report IIPS, 2007).

Osmani and Sen (2003), Ettinger (2004), Som *et al* (2007) and Regina *et al* (2010) were discussed the significance of child health in order to produce healthy human capital which is essential for all kind of development of the society as a whole. For this purpose, they are mainly concerned with the interaction between the healths of children with the health of adults. With help of this analysis, they found that there are different pathways through which poor child health, particularly girl child, adversely affects the health of adults and hence adult's poor health (mothers particular) turn leads to long-term health risk for the society as a whole.

Mehrotra (2006) emphasized on the important of child health and point out the way through which child poor health status has long life implication that will span over generations. First, low birth weight has a higher risk of suffering from intra-uterine growth retardation and a variety of development deficit in the neonatal and later period. Second, infections and insufficient nutrients during infancy and early childhood tend to have a more severe illness in the form of fever, diarrhea, stunting, and underweight, and it might continue for a long time. In this regard, he concluded that a stunted child more likely to become a stunted adolescent and later a stunted adult.

Joe *et al* (2008) measured the state level inequalities in India in the case of child health condition. Furthermore, they also measure the relationship between health status and income inequality in Indian context. For this analysis they used NFHS third round data and measure of concentration indices. They found that in the case of child health, higher degree of inequality persisted across states of India. In this study, it is found that Punjab, Tamil Nadu, Gujarat, Madhya Pradesh, Maharashtra and other developed states experience greater health inequality within the states that underdeveloped states like Bihar, Utter Pradesh and Rajasthan. So, they also concluded that degree of health inequality increases when the average income of the population increases as well as when an income inequality increases.

Kanjilal *et al* (2010), by using NFHS data, measured the nutritional status of children that explained by the household socioeconomic condition. They argued that despite the limited improvement in child malnutrition status, it failed to secure among all children. It means that child nutritional status is varies according to socioeconomic condition. They found that there was a positive relation between poor socioeconomic status and malnutrition status among children. The empirical results of this analysis demonstrated that children from lowest socioeconomic quintile posses 50% poor nutritional status than those from the highest quintile.

Pande and Yazbeck (2003) measure the national average of healthcare status (immunization) of India, and further for better understanding of health disparities, disaggregate it across the socioeconomic status, gender, state and urban-rural level. As regional inequality, children from rural areas were less likely to immunize than urban child (20%), and gender discrimination against surviving girls in immunization (5%) are found in this study. In this consideration, they also argued that regional inequality as well as gender discrimination against girl children in child health care are the most

important obstruction for betterment of child health as a whole (Onis *et al*, 2004; Mehrotra, 2006; Joe *et al*, 2008).

Onis *et al* (2004) extracted the data of 139 countries from WHO database, and measure the level of malnutrition in terms of stunting and underweight among children across all these countries. They were found that the level of stunting and underweight has declines at a global level (from 34% and 27% to 27% and 22%, respectively), but at a higher range of variation across the countries. The level of malnutrition substantially declines only in Eastern and South-eastern Asia and Latin America, whereas, it is very high in South-central Asia. It is also found that the level of stunting and underweight among children were increases in Africa.

Tiwari (2013) focuses on different faces of gender in equality in terms of health and nutrition in India. NFHS-3 data and gender parity index and health development index methods were used in this study. He documented that girls are more probably to malnourished as compare to boys. In terms of body mass index of adults, higher level of gender gap is found in the states of West Bengal, Bihar, Maharashtra, Karnataka and Orissa, while there is no gender gap in Punjab, Kerala, Rajasthan and Utter Pradesh. Similarly, in the case of adult food consumption, child mortality, vaccination coverage and malnutrition; different degrees of gender deprivation are found in different states. It means that child health status as well as gender discrimination in health and nutrition differs with high range across the states of India.

Pathak and Singh (2011) measured the trend of inequality in malnutrition among children across the wealth, region and states of population in India. The extracted data from NFHS and concentration indices method were used in this paper. Result clearly indicated that the prevalence of malnutrition among children slightly declined from 1992 to 2006 (from 53% to 46%), but inequality across the wealth increases over the time and burden of malnutrition were much higher if child belong from low wealth status. The rate of decline in malnutrition among children from richest wealth (27%) was much higher than poorest (5%), and poor-rich ratio increased during this period (from 1.8 to 2.4). Despite of these, different states were experienced different rate of reduction. Thus, it provided the empirical based clear understanding about child malnutrition inequality across the wealth, states and over the time (Subramanayam *et al*, 2010).

Poel *et al* (2008) examined the level of association between socioeconomic status and level of inequality in child health (stunting and wasting). They found that stunting and wasting existed throughout all developing countries. They showed that these are highly concentrated among poor people in all developing countries, and trend of inequality is differing in each developing country over the socioeconomic status. They also found that socioeconomic inequality in stunting (-0.15) was much higher than in wasting (-0.04). This means that inequality in malnutrition is not only found across the socioeconomic status and states, but it also differs according to different indicators of malnutrition.

3. Data and Variables:

To articulate the given objectives the present study will use all three rounds of National Family Health Survey data (NHHS-1, 1992-93; NFHS-2, 1998-99; NFHS-3, 2005-06). The NFHS was designed to provide the estimates of important health indicators including nutritional status for young children and it also provide the information about other characteristics of respondents and household.[2] Children under the age of three years of all three rounds of NFHS have been used as unit of analysis, this is chosen because observation of children less than three years ages is available in all three rounds, and this is best age to study about child health.

To construct a composite child health index of states through PCA, 20 indicators of child health are taken (as original variables): 10 for child health care and 10 for child health outcomes. There are a large number of health-related indicators for a state. The selected indicators of child health care are: three vaccination coverage (BCG, DPT and Measles), currently breastfeeding, at least six months of breastfed, nutritional foods (powder, tinned or fresh milk), medical treatment-diarrhoea treatment, fever and cough treatment, prenatal care by the doctors and babies being delivered safely (delivered in the medical hospital). The selected indicators of the health outcomes are: baby size at birth-birthweight, morbidity- childhood diarrhoea, childhood fever and childhood cough, nutritional status- stunting (height-for-age, -2 SD), severely stunting (height-for-age, -3 SD), wasting (weight-for-height, -2 SD), severely wasting (weight-for-height, -3 SD), underweight (weight-for-age, -2 SD) and severely underweight (weight-for-age, -3 SD) among children. The estimated proportions of children of health care indicators and minus one proportion of children of health outcomes indicators are used as value of the original variables for the respective states (child health = child health care + (1 - child health outcomes)).

4. Methodology (Principle Component Analysis):

To measure the state level inequality in child health, we prefer to use Principle Component Analysis (PCA) method. Principal component analysis is a useful multivariate technique for transforming the large number of variables in a smaller number of 'dimensions', or uncorrelated components, where each component is a linear combination of the original variables (Vyas, 2006, 2010). The extracted components, which are uncorrelated, called principal components (PC) and these are estimated with the help of eigenvectors of the correlation or covariance matrix of the original variables.

For example, from a set of variables X_1 to Xp (p=20 in this analysis),

$$PC_1 = \theta_{11} X_1 + \theta_{12} X_2 + \theta_{13} X_3 + \ldots\ldots\ldots\ldots\ldots\ldots + \theta_{1p} X_p$$

$$PC_m = \theta_{m1} X_1 + \theta_{m2} X_2 + \theta_{m3} X_3 + \ldots\ldots\ldots\ldots\ldots\ldots + \theta_{mp} X_p$$

Where θ_{mp} is the weight for the m^{th} principal component and the p^{th} variable. The weight for each PC is given by eigenvector of the correlation matrix. The variance for each PC (l) is given by the Eigenvalue of the corresponding eigenvector. Moreover, the PCs are those linear and uncorrelated combinations whose variances are as large as possible. Thus, the first PC is the linear combination of maximum variance, and followed by the following, which is uncorrelated from previous ones (l_1 ³ l_2 ³ L ³ l_p ³ 0). Kaiser Criterion suggests retaining only those factors with Eigen values equal or higher than 1. So, PCA is helped to decrease dimensionality by extracting the smallest number components that explained most of the variation in the original multivariate variables and to summarize the data with little loss of information. After that as a first step in the computation of a single index, factor score coefficients also called component scores were required to estimate. As the importance of the components are not the same in measuring overall child health index. By using the proportion of these percentages as weights on the factor score coefficients, and then non-standardized index (NSI) calculated for each state. The value of this index can be positive or negative, which is making it difficult to explain. So, we can also calculate a standardized index (SI), the value of which is range from 0 to 1, by using the formula given below, which is child health index.

5. Results and Explanations:

5.1. The State of Child health:

As we discussed, child health is vital assets of the society, which has many effects that far reach into adult health (Ettinger, 2004). In the case of child health, not sufficient improvement has occurred over the past several years in India in such areas as reducing morbidity from many childhood infection diseases; improve the child nutritional status and increasing the practices of child health care. Consequently, the nutritional status of children remains almost stagnant at a lower rate in the form of higher level stunting, underweight and anemia, and sometimes it is increasing also (IIPS, 2007).[3]

5.2. Trends of child health in India:

To study the status and pattern of child health in India, Table 1 demonstrates the percentage of children under the age of three years (0-35 months), except fully vaccinated, with the different indicators of child health care and child health outcomes in all three rounds of NFHS. For fully vaccinated indicator, children from the age of 12 to 35 months are taken.[4] Vaccination is one of the most important and cost-effective child health cares to prevent many childhood illnesses and improve the child health. Table-1 shows that only less than half of the children (48%) aged 12-35 months are fully vaccinated in India in NFHS-3 (2005-06), and around 6% receive no vaccine at all. The fully vaccinated rate has improved inadequately from 37.5% (in NFHS-1) to 43% (in NFHS-2), and to 48% (in NFHS-3).

Sufficient amount of breastfeeding leads to improve child health through direct effect as improve the nutritional status as well as through a reduction in fertility rate among women. The percentage of breastfeeding remains stagnant almost at around 81% for currently breastfeeding and 78% for at least six months of breastfeeding in all three rounds of NFHS. Types of supplementary food commence in the diet of children also have important effects on the child health. Out of all supplementary foods, powder or fresh milk provide to children is most important nutritional food. The provision of this nutritional food to children was slightly increased over the time. There are around 30%, 56% and 67% children received nutritional foods in NFHS-1, NFHS-2 and NFHS-3, respectively.

Table 1: Trend of Child health Status in India at Various Rounds of NFHS (in %)

Variables	NFHS-1	NFHS-2	NFHS-3
Fully Vaccinated	37.55	43.09	48.54
Currently breastfeeding	82.90	83.76	81.53
Six-month breastfeeding	78.13	77.94	78.93
Nutritional foods	30.76	56.43	67.77
Diarrhea treatment	62.05	63.47	63.88
Fever/cough treatment	66.04	60.08	67.45
Prenatal care	42.20	49.98	49.52
Medical delivery	24.40	29.49	35.64
Birth weight	21.05	23.82	22.10
Morbidity	32.31	49.54	31.68
Stunting	47.22	45.04	38.49
Wasting	19.31	15.75	19.13
Underweight	52.54	46.89	46.07
Anemia	NA	74.00	79.15

Source: values in Percentage calculated by author from all three rounds of NFHS.

Birth at home is more common in India, especially for those women who have no education, no income, old age, and more numbers of children. It is expected that birth in a medical hospital (private and government) provide comparatively more delivery cares than birth in other public health center and in home. Regarding the pregnancy care, successive rounds of NFHS indicates the insignificant increasing trend of percentage of birth in the medical hospital over the time. There are around 24% births were delivered in medical hospital in NFHS-1,

whereas, it goes up to only 36% in the third round of NFHS. Similarly, postnatal care by the doctor increases only from 42% in NFHS-1 to 49% in NFHS-3.

Prevalence of diarrhea, fever and cough are the leading cause of morbidity among children under the age three years in India. Table 1 shows the percentage of morbidity among the children under the age of three years with diarrhea, fever or cough. Overall, 32% of children had either form of diseases in the last two weeks preceding the survey in the NFHS-1. With the negligible rate of reduction, the morbidity rates were reached to 31% in the NFHS-3. Treatment practices, particularly with medical services among ill children for the most prevalent childhood diseases, are most important to curb the chance of morbidity. The medical treatment for the diarrhea and fever/cough treatment were increased only to some extent from 62% and 66% in NFHS-1 to 64% and 67% in NFHS-3, respectively.

Because of low and inadequate dietary intakes, lack of appropriate care and childhood infection diseases, children are vulnerable to the malnutrition in India. Estimated trends with the help of successive rounds of NFHS demonstrates the deficient declining trends in the prevalence of nutritional deficiency (malnutrition) among children in the form of stunting and underweight, while it was increasing in the form of anemia. Stunting and underweight among children was around 47% and 52%, respectively, in first round of NFHS, and it deficiently declined over the time and reached to around 38% and 46% in third round of NFHS. Whereas, the prevalence of wasting is remain stagnant at around 19% between this period. But for the case of iron deficiency, prevalence any form of anemia among children were increased from 74% in the second round of NFHS to 79% in the third round of NFHS.

5.3. Degree of Regional Heterogeneity in child health:

In spite of recent economic development, the fruit of progress has failed to improve the nutritional status of all the children in India. Moreover, even with the some improvements in child health care and child health outcomes, the fruits of this achievement were not reached equally to each and every section of the society and regions. Hence, India is a country that is witnessing the higher degree of inequality in the indicators of child health status across all the states of India. So, this section mainly focuses on to provide the overview of the child health inequality in terms child health care and child health outcomes across all the states of India.

Table 2: State-wise Child Health Care Status, third round of NFHS (values in percentage)

States	Fully Vaccinated	Breast-feeding	Nutritional Foods	Medical Treatment	Medical Care
Jammu and Kashmir	74.2	80.0	60.3	81.6	84.1
Himachal Pradesh	79.9	78.2	58.1	82.0	71.0
Punjab	64.1	73.1	49.7	85.5	62.6
Uttaranchal	64.0	80.1	51.3	83.6	51.0
Haryana	67.4	76.6	38.3	85.6	61.9
Delhi	71.4	70.7	58.6	94.2	73.2
Rajasthan	29.1	82.2	45.6	78.3	33.6
Utter Pradesh	26.5	83.2	40.5	78.1	33.8
Bihar	34.4	86.0	56.6	73.2	91.4
Sikkim	79.0	86.3	58.9	60.5	69.9
Arunachal Pradesh	24.7	91.3	28.1	53.6	82.8
Nagaland	21.2	72.4	44.6	31.3	88.4
Manipur	52.3	87.2	47.7	57.5	91.7
Mizoram	56.3	71.9	56.8	57.3	40.3
Tripura	58.7	88.0	30.4	81.2	95.1
Meghalaya	43.2	77.6	53.7	80.0	76.8
Assam	33.1	91.1	45.5	39.4	62.6
West Bengal	65.4	91.1	30.3	77.8	54.5
Jharkhand	35.0	87.5	29.6	66.0	62.5
Orissa	57.8	90.6	45.4	81.2	52.7
Chhattisgarh	50.7	93.2	33.6	78.4	53.7
Madhya Pradesh	47.5	83.8	42.0	80.4	41.3
Gujarat	53.9	76.9	56.7	84.4	58.1
Maharashtra	72.4	78.3	35.8	91.4	71.5
Andhra Pradesh	50.0	75.9	24.0	89.6	87.7
Karnataka	62.6	71.9	48.0	84.8	77.9
Goa	86.7	62.9	78.5	89.7	100.0
Kerala	80.7	75.1	78.4	88.9	100.0
Tamil Nadu	91.0	57.1	58.2	77.9	96.4
India	48.5	81.5	43.7	78.7	52.1

Source: values in percentage calculated by author from third round of NFHS.

Overall, table 2 reveals a differential scenario of the indicators of child health care practices among the children under the age of three years across all the states of India in third round of NFHS (NFHS-3, 2005-06). To explain further, the states of Goa (86%) and Kerala (80%) have showed the highest numbers of children were fully vaccinated. While, Nagaland and Andhra Pradesh were the states with the lowest rate of full immunization coverage that is around 21% and 24%, respectively. The practice of breastfeeding was highest in Assam (91%), West Bengal (91%), Orissa (90%) and other underdeveloped states, and it was lowest in Goa (62%), Delhi (70%) and Kerala (75%).

In the case of the introduction of nutritional foods into the diet of children, Kerala (78%), Goa (78%), Jammu and Kashmir (60%) and Delhi (58%) showed the significant higher percentage values. Whereas, the opposite side, only 24%, 28% and 29% children received nutritional foods in Andhra Pradesh, Arunachal Pradesh and Jharkhand, respectively.

The next categories of child health care are medical care (if child get either of cares; prenatal, antenatal or postnatal care) and medical treatment (if child get medical treatment for diarrhea, fever or cough when they needed). Like other indicators, India exhibits a higher degree of variation in the provision of medical care and medical treatment across the states. Table 2 demonstrated that Delhi (94%) and Goa (89%) was rank at the top highest states, and Nagaland (31%) and Assam (39%) at the top lowest in the case of the provision of medical treatment. Whereas, in the case of the provision of medical care, Kerala (100%) and Goa (100%) were at the top highest and Rajasthan (34%) and Utter Pradesh (34%) were at the top lowest.

Similarly, table 3 reveals a state differential scenario of the percentage of the indicators of child health outcomes among the children under the age of three years in India in NFHS-3. Regarding the child health outcomes, low birth weight, morbidity, nutritional deficiency (malnutrition) and iron deficiency (anemia) are universal in India, but extent of these differ greatly by the states.

A higher percentage of children with low birth weight were in the state of Jammu and Kashmir (36%) and Tripura (36%), and the lowest percentage in Andhra Pradesh (8%) and Delhi (10%). Moreover, percentage of morbidity among children less than three years age is higher in Tripura (46%), Sikkim (43%) and west Bengal (42%), while, lowest in Meghalaya (14%) and Tamil Nadu (20%).

Inadequate nutrition and anemia among children are immense problems in India, but the situation is comparatively better in some states as compared to other states. Table-3 shows that stunting is more pronounced in Utter Pradesh (46%), Chhattisgarh (45%), and Gujarat and Bihar (42%), whereas, it least in Goa (21%), Kerala (21%) and Manipur (24%). Underweight is also significantly higher in Madhya Pradesh (60%), Jharkhand (59%) and Bihar (58%) as compared to Mizoram (21%), Sikkim (22%) and Manipur (24%). In addition, iron deficiency (anemia) is a most serious problem throughout India (79%), but it also considerably varies from state to state. Estimated percentage values demonstrated that percentage of anemic children is higher in the state of Bihar (87%) and Utter Pradesh (85%), while, it lowest in Goa (49%) and Kerala (56%), with the 79% in India.

Table 3: State-wise Child Health Outcomes, third round of NFHS (values in percentage)

States	Birth Weight	Morbidity	Stunting	Wasting	Under-weight	Anemia
Jammu and Kashmir	36.1	33.6	27.5	15.5	29.7	68.2
Himachal Pradesh	23.9	22.8	26.7	18.8	36.3	62.4
Punjab	32.1	30.8	28.1	9.0	27.0	80.1
Uttaranchal	21.5	30.6	32.2	16.1	38.4	69.7
Haryana	18.1	24.9	35.9	16.8	42.4	82.5
Delhi	10.9	26.2	35.6	15.6	33.1	63.2
Rajasthan	27.8	30.7	33.8	19.7	44.2	80.0
Utter Pradesh	22.3	31.3	46.2	13.5	47.5	85.1
Bihar	21.4	33.3	42.5	27.7	58.4	87.4
Sikkim	12.6	43.2	29.0	13.1	22.6	63.9
Arunachal Pradesh	29.1	41.9	34.5	16.4	37.2	68.1
Nagaland	14.6	22.2	30.1	14.7	29.7	NA
Manipur	17.9	29.6	24.7	8.4	24.0	52.8
Mizoram	12.8	34.6	30.0	9.3	21.9	54.1
Tripura	36.1	46.5	30.1	19.9	39.0	67.9
Meghalaya	27.0	14.3	42.1	28.5	46.6	72.1
Assam	20.4	29.8	35.0	13.1	40.6	77.2

West Bengal	25.6	42.4	33.1	19.0	43.7	69.3
Jharkhand	23.8	39.9	41.6	31.1	59.4	77.9
Orissa	27.0	38.1	38.3	18.4	44.2	74.2
Chhattisgarh	15.6	30.5	45.5	17.9	52.3	81.1
Madhya Pradesh	24.2	34.6	39.9	33.4	60.5	82.6
Gujarat	20.4	40.7	42.6	17.0	47.4	79.9
Maharashtra	18.0	25.4	38.1	14.6	39.9	71.9
Andhra Pradesh	7.7	22.6	33.9	12.7	36.4	79.9
Karnataka	24.7	27.7	38.0	17.9	41.2	84.0
Goa	21.6	33.1	21.4	12.2	29.4	49.2
Kerala	12.7	33.7	21.4	16.1	28.9	56.2
Tamil Nadu	30.5	20.6	25.1	21.7	33.6	72.8
India	22.1	31.7	38.5	19.1	46.1	79.2

Source: calculated percentage values by author from third round of NFHS.

Table 1, 2 and 3, jointly, clearly confirmed that despite the improvement in child health in India during last fifteen years from first round to third round of NFHS, the fruits of this achievement were not equally reached to the each and every section of the society. Table 2 and 3 proved that the status of child health was not the same throughout India, but it greatly differs across the states. Furthermore, the important point is here; one state is not at the rank of highest in all the indicators of child health. It means that one state is comparatively better off in the case of one or some indicators, but the same state is worse off in the case of other indicators of child health. Hence, one cannot argue that this particular state is comparatively at an advantage in case of child health. So, to answer and solve this problem, Principle Component Analysis (PCA) model have been used in this study to construct the health index for each state and give the rank according to it.

5.4. Patter of Regional Heterogeneity in child health (Interpretation of Results from the PCA):

Let start with the constructing the health index using third round of NFHS (NFHS-3, 2005-06) data with the indicator of child health care practices and child health outcomes of children under the age of three years. A popular multivariate technique (factor analysis) is going to be used to reduce the dimensionality of p multi-attributes (20 in this case) to the limited number of dimensions. Factor analysis leads to summarize the variation in original correlated factors to a set of components, which are uncorrelated and linearly related to original variables. The extracted components are called principal components (PC).

Table 4: Factor analysis or correlation method: principle component factors, NFHS-3

Factors	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
Factor 1	7.406	3.373	0.370	0.370
Factor 2	4.033	1.348	0.202	0.572
Factor 3	2.686	1.190	0.134	0.706
Factor 4	1.496	0.053	0.075	0.781
Factor 5	1.442	0.578	0.072	0.853
Factor 6	0.864	0.305	0.043	0.896
Factor 7	0.559	0.171	0.028	0.924
Factor 8	0.387	0.059	0.019	0.944
Factor 9	0.328	0.064	0.016	0.960
Factor 10	0.264	0.073	0.013	0.973
Factor 11	0.190	0.058	0.010	0.983
Factor 12	0.132	0.031	0.007	0.989
Factor 13	0.101	0.040	0.005	0.994
Factor 14	0.061	0.036	0.003	0.998
Factor 15	0.025	0.013	0.001	0.999
Factor 16	0.012	0.003	0.001	0.999
Factor 17	0.010	0.008	0.001	1.000
Factor 18	0.002	0.001	0.000	1.000
Factor 19	0.001	0.001	0.000	1.000
Factor 20	0.000	.	0.000	1.000
LR test: independent vs. saturated: chi2(190) = 724.92 Prob>chi2 = 0.0000				

Source: calculated values by author.

The number of factors can be used that is decided by Kaiser Criterion or Eigenvalue rule technique. This technique recommended to retain those factors with have Eigenvalue equal to or higher than 1. The result of factor analysis was producing the principle component factors

that are presented in table 4. In this table it is cleared that factors 1, 2, 3, 4 and 5 have Eigenvalues greater than one and they together explained more than 85% (85.32%) of variation in data. Hence, they (only first five factors) are must be retained.

Here we need to rotate the factor loads to get a clear pattern about the each variable with factors (given in Table 5). This rotation produces orthogonal factors, which is recommended when we identify variables to create indices or new variables without inter-correlated components. Estimated factor loadings are the weights and correlations between each variable with the factors. The higher the load of the factors is the more relevant in defining the factor's dimensionality. A negative value indicates an inverse impact on the factors. Variables that are highly correlated with a factor are thus clubbed under it. This reduces the dimensionality of the original vector of random variables. Uniqueness is the variance that is 'unique' to the variable and not shared with other variables. It is equal to 1 for commonality (variance that is shared with other variables).

Table 5: Results of PCA: rotated factor loadings (pattern matrix) and unique variance, NFHS-3.

Variables	Factor1	Factor2	Factor3	Factor4	Factor5	Uniqueness
BCG	**0.916**	0.276	-0.024	-0.063	0.028	0.080
DPT3	**0.885**	0.344	-0.086	0.075	0.057	0.083
Measles	**0.933**	0.282	0.017	-0.016	-0.059	0.046
Currently Breastfeeding	-0.525	-0.295	**-0.527**	-0.273	-0.007	0.285
6 month Breastfeeding	-0.223	-0.018	-0.103	-0.084	**0.870**	0.176
Nutritional Foods	**0.534**	0.237	0.147	0.400	0.390	0.326
Diarrhea Treatment	**0.772**	-0.370	-0.031	0.124	-0.440	0.057
Fever/ Cough Treatment	**0.902**	-0.129	0.026	-0.066	-0.289	0.081
Prenatal Care	**0.589**	0.533	-0.171	0.315	0.159	0.215
Medical Delivery	**0.795**	0.119	0.159	0.037	0.190	0.292
Stunting	0.191	**0.861**	-0.227	0.295	0.086	0.076
Severe Stunting	0.245	**0.845**	-0.278	0.172	0.123	0.105
Wasting	0.025	**0.855**	0.169	-0.395	-0.120	0.070
Severe Wasting	0.116	**0.624**	-0.190	**-0.636**	0.066	0.153
Underweight	0.083	**0.945**	0.076	0.109	-0.006	0.083
Severe Underweight	0.145	**0.965**	0.063	-0.112	0.093	0.023
Birth Weight	0.069	0.202	**0.657**	-0.074	**0.559**	0.206
Diarrhea	0.039	0.166	0.234	**0.786**	-0.158	0.273
Fever	-0.088	-0.149	**0.883**	0.017	-0.217	0.143
Cough	0.027	-0.121	**0.873**	0.230	0.073	0.164
Percentage of variation (85.3%)	*28.2%*	*26.9%*	*13.0%*	*8.7%*	*8.4%*	

Looking at the rotated factor loadings (Table 5), the first five factors accounted for 28.2%, 26.9%, 13.0%, 8.7% and 8.4% of the variance and explain the variation in different respective indicators. However, here we can see that the variables regarding vaccination coverage against tuberculosis (BCG), diphtheria (DPT3) and measles (measles), medical treatment for diarrhoea, medical treatment for fever and cough, prenatal care, birth delivery under the medical facilities and nutritional foods define factor 1 (28.2%); the variables related to nutritional status like stunting, severe stunting, wasting, severe wasting, underweight and severe underweight among the children define factor 2 (26.9%); variable currently breastfeeding and morbidity in terms of fever and cough, and birth weight defines factor 3 (13.0%), variable morbidity in the form of diarrhoea, and severe underweight define factor 4 (8.7%); and variables at least six months of breastfeeding and babies weight at time of

birth define factor 5(8.4%). Observing high positive (or negative) loadings associated to specific variables means that these variables contribute positively (or negatively) to this component; hence, states scoring high on these variables will tend to have higher (or lower) factor scores on this particular dimension. Thus, indicators are dimensionality reduces.

5.6. Calculating the Child health Index:

As a first step in the calculation of a single child health index, factor score coefficients, which often called component scores were estimated using principle component analysis. The individual factor scores are obtained. The five factors explained 86.3 % of the total variation, with the first five factors, explaining 28.2%, 26.9%, 13.0%, 8.7% and 8.4%, respectively. For that reason, the significance of the each factor in calculating overall child health is not the same (Vijaya, 2010). Thus, the proportions of these percentage values are used as the weights, instead of equal weight, on the coefficient values of each factor and, hence, generate a non-standardized Index (NSI) of the child health for each state, by using the formula:

Moreover, a similar procedure of this method is also applied for the other two rounds of the NFHS (NFHS-2 and NFHS-1) with same indicators of child health. The state-wise calculated health index (NSI) using principle component analysis and ranked according it for the all three rounds of NFHS is presented in Table 6. These indexes measure the child health status of one state relative to the other state on a linear scale for the particular round of NFHS. Furthermore, the index values of the same state at different rounds of NFHS measure the trend of child health status for that particular state over the time.

The estimated value of this index, which is non-standardized (NSI), can be positive or negative (as presented in Table 5), this is making it difficult to interpret and compare. Therefore, to solve this complication, a Standardized Index (SI) was generated, the value of which can range from 0 to 1, which is called composite child health index.

The results of the state-wise standardized index for all three rounds are given in Figure 1. The higher the value of the index (in case of NSI, Table-6) or closer to 1 (in case of SI, Figure 1) indicates that the comparatively better child health status of a state.

As it is discussed earlier the distribution of child health status in terms of child health care and child health outcomes do not be uniform throughout the India. In addition, with the great variation in each indicator of child health, one cannot argue that this particular state is relatively better than others in the case of child health. But, the calculated composite index within the PCA framework provides a better picture to compare the each state and rank according to it.

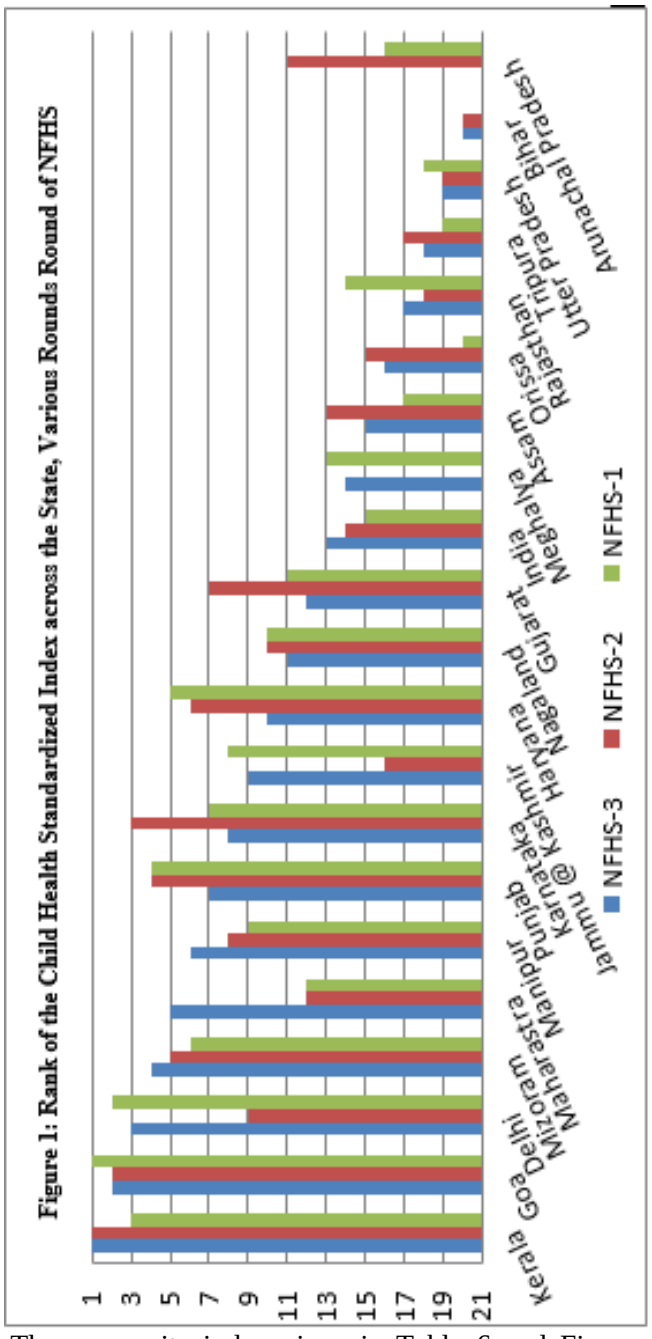
Table 6: State-wise Child health Index and Rank, Various NFHS Rounds

States#	NFHS-3		NFHS-2		NFHS-1	
	Index	Rank	Index	Rank	Index	Rank
Kerala	1.014	1	0.904	1	0.547	3
Goa	0.960	2	0.778	2	0.961	1
Delhi	0.510	3	0.153	9	0.637	2
Mizoram	0.471	4	0.428	5	0.324	6
Maharashtra	0.313	5	0.050	12	0.019	12
Manipur	0.312	6	0.212	8	0.121	9
Punjab	0.276	7	0.512	4	0.460	4
Karnataka	0.195	8	0.526	3	0.140	7
Jammu and Kashmir	0.189	9	-0.247	16	0.135	8
Haryana	0.110	10	0.264	6	0.351	5
Nagaland	-0.045	11	0.123	10	0.081	10
Gujarat	-0.093	12	0.249	7	0.047	11
India	-0.238	13	-0.180	14	-0.225	15
Meghalaya	-0.300	14	-0.814	21	-0.116	13
Assam	-0.328	15	-0.105	13	-0.506	17
Orissa	-0.359	16	-0.233	15	-0.802	20
Rajasthan	-0.454	17	-0.666	18	-0.220	14
Tripura	-0.474	18	-0.480	17	-0.562	19
Utter Pradesh	-0.623	19	-0.743	19	-0.538	18

Bihar	-0.657	20	-0.797	20	-0.889	21
Arunachal Pradesh	-0.780	21	0.063	11	-0.503	16
# States are ordered according to NFHS-3, and States are not presented here whose estimated values are missed in any of three rounds of NFHS.						

Source: calculated values by author.

Figure 1: Rank of the Child Health Standardized Index across the State, Various Rounds Round of NFHS



The composite index given in Table 6 and Figure 1 clearly indicates that Kerala has the highest rank (first rank) while Arunachal Pradesh has the poorest rank in the child health status in the third round of NFHS. Whereas, India, as whole, has appears at the thirteenth rank in this round. Goa, Delhi, Mizoram and Maharashtra stands with the second, third fourth and fifth rank, respectively, while Arunachal Pradesh, Bihar, Utter Pradesh Tripura and Rajasthan comes under the last five poorest states in terms of child health in NFHS-3.

Kerala and Goa have first rank in the second round and the first round of NFHS, while Meghalaya and Bihar have the lowest rank of child health in second and first rounds of NFHS. Whereas, Goa and Delhi have the second rank in NFHS-2 and NFHS-1, respectively, and India has the fourteenth rank in NFHS-2 and fifteenth in NFHS-1. After Goa and Kerala; Delhi, Punjab, Haryana and Mizoram has comparatively better child health status, while after Bihar; Orissa, utter Pradesh, Rajasthan and Arunachal Pradesh has comparatively poor child health status in first and second rounds of NFHS. So, here we can conclude that Kerala, Goa, and Delhi have the highest, whereas Bihar, Utter Pradesh and Tripura has lowest child health status in around all three rounds of NFHS.

To study the trend, above table and figure pointed out that India witnessing a continuous, but not enough, improvement in child health status over the time (from 15th rank in 1st round to 14th and 13th rank in 2nd and 3rd round). Along with India, Kerala Mizoram, Manipur and Maharashtra are only the states that are witnessing the improvement in the child health status from the first round to third round of NFHS. Whereas, Haryana, Nagaland, Meghalaya, Rajasthan, and Utter Pradesh witnessing a clear declining trend in the case of child health status over the time. Additionally, Assam, Orissa, Tripura and Bihar has a little improvement, while Goa, Delhi, Jammu and Kashmir and Gujarat has little disgrace from the first round to third round of NFHS.

The estimated results of regional heterogeneity in case of child health status are also clearly visible in the given map (in Appendix), which shows the state-wise child health status in all three rounds of NFHS. In these maps, all the states are categorized in three categories, higher level, middle level and poor level of child health status, which are shown by green color, blue color and red color, respectively. States that are colored grey do not have data available. These are categorized on the basis of the estimated values of standardized index, which lies between 0 to 1: 0 to 0.4 for low level, 0.41 to 0.75 for middle level and 0.75 to 1 for higher level of child health.

Bihar, Utter Pradesh, Rajasthan, Arunachal Pradesh, Assam, Orissa and Tripura have poor child health status in all three rounds of NFHS (with red color in Map-1). Similarly, Kerala and Goa in all three rounds of NFHS, and Kerala, Goa, Tamil Nadu and Andhra Pradesh in second and third round of NFHS display the comparatively higher level of child health status. Whereas, Jammu and Kashmir, Haryana, Manipur, Mizoram, Gujarat, Maharashtra and Karnataka come under the category of middle level of child health in all three rounds of NFHS. State-wise trends of child health

also clearly understand from this map that changes the color of states over the time, as explained above.

6. Conclusion:

So, here it is evident that the regional heterogeneity exists in selected indicators of child health care and child health outcomes across all the states of India. The degrees and trends of regional heterogeneity for the particular indicator change over the time and across the states. Moreover, some of the states like, Kerala, Goa and Delhi are the witness of clear improving trend of child health status from first round to third round of NFHS. On the other hand, many states like Bihar, Utter Pradesh, Assam, and Arunanchal Pradesh at a lowest level, some time with declining trend of child health.

Regarding the regional heterogeneity, three important conclusions come out from the analysis of this section: first, the problem of child health in the form of poor child health care and child health outcomes persisted in India, but at varying rate across all the states of India. Second, each state has different degrees of regional heterogeneity in different indicators, it means that regarding the child health, some states have good condition in case of some indicators, but it have bad condition in case of other indicators. Third, only in some of the states witnessing a sustained improvement in child health status over the time, it means that child health status does improved in India as whole, but it is still unfortunate and at lower rank particularly in those states whose are comes under the socially and economically backward states.

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Appendix:

Map-1: State-wise Child health Status at Various Rounds of NFHS

[2] For the full information about data, please see the IIPS, 2007 Survey report.

[3] See at International Institute for Population Sciences (2007), National Family Health Survey (NFHS-3), 2005-06 (Vol. 1).

[4] According to Government of India and WHO guidelines a child considered as fully immunized if they have received one BCG dose, three DPT doses and one measles dose at the end of their first year of birth (Pande and Yazbeck, 2003; Pande, 2003; Jatrana, 2003; Mishra and et al, 2004; IIPS, 2007).