Geospatial Inequality in Reproductive, Maternal, Neonatal and Child Health (RMNCH) Coverage in Districts of India

Despite the continued global effort on improving maternal and child health in Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs), the progress on reduction of maternal and child mortality remained uneven among and within countries. For instance, out of 75 countries included in countdown study, 50 countries failed to achieve the millennium development goal (MDG) 4 and 69 countries failed to achieve MDG 5. Globally 0.3 million mothers die during childbirth, or pregnancy-related complexities and 2.6 million neonatal deaths occurred in 2015, and almost all of maternal and neonatal the takes place in developing countries. Irrespective of other concerned factors high impact intervention and strengthening health system remains a prime component to reduce maternal and child mortality. Moreover, in disadvantaged population subgroups; that is, the poorest, the least educated and those residing in rural areas had lower health care access and coverage and worse health outcomes than their counterparts in developed World.

In India RMNCH as a flagship programme under National Health Mission (NHM) is a strategic roadmap for improving child survival and maternal health. In the last decade, India has made a substantial improvement in reducing maternal and neonatal mortality. The maternal mortality ratio (MMR) has declined from 254 (per 100000 live births) in 2004-06 to 130 in 2014-16, and the neonatal mortality has declined from 39 (per 1000 live births) to 29 during the same period. India's progress in many sectors, it failed to fulfill the millennium development targets on maternal and child mortality. India ranked 143 among 188 countries in the SDG progress indicators, and considerable heterogeneity remains at the regional level.

In this concern, the rationale of the study is systemized for the two reasons. The aim of the study is of two-fold. First, the study tries to find the variation in coverage gap for a key set of interventions of maternal and child health services through the Coverage Gap Index (CGI) at states and districts of India. Using spatial analysis, it explores the spatial implications of maternal and child health coverage at the sub-national level and facilitates the identification of hotspots (Districts with higher CGI gap). Secondly, the study finds the inequality in the coverage of these indicators among the wealth quintile and the place of residence, which is again an important concern to reduce the inequality within the sub-regional level.

Data

We used data from the National Family Health Survey (NFHS-4) most recent large-scale multistage survey conducted in India in 2015-16. The survey provides the comprehensive estimates on the national and regional level. First time NFHS-4 has provided district-level estimates for many health-related indicators. It contains large data on a range of interventions across the continuum of care, reproductive and sexual health, HIV/AIDS, nutrition, domestic violence, and the fertility and family planning. It also includes information on household assets, sanitation, and hygiene, drinking water and electricity. The study uses the multistage stratified random sampling method to select the household and proper methods to find the women in the household. A total of 6, 01,509 household, 6, 99,686 number of women and 1, 12,122 number of men, were interviewed in the survey. Information on 2, 57,000 number of children were

collected from their mother who is born in the last five years. Details about the sample size, design and sample weights were provided in the final report of NFHS-4.

Methodology

Coverage gap index: context, dimensions, and indicators

The outcome variable of this study is Coverage Gap Index (CGI) which is the difference of Composite Coverage Index (CCI) from 100. The composite coverage index (CCI) was first proposed in 2008 as the weighted average coverage of eight preventive and curative interventions received along the continuum of maternal and child care. The index is calculated at the group level, either for a whole country or by subgroups such as wealth quintiles or geographical regions. The whole selected indicators are categorized into four groups: first- reproductive services (family planning coverage) (FP), second- maternal and newborn care (antenatal care and skilled birth attendant), third- immunisation (BCG; three doses of diphtheria, pertussis, and tetanus [DPT3]; and measles vaccines (MSL) and forth- management of illness (oral rehydration therapy and care seeking for pneumonia). All the four domains are equally weighted, and within each domain, all indicators have the same weight, except for DPT3, which has a higher weight because three doses are needed.

Based on these indicators explained above the CGI is calculated at the district level and presented in **S1 Table**. The formula for finding the CGI are given below.

$$CGI = 100 - \left(\frac{1}{4}\left(FP + \frac{ORT + ARI}{2} + \frac{SBA + ANC}{2} + \frac{MSL + 2DPT3 + BCG}{4}\right)\right)$$

Spatial Analysis

Spatial distribution map was used to understand the spatial pattern of the CGI in the districts of India. It gives a bird's eye view of spatial inequality in maternal and child health coverage at the sub-regional level (states and districts). Global Moran I statistic is used to understand whether there is a spatial autocorrelation are pervasive among the regional distribution. Local indicator of spatial association (LISA) measure of local Moran's I, which is used to identify the presence or absence of significant spatial clusters or outliers for each geographical unit in a dataset. We used the GeoDa 1.12.1.59 software package for this analysis with 999 permutations and a pseudo-p-value for cluster of <0.05 specified.

Inequality

In order to understand the disparity between various wealth group and by the place of residence, the study uses absolute as well as a relative measure of inequality. For wealth-related inequality, the difference between the fifth (Q5) and first wealth quintile (Q1) was calculated. The ratio between both fifth and first quintile was calculated to understand the relative inequality. Similarly, for the place of residence, the differential in the rural and urban area and rural-urban disparity ratio was calculated.

Results

Figure 1 presents the coverage gap index for India and its states. The CGI in India found to be 25 percent. Among the states, the lower CGI is found for Kerala followed by Punjab and Tamil Nadu. Similarly, higher CGI is found for the Nagaland followed by Arunachal Pradesh and Bihar. Among the high focussed sates (EAG states) Odisha have the lowest CGI followed by Chhattisgarh whereas Bihar has the highest CGI followed by Uttar Pradesh.

Figure 1. Coverage Gap Index (CGI) of India and its states in 2015-16.

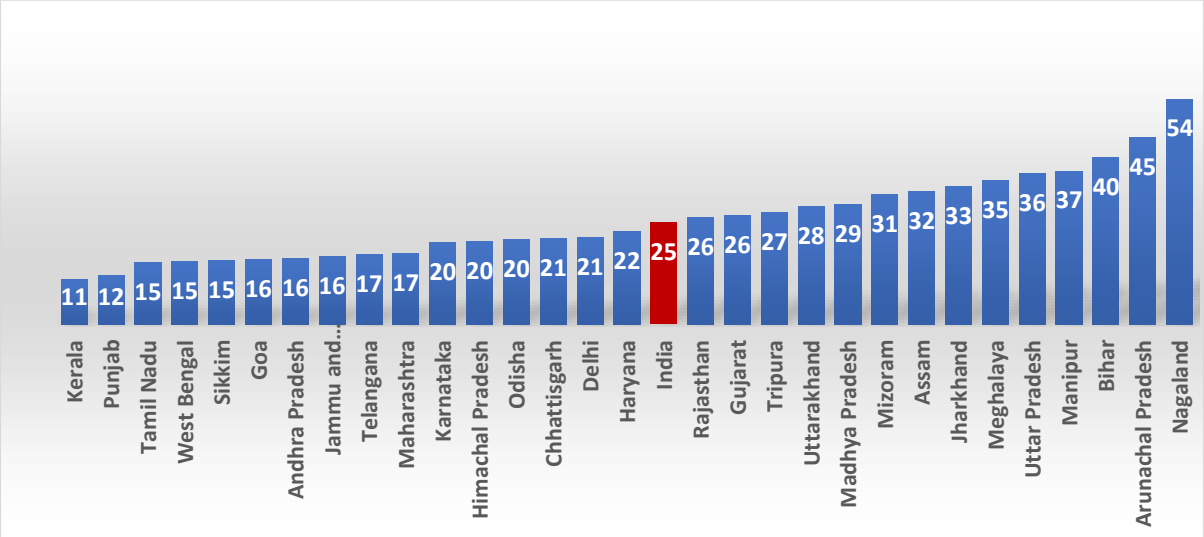


Figure 2. A. Coverage Gap Index (CGI) and B. Level of development in districts of India 2015-16

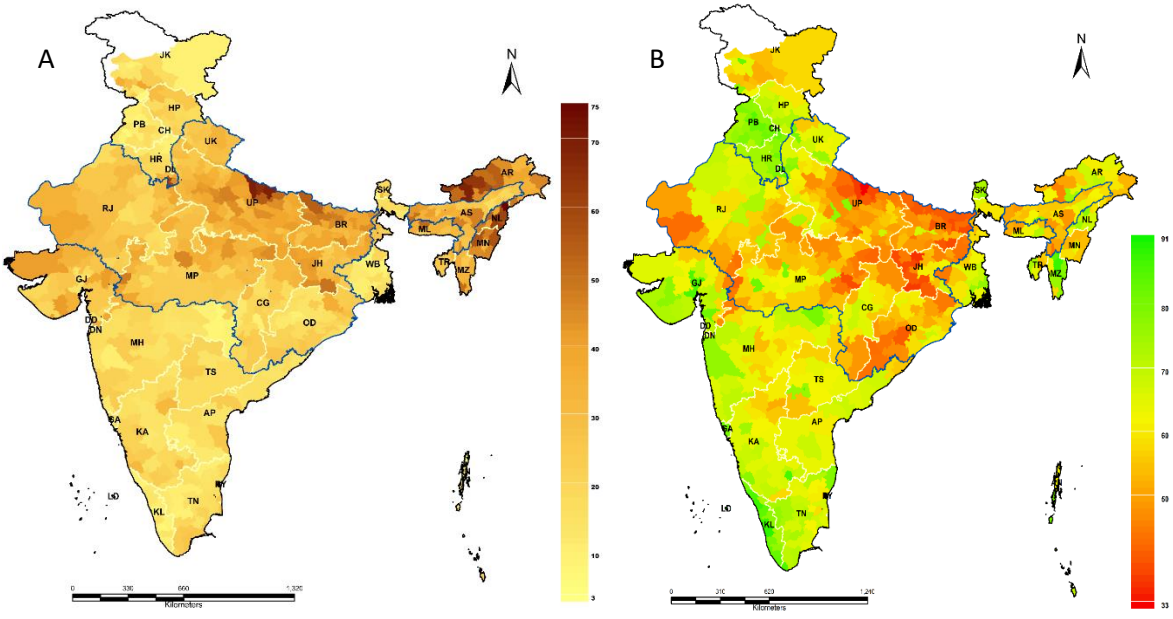
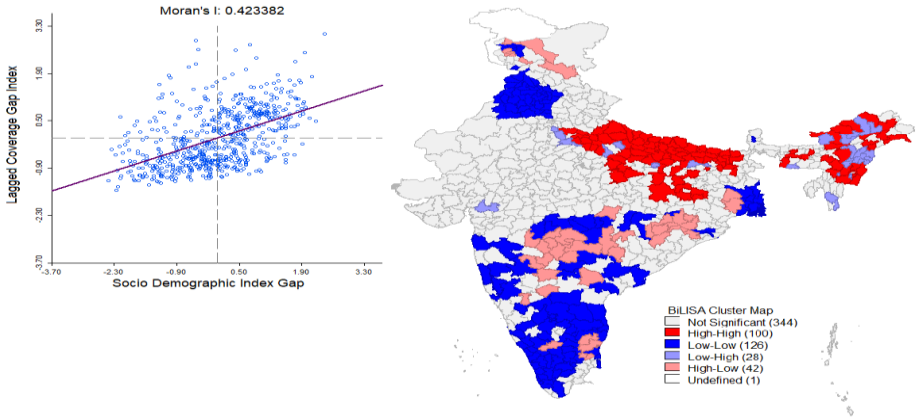


Figure 2. A. CGI at district level indicates that 332 districts have the lower CGI and 308 districts have higher CGI as compared to the national average. Only 31 districts have CGI lower than 10 percent while 458 districts between 10-35 percent and 124 districts between 35-50 percent and 27 districts have CGI higher than 50 percent. Figure 2. B. The map depicts the clear picture of inter districts and intra-state disparity in development level. Districts of Kerala,

Goa, western Maharashtra, Gujarat, Punjab, and Haryana have a high level of development (More than 70 percent) whereas districts of Bihar, Uttar Pradesh, Madhya Pradesh Rajasthan, Northeastern states have a low level of development (Below 40 percent). The correlation coefficients among the two were found to be -0.54 (Negative) which signifies the higher the development lower is the CGI. The relationship between CGI and SDI can be written as

CGI= 60.70 – 0.56* SDI

Figure 3: Global Moran's I and Bivariate LISA map of CGI and SDI gap in districts of India. *A: Moran's I scatter plot, B: Bivariate LISA cluster map.*



The global Moran's I index was found to be 0.42 ($p<0.01$, 999 permutation) which signifies the moderate autocorrelation but positive association among the CGI and development status in the districts of India (fig 6A). It is observed from fig 6B the bivariate LISA analysis map of CGI versus SDI gap that 100 districts have high-high clusters (Hotspots) and 126 districts have low-low clusters (cold spots). The hotspots districts are found from the districts of Bihar, Uttar Pradesh, Assam, Arunachal Pradesh, and Nagaland whereas the cold spot districts are found in the states of Kerala, Tamil Nadu, Maharashtra, West Bengal, and Punjab.

Both absolute and relative inequality was used to understand the pattern of inequality in the selected indicators. The CGI is 2.3 times higher among the poorest as compared to richest. Richest to poorest gap and the ratio among richer and poorer wealth quintile was highest for the antenatal care coverage followed by skilled birth attendance and lowest for the BCG vaccines. The CGI of the urban area is 0.74 times lower as compared to rural areas. The rural-urban CGI difference is higher for ANC followed by SBA and ORT.

Discussion and Conclusion

We present a comprehensive set of analyses on the spatial pattern of coverage gap index at the all 640 districts of India. The study finds spatial clustering of MCH services using geospatial analysis. The geographical distribution of CGI demonstrates that many districts of high focused state Uttar Pradesh, Bihar, and Rajasthan and North-Eastern states have the higher CGI. The clustering pattern guide the policy makers to understand the poor coverage of MCH services, which imply a reduction of maternal and child mortality. Further this study found the negative association of the socio-demographic index with the CGI in districts of India.