Title: Child Malnutrition across the Parliamentary Constituencies of India: A Geo-Spatial Analysis

Apoorva Nambiar[1], Satish B Agnihotri[1]

1 Indian Institute *of Technology Bombay*

Extended Abstract:

Background: GIS when combined with spatial analytical methods are very helpful in examining the spatial patterns. Their application and use are invaluable in research as it allows for more precise identification of spatial patterns and highlights the results which may otherwise be hidden. These applications have important implications in policymaking, since it also helps to understand the associations between geography and child malnutrition and its various correlates such as maternal health, education, sanitation, and other socio-economic determinants, and are relatively important in planning programs to eradicate malnutrition. The situation of child malnutrition in India has been extremely critical for the last few decades. Majority of the studies in India are based on data either at the state level or district level. Majority of the studies are based on data either at the state level or district level. There has been no study nationally which estimates health determinants, especially child malnutrition below the district level. A recent study on the burden of child malnutrition across the Parliamentary constituencies of India brings in another decentralized and important take on the policy interventions, having a stronger political influence and accountability. This study developed two GIS methodologies to derive the parliamentary constituencies (PCs) estimates of child malnutrition, using the National Family Health Survey-4 data (Kim, R. et al., 2019). A study at the level of Parliamentary constituencies is important in terms of measurement of governance and setting the manifesto for public elections.

The present study is motivated from the above-mentioned study on Parliamentary Constituencies, using their calculated estimates, to conduct a more nuanced study on the spatial heterogeneity of malnutrition indicators among the children across the 543 parliamentary constituencies of India using univariate, bivariate LISA techniques and spatial regression models, and in terms of better visualization of the affected areas.

Hence, this study is of more significance, and is an opportunity for the Government to reflect upon and initiate around the importance of collecting data at the political constituency level.

Data:

The parliamentary constituency level estimates used in this current study were downloaded from the “Parliamentary Constituency Factsheet for Indicators of Nutrition, Health and Development” (provided in *Kim R, Swaminathan A, Swaminathan G, Kumar R, Rajpal S, Blossom J, Joe W, Subramanian S V. 2019. Parliamentary Constituency Factsheet for Indicators of Nutrition, Health and Development in India. HCPDS Working Paper Vol. 18, No. 4.*).
The India 543 PC boundary shapefile was downloaded from Github (https://github.com/datameet/maps/tree/master/parliamentary-constituencies.).

Outcome Variables: The three indicators of child malnutrition- children under the age of five, stunted, underweight and wasted, were studied as the dependent variables. According to the WHO these measures are defined as: (1) stunting - height-for-age <-2 SD of the WHO Child growth standards median; (2) wasting - weight-for-height <-2 SD of the WHO Child growth standards median; and (3) underweight - weight-for-age <-2 standard deviations (SD) of the WHO Child growth standards median.

Predictor variables: A set of indicators based on the data availability and prior studies were selected. All the variables selected were from the factsheet provided by the Harvard study mentioned previously. Household characteristics were considered in terms of poverty head count ratio and the usage of improved sanitation facility, the maternal health and related aspects were studied using the variables: percentage of women with ten or more years of schooling, percent wwomen aged 20-24 years married before the age of 18, percentage of mothers who had at least four antenatal care visits and women whose Body Mass Index (BMI) was below 18.5 kg/m2. Delivery care was taken into account through percentage of institutional births, and child health variables considered were: percentage children aged 12-23 who received adequate diet and children aged 6-59 months who were anaemic.

<u>Measures:</u> Various spatial statistical techniques were applied to explore the spatial distribution and autocorrelation of the indicators of child malnutrition and its predictors, across the parliamentary constituencies. The local indicator of spatial association (LISA) was applied to measure the clustering in the dataset, to identify the presence and absence of significant spatial clusters and outliers for each location. Spatial weight matrix was computed using the queen contiguity. The spatial autocorrelation was measured using the Local Moran's I. The bivariate LISA gave the LISA functionality of two different variables, one for the location and another for the weighted average of its neighbours. Spatial regression models- error and lag models, were used to explore and examine the spatial relationships which could help in describing the factors behind the observed spatial patterns.

Results:

- <u>Univariate Local Moran's I- Child malnutrition indicators and its related predictors</u>

The spatial variations convey mainly three statistical meanings: (a) variations were non-random; (b) variation were statistically significant; (c) variations exhibited effects of neighbouring interactions. The Univariate LISA cluster and significance maps (*Fig1-3*) identified significant clusters of high-high spatial association of children stunted in 135 parliamentary constituencies, i.e, 135 PCs had higher-than-average prevalence of stunting, whereas 131 constituencies showed significant low-low spatial association, i.e, having lower prevalence than the average of its neighbours. Significant hot-spots were seen for children underweight in 148 parliamentary constituencies, while 117 constituencies were identified as the cold-spots. In terms of children wasted, high-high spatial association were seen in 112 parliamentary constituencies and low-low spatial association in 97 constituencies. The univariate Moran's I result confirmed a strong and statistically significant clustering of parliamentary constituencies for children under the age of five malnourished (stunted, underweight and wasted) and their selected predictors.

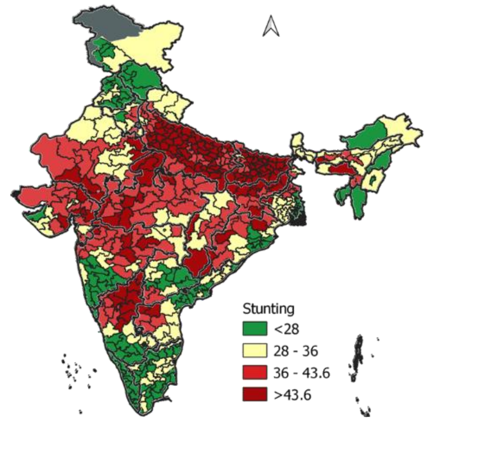

Fig 1.A: Percentage of children stunted across Parliamentary constituencies

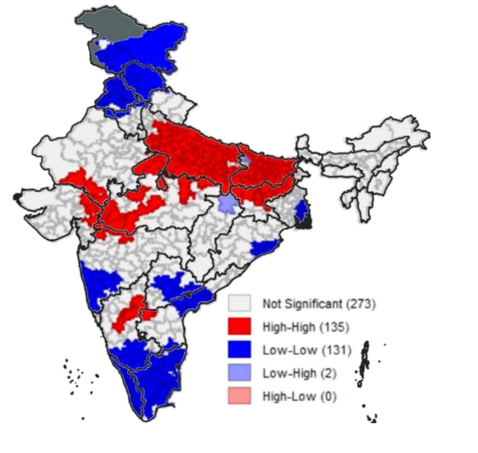

Fig 1.B: Univariate LISA cluster map for children stunted across Parliamentary constituencies

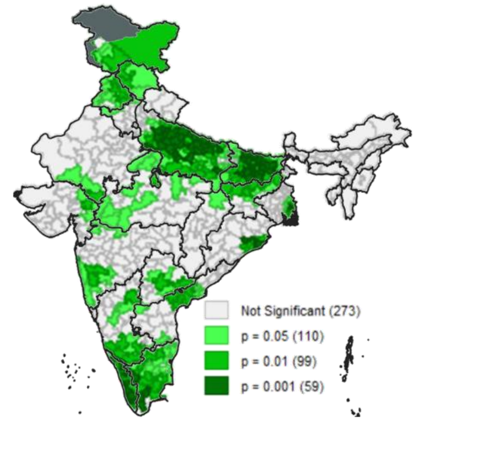

Fig 1.C: Univariate LISA significance map for children stunted across Parliamentary constituencies

- <u>*Bi-variate Local Moran's I- Children malnourished with its correlates*</u>

The bivariate LISA examined the spatial relationship between the predictor and the outcome variables across the PCs of India. A significantly high and positive spatial autocorrelation is observed between underweight and stunting in children with poverty, BMI of mother, women having early marriage and children anaemic. And a significantly high and negative spatial autocorrelation is confirmed between children stunted and underweight with sanitation facilities, women's education, institutional births, antenatal-care and children receiving adequate diet, across the parliamentary constituencies.

The bivariate LISA cluster map indicated that 22% of all the PCs (124 of 543 PCs) had level of stunting as well as high level of poverty (called hotspots) and a cluster of 126 constituencies (23% of all the PCs) had high underweight and high poverty. These PCs were mostly from the states of Uttar Pradesh, Bihar, Jharkhand, Madhya Pradesh. Twenty percent of PCs were classified as the cold spots-- low poverty and low stunting, falling mainly in the states of Kerala, Punjab, Himachal Pradesh, Jammu & Kashmir. PCs having low level of poverty but surrounded by high level malnutrition were also identified, and some of these PCs were from Rajasthan, UP, Bihar, Karnataka, Gujarat, Madhya Pradesh and Jharkhand. Constituencies having more than average level of poverty but low level of malnutrition were also discovered, broadly from the states of West Bengal, Tamil Nadu, Telangana and Odisha.

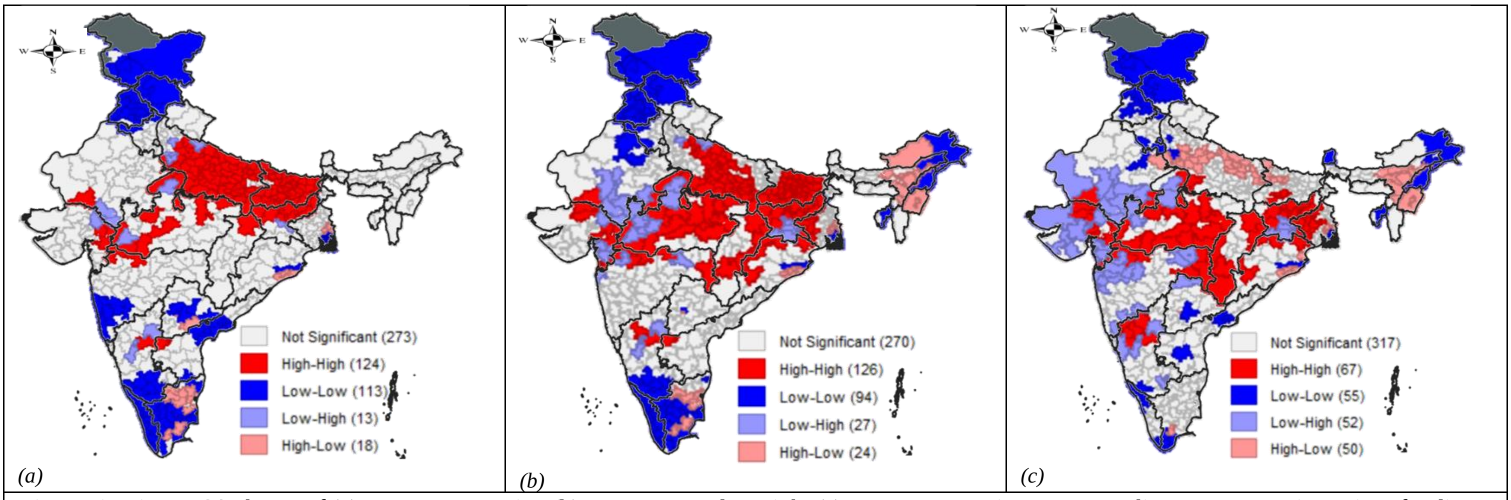

Fig 2: Bivariate LISA cluster of (a) poverty vs stunting (b) poverty vs underweight (c) poverty vs wasting across parliamentary constituencies of India

- *Spatial Regression- Children malnutrition and its correlates*

Spatial effect has been modelled in two ways by estimating spatial lag and spatial error model. The models are re-estimated with the maximum likelihood approach while controlling for the spatial dependence. In comparison, the spatial lag as well as the spatial error model, yield improvement to the original OLS model.

Based on the model diagnostics, the spatial error model was found to be better performing, having a greater R-squared and Log likelihood values, and a smaller AIC; and hence the error model was considered to study the final estimates of the association with respect to the three malnutrition indicators.

With respect to children underweight, the largest statistically significant coefficient was for women's BMI level (β= 0.5) followed by anaemia in children (β=0.17), and with respect to stunting in children, the strongest statistically significant coefficient was for women's BMI level (β= 0.27) followed by institutional births (β=-0.14). The coefficient estimates for women's BMI level confirmed that a 10-point increase in the proportion of women having BMI below normal across the PCs was associated with 5 -point increase in the children underweight prevalence and a 3-point increase in children stunted. A ten-point increase in the proportion of anaemia in children was associated with a 0.8-point increase in the children stunted and 1.7-point increase in children underweight. A ten-point increase in the improvement in sanitation facilities was statistically supposed to bring down the underweight and stunting prevalence by 0.5 points each.

Table 1 Results- Spatial regression models: OLS, Spatial Lag & Spatial error model; to assess the association of child stunted and its correlates, across PCs

PC- level correlates	OLS		Spatial Lag Model		Spatial Error Model	
	Coefficients	Probability	Coefficients	Probability	Coefficients	Probability
Poverty Head Count Ratio	0.078	0	0.03	0.042	0.04	0.016
Households using improved sanitation facility	-0.054	0.003	-0.033	0.028	-0.05	0.035
Women with 10 or more years of schooling	0.043	0.168	0.007	0.791	-0.08	0.036
Institutional births	-0.133	0	-0.085	0	-0.138	0
Mothers who had at least 4 antenatal care visits	-0.076	0	-0.026	0.036	-0.012	0.508
Women whose Body Mass Index (BMI) is below normal (BMI < 18.5 kg/m2)	0.344	0	0.226	0	0.268	0
Women aged 20-24 years married before age 18 years (%)	0.04	0.112	0	0.981	-0.018	0.57
Children aged 6-59 months who are anaemic	0.117	0	0.07	0	0.079	0

Children agedd 6-23 months receiving an adequate diet	-0.124	0	-0.042	0.124	-0.058	0.13
R- squared value	0.73		0.81		0.84	
Lambda Value (Lag Coefficient)					0.765	0
Rho Value (Lag coefficient)			0.521	0		
Log likelihood	-1645.39		-1561.78		-1540.47	
AIC value	3310.78		3145.56		3100.93	
No. of PCs	543		543		543	

Conclusion:

Thus, these PC level estimates and spatial patterns on the different indicators of child malnutrition, stunting, wasting, and underweight, reflect the need to focus and build new interventions around the identified PCs to address child malnutrition in a better and streamlined way. These findings will help people track how their MPs prioritise their agenda and how focused they are in spending towards developing their constituencies. Thus, these PC level estimates and spatial patterns on the different indicators of child malnutrition, stunting, wasting, and underweight, reflect the need to focus and build new interventions around the areas identified to address child malnutrition in a better and streamlined way. The findings could be useful for public health planning and targeting the various underlying factors associated with child nutrition in India. It also suggests utilization of MP funds allocated for the PCs appropriately and the focussed implementation of welfare schemes and campaigns like POSHAN Abhiyan and Swatchata Abhiyan, which are crucial to addressing child malnutrition. The study also points towards the need to collect micro-level data such as at the level of PCs or at block levels, for future large scale national surveys. The spatial variability and pattern of malnutrition indicators and their correlates, recognized in this present study, indicate that priority-setting in research may also heavily depend on the neighbourhood association.