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EL ROL DE LOS ESTUDIOS DE POBLACIÓN TRAS LA PANDEMIA DE COVID-19 Y EL DESAFÍO DE LA IGUALDAD EN AMÉRICA LATINA Y EL CARIBE

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Identifying Geographical Heterogeneity of Under-five Child Nutritional Status in Districts of India

Background: Globally, 156 million children under five years of age were stunted, 93 million were underweight, and 50 million were wasted in 2015. The efforts on the reduction of child malnutrition began with the Copenhagen Consensus. They continued through the Millennium Development Goals (MDGs) 1 targeted in reducing the half of the number of underweight children by 2015 and Sustainable Development Goals (SDGs) 2 aimed to end hunger and all forms of malnutrition by 2030. Despite concerted efforts globally and nationally, the prevalence of malnutrition remained high in developing countries, particularly in the South Asian Region. In the last two decade, India has experienced sustained economic growth (over 5% growth in GDP) and reduced the poverty level by half (from 50% in 1993–94 to 22% by 2011–12). However, the reduction in stunting, wasting and underweight have not been observed on the same scale. Indian National Family Health Survey (NFHS) estimates suggest that the level of stunting and underweight were declined from 52% to 38% and 53% to 36%, while the prevalence of wasting had increased from 17% to 21% from 1992–93 to 2015–16, respectively. Despite these improvements, progress toward reducing the proportion of undernourished children in India has been sluggish. Hence it is essential to understand contextual risk factors influencing childhood malnutrition in India. Therefore, the objective of the study aims to identify the place-specific spatial dependencies and heterogeneities in the association between nutritional status and socio-economic and demographic risk factors in India. The findings of this study provide an improved understanding of the district-level child nutritional status are exposed to in India today, which may help in designing and implementing appropriate regional and/or state-specific strategies and intervention programs to prevent child undernutrition in India

Methods

Data: The analysis of the study is based on recently published data from the fourth round of NFHS conducted in 2015-2016 by the Health Ministry, Government of India and therefore, does not require any separate ethical approval. The sample was selected through a multistage stratified random sample design to identify the household and a proper method to find the women in the household. The study restricted to sample of 259,627 children that were born in the five years before the survey. The unit of analysis is the 640 districts of India.

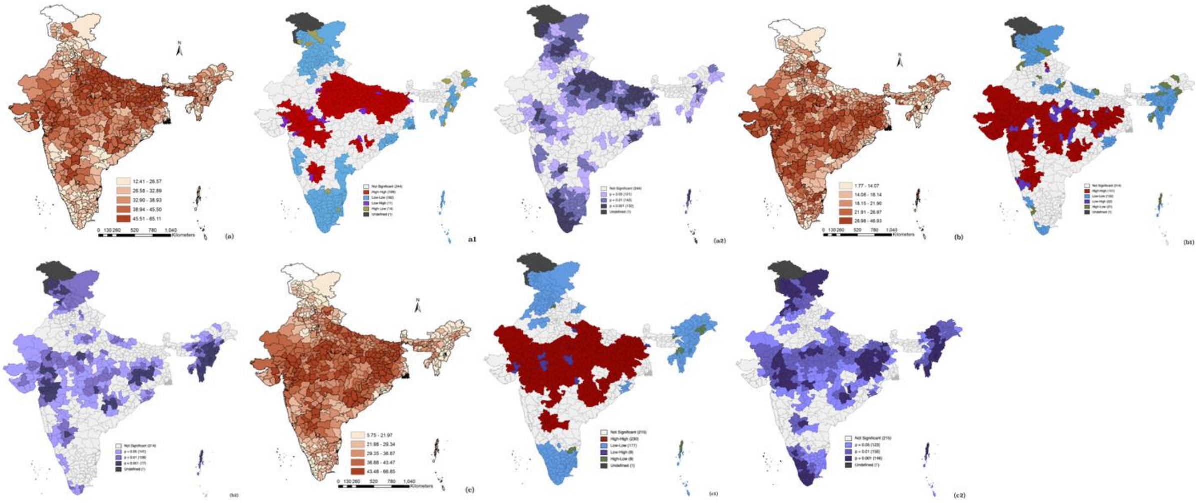
Outcome measures: District-wise proportion of three anthropometric indicators of nutritional status namely stunting (height-for-age), wasting (weight-for-height) and underweight (weight-for-age) of children aged 0-59 months respectively, if their Z-scores are below minus two standard deviations from the median of the reference population (Following WHO guidelines (2011) were considered as the dependent variables used for the statistical analysis.

Independent variables: A set of proximate and distal determinants of childhood nutrition status were selected based on an exhaustive review of literature, keeping with the frameworks of previous studies and data availability derived at the district-level information on the proportion of (i) mothers age <20, (ii) mothers BMI, (iii) Institutional births, (iv) complete immunization, (v) breastfeeding, (vi) women education, (vii) poor, (viii) drinking water, and (ix) toilet facility. Therefore, a proxy wealth quintile (taken poor and poorest) was constructed based on households assets based indicators, excluding drinking water and toilet facility from the district level composite index because they were explicitly controlled for as part of the analysis.

Statistical analysis: To analyzed the district-level childhood nutritional status, Moran's *I* statistics and a set of univariate LISA maps were drawn to measure spatial autocorrelation and identify the local patterns of spatial clusters. Two types of spatial econometric regressions were run to detect spatial autocorrelation and heterogeneity in the association of district-level childhood nutritional status and its correlates. First, the global coefficients were estimated for the set of predictors by using both the OLS and the SAR (error/lag) models. Second, the local coefficients were estimated using the GWR models. Finally, these models were examined and compared for the better understanding of performance and prediction accuracy.

Results: The percentile maps (Figure 1, a, b and c) show that among under-five children, 38% were stunted, 36% were wasted, and 21% were underweighted in India. The univariate Moran's *I* statistics was 0.63, 0.49 and 0.72 for stunting, wasting and underweight suggesting spatial heterogeneity of nutritional status over the space. Univariate LISA maps (Figure 1, a1, b1 and c1) signifies the local spatial clusters/outliers functionality shows the geographical pattern and magnitude of nutritional coverage (hotspots) that individually identified 189, 151 and 230 districts for stunting, wasting and underweight tend to high–high cluster as hot spots (red colour) whereas 182, 132 and 177 districts for stunting, wasting and underweight tend to low–low cluster as cold spots (blue colour). The global OLS coefficient (Table 1) of women education, mothers BMI (<18.5 kg/m2), drinking water and toilet facility were statistically strong significant predictors of all three outcome variables and gauged the positive and negative signs. Results of spatial error model (Table 1) confirmed that the coefficient of women education, mothers BMI, institutional births, complete immunization and toilet facility were more likely significant risk factors of all three anthropometric indicators. The coefficients from the spatial lag model (Table 1) presented mothers BMI, institutional births, women education and improved drinking water showed statistically significant associated with three anthropometric indicators. The local GWR models were used to decipher location-based relationships between the district-level anthropometric indicators and its predictors. The results of each model (Figure 2, 3 and 4) displayed the relationships between district-level all three outcome variables and a set of covariates (% of mothers age below 20, mothers BMI, institutional births, complete immunization, breastfeeding, women education, poor, drinking water and toilet facility) were spatially varied, place-specific and clustering in terms of their respective magnitude, direction and differences due to complexities in local characteristics in India. In terms of overall goodness-of-fit (Table 2), compared to the global OLS models the GWR models explain 73%, 50% and 81% of the variation in district-level stunting, wasting and underweight of the malnutritional status. The AICc of the GWR models is relatively lower compared to traditional models, which suggests that the GWR models have a better fit and more realistic in terms of models performance and prediction accuracy than the traditional one. *Statistical analysis:* To analyzed the district-level childhood nutritional status, Moran's *I* statistics and a set of univariate LISA maps were drawn to measure spatial autocorrelation and identify the local patterns of spatial clusters. Two types of spatial econometric regressions were run to detect spatial autocorrelation and heterogeneity in the association of district-level childhood nutritional status and its correlates. First, the global coefficients were estimated for the set of predictors by using both the OLS and the SAR (error/lag) models. Second, the local coefficients were estimated using the GWR models. Finally, these models were examined and compared for the better understanding of performance and prediction accuracy.

Figure 1. Spatial distribution (%), spatial clustering and outliers of the district-level childhood nutritional status, India, 2015–



Data Source: Estimated by authors from NFHS, 2017.
Note : (a) Stunting; (a1) Univariate LISA cluster map of stunting; (a2) LISA significant map of Stunting; (b) Wasting; (a1) Univariate LISA cluster map of wasting; (a2) LISA significant map of wasting; (c) Underweight; (a1) Univariate LISA cluster map of underweight; (a2) LISA significant map of underweight. Spatial autocorrelation spatially drawn by using GeoDa.

Conclusion: The results reveal strong geographical clustering among the districts of India. The prevalence of anthropometric indicators varies across space at a different scale. This study can find that rural districts of India yield far worse child outcomes in terms of nutritional development. The study also takes into account spatial heterogeneity of significant risk factors of district-level childhood three anthropometric indicators to explore the prevalence of nutritional deficiencies among under-five children. Districts having Lack of these factors and public health infrastructure facilities for children and mothers indicate that nutritional deficiencies remain the public health challenges of the 21st century. Moreover, the present and previous findings confirm the determinants mothers BMI, complete immunization, women education, poor wealth status, improved sanitation female and clean water are positively associated with nutritional indicators. It also suggests that the allocation of health resources and the implementation of child health-specific interventions in the geographical hotspots of higher malnutrition prevalence. Hence, needs focused programme and policy formulation targeted to improve these distal and proximate risk factors might help to avert the burden of child malnutrition in Indian society in near future.

Figure 2. Spatial distribution of GWR local coefficients of the district level stunting (only significant areas), India, 2015–16

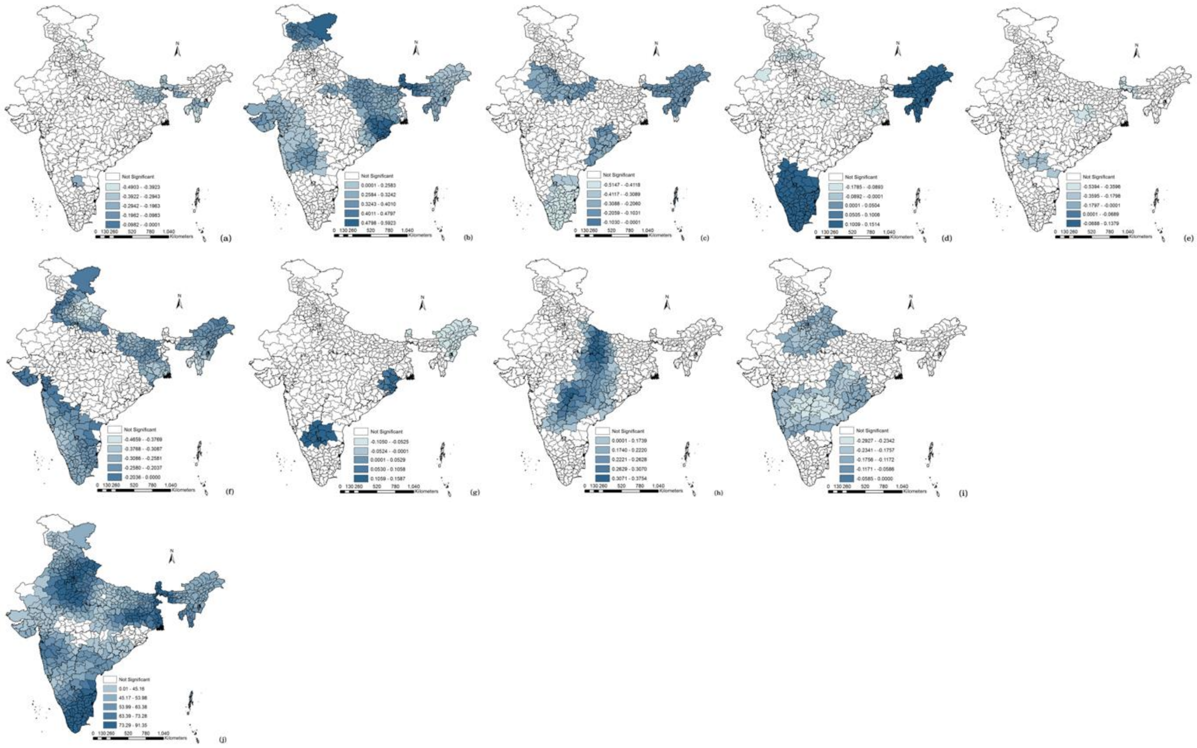


Figure 3. Spatial distribution of GWR local coefficients of district level wasting (only significant areas), India, 2015–16

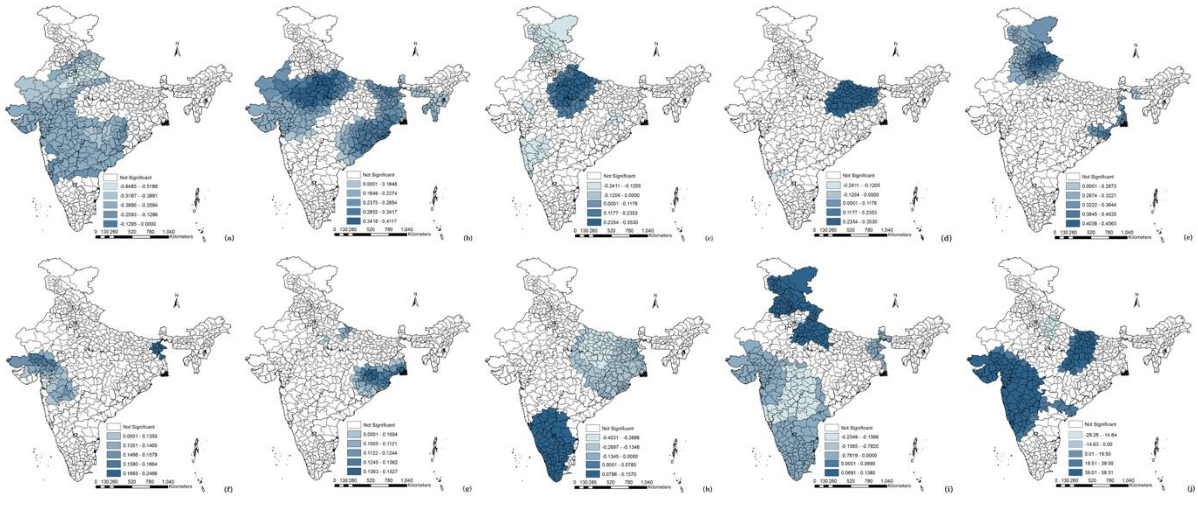
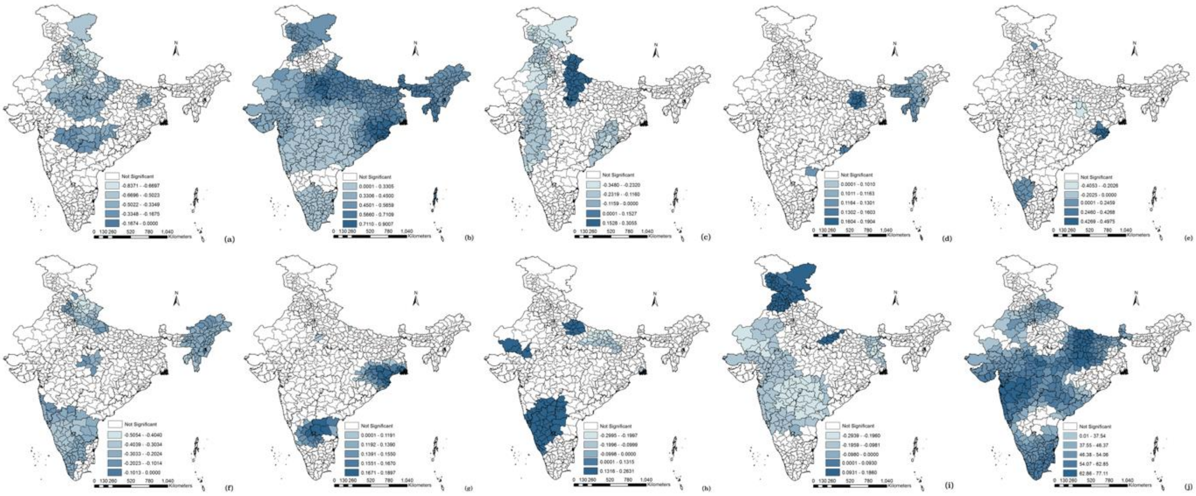


Figure 4. Spatial distribution of GWR local coefficients of district level underweight (only significant areas), India, 2015–16



Source: Estimated by authors from NFHS, 2017

Note : (a) Mothers age <20; (b) Mothers BMI; (c) Institutional Births; (d) Complete Immunization; (e) Breastfeeding; (f) Women Education; (g) Poor; (h) Drinking Water; (i) Toilet Facility; (j) Intercept**.** Local coefficients are displayed by using the natural breaks scale (Jenks & Caspall, 1971). All coefficients are significant at the 5% level.

Table 1. Estimated coefficients of the OLS, Spatial error and Spatial lag Models for stunting, wasting and underweight in districts of India, 2015–16 (n=640)

	OLS		Spatial Error		Spatial Lag	
Variables	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI
Stunting						
Mothers age <20	–0.147***	–0.236, –0.059	–0.118**	–0.211, –0.025	–0.125***	–0.208, –0.042
Mothers BMI	0.303***	0.236, 0.369	0.232***	0.165, 0.300	0.210***	0.145, 0.275
Institutional Births	–0.116***	–0.157, –0.075	–0.120***	–0.164, –0.075	–0.104***	–0.142, –0.065
Complete Immunization	–0.046***	–0.080, –0.012	–0.016**	–0.051, 0.020	–0.040**	–0.071, –0.008
Breastfeeding	0.008	–0.059, 0.075	–0.025	–0.098, 0.049	–0.076**	–0.141, –0.012
Women Education	–0.170***	–0.226, –0.115	–0.154***	–0.212, –0.096	–0.135***	–0.187, –0.082
Poor	0.010	–0.021, 0.041	–0.001	–0.034, 0.032	–0.020	–0.050, 0.009
Drinking Water	0.094***	0.056, 0.133	0.083***	0.044, 0.122	0.064***	0.027, 0.100
Toilet Facility	–0.071***	–0.10, –0.042	–0.083***	–0.116, –0.049	–0.058***	–0.085, –0.031
Intercept	47.736***	40.116, 55.356	42.448***	19.953, 64.944	30.220***	22.217, 38.222
F(9, 630)	112.17					
Adjusted R^2	0.610		0.734		0.675	
AIC	4160.4		4086.5		4090.4	
Stunting (lag coef. (λ))			0.965***			
Stunting (lag coef. (ρ))					0.709***	
Likelihood Ratio Test			77.99***		74.08	
Wasting						
Mothers age <20	–0.001	–0.096, 0.093	–0.013	–0.111, 0.084	–0.024	–0.110, 0.063
Mothers BMI	0.298***	0.228, 0.368	0.191***	0.12, 0.262	0.188***	0.122, 0.253
Institutional Births	0.052**	0.009, 0.096	–0.021	–0.068, 0.025	–0.004	–0.044, 0.037
Complete Immunization	0.008	–0.028, 0.044	0.041**	0.003, 0.078	0.020	–0.014, 0.053
Breastfeeding	0.021	–0.049, 0.092	0.107***	0.030, 0.184	0.042	–0.023, 0.107
Women Education	0.014***	–0.044, 0.073	0.013***	–0.048, 0.074	0.011***	–0.043, 0.065
Poor	–0.017	–0.05, 0.016	0.020	–0.015, 0.055	–0.004	–0.034, 0.026
Drinking Water	–0.016***	–0.057, 0.025	–0.018	–0.059, 0.023	–0.024***	–0.062, 0.013
Toilet Facility	–0.051***	–0.082, –0.021	–0.042***	–0.077, –0.007	–0.020	–0.048, 0.008
Intercept	11.374***	3.295, 19.452	7.858	–8.655, 24.371	–4.584	–12.18, 63.018
F(9, 630)	26.58					
Adjusted R^2	0.266		0.397		0.349	
AIC	4235.3		4151.0		4149.2	
Wasting (lag coef. (λ))			0.967***			
Wasting (lag coef. (ρ))					0.935***	
Likelihood Ratio Test			88.32***		90.02	
Underweight						
Mothers age <20	–0.114**	–0.207, –0.020	–0.089*	–0.182, 0.005	–0.107**	–0.189, –0.025
Mothers BMI	0.631***	0.562, 0.701	0.488***	0.420, 0.556	0.458***	0.392, 0.524
Institutional Births	–0.008	–0.051, 0.035	–0.064***	–0.108, –0.019	–0.044***	–0.082, –0.005
Complete Immunization	0.014	–0.022, 0.05	0.047**	0.011, 0.083	0.018	–0.014, 0.049
Breastfeeding	0.010	–0.060, 0.080	0.049	–0.024, 0.123	–0.047	–0.110, 0.015
Women Education	–0.115***	–0.174, -0.057	–0.114***	–0.172, –0.056	–0.089***	–0.141, –0.038
Poor	–0.005	–0.038, 0.027	0.016	–0.018, 0.049	–0.019	–0.047, 0.010
Drinking Water	0.044**	0.004, 0.085	0.028	–0.011, 0.067	0.010***	–0.026, 0.046
Toilet Facility	–0.099***	–0.130, –0.069	–0.080***	–0.114, –0.047	–0.051***	–0.079, –0.024
Intercept	27.229***	19.216, 35.242	8.945***	–38.026, 55.915	11.492***	04.098, 18.886
F(9, 630)	158.38	158.38				
Adjusted R^2	0.689	0.689	0.774		0.752	
AIC	4224.8	4224.8	4089.9		4080.9	
Underweight (lag coef. (λ))			0.982***			
Underweight (lag coef. (ρ))					0.785***	
Likelihood Ratio Test			138.95***		149.93	

Note : *p*-value: ***p*<0.05, ****p*<0.01;; AICc = Akaike information criterion with a correction

Table 2. Comparison between GWR and OLS Models Fitness (*n*=640), India, NFHS, 2015–16

Parameters	OLS	GWR
Stunting		
Adjusted R^2	0.609	0.729
AICc	4162.89	4026.49
AICc reduction		136.40
Wasting		
Adjusted R^2	0.264	0.499
AICc	4237.70	4060.29
AICc reduction		177.41
Underweight		
Adjusted R^2	0.689	0.809
AICc	4227.25	4025.98
AICc reduction		201.27

Source: Estimated by author from NFHS, 2017