



Introduction

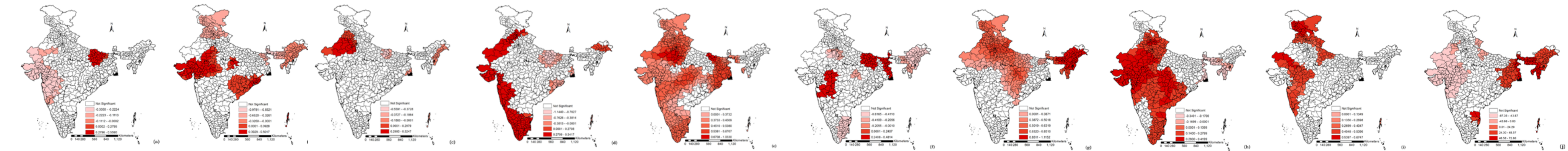
- ❑The coverage of full immunization among under-five children has remained a foremost challenge facing the world.
- ❑Recognizing its importance, the Government of India launched a series of policies and programmes during 1978 - 2013 to protect children from Vaccine-preventable diseases (VPDs) by ensuring full immunization care.
- ❑India has been significantly progressed over the last couple of decades. According to the National Family Health Survey 4 (NFHS-4) estimates, India has significantly increased full immunization care of children aged 12–23 months from 43 to 62% (19% increased) between 2005–06 to 2015–16, respectively.
- ❑Previous studies have not addressed the potential spatial variations in local relationships between full immunization coverage and its factors at the district level in India.
- ❑Given that context, the study aimed to explore place-specific spatial dependencies and heterogeneities in the relationships of socio-economic factors associated with district-level full immunization coverage in India.

Data and Method

- ❑The study used a geocoded database for 632 districts of India, drawn from the 4th wave of NFHS conducted in 2015–16, which is also known as Indian Demographic and Health Survey (IDHS).
- ❑The variable of interest was the district-wise proportion of children aged 12–23 months who received complete immunization (one dose of BCG, measles and three doses of polio and DPT according to WHO guidelines) considered for the statistical analysis.
- ❑Univariate Moran’s *I* and LISA maps were used to explore the spatial autocorrelation and geographical hotspots of the district-level full immunization coverage.
- ❑Two multivariate regression models were used to detect spatial autocorrelation and heterogeneity in district-wise full immunization coverage in India. First, the global coefficients were estimated for the set of predictors using the traditional Ordinary Least Squares (OLS) model. Second, Geographically-weighted regression (GWR) model was used to explore the spatial variability of local relationships between the outcome and its associated predictors.
- ❑Finally, these models were examined and compared for a better understanding of performance and prediction accuracy.

Results

- ❑The percentile map (Figure 1, a) shows that almost 38% of the children in India were not fully immunized in India, which varies from 11% in Punjab to 63% in Nagaland, respectively.
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- ❑Moran’s *I* statistics was 0.50 suggesting spatial heterogeneity of complete immunization coverage in India. Univariate LISA map (Figure 1, b) signifies local spatial clusters/outliers functionality shows the spatial pattern and magnitude of full immunization coverage, which identified 128 districts tend to high–high cluster (**Red** in colour) and 130 districts tend to low–low cluster (**Violet** in colour).
- ❑The OLS estimates that variable such as women education, full ANC, full PNC, JSY assistance, MPC card were more likely significant correlates of complete immunization care and gauge the expected positive signs.
- ❑The GWR results (Figure 2) revealed that the relationships between outcome and set of correlates were significantly place-specific and spatially clustering in terms of their respective magnitude, direction, and differences in due to local characteristics across India.
- ❑In terms of model performance and prediction accuracy (Table 1), the GWR model was performing better over OLS estimates through comparisons of R2 and Akaike Information Criterion (AIC).
- ❑The local R2 map (Figure 3a) shows that the GWR model fits well in most districts of North, West, East and North-east region in India, while local standard residual (Figure 3b) shows the immunization coverage was spatially non-cluster, place-specific and less dependency. It can also be suggested that the GWR model resulted in a significantly better fit than the traditional OLS model.



Note. : (a) Urban women; (b) Women education; (c) SC/STs; (d) Non-poor; (e) Full ANC; (f) Institutional Delivery; (g) Full PNC; (h) JSY Assistance; (i) MCP Card; (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. Comparison between GWR and OLS Models Fitness ($n=632$), India, NFHS, 2015–16
Source : Estimated by author from NFHS, 2017

Parameters	OLS	GWR
Adjusted R2	0.4085	0.6761
AICc	5072.77	4776.24
AICc Reduction		296

Figure 1. Estimated results of the (a) percentage map in quintile scale, (b) univariate LISA local cluster and (c) significant maps of the district-level complete immunization coverage, India, 2015–16

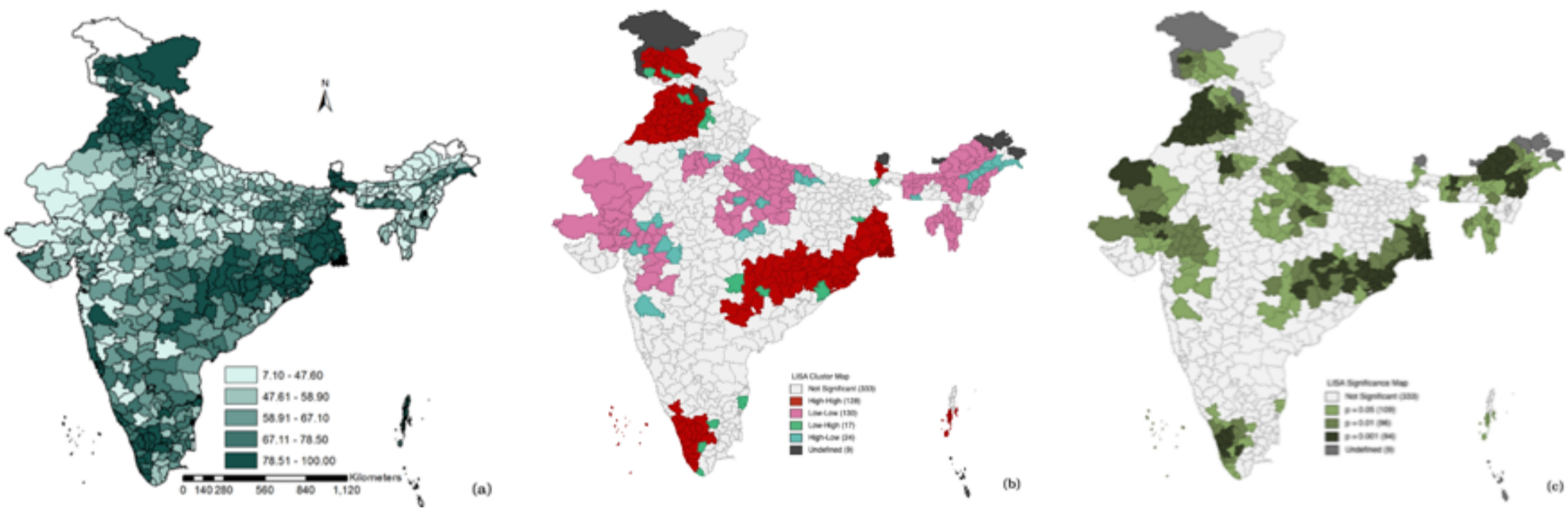
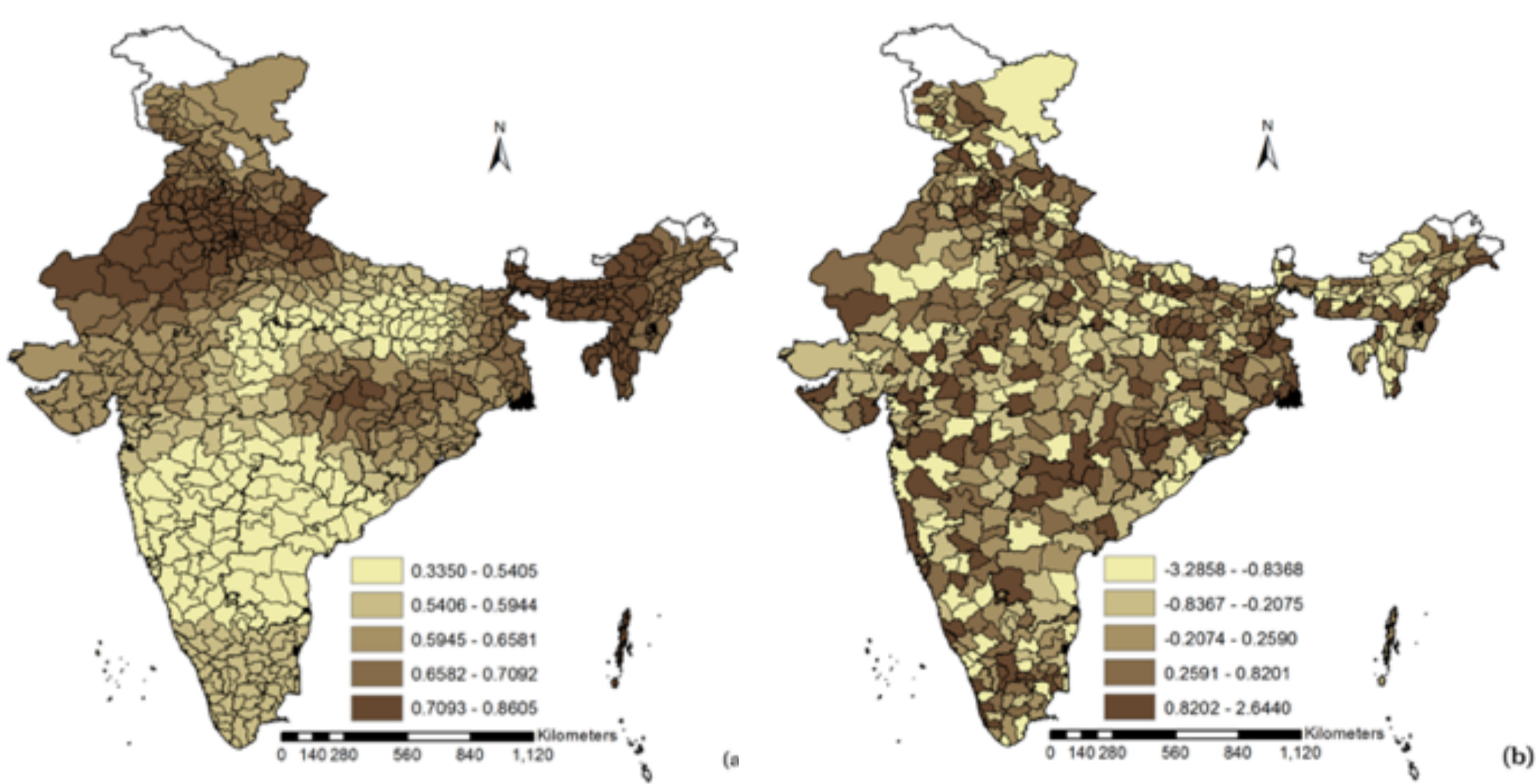


Figure 3. Estimated results of the GWR model fits (a) Local R2; (b) Local standardized residual, India, 2015–16
Note : Local coefficients are displayed in quintile



Conclusion

- ❑The geographic snapshots of child immunization can potentially help to ensure that every child across India received full immunization to leading a healthy life. The findings from this study suggest that immunization coverage is considerably low and unevenness in the geographical hot-spots as compared with the national figure.
- ❑A modelling-based study using GWR and OLS regression identify important risks factors as well as to understand regarding the occurrence of complete immunization hot-spots in India.
- ❑The GWR model has the potential to explain complexities in place-specific variations could be ignored by OLS on the local causes of district-level immunization coverage.
- ❑Appropriate intervention should be devised to safeguard the child from the VPDs, which would help to reduce the geographical heterogeneity of full immunization coverage across India.
- ❑Efforts have to be made by the government to ensure the universalization of education, along with accessible and affordable healthcare for all ensuring universal health coverage in India.

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