

Spatial Analysis of Child Malnutrition in Bihar: A District Level Study

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ABSTRACT

Child malnutrition remains a major public health issue in Bihar, with widespread undernutrition, including high rates of stunting, wasting, and underweight among children, alongside rising levels of childhood overweight. These forms of malnutrition present serious challenges to child survival, health, and development. This study conducts a district-level spatial analysis of child malnutrition in Bihar, focusing on the distribution and clustering of stunting, wasting, underweight, and overweight across the 38 districts. Using data from the National Family Health Survey (NFHS-5, 2019-20), the study applies the Choropleth mapping technique to visualize and interpret spatial disparities. The analysis identifies significant geographic variations and highlights persistent malnutrition hotspots. These spatial patterns reflect underlying socio-economic and regional inequalities that influence child health outcomes. By providing a clear spatial perspective, the study offers valuable insights into public health planning and policymaking. The findings underscore the importance of geographically targeted strategies and improved resource allocation to address both undernutrition and emerging overweight trends. This evidence-based approach can support Bihar's progress toward achieving Sustainable Development Goal 2: Zero Hunger and promote more equitable child health interventions across districts.

Keywords: Child Malnutrition, Stunting, Wasting, Underweight, Overweight

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Introduction:

Child malnutrition remains a major challenge in India, with serious consequences for children's physical and cognitive development. Bihar bears a particularly high burden, where many children fail to achieve healthy growth. The impacts of malnutrition extend beyond health, affecting learning ability, future livelihoods, and overall well-being. Over time, this reinforces social and economic disadvantages and weakens the state's development prospects. Addressing malnutrition in Bihar is therefore crucial for improving child health and strengthening future human capital.

The World Health Organization (WHO) defines malnutrition as deficiencies, excesses, or imbalances in energy and nutrient intake. It is commonly classified into three forms: undernutrition (stunting, wasting, and underweight), micronutrient-related malnutrition involving vitamin and mineral deficiencies or excesses, and overweight and obesity associated with non-communicable diseases.

Malnutrition is especially critical during the first five years of life, a phase of rapid physical and mental development. Adequate nutrition during this period is essential for healthy growth and long-term productivity. Efforts to reduce child malnutrition are also linked to Sustainable Development Goal 2 (SDG 2), which aims to eliminate all forms of malnutrition by 2030. Several studies have examined child malnutrition in India, yet limited attention has been given to its variation across smaller geographic units, particularly within Bihar. Earlier research has highlighted the role of social disadvantage, poverty, rural residence, low maternal education, sanitation, and disease exposure in shaping child nutritional outcomes. However, most studies rely on aggregate analyses and do not sufficiently capture local-level disparities.

While conventional methods provide important insights, Geographic Information System (GIS) techniques offer added value by visually representing spatial patterns of malnutrition.

Mapping these indicators helps identify high-risk areas and supports evidence-based, location-specific planning. Accordingly, this study uses district-level spatial analysis to examine the distribution and clustering of stunting, wasting, underweight, and overweight among children in Bihar, aiming to generate spatial evidence to inform targeted nutrition and health interventions.

Study Area:

This study examines child malnutrition at the district level across all districts of Bihar using data from the National Family Health Survey (NFHS). Bihar is situated in eastern India between 24°20'10" and 27°31'15" North latitude and 83°19'50" to 88°17'40" East longitude. Although landlocked, the state has relatively close access to the Port of Kolkata. Its location between the humid region of West Bengal and the sub-humid region of Uttar Pradesh influences its climate, economy,

and cultural setting. Bihar is bordered by Nepal in the north and Jharkhand in the south, while the Ganga River flows west to east, dividing the state into two broad plains.

Bihar covers a total geographical area of 94,163 square kilometres, of which 92,257.51 square kilometres are rural and 1,095.49 square kilometres are urban. The state has an average elevation of about 173 feet above sea level and experiences approximately 52.5 rainy days annually.

As per the 2011 Census, Bihar has a population of about 104.1 million, with a sex ratio of 918 females per 1,000 males. The population density is 1,106 persons per square kilometre, and the literacy rate is 61.80%. In 2017-18, Bihar's Gross State Domestic Product at current prices was '4,87,628 crores, with a per capita GSDP of '42,242 (Government of Bihar, n.d.).

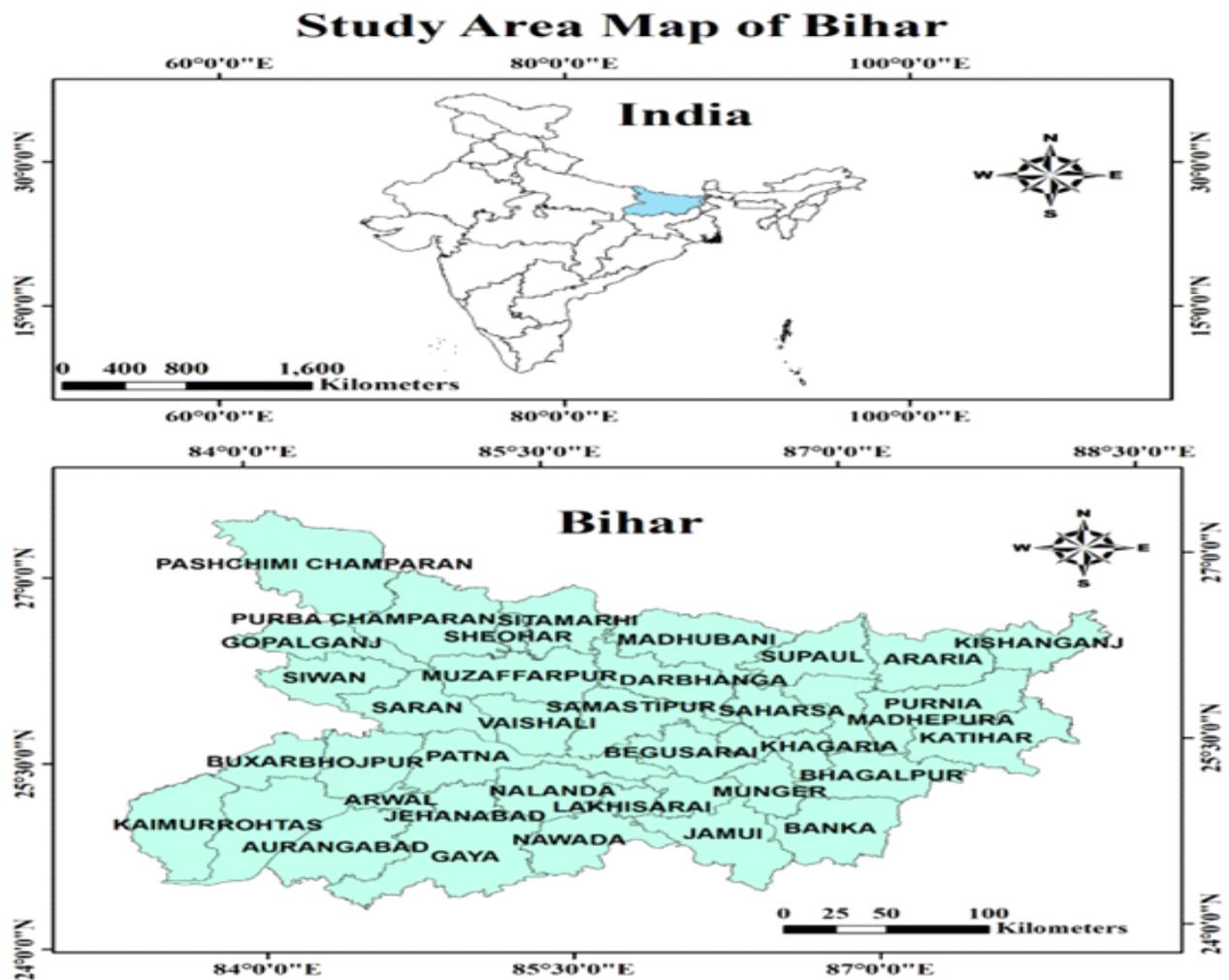


Figure 1: Location map of the study area

Aims and Objectives

1. To examine the spatial pattern and clustering of child stunting in Bihar
2. To examine the spatial pattern and clustering of child wasting in Bihar
3. To examine the spatial pattern and clustering of child underweight in Bihar
4. To examine the spatial pattern and clustering of child overweight in Bihar

Sources of Data and Methodology:

Data for this study was obtained from the National Family Health Survey (NFHS-5, 2019-20). This dataset provides district-level information on key child health indicators such as child stunting, wasting, underweight, and overweight, which are central to the analysis. The spatial distribution of child malnutrition in Bihar is visualized using

choropleth mapping, which highlights the variation across districts. Spatial autocorrelation techniques are applied to assess the clustering of malnutrition, identifying whether areas with higher or lower rates of malnutrition are geographically concentrated. The analysis is conducted using ArcGIS software, enabling spatial analysis and the creation of maps to visualize the patterns and clusters of child malnutrition.

Results and Discussion

Spatial Pattern and Clustering of Child Stunting

Child stunting, defined as low height-for-age, is a manifestation of chronic undernutrition and reflects cumulative growth deficits. In Bihar, the prevalence of stunting among children under five remains alarmingly high, with significant variations across districts

Table-1.
Classification of Bihar Districts According to Stunting Prevalence

Class Interval	No. of Districts	Name of Districts
Very Low (<38.17)	7	Gopalganj, Sheohar, Patna, Khagaria, Munger, Siwan, Begusarai
Low (38.17-42.18)	9	Vaishali, Kishanganj, Buxar, Saran, Bhagalpur, Rohtas, Bhojpur, Aurangabad, Jehanabad
Moderate (42.18-46.19)	13	Supaul, Nalanda, Muzaffarpur, Lakhisarai, Jamui, Madhubani, Pashchim Champaran, Purnia, Katihar, Samastipur, Kaimur (Bhabua), Darbhanga, Arwal
High (46.19-50.2)	7	Madhepura, Banka, Gaya, Saharsa, Purba Champaran, Nawada, Araria
Very High (>50.2)	2	Sheikhpura, Sitamarhi

Source: Compiled by Author

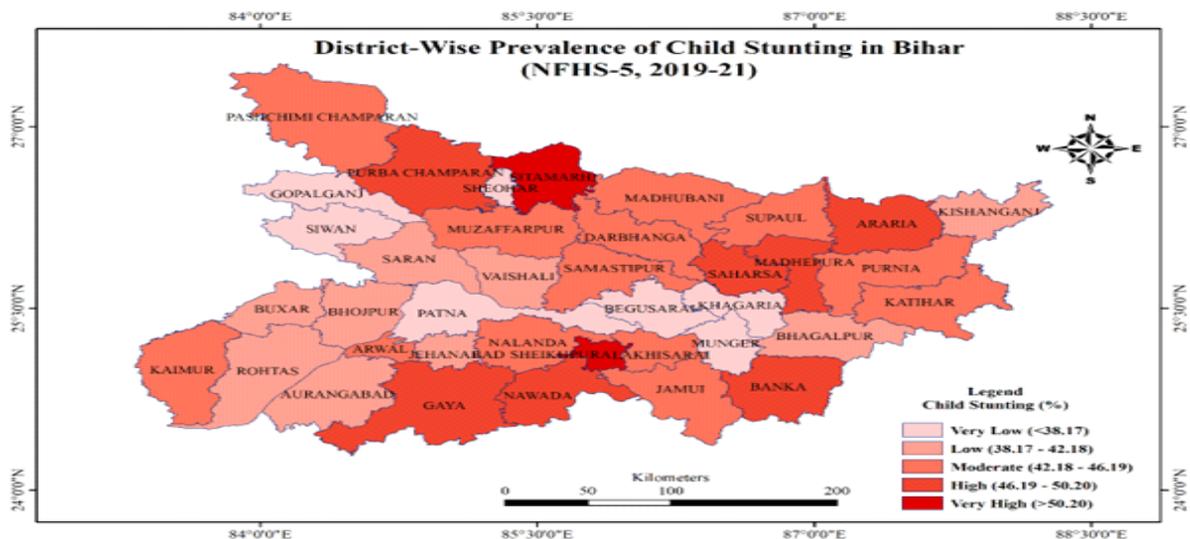


Figure 2: Choropleth Map of Child Stunting Rates in Bihar (NFHS-5, 2019-20)

The district-wise analysis of child stunting in Bihar, based on NFHS-5 (2019–20), reveals a wide spatial variation, with prevalence ranging from 34.16% in Gopalganj to 54.18% in Sitamarhi, while the state average stands at 42.94%. For better interpretability, the districts were categorized into five class intervals and mapped using a choropleth map.

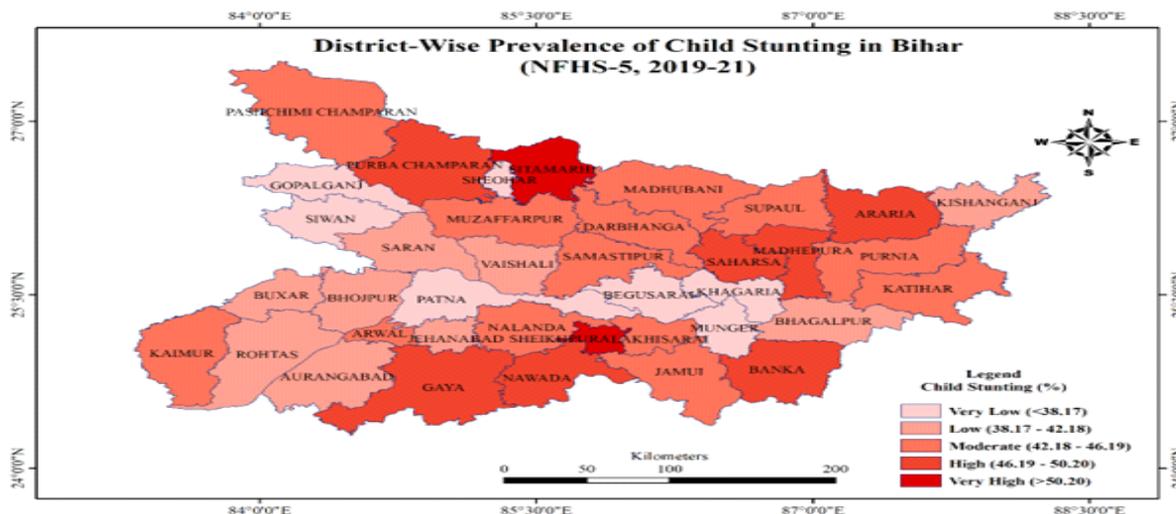


Figure 2: Choropleth Map of Child Stunting Rates in Bihar (NFHS-5, 2019-20)

An integrated analysis of Table 1 and the choropleth map reveal a pronounced spatial heterogeneity in child stunting across Bihar. Districts falling under the very low and low categories (16 districts) are mainly located in north-western and central Bihar, reflecting relatively favorable socio-economic conditions and better access to health and nutrition services. The moderate stunting category comprises the largest share of districts (13), forming a wide belt across northern, eastern, and central-southern Bihar, which indicates a transitional nutritional status where improvements are feasible with focused interventions. High stunting districts (7) are spatially clustered in north-eastern and southern Bihar—particularly Madhepura, Saharsa, Araria, Gaya, and Nawada—while very high stunting is

confined to Sitamarhi and Sheikhpura, emerging as intense pockets of nutritional deprivation. Overall, the map clearly corroborates the tabular classification by highlighting regional clustering rather than random distribution, emphasizing that child stunting in Bihar is strongly shaped by localized socio-economic, infrastructural, and demographic factors, thereby necessitating district-specific and regionally differentiated policy responses.

Spatial Pattern and Clustering of Child Wasting

Child wasting, characterized by low weight-for-height, reflects acute undernutrition and is a critical public health concern. In Bihar, the prevalence of wasting among children under five varies significantly across districts, indicating potential spatial patterns and clusters that warrant investigation.

Table-2. Classification of Bihar Districts According to Wasting Prevalence

Class Interval	No. of Districts	Name of Districts
Very Low (<17.94)	5	Pashchim Champaran, Sitamarhi, Sheikhpura, Purba Champaran, , Madhubani
Low (17.94-22.64)	12	Siwan, Nawada, Darbhanga, Jamui, Vaishali, Muzaffarpur, Saharsa, Madhepura, Begusarai, Bhagalpur, Samastipur, Gopalganj
Moderate(22.64-27.34)	11	Katihar, Kishanganj, Araria, Gaya, Khagaria, Lakhisarai, Supaul, Purnia, Munger, Banka, Kaimur(Bhabua)
High (27.34–32.04)	5	Patna, Nalanda, Saran, Bhojpur, Rohtas
Very High (>32.04)	5	Aurangabad, Buxar, Sheohar, Jehanabad, Arwal

Source : Compiled by Author

The spatial distribution of child wasting in Bihar shows clear inter-district variation and distinct clustering patterns. Very low and low wasting levels are largely concentrated in northern and north-central Bihar, indicating relatively better short-term nutritional outcomes in these areas, though isolated southern districts also show favourable conditions.

The moderate wasting category is mainly clustered in eastern Bihar, with a few districts in central and southern parts, suggesting transitional zones where timely interventions could prevent further deterioration. In contrast, high wasting districts form a noticeable cluster in central and western Bihar, reflecting persistent acute nutritional stress.

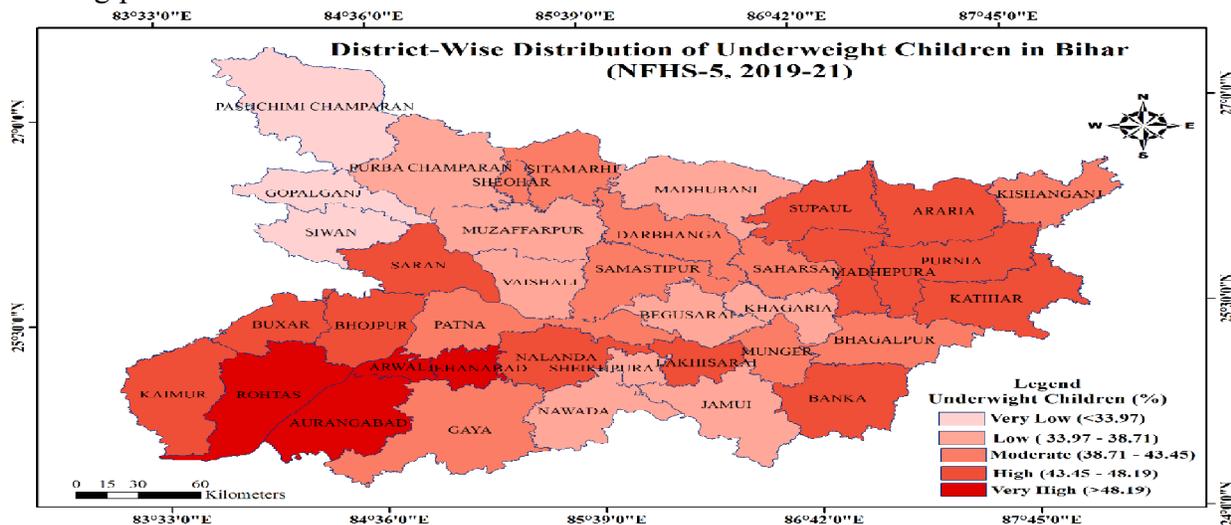


Figure 3: Choropleth Map of Child Wasting Rates in Bihar (NFHS-5, 2019-20)

Districts with very high wasting show a strong concentration in southern Bihar along with scattered pockets elsewhere, highlighting localized vulnerability to acute undernutrition. Overall, the spatial pattern of wasting in Bihar underscores pronounced regional inequalities and reinforces the need for district-specific, spatially targeted nutrition and health interventions rather than uniform state-wide strategies, possibly due to better access to health services, nutrition awareness, and public schemes in these areas.

Spatial Pattern and Clustering of Child Underweight :

Child underweight, defined as low weight-for-age, is a composite indicator of both acute and chronic undernutrition. It reflects the cumulative effects of insufficient food intake, frequent illness, and inadequate maternal-child care over time. In Bihar, underweight prevalence among children under five remains a major public health concern, with substantial inter-district disparities

Table-3.

Classification of Bihar Districts According to Underweight Prevalence

Class Interval	No. of Districts	Name of Districts
Very Low (<33.97)	3	Gopalganj, Pashcim Champaran, Siwan
Low (33.97-38.71)	8	Muzaffarpur, Begusarai, Madhubani, Khagaria, Nawada, Jamui, Sheikpura, Purba Champaran, Vaishali
Moderate (38.71-43.45)	10	Darbhanga, Munger, Patna, Bhagalpur, Sitamarhi, Kishanganj, Sheohar, Saharsa, Samastipur
High (43.45-48.19)	13	Gaya, Madhepura, Bhojpur, Saran, Supaul, Lakhisarai, Buxar, Banka, Nalanda, Purnia, Kaimur (Bhabua), Araria, Katihar
Very High (>48.19)	4	Rohtas, Aurangabad, Jehanabad, Arwal

Source: Compiled by Author

The prevalence of underweight among children under five in Bihar remains a serious public health concern, with wide district-level disparities. Based on NFHS-5 (2019-20) data, the proportion of underweight children ranges from less than 29.23% to over 52.94%. while the state average at 22.89%.

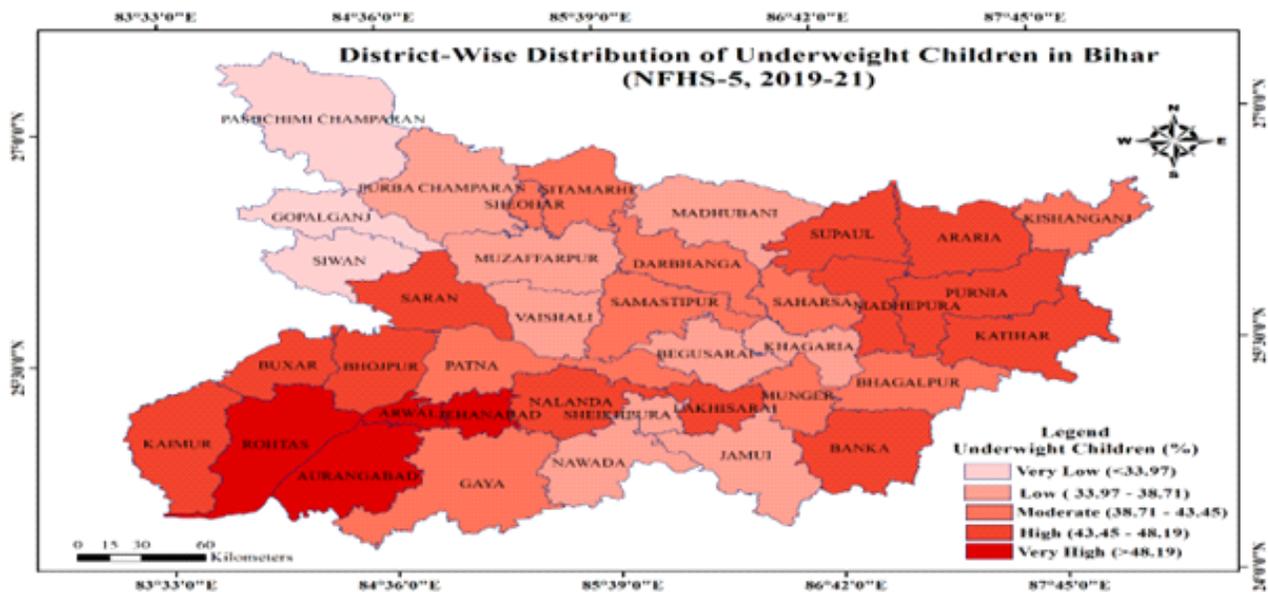


Figure 4: Choropleth Map of Child Underweight Rates in Bihar (NFHS-5, 2019-20)

The spatial distribution of child underweight in Bihar shows clear regional disparities and clustering. Very low underweight prevalence is concentrated in northwestern Bihar, indicating relatively better child nutritional conditions. Districts with low prevalence are more dispersed, though small clusters in eastern-central and southern Bihar point to the role of localized health interventions and governance.

Moderate underweight prevalence forms a distinct cluster in north-central Bihar, marking these districts as transitional zones where sustained nutrition and health efforts could bring improvement. High underweight prevalence is more widespread, with notable clustering in northeastern Bihar and additional pockets in western and southern regions, reflecting persistent structural challenges such as poverty, flooding, migration, and gaps in service delivery.

A pronounced micro-cluster of very high underweight prevalence appears in southwestern Bihar, where adjoining districts experience severe nutritional stress. Overall, the spatial pattern highlights strong regional inequalities in Bihar and emphasizes the need for decentralized, district-specific strategies to effectively reduce child undernutrition.

Spatial Pattern and Clustering of Child Overweight

Child overweight, marked by excess body weight for age and height, is increasingly emerging as a public health concern in Bihar alongside persistent undernutrition. This coexistence reflects a growing dual burden of malnutrition, with early-life being overweight raising the risk of future non-communicable diseases. Mapping the spatial distribution of childhood overweight is therefore important for identifying risk-prone areas and guiding preventive nutrition policies.

Table-4. Classification of Bihar Districts According to Overweight Prevalence

Class Interval	No. of Districts	Name of Districts
Very Low (<1.792)	13	Purnia, Nawada, Supaul, Katihar, Khagaria, Patna, Lakhisarai, Kishanganj, Madhepura, Darbhanga, Jamui, Samastipur, Nalanda
Low (1.792-2.744)	11	Jehanabad, Saharsa, Muzaffarpur, Madhubani, Saran, Sitamarhi, Bhojpur, Munger, Paschim Champaran, Kaimur (Bhabua), Rohtas
Moderate (2.744-3.696)	6	Bhagapur, Arwal, Araria, Siwan, Sheohar, Gopalganj
High (3.696-4.648)	4	Gaya, Purba Champaran, Vaishali, Begusarai,
Very High (>4.648)	4	Aurangabad, Buxar, Banka, Sheikhpura

Source: Compiled by Author

According to the National Family Health Survey (NFHS-5, 2019-20), Bihar exhibits notable inter-district variations in the prevalence of overweight children under five. The proportion ranges from 0.8% to over 5.60%, reflecting both demographic and nutritional transitions occurring unevenly across the state. To interpret and visualize this disparity, the districts have been classified into five categories—from very low to very high prevalence—and displayed using a choropleth map.

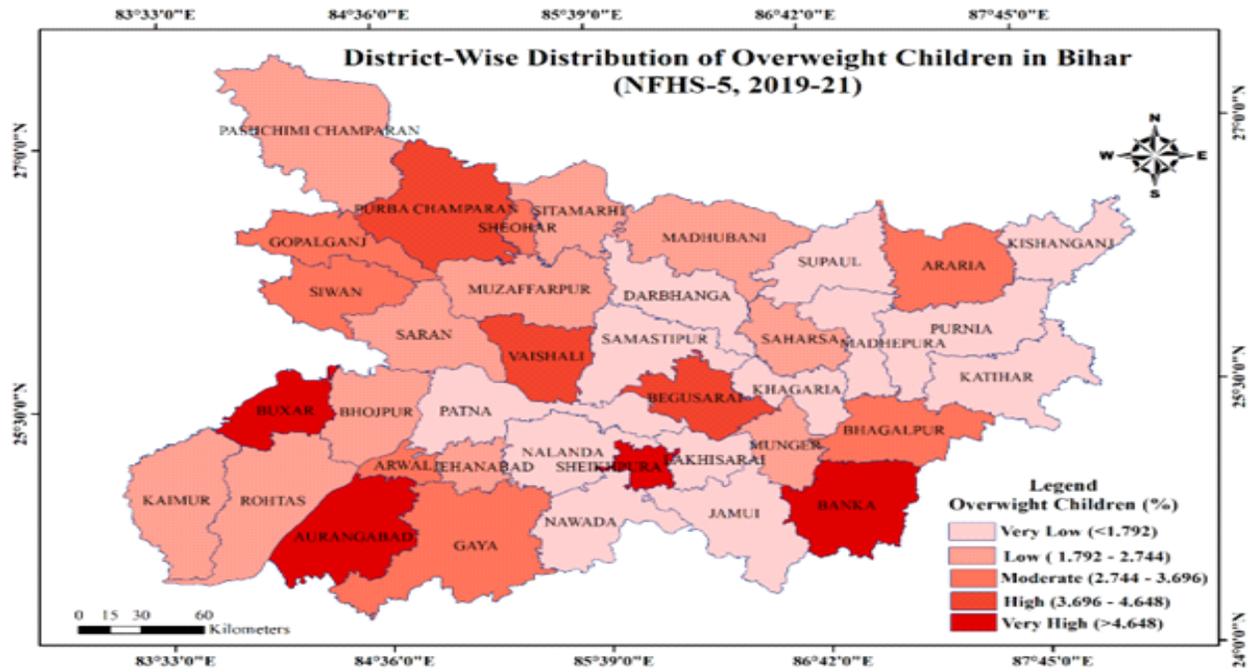


Figure 5: Choropleth Map of Child Overweight Rates in Bihar (NFHS-5, 2019-20)

The spatial pattern of child overweight in Bihar shows an early and uneven spread of overnutrition across districts. Low prevalence in many northern, western, and southern districts suggests that most areas are still at an initial stage of nutrition transition, though regional differences persist. Moderate overweight levels are scattered across the state, indicating localized dietary and lifestyle changes rather than a clear regional trend.

High overweight prevalence is beginning to cluster along the central Ganga plains and in parts of northern and southern Bihar, reflecting the growing influence of urbanization and changing food environments. A distinct very high micro-cluster in southern and southwestern Bihar signals a critical shift toward childhood overnutrition. Overall, these patterns highlight the need for spatially targeted and integrated interventions to address the emerging dual burden of malnutrition in the state.

Finding and Conclusion:

The findings indicate that child overweight in Bihar is emerging gradually and unevenly across districts. Low overweight prevalence in several northern, western, and southern districts suggests that much of the state is still at an early stage of nutrition transition; however, noticeable regional differences point to the presence of a potential dual burden of malnutrition. Districts with moderate overweight prevalence are distributed across eastern, northern, and southern Bihar. This scattered pattern reflects localized changes in food habits, lifestyle, and economic activities rather than a uniform regional trend, indicating that nutrition transition is progressing unevenly within the state.

Higher overweight prevalence shows emerging clustering along the central Ganga plains and in parts of northern and southern Bihar. These clusters highlight the increasing influence of

urbanization, market access, and dietary shifts, affecting not only urban centers but also semi-urban and rural areas.

A distinct micro-cluster of very high child overweight prevalence in southern and southwestern Bihar signals a critical transition towards childhood overnutrition. In conclusion, the spatial patterns reveal an evolving dual burden of malnutrition in Bihar, emphasizing the need for region-specific and integrated nutrition strategies that simultaneously address both undernutrition and emerging overnutrition.

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