International Journal of Geography, Geology and Environment

P-ISSN: 2706-7483
E-ISSN: 2706-7491
www.geojournal.net
IJGGE 2024; 6(1): 01-09
Received: 02-11-2023
Accepted: 05-12-2023

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Spatiotemporal variations in child undernutrition in Bihar: A district level analysis

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DOI: https://doi.org/10.22271/27067483.2024.v6.i1a.193

Abstract
Child undernutrition is an important public health and development indicator and is an issue that needs urgent attention especially among developing countries. There is a universal acceptance among experts that children of all ethnic backgrounds cutting across geographical boundaries have similar growth potentials to at least five years of age. The three anthropometric measures *viz*. stunting, underweight and wasting are used to find out the amount of undernourishment. Bihar with 18.6% child population (0-6 years) ranks second only to Uttar Pradesh. As per the NFHS-5, Bihar with 42.5% stunted children is the highest among major states, underweight children at 41% is the highest in India and 22.9% wasting rate reflects that this state has miles to go to achieve this important public health challenge. The present study tries to study the spatial- temporal variations in child undernutrition among the districts using geospatial mapping in Bihar comparing the NFHS-4 and NFHS-5 data and seeks to find any regional pattern in its concentration. Spatial heterogeneity has been found in the anthropometric measures suggesting that the variations in determinants of child undernutrition play key role and the improvements vary over districts. Concentrating upon the regional hotspots of child undernutrition and targeted interventions can bring positive outcomes.

Keywords: Bihar, child undernutrition, stunting, development concern, spatiotemporal

Introduction
Child undernutrition is a serious public health and development concern, particularly in developing nations, and is an important marker of the well-being of any community. Generally, it refers to a condition in which a child consumes insufficient calories to meet their demands for growth, physiological function, and the ability to fight off diseases [1]. There is a clear causative relationship as well as a high correlation between infant mortality and widespread child undernutrition [2-5]. Additionally, undernourished children have a higher chance of experiencing stunted intellectual growth, delayed cognitive development, poor school performance, and a markedly increased likelihood of developing functional impairments as adults [6-8]. Given this background, child undernutrition cannot be taken lightly by any country or state which seriously intends to fight this major public health and development challenge.

A child's undernourishment is measured using the new growth criteria recommended by WHO [9, 10], which are based on anthropometric measures. Stunting, wasting, and underweight are its three indicators. A child considered stunted is one who is too small for their age. It accurately captures the extent of socioeconomic disparity and serves as a summative indicator of children's well-being [11]. It is an indicator of chronic malnutrition. The Lancet series highlighted the long-term effects of stunting on adult health and human capital [12]. Wasting refers to a child who is too thin for his/her height. It is due to recent rapid weight loss or failure to gain weight. It is an indicator of acute undernutrition. Underweight refers to a child who has inadequate weight for age. It considers both chronic and acute undernutrition. Previous studies argue that underweight and wasting are more accurate indicators of mortality than stunting [13].

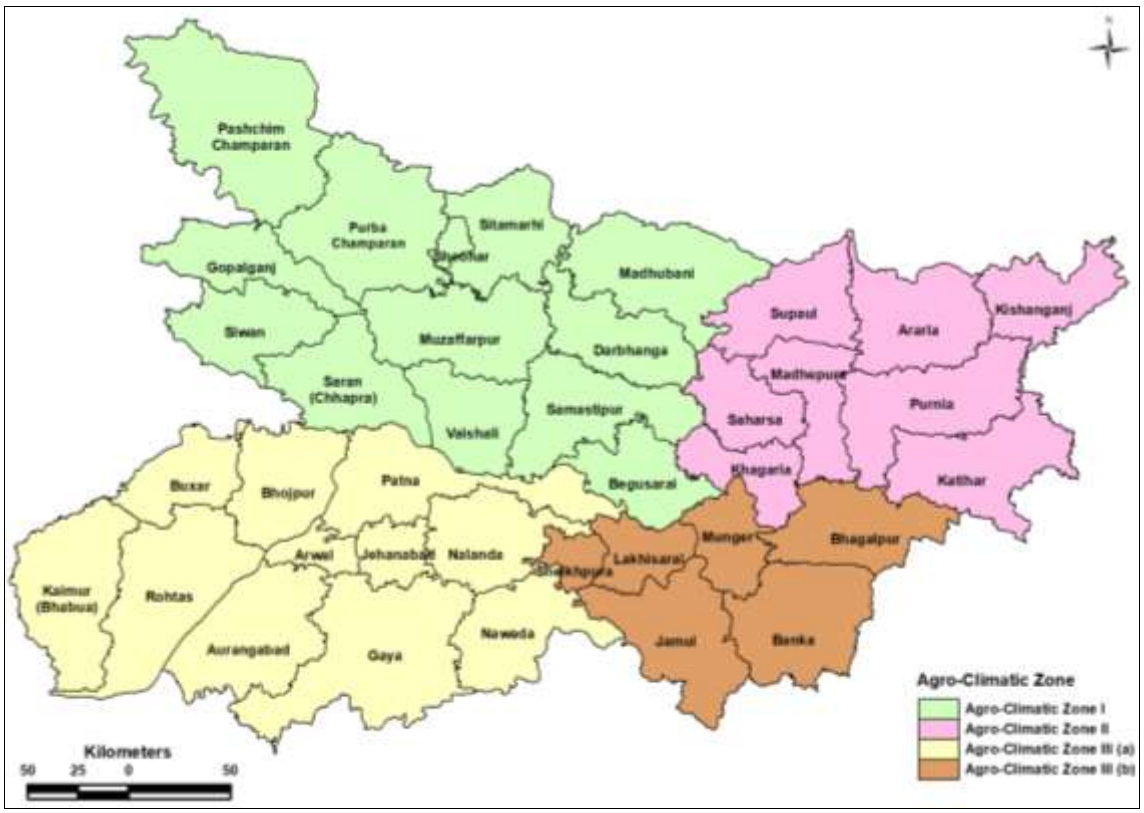
Literature review
Child undernutrition rates are a good way to gauge the state of public health because they reveal a lot about the existence of discrimination, marginalisation, and exclusion due to factors like widespread poverty, ingrained gender and sociocultural disparities, caste

divisions, inadequate infrastructure, a shortage of essential services, and frequent natural disasters. In the Indian context, the socioeconomic indicators of nutritional deprivation tend to be based on caste. The correlation between caste identity and child nutrition status is especially obvious in Bihar. According to data from NFHS-4 [15], there are 55.8 and 51 percent, respectively, of wasted and stunted children in scheduled castes. Comparable percentages for "Others" are 37.8 and 33.3, respectively. For Bihar, the total percentages of stunting and wasting are 48 and 44 percent, respectively, across all social categories. According to the preceding statistics, Scheduled Castes differ from "Others" in terms of stunting and wasting by 18% in each indicator. Furthermore, Bihar has the greatest percentage of stunted children from scheduled castes out of all the states, and Jharkhand is the only state with lower rates of wasting. Nevertheless, these numbers obscure the geographical differences in child malnutrition at lower regional levels, such as district level [16] found in their study that SC-ST children are 50 percent more likely to be stunted than 'Others' children. An essential factor in determining a child's nutritional health is the mother's educational attainment. Numerous studies emphasise how important it is in overcoming this obstacle. Mother's educational attainment is proven to be more significant than father's education, household financial situation, and accessibility to health care [17-19].

Several studies have been made in the past in which the findings reiterate the linkage between access to land and undernutrition [20-23]. In contrast to all other developing economies, India's prevalence of child undernutrition deviates more than predicted from the nation's per capita GDP [24, 25]. Out of all the states in the nation, Bihar has the lowest per capita income. There are also stark variations among districts in terms of per capita income. It might be a significant factor in explaining the differences in child undernutrition. Numerous studies demonstrate that, in comparison to their rural counterparts, children living in urban areas receive superior nutrition and are less likely to be stunted and underweight [26-28]. The NFHS-4 data shows that the rates of stunting in urban and rural areas are 10 percentage points different, at 31 and 41 percent, respectively in India. The comparable percentages for Bihar are 40 and 49 percent, respectively, which is horribly high. The above studies underline the various socio-economic correlates of child undernutrition.

As per the NFHS-5 Report (2019-20), India cuts a sorry figure in terms of stunting with almost every third Indian child reported to be too short for his/her age (35.5%) and wasting at 19.3 percent which is way higher than the global average. India is home to every fourth stunted child in the world. It still has a long way to go before it reaches the WHO's Global Nutrition Targets 2030 [29], which aim to keep childhood wasting at less than 3% and cut the percentage of stunted children under 5 by 50%. The states of India share a disproportionate share of the burden of child undernutrition. Bihar holds the dubious distinction of having the highest number of stunted children among major states in terms of population (42.9%) in the country, according to the NFHS-5 Report. At 41 percent, the percentage of underweight children is likewise startlingly high and wasting at 22.9% is third only to Maharashtra and Gujarat.

Drawing on the preceding discourse on the socioeconomic determinants of child undernutrition, the principal objective of this study is to comprehend the regional disparities in nutritional patterns among children under five years of age across the districts of Bihar. The present study attempts to analyse the spatial and temporal variations in child undernutrition in Bihar at the district level using the NFHS-4 (2014-15) and NFHS-5 data on anthropometric measurements. We also seek to identify any regional hotspots in terms of child undernutrition indicators in the agro-climatic zones districts.



Study area

Bihar, one of India's largest states, has been considered in the purposes of study. According to the Geographic Survey of India (GSI, Government of India, 2015), Bihar is situated in the eastern part of the country, between latitudes 24°20'10"N and 27°31'15"N and longitudes 83°19'50"E and 88°17'40"E. In Bihar, there are four distinct agro-climatic zones based on soil composition, precipitation patterns, temperature, and topography namely Zone I, North Alluvial Plain; Zone II, North East Alluvial Plain; Zone III A, South East Alluvial Plain; and Zone III B, South West Alluvial Plain [14]. Out of these three, Zone-I and Zone II are to the north of the Ganga River and are prone to floods every year and Zone-III is in the south and receives less amount of rain. The map below shows the districts which come under different agro-climatic zones of Bihar.

Data and Methods

The present study uses National Family Health Survey (NFHS) data NFHS has been conducted in India during 1992-93, 1998-99, 2005-06, 2015-16 & 2019-20. It is a large scale, multi-round survey conducted in representative sample households across the states and union territories throughout India. They were done in collaboration with the International Institute for Population Sciences (IIPS), Mumbai, India, ORC Macro, Calverton, Maryland, USA, and the East-west Centre, Honolulu, Hawaii, USA. IIPS coordinated these surveys and collaborated with number of Field Organizations for survey implementation. The NFHS-4 (2015-16) and NFHS- 5 (2019-20) provide reliable data on estimates of fertility, infant and childhood mortality, nutritional status of children, use of maternal and child healthcare etc. at the state and district level. The present study uses the NFHS data on child nutritional status through anthropometric indicators on states of India and the districts of Bihar to understand its spatiotemporal variations and identify the hotspots where there is a pressing need for action.

The present study employs cartographic methods to show the district level variations in anthropometric measurements of child undernutrition. The districts have been clubbed into four agro-climatic zones as discussed in the study area. Geospatial mapping has been done to identify the patterns and the differences in stunting, wasting and underweight from NFHS-4 and NFHS-5 in these agro-climatic zones.

Results

NFHS-5 Report shows that there are variations in the prevalence of anthropometric measurements in children (0-59 months) among the states in India with Meghalaya, Maharashtra and Bihar recording the highest percentages of stunting, wasting and underweight respectively. At the district level, the picture may be very different. The results are the representations of variations in socio-economic, geographical and demographic factors.

Figure 1 depicts the relative position of Bihar in the prevalence of stunting and the change observed in NFHS-5 over NFHS-4 with respect to other states. The stunting was at 48.3% in NFHS-4 report which has declined by 5.4 percentage points in NFHS-5 at 42.9%. Stunting is an indicator of chronic malnutrition. This figure for Bihar is second only to Meghalaya and is the highest among all major states of India. Although, it has come a long way in its fight against child undernutrition but the results are moderate.

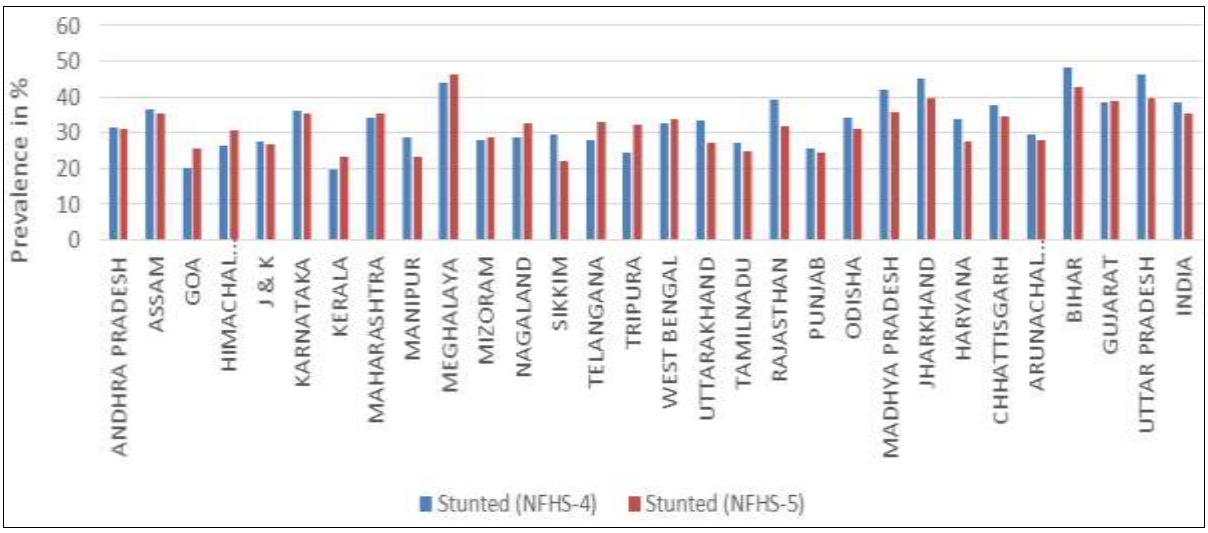


Fig 1: Change in prevalence of stunting in children (0-5 years)

Figure 2 shows the change in prevalence of wasting among the states. States like Assam, Himachal Pradesh, Manipur, Mizoram, Nagaland, Telangana, Tripura and Bihar have recorded increase in the prevalence of wasting which is not very encouraging. Wasting percentage for Bihar has gone up by 2.1 percentage points from 20.8% to 22.9% which is an indicator of acute malnutrition.

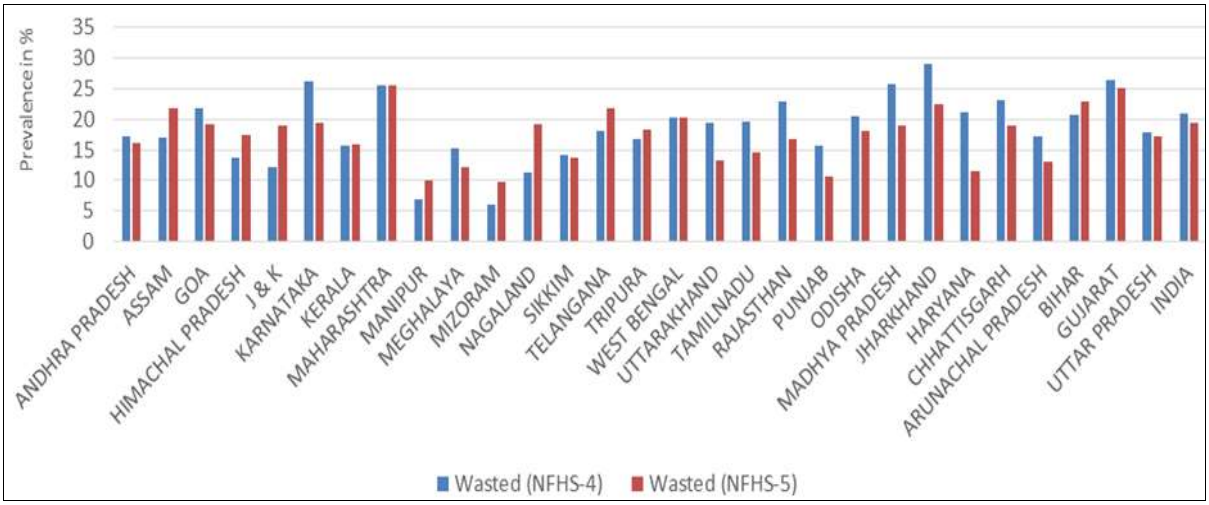


Fig 2: Change in prevalence of wasting among children (0-5 years)

Figure 3 denotes the change in prevalence of underweight children among the states. It is an indicator of both acute and chronic malnutrition. Assam, Himachal Pradesh, J & K, Kerala, Nagaland and Telangana have recorded significant increase in the percentage of underweight children in NFHS-5 when compared with the previous report. Bihar despite recording a decline in the percentage share of underweight children stands the tallest in the overall percentage share at 41% and is 9 percentage point higher than the national average.

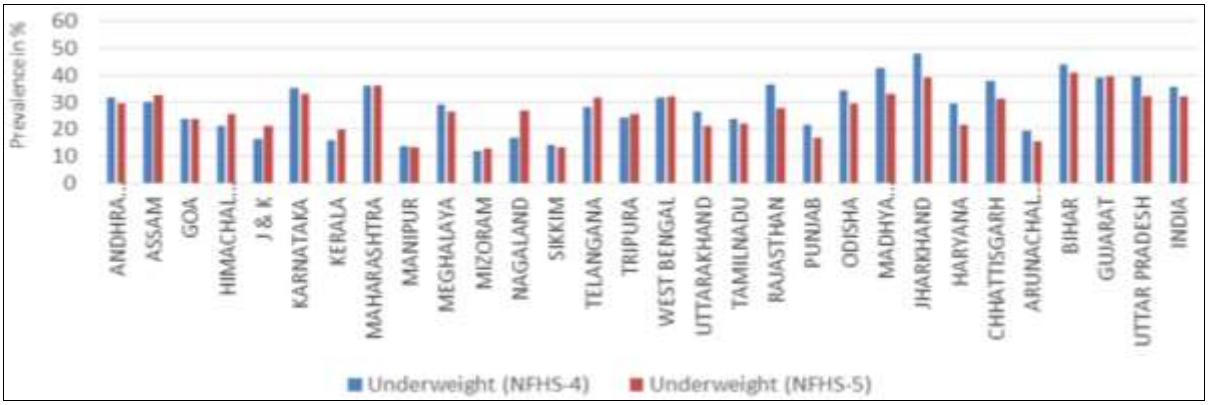


Fig 3: Change in prevalence of underweight among children (0-5 years)

Bihar is the third most populous state of India and only Uttar Pradesh has a higher percentage of children (0-6 years) than Bihar with 18.6% child population (Census, 2011) [30]. It has great potential to convert its young population into demographic dividend. The degree of child undernutrition in the state is a major developmental challenge. There is a great deal of socioeconomic diversity with caste playing a dominant role in the distribution of resources. As it is well established that mother's educational level plays a significant role in the nutritional status of a child, Bihar has the lowest female literacy rate among all the states of India (Census, 2011) [30] and is a major obstacle in fighting off child undernutrition. District is an important administrative unit for the allocation of resources to the masses and in the dissemination of public policies. Based on anthropometric parameters, NFHS-5, like NFHS-4, offers district-level estimates of undernutrition in children and is comparable over time.

Figure 4 shows the variations in the prevalence of child stunting among the districts in Bihar with Sitamarhi (54.2%), Sheikhpura (53.6%), Araria (49.9%), Nawada (49.4%), Purbi Chamaparan (49.1%), Saharsa (47.8%), Gaya (47.4%), Banka (46.7%), Madhepura (46.3%), Arwal (45.6%), Darbhanga (45.4%), Kaimur (44.1%), Samastipur (44%), Katihar (43.9%), Paschim Champaran (43.5%), Purnia (43.5%), Madhubani (43.3%) and Jamui (43%) having recorded higher percentage than the state average. Gopalganj, Sheohar, Patna, Khagaria and Munger are the only districts which has lower percentage than the national average of 35.5% stunting. Flood prone districts such as Supaul, Araria, Madhepura, Saharsa, Purnia, Katihar and the Shiwalik Terai districts such as Sitamarhi, Purbi and Paschimi Champaran, Madhubani have higher occurrence than the districts which are nearer to the Ganga River namely Siwan, Saran, Buxar, Patna, Vaishali, Begusarai, Munger and Bhagalpur. Recurrence of flood every year may be a possible cause of food insecurity in the region.

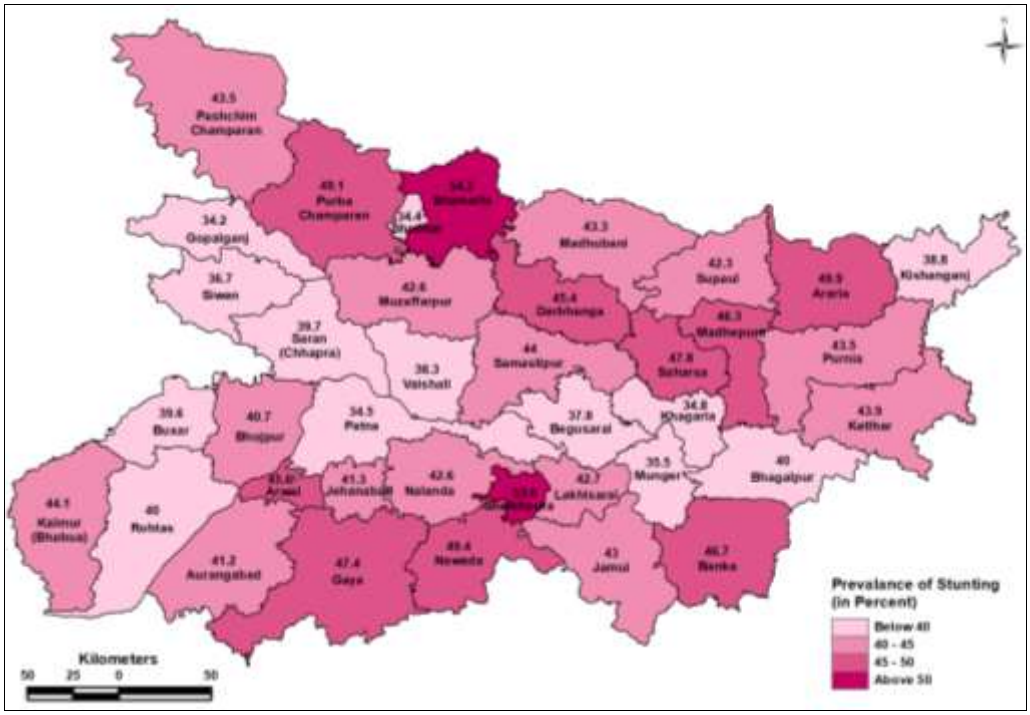


Fig 4: District wise prevalence of stunting in children in Bihar (NFHS-5)

Figure 5 shows the most of the districts with higher percentage share of wasting than the state average are concentrated in the north east alluvial plains and the southwest regions. Arwal (36.8%), Jehanabad (36.6%), Buxar (33.2%), Aurangabad (32.9%), Rohtas (31.8%) and Bhojpur (31.3%) have recorded more than 30% wasting among children and most of these are south west region districts. Districts belonging to the northwest region of the state such as Purbi and Paschimi Champaran, Sitamarhi, Madhubani, Darbhanga and Nawada and Sheikhpura in southern Bihar have fared much better and are below the national average of 19.3% wasting.

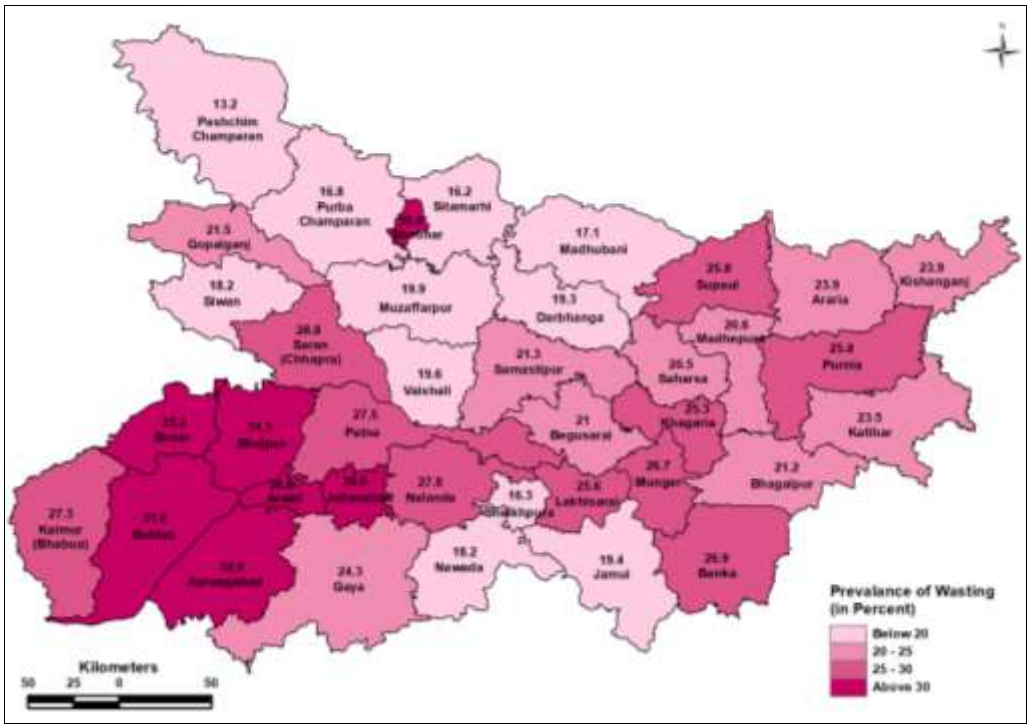


Fig 5: District wise prevalence of wasting in children in Bihar (NFHS-5)

Figure 6 shows the underweight percentages which is an anthropometric measure that indicates both acute and chronic malnutrition plotted against their respective districts of Bihar as per the NFHS-5 data. There is spatial heterogeneity in terms of its distribution with north east region districts such as Araria (47.8%), Purnia (47.1%), Katihar (48.1%) and Kaimur (47.2%), Rohtas (48.2%), Buxar (45.2%), Aurangabad (48.7%) Arwal (52.9%), Jehanabad (51.7%), Nalanda (46.7%) Lakhisarai (45.1%) and Banka (45.8%) among the south Bihar districts have reported more than 45% wasting which is alarming from the angle of public health condition. Only Gopalganj (29.2%),

Paschimi Champaran (30.3%) and Siwan (30.8%) all in the north-west alluvial plain region have recorded less percentage share than the national figure of 32.1%.

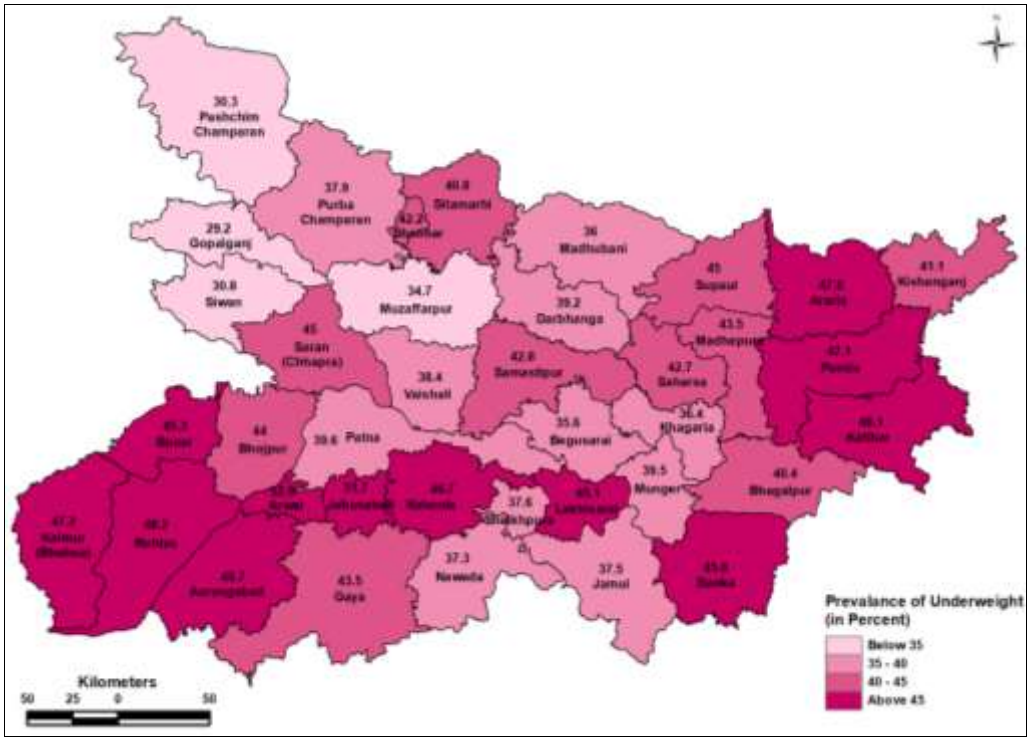


Fig 6: District wise prevalence of underweight children in Bihar (NFHS-5)

Figure 7 shows the change in prevalence of stunting over NFHS-4 and NFHS-5 in the districts of Bihar. It reflects spatiotemporal variations in stunting and is an indicator of the performances of the stakeholders in fighting off this important public health challenge. The worst performing districts are Sheikhpura, Saharsa, Purbi Chamaparan and Araria which has reported increase in stunting by 7.2, 3.9, 1.9 and 1.5 percentage points respectively. Except these all other districts have shown decrease in the percentage share of stunting as shown in the figure. The districts such as Sheohar, Vaishali, Khagaria, Munger, Nalanda and Jehanabad have performed remarkably and have brought down the share of stunting by 18.6, 15.4, 15, 11.1, 11.5, 10.8 percentage points respectively. However, there is no spatial homogeneity in the share of stunting from the vantage of physiographic divisions of Bihar.

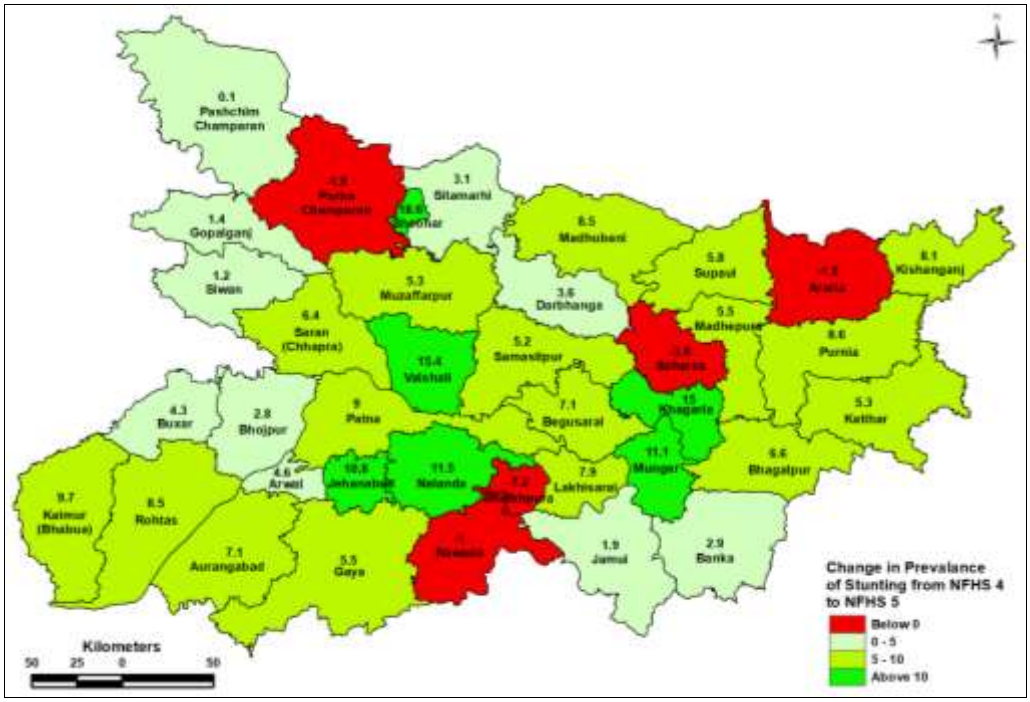


Fig 7: District wise change in prevalence of stunting in children in Bihar

Figure 8 maps the change in the prevalence of wasting among children from NFHS-4 and NFHS-5. Paschim Champaran, Sheikhpura and Jamui stand out as the outstanding performers which have brought down the wasting by 8.5, 12.6 and 10 percentage points. There are districts such as Purbi Champaran, Madhubani, Madhepura, Saharsa, Bhagalpur, Patna, Gaya and Nawada which have shown reduction in the percentage share of wasting. Except these 11 districts, all have performed poorly and there has been an increase in the percentage share of wasted children which is a matter of great concern. Most of the southwestern districts of Bihar such as Kaimur, Rohtas, Buxar, Aurangabad, Bhojpur, Aurangabad, Arwal and Jehanabad have shown poor performance in terms of reduction of wasting share. The share of wasting has risen up by more than 5 percentage points in these districts. Jehanabad is the worst performer with an increase of 17 percentage points.

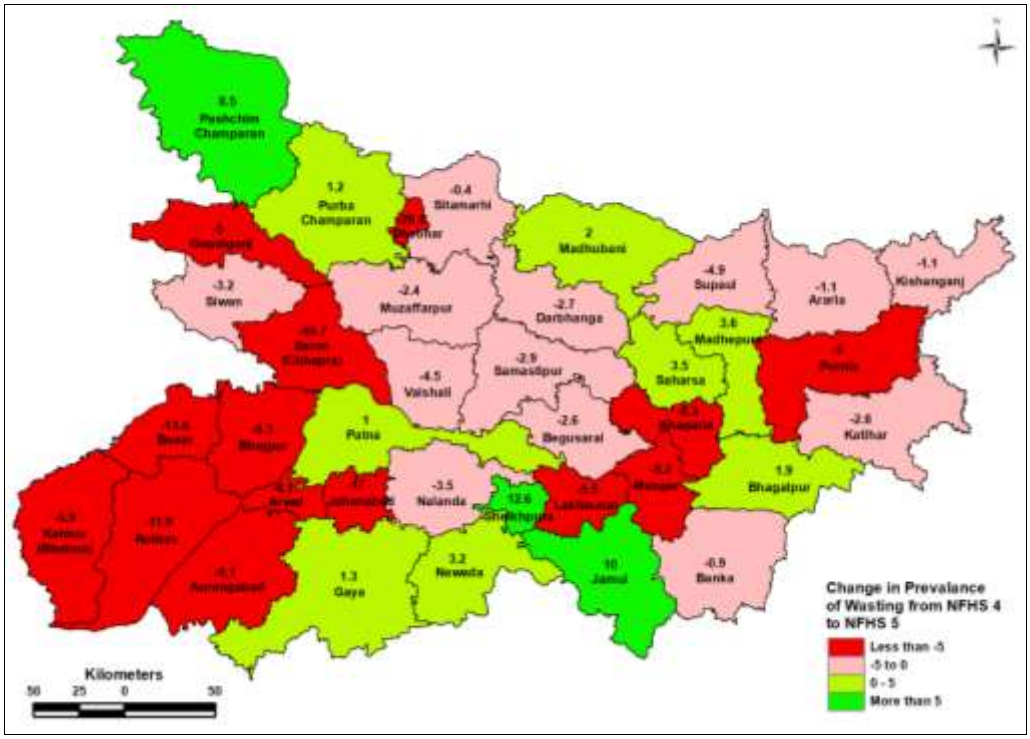


Fig 8: District wise change in prevalence of wasting among children in Bihar

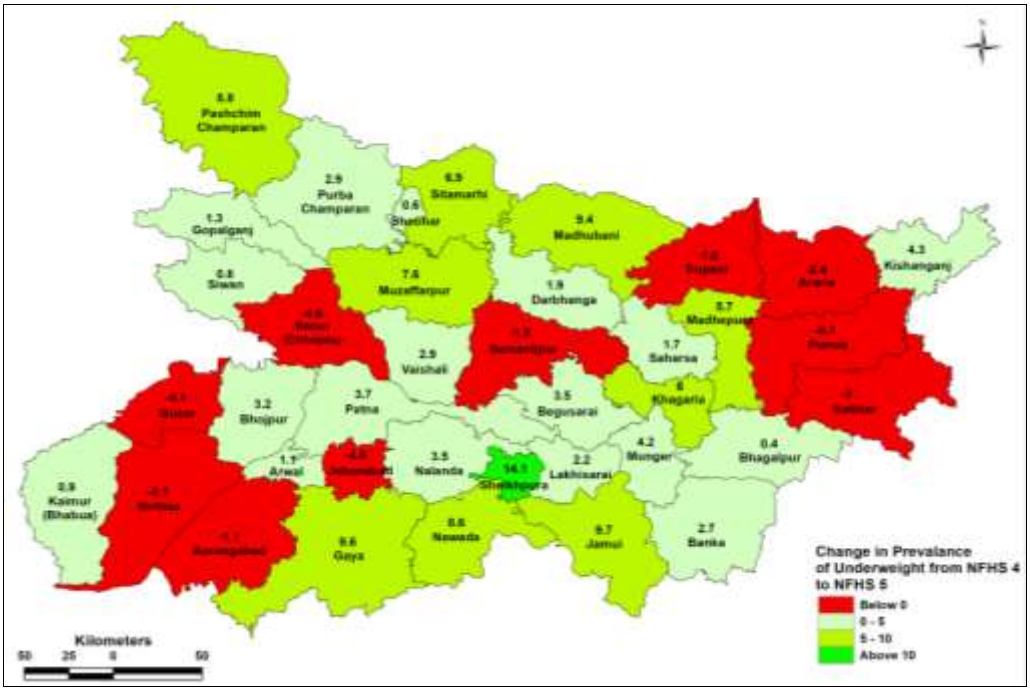


Fig 9: District wise change in prevalence of underweight children in Bihar

Figure 9 demonstrates the change in prevalence of underweight among children in the districts of Bihar from NFHS-4 to NFHS-5. There are 9 districts which have fared poorly on this account and have shown increase in the percentage share of underweight children. Buxar, Rohtas, Aurangabad and Jehanabad are the four southwest region

districts which have registered increase in underweight share by 4.1, 3.1, 1.1 and 4.6 percentage points respectively. Supaul, Araria, Purnia and Katihar are the northeast region districts of Bihar which have reported an increase in the share of underweight children by 1.6, 2.4, 0.1, and 3 percentage points respectively. These districts are neighbouring districts and regional homogeneity may be a criterion to interpret the increase in the underweight children share. Apart from that Sheikhpura has shown exemplary performance by reducing underweight children by 14.1 percentage points

Conclusion

There is no spatial homogeneity in the prevalence of stunting and it does not seem to follow any administrative or agro-climatic boundary. In case of wasting and underweight, there is greater prevalence of wasting and underweight incurrence in the south west and north east plain regions. Generally, north-west region has fared better relative to the above two regions. Bihar has considerable variations among districts in terms of per capita income, female literacy rate, urbanization rate, caste composition, land ownership etc. which may better explain the spatial heterogeneity in anthropometric indicators and attempts should be made to clinically deal with this public health issue.

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