

Spatial and Socio-Demographic Factors Associated with Stunting Among Under-Five Children in Bangladesh: Evidence from the Bangladesh Demographic and Health Surveys, 2011–2022

Rasedul Islam

Mawlana Bhashani Science and Technology University

Prayas Sur Antu

Mawlana Bhashani Science and Technology University

Farjana Afrin Koasha

Mawlana Bhashani Science and Technology University

Md. Hazrat Ali

Mawlana Bhashani Science and Technology University

Faijun Nahar Mim

`fai.jun@mbstu.ac.bd`

Mawlana Bhashani Science and Technology University

Research Article

Keywords: Stunting, Under-five children, Bangladesh, Spatial distribution, Socio-demographic correlates, BDHS

Posted Date: October 14th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11156871/v1>

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Additional Declarations: No competing interests reported.

Abstract

Background

Stunting remains a major public health challenge among children under five years of age in Bangladesh, with potential long-term consequences for physical growth, cognitive development, and future productivity. This study assessed temporal trends in stunting prevalence and examined its spatial distribution and socio-demographic correlates among under-five children in Bangladesh.

Methods

Data from four rounds of the Bangladesh Demographic and Health Survey (BDHS) conducted in 2011, 2014, 2017–18, and 2022 were analyzed, including 34,218 under-five children. Descriptive statistics and chi-square tests were used to examine associations between stunting and selected socio-demographic characteristics. Geographic Information System (GIS)-based mapping was used to visualize variation in stunting prevalence across administrative divisions and urban–rural settings.

Results

The prevalence of stunting declined from 36.0% in 2011 to 32.1% in 2014, 27.4% in 2017–18, and 10.8% in 2022. Stunting was significantly associated with child age, maternal education, household wealth status, sanitation facilities, and place of residence ($p < 0.001$). A larger share of stunted children was observed among poorer households, children of mothers with lower educational attainment, households with less adequate sanitation facilities, and rural areas. Spatial analysis indicated persistent regional disparities, with Sylhet and Mymensingh showing comparatively higher stunting prevalence across the study period despite overall national improvement.

Conclusion

Bangladesh has made substantial progress in reducing childhood stunting; however, socioeconomic and geographical disparities persist. Efforts to improve maternal education, reduce socioeconomic disadvantage, strengthen sanitation, and address areas with comparatively high stunting prevalence may help sustain progress and reduce remaining inequalities in child nutrition.

INTRODUCTION

Child malnutrition remains one of the most important public health challenges worldwide, particularly in low- and middle-income countries (LMICs). Among the major forms of undernutrition, stunting is a key indicator of chronic undernutrition and is defined as a height-for-age Z-score (HAZ) below -2 standard deviations according to the World Health Organization (WHO) Child Growth Standards. Stunting reflects sustained nutritional deprivation and repeated exposure to infection during critical periods of growth and development (Mulyani et al., 2025). It can have long-term consequences for physical growth, cognitive development, educational attainment, and economic productivity, potentially contributing to intergenerational cycles of poor health and socioeconomic disadvantage (De Sanctis et al., 2021).

Despite substantial global progress in reducing child undernutrition, stunting remains prevalent in many developing countries. Previous studies have identified a range of socio-demographic, economic, and environmental factors associated with stunting, including child age, parental education, household wealth, sanitation facilities, maternal nutritional status, and place of residence (Arief et al., 2025; Mulyani et al., 2025; Siddiqi et al., 2026; Tewachew & Minale, 2025). Evidence from countries such as Ethiopia also indicates that both individual- and community-level characteristics may be associated with childhood stunting, underscoring the importance of contextual differences when designing nutrition interventions (Ayele et al., 2025).

Bangladesh has made substantial progress in child health and nutrition over the past two decades; however, childhood stunting remains an important public health concern (S. Kundu et al., 2025). Although national prevalence has declined considerably, a notable proportion of under-five children continue to experience chronic undernutrition. Recent studies have reported associations between stunting and household socioeconomic conditions, parental education, sanitation, and regional inequalities (Khan et al., 2025; Nahar & Zahangir, 2024; Suchana et al., 2026a). Geographical variation also persists across administrative divisions, indicating that the burden of stunting is not evenly distributed across the country (R. N. Kundu et al., 2024; Md. M. Rashid et al., 2024). Children living in socioeconomically disadvantaged households and underserved communities remain particularly vulnerable to poor nutritional outcomes (Hasan et al., 2020).

Several studies in Bangladesh have examined factors associated with childhood stunting using demographic and health survey data. These studies have consistently identified child age, birth order, parental education, household socioeconomic status, sanitation facilities, and place of residence as relevant correlates of stunting (Abdulla et al., 2023; Akter & Nishu, 2025; S. Kundu et al., 2025). Recent spatial analyses have also reported geographical clustering of child malnutrition, particularly in Sylhet and Mymensingh divisions, suggesting persistent regional inequalities in nutritional outcomes (Das et al., 2022; Rima et al., 2025; Suchana et al., 2026).

However, many previous studies have focused on a single survey year or on selected determinants of child malnutrition (Hussain et al., 2025; Mim et al., 2026). Relatively few studies have jointly examined temporal trends in stunting, urban–rural disparities, and divisional-level spatial patterns over an extended

period (Ntawuyirushintege et al., 2025; M. Rashid et al., 2026). Consequently, evidence describing how the magnitude and geographical distribution of stunting have changed over time remains limited.

This study aimed to assess temporal trends in stunting prevalence, its spatial distribution, and its socio-demographic correlates among under-five children in Bangladesh using BDHS data from 2011, 2014, 2017–18, and 2022. Specifically, the study examined changes in stunting prevalence over time, described spatial patterns across administrative divisions and urban–rural areas using GIS-based mapping, and assessed associations between stunting and selected socio-demographic, economic, and environmental characteristics. The findings may help inform geographically and socioeconomically targeted strategies to reduce childhood stunting in Bangladesh.

METHODS

Study Design, Setting, and Data Source

This study used data from four rounds of the Bangladesh Demographic and Health Survey (BDHS) conducted in 2011, 2014, 2017–18, and 2022. The BDHS is a nationally representative cross-sectional survey implemented by the National Institute of Population Research and Training (NIPORT) in collaboration with ICF International. The datasets are publicly available through the DHS Program (<https://www.dhsprogram.com>).

Study Population and Sampling

The study population comprised children aged 0–59 months who were living with their mothers at the time of each survey. Each BDHS round used a multistage cluster sampling design with stratification by urban and rural areas to ensure representation across the administrative divisions of Bangladesh. Data for this study were extracted from the Kids Recode (KR) files, which contain anthropometric and socio-demographic information on under-five children. After excluding records with missing values, the final sample included 8,789 children in 2011, 7,886 in 2014, 8,759 in 2017–18, and 8,784 in 2022.

Variables

The primary outcome was stunting, defined as chronic undernutrition based on the WHO Child Growth Standards. Children with a height-for-age Z-score (HAZ) below – 2 standard deviations were classified as stunted, while those with HAZ ≥ – 2 standard deviations were classified as not stunted. For analysis, stunting was treated as a binary outcome.

The explanatory variables included child age, sex, place of residence (urban/rural), household wealth index, type of toilet facility, and administrative division. Child age was categorized into eight groups: <6, 6–8, 9–11, 12–17, 18–23, 24–35, 36–47, and ≥ 48 months. Household wealth status was categorized into five quintiles (poorest, poorer, middle, richer, and richest) according to the DHS wealth index. Toilet facilities were categorized as flush toilet, pit toilet, and no facility. The administrative divisions included Barishal, Chattogram, Dhaka, Khulna, Mymensingh, Rajshahi, Rangpur, and Sylhet.

Data Management and Statistical Analysis

Data management and preliminary processing were conducted using IBM SPSS Statistics version 23. Descriptive statistics were used to summarize the characteristics of the study population, with frequencies and percentages reported for categorical variables. Chi-square tests of independence were used to assess associations between stunting and the explanatory variables. Statistical significance was defined as $p < 0.05$. Because the analysis was based on cross-sectional data and bivariate association tests, the results were interpreted as associations rather than causal effects or independent determinants.

Spatial Analysis

Spatial analyses were performed using R software (version 4.4.2). Administrative boundary shapefiles obtained from the Global Administrative Areas (GADM) database were used to represent the administrative divisions of Bangladesh. Division-level stunting prevalence was calculated and visualized using choropleth maps. GIS-based maps were produced using R packages including ggplot2 and tmap to describe regional differences and changes in stunting prevalence across survey years.

Ethical Considerations

The BDHS surveys received ethical approval from the Bangladesh Medical Research Council (BMRC) and the ICF Institutional Review Board. Informed consent was obtained from all respondents before data collection. The datasets used in this study are anonymized and publicly available, thereby protecting participant confidentiality. As this study involved secondary analysis of publicly available, anonymized data, no additional ethical approval was required.

RESULTS

Table 1 summarizes the socio-demographic characteristics of the under-five children included in the four BDHS rounds. Across survey years, the sex distribution remained relatively balanced, with males comprising approximately 51–52% of the samples and females 48–49%.

The age distribution varied across survey rounds, with older children representing a larger share of the 2022 sample. Children aged ≥ 48 months accounted for 25.0% of the sample in 2011 and 61.5% in 2022. Most children lived in rural areas throughout the study period, although the proportion residing in urban

areas increased from 22.2% in 2011 to 33.0% in 2022.

Maternal educational attainment improved over the study period. The proportion of mothers with no formal education decreased from 20.3% in 2011 to 6.3% in 2022, whereas the proportion with higher education increased from 7.0% to 17.8%. The distribution across household wealth quintiles remained broadly balanced, with each quintile comprising approximately one-fifth of the sample. All eight administrative divisions were represented in each survey round, with Dhaka and Chattogram accounting for substantial proportions of the study populations.

Table 2 presents the distribution of stunting status across selected socio-demographic characteristics. Child age was significantly associated with stunting in every survey round ($p < 0.001$). Across the survey years, stunted children were more commonly represented in the 18–47-month age groups, while younger children, particularly those aged < 6 months, represented a smaller share of stunted cases.

Sanitation facilities were significantly associated with stunting in all survey rounds ($p < 0.001$). In each survey, stunted children were more commonly represented among those living in households using pit toilets or reporting no toilet facility than among those using flush toilets.

Maternal education was significantly associated with stunting in all survey rounds ($p < 0.001$). In 2011, children of mothers with no formal education accounted for 24.8% of stunted cases, compared with 3.7% among children whose mothers had higher education. Comparable differences were observed in 2014 (21.2% vs. 5.6%), 2017–18 (10.2% vs. 8.0%), and 2022 (10.9% vs. 9.9%). These results indicate a persistent socioeconomic pattern in the distribution of stunting across maternal education groups.

Table 2
Association Between Stunting and Selected Socio-demographic Characteristics Among Under-Five Children in Bangladesh, BDHS 20

Covariates		2011			2014			2017–18		
Child's age in months	Category	Not Stunted n(%)	Stunted n(%)	χ^2 Statistic	Not Stunted n(%)	Stunted n(%)	χ^2 Statistic	Not Stunted n(%)	Stunted n(%)	χ^2 Statistic
	< 6	692(12.3%)	121(3.8%)	436.815*	573(10.7%)	65(2.6%)	343.051*	790(12.5%)	188(7.6%)	243.41
	6–8	354(6.3%)	70(2.2%)		345(6.5%)	62(2.4%)		332(5.3%)	82(3.3%)	
	9–11	326(5.8%)	114(3.6%)		314(5.9%)	101(4.0%)		314(5.0%)	78(3.2%)	
	12–17	465(8.3%)	364(11.5%)		541(10.1%)	264(10.4%)		609(9.7%)	252(10.2%)	
	18–23	365(6.5%)	347(11.0%)		439(8.2%)	302(11.9%)		482(7.7%)	325(13.2%)	
	24–35	858(15.3%)	673(21.3%)		931(17.4%)	596(23.4%)		1038(16.5%)	588(23.9%)	
	36–47	1037(18.4%)	803(25.4%)		864(16.2%)	628(24.7%)		1064(16.9%)	505(20.5%)	
	≥ 48	1528(27.2%)	671(21.2%)		1332(24.9%)	529(20.8%)		1669(26.5%)	443(18.0%)	
Type of toilet facility	Flush Toilet	825(14.7%)	317(10.0%)	41.033*	1027(19.2%)	275(10.8%)	90.376*	1903(30.2%)	476(19.3%)	113.96
	Pit Toilet	3591(63.8%)	2083(65.9%)		3583(67.1%)	1863(73.1%)		3552(56.4%)	1662(67.5%)	
	No facilities	1210(21.5%)	763(24.1%)		729(13.7%)	409(16.1%)		843(13.4%)	323(13.1%)	
Wealth index	Poorest	1100(19.6%)	969(30.6%)	254.496*	962(18.0%)	775(30.4%)	291.707*	1210(19.2%)	718(29.2%)	289.56
	Poorer	1078(19.2%)	721(22.8%)		969(18.1%)	534(21.0%)		1139(18.1%)	616(25.0%)	
	Middle	1104(19.6%)	600(19.0%)		998(18.7%)	518(20.3%)		1125(17.9%)	438(17.8%)	
	Richer	1157(20.6%)	529(16.7%)		1153(21.6%)	449(17.6%)		1310(20.8%)	427(17.4%)	
	Richest	1187(21.1%)	346(10.9%)		1257(23.5%)	271(10.6%)		1514(24.0%)	262(10.6%)	
Education level	No Education	999(17.8%)	786(24.8%)	188.095*	692(13.0%)	541(21.2%)	245.797*	392(6.2%)	250(10.2%)	256.04
	Primary	1602(28.5%)	1105(34.9%)		1341(25.1%)	865(34.0%)		1650(26.2%)	898(36.5%)	
	Secondary	2526(44.9%)	1156(36.5%)		2623(49.1%)	998(39.2%)		2999(47.6%)	1116(45.3%)	
	Higher	498(8.9%)	117(3.7%)		683(12.8%)	143(5.6%)		1257(20.0%)	197(8.0%)	
Place of residence	Urban	1337(23.8%)	619(19.6%)	20.656*	1785(33.4%)	703(27.6%)	27.159*	2346(37.2%)	711(28.9%)	54.422
	Rural	4289(76.2%)	2545(80.4%)		3554(66.6%)	1844(72.4%)		3952(62.8%)	1750(71.1%)	

Figure 1 shows the temporal trend in stunting prevalence among under-five children in Bangladesh. The reported prevalence declined from 36.0% in 2011 to 32.1% in 2014 and 27.4% in 2017–18, followed by a larger reduction to 10.8% in 2022. Overall, the reported prevalence decreased by approximately 26 percentage points between 2011 and 2022.

Figure 2 illustrates the spatial distribution of stunting prevalence among under-five children across the administrative divisions of Bangladesh from 2011 to 2022. In 2011, Sylhet had the highest reported prevalence (approximately 42%), followed by Mymensingh and Rangpur (approximately 37–38%), whereas Rajshahi had the lowest (approximately 30%). A similar pattern was observed in 2014, when Sylhet again had the highest reported prevalence (> 40%), while Khulna and Rajshahi had comparatively lower values (approximately 25–27%).

Although stunting prevalence declined across all divisions over time, regional differences remained. In 2017–18, Sylhet continued to have the highest reported prevalence (approximately 37%), followed by Mymensingh (around 34%), while Dhaka and Khulna had lower values (approximately 23–25%). By 2022, reported prevalence ranged from approximately 9% to 16% across divisions. Sylhet (16%) and Mymensingh (14%) remained the divisions with the highest reported prevalence, whereas Khulna and Rajshahi had the lowest levels (approximately 9–10%).

Figure 3 presents the spatial distribution of urban stunting prevalence among under-five children across the administrative divisions of Bangladesh from 2011 to 2022. In 2011, Chattogram and Rangpur had the highest reported urban prevalence (approximately 37–38%), while Rajshahi had the lowest (around 26%). In 2014, Sylhet had the highest reported urban prevalence (> 40%), whereas Khulna had the lowest (approximately 23%).

A declining trend in urban stunting prevalence was observed across the divisions over time. In 2017–18, Sylhet and Mymensingh continued to show relatively high reported prevalence (approximately 32% and 29%, respectively), whereas Dhaka and Khulna had lower levels (around 20–22%). By 2022, urban stunting prevalence had declined to approximately 7–12% across divisions. Mymensingh (12%) and Sylhet (11–12%) remained among the divisions with the highest reported prevalence, while Rangpur and Rajshahi had the lowest levels (approximately 7–8%).

Figure 4 shows the spatial distribution of rural stunting prevalence among under-five children across the administrative divisions of Bangladesh from 2011 to 2022. In 2011, Sylhet had the highest reported rural prevalence (approximately 46%), followed by Mymensingh and Dhaka (around 41–43%), whereas Rajshahi had the lowest (approximately 30%). In 2014, Sylhet continued to have the highest reported prevalence (about 42%), while Khulna and Rajshahi had comparatively lower values (approximately 27–29%).

Although rural stunting prevalence declined substantially across all divisions, regional differences persisted. In 2017–18, Sylhet remained the division with the highest reported prevalence (approximately 38%), followed by Mymensingh (around 34%), whereas Dhaka and Khulna had lower levels (approximately 27–28%). By 2022, rural stunting prevalence had declined to approximately 9–16% across divisions. Sylhet (16%) and Mymensingh (14%) continued to report the highest levels, while Khulna and Rajshahi had the lowest (approximately 9–10%).

DISCUSSION

This study examined temporal trends, spatial patterns, and socio-demographic correlates of stunting among under-five children in Bangladesh using nationally representative BDHS data from 2011 to 2022. The findings showed a substantial decline in reported stunting prevalence over time, alongside persistent socioeconomic and geographical disparities. Child age, maternal education, household wealth status, sanitation facilities, and place of residence were consistently associated with stunting across survey rounds.

The most prominent finding was the reported decline in stunting prevalence from 36.0% in 2011 to 10.8% in 2022. This reduction indicates substantial improvement in child nutritional status during the study period. Similar downward trends have been reported in Bangladesh and other LMICs (S. Kundu et al., 2025; Sin et al., 2024). These patterns may reflect the cumulative effects of improvements in socioeconomic conditions, health services, nutrition programs, and living environments, although the cross-sectional design of the present study does not allow the contribution of specific factors to be established.

Child age was significantly associated with stunting across all survey rounds. Stunting was more common among children in the 18–47-month age range, whereas children younger than six months represented a smaller share of stunted cases. Similar age patterns have been reported elsewhere and may be related to complementary feeding, dietary adequacy, and exposure to childhood infections during early childhood (Ayele et al., 2025; Gebreayohanes & Dessie, 2022). Because these mechanisms were not directly measured in the present analysis, they should be regarded as possible explanations rather than demonstrated causes.

Maternal education was significantly associated with childhood stunting, with stunted children more frequently represented among those whose mothers had no formal education than among those whose mothers had secondary or higher education. This pattern is consistent with previous research linking maternal education with child growth and nutritional outcomes (Gbratto-Dobe & Segnon, 2025; Rezaeizadeh et al., 2024). Maternal education may be related to knowledge of child feeding, hygiene, and healthcare practices, as well as broader socioeconomic resources; however, these pathways were not directly evaluated in this study.

Household wealth status was significantly associated with childhood stunting, with the poorest households consistently accounting for a larger share of stunted children than the richest households. This pattern is consistent with previous studies and may reflect differences in access to nutritious food, healthcare, sanitation, and adequate living conditions (Ndagijimana et al., 2025; Sultana et al., 2025). The findings underscore the close relationship between socioeconomic disadvantage and child nutritional outcomes, while the observational design prevents attribution of a causal effect to household wealth alone.

Sanitation facilities were also significantly associated with childhood stunting. A greater share of stunted children lived in households reporting pit toilets or no toilet facility than in households using flush toilets. This finding is consistent with previous research suggesting that inadequate sanitation may increase exposure to infections and diarrheal disease, which can adversely affect child growth and nutritional status (Dahir et al., 2026; Nisa et al., 2026). However, sanitation was assessed cross-sectionally, and the present analysis did not establish a causal pathway between sanitation conditions and stunting.

The spatial analysis demonstrated persistent regional variation in childhood stunting across Bangladesh. Despite the overall decline, Sylhet and Mymensingh repeatedly showed higher reported prevalence than several other divisions, whereas Khulna and Rajshahi generally reported lower levels. Similar geographical differences have been documented in previous studies (Rafi & Pal, 2025; M. Rashid et al., 2026). The persistence of these regional patterns suggests that national improvements have not been uniform and that local socioeconomic and environmental contexts may remain relevant to child nutrition.

This study has several limitations. First, the cross-sectional design of the BDHS data prevents causal inference. Second, several potentially relevant factors, including dietary diversity, feeding practices, birth weight, and maternal nutritional status, were not included in the analysis. Third, the spatial analysis was conducted at the divisional level, which may obscure important within-division variation. Fourth, the bivariate chi-square analysis does not account for potential confounding or identify independent associations among correlated variables. Nevertheless, the use of large nationally representative BDHS datasets spanning more than a decade provides useful evidence on temporal and spatial patterns of childhood stunting in Bangladesh.

CONCLUSION

This study assessed temporal trends, spatial distribution, and socio-demographic correlates of stunting among under-five children in Bangladesh using BDHS data from 2011 to 2022. The reported prevalence of stunting declined substantially over the study period, while meaningful disparities persisted across socioeconomic groups, places of residence, and administrative divisions. Child age, maternal education, household wealth status, sanitation facilities, and place of residence were significantly associated with stunting in the survey rounds. Stunting was more frequently represented among children from poorer households, children of less-educated mothers, households with less adequate sanitation, and rural areas. Spatial analysis further indicated persistent regional differences, particularly in Sylhet and Mymensingh, despite overall national improvement. These findings support continued attention to maternal education, socioeconomic disadvantage, sanitation, and geographically concentrated areas of higher burden when planning strategies to reduce childhood stunting and related inequalities in Bangladesh.

Declarations

Conflicts of Interest: The author(s) declare no known competing interests that could have appeared to influence the work reported in this paper.

Funding statement: No funding or incentives were received for this research project and publication of the manuscript.

Clinical Trial Number: Not applicable.

Data availability statement: The data that support the findings of this study are openly available in the Bangladesh Demographic and Health Survey (BDHS) 2022 at <https://dhsprogram.com/>.

Ethical approval and consent to participate: This study analyzed fully anonymized, publicly available secondary data from the 2022 BDHS, obtained with permission from the DHS Program (<https://dhsprogram.com>). The original survey protocol was reviewed and approved by the ICF Institutional Review Board and the Bangladesh Medical Research Council, and all procedures were carried out in accordance with the Declaration of Helsinki. Informed consent was obtained from all participants before the interview. No additional ethical approval was required for this secondary analysis of de-identified data.

Authors' Contributions: R.I., P.S.A. and F.A.K. contributed to conceptualization, methodology, data curation, formal analysis, validation, visualization, and writing – original draft. M.H.A. and F.N.M. contributed to supervision, methodology, and writing – review & editing. All authors read and approved the final manuscript.

Acknowledgement: The authors thank the Bangladesh Demographic and Health Survey (BDHS) Program and all survey participants for their invaluable contributions to this research.

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Table 1

Table 1 is available in the Supplementary Files section.

Figures

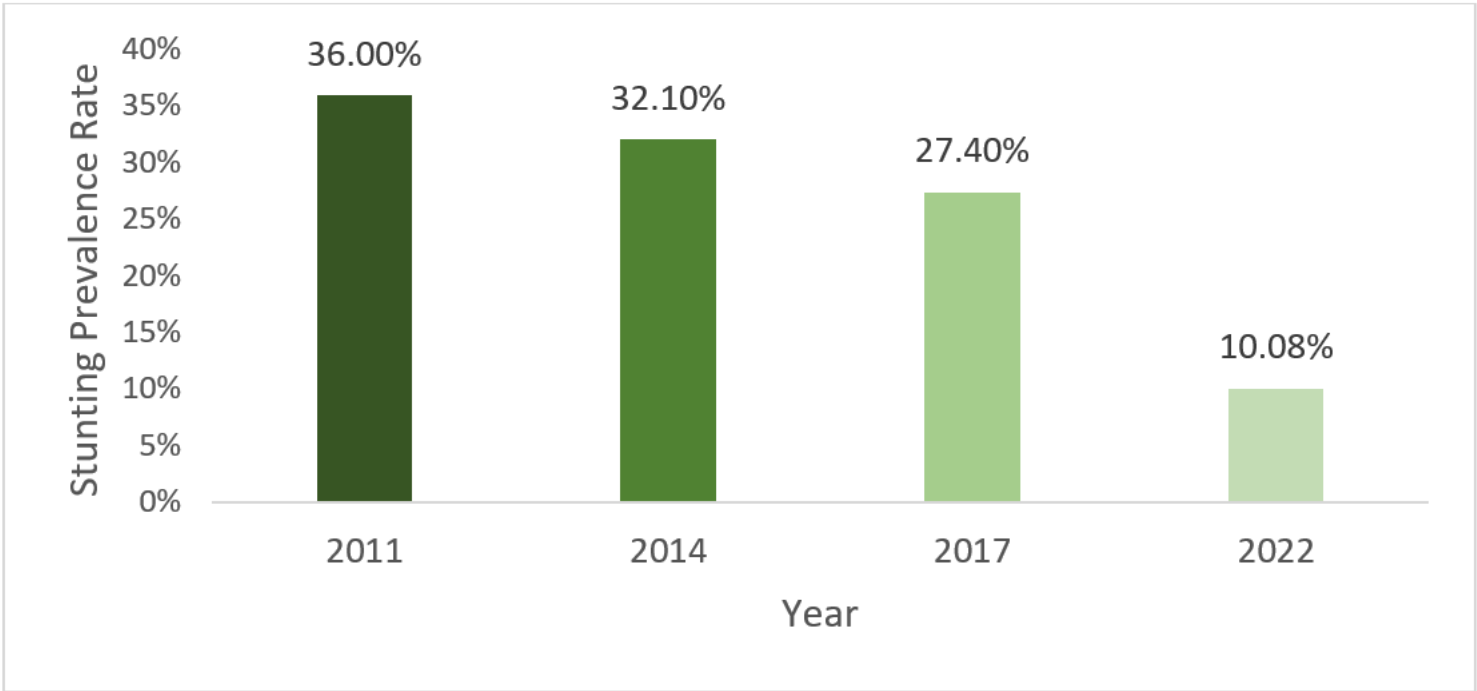


Figure 1
Trends in Stunting Prevalence Rate Among Under-Five Children in Bangladesh, 2011–2022

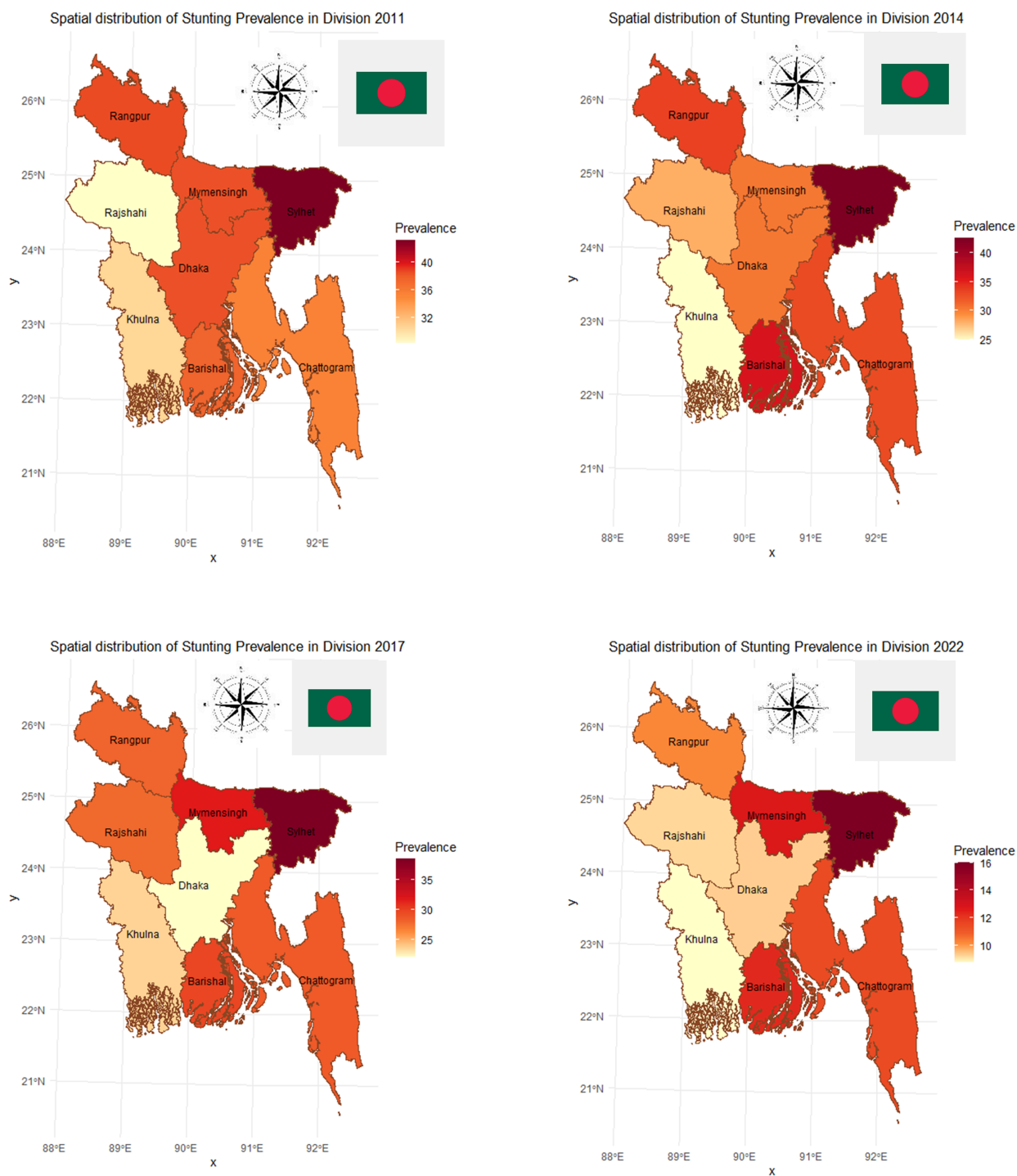


Figure 2

Spatial Distribution of Stunting Prevalence Among Under-Five Children Across Administrative Divisions of Bangladesh, 2011–2022

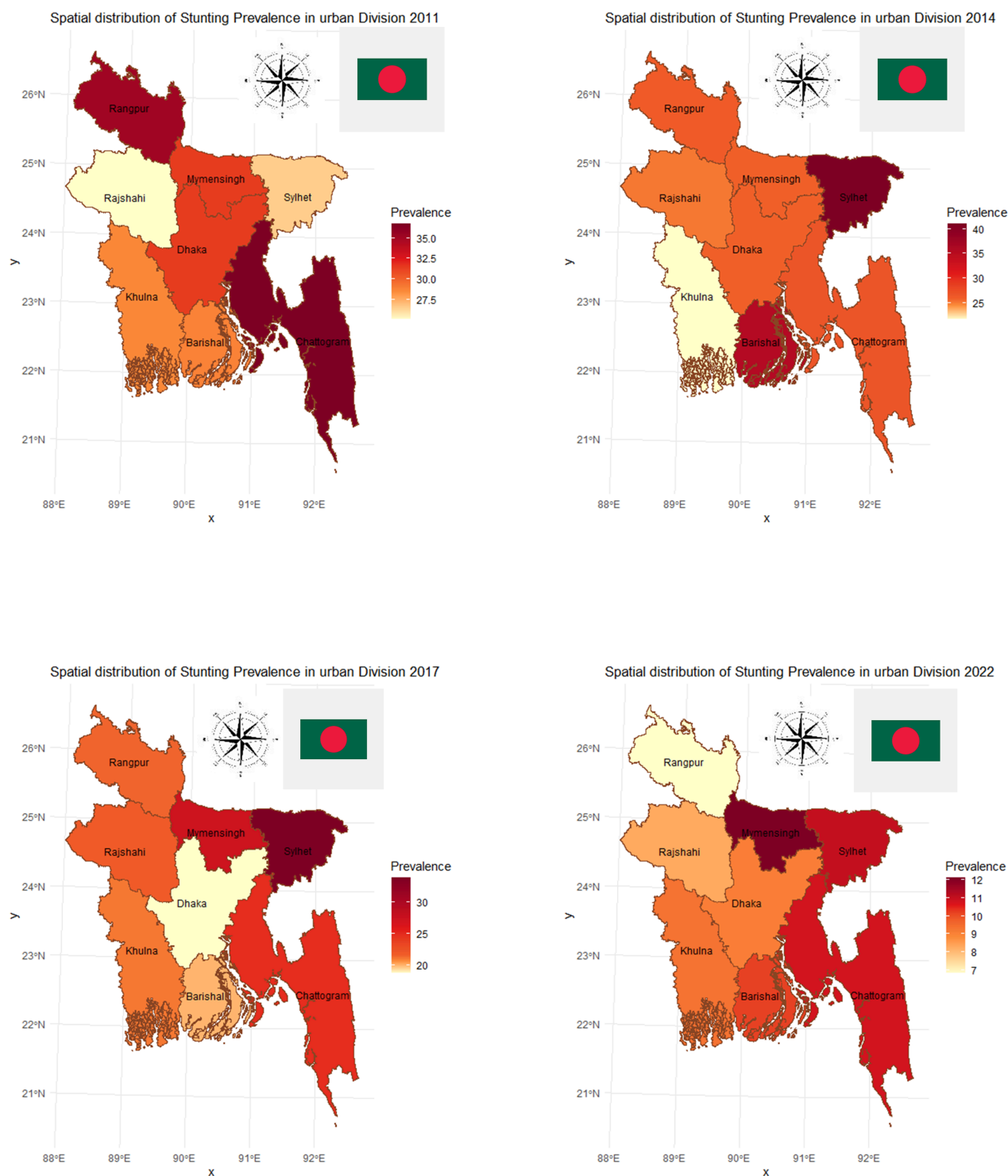


Figure 3

Spatial Distribution of Urban Stunting Prevalence Among Under-Five Children Across Administrative Divisions of Bangladesh, 2011–2022

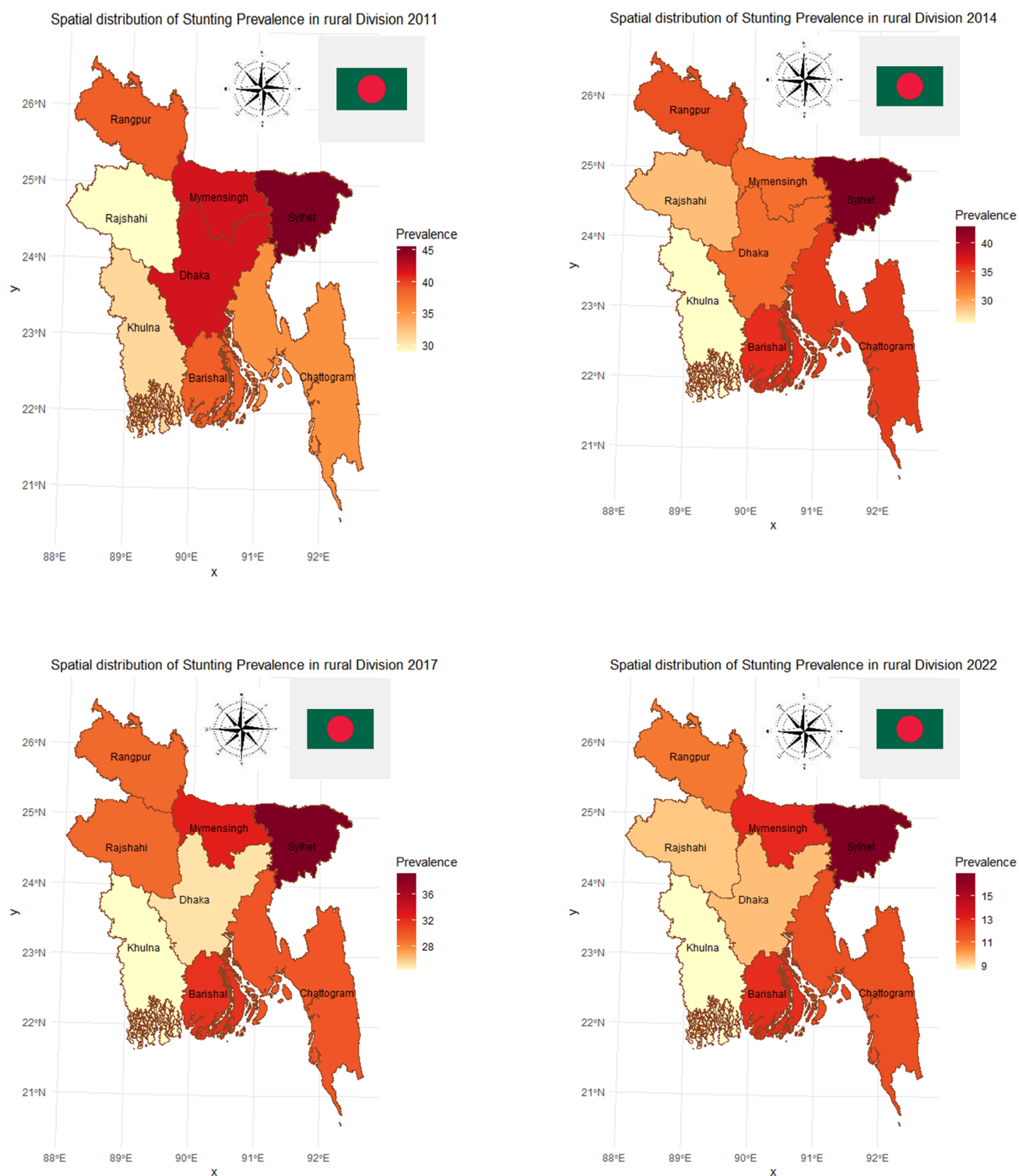


Figure 4

Spatial Distribution of Rural Stunting Prevalence Among Under-Five Children Across Administrative Divisions of Bangladesh, 2011–2022

Supplementary Files

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- [Table1.docx](#)