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Spatial Disparity and Change Detection of Children and Reproductive Age Women's Nutritional Status among Tribes in West Bengal, India: A Comparative Study on NFHS-4 & 5

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Abstract

Undernutrition is more prevalent among Scheduled Tribe children under 5 years of age and women of reproductive age compared to other demographics. The present study aims to demonstrate the spatial disparity in nutritional status among tribal children (U5A) and women (URA) by analysing anthropometric indices, including children's and women's anaemia and underweight BMI status. The research utilises Z-score statistics to standardise the raw data from the National Family Health Survey (NFHS) of India in accordance with World Health Organisation (WHO) standards. According to the latest NFHS-5, the findings reveal that the high prevalence of undernutrition among tribal children is primarily concentrated in nine districts of West Bengal. Additionally, the results indicate that twelve districts exhibit a significant prevalence of undernutrition among tribal women. Special educational assistance, empowerment opportunities, and improved access to better healthcare facilities are crucial in addressing these issues. A strong local governance framework and active stakeholder involvement must also be established to combat undernutrition effectively. The study identified districts of West Bengal with high rates of undernutrition among children and women, thereby informing the implementation of various nutritional programs and policies.

Keywords: nutritional disparity, children, women, Scheduled Tribe, West Bengal, India

Introduction

Undernutrition is a significant public health issue, particularly concerning tribal populations. Despite India's considerable economic growth in recent years and its capacity to produce enough food for its population, the country still faces

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higher rates of undernutrition among certain population groups (Chand & Singh, 2023). According to the Global Nutrition Report 2019, 194.4 million people, or 14.5% of the population, were undernourished in India. Furthermore, 20.8% of children were reported as underweight, and an analysis of the National Family Health Survey (NFHS) data indicated that 51.4% of women are anaemic (Sahota, 2022). In the 2023 Global Hunger Index (GHI), India ranks 111th out of 125 nations, with a GHI score of 28.7, indicating a severe hunger crisis (Global Hunger Index, 2023). Undernutrition negatively impacts the health and development of children under five years of age (U5A) and women under reproductive age (URA), 15-49 years. It is primarily caused by deficiencies in macronutrients and micronutrients, which impair cognitive development and hinder physical growth (Gernand et al., 2016).

Undernutrition, which includes insufficient nutritional intake, can be categorised into three types: wasted (low weight-for-height), stunting (low height-for-age), and underweight (low weight-for-age), as well as micronutrient-related undernutrition, which is a deficiency of essential vitamins and minerals (WHO, 2024). Undernutrition is especially prevalent in regions and population subgroups with significant disparities (De Onis & Branca, 2016). Tribal communities, compared to other groups, are often isolated and face social and economic disadvantages. Their unique geographic habitats and dietary habits further distinguish them from other populations (Barman & Chowdhury, 2024).

Tribal communities exhibit characteristics such as geographic isolation, primitive farming methods, social taboos, harmful health-seeking behaviours, poverty, and inconsistent food supplies, all of which contribute to various health issues and malnutrition (National Institute of Nutrition, 2009). The prevalence of undernutrition, wasting, and underweight among children indicates poor nutritional status, which leads to stunted development. Factors associated with wasting and being underweight include regional conditions, birth size (i.e., small versus normal), and delivery location (i.e., institutional versus non-institutional) (Akombi et al., 2017).

Notwithstanding steady economic growth and a reduction in monetary poverty over the last two decades, the incidence of undernutrition in India remains high (Khan & Mohanty, 2018). Child undernutrition is particularly prevalent among low-income families (Singh et al., 2020). Studies by Bentley and Griffiths (2003) and Barman (2024) show that rural women experience a higher prevalence of anaemia than their urban counterparts, especially in poorer communities. Women with a lower body mass index (BMI; less than 18.5 kg/m^2) face a greater risk of anaemia compared to those with normal or elevated BMI. Moreover, this malnutrition among tribal women presents a significant health concern in India, indicating severe

nutritional stress within these communities.

From a public health perspective, it is crucial to implement appropriate nutritional programmes for this ethnic group swiftly. The Government of India must take active measures to reduce undernutrition among the tribal population (Bisai & Bose, 2009). To promote good health, government officials and health experts must identify the underlying causes and intervene effectively through various promotional and therapeutic strategies (Rohisha et al., 2019). The NFHS report for children under five found that the proportion of stunted (32.5% to 33.8%) and underweight (31.6% to 32.2%) children increased slightly from NFHS-4 to NFHS-5. While the rates of wasting (20.3%) have remained unchanged over both the NFHS rounds. Nonetheless, the persistently high levels of undernutrition in West Bengal remain a serious concern (MoHFW & IIPS, 2020).

To the best of our knowledge, there are currently no studies focusing on the nutritional status of Scheduled Tribe (ST) children and women within West Bengal's primitive tribal population, specifically regarding inter-district nutritional assessments based on the NFHS-4 and NFHS-5. For this, the present study aims to investigate inter-district inequalities in the nutritional conditions of ST children (U5A), focusing on stunting, wasting, and underweight, as well as the nutritional status of ST women (URA) based on anaemia levels and body mass index (BMI) across districts in West Bengal.

Additionally, this research aims to highlight the differences in undernutrition status between the two rounds of the NFHS in districts that faced high levels of undernutrition. The findings of this study can inform the formulation of nutritional intervention policies and programs that focus on key nutritional interventions to address the challenges faced by the tribal population, particularly among young children and women of reproductive age.

Materials and Methods

Database

The study utilised data on children's anthropometric indices, women's anaemia status, and height and weight for BMI assessment from the NFHS databases. The analysis was based on two rounds of the NFHS: NFHS-4 (2015-16) and NFHS-5 (2019-21). The NFHS datasets are available on the Demographic Health Survey (DHS) site, though access to the dataset requires a prior request.

All NFHS surveys were conducted under the administration of the Ministry of Health and Family Welfare (MoHFW) of the Government of India. The MoHFW appointed the International Institute for Population Sciences (IIPS), Mumbai, as the nodal agency to carry out the survey. While various health, socio-economic, and demographic

datasets are available on the website, our study focused specifically on data related to children and women with completed interview records (IIPS & ICF, 2022).

The survey included children who lived in the sampled households on a regular basis. Anthropometric measurements, including height and weight, were collected for children under five years of age and women aged 15 to 49 years. Additionally, haemoglobin levels were recorded to assess the anaemia levels of the women. This information is included in the DHS datasets, which also gather caste information for each household (IIPS & ICF, 2022). For this study, we specifically selected datasets for ST children and women, as illustrated in Figure 1.

Anthropometry of Children

This study examines the anthropometric indices of stunted (ST) children, specifically focusing on the conditions of stunting, wasting, and underweight in children under 5 years of age (U5A). The analysis utilises the NFHS dataset to calculate three key indicators: Z-scores of height-for-age (HAZ), weight-for-height (WHZ), and weight-for-age (WAZ). The NFHS authorises surveyors to collect data on children's height and length, as well as their weight measurements (WHO, 2006).

Statistical evaluations were performed on this data using Z-scores to assess the nutritional status of children under five in tribal communities in West Bengal. Z-scores were used because this standardises the raw values, making comparisons across the population more effective. Furthermore, each anthropometric index is classified as either mild or severe, indicating different levels of undernutrition.

Women's Body Mass Index

The Body Mass Index (BMI) is a measurement that is expressed as the weight in kilograms divided by the height in meters squared. It is widely used across various nations, groups, races, and ethnicities to classify individuals as underweight, normal weight, overweight, and obese. There is a clear relationship between height and weight; BMI accounts for this by adjusting weight according to the square of height (Roth et al., 2005).

In this analysis, we defined a BMI of less than 18.5 as underweight. BMI is calculated by dividing a person's weight in kilograms by the square of their height in meters. To determine the percentage of women in each BMI category, we divided the number of women in each category by the total number of women and then multiplied by 100. Women with a BMI between 18.5 and 24.9 are considered to have a normal body mass, while those with a BMI above 25.0 are classified as overweight or obese (*Guide to DHS statistics*, n.d.).

Women's Anaemia Status

Anaemia occurs when the amount or concentration of haemoglobin in red blood cells is lower than normal. Where haemoglobin is essential for transporting oxygen, therefore, when there are too few or defective red

blood cells, or insufficient haemoglobin, the blood's ability to deliver oxygen to the body's tissues is compromised (WHO, 2019). Anaemia is defined based on haemoglobin levels: for non-pregnant women, a haemoglobin level below 12.0 g/dL indicates anaemia, while for pregnant women, the threshold is below 11.0 g/dL (*Guide to DHS statistics*, n.d.). We have analysed the anaemia status of women of reproductive age using a specific variable, and our findings indicate that a significant number of them appear to be anaemic.

Statistical and Geospatial Techniques

MS Excel and StataSE version 14 (CropLP) were used for statistical analyses. The sequential analytical methods used to assess the nutritional status of children and women are illustrated in Figure 2. All datasets were weighted according to DHS standards to adjust for changes in probability, ensuring that the sample remained representative of the overall population distribution in the country. And the missing data were excluded from the datasets for the analysis of the reported variables. Additionally, ArcGIS version 10.8 was utilised for thematic mapping and spatial analysis of the prevalence of undernutrition among children (U5A) and women (URA) across the districts of West Bengal, comparing data from the current and previous rounds of the NFHS survey.

Figure 1

Sample Size at Different Levels of the NFHS Dataset for West Bengal, India

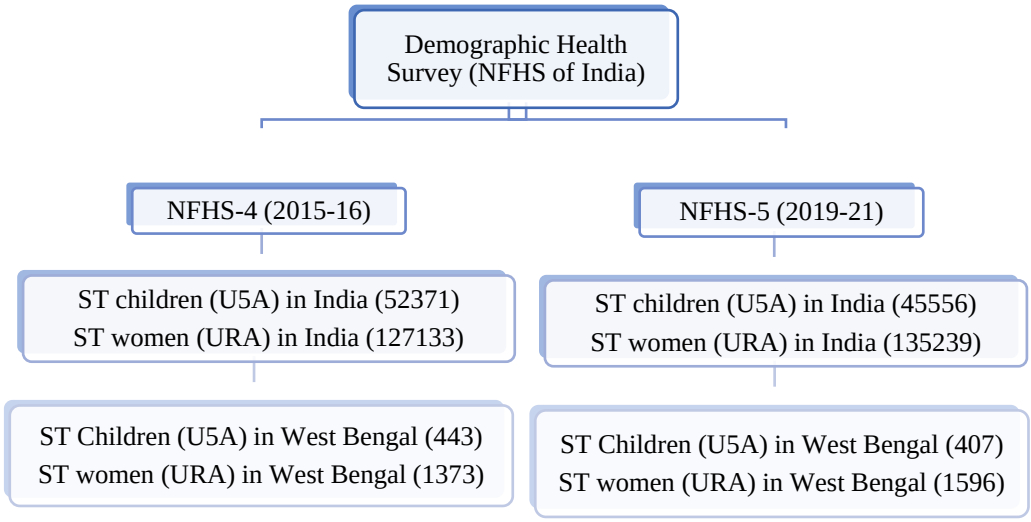
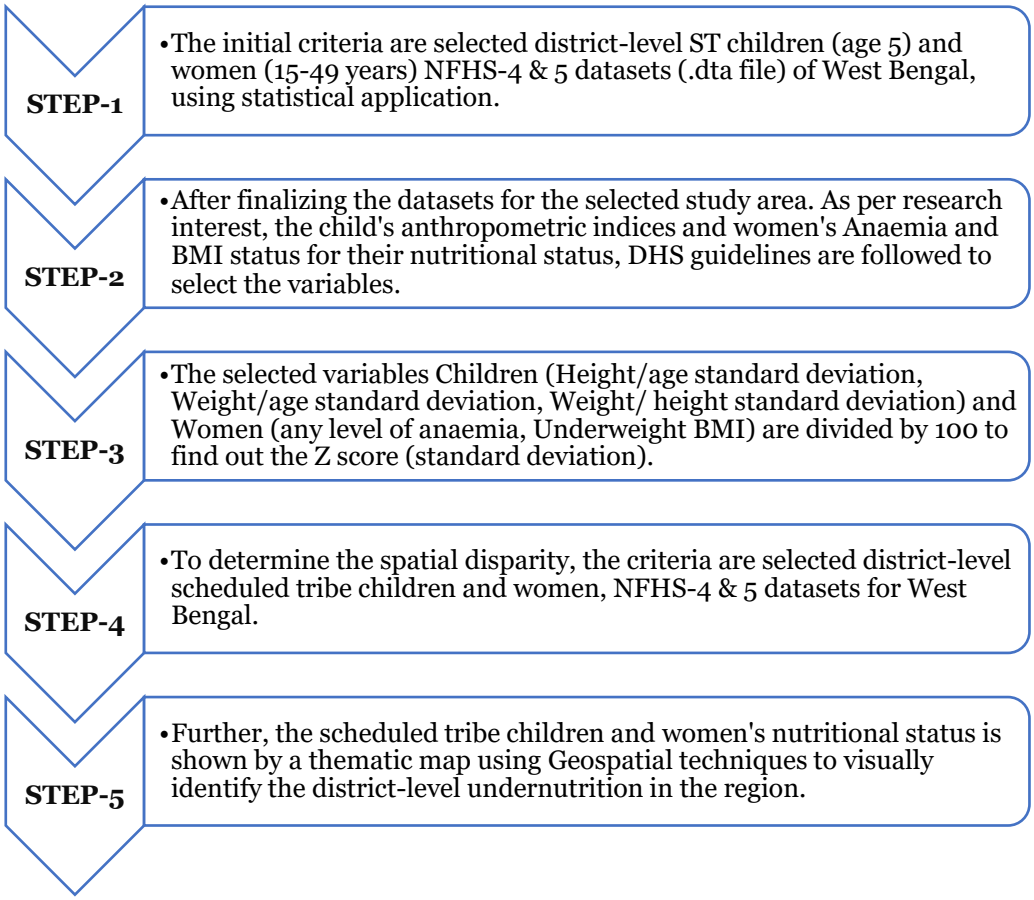


Figure 2



Sequential Steps of Analytical Methods for Children (u5 age) and Women (15-49 years) Nutrition

Results

Disparity of Chronic Undernutrition Status of ST Children in the Districts of West Bengal

According to the NFHS datasets, the incidence of stunting, or chronic undernutrition, among ST children has been classified into two groups: moderate and severe stunting. A concerning trend of severe stunting has been observed in six districts: Haora, Birbhum, Jalpaiguri, Dakshin Dinajpur, Bankura, and Uttar Dinajpur. Similarly, moderate stunting is also on the rise in eight districts: Haora, Birbhum, Jalpaiguri, Dakshin Dinajpur, Uttar Dinajpur, Purulia, Paschim Medinipur, and Barddhaman within West Bengal (see Table 1).

Table 1: *Disparity of Stunted Children (ST) in West Bengal, India*

Districts	Prevalence of stunted children (%)			
	NFHS- 4		NFHS- 5	
	Moderate	Severe	Moderate	Severe
Haora	0.0	0.0	53.8	46.2
Birbhum	29.1	0.0	22.7	31.1
Jalpaiguri	18.6	23.1	20.2	27.6
Dakshin Dinajpur	17.2	8.6	20.7	24.4
Bankura	14.4	12.9	11.2	21.5
Uttar Dinajpur	37.4	24.7	27.7	20.3
North 24 Parganas	30.5	0.0	19.2	19.2
Darjeeling	25.6	12.5	19.4	17.9
Puruliya	26.3	20.5	28.6	17.6
Hugli	35.2	0.0	11.4	16.8
Maldah	34.6	15.8	14.2	14.5
Paschim Medinipur	26.5	6.0	26.3	10.2
Barddhaman	27.6	13.4	31.3	7.7
Kochbihar	25.4	23.4	0.0	0.0
Kolkata	36.2	0.0	0.0	0.0
Murshidabad	0.0	0.0	8.5	0.0
Nadia	20.1	0.0	0.0	0.0
Purba Medinipur	50.0	0.0	0.0	0.0
South 24 Parganas	0.0	15.3	0.0	0.0

Source: DHS datasets of NFHS-4 & 5

Overall, four districts in West Bengal- Haora, Birbhum, Jalpaiguri, and Dakshin Dinajpur show a significantly higher (over 20%) number of undernourished children in both severe and moderate stunting. Currently, 31.07% of ST children under the age of five are stunted or severely undernourished. However, the prevalence of stunting among ST children under five has changed since 2015-16. The NFHS data from 2019-21 indicates that the rate of stunted ST children in West Bengal has slightly decreased from the previous two rounds, dropping from 33.21% to 31.07%, although this figure remains alarming.

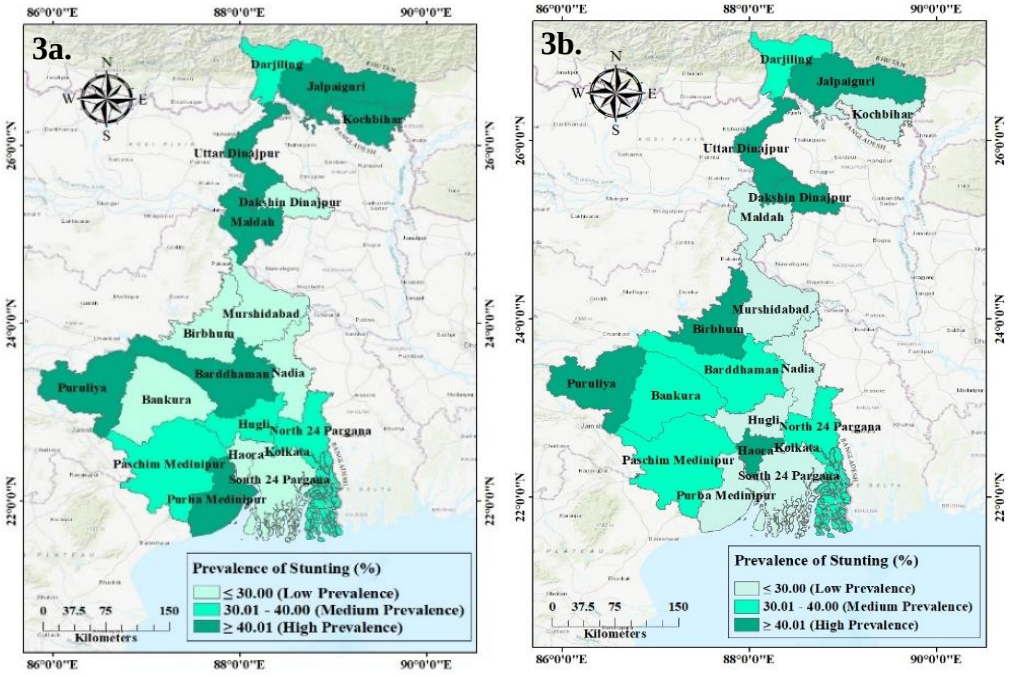
The prevalence of stunted children varies significantly across districts, ranging from 15.3% in South 24 Parganas to 62.1% in Uttar Dinajpur (see Figure 3a). In the fifth round of the NFHS, the proportion of stunted children ranges from 8.5% in Murshidabad to 53.8% in Birbhum (see Figure 3b). As per NFHS-5, West Bengal has five districts with a high prevalence of stunted ST children: Birbhum, Dakshin Dinajpur, Jalpaiguri, Purulia, Uttar Dinajpur and Haora above 40%. Whereas, seven districts report lower rates of stunting: Hugli, Maldah, Murshidabad, Nadia, South 24 Parganas, Purba Medinipur, and Kochbihar. The remaining districts fall into a moderate prevalence category, with stunted children making up between 30% to 40%.

The high rates of childhood stunting are primarily due to

inadequate nutritional intake during critical growth periods, including conception and birth, as well as various other contributing factors (Bloem et al., 2013)

Figure 3

Spatial Disparity of ST Stunted Children of West Bengal, India (3a. NFHS-4, 3b. NFHS-5)



Disparity of Acute Undernutrition Status of ST Children in the Districts of West Bengal

The data presented in Table 2 reveal concerning trends related to wasted ST children, which can be classified as moderate and severe wasting. Three districts are experiencing increasing rates of severe wasting in NFHS-5 from the previous round: Paschim Medinipur, Darjeeling, and Hugli. Additionally, nine districts in West Bengal have reported rising trends in moderate wasting: Darjeeling, Dakshin Dinajpur, Puruliya, Birbhum, Barddhaman, Haora, Kochbihar, Murshidabad, and North 24 Parganas.

It is noteworthy that six districts in West Bengal have reduced the percentage of wasted children. However, Darjeeling is the only district experiencing a significant increase in the number of chronically undernourished ST children in both moderate and severe wasting. Currently, 19% of ST children under five years old in West Bengal are classified as wasted. Since the 2015-16 period, there has been a significant change in the prevalence of wasting among ST children under five. Data from the state's NFHS, conducted

between 2019 and 2021, indicate that the percentage of wasted children in this age group plummeted dramatically from 33% to 19% over two successive rounds.

Despite this overall reduction, certain districts still display unacceptably high rates of ST child wasting (see Figure 4a), with percentages ranging from 9.3% in Darjeeling to 48.6% in Kochbihar. Only nine districts accounted for less than 25% of wasted ST children. The rest of the districts fall under the moderate (5 districts) and high prevalence (5 districts) categories, with prevalence rates ranging from 25% to 35% and above 35% of wasted children. The latest data further highlight this issue (see Figure 4b), indicating that the incidence of wasting among children varies from 7.3% in Jalpaiguri to 47% in Paschim Medinipur. There are two high and three moderate prevalence districts in West Bengal where stunted children were found, i.e., Birbhum, Haora, Kochbihar, Paschim Medinipur, and Puruliya.

Research indicates that the high incidence of wasting among these children, characterised by both acute and chronic undernutrition, is closely linked to their low socioeconomic and demographic circumstances (Sen & Mondal, 2012).

Figure 4
Spatial Disparity of ST Wasted Children of West Bengal, India (4a. NFHS-4, 4b. NFHS-5)

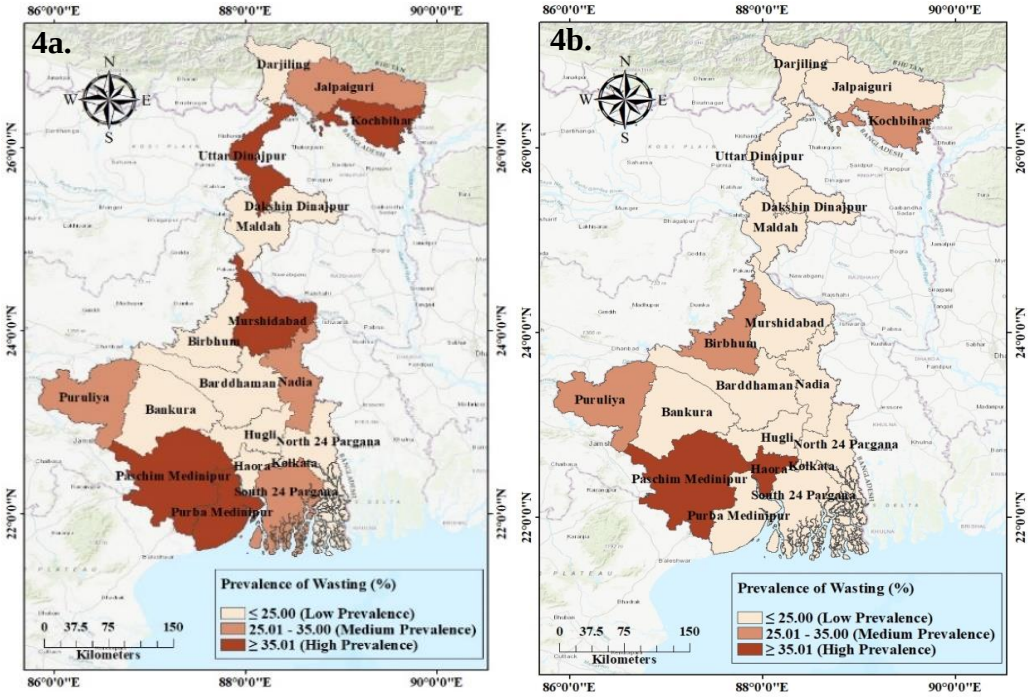


Table 2

Disparity of Wasted Children (ST) in West Bengal, India

Districts	Prevalence of wasted children (%)			
	NFHS- 4		NFHS- 5	
	Moderate	Severe	Moderate	Severe
Paschim Medinipur	26.4	12.5	20.9	26.2
Darjeeling	6.3	3.0	10.4	14.1
Hugli	25.0	0.0	10.7	11.0
Dakshin Dinajpur	10.7	8.0	16.9	7.7
Bankura	19.2	0.0	14.8	7.2
Puruliya	20.1	9.9	26.0	6.9
Birbhum	10.2	9.4	24.2	6.7
Barddhaman	6.1	16.8	19.0	4.7
Haora	0.0	0.0	46.2	0.0
Jalpaiguri	16.9	12.9	7.3	0.0
Kochbihar	25.2	23.4	33.3	0.0
Kolkata	0.0	18.0	0.0	0.0
Maldah	13.7	2.7	0.0	0.0
Murshidabad	0.0	100.0	7.8	0.0
Nadia	19.9	9.6	0.0	0.0
North 24 Parganas	9.4	15.3	19.9	0.0
Purba Medinipur	100.0	0.0	0.0	0.0
South 24 Parganas	30.2	0.0	0.0	0.0
Uttar Dinajpur	37.7	0.0	18.7	0.0

Source: DHS datasets of NFHS-4 & 5

Disparity of Underweight Status of ST Children in the Districts of West Bengal

The analysis of underweight ST children reveals concerning trends (Table 3) across nine districts of West Bengal. For severe underweight, higher prevalence rates were noted in NFHS-5 for the districts of Birbhum, Howrah, Puruliya, Paschim Medinipur, and South 24 Parganas. Regarding moderate underweight, increasing trends have been observed in six districts: Birbhum, Puruliya, Dakshin Dinajpur, Hugli, Barddhaman, and North 24 Parganas.

Despite an overall reduction in the percentage of underweight ST children across 11 districts from the fifth to the fourth round of evaluation, Birbhum, Dakshin Dinajpur, Howrah, Hooghly, and South 24 Parganas show a concerning growth trend (higher than 10%) in the prevalence of underweight ST children. Currently, 37.08% of ST children under the age of five in West Bengal are underweight and undernourished, indicating a shift in proportions from 2015-16 to 2019-21.

According to state-level data from the NFHS conducted between 2019 and 21, the percentage of ST children under 59 months of age classified as underweight decreased from 42.56% to 37.08% compared to the previous round. However, this rate remains above normal levels. Regionally (see Figure 5a), the prevalence of underweight ST children varies significantly, with more than 50% prevalence found in five districts. The latest round reports four districts with a higher proportion of underweight ST children (see Figure 5b).

Table 3

Disparity of Underweight Children (ST) in West Bengal, India

Districts	Prevalence of underweight children (%)			
	NFHS- 4		NFHS- 5	
	Moderate	Severe	Moderate	Severe
South 24 Parganas	14.9	15.3	0.0	100.0
Haora	0.0	0.0	0.0	46.2
Paschim Medinipur	35.4	11.9	28.6	26.0
Birbhum	29.1	0.0	29.9	25.1
Puruliya	36.1	22.3	39.2	22.3
Darjeeling	19.4	9.3	17.2	18.2

Dakshin Dinajpur	11.4	5.4	27.8	15.4
Hugli	13.4	11.6	37.3	11.8
Bankura	34.9	0.0	21.6	11.4
Uttar Dinajpur	50.1	12.4	28.5	9.2
Jalpaiguri	23.9	19.4	21.7	8.4
Murshidabad	100.0	0.0	15.5	7.8
Barddhaman	32.5	8.2	37.4	3.1
Kochbihar	50.6	23.4	33.3	0.0
Kolkata	0.0	18.0	0.0	0.0
Maldah	34.2	10.8	16.1	0.0
Nadia	20.1	9.6	0.0	0.0
North 24 Parganas	9.7	15.3	19.9	0.0
Purba Medinipur	100.0	0.0	25.5	0.0

Source: DHS datasets of NFHS-4 & 5

Specifically, in NFHS-5, four districts—Birbhum, Paschim Medinipur, Puruliya, and South 24 Parganas—have a prevalence rate of over 50% for underweight Scheduled Tribe (ST) children. In contrast, ten districts show a lower frequency of underweight children, while the other districts fall within the moderate prevalence category, where 40% to 50% of ST children are underweight.

Research indicates that undernutrition in tribal children persists due to remote-based living conditions, poverty, cultural taboos, insufficient nutritional information, poor health values, inadequate services, and weak infrastructure (Gangadharan & Kumar, 2014).

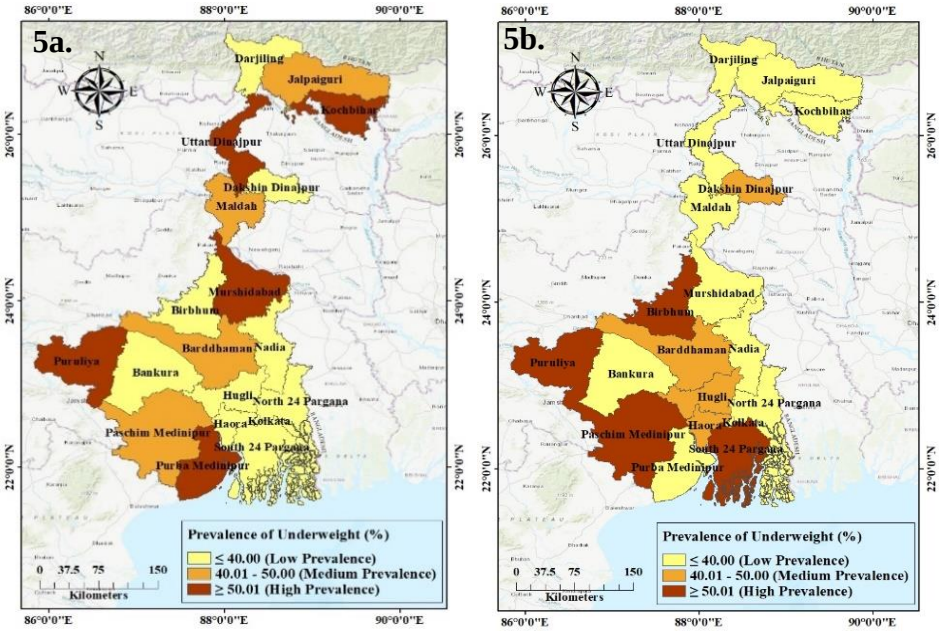
Anaemia Status of the Scheduled Tribal Women in the Districts of West Bengal

According to the NFHS datasets, a concerning trend of anaemia among scheduled tribal women has been observed in 14 districts of West Bengal. The prevalence rates of districts increased from NFHS-4 to NFHS-5 are as follows: Bankura, Birbhum, Dakshin Dinajpur, Darjeeling, Howrah, Hooghly, Jalpaiguri, Koch Bihar, Malda, Nadia, North 24 Parganas, Paschim Medinipur, Purba Medinipur, and South 24 Parganas.

The districts with the most significant decrease in anaemia rates are Barddhaman, Kolkata, Murshidabad, Purulia, and Uttar Dinajpur, with the largest decrease (over 8%) observed between the NFHS-4 and NFHS-5 surveys. However, five districts in West Bengal demonstrated a reduction in the proportion of anaemic women from the fifth to the fourth round of NFHS. The districts that experienced the largest increases in anaemia prevalence (higher than 10%) include Bankura, Howrah, Koch Bihar, Malda, Nadia, North 24 Parganas, Paschim Medinipur, and South 24 Parganas. Consequently, anaemia affects approximately 81.87% of women aged 15-49 in West Bengal. The incidence of anaemia among women aged 15 to 49 in West Bengal has shifted since the 2015-16 survey. According to the 2019-21 NFHS report, the percentage of ST women (URA) categorised as underweight dramatically increased from 73.73% to 81.87% between the last two NFHS cycles.

Figure 5

Spatial Disparity of ST Underweight Children of West Bengal, India (5a. NFHS-4, 5b. NFHS-5)



The prevalence of anaemia among ST women in the reproductive age group varies across districts, ranging from 45.8% in Koch Bihar to nearly all in Murshidabad and Kolkata in NFHS-4. According to NFHS-4, seven districts in West Bengal were found to have a percentage of anaemic ST women exceeding 80% (Table 4 & Figure 6a): Barddhaman, Dakshin Dinajpur, Hugli, Kolkata, Murshidabad, Purulia, and Uttar Dinajpur. Conversely, seven districts report comparatively lower prevalence rates: Bankura, Darjeeling, Howrah, Koch Bihar, Malda, Nadia, and North 24 Parganas. The remaining districts fall into the moderate prevalence category, with 70% to 80% of ST women being anaemic.

As per NFHS-5, twelve districts in West Bengal reported (Table 4 & Figure 6b) that the percentage of anaemic ST women exceeds 80%, placing them in the high-prevalence category (Table 4 & Figure 6b): Koch Bihar, South 24 Parganas, Haora, Dakshin Dinajpur, Malda, Paschim Medinipur, Murshidabad, Bankura, Hugli, Jalpaiguri, Purulia, and Birbhum.

Table 4
Disparity of Women (ST) Anaemia Status in West Bengal, India

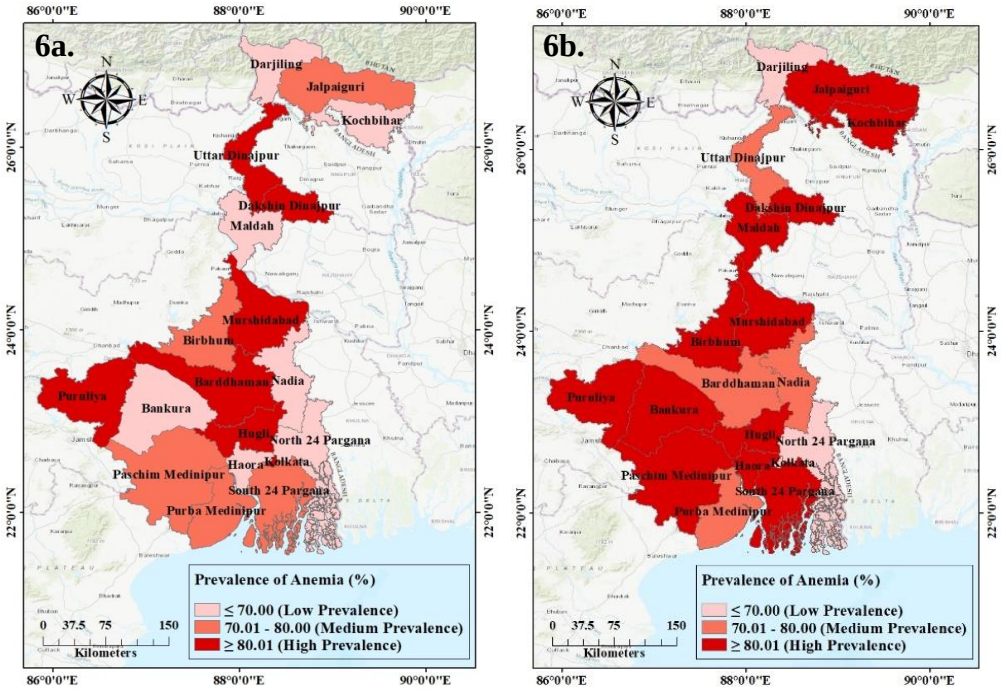
Districts	Prevalence of anaemia (%)	
	NFHS- 4	NFHS- 5
Kochbihar	45.8	100
South 24 Parganas	75.6	100
Haora	49.6	91.5
Dakshin Dinajpur	81.5	91.1
Maldah	65.0	90.6
Paschim Medinipur	76.4	89.2
Murshidabad	100	89.0
Bankura	68.1	86.2
Hugli	82.9	84.1
Jalpaiguri	77.4	82.2
Puruliya	91.0	82.0
Birbhum	74.5	81.7
Barddhaman	87.2	79.2
Uttar Dinajpur	87.3	78.7
Nadia	59.8	75.2
Purba Medinipur	70.7	74.7
North 24 Parganas	55.0	65.8
Darjeeling	52.8	61.7
Kolkata	100	52.4

Source: DHS datasets of NFHS-4 & 5

Conversely, three districts report comparatively lower prevalence rates (<70%), classifying them as lower-prevalence districts: Kolkata, Darjeeling, and North 24 Parganas. The remaining three districts fall into the moderate-prevalence category (70% to 80%): Barddhaman, Uttar Dinajpur, Nadia and Purba Medinipur. These statistics indicate a worsening anaemia scenario in many districts compared to NFHS-4, with a marked rise in high-prevalence zones.

Most anaemic tribal women are impoverished and illiterate, highlighting the high anaemia rates in this group. Heavy workloads with little rest and poor diets lacking fruits, vitamin C, and pulses further contribute to their anaemia (Unisa et al., 2010; De et al., 2011).

Figure 6
Spatial Disparity of ST Anaemic Women of West Bengal, India (6a. NFHS-4, 6b. NFHS-5)



BMI status of the scheduled tribal women in the districts of West Bengal

According to recent NFHS records, there is a rising trend of underweight Body Mass Index (BMI) conditions from the previous round among scheduled tribal women in six districts of West Bengal: Haora, Hugli, Kolkata, Maldah, Purba Medinipur, and South 24 Parganas (see Table 5). Whereas, ten districts showing the most significant improvement in reducing underweight conditions are Barddhaman, Birbhum, Darjeeling, Jalpaiguri, Kochbihar, Murshidabad, North 24 Parganas, Paschim Medinipur, Puruliya, and Uttar Dinajpur, all of which have experienced a decrease of more than 5% between the NFHS-4 and 5 survey cycles. However, 13 districts in West Bengal reported a decline in the prevalence of underweight children from the fourth round of NFHS to the fifth round.

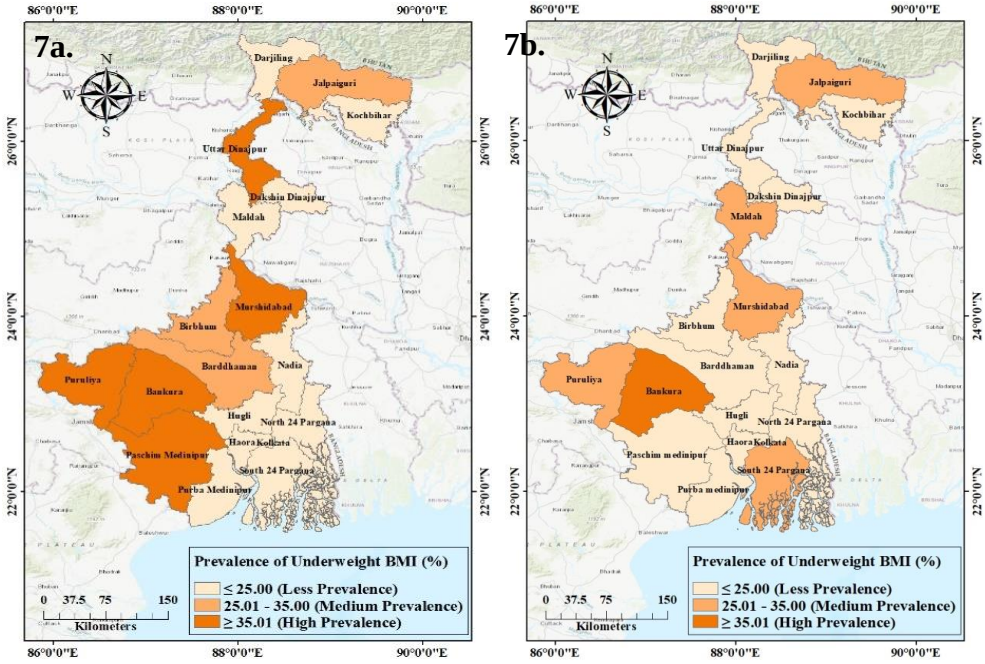
Haora and Kolkata are the two districts where there has been a significant increase (over 10%) in underweight BMI among women. Additionally, anaemia affects 21.19% of women in West Bengal aged 15–49. The prevalence of underweight BMI among women in this age group changed between the 2015-16 and 2019-21 surveys. The statewide NFHS reported a decrease in the percentage of women with an underweight BMI, from 29.30% to 21.19% over the last two NFHS rounds.

In specific districts, the frequency of underweight BMI among women aged 15 to 49 in West Bengal ranges from 10.8% in Hugli to 49.5% in Puruliya, as per NFHS-4 (see Figure 7a). Five districts exhibit a high prevalence of underweight BMI among women, exceeding 35%: Bankura, Murshidabad, Paschim Medinipur, Puruliya, and Uttar Dinajpur. Conversely, eight districts report a lower prevalence of underweight women with a BMI: Dakshin Dinajpur, Darjeeling, Kochbihar, Malda, Nadia, and North 24 Parganas. The remaining districts in West Bengal fall into the moderate prevalence category, with underweight BMI rates among women ranging from 25% to 35%.

Across the districts, as per NFHS-5, the proportion of underweight BMI among scheduled tribe women varies from 10.2% in Haora to 35.3% in Bankura (see Table 5 & Figure 7a). Additionally, Bankura is the only district where the proportion of women with underweight BMI exceeds 35%. Only five districts have a moderate prevalence of underweight BMI ST women: Jalpaiguri, Malda, Murshidabad, Puruliya, and South 24 Parganas. The rest fall into the lower prevalence category, with a proportion of underweight BMI women ranging from less than 25%.

Figure 7

Spatial Disparity of ST Underweight BMI Women of West Bengal, India (7a. NFHS-4, 7b. NFHS-5)



Several factors contribute to poor nutritional status and low BMI among vulnerable groups, including persistent poverty, unhygienic and crowded living conditions, lack of sanitation and clean water, and limited awareness of healthy practices. These interrelated socio-environmental issues create a cycle of deprivation that hinders dietary intake, nutrient absorption, and overall health (De & Kundu, 2016).

Table 5

Disparity of Underweight BMI Women (ST) in West Bengal, India

Districts	Prevalence of underweight BMI (%)	
	NFHS- 4	NFHS- 5
Bankura	48.5	35.3
Puruliya	49.5	34.7
South 24 Parganas	24.7	33.1
Murshidabad	100.0	30.8
Jalpaiguri	34.4	27.6
Maldah	22.5	25.7
Birbhum	30.0	23.7
Barddhaman	29.7	21.9
Purba Medinipur	13.9	21.8
Dakshin Dinajpur	24.5	21.2
Uttar Dinajpur	44.2	20.9
Kolkata	0.0	16.8
Kochbihar	24.3	15.3
Darjiling	24.3	14.8
Hugli	10.8	13.2
Nadia	14.3	12.5
North 24 Parganas	22.6	12.0
Paschim Medinipur	38.6	11.2
Haora	0.0	10.2

Source: DHS datasets of NFHS- 4 & 5

Discussion

This research examines the nutritional status of ST children (U5A) and women (URA) utilising anthropometric indicators and anaemia for women, across the districts of West Bengal. It highlights the disparities in nutritional conditions among ST children (U5A) and quantifies the differences. The study identified 13 districts, Bankura, Birbhum, Dakshin Dinajpur, Howrah, Jalpaiguri, Paschim Medinipur, Purulia, South 24 Parganas, Murshidabad, North 24 Parganas, Bardhaman, Darjeeling, and Hooghly, as high-priority areas. In these districts, at least one development indicator, such as stunting, wasting, or underweight, has either increased moderately or remained unchanged from 2015-16 to 2019-21.

Furthermore, nine districts have been identified where the prevalence of specific issues is particularly high: stunting is most prevalent in Birbhum, Dakshin Dinajpur, Jalpaiguri, Purulia, Uttar Dinajpur, and Howrah; wasting is notably high in Birbhum, Howrah, and Paschim Medinipur; and underweight status is highest in Birbhum, Purulia, Paschim Medinipur, and South 24 Parganas.

The disparities in nutritional status among children in these districts are attributed to uneven development across geographic regions, a lack of awareness about proper nutrition, and inadequate hygiene and sanitation compared to other social groups (Khadse & Chaurasia, 2020). Therefore, it is crucial to focus efforts on these nine high-prevalence districts to address undernutrition among ST children.

Despite India's various child development programmes, progress in nutritional development has been slow. Previous research indicates that child undernutrition has increased in recent years (Chatterjee, 2007).

The study also provides an overview of women's nutritional status in West Bengal, focusing on anaemia and body mass index (BMI) across various districts. Through thematic representations, it highlights significant variations in the nutritional status of ST women (URA).

Twelve districts have been identified as hotspots for anaemia among women: Jalpaiguri, Kochbihar, Dakshin Dinajpur, Maldah, Murshidabad, Birbhum, Purulia, Bankura, Paschim Medinipur, Hugli, Howrah, and South 24 Parganas. These districts exhibit the highest prevalence of anaemia, highlighting a need for targeted interventions to address women's undernutrition in these high-risk areas.

Moreover, Bankura has been identified as a hotspot for women with a low BMI, showing the highest rates of underweight women in the region. Targeted efforts are essential in this district to reduce the prevalence of underweight status among women.

It is essential to closely observe social groups to understand and address these nutritional and health inequities. The ST population, in particular, faces significant marginalisation and represents one of

the most socioeconomically disadvantaged groups regarding health outcomes (Sharma, 2020).

Nutritional issues among tribal children remain a significant concern in India, particularly in West Bengal. A noticeable socioeconomic disparity exists in children's health at the district level. Research indicates that the burden of undernourished children is higher in the least developed districts of India (Liou et al., 2020). According to the Comprehensive National Nutrition Survey (2016-2018), approximately 4.7 million children under the age of five suffer from chronic undernutrition, which adversely affects their growth, development, education, and overall academic performance.

Several factors contribute to this issue, including inadequate food intake, illness, family food insecurity, poverty, and a range of other challenges, such as insufficient infrastructure, geographical isolation, limited access to public services, and cultural differences. These factors often hinder the effectiveness of health and nutrition interventions (ALEKH, 2020).

The prevalence of the Composite Index for Anthropometric Failure among tribal children closely relates to these challenges. Tribal children under five who receive irregular supplemental nutrition and come from households with low food security are more likely to experience various anthropometric inadequacies (Mukhopadhyay & Biswas, 2010).

To address childhood undernutrition, complementary nutrition and health promotion initiatives could be developed based on new anthropometric indices (Das & Bose, 2011).

Mostly, the primitive tribal women had a low socioeconomic status and belonged to the lowest and middle classes; they also consumed a significantly lower number of macronutrients, which contributed to their malnourished status (Dash & Adhikari, 2017). Furthermore, the nutritional status of tribal women of reproductive age is alarmingly poor, with disparities observed among different subtribes (Mohandas et al., 2019).

A significant barrier to the sustainable development of tribal communities is a lack of awareness about policies and programs specifically designed for them. This situation can only be improved by increasing literacy rates within these communities. Many tribal individuals drop out of school at a young age and lack knowledge about the policies and programs available, as well as their rights. Therefore, government policies should not only focus on tribal development but also promote long-term growth among tribal populations (Minz, 2020).

Recommendations

Government programs aimed at combating undernutrition often face challenges such as a lack of coordination, insufficient staffing, inadequate funding, and disorganised efforts (V, & Pal, 2022). This discussion examines district-wise undernutrition rates for ST children (U5A) and women (URA) in West Bengal. It provides recommendations

for enhancing nutritional and health conditions based on data from the NFHS. The analysis focuses on nine districts with high rates of undernutrition: Birbhum, Dakshin Dinajpur, Howrah, Jalpaiguri, Koch Bihar, Paschim Medinipur, Puruliya, South 24 Parganas, and Uttar Dinajpur. Moreover, 12 districts (Jalpaiguri, Koch Bihar, Dakshin Dinajpur, Malda, Murshidabad, Birbhum, Puruliya, Bankura, Paschim Medinipur, Hooghly, Howrah, and South 24 Parganas) report a high prevalence of undernutrition among ST women. Based on the study, several recommendations are proposed:

1. Establish a clear administrative role and institutional framework, along with a revised policy structure tailored to the needs of the tribal region.

2. Focus on creating effective policies for undernourished tribal sub-plans.

3. Ensure effective implementation of the Public Distribution System, the Integrated Child Development Scheme, and Accredited Social Health Activists services with ongoing monitoring and awareness led by local authorities.

4. Collaborate with non-governmental organisations to support the tribal population in improving their nutritional status.

5. Address the key determinants of nutrition, which include education, socioeconomic status, and awareness of healthy lifestyles, through various interventions, policies, and programs.

6. Provide special educational assistance to raise awareness among tribal populations, ultimately promoting better nutritional and health outcomes for both children and women.

Limitations

This study used spatial and descriptive methods to examine undernutrition in West Bengal. It did not statistically assess the determinants and instead relied on existing evidence. NFHS data are cross-sectional and not specifically tribal, which limits causal inference and representativeness.

Conclusion

The anthropometric indices of children under five years of age (U5A) and the body mass index and anaemia status of reproductive-aged women (URA) are vital indicators of nutritional status. This study reveals that in numerous districts of West Bengal, Scheduled Tribe (ST) children under five years are more nutritionally vulnerable than the average population. The prevalence of undernutrition among these ST children is higher than both the state and national averages in several districts. Conversely, many districts in West Bengal also exhibit elevated rates of anaemia and an underweight body mass index among ST women compared to state and national averages.

The rising issue of undernutrition in various tribal areas and districts of West Bengal poses a significant concern for the health and well-being of ST children under the age of five and reproductive-aged women. It is vital to implement targeted

educational initiatives, empower communities through public-private partnerships, and enhance the affordability and accessibility of healthcare facilities in the undernourished tribal regions.

The findings of this study aim to highlight these issues and assist in reducing the nutritional disparities faced by ST children and women in various districts of West Bengal through a range of initiatives and policy decisions.

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