The Intersection of Socio-Economic Vulnerability and Malnutrition: A Study on Scheduled Tribe Women in Northeast India

Barnita Das[1], Nandita Saikia[2], Aditi[3], Punit Mishra[4], Minakshi Buragohain[5], Laishram Ladu Singh[6]

Abstract

Keywords

Malnutrition, Northeast, India, Socioeconomic vulnerability, NFHS-5

This study investigates socio-economic vulnerability among the scheduled tribe population of North-East India and its impact on malnutrition, in women aged 15-49 years. Data from the various rounds of National Family Health Survey (NFHS) were used to create a Socioeconomic Vulnerability Index (SeVI) based on various socio-economic variables. Districts of Northeastern states were categorized by SeVI. In this study, the principal outcome variable is women's Body Mass Index (BMI), classified by WHO guidelines into four groups: underweight, normal weight, overweight, and obese. The SeVI index was found to perform best in states like Delhi, Punjab, Goa, and Mizoram, while it showed the poorest performance in states such as Jharkhand, West Bengal, Bihar, and Odisha. Within North-eastern states, the SeVI index is better for the non-Tribal population than the Tribal population, except for Mizoram. District-wise analysis shows that tribal population has the highest vulnerability in Assam and Tripura. The Multinomial logistic regression was carried out to examine the association between the BMI and independent variables. The study reveals a complex interplay between socio-economic factors, demographic traits, and weight status among reproductive-age women in North-East India. SeVI index is significantly correlated with underweight, overweight, and obesity risk of women Reducing socio-economic vulnerability is essential for improving scheduled tribe women's health in North-East India.

[1] Indian Statistical Institute (ISI), Tezpur. Email: barnitadas01@gmail.com
[2] International Institute for Population Sciences, Mumbai. Email: nanditasaikia@iipsindia.ac.in
[3] PopulationCouncil Consulting Pvt. Ltd., Delhi. Email: aditi@pcconsulting.co.in
[4] PopulationCouncil Consulting Pvt. Ltd., Delhi. Email: punitrd@gmail.com
[5] Tata Institute of Social Sciences, Gauwahati. Email: minakshi.buragohain@tiss.edu
[6] The Assam Royal Global University, Gauwahati. Email: ladusingh2010@gmail.com

Introduction

As per the Indian Constitution, the Scheduled Tribes (ST) population is defined under Article 342. Under this article, the President of India may, for any state or union territory, and after consultation with the Governor of the state concerned, specify the tribes or tribal communities or parts of or groups within tribes or tribal communities which shall be deemed to be Scheduled Tribes concerning that state or union territory (NHRC India, 2021). As per the constitution, Parliament may, by law, include or exclude tribes or tribal communities from the list of Scheduled Tribes specified under Article 342(1). ST identification is based on a combination of social, educational, economic, and cultural indicators such as Primitive traits; Distinctive culture; Geographical isolation; Shyness of contact with the community at large and Backwardness According to the 2011 census, 10.42 million Indians—or 8.6% of the nation's population—were classified as "Scheduled Tribes" (ST). Scheduled Tribe Population (hereafter mentioned as "tribal population") groups are particularly prone to malnourishment due to their remote locations, erratic food supply, scarcity of proper healthcare facilities, and specific cultural and traditional behaviors. Many such communities are technologically and economically backward, have low literacy rates, pre-agricultural technology levels, dwindling or stagnant populations, and remains distinct from the rest of the population. The Indian government has labeled these communities as particularly vulnerable tribal groups (PVTGs) to monitor their progress (Kanrar et al., 2020).

For a long time, researchers have been examining the link between socioeconomic status (SES) and health. In the 1960s, academics largely believed that advancements in medical science and economic growth would reduce health inequality, at least in industrialized nations (Wang & Geng, 2019). However, such transformations did not happen particularly in low- and middle-income countries due to underlying socio-economic disparity. A longitudinal study in four low- and middle-income countries, Ethiopia, India, Peru, and Vietnam, found high disparities in children's language proficiency and height levels exist based on household wealth (Georgiadis et al, 2017). Along similar lines, an Indian study found that higher mortality rates among lower-income individuals are prevalent than those with higher income, this also varies with education level, and across caste and religion (Saikia et al., 2019). From the literature available, it is evident that SES inequalities are more pronounced within marginalized communities such the tribal population. Malnutrition is characterized by deficiencies, excesses, or imbalances in a person's nutrient and/or energy intake. It encompasses two major categories of diseases. The first category

includes undernutrition, which manifests as stunting (low height for age), wasting (low weight for height), underweight (low weight for age), and micronutrient deficiencies or insufficiencies (a lack of important vitamins and minerals). The second category includes non-communicable diseases (such as cancer, diabetes, heart disease, and stroke) caused by being overweight, obese, or having a poor diet. Over the past forty years, the incidence of overweight and obesity has rapidly increased, posing a serious public health concern for both industrialized and developing nations (Tiwari & Balasundaram, 2021). According to the World Health Organization (WHO), in 2022, 2.5 billion adults aged 18 years and older were overweight, which comprises over 890 million obese adults. This was around 43% of adults aged 18 years and over (43% of men and 44% of women) who were overweight; an increase from 1990, when 25% of adults aged 18 years and over were overweight. Prevalence of overweight varied largely across regions, from 31% in the WHO South-East Asia Region and the African Region to 67% in the Region of the Americas (WHO, 2025). Since independence, various government policies and programs have aimed to improve the livelihood, education, and health of tribal populations. Despite sixty years of special treatment, the ST Population remains the most undernourished group in Indian society. Around 4.7 million Indian Scheduled tribe

children face chronic malnutrition, which affects their survival chances, development, learning, and productivity in later years of life (MG et al., 2024). In India, 40% of tribal children under five are stunted, and 16% are severely stunted. Both tribal and non-tribal children exhibit mild to moderate stunting, but severe stunting is more prevalent among tribal children (16% vs. 9%) than non-tribal children (CNNS 2016-18). According to the Food and Agriculture Organization (FAO), 13.7% of India's population is undernourished, and in the 2024 Global Hunger Index, India ranks 105 out of 127 nations (GHI, 2024).

Though the problem of malnourishment among the tribal population persists across the country, there exists a lack of significant evidence or research focusing on the socio-economic vulnerability and malnutrition among the tribal population of North-East India. The relationship between socio-economic vulnerability and health issues, such as malnutrition, is becoming increasingly critical, especially when compared to other tribal regions in India. This study aims to explore the district-level disparities in the Socioeconomic Vulnerability Index (SeVI) among tribes in North-East India and examine their association with nutritional outcomes. By addressing these research questions, the study seeks to provide an assessment of the progress made by states in eradicating socio-economic

vulnerability and health disparities in North-East India. The current study's findings would help policymakers address these concerns before they further exacerbate the North-Eastern tribal population.

Data and Methodology

Data source

We used the secondary data source from the National Family Health Survey; for index formation (IIPS & ICF, 2021). The NFHS datasets are published by the International Institute of Population Sciences (IIPS) Mumbai, India. The NFHS-5 (2019-21) dataset was mainly used for analysis. The NFHS survey provides state- and country-level data on fertility, infant and child mortality, family planning usage, maternal and child health, and women's and children's nutrition. The most recent round of the NFHS (2019-21) survey for India was conducted in 2019-21 and covered 636,699 homes with a 98% response rate, 724,115 women with a 97% response rate, and 101,839 males with a 92% response rate were included in the study. The analysis is limited to a reproductive woman aged 15-49 years. Those women who are not of reproductive age have been excluded. The

final sample size for women after restricting it only to reproductive women was 103,433 cases (IIPS & ICF, 2021).

Construction of Socioeconomic Vulnerability Status

SeVI was created by reviewing the factors that were used in SeVI in earlier research (Park & Ko, 2021). They developed the socioeconomic vulnerability index with seven indicators: education level, personal income level, household income level, social activity participation, economic satisfaction, private insurance coverage, and residential area to assess socioeconomic vulnerability by education level. SeVI was determined using the total of these items, each of which had a score between 0 and 1(Park & Ko, 2021). So, after reviewing the data survey items obtained from the NFHS-2019-21, SeVI was created using seventeen socioeconomic status indicators: education level, place of residence, insurance, marital status, drinking water, sanitation toilet, cooking fuel, floor, wall, roof, electricity, radio, television, refrigerator, bicycle, motorcycle, car. Using the SeVI's rating system from earlier research (Park et. al, 2021), variables used for constructing the SeVI index can be found in table A..

Table A. List of variables used for constructing the SeVI index.

Variables	Categories	Unit/code
Residence	Rural	0
	Urban	1

	No education	0
Education	Primary	1
	Secondary	2
	Higher	3
Insurance	No	0
	Yes	1
Marital status	Without Spouse	0
	Never Married	1
	Currently married	2
Drinking water	Unimproved water	0
	Improved water	1
Toilet sanitation	Unimproved	0
	Improved	1
Cooking fuel	Solid	0
	Clean	1
Floor	Unimproved	0
	Improved	1
Wall	Unimproved	0
	Improved	1
Roof	Unimproved	0
	Improved	1
Electricity	No	0
	Yes	1
Radio	No	0
	Yes	1
Television	No	0
	Yes	1
Refrigerator	No	0
	Yes	1
Bicycle	No	0
	Yes	1
Motorcycle/bike	No	0
	Yes	1
Car/Truck	No	0
	Yes	1

To create SeVI principle component analysis (PCA) was used for all seventeen components. A higher score indicates lesser socioeconomic vulnerability.

According to the SeVI 5 quartile score we classified SeVI as 1 "poorest", 2 "poorer" 3 "middle" 4 "richer" and 5 "richest".

Demographic Characteristics

Demographic characteristics included in the model were the age of women, religion, and language.

Outcome variable

This study was carried out using an individual file from NFHS- 2019-21 data on women (aged 15–49). The dependent variable is health outcome malnutrition: underweight, normal weight, overweight, and obesity. To assess the malnutrition level of everyone, the body mass index (BMI) was calculated from height and weight.

Independent variables

The predictor variables in this study were the age of women, religion, language, and SeVI.

Statistical Analysis

We carried out a multinomial logistic regression model to estimate the relationship between socioeconomic vulnerability and malnutrition of North-Eastern tribal women in their reproductive years (15–49). All the analysis was carried out using STATA version 17. Maps were generated using GeoDa.

Results

The different states and UT's mean Socioeconomic Vulnerability Index Score in India can be seen from **Figure 1**. The Socioeconomic Vulnerability Index (SeVI) gauges how susceptible a population Here, considerations including poverty, education, health, housing, and social protection are made. The state of Jammu and Kashmir has a SEVI score of -0.85, indicating that it is more vulnerable to socioeconomic conditions. Himachal Pradesh has a favorable SeVI score of 0.31, indicating that the state is comparatively less vulnerable. With SeVI scores of 0.47 and 0.88, respectively, Uttarakhand and Haryana are less vulnerable states. In comparison to all other states and union territories, Delhi's National Capital Territory (NCT) has the highest SeVI score, with a 1.78. It is clear from this that Delhi is much better off in terms of socio-economic condition. The states with the lowest SeVI ratings are Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh, Bihar, West Bengal, Jharkhand, and Odisha. As a result, it can be inferred that these states are considerably more susceptible to socioeconomic stressors and shocks. Among all the states and union territories, Bihar and West Bengal share the same SeVI score of -1.76, the lowest possible. Odisha and Jharkhand have extremely low SeVI values, at -1.99 and -1.74, respectively. Among the states with SeVI values between -0.49 and 0.72 are Sikkim, Arunachal Pradesh, Nagaland, Manipur,

Meghalaya, and Assam. Karnataka has a SeVI score of 0.30, which indicates that the state is considerably less vulnerable. SeVI scores for Goa, Lakshadweep, and Puducherry are 1.66, 1.59, and 2.43, respectively. These states are least susceptible to socio economic vulnerabilities. In comparison to other states and union territories, Kerala and Tamil Nadu are neither more nor less vulnerable, with SeVI values of 0.00 and 0.48, respectively. With SeVI scores of 0.29, Telangana can be considered to be a less vulnerable state.

The socioeconomic vulnerability index scores for scheduled tribes and non-tribal groups in various of India's northeastern states is given in **Figure 2**. In this bar diagram, the scores are divided into two categories, i.e., tribal and non-tribal women. Due to its high scores in all categories, Mizoram is considered to be less vulnerable to socioeconomic conditions. Tripura scored lower in the non-tribal category than in the scheduled tribe category, showing that the state's non-tribal population is more susceptible to socioeconomic risks and shocks. On the other hand, Sikkim scored highest in both the non-tribal and scheduled tribe categories, showing that both groups are comparatively less vulnerable to socioeconomic risks in the state. On the other hand, Arunachal Pradesh, Nagaland, Manipur, Meghalaya, and Assam have low scores, indicating a

relatively significant sensitivity to risks and shocks for both scheduled tribe and non-tribal categories.

The district-level socioeconomic vulnerability variation in different North-Eastern states of India are shown in **Figures 3 and 4**. It represents the district-level socioeconomic vulnerability index (SeVI) score for (15-49) women of North-Eastern states of all the districts' overall population, 2019-2021, and tribal women. The score ranges from -0.75 to .25, where negative values indicate higher vulnerability, zero represents the national average, and positive values indicate lower vulnerability. The SeVI score varies considerably between districts, as can be seen by looking at the map. According to its highest SeVI score of 1.95, the Aizawl district of Mizoram is comparatively well-off than other districts in India. Other Mizoram districts with high SeVI scores, such as Champhai, Serchhip, and Lunglei, also have comparatively low vulnerability. Arunachal Pradesh's East Kameng and Upper Subansiri, Nagaland's Mon, West Karbi Anglong, and Assam's Longding are a few exceptions that have extremely low SeVI scores, signifying considerable susceptibility. Some of the lowest SeVI scores are found in the districts of Dhubri, Karimganj, and Hailakandi in Assam, and Cachar in Assam and Tripura. It's also important to notice that some of the districts in the nation's metropolitan

Figure 1. State-level socioeconomic vulnerability index (SeVI) for (15-49), tribal women, 2019-2021, India
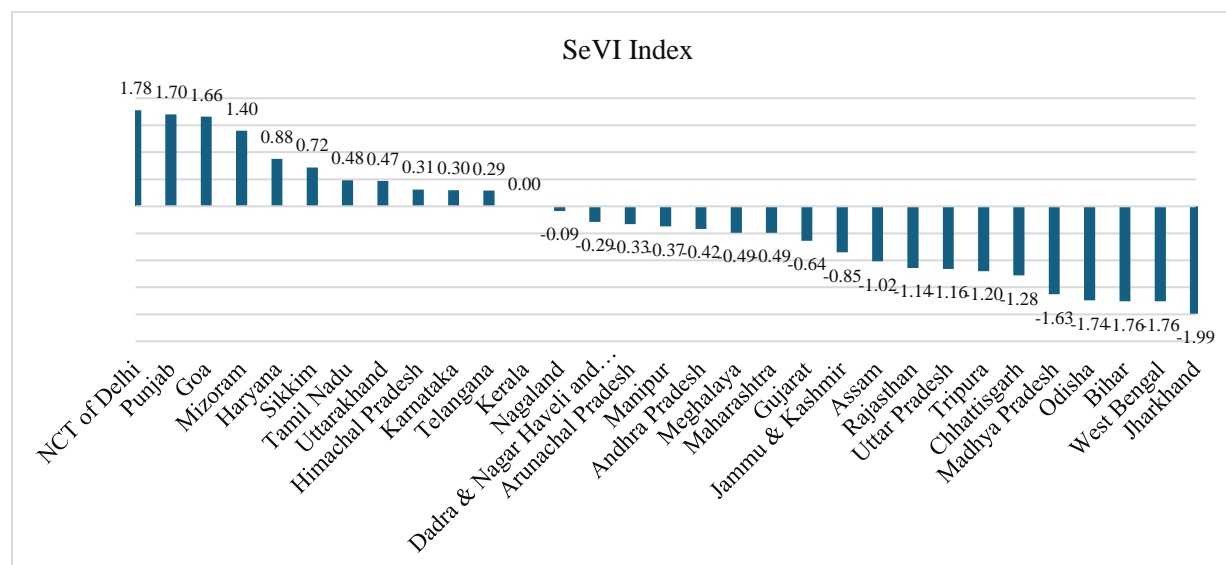

figure 4 areas, like Kamrup Metropolitan in Assam, have positive SeVI scores, indicating comparatively less risk. The district-level socioeconomic vulnerability index (SeVI) score for (15-49) tribal women of North-Eastern states of all the districts, 2019-2021, as shown, total score ranges from -0.75 to 0.25, where negative values indicate higher vulnerability, zero represents the national average, and positive values indicate lower vulnerability. The highest scores are concentrated in the northeastern states, like Arunachal Pradesh, Manipur, and Mizoram. Some of the districts with the good SeVI scores are East Kameng, Upper Subansiri, Mon, and Dhalai. The information on various demographic and socio-economic characteristics of tribal women aged 15-49 from the Northeastern region of India, based on the National Family Health Survey (NFHS) conducted between 2019-2021 is shown in **Table 1**. The data is presented in terms of sample size and percentage for each variable. The first variable is residence, which shows that the majority of the tribal women surveyed reside in rural areas (85.57%), while a smaller proportion live in urban areas (14.43%). Education level indicates that a significant proportion of tribal women have at least some level of education, with 44.64% having completed secondary education and 7.81% having received higher education. However, a substantial portion of the population still lacks formal education, with 34.4% having no education and 13.15% having completed only primary education. The third variable, insurance, shows that just over a third of the surveyed women have some form of insurance (37.57%), while

the majority do not have any insurance coverage (62.43%). Marital status is the next variable, which shows that the majority of tribal women surveyed have never been married (71.14%), while 23.76% are currently married, and 5.1% are without a spouse. The next set of variables are related to basic amenities and infrastructure. Vast majority of tribal women have access to improved sources of drinking water (86.57%), while a small proportion still rely on unimproved sources (13.43%). While the majority of tribal women have access to improved toilet facilities (61.02%), a significant proportion still use unimproved facilities (38.98%). Solid fuel (66.98%) is still widely used for cooking among tribal women, while 33.02% use clean fuel.

A little over half of the surveyed women have an improved floor (47.11%) and an improved wall (53.29%). However, a substantial proportion still have unimproved floors (52.89%) and walls (46.71%). In terms of the roof, the majority of the women surveyed have access to improved roofing (81.4%), while a smaller proportion still have unimproved roofing (18.6%). The next set of variables pertains to access to electricity and electronic appliances. A large majority of tribal women surveyed have access to electricity (93.15%), while a small proportion still do

not (6.85%). Majority of tribal women surveyed fall in the age group of 20-39 years (61.1%), while a smaller proportion fall in the age group of 15-19 years (17.38%) or 40-49 years (21.52%). Most of the tribal women speak Hindi (39.08%) or belong to other language groups (50.14%). Around 61.89% of the women had a normal BMI, while 25.5% were underweight, 10.06% were overweight and only 2.55% women have had obesity. The estimates of the association between various factors and the risk ratios of being normal weight, underweight, overweight, and obese can be seen in table 2. The table includes BMI (body mass index), socio-economic variables (SeVI index and wealth quintile), age, religion, and language. The results provide the risk ratios (RRR) for each variable in comparison to a reference group (indicated by the (ref.) symbol). The dependent variable in this analysis is body mass index (BMI), which is categorized into four groups: normal weight, underweight, overweight, and obese. The independent variables are socioeconomic and demographic factors such as wealth status, age, religion, and language. RRR greater than 1 indicates an increased risk of being in the respective BMI category, while RRR less than 1 indicates a decreased risk.

Figure 2. Socioeconomic vulnerability index for tribal and non-tribal women aged 15-45, North-Eastern states of India, India
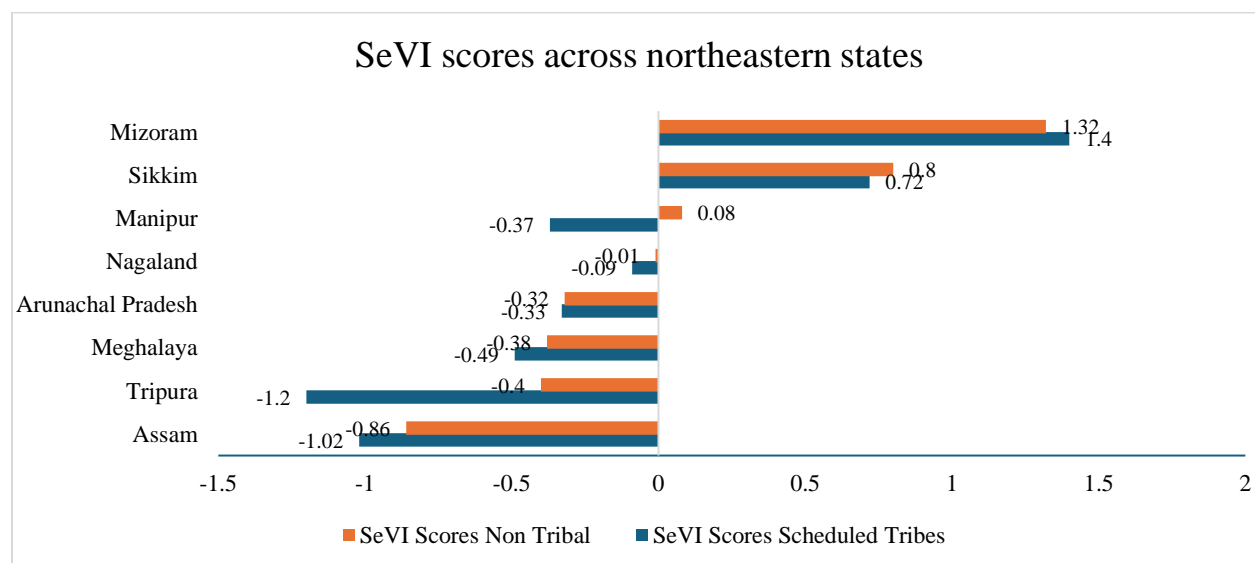
Compared to the reference group of normal weight, being in the poorer, middle, richer, or richest is associated with a decreased risk of being underweight, with decreasing RRRs ranging from 0.81 to 0.63. Age is also associated with a decreased risk of being underweight, with RRRs ranging from 0.51 to 0.32 for the age groups of 20-29, 30-39, and 40-49 years compared to the reference group of 15-19 years. Among the different religions, only being of the "Other" religion is associated with a decreased risk of being underweight (RRR=0.46), while language does not appear to have a significant association with underweight status. Moving on to the overweight category, the table shows that, compared to the reference group of normal weight, being in any of the poorer to richest SeVI is associated with an increased risk of being overweight, with increasing RRRs ranging from 1.38 to 2.61. Age is also associated with an increased risk of being overweight, with RRRs ranging from 2.74 to 7.42 for the age groups of 20-29, 30-39, and 40-49 years compared to the reference group of 15-19 years. Among the different religions, being of the Buddhist or "Other" religion is associated with an increased risk of being overweight, with RRRs ranging from 1.43 to 1.53. Language also shows significant associations with overweight status, with being of the Nepali language group being associated with the highest risk (RRR=1.56) and

being of the Garo or Khasi language groups being associated with a decreased risk (RRRs ranging from 0.44 to 0.65).

Finally, for the obese category, the table shows that, compared to the reference group of normal weight, being in any of the poorer to richest SeVI is associated with an increased risk of being obese, with increasing RRRs ranging from 1.61 to 5.28. Age is also associated with an increased risk of being obese, with RRRs ranging from 1.83 to 7.75 for the age groups of 15-19 and 20-39 years compared to the reference group of 15-19 years. Among the different religions, being of the Hindu or Christian religion is associated with an increased risk of being obese, with RRRs ranging from 1.49 to 2.27. Language shows some significant associations with obesity status, with the Garo language group being associated with the lowest risk (RRR=0.19).

Discussion

The Scheduled Tribe (ST) population in India continues to face significant health disparities, with tribal health remaining a key area of concern due to systemic neglect. These communities are often constrained by poor socioeconomic conditions, inadequate hygiene, and limited access to healthcare, which collectively increase their susceptibility to health risks and shocks (Negi & Singh, 2019a; Negi & Singh, 2019b). This study contributes to the understanding of these challenges by exploring the relationship between socioeconomic vulnerability, demographic characteristics, and nutritional outcomes among reproductive-age women in North-East India.

Guided by two research questions, this study examined (1) whether socioeconomic conditions differ among tribal and non-tribal populations across Indian states and within districts of North-East India, and (2) whether socioeconomic vulnerability is associated with women's nutritional status. The analysis of the Socio-Economic Vulnerability Index (SeVI) showed significant regional variation, indicating that vulnerability among tribal communities is not uniform (Kanrar & Goswami., 2020). .These differences highlight the need for region-specific strategies rather than a one-size-fits-all approach to tribal development. This observation is consistent with NFHS-2019-21 district-level trends, which show marked disparities in wealth, education, and health indicators across North-East India (IIPS & ICF, 2021). In addition, we found significant disparity among tribal women

Figure 3. District level SeVI score for all women of North-Eastern India, 2019-21
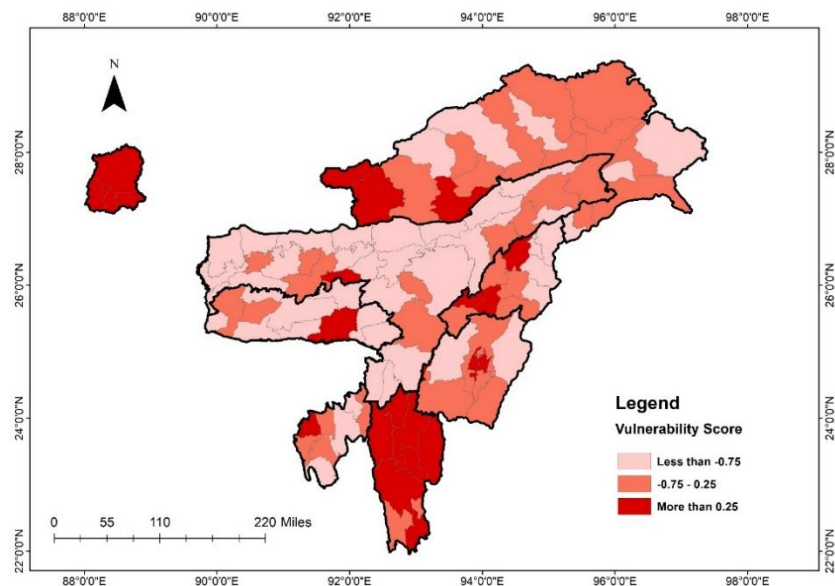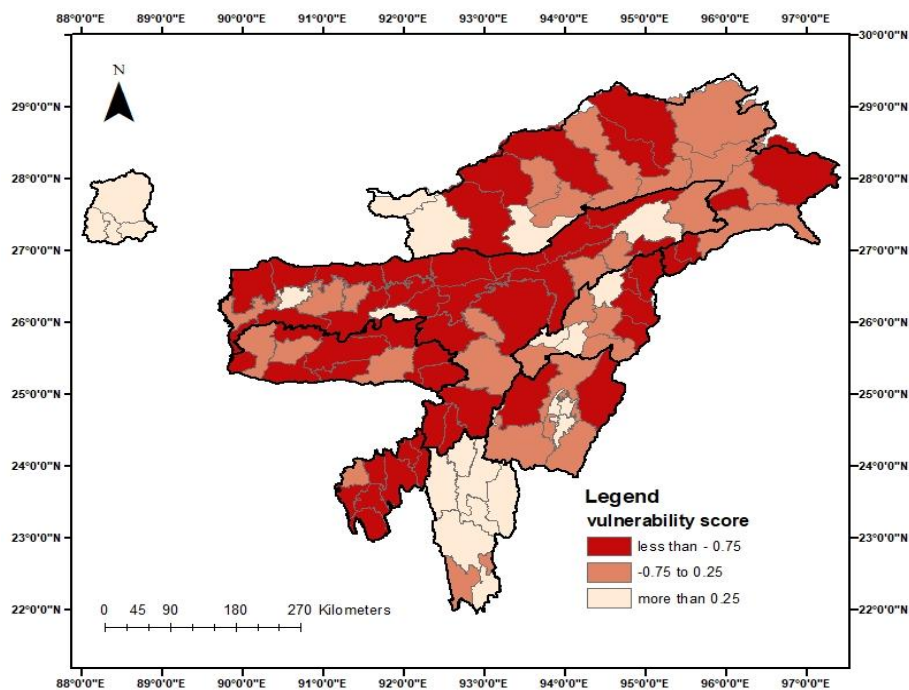

Figure 4. . District level SeVI score for tribal women of North-Eastern India, 2019-2021

across the districts of the North-eastern states. In relation to nutritional outcomes, findings reveal that socioeconomic indicators—particularly wealth quintiles and the SeVI—are strongly associated with BMI categories. Women belonging to higher SeVI wealth quintiles had a lower risk of being underweight, suggesting that better socioeconomic status may offer protection against undernutrition.

Descriptive statistics of the study variables

Table 1. Sample description of (15-49) North-Eastern (NE) tribal women, NFHS-5 (2019-2021), India

SeVI score variables	Sample	Percentage
Residence		
Rural	116,507	85.57
Urban	18,732	14.43
Education		
No education	37,643	34.40
Primary	17,760	13.15
Secondary	67,918	44.64
Higher	11,918	7.81
Insurance		
No	82,999	62.43
Yes	52,240	37.57
Marital status		
Without Spouse	6,710	5.10
Never Married	91,976	71.14
Currently married	36,553	23.76
Drinking water		
Unimproved water	20,233	13.43
Improved water	115,006	86.57
Toilet sanitation		
Unimproved	37,550	38.98
Improved	97,689	61.02
Cooking fuel		
Solid	88,077	66.98
Clean	47,162	33.02
Floor		
Unimproved floor	67,568	52.89
Improved floor	67,671	47.11
Wall		

Unimproved wall	73,837	46.71
Improved wall	61,402	53.29
Roof		
Unimproved roof	26,927	18.60
Improved roof	108,312	81.40
Electricity		
No	8,210	6.85
Yes	127,029	93.15
Radio		
No	126,923	96.65
Yes	8,316	3.35
Television		
No	59,787	47.76
Yes	75,452	52.24
Refrigerator		
No	106,274	81.08
Yes	28,965	18.92
Bicycle		
No	84,305	51.45
Yes	50,934	48.55
Motorcycle/bike		
No	84,091	57.95
Yes	51,148	42.05
Car/Truck		
No	123,141	96.20
Yes	12,098	3.80
Background characteristics		
Age		
15-19	22,563	17.38
20-29	45,117	33.88
30-39	37,600	27.22
40-49	29,959	21.52
Religion		
Hindu	75,539	85.89
Muslim	4,419	2.14
Christian	42,551	8.23
Buddhist	4,939	0.58
Other	7,791	3.16
Language		
Assamese	3,596	2.35
Bengali	2,217	5.03
Hindi	38,022	39.08

Manipuri	224	0.03
Nepali	1,576	0.30
Garo	5,440	0.95
Khasi	5,403	1.31
Mizo	6,596	0.82
Other	72,164	50.14
BMI		
Normal weight	83,452	61.89
Underweight	23,456	25.50
Overweight	14,961	10.06
Obesity	3,050	2.55

Table 2. Multinomial logistic Regression analysis of nutritional status of women aged 15-49 (2019-21)

	RRR [95% CI] BMI Normal weight (ref.) v/s Underweight	RRR [95% CI] BMI Normal weight (ref.) v/s Overweight	RRR [95% CI] Normal weight (ref.) v/s Obese
SeVI index			
Poorest (ref.)			
Poorer	0.81**[0.71,0.92]	1.38***[1.22,1.57]	1.61**[1.18,2.20]
Middle	0.76***[0.65,0.89]	1.78***[1.55,2.04]	2.19***[1.57,3.05]
Richer	0.71***[0.59,0.85]	2.29***[1.99,2.64]	3.38***[2.46,4.63]
Richest	0.63***[0.51,0.78]	2.61***[2.24,3.04]	5.28***[3.79,7.37]
Age			
15-19 (ref.)			
20-29	0.51***[0.45,0.57]	2.74***[2.24,3.36]	1.83*[1.08,3.11]
30-39	0.27***[0.23,0.31]	5.80***[4.76,7.05]	6.26***[3.77,10.38]
40-49	0.32***[0.27,0.39]	7.42***[6.09,9.04]	7.75***[4.67,12.88]
Religion			
Hindu (ref.)			
Muslim	1.37[0.59,3.17]	0.62[0.19,1.94]	2.27[0.41,12.43]
Christian	0.83**[0.73,0.95]	1.14*[1.01,1.29]	1.06[0.80,1.39]
Buddhist	0.75*[0.57,1.00]	1.43***[1.20,1.71]	1.49*[1.07,2.08]
Other	0.46***[0.35,0.61]	1.53***[1.28,1.82]	1.24[0.89,1.71]
Language			
Assamese (ref.)			
Bengali	1.05[0.79,1.40]	1.18[0.88,1.59]	1.17[0.61,2.26]
Hindi	0.45***[0.32,0.63]	1.06[0.84,1.33]	1.1[0.71,1.70]
Manipuri	0.96[0.39,2.33]	1.31[0.83,2.07]	1.43[0.66,3.08]
Nepali	0.52*[0.31,0.88]	1.56***[1.20,2.03]	1.15[0.72,1.83]
Garo	0.65***[0.52,0.81]	0.44***[0.36,0.55]	0.19***[0.11,0.33]

Khasi	1.2[0.97,1.48]	0.63***[0.51,0.77]	0.44***[0.28,0.71]
Mizo	0.61***[0.48,0.77]	0.84[0.69,1.01]	0.76[0.51,1.13]
Other	0.79**[0.67,0.94]	0.88[0.76,1.03]	0.76[0.56,1.05]

Note: Underweight (BMI <18.5 kg/m²), normal weight (BMI between 18.5-24.9 kg/m²), Overweight (BMI between 25.0-29.9 kg/m²), and Obese (BMI >29.9 kg/m²) | Standard errors are in the parentheses | ***: p<0.001, **: p<0.01, *: p<0.05 | (ref.): reference category | RRR = Relative Risk Ratio

However, those in the same SeVI categories also faced a higher likelihood of being overweight or obese. These findings point to a double burden of malnutrition, where improved economic standing can simultaneously reduce underweight but increase overweight risk (Das & Bose, 2015; Georgiadis et al., 2017; Kshatriya & Acharya, 2016). Similar trends have been documented at the national level, where rising income and urbanization have been linked to increasing overweight and obesity among women, even in previously underserved communities (Corsi, Mejía-Guevara, & Subramanian, 2021; WHO, n.d.).

Age emerged as another critical factor. Compared to adolescents (15–19 years), women in older age groups (20–29, 30–39, and 40–49 years) were less likely to be underweight but more likely to be overweight. This trend underscores the importance of age-specific considerations in nutritional programming and highlights how physiological and lifestyle changes across age cohorts may influence body weight (Kumar & Singh, 2023).

Additionally, the study identified associations between weight status and other variables such as language and religion, suggesting that cultural and linguistic factors may shape dietary practices, health behaviours, and access to nutrition. Such social determinants of health are increasingly recognized as critical to understanding malnutrition across tribal and rural India (Sinha & Ghosh, 2023). These findings underline the importance of tailoring health and nutrition interventions to cultural and regional contexts within tribal communities.

Overall, the study provides valuable insights into the intersection of socioeconomic vulnerability and malnutrition among tribal women in North-East India. It demonstrates that both undernutrition and overnutrition are influenced by complex interplays of wealth, age, and cultural background. These results reinforce findings from earlier studies that identified low income and limited education as major contributors to malnutrition among tribal women, with serious implications for reproductive health (Das & Bose, 2015;

Kshatriya & Acharya, 2016; Lahiri et al., 2015a; Lahiri et al 2015b).

The findings have practical implications for public health policies and interventions. Addressing malnutrition in tribal areas requires not only economic support but also culturally informed, age-sensitive strategies that reflect the heterogeneous nature of tribal populations. Policymakers and stakeholders must incorporate these multidimensional factors into program design to effectively promote healthy weight and well-being among women.

However, this study has certain limitations. The use of cross-sectional data restricts causal inference between socioeconomic factors and nutritional outcomes. Additionally, focusing exclusively on a specific geographic and demographic segment may limit the generalizability of the findings to other regions or populations. Despite these limitations, the study offers critical insights for researchers and practitioners working to improve nutrition and health equity among India's tribal communities.

Conclusion

This study advances our understanding of the relationship between socioeconomic vulnerability and malnutrition among tribal women in North-East India. The findings underscore the need for comprehensive, culturally sensitive interventions that address socioeconomic disparities while accounting for the region's sociocultural context. Reducing socio-economic vulnerability is essential for improving scheduled tribe women's health in North-East India.

Declarations

Ethical declarations

The present study utilizes a secondary dataset available in the public domain for legitimate research purposes with no identifiable information on the survey participants. Hence, there is no requirement for any additional ethical approval.

Consent for publication

Not applicable. No details, images or videos related to individual participants

were obtained. In addition, data are available in the public domain.

Competing interests

The authors declare no competing interests.

References

Akhtar, S. (2016). Malnutrition in South Asia—a critical reappraisal. Critical Reviews in Food Science and Nutrition, 56(14), 2320–2330. https://doi.org/10.1080/10408398.2013.832143

Akseer, N., Kandru, G., Keats, E. C., & Bhutta, Z. A. (2020). COVID-19 pandemic and mitigation strategies: Implications for maternal and child health and nutrition. The American Journal of Clinical Nutrition, 112(2), 251–256. https://doi.org/10.1093/ajcn/nqaa171

Biswas, S., Pramanik, K. R., & Sonowal, C. J. (2023). Marginalised social groups differentials in nutritional status (BMI) among reproductive-aged women in West Bengal. BMC Public Health, 23, 842. https://doi.org/10.1186/s12889-023-15635-6

Cabral, J. F., Silva, A., Mattos, I. E., Neves, Á. Q., Luz, L. L., Ferreira, D. B., Santiago, L. M., & Carmo, C. (2019). Vulnerability and associated factors among older people using the Family Health Strategy. Ciencia & Saude Coletiva, 24(9), 3227–3236. https://doi.org/10.1590/1413-81232018249.22962017

Chhungi, V., Ningombam, S. S., Yadav, S., Singh, H., Kiranmala, N., Chandel, S., Mondal, P., Sachdeva, M., & Saraswathy, K. (2019). Prevalence of cardiovascular risk factors among tribal and non-tribal populations with East Asian ancestry from North East India. American Journal of Human Biology, 31(5), e23263. https://doi.org/10.1002/ajhb.23263

Corsi, D. J., Mejía-Guevara, I., & Subramanian, S. V. (2021). The double burden of malnutrition in India: Trends and inequalities (2006–2016). The American Journal of Clinical Nutrition, 113(2), 398–407. https://doi.org/10.1093/ajcn/nqaa343

Das, S., & Bose, K. (2015). Adult tribal malnutrition in India: An anthropometric and socio-demographic review. Anthropological Review, 78(1), 47–65. https://doi.org/10.1515/anre-2015-0004

Georgiadis, A., Reynolds, S., Behrman, J., Benny, L., & Crookston, B. (2017). Disparities in children's vocabulary and height in relation to household wealth and parental schooling: A longitudinal study in four low- and middle-income countries. Unpublished manuscript.

Global Hunger Index. (2024). India. https://www.globalhungerindex.org/india.html

International Institute for Population Sciences (IIPS), & ICF. (2021). National Family Health Survey (NFHS-5), 2019–21: India. Mumbai: IIPS.

Kanrar, P., & Goswami, M. (2020). Sociodemographic profile, reproductive health and nutritional status among the Juangs—A particularly vulnerable tribal group of Odisha, India. The Oriental Anthropologist. https://doi.org/10.1177/0972558X20913730

Kshatriya, G. K., & Acharya, S. K. (2016). Gender disparities in the prevalence of undernutrition and the higher risk among the young women of Indian tribes. PLOS ONE, 11(7), e0158308. https://doi.org/10.1371/journal.pone.0158308

Kumar, A., & Singh, A. (2023). Determinants of nutritional status among scheduled tribe women in India: Evidence from NFHS-5. Journal of Public Health, 45(1), e1–e9. https://doi.org/10.1016/j.jpubhealth.2022.09.005

Lahiri, S., Biswas, A., Santra, S., & Lahiri, S. K. (2015). Assessment of nutritional status among elderly population in a rural area of West Bengal, India. International Journal of Medical Science and Public Health, 4(4), 569–572.

Lahiri, S., Chakrabarty, S., & Dey, D. (2015). Prevalence and determinants of malnutrition

among tribal women in India: A cross-sectional study. Health and Population: Perspectives and Issues, 38(2), 60–66.

Meitei, W. (2020). Nutritional status of under-five children in Northeast India: Effect of household socioeconomic status. Indian Journal of Public Health Research and Development, 11, 1003–1008. https://doi.org/10.37506/ijphrd.v11i7.10220

MG, A., MN, D., BK, V., & GR, S. S. (2024). Nutritional status prevalence and its determinants among children aged 12 to 23 months in tribal settlements of Chamarajanagar District, Southern India. International Journal of Medicine & Public Health, 14(4).

Ministry of Health and Family Welfare. (2017). National Health Policy 2017. Government of India. https://mohfw.gov.in/sites/default/files/914756 2941489753121.pdf

Mitra, D. K., Mistry, S. K., Afsana, K., & Rahman, M. (2018). Demographic, socio-economic and lifestyle determinants of under- and over-nutrition among Bangladeshi adult population: Results from a large cross-sectional study. Journal of Epidemiology and Global Health, 8(3–4), 134–142. https://doi.org/10.2991/j.jegh.2018.03.002

National Human Rights Commission of India. (2021). Constitutional and civil rights to protect Scheduled Castes and Scheduled Tribes. https://nhrc.nic.in/sites/default/files/Civil%20 Rights.pdf

Negi, D. P., & Singh, M. M. (2019). Tribal health in India: A need for a comprehensive health policy. International Journal of Health Sciences and Research, 9(3), 299–305.

Negi, R. S., & Singh, B. (2019). Health status of scheduled tribes in India: A review. Indian Journal of Community Health, 31(4), 469–473.

Park, E., & Ko, Y. (2021). Socioeconomic vulnerability index and obesity among Korean adults. International Journal of Environmental Research and Public Health, 18(24), 13370.

Pathak, J., Mahanta, T. G., Arora, P., Kalita, D., & Kaur, G. (2020). Malnutrition and household food insecurity in children attending Anganwadi centres in a district of North East India. Indian Journal of Community Medicine, 45(4), 405–409. https://doi.org/10.4103/ijcm.IJCM_428_19

Saikia, N., Bora, J. K., & Luy, M. (2019). Socioeconomic disparity in adult mortality in India: Estimations using the orphanhood method. Genus, 75(1), 1–14.

Shankar Mishra, P., Jamadar, M., Tripathy, A., & et al. (2022). Understanding the socio-economic vulnerability in child malnutrition between migrants and non-migrants children (12–59 months) in India: Evidence from a cross-sectional study. Child Indicators Research, 15, 1871–1888. https://doi.org/10.1007/s12187-022-09943-3

Shrestha, N., Mishra, S. R., Ghimire, S., Gyawali, B., Pradhan, P. M. S., & Schwarz, D. (2020). Application of single-level and multi-level modeling approach to examine geographic and socioeconomic variation in underweight, overweight and obesity in Nepal: Findings from NDHS 2016. Scientific Reports, 10, 2406.

Sikdar, M. (2012). Prevalence of malnutrition among the Mising children of Northeast India: A comparison between four different sets of criteria. North American Journal of Medical Sciences, 4(7), 305–309. https://doi.org/10.4103/1947-2714.98589

Singh, S. K., Menon, P., & Aditi. (2020). Tracking progress in anthropometric failure among children in India: A geospatial analysis. Epidemiological Science, 10, 389.

Tiwari, A., & Balasundaram, P. (2021). Public health considerations regarding obesity. Unpublished manuscript.

Wang, J., & Geng, L. (2019). Effects of socioeconomic status on physical and psychological health: Lifestyle as a mediator. International Journal of Environmental Research

and Public Health, 16(2), 281. https://doi.org/10.3390/ijerph16020281

World Health Organization (WHO). (n.d.). Double burden of nutrition. https://www.emro.who.int/nutrition/double-burden-of-nutrition/index.html

World Health Organization. (2025). Obesity and