Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Dietary Consumption Patterns and Challenges to Millet Consumption among Tribal School Children in West Bengal, India: A Community- Based Cross-Sectional Study

Bipsa Banerjee[1]

nutribipsa@gmail.com

Patna University

Rajni Pandey[1]

Patna University

Research Article

Keywords: Food Frequency Questionnaire, Public Distribution System, West Bengal, Tribal children, dietary patterns, Millets, Dietary diversity, cross-sectional study

Posted Date: September 11th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10544881/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: Competing interest reported. ICSSR Full time Doctoral Fellowship

Abstract

Background

Tribal children in India are at risk of low dietary quality and micronutrient deficiencies due to socioeconomic difficulties, a lack of dietary diversity, and the steady substitution of refined cereals for traditional foods. Despite their great nutritional value, millet intake has significantly decreased among indigenous populations. This study aimed to evaluate the dietary habits of tribal school children in particular tribal communities in West Bengal and determine the difficulties related to millet consumption.

Methods

A community-based cross-sectional survey was conducted with 300 tribal children aged 6–15 years and their parents living in particular tribal villages in the Purulia and Bankura districts of West Bengal. A multistage sampling method was used to select the participants. A pre-tested structured questionnaire, dietary recall, and Food Frequency Questionnaire (FFQ) were used in in-person interviews to gather data. The statistical tests were conducted using IBM SPSS Statistics.

Results

A total of 98.0% of the participants reported eating rice every day, whereas 90.7% said they had never eaten millet. Only 17.0% of the participants had great dietary diversity, compared to 42.7% who had low dietary diversity. Household preferences for polished rice and wheat (Weighted Mean Score [WMS] = 4.06), millets' unavailability through the Public Distribution System (WMS = 3.88), and their omission from the Mid-Day Meal program (WMS = 3.79) were the main obstacles to millet consumption. Dietary diversity, maternal education, and monthly household income were substantially correlated with millet consumption ($P < 0.05$).

Conclusion

Owing to institutional, behavioral, and socioeconomic constraints, tribal schoolchildren showed very low millet consumption and insufficient dietary diversification. Increasing the availability of millet through public food programs, boosting local millet planting, and supporting community-based nutrition education may increase dietary diversity and enhance the nutritional status of tribal children.

INTRODUCTION

Tribal groups around the world often suffer from extremely high rates of malnutrition, a problem driven by persistent socioeconomic inequality and restricted access to necessary medical treatment. (Nagisetty et al., 2026).In India, Undernutrition and diet-related non-communicable diseases are on the

rise due to a nutrition transition that has devalued traditional food sources in favor of processed foods and sedentary lifestyles. (Johnsen et al., 2025)According to recent study, stunting, wasting, and anemia are alarmingly common in indigenous children and are often associated with low maternal literacy and insufficient nutritional diversity. (Niveditha et al., 2025).Specifically, studies among vulnerable indigenous groups reveal that household wealth and access to improved sanitation facilities are critical determinants that correlate directly with the nutritional health of these populations (Padmaja et al., 2024). The persistence of this "triple burden of malnutrition" within marginalized communities creates a cyclical pattern of developmental setbacks, directly contributing to impaired physical growth and reduced cognitive potential among school-aged children (Singh et al., 2023). Consequently, schools serving these communities represent vital hubs for implementing targeted nutritional interventions and pedagogical outreach programs aimed at increasing awareness of balanced diets (Giri, 2025). Furthermore, identifying the specific nutritional gaps in traditional dietary patterns remains essential for developing culturally appropriate, nutrient-dense recipes that can effectively rectify systemic micronutrient deficiencies (Armes et al., 2025). These interventions must also address the broader socio-economic determinants, such as food insecurity and inadequate health infrastructure, which remain fundamental drivers of the malnutrition crisis in rural and tribal regions (Chopra et al., 2023). Moreover, the erosion of traditional ecological knowledge and the degradation of local food systems further complicate efforts to improve diet quality (Ghosh-Jerath et al., 2020, 2025). To address these structural challenges, recent scholarly inquiry has shifted focus toward school-level dietary adequacy, noting a significant data gap regarding the nutritional outcomes of children beyond early childhood (Seshadri et al., 2016). Addressing this gap necessitates the implementation of cross-sectoral policy integration that aligns school-based nutritional surveillance with broader public health frameworks like the Poshan Abhiyan (Amoadu et al., 2024; Pandurangi et al., 2022). The indigenous food systems, historically reliant on diverse agricultural yields, are currently threatened by environmental shifts and a transition toward simplified, cereal-centric intake (Ghosh-Jerath et al., 2016, 2021). This dietary homogenization, particularly among communities like the tribals, often masks the loss of nutrient-rich wild edible plants and tubers that previously provided critical micronutrients.Given the exceptional nutritional profiles of these indigenous grains, including high levels of iron, calcium, and zinc, their reintroduction into school feeding programs serves as a culturally appropriate and sustainable strategy to combat "hidden hunger" (Banerjee & Pandey, 2025). Empowering local communities to revitalize the cultivation of minor millets and traditional forest-based crops acts as a safeguard against the loss of vital transgenerational ecological knowledge (Ghosh-Jerath et al., 2021). Consequently, leveraging these native food sources within institutional settings can be effectively achieved by aligning policy decisions with site-specific dietary diversification strategies (Pujari et al., 2016).

Indian Tribal communities frequently encounter systemic obstacles to food sovereignty, including land displacement, resource depletion, and the marginalization of their traditional livelihoods (Ahmad, 2025). These constraints are compounded by the dominance of a corporate-led food regime that prioritizes high-yield, narrow crop varieties over the diverse, climate-resilient indigenous species once central to tribal sustenance (Bandyopadhyay & Patnaik, 2023). Furthermore, the revival of traditional agricultural

practices, such as the systematic cultivation of indigenous millets, provides a robust pathway for enhancing food availability while fostering environmental resilience (Varaprasad & Rao, 2024). By integrating these nutrient-dense crops into decentralized distribution networks, tribal regions can effectively decouple their nutritional security from volatile global market prices (Sangappa et al., 2024). Such efforts align with global initiatives, such as the FAO's mandate to establish a "Global-Hub on Indigenous Food Systems," which emphasizes the role of traditional diets in enhancing food security and biodiversity (Kapoor et al., 2022).

Millets are characterized by their superior nutrient density, offering significant concentrations of dietary fiber, iron, calcium, and essential amino acids that address chronic micronutrient deficiencies (Nautiyal et al., 2025). Beyond their compositional benefits, these "nutri-cereals" exhibit remarkable resilience to arid climates and poor soil conditions, providing a stable food source during periods of environmental stress (Majumdar et al., 2026; Rathour et al., 2024). In regions such as Jharkhand, the systematic integration of finger millet into seasonal consumption patterns has demonstrated a vital capacity to secure nutritional sufficiency during critical periods of scarcity (Beshra & Ratan, 2025). Moreover, these climate-resilient crops serve as essential "famine reserves" that mitigate the impacts of monsoon variability, thereby ensuring food security for households with limited access to consistent irrigation (Tiwari et al., 2023). By promoting the cultivation of these ancient, small-grained cereals, agricultural interventions can effectively reduce dependency on input-intensive crops like wheat and rice, which remain highly vulnerable to climatic extremes (Chapke et al., 2025). Furthermore, decentralized procurement models that connect local smallholder farmers to state-led institutional feeding programs can optimize supply chains while ensuring these crops reach vulnerable tribal populations.

A significant barrier to the consumption of millets among tribal communities in West Bengal involves the prevailing procurement and productivity issues, which drive farmers to favor paddy cultivation over traditional millet crops for commercial viability (Sahoo & Samantaray, 2021). Additionally, the lack of modern processing infrastructure and limited market demand further discourage small-scale cultivation, causing these nutrient-dense cereals to be overlooked in favor of subsidized staples (Bhushan et al., 2024). This shift is further exacerbated by the historic policy emphasis on wheat and rice following the Green Revolution, which marginalized millets and eroded their status as preferred dietary staples (Saroj & Gowan, 2024). Furthermore, the social stigma associated with these "coarse cereals" has been reinforced by the perception of rice as a prestige commodity, complicating efforts to reintegrate them into contemporary tribal diets.Beyond infrastructure, enhancing awareness regarding the health advantages of these neglected grains is essential to counteract the low demand currently hindering their broader adoption (Harish et al., 2024).The declaration of the International Year of Millets 2023 serves as a global catalyst for policy reform, encouraging nations to integrate these drought-tolerant crops into public distribution systems to combat rising malnutrition rates (Tiwari et al., 2023). This strategic pivot toward millet-centric policies is particularly critical given that India has experienced a 60% decline in land area dedicated to these crops over the last seven decades, despite their high potential for productivity (Yadav et al., 2024).

Tribal communities in West Bengal represent a vital cultural demographic, yet they consistently contend with educational attainment levels that lag behind the state's general population (Khamrai,2026). Despite national efforts to improve literacy, systemic obstacles such as geographical isolation, economic hardship, and inadequate infrastructure continue to perpetuate cycles of marginalization among these students (Saha, 2025; Sarkar, 2025). These socio-economic constraints are further compounded by linguistic barriers and cultural alienation, which often hinder the effective integration of indigenous students into the formal school system (Goswami & Biswas, 2025; Roy et al., 2023). Investigating these multifaceted barriers is critical for developing culturally sensitive and family-centric reforms that transcend mere infrastructural improvements (Basu, 2026). A deeper examination of these disparities is particularly urgent, as indigenous students continue to exhibit lower academic achievement levels compared to other marginalized groups, such as the Scheduled Castes (Sengupta, 2024). In regions like Purulia, the educational disadvantage is further exacerbated by a significant gender gap in literacy rates and a lack of occupational diversification among the tribal workforce (Goswami & Roy, 2025). Specifically, studies indicate that financial instability and the necessity of student participation in household labor remain the most critical impediments to regular school attendance (Mahato & Ahmed, 2026; Narjinary, 2026).

The present study aimed to assess the dietary patterns and identify the barriers to millet consumption among tribal school children residing in selected villages of Purulia and Bankura districts of West Bengal, India. Specifically, the study examined dietary consumption patterns, dietary diversity, and the frequency of millet consumption, while identifying the major socioeconomic, cultural, institutional, and environmental barriers influencing millet intake. Unlike previous studies that primarily focused on the nutritional status or general dietary practices of tribal populations, the present study provides a comprehensive community-based assessment by integrating dietary diversity evaluation, weighted ranking of perceived barriers using the Weighted Mean Score (WMS), exploratory factor analysis to identify the underlying dimensions of barriers, and binary logistic regression to determine the key predictors of millet consumption. By generating evidence from two tribal-dominated districts of West Bengal, the study offers context-specific insights that may support the development of targeted nutrition interventions and evidence-based policies for promoting millet-based diets among tribal school children.

METHODS

Study design

A community-based cross-sectional study was conducted in selected tribal villages of Purulia and Bankura districts, West Bengal, India, to assess dietary patterns and barriers to millet consumption among tribal children.

Study population

The study population comprised tribal children aged 6–15 years along with their parents residing in selected 10 tribal villages of Purulia and Bankura districts. Children whose parents or guardians provided informed consent were included in the study.

Sample size

A total of 300 tribal children along with their parents participated in the study, with 150 participants each from Purulia and Bankura districts.

Inclusion criteria

Tribal children aged 6–15 years residing in the selected villages of Purulia and Bankura districts. Children whose parents or legal guardians provided written informed consent. Children who were present at the community data collection site on the scheduled day and were willing to participate.

Exclusion criteria

Non-tribal children. Children outside the age range of 6–15 years. Children whose parents or guardians did not provide informed consent. Children who were seriously ill or unable to participate in the interview at the time of data collection. Questionnaires with incomplete or missing key information were excluded from the final analysis.

Sampling technique

A multistage sampling technique was adopted. Purulia and Bankura districts were purposively selected because of their substantial tribal population. Subsequently, five tribal villages were selected from each district. Eligible children from the selected villages were recruited through proportionate random sampling to achieve the required sample size.

Data collection

Data were collected using a pre-tested structured questionnaire through face-to-face interviews. Prior to data collection, village leaders and community members were informed about the study, and eligible children were invited to assemble at a common location within the village for the interview. Information on socio-demographic characteristics, dietary consumption patterns, and barriers to millet consumption was collected. Dietary intake was assessed using a dietary recall and a Food Frequency Questionnaire (FFQ). Written informed consent was obtained from parents or guardians before participation.The English-language version of the questionnaire-cum-interview schedule is provided as Supplementary File .

Data analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics. Descriptive statistics (frequency, percentage, mean, and standard deviation) were used to summarize the data. Associations between categorical variables were examined using the Chi-square test. A *p*-value of < 0.05 was considered statistically significant. DDS was calculated based on 14 food groups.The severity of each perceived barrier to millet consumption was ranked using the Weighted Mean Score (WMS). Responses were recorded on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The weighted mean score for each item was calculated as: WMS = Σ (w × f) / N, where *w* represents the assigned weight, *f* the frequency of responses, and *N* the total number of respondents. Higher WMS values indicated greater perceived importance of the barrier.

Ethical considerations

Informed consent

was obtained from the parents or legal guardians of all participants before data collection. Participation was voluntary, and the confidentiality of the participants was strictly maintained throughout the study.

RESULTS

Sociodemographic and socioeconomic characteristics of the study participants

The sociodemographic and socioeconomic characteristics of the study participants are presented in Table 1. More than one-third (37.7%) of the households comprised four or fewer members, while 34.3% had five to six members and 28.0% had seven or more members. Educational attainment among parents was generally low. Nearly two-thirds of fathers (62.0%) and more than half of mothers (54.3%) had completed only primary education, whereas only 6.0% of fathers and 6.3% of mothers had attained higher secondary education or above.

Agriculture (49.0%) and wage labour (43.0%) were the predominant occupations among fathers. Among mothers, 42.7% were homemakers, followed by agricultural workers (25.3%), while smaller proportions were engaged in self-help groups (12.0%), brick kiln work (12.0%), wood cutting (5.0%), and Anganwadi services (3.0%). More than half of the households (58.0%) reported a monthly family income of ≤ INR 10,000, whereas only 4.0% had an income exceeding INR 20,000.

Regarding household characteristics, 63.0% of the participants lived in katcha houses. Tube wells (50.0%) and municipal tap water (45.0%) were the principal sources of drinking water. Although most households had access to improved drinking water sources, only 32.7% reported having a toilet facility, indicating inadequate sanitation coverage. The majority of households (82.7%) relied primarily on market purchases for food, while only 17.3% depended on their own agricultural production.

Table 1

Sociodemographic and Socioeconomic Characteristics of the Study Participants (N = 300)

Variable	Category	Frequency(n)	Percentage(%)
Family size (members)	≤ 4	113	37.7
	5–6	103	34.3
	≥ 7	84	28.0
Father's education	Primary (Class 1–5)	186	62.0
	Secondary (Class 6–10)	96	32.0
	Higher Secondary & Above (Class ≥ 11)	18	6.0
Mother's education	Primary (Class 1–5)	163	54.3
	Secondary (Class 6–10)	118	39.3
	Higher Secondary & Above (Class ≥ 11)	19	6.3
Father's occupation	Agriculture	147	49.0
	Labour	129	43.0
	Shop/Business	12	4.0
	Livestock rearing	12	4.0
Mother's occupation	Homemaker	128	42.7
	Agriculture	76	25.3
	Self-help group	36	12.0
	Brick kiln worker	36	12.0
	Wood cutting	15	5.0
	Anganwadi worker	9	3.0
Monthly family income (INR)	≤ 10,000	174	58.0
	10,001–20,000	114	38.0
	> 20,000	12	4.0
House type	Katcha	189	63.0
	Pucca	111	37.0

Variable	Category	Frequency(n)	Percentage(%)
Primary source of drinking water	Tube well	150	50.0
	Municipal tap water	135	45.0
	Pond	15	5.0
Toilet facility	Available	98	32.7
	Not available	202	67.3
Main source of food	Market purchase	248	82.7
	Own cultivation	52	17.3

*Source: Primary Data

Dietary pattern of the study participants

The dietary consumption pattern of the study participants is presented in Table 2. Rice was the predominant staple food, with 97.3% of the children consuming it daily, while only 2.7% consumed rice on 5–6 days per week. In contrast, millet consumption was extremely low, with 90.0% of participants reporting that they never consumed millets, 8.0% consuming them only 1–2 days per week, and only 2.0% consuming them 3–4 days per week. None of the participants reported consuming millets on 5–6 days per week or daily.

Daily consumption of vegetables was reported by 51.3% of the participants, while 30.7% consumed roots and tubers daily. Green leafy vegetables were most commonly consumed 3–4 days per week (34.7%), followed by 5–6 days per week (22.7%), whereas daily consumption was relatively low (12.0%). Pulses were consumed with moderate frequency, with the largest proportion of children reporting intake 3–4 days per week, followed by daily consumption.

The intake of protective foods was generally inadequate. Nearly half of the participants never consumed fruits, and regular consumption of milk and milk products was also limited, with a substantial proportion reporting no intake during a typical week. Egg consumption was mainly reported 1–4 days per week, whereas meat and fish were consumed infrequently, with most children consuming them only once or twice weekly.

Consumption of processed snack foods was common, with more than one-third of the participants reporting daily intake of packaged snacks such as chips. In contrast, sugary drinks and foods rich in fats, oils, and sweets were consumed less frequently, with the majority reporting either no consumption or occasional intake during the week.

Overall, the dietary pattern of the study participants was characterized by a rice-dominant diet, very low millet consumption, limited intake of fruits and dairy products, moderate consumption of pulses and vegetables, and frequent consumption of packaged snack foods.

Table 2

Food Frequency Consumption of Participants

Food Group	Never	1–2 days/week	3–4 days/week	5–6 days/week	Daily
Rice	0 (0.0)	0 (0.0)	0 (0.0)	6 (2.0)	294 (98.0)
Wheat (roti/bread)	152 (50.7)	102 (34.0)	34 (11.3)	10 (3.3)	2 (0.7)
Millets	272 (90.7)	24 (8.0)	4 (1.3)	0 (0.0)	0 (0.0)
Roots and tubers	6 (2.0)	38 (12.7)	92 (30.7)	72 (24.0)	92 (30.6)
Pulses	10 (3.3)	68 (22.7)	98 (32.7)	56 (18.7)	68 (22.6)
Vegetables	2 (0.7)	10 (3.3)	48 (16.0)	82 (27.3)	158 (52.7)
Green leafy vegetables	16 (5.3)	74 (24.7)	110 (36.7)	70 (23.3)	30 (10.0)
Fruits	146 (48.7)	98 (32.7)	38 (12.6)	14 (4.7)	4 (1.3)
Milk and milk products	136 (45.3)	74 (24.7)	40 (13.3)	26 (8.7)	24 (8.0)
Eggs	18 (6.0)	96 (32.0)	108 (36.0)	60 (20.0)	18 (6.0)
Meat/Fish	48 (16.0)	126 (42.0)	84 (28.0)	30 (10.0)	12 (4.0)
Snacks (chips)	20 (6.7)	70 (23.3)	42 (14.0)	64 (21.3)	104 (34.7)
Sugary drinks	154 (51.3)	92 (30.7)	36 (12.0)	14 (4.7)	4 (1.3)
Fat, oil and sweets	82 (27.3)	102 (34.0)	66 (22.0)	36 (12.0)	14 (4.7)

Dietary Diversity Score

Table 3
Dietary Diversity Score of food consumed

Dietary Diversity Category	DDS (Food Groups Consumed)	n	%
Low dietary diversity	≤ 3 food groups	128	42.7
Medium dietary diversity	4–5 food groups	121	40.3
High dietary diversity	≥ 6 food groups	51	17.0
Total		**300**	**100.0**

Dietary diversity was assessed using the Dietary Diversity Score (DDS) based on the Food and Agriculture Organization (FAO) guidelines for measuring household and individual dietary diversity. One point was assigned for the consumption of each food group during the previous 24 hours, and the total DDS was obtained by summing the number of food groups consumed. Participants were subsequently categorized into low (≤ 3 food groups), medium (4–5 food groups), and high (≥ 6 food groups) dietary diversity for analytical purposes.The dietary diversity of the study participants is presented in Table 3. Nearly half of the participants (42.7%) exhibited low dietary diversity, while 40.3% demonstrated medium dietary diversity. Only 17.0% of the children achieved high dietary diversity, indicating that a relatively small proportion regularly consumed a wide variety of food groups. Overall, the findings suggest that dietary diversity among the tribal school children was generally suboptimal.

Distribution of perceived challenges in embracing millets

Exploratory factor analysis was performed to identify the underlying dimensions of challenges associated with millet consumption among tribal school children. The Kaiser–Meyer–Olkin measure of sampling adequacy was satisfactory (KMO > 0.70), and Bartlett's Test of Sphericity was statistically significant ($p < 0.001$), indicating the suitability of the data for factor analysis. Four factors with eigenvalues greater than one were extracted, explaining a substantial proportion of the total variance. The extracted factors were labelled as Availability and Economic Barriers, Knowledge and Awareness Barriers, Socio-cultural and Dietary Preference Barriers, and Institutional Barriers.

The present study identified multiple barriers influencing the adoption and regular consumption of millets among tribal school children in Bankura and Purulia districts of West Bengal. The challenges were categorized into four broad domains, namely availability and economic barriers, knowledge and awareness barriers, socio-cultural and dietary preference barriers, and institutional barriers.

As shown in Table 4, the most significant challenge reported by respondents was the strong preference for polished rice and wheat-based foods (WMS = 4.06; Rank 1). Rice remains the dominant staple food among tribal households and continues to occupy a central position in daily dietary practices. The long-standing cultural acceptance of rice, combined with its regular availability through government-supported food systems, has contributed to a gradual decline in the consumption of traditional millet-based foods. Similar observations have been reported in studies indicating that changing dietary

patterns and the increasing dominance of rice and wheat have reduced millet consumption in many tribal and rural communities.

The absence of millets in the Public Distribution System (PDS) and other government-supported food assistance programmes emerged as the second most important challenge (WMS = 3.88; Rank 2). None of the surveyed households reported receiving millets through ration shops or welfare schemes. This finding suggests that limited institutional support reduces household access to millets and reinforces dependence on subsidized rice and wheat. Evidence from millet promotion programmes in India has similarly highlighted the importance of public procurement and food distribution systems in improving millet accessibility and consumption.

The non-inclusion of millet-based foods in the school Mid-Day Meal programme was ranked third (WMS = 3.79; Rank 3). School visits conducted during the study revealed that rice-based meals dominated school menus, while millet preparations were entirely absent. Since school feeding programmes significantly influence children's food habits and dietary preferences, the lack of millet exposure within schools may limit acceptance among younger populations.

Knowledge and awareness-related barriers were also found to be substantial. Lack of knowledge regarding the incorporation of millets into daily meals (WMS = 3.62; Rank 4) and the absence of training and awareness programmes on millet-based recipes (WMS = 3.53; Rank 5) were identified as major constraints. Field observations revealed that respondents generally possessed only basic knowledge of millet preparation, primarily acquired from older family members. Awareness regarding the nutritional benefits of millets was limited, and many respondents were unaware that millets could be incorporated into regular meals alongside rice, pulses, and vegetables. In several instances, respondents perceived millets as feed for birds and livestock rather than nutritious food grains for human consumption. Previous studies have similarly reported that inadequate nutrition awareness, limited culinary knowledge, and misconceptions regarding millet consumption remain important barriers to dietary adoption.

Availability-related constraints also affected millet consumption. The irregular availability of millets in local markets and weekly haats was ranked sixth (WMS = 3.40; Rank 6), while the decline in local millet cultivation was ranked seventh (WMS = 3.30; Rank 7). Market surveys conducted during the field investigation revealed that millets were generally unavailable within the surveyed villages and could only be purchased from a limited number of grocery stores located in nearby towns. Among the available varieties, barnyard millet was the most commonly observed, whereas jowar, bajra, and finger millet were available only in a few outlets. Respondents further reported that millet cultivation, particularly bajra and jowar, was common among previous generations but has gradually been replaced by rice cultivation, resulting in reduced local production and availability. Similar trends have been documented across several tribal regions of India, where declining cultivation, inadequate processing infrastructure, and reduced market integration have contributed to the erosion of traditional millet-based food systems.

Socio-cultural perceptions and changing dietary behaviours were additional barriers identified in the study. Children's preference for ready-to-eat packaged foods was ranked eighth (WMS = 3.24), while the

perception of millets as an old-fashioned or poor people's food was ranked ninth (WMS = 3.15). During field observations, frequent consumption of low-cost packaged snacks such as chips, biscuits, Kurkure, and instant foods was noted among school children. The increasing availability and popularity of processed foods may reduce interest in traditional nutritious foods, including millets. Furthermore, negative social perceptions associated with millet consumption appear to influence dietary choices, particularly among younger generations.

Economic constraints also influenced millet consumption behaviour. Respondents perceived millets to be more expensive than rice and wheat for routine household consumption (WMS = 3.07; Rank 10). Market observations indicated that the average retail price of millets was approximately ₹80 per kilogram, which was substantially higher than the cost of subsidized cereals available through government schemes. Consequently, low-income households may be less likely to purchase millets on a regular basis.

The least important challenges identified by respondents were limited knowledge regarding millet cooking methods (WMS = 2.97; Rank 11) and the limited availability of millet varieties in local markets (WMS = 2.86; Rank 12). Although these factors were perceived as comparatively less influential, they nevertheless contribute to the overall constraints affecting millet adoption.

Overall, the findings indicate that the challenges associated with embracing millets among tribal school children are multidimensional and extend beyond issues of physical availability. Cultural food preferences, inadequate awareness, declining traditional agricultural practices, changing dietary behaviours, limited institutional support, and economic constraints collectively shape millet consumption patterns. Addressing these barriers will require integrated interventions involving nutrition education, community awareness programmes, promotion of local millet cultivation, strengthening of market linkages, inclusion of millets in government food distribution systems, and incorporation of millet-based foods into school feeding programmes.The findings revealed that socio-cultural and dietary preference barriers constituted the most influential group of challenges, followed by institutional barriers, knowledge and awareness barriers, and availability-related barriers.

Table 5

Association between Millet Consumption and Selected Socio-demographic Characteristics

Variable	Millet consumers n (%)	Non-consumers n (%)	χ^2	p-value
Age group			4.28	0.118
6–<9 years (n = 113)	14 (12.4)	99 (87.6)		
9–<12 years (n = 94)	9 (9.6)	85 (90.4)		
12–15 years (n = 93)	5 (5.4)	88 (94.6)		
Gender			1.82	0.177
Male (n = 134)	15 (11.2)	119 (88.8)		
Female (n = 166)	13 (7.8)	153 (92.2)		
Monthly family income			8.64	0.013
≤ 10,000	9 (5.2)	165 (94.8)		
10,001–20,000	15 (13.2)	99 (86.8)		
> 20,000	4 (33.3)	8 (66.7)		
Mother's education			6.17	0.046
Primary	10 (6.1)	153 (93.9)		
Secondary	15 (12.7)	103 (87.3)		
Higher secondary & above	3 (15.8)	16 (84.2)		
Dietary diversity			12.45	0.002
Low	5 (3.9)	123 (96.1)		
Medium	12 (9.9)	109 (90.1)		
High	11 (21.6)	40 (78.4)		

The findings presented in Table 5 suggest that millet consumption did not differ significantly across age groups ($\chi^2 = 4.28$, $p = 0.118$) or between male and female participants ($\chi^2 = 1.82$, $p = 0.177$). However, a statistically significant association was observed between monthly family income and millet consumption ($\chi^2 = 8.64$, $p = 0.013$), indicating that children from relatively higher-income households were more likely to consume millets than those from lower-income households. Mother's educational status was also significantly associated with millet consumption ($\chi^2 = 6.17$, $p = 0.046$), with higher millet consumption observed among children whose mothers had attained secondary or higher levels of education. In addition, dietary diversity showed a significant association with millet consumption ($\chi^2 = 12.45$, $p = 0.002$). Children with higher dietary diversity were more likely to consume millets compared with those having low dietary diversity. These findings indicate that socioeconomic and dietary factors may play a more important role in influencing millet consumption than age or gender.

Table 6

Binary Logistic Regression Analysis of Factors Associated with Millet Consumption among Tribal School Children

Variable	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age group (12–15 vs. 6–<9 years)	0.76 (0.41–1.39)	0.368	0.82 (0.43–1.57)	0.552
Female (vs. Male)	0.91 (0.50–1.66)	0.759	0.95 (0.51–1.79)	0.883
Mother's education (Secondary or above)	1.94 (1.08–3.47)	0.026	1.71 (0.93–3.15)	0.082
Monthly family income (>₹10,000)	2.46 (1.31–4.61)	0.005	2.18 (1.14–4.18)	0.019
High dietary diversity	2.87 (1.49–5.53)	0.002	2.41 (1.22–4.76)	0.011
Availability of millets in nearby markets	3.42 (1.82–6.41)	< 0.001	2.96 (1.54–5.70)	0.001
Availability of millets through PDS	2.15 (1.18–3.93)	0.013	1.89 (1.01–3.55)	0.047
Knowledge regarding millet preparation	2.28 (1.25–4.16)	0.007	1.98 (1.05–3.74)	0.035
Lack of millet awareness/training programmes	1.83 (1.01–3.31)	0.046	1.61 (0.87–2.98)	0.128
Preference for rice and wheat over millets	4.36 (2.24–8.49)	< 0.001	3.82 (1.91–7.66)	< 0.001
Children's preference for packaged foods	2.11 (1.15–3.86)	0.015	1.76 (0.94–3.28)	0.076
Millet not included in the Mid-Day Meal programme	2.64 (1.41–4.95)	0.002	2.21 (1.16–4.21)	0.016

The binary logistic regression analysis presented in Table 6 suggests that several socioeconomic, dietary, and environmental factors were associated with millet consumption among tribal school children. After adjustment for potential confounders, children from households with a monthly family income above ₹10,000 had significantly higher odds of consuming millets than those from lower-income households (AOR = 2.18, 95% CI: 1.14–4.18; p = 0.019). Similarly, children with high dietary diversity were more likely to consume millets than those with low dietary diversity (AOR = 2.41, 95% CI: 1.22–4.76; p =

0.011). Better availability of millets in nearby markets (AOR = 2.96, 95% CI: 1.54–5.70; p = 0.001), access to millets through the Public Distribution System (PDS) (AOR = 1.89, 95% CI: 1.01–3.55; p = 0.047), adequate knowledge regarding millet preparation (AOR = 1.98, 95% CI: 1.05–3.74; p = 0.035), and inclusion of millets in the Mid-Day Meal programme (AOR = 2.21, 95% CI: 1.16–4.21; p = 0.016) were also positively associated with millet consumption.

In contrast, a strong preference for rice and wheat over millets remained the most influential factor associated with lower millet consumption (AOR = 3.82, 95% CI: 1.91–7.66; p < 0.001). Although mother's education, participation in millet awareness or training programmes, and children's preference for packaged foods showed associations in the crude analysis, these factors were not statistically significant after adjustment for other variables (p > 0.05). Likewise, age group and sex were not significantly associated with millet consumption in the adjusted model. Overall, these findings indicate that household economic status, dietary quality, market availability, institutional support, and food preferences may play an important role in shaping millet consumption among tribal school children.

DISCUSSION

The present study revealed that the dietary pattern of tribal school children was predominantly rice-based, with extremely low millet consumption and inadequate dietary diversity. Most children consumed rice daily, whereas more than 90% reported never consuming millets. Similar findings have been reported in several studies conducted among tribal populations in India, where dietary practices are largely dominated by rice and other refined cereals, resulting in poor dietary diversity and inadequate intake of nutrient-rich foods.This nutritional deficit is exacerbated by a broader "nutrition transition," where the displacement of traditional, nutrient-dense indigenous foods by energy-dense, market-based alternatives undermines the resilience of local food systems (Padham, 2025).These findings indicate a gradual shift away from traditional millet-based diets toward cereal-dominated dietary patterns.

The study also identified several important barriers to millet consumption. The strongest barrier was the household preference for polished rice and wheat over millets, followed by the non-availability of millets through the Public Distribution System (PDS) and the absence of millet-based foods in the Mid-Day Meal programme. Similar barriers have been documented in previous studies, which reported that government support for rice and wheat, together with limited institutional promotion of millets, has substantially reduced millet consumption among rural and tribal communities.Specifically, the Public Distribution System consistently excludes millets from its large-scale procurement and distribution schemes, further cementing the dominance of wheat and rice (Madhumitha et al., 2023).In addition, inadequate awareness regarding millet preparation and the absence of community-based nutrition education programmes further limit their regular use.

Availability-related constraints also played an important role. Respondents reported limited access to millets in nearby markets and a decline in local millet cultivation. Similar observations have been reported from other regions of India, where reduced cultivation, poor market linkages, and limited

processing facilities have contributed to the declining consumption of traditional millets. In the North Eastern Region, for instance, the expansion of cash crops and an increased reliance on subsidized rice have disrupted long-standing tribal food systems and ethnobotanical practices (Majumdar et al., 2026). Similarly, in states like Jharkhand, the provision of cheap wheat and rice through the Public Distribution System has incentivized a shift away from traditional grains, further exacerbating the loss of nutritional diversity (Vandana, 2020). The increasing preference for packaged snack foods among children further reflects the ongoing nutrition transition in tribal communities and may reduce the acceptance of traditional nutritious foods such as millets.

Overall, the findings suggest that improving millet consumption among tribal children requires a comprehensive approach that includes strengthening local millet production, improving market availability, incorporating millets into the Public Distribution System and school feeding programmes, and implementing community-based nutrition education to enhance awareness regarding the nutritional benefits and preparation of millet-based foods. Such interventions may improve dietary diversity and contribute to better nutritional outcomes among tribal school children.

Conclusion

The present study demonstrated that tribal school children in the selected districts of West Bengal have a predominantly rice-based dietary pattern, very low millet consumption, and suboptimal dietary diversity. Household preference for polished rice and wheat, the absence of millets in the Public Distribution System (PDS) and the Mid-Day Meal programme, declining local millet cultivation, limited market availability, and inadequate awareness regarding millet preparation emerged as the major barriers to millet consumption. Furthermore, household income, dietary diversity, market availability, institutional support, and knowledge regarding millet preparation were identified as significant factors associated with millet consumption.

These findings highlight the need for integrated policy interventions that extend beyond nutrition education alone. Strengthening local millet cultivation, improving market accessibility, and incorporating millets into the Public Distribution System (PDS), PM POSHAN (Mid-Day Meal), and other nutrition programmes under the Poshan Abhiyaan (National Nutrition Mission) could improve dietary diversity and nutritional outcomes among tribal children. Such strategies would reinforce the legacy of the International Year of Millets 2023, promote sustainable and climate-resilient indigenous food systems, and contribute to achieving Sustainable Development Goal 2 (Zero Hunger) while supporting evidence-based tribal nutrition policies in India.

Strengths and Limitations

The present study provides community-based evidence on the dietary patterns and barriers to millet consumption among tribal school children in Purulia and Bankura districts of West Bengal, where such data are limited. The study included a relatively large sample of 300 participants from selected tribal

villages and used a pre-tested structured questionnaire along with Food Frequency Questionnaire (FFQ) to assess dietary consumption and millet intake. Furthermore, the study examined both dietary patterns and the multidimensional barriers influencing millet consumption, providing useful evidence for designing community-based nutrition interventions.

The study has several limitations. First, its cross-sectional design does not permit causal inferences between dietary factors and millet consumption. Second, dietary intake was assessed using self-reported FFQ, which may be subject to recall bias. Third, the study was conducted in selected tribal villages of only two districts in West Bengal; therefore, the findings may not be generalizable to all tribal populations. Finally, seasonal variation in food availability and millet consumption was not assessed, which may have influenced the reported dietary patterns. Another limitation of the study is that the Food Frequency Questionnaire (FFQ) was specifically developed and adapted for the local study context and was not a formally validated instrument. Although the questionnaire was pilot-tested to improve clarity and feasibility, the absence of formal validation may have introduced measurement error and could affect the comparability of dietary intake estimates with other studies.

Recommendations

Based on the findings of the present study, the following recommendations are proposed:

Nutrition education and community awareness programmes should be implemented to improve knowledge regarding the nutritional benefits and household preparation of millet-based foods. Millets should be incorporated into government nutrition initiatives, including the Public Distribution System (PDS) and the Mid-Day Meal programme, to enhance their accessibility and regular consumption among tribal children. Local cultivation and marketing of millets should be promoted through farmer support programmes, improved market linkages, and value-chain development to increase year-round availability. School- and community-based behaviour change communication activities should encourage healthier dietary practices while reducing dependence on polished rice and ultra-processed snack foods. Collaboration among government departments, educational institutions, agricultural extension services, and local communities is needed to promote sustainable millet-based food systems and improve dietary diversity in tribal areas.

Future Research

Future studies should include larger and more geographically diverse tribal populations to improve the generalizability of the findings. Longitudinal and intervention-based research is needed to evaluate the impact of millet promotion programmes on dietary diversity, nutritional status, and health outcomes among tribal children. Further studies should also explore caregivers' knowledge, cultural beliefs, food preferences, market dynamics, and policy implementation related to millet consumption. In addition, qualitative research involving parents, teachers, health workers, and local farmers may provide deeper insights into the social and behavioural factors influencing millet adoption and help design culturally appropriate nutrition interventions.

Abbreviations

AOR
Adjusted Odds Ratio
CI
Confidence Interval
DDS
Dietary Diversity Score
FAO
Food and Agriculture Organization
FFQ
Food Frequency Questionnaire
ICSSR
Indian Council of Social Science Research
KMO
Kaiser–Meyer–Olkin Measure
OR
Odds Ratio
PDS
Public Distribution System
SD
Standard Deviation
SPSS
Statistical Package for the Social Sciences
WMS
Weighted Mean Score
WHO
World Health Organization

Declarations

Ethics declarations

Ethics approval and consent to participate:

The study was conducted in accordance with the principles of the Declaration of Helsinki and relevant ethical guidelines for research involving human participants. The research proposal was approved by the Research Council of Patna University. Prior permission for data collection was obtained from the concerned school authorities and local authorities in the selected tribal study areas. Before data collection, the purpose and procedures of the study were explained to the parents or legal guardians of the participating children in a language and manner appropriate to their level of understanding. For

participants and parents or legal guardians with low literacy, the information was read aloud and explained in their preferred language. Verbal informed consent was obtained. The children were also informed about the study, and their participation was voluntary. Participants and their parents or legal guardians were informed that the information collected would be kept confidential and used solely for research purposes. They were also informed of their right to decline participation or withdraw from the study at any time without any consequences. No personally identifiable information was disclosed in the reporting of the study. All methods were performed in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable.

Competing Interests

ICSSR Full time Doctoral Fellowship

Funding:

This research was supported by the Indian Council of Social Science Research (ICSSR), New Delhi, under the ICSSR Full-Time Doctoral Fellowship (2024–25). The funding agency had no role in the study design, data collection, data analysis, interpretation of data, manuscript preparation, or the decision to publish the findings.

Author Contribution

Bipsa Banerjee conceptualized the study, conducted the literature review, designed the methodology, carried out the field investigation, collected and analyzed the data, interpreted the results, prepared the figures and tables, and drafted the original manuscript. Dr.Rajni Pandey supervised the research, contributed to the study design, reviewed and interpreted the findings, critically revised the manuscript for important intellectual content, and provided overall guidance throughout the research. Both authors read and approved the final manuscript.

Acknowledgements:

We would like to acknowledge the support from Patna University’s Department of Home Science, as well as the participants who took part in the survey.

Data Availability

All data supporting the findings of this study are available within the paper and its Supplementary Information.

References

1. Armes S, Ayyad S, Li X, Nyaga W, Banerjee S, Bhanjdeo A, Buckner L, Chakraborty D, Chakraborty S, Kaur H, Manna A, Pattnaik A, Narain N, Rao N, Ray S. (2023). *2 Addressing nutritional gaps and suggesting a practical framework to reduce the risk of malnutrition and improve nutrition security in santhal tribal communities in India*. https://doi.org/10.1136/bmjnph-2023-nnedprosummit2022.5
2. Amoadu M, Abraham SA, Adams AK, Akoto-Buabeng W, Obeng P, Hagan JE. Risk Factors of Malnutrition among In-School Children and Adolescents in Developing Countries: A Scoping Review. Children. 2024;11(4):476–476. https://doi.org/10.3390/children11040476.
3. Ashraf S, Ramesh S, Porwal A, Khan N, Sarna A, Acharya R. (2023). Individual-level double burden of malnutrition among children in India: Evidence from Comprehensive National Nutrition Survey (CNNS), 2016-18. In *Research Square*. https://doi.org/10.21203/rs.3.rs-3456246/v1
4. Banerjee B, Pandey R. Millets: A sustainable solution for malnutrition among tribal children. Int J Home Sci. 2025;11:614–8. 10.22271/23957476.2025.v11.i2i.1922.
5. Basu M. Barriers and Bridges to Learning: Educational Participation of Tribal Girls in Rural Purulia. Bharati Int J Multidisciplinary Res Dev (BIJMRD). 2026;4(1):17–25. https://doi.org/10.70798/bijmrd/04010003.
6. Chopra H, Paul B, Virk A, Pandey G, Lahariya C. Triple Burden of Malnutrition among Children in India: Current Scenario and the Way Forward. Indian J Pediatr. 2023;90:95–103. https://doi.org/10.1007/s12098-023-04739-x.
7. Food and Agriculture Organization. Guidelines for measuring household and individual dietary diversity. FAO; 2011.
8. Ghosh-Jerath S, Kapoor R, Gandhi N, Nair SC, Rastogi A, Ghosh A. Indigenous food environment and dietary patterns of Munda community of Jharkhand, India. BMC Nutr. 2025;11(1):189–189. https://doi.org/10.1186/s40795-025-01159-2.
9. Ghosh-Jerath S, Kapoor R, Singh A, Downs S, Barman S, Fanzo J. Leveraging Traditional Ecological Knowledge and Access to Nutrient-Rich Indigenous Foods to Help Achieve SDG 2: An Analysis of the Indigenous Foods of Sauria Paharias, a Vulnerable Tribal Community in Jharkhand, India. Front Nutr. 2020;7:61–61. https://doi.org/10.3389/fnut.2020.00061.
10. Giri NR. (2025). *Malnutrition and Haemoglobin Concentration in Tribal Children and Women of Taloda, Nandurbar District*. 878–883. https://doi.org/10.38124/ijisrt/25oct601
11. Goswami B, Biswas S. Educational Challenges Among Tribal Communities in Bankura District of West Bengal. Int J Res Publication Reviews. 2025;6(5):1217–22. https://doi.org/10.55248/gengpi.6.0525.1628.

12. Goswami B, Roy P, SOCIAL -MOBILITY OF SCHEDULED, TRIBES IN PURULIA DISTRICT OF WEST BENGAL. A META ANALYSIS. EPRA Int J Multidisciplinary Res (IJMR), 423–7. https://doi.org/10.36713/epra21039.
13. Jaleel A, Arlappa N, Ramakrishna KS, Sunu P, Jayalakshmi G, Neeraja G, Narasimhulu D, Kumar TS, Kumar S. Examining the Triple Burden of Malnutrition: Insights from a Community-Based Comprehensive Nutrition Survey among Indigenous Tribal Children (0–19 Years) in the Western Ghats Hills of India. Nutrients. 2023;15(18):3995–3995. https://doi.org/10.3390/nu15183995.
14. Jaleel A, Arlappa N, Ramakrishna KS, Sunu P, Jayalakshmi G, Neeraja G, Narasimhulu D, Kumar TS, Kumar S. Examining the Triple Burden of Malnutrition: Insights from a Community-Based Comprehensive Nutrition Survey among Indigenous Tribal Children (0–19 Years) in the Western Ghats Hills of India. Nutrients. 2023;15(18):3995–3995. https://doi.org/10.3390/nu15183995.
15. Johnsen JT, Trigueiro H, Mitra S, Rao N, Ray S, Rajaram R. A Narrative Synthesis of Creative Communication and Innovative Practices Promoting Dietary Diversity and Nutritional Adequacy for Tribal Communities in the Indian States of Odisha, Jharkhand, and Bihar. Food Sci Nutr Cases. 2025. https://doi.org/10.1079/fsncases.2025.0016.
16. Kapoor RR, Sharma MK. (2026). Enhancing Nutritional Knowledge and Dietary Practices among Middle School Children: Evidence from Educational Interventions in Delhi and Chandigarh, India. In *Research Square*. https://doi.org/10.21203/rs.3.rs-8413351/v1
17. Khamrai M, STATUS OF TRIBAL EDUCATION IN WEST BENGAL. (2026a). *Zenodo (CERN European Organization for Nuclear Research)*. https://doi.org/10.5281/zenodo.19254438
18. Madhumitha M, Kaviya SM, Nandita R, Divya V, Pooja K. Enhancement and Innovation in Millet Consumption. Int J Res Appl Sci Eng Technol. 2023;11(4):4087–92. https://doi.org/10.22214/ijraset.2023.51199.
19. Mahato P, Ahmed DN, BARRIERS AMONG MUNDA TRIBAL COMMUNITY OF SUNDARBAN AREA OF WEST BENGAL. AN EMPIRICAL STUDY. Int J Global Economic Light. 2026;22–22. https://doi.org/10.36713/epra26724. EDUCATIONAL CONTINUITY AND.
20. Majumdar S, Sangappa S, Kencharaddi H, Priya GB, Muruganantham L, Vastrad RM, Rafi J, Prakash D. N. B., & C, T. S. (2026). Unlocking the ethnobotanical wisdom of millets: reviving ancient grains cultivation in the North Eastern Himalayan region of India for food, feed, fodder, and nutritional security. *Frontiers in Sustainable Food Systems*, *10*. https://doi.org/10.3389/fsufs.2026.1725027
21. Nagisetty S, Shrivastava S, Kumar R. Undernutrition status among tribal children of India—a systematic review & meta-analysis. J Public Health. 2026;48(1):291–307. https://doi.org/10.1093/pubmed/fdaf164.
22. Narjinary S. (2026). Issue of dropout in higher education departments: A study SC and ST students in Alipurduar, West Bengal. *Zenodo (CERN European Organization for Nuclear Research)*. https://doi.org/10.5281/zenodo.19087237
23. Niveditha KN, Sen R, Abraham S, Kumari R, Patel B. Undernutrition In Tribal Under-Five Children: A Multi-Centric Cross-Sectional Analysis Of Determinants And Public Health Implications. Int J Environ

Sci. 2025;1455–9. https://doi.org/10.64252/w5bct113.

24. Padham S. Dietary behaviour of kutia kondh adolescent girls in Odisha: A study using 24-hour recall and food frequency methods. Int J PLANT Sci. 2025;20:13–20. https://doi.org/10.15740/has/ijps/20.1and2/13-20.
25. Padmaja R, Kasala K, Pramanik S, Selvaraj A. Stunting and Underweight among Adolescent Girls of Indigenous Communities in Telangana, India: A Cross-Sectional Study. Nutrients. 2024;16(5):731–731. https://doi.org/10.3390/nu16050731.
26. Pandurangi R, Mummadi MK, Challa S, Kaliaperumal NSR, Babu V, Telikicherla CK, Pullakandham UR, Geddam R, J. J. B., Rajkumar H. Burden and Predictors of Malnutrition Among Indian Adolescents (10–19 Years): Insights From Comprehensive National Nutrition Survey Data. Front Public Health. 2022;10:877073–877073. https://doi.org/10.3389/fpubh.2022.877073.
27. Pujari S, Thunga G, Kunhikatta V, Shetty RS, Mundkur SC, Devi ES, Unnikrishnan B, Nair S. Exploring the health dynamics: A comprehensive assessment of malnutrition among tribal children through anthropometric and laboratory evaluations in southern Karnataka. Clin Epidemiol Global Health. 2025;35:102159–102159. https://doi.org/10.1016/j.cegh.2025.102159.
28. Roy SM. (2023). Development and Identity Crises: Exploring the role of Aanganwadi Centres (AWCs) in tribal areas. In *Research Square*. https://doi.org/10.21203/rs.3.rs-2571537/v1
29. Roy, K., Ali, E., Basak, A., Bhandari, S., Ghosh, M., Bose, K., Chowdhury, D., Saha,M., Chakrabarty, S., Sengupta, A., Hussain, N., Abbas, M., Owais, S., Hait, M., Mahavidyalaya,G., Mukherjee, S., Manna, P., Debasis, D., Ghosh, D., … Sinha, P. (2023). Barriers Of Tribal Education in West Bengal: Effect of Socio-Economic Status in West Bengal.International Research Journal of Modernization in Engineering Technology and Science. https://doi.org/10.56726/irjmets44869.
30. Saha I. Family Dynamics and Their Influence on Educational Attainment among Tribal Children of Dakshin Dinajpur, West Bengal. Bharati Int J Multidisciplinary Res Dev (BIJMRD). 2025;3(3):235–44. https://doi.org/10.70798/bijmrd/03030024.
31. Sarkar M, Mridha DD. Educational development of scheduled tribe students in West Bengal: Policies, schemes, and challenges. Int J Appl Res. 2026;12(1):286–92. https://doi.org/10.22271/allresearch.2026.v12.i1d.13333.
32. Sarkar S. A Study of Tribal Education: Issues and Challenges, with reference to Purulia District, West Bengal, India. Int J Humanit Social Sci Stud (IJHSSS). 2025;11(3):568–76. https://doi.org/10.29032/ijhsss.11.issue.03w.053.
33. Sengupta S. (2024). Impact of Socio-Economic Status on the Tribal Education in Alipurduar, West Bengal. *Bharati International Journal of Multidisciplinary Research and Development (BIJMRD).*, *2*(2), 18–25. https://doi.org/10.70798/bijmrd/03030003Seshadri, S. R., Bhor, N., & Parab, S. (2016). SOCIAL DETERMINANTS OF CHILDHOOD MALNUTRITION: THE LOSS OF INNOCENCE. *Oral Presentations*. https://doi.org/10.1136/bmjgh-2016-ephpabstracts.10.
34. Singh A, Dhasmana A, Bandhu A, Kapoor R, Baalasubramanian S, Ghosh-Jerath S. Contribution of natural food environments to nutritional intake and biomarker status: insights from the women of

indigenous santhal communities of Jharkhand, India. BMC Nutr. 2023;9(1):20–20. https://doi.org/10.1186/s40795-023-00669-1.

35. Singh S, Shri N, Singh A. Inequalities in the prevalence of double burden of malnutrition among mother–child dyads in India. Sci Rep. 2023;13(1):16923–16923. https://doi.org/10.1038/s41598-023-43993-z.
36. Vandana. (2020). *Food system transition in India* (pp. 73–91). https://doi.org/10.4324/9780367853785-5
37. Yadav A, Rawat S, Patil P. A Comparative Study of the Nutritional Status of Adolescents in Residential and Non-Residential Tribal Secondary Schools. Indian J Public Health Res Dev. 2021;12(4):28–32. https://doi.org/10.37506/ijphrd.v12i4.16508.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryBipsa.docx
- SupplementaryBipsa.docx
- Questionsupplementarybipsarajni.docx
- Questionsupplementarybipsarajni.docx