Original Article

Malnutrition and Anemia Among Particularly Vulnerable Tribal Groups of Odisha, India: Needs for Context-Specific Intervention

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Abstract

Background: As undernutrition and anemia persist to be prevalent in India, the socioeconomically disadvantaged groups continue to take the greater brunt. Odisha is home to the largest number of particularly vulnerable tribal groups (PVTGs) in India. The study aimed to provide a comprehensive report on the undernutrition and anemia status of all the PVTGs of Odisha. **Methods:** A community-based cross-sectional study was conducted among (N = 1461, 683 males and 779 females) 13 PVTGs spread across 12 districts of Odisha from August 2018 to February 2019. **Results:** Among the under-five children, the prevalence of underweight was observed in 75.26%, stunting in 55.42%, and wasting in 60.00% and all forms of undernutrition were higher among girls. Among children and adolescents belonging to the age group of 5 to 19 years, the prevalence of thinness was 46.7%. In individuals above the age of 20, the prevalence of underweight among males was 37.7% and females was 44.3% and severe anemia was present in 36.5% of females and 35.8% of males. Women in the reproductive age have a higher prevalence of anemia. **Conclusion:** The study shows that undernutrition and anemia remain high in the PVTGs, especially among the under-five children and women in the reproductive age. As the country heads toward fulfilling Sustainable Development Goals (SDG) by 2030, national and state health policies need to be designed and implemented, giving special focus to these vulnerable groups.

Keywords: Anemia, particularly vulnerable tribal groups, tribe, undernutrition

Introduction

Tribal communities, particularly the particularly vulnerable tribal groups (PVTGs), face social and economic disadvantages due to their remote locations, dietary habits, primitive agriculture, sociocultural taboos, lack of education, poor infrastructure, reliance on informal health care, and poverty.[1] Malnutrition remains a significant challenge in India, despite impressive Gross Domestic Product (GDP) growth, increased food self-sufficiency, and food security efforts.[2] The country accounts for one-third of the global burden of stunting and malnutrition, the leading risk factor for under-five child mortality.[3] Malnutrition rates among tribal populations exceed the national average, as shown by the 2015–2016 National Family Health Survey (NFHS).[4] Odisha, an eastern Indian state, is home to 62 tribal groups, including 13 PVTGs, representing 22.1 percent of the state's total population and 9.7 percent of the country's tribal population.[5]

Recognizing the unique challenges faced by PVTGs, the Government of India has identified them as a separate category requiring special emphasis to improve their socioeconomic and health conditions.[6] However, a lack of comprehensive information on PVTGs' health and nutritional status hampers effective policymaking.[7] Addressing the concerns of this vulnerable population is crucial for India's socioeconomic transformation and the achievement of UN Sustainable Development Goals such as "No poverty" (SDG1) and "Good health and well-being" (SDG3).[8] Therefore, the present survey

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was undertaken to assess the nutritional and anemia status of the PVTGs of Odisha, residing in 17 micro-project areas (MPAs) spread over 12 districts in collaboration with the Scheduled Caste and Scheduled Tribe Research and Training Institute (SCSTRTI), Bhubaneswar, to bridge this knowledge gap. The findings may help develop a targeted intervention to reduce the nutritional challenges faced by PVTGs and improve their overall health status.

Materials and Method

Study design

This community-based cross-sectional survey was conducted from August 2018 to February 2019, adopting a two-stage random sampling strategy. The study used households as the unit-level data collection, and all the households of the 17 MPAs constitute the universe. In the first stage, two primary sampling units (PSUs), that is, villages (from every MPA), were selected randomly based on approximating their distance (first group of villages: situated within 2 km radius and second group of villages: situated within 6 km radius) from the government health facility (Community Health Centre (CHC)) with a presumption that the availability or approachability of healthcare facility might be affecting the utilization of health system and their awareness on health status. The second stage of sampling involved systematic random sampling. For that, first a line listing of all the households was performed, and then, after the calculation of the sampling interval, 20 households were selected. If the 20 households were not found in one village, then nearby villages were taken into consideration. All the consenting members of each household were included in the study, and those who did not provide their consent were excluded from the study. In this case, the selected household was locked after three consecutive visits, and the next household was considered for the study.

Sample size

The sample size was estimated by applying the formula: n = [DEFF* Np (1-p)]/[d2/Z^2 1-α/2*(N-1) +p* (1-p)] using OpenEpi (version 3.01) software.[9] The population size, anticipated % frequency (p), confidence limits, and design effect (DEFF) were used for sample size calculation. We have considered 50% as the anticipated frequency (p) at a 95% confidence limit and design effect 2 to get the largest sample size as we are unsure of the disease prevalence. The total sample size derived was 1327. By following the method mentioned above, a total of 697 households and 1461 individuals belonging to the 13 PVTGs were evaluated.

Data collection procedure

Sociodemographic characteristics

Pretested and structured questionnaires were used to collect the socioeconomic and demographic characteristics of the family of each selected household.

Clinical examination

A detailed clinical examination was performed by a physician for nutritional deficiency signs.

Anthropometric measurements

Weight was measured using the electronic Seca 874 flat scale. For children below 24 months of age, the tared weighing procedure was used. The height of the adults and older children was measured using a Seca 213 Stadiometer, and the length of children aged 6–23 months was measured in a recumbent position using a 417 infantometer.

Hemoglobin (Hb)

Blood collection was performed by finger prick, and 20 µl of blood was collected in Whatman grade 3 filter paper and transported to the laboratory for spectrophotometric determination of Hb concentration by cyanmethemoglobin method at 540 nm and the results were recorded.

Variables

The sociodemographic variables such as education were collected as educational attainment in completed years and categorized as illiterate: primary education: 1–5 years, secondary education: 6 to 10 years, higher secondary: 11–12 years, and above secondary: 12 years and above. For marital status, the participants were divided into three groups (married: those who were married, unmarried: participants who were not married, and widow: individuals who lost their spouse). Information collected on house type, family type, electricity availability, number of bedrooms, number of domestic animals, kitchen type, and occupation was used to calculate the wealth index using principal component analysis. The value so derived was categorized into terciles to get the three strata of the wealth index (low, middle, and high). The patients between the age groups of 15 years and above were categorized into the following groups: 15–19 years, 20–29 years, 30–39 years, 40–49 years, 50–59 years, and 60 years and above. In the logistic regression analysis, age group, marital status, and education were used as independent variables and nutritional status (underweight, normal, and overweight) and anemia status (normal, any anemia, mild, moderate, severe) in male and female participants were used as dependent variables. Figure 1 shows schematically the selection of samples for anthropometric and anemia assessment.

Analysis of data

All data were entered in Microsoft (MS) Excel and analyzed using R version 3.5.1. A subgroup analysis was performed for the age groups of 0 to 59 months (under-five), 5–19 years, and 20 years and above to assess their nutritional status and across the age groups of 6 to 59 months (under-five), 5 to 19 years, and 20 years and above for anemia status. The anthropometric assessment (height-for-age, weight-for-height, and weight-for-age) of the children below 5 years was conducted using the World Health Organization (WHO) R package "Anthro."[10] Children whose height-for-age Z-score <-2 standard deviation (SD) from the median of the reference population were considered "stunted," weight-for-height Z-score <−2 SD were considered "wasted," and weight-for-age Z-score<−2 SD were classified as "underweight." The WHO

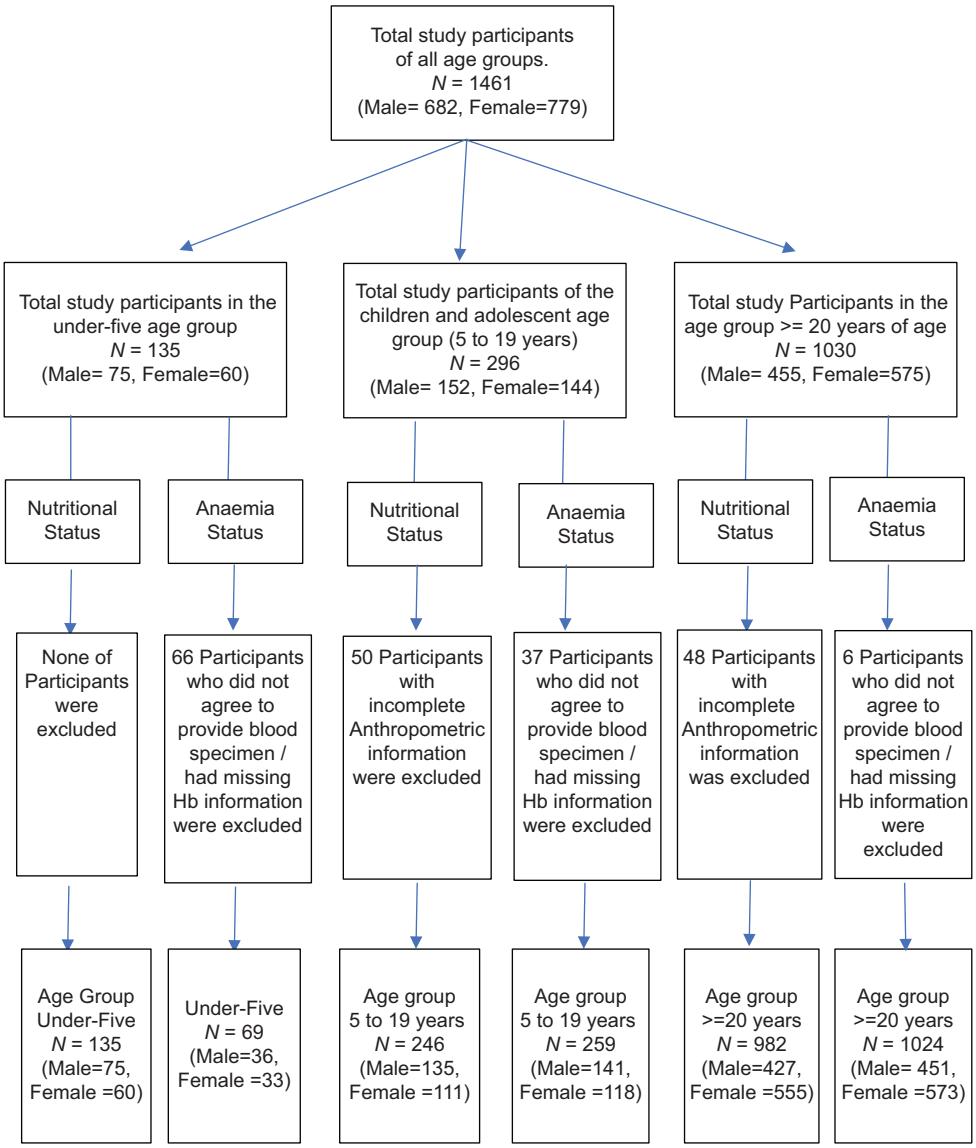

Figure 1: Schematic representation of the sample section for anthropometric and anemic assessment

Anthro Plus software (version 1.0.4) was used for estimating the anthropometric measurement of children from the age group of 5 to 19 years. The nutritional status in terms of body mass index (BMI) of the adults was evaluated with reference to the WHO Global Standard. Anemia (mild, moderate, and severe) was classified based on Hb level according to age and gender based on the WHO standard.[11] The Chi-square test and logistic regression were performed to evaluate the association between dependent and independent variables.

Ethical approval and consent to participate

Research has been performed in accordance with the Declaration of Helsinki and has been approved by the Indian Council of Medical Research-Regional Medical Research Centre-Institutional Ethical Committee (RMRC/IHEC-2018/015 dated 30/07/2018). Informed consent was obtained from each participant before conducting the interview.

Results

Sociodemographic characteristics

A total number of 1461 (682 male and 779 female) individuals comprising all the 13 PVTGs spread over 34 villages in 12 districts have been included in the study. The median age of the enrolled population was 30.0 years (interquartile range (IQR) 13–50 years). Of the enrolled individuals, 135 (9.3%) were children under-five years of age, 239 (164%) school-age children (5–14 years), 417 (28.5%) women in the reproductive age (15–49 years), and 204 (13.9%) above 60 years of age. The "wealth index" indicating the socioeconomic condition of a family reveals that 67.1% of the study population belonged to the middle socioeconomic group and at least 75% were illiterate. The sociodemographic status of the sampled population is depicted in Table 1. The sample characteristics among different PSUs and different tribes are mentioned in Supplementary Table 1.

Anthropometric status

Under-five children

Of the 135 children enrolled in the study, there were 75 (55.6%) boys and 60 (44.4%) girls. As shown in Figure 2, underweight remains by far the most common nutritional disorder followed by wasting and stunting. For all children, the prevalence of moderate (<-2SD) and severe (-3SD) underweight was found to be 75.26% and 53.61%, stunting in 55.42% and 36.14%, and wasting in 60.00% and 33.75%. All forms of undernutrition were more prevalent among girls than boys.

School-age children and adolescents (age group of 5 to 19 years)

A total number of 246 school-age children and adolescents (135 males and 111 females) in the age group of 5–19 years have been included for analysis. Based on the thinness indicator, 28.4% had severe thinness, 18.3% had thinness, and 6.9% were overweight. The prevalence of severe thinness was higher among males compared with females [Figure 3].

Table 1: Sociodemographic characteristics

Variable	Total (n=1461)
Age (in years)	
0–5	135 (9.2%)
5–14	239 (16.4%)
15–49	707 (48.4%)
50–59	175 (12%)
60 years and above	204 (14%)
Median age (years)	30.0 (13–50)
Gender	
Male	682 (46.7%)
Female	779 (53.3%)
Marital status	
Married	985 (67.4%)
Unmarried	458 (31.3%)
Widow or divorce	18 (1.27%)
Education	
Illiterate	967 (75.0%)
Up to primary	233 (18.1%)
Secondary	67 (5.2%)
Higher secondary	15 (1.2%)
Above secondary	7 (0.5%)
Socioeconomic status	
Low	214 (14.6%)
Middle	981 (67.1%)
High	266 (18.2%)

Adults (20 years and above)

Of the 982 adult individuals included in the analysis, 427 were males and 555 were females. The prevalence of underweight (BMI <18.5) among males was 37.7% and females was 44.3%, while overweight or obese (BMI >24.9) was 4% in males and 3.4% in females. In the case of males, the prevalence of underweight was found to be statistically increasing with an increase in age ($\chi^2 = 22.4$, $P = 0.01$), but in the case of females no statistically significant association was found ($\chi^2 = 17.1$, $P = 0.07$) between age group and BMI. However, the prevalence of undernutrition was highest in women aged 50 years and above, followed by women in the age group of 40 to 49 years [Figure 4]. Furthermore, the overall prevalence of malnutrition was found to be significantly high among females compared with males ($\chi^2 = 5.2$, $P = 0.07$) [Table 2a and 2b].

Anemia

Under-five children

A total of 69 (36 male and 33 female) children under-five years of age have been included for analysis. The overall prevalence of anemia was observed to be 82.4%. Among them, 23.1% were mildly anemic, 40.5% were moderately anemic, and 4.3% were severely anemic [Figure 5].

Children and adolescents (age group of 5 to 19 years)

There were a total of 259 children (141 males and 118 females) in this age group. The WHO criteria were used to categorize the observed Hb level into mild, moderate, and severe anemia. The overall prevalence of anemia in females of the age group of 5 to 11 years was 76.7% (mild: 13.3%, moderate: 35.0%, and severe: 28.3%). In females of the age group of 12 to 14 years, the overall prevalence of anemia was 78.6% (mild: 17.9%, moderate: 17.9%, and severe: 42.9%). Anemia in females of age group of 15 to 19 years was 90% (mild: 20%, moderate: 33.3%, and severe: 36.7%). In males of the age group of 5 to 11 years, the prevalence of anemia was 68.5% (mild: 14.8%, moderate: 24.1%, and severe: 29.6%), and in the males of the age group

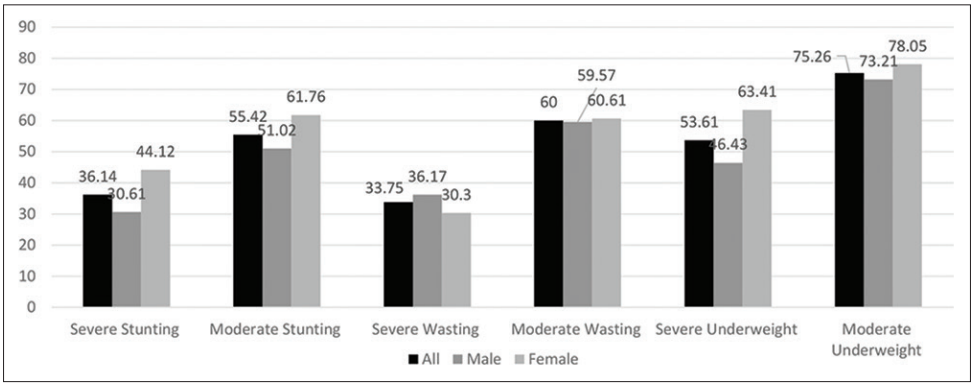

Figure 2: Nutritional status of PVTG under-five children

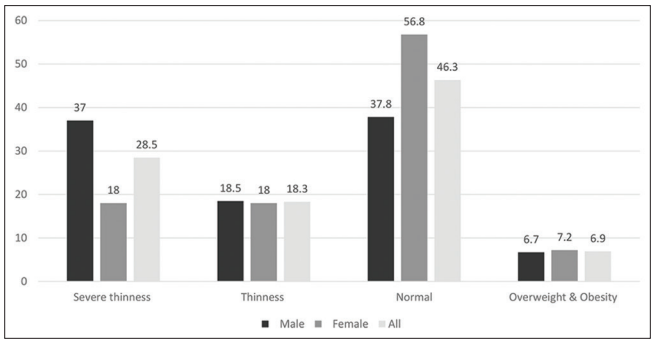

Figure 3: Nutritional status of school-age children and adolescents from 5 to 19 years of age

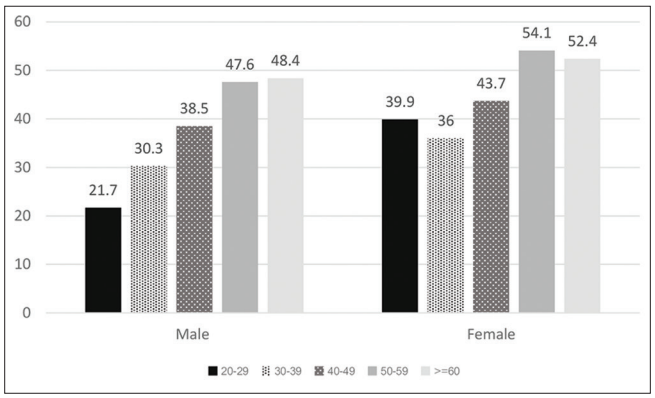

Figure 4: Age group-wise prevalence of undernutrition

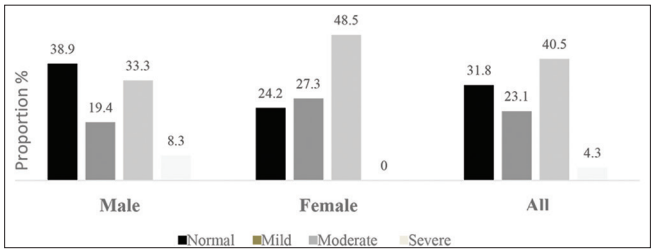

Figure 5: Prevalence of anemia among under-five children of PVTGs

of 12 to 14 years, the prevalence was 56.2% (moderate: 31.2% and severe: 25%). Overall anemia in males of age group of 15 to 19 years was 88.2% (moderate: 23.5% and severe: 64.7%).

20 years and above

Of a total of 1024 adults included in the study, 573 were females and 451 were males. In females, the overall anemia in the age group of 20 years and above was 93.1%. In males, the overall anemia in the age group of 20 years and above was 78.5%.

Association estimates

The overall prevalence of anemia in females aged 5 years and above was 90.6% (mild: 26.2%, moderate: 27.9%, and severe: 36.5%) [Table 3a] and in males aged 5 years and above was 76.6% (mild: 23.1%, moderate: 17.7% and severe: 35.8%) [Table 3b]. Statistical analysis shows that females were more affected by anemia than males ($\chi^2 = 56.3$, $P < 0.001$).

Binary logistic regression analysis indicates that women in the reproductive age group (20–49) and elderly women (>60 years) were at higher risk of developing anemia when compared to children in the age group of 5 to 11 years (age group of 20–29 years, odds ratio (OR) =3.696, 95% confidence interval (CI) =1.637 to 8.370; age group of 30–39 years: OR = 5.965, 95% CI = 2.142 to 19.374; age group of 40–49 years: OR = 4.261, 95% CI = 1.595 to 12.727). Women in the elderly age group also had higher chances of developing anemia when compared to children in ages of 5 to 11 (age group of 50–59 years: OR = 4.210, 95% CI = 1.576 to 12.578; age group of 60 years and above: OR = 3.766, 95% CI = 1.506 to 10.028). Married women have 3.794 times higher odds of having anemia compared with unmarried women (OR = 3.794, 95% CI = 2.226 to 6.446). Males above the age of 60 have 3.5 times higher risk of developing anemia compared with men in other age groups (age group of 50–59 years: OR = 2.175, 95% CI = 1.108, 4.431; age group of 60 years and above: OR = 3.592, 95% CI = 1.748, 7.890).

Vitamin A deficiency

Of the 1461 participants (682 males and 779 females) of all age groups, the overall prevalence of vitamin A deficiency in the form of xerophthalmia was 1.3% (male: 1.2% (n = 8) and female: 1.4% (n = 11)), bitot's spot was 1.7% (male: 1.3% (n = 9) and female: 1.9% (n = 15)), and night blindness was 2.6% (male: 2.2% (n = 15) and female: 3.0% (n = 23)), and the prevalence is similar between male and female populations [Figure 6].

Discussion

The nutritional status and sociodemographic profile of tribal people, especially PVTGs, are important issues in India due to their marginalization and isolation from the mainstream population with respect to varied facilities they receive. However, comprehensive nutritional status data on tribes, especially on PVTGs, are limited. The present survey thereby provides a comprehensive report on the nutritional and anemia status of all the 13 PVTGs present in the state (Birhor, Mankirdia, Hill Kharia, Juang, Lodha and Paudi Bhuyan, Bonda, Didayi, Chuktia Bhunjia, Dongria Kandha, Kutia Kandha, Lanjia Saora, and Saora).

Children's nutritional status

Undernutrition in under-five children has been called "*silent emergency*" by the United Nations Children's Fund[12] and is the reason behind 45% of all child mortality.[13] In the present study, we have observed that at least four of seven are stunted and three of five were wasted among the under-five children. Similarly, three of four children (<5 yrs) were underweight indicating continued inadequate food uptake. Most importantly, the prevalence of all forms of undernutrition among PVTG children (<5 years) was significantly higher than the whole tribal communities of the state[2,14] and the country.[15] Higher stunting and wasting in our study can be attributed to delayed and inefficient weaning practices, even

Table 2a: Nutritional status among PVTG adult male

	Male			
Background characters	**Underweight (*n*=161)**	**Normal (*n*=249)**	**Overweight and obese (*n*=17)**	**Total (*n*=427)**
Age				
20–29 years	18 (21.7%)	61 (73.5%)	4 (4.8%)	83 (100.0%)
30–39 years	23 (30.3%)	50 (65.8%)	3 (3.9%)	76 (100.0%)
40–49 years	35 (38.5%)	51 (56.0%)	5 (5.5%)	91 (100.0%)
50–59 years	39 (47.6%)	39 (47.6%)	4 (4.9%)	82 (100.0%)
60 years and above	46 (48.4%)	48 (50.5%)	1 (1.1%)	95 (100.0%)
All	37.7%	58.3%	4%	
ST (NFHS-4)	23.7%	65.4%	10.9%	
Marital status				
Married	153 (37.8%)	236 (58.3%)	16 (4.0%)	405 (100.0%)
Unmarried	7 (33.3%)	13 (61.9%)	1 (4.8%)	21 (100.0%)
Education				
Illiterate	127 (42.2%)	163 (54.2%)	11 (3.7%)	301 (100.0%)
1 to 8	16 (26.7%)	43 (71.7%)	1 (1.7%)	60 (100.0%)
9 to 10	9 (26.5%)	22 (64.7%)	3 (8.8%)	34 (100.0%)
11 to 12	1 (16.7%)	5 (83.3%)	0 (0.0%)	6 (100.0%)
Above 12	1 (16.7%)	4 (66.7%)	1 (16.7%)	6 (100.0%)

Table 2b: Nutritional status among PVTG adult female

Background characters	Female			
	Underweight (*n*=246)	**Normal (*n*=290)**	**Overweight and obese (*n*=19)**	**Total (*n*=591)**
Age				
20–29 years	71 (39.9%)	103 (57.9%)	4 (2.2%)	178 (100.0%)
30–39 years	36 (36.0%)	57 (57.0%)	7 (7.0%)	100 (100.0%)
40–49 years	38 (43.7%)	46 (52.9%)	3 (3.4%)	87 (100.0%)
50–59 years	46 (54.1%)	38 (44.7%)	1 (1.2%)	85 (100.0%)
60 years and above	55 (52.4%)	46 (43.8%)	4 (3.8%)	105 (100.0%)
All	44.3	51.3%	3.4%	
ST (NFHS-4)	36.5%	57.2%	6.3%	
Marital status				
Married	233 (44.5%)	273 (52.1%)	18 (3.4%)	524 (100.0%)
Unmarried	9 (56.2%)	7 (43.8%)	0 (0.0%)	16 (100.0%)
Education				
Illiterate	200 (46.7%)	213 (49.8%)	15 (3.5%)	428 (100.0%)
1 to 8	11 (32.4%)	21 (61.8%)	2 (5.9%)	34 (100.0%)
9 to 10	4 (25.0%)	11 (68.8%)	1 (6.2%)	16 (100.0%)
11 to 12	1 (25.0%)	3 (75.0%)	0 (0.0%)	4 (100.0%)
Above 12	0 (NaN%)	0 (NaN%)	0 (NaN%)	0 (NaN%)

though prolonged breastfeeding was commonly observed in the studied population.

Among the children and adolescents (5–19 years), the prevalence of overall thinness was 70% with 18.3% mild or moderate thinness and 28.5% severe thinness, and this was in contrast to the report by the National Nutrition Monitoring Bureau (2017), which has shown 5.5% severe thinness in the age group of 5–9 years and 7.1% in the age group of 10–13 years among the tribal children of the state of Odisha.[16] The observed high prevalence of thinness might be due to the limited quantity and quality of food, the high rate of infectious diseases because of limited access to safe drinking water, sanitary facilities and health care, and poor utilization of available services due to low educational level and lack of awareness. Furthermore, we have observed a significantly more prevalence of severe undernutrition among males than females similar to studies conducted among tribal children in nine other states of India, which have shown the overall prevalence of thinness to be 63% among boys and 42% among girls.[17] The observed higher prevalence in boys compared with girls could be due to increased gain in height among boys compared with girls in this age group.[18]

Adult nutritional status

Poor nutritional status of women in the reproductive age

Table 3a: Prevalence of anemia in females

	Female								
Background characters	**Normal (*n*=67)**	**Any anemia (*n*=649)**	**Mild (*n*=187)**	**Moderate (*n*=200)**	**Severe (*n*=262)**	**Total (*n*=716)**	**Odds ratio (OR)**	**95% confidence interval (CI)**	***P***
Age									
5–11 years	14 (23.3%)	46 (76.7%)	8 (13.3%)	21 (35.0%)	17 (28.3%)	60 (100.0%)	Re	Ref	Ref
12–14 years	6 (21.4%)	22 (78.6%)	5 (17.9%)	5 (17.9%)	12 (42.9%)	28 (100.0%)	1.116	(0.389, 3.505)	0.843
15–19 years	3 (10.0%)	27 (90.0%)	6 (20.0%)	10 (33.3%)	11 (36.7%)	30 (100.0%)	2.739	(0.804, 12.656)	0.139
20–29 years	14 (7.6%)	170 (92.4%)	63 (34.2%)	50 (27.2%)	57 (31.0%)	184 (100.0%)	3.696	(1.637, 8.370)	0.0016**
30–39 years	5 (4.9%)	98 (95.1%)	36 (35.0%)	24 (23.3%)	38 (36.9%)	103 (100.0%)	5.965	(2.142, 19.374)	0.0012**
40–49 years	6 (6.7%)	84 (93.3%)	15 (16.7%)	26 (28.9%)	43 (47.8%)	90 (100.0%)	4.261	(1.595, 12.727)	0.0054**
50–59 years	6 (6.7%)	83 (93.3%)	21 (23.6%)	25 (28.1%)	37 (41.6%)	89 (100.0%)	4.21	(1.576, 12.578)	0.0058**
60 years and above	8 (7.5%)	99 (92.5%)	29 (27.1%)	33 (30.8%)	37 (34.6%)	107 (100.0%)	3.766	(1.506, 10.028)	0.0055**
All	67 (9.4%)	649 (90.6%)	187 (26.2%)	200 (27.9%)	262 (36.5%)				
ST (NFHS-4)	48	51	40.5	9.8	0.7				
Marital status									
Unmarried	30 (20.0%)	120 (80.0%)	26 (17.3%)	41 (27.3%)	53 (35.3%)	150 (100.0%)	Ref	Ref	Ref
Married	34 (6.2%)	516 (93.8%)	157 (28.5%)	153 (27.8%)	206 (37.5%)	550 (100.0%)	3.794	(2.226, 6.446)	0.0000008**
Education									
1 to 8	11 (13.9%)	68 (86.1%)	21 (26.6%)	24 (30.4%)	23 (29.1%)	79 (100.0%)	Ref	Ref	Ref
9 to 10	3 (13.6%)	19 (86.4%)	9 (40.9%)	7 (31.8%)	3 (13.6%)	22 (100.0%)	1.025	(0.284, 4.861)	0.972
11 to 12	0	8 (100.0%)	3 (37.5%)	4 (50.0%)	1 (12.5%)	8 (100.0%)	2.53E+06	(3.054E-25, NA)	0.986
Above 12	0	0	0	0	0	0			
Illiterate	38 (7.7%)	458 (92.3%)	126 (25.4%)	134 (27.0%)	198 (39.9%)	496 (100.0%)	1.949	(0.912, 3.881)	0.068
BMI									
Underweight	35 (9.9%)	319 (90.1%)	94 (26.6%)	100 (28.2%)	125 (35.3%)	354 (100.0%)	Ref	Ref	Ref
Normal	27 (8.6%)	288 (91.4%)	82 (26.0%)	93 (29.5%)	113 (35.9%)	315 (100.0%)	1.17	(0.693, 1.996)	0.558
Overweight and obese	2 (10.0%)	18 (90.0%)	3 (15.0%)	5 (25.0%)	10 (50.0%)	20 (100.0%)	0.987	(0.269, 6.375)	0.987
Socioeconomic status									
Low	5 (7.8%)	59 (92.2%)	23 (35.9%)	13 (20.3%)	23 (35.9%)	64 (100.0%)	Ref	Ref	Ref
Middle	59 (10.6%)	500 (89.4%)	147 (26.3%)	174 (31.1%)	179 (32.0%)	559 (100.0%)	0.718	(0.244, 1.701)	0.496
High	3 (3.2%)	90 (96.8%)	17 (18.3%)	13 (14.0%)	60 (64.5%)	93 (100.0%)	2.542	(0.601, 12.771)	0.213

*Significance code: "***", 0.001; "**", 0.01; "*", 0.05

not only affects the current generation but perpetuates the intergenerational cycle of undernutrition[19] and thereby poses a burden on the public health system.[20,21] The overall prevalence of undernutrition among the women (>=20 years) was 44.3%, in the present study among PVTGs, which is at par with the observations made on tribal women in the reproductive age group (47%) from Odisha, West Bengal, and Gujarat,[22] but in contrast to NFHS-4 survey report, the prevalence of undernutrition among tribal women in the reproductive age group of Odisha was found to be 36.5%.

The overall undernutrition among adults known as chronic energy deficiency (CED) was found to be high among PVTGs (male: 37.7% and female: 44.3%) compared with the tribal population of Odisha as a whole (male: 23.7% and female: 36.5%) as reported in NFHS-4 (2015) and lower (male: 38.6% and female: 52.3%) than the report of the National Nutrition Monitoring Bureau (2017).[16] However, similar to our study, the high prevalence of undernutrition among females was observed by other tribes of the country including Odisha.[23,24] High prevalence of CED observed among the elderly female PVTGs (>50%) was at par with the observations made in four PVTGs of Odisha and other elderly tribal populations of the country.[25,26] The sex-specific prevalence of CED demonstrated that both tribal females and males are passing through a critical situation with respect to nutritional status with females being worse off. The prevalence of CED in nonpregnant and non-lactating mothers can lead to severe perinatal risks. Children of mothers with undernutrition are more likely to be malnourished themselves, leading to an increased risk of morbidity and mortality in the future. Therefore, CED in females in the reproductive age group is a major public health concern.[27]

Anemia among children

The prevalence of anemia observed among the children <5 years in this study was 68.1%, which was higher than that observed in NFHS-4 (58.4%) but at par with other tribes of the

Table 3b: Prevalence of anemia in male PVTGs

	Male								
Background characters	**Normal (*n*=142)**	**Any anemia (*n*=461)**	**Mild (*n*=138)**	**Moderate (*n*=108)**	**Severe (*n*=215)**	**Total (*n*=603)**	**Odds ratio (OR)**	**95% confidence interval (CI)**	***P***
Age									
5–11 years	34 (31.5%)	74 (68.5%)	16 (14.8%)	26 (24.1%)	32 (29.6%)	108 (100.0%)	Ref	Ref	Ref
12–14 years	7 (43.8%)	9 (56.2%)	0 (0.0%)	5 (31.2%)	4 (25.0%)	16 (100.0%)	0.591	(0.203, 1.777)	0.334
15–19 years	2 (11.8%)	15 (88.2%)	0 (0.0%)	4 (23.5%)	11 (64.7%)	17 (100.0%)	3.446	(0.904, 22.642)	0.113
20–29 years	26 (28.6%)	65 (71.4%)	19 (20.9%)	8 (8.8%)	38 (41.8%)	91 (100.0%)	1.149	(0.626, 2.125)	0.656
30–39 years	25 (31.2%)	55 (68.8%)	25 (31.2%)	4 (5.0%)	26 (32.5%)	80 (100.0%)	1.011	(0.543, 1.896)	0.973
40–49 years	20 (20.6%)	77 (79.4%)	27 (27.8%)	13 (13.4%)	37 (38.1%)	97 (100.0%)	1.769	(0.942, 3.390)	0.08
50–59 years	15 (17.4%)	71 (82.6%)	26 (30.2%)	16 (18.6%)	29 (33.7%)	86 (100.0%)	2.175	(1.108, 4.431)	0.027*
60 years and above	11 (11.3%)	86 (88.7%)	25 (25.8%)	28 (28.9%)	33 (34.0%)	97 (100.0%)	3.592	(1.748, 7.890)	0.0008***
All	142 (23.4%)	461 (76.6%)	138 (23.1%)	108 (17.7%)	215 (35.8%)				
ST (NFHS-4)	71.60%	28.40%	15.60%	11.80%	0.90%				
Marital status									
Unmarried	52 (30.2%)	120 (69.8%)	22 (12.8%)	40 (23.3%)	58 (33.7%)	172 (100.0%)	Ref	Ref	Ref
Married	90 (21.0%)	339 (79.0%)	116 (27.0%)	67 (15.6%)	156 (36.4%)	429 (100.0%)	1.632	(1.090, 2.429)	0.0163*
Education									
Illiterate	60 (18.0%)	274 (82.0%)	76 (22.8%)	63 (18.9%)	135 (40.4%)	334 (100.0%)	2.172	(1.397, 3.374)	0.001***
1 to 8	49 (32.2%)	103 (67.8%)	31 (20.4%)	26 (17.1%)	46 (30.3%)	152 (100.0%)	Ref	Ref	Ref
9 to 10	13 (28.9%)	32 (71.1%)	16 (35.6%)	2 (4.4%)	14 (31.1%)	45 (100.0%)	1.171	(0.575, 2.493)	0.671
11 to 12	2 (28.6%)	5 (71.4%)	2 (28.6%)	1 (14.3%)	2 (28.6%)	7 (100.0%)	1.189	(0.247, 8.508)	0.839
Above 12	1 (14.3%)	6 (85.7%)	2 (28.6%)	1 (14.3%)	3 (42.9%)	7 (100.0%)	2.854	(0.470, 54.687)	0.338
BMI									
Underweight	71 (24.7%)	216 (75.3%)	52 (18.1%)	73 (25.4%)	91 (31.7%)	287 (100.0%)	Ref	Ref	Ref
Normal	55 (20.9%)	208 (79.1%)	76 (28.9%)	30 (11.4%)	102 (38.8%)	263 (100.0%)	1.243	(0.834, 1.860)	0.287
Overweight and obese	7 (36.8%)	12 (63.2%)	6 (31.6%)	1 (5.3%)	5 (26.3%)	19 (100.0%)	0.563	(0.218, 1.565)	0.246
Socioeconomic status									
Low	40 (26.0%)	114 (74.0%)	39 (25.3%)	30 (19.5%)	45 (29.2%)	154 (100.0%)	Ref	Ref	Ref
Middle	70 (24.8%)	212 (75.2%)	49 (17.4%)	51 (18.1%)	112 (39.7%)	282 (100.0%)	1.063	(0.674, 1.66)	0.791
High	32 (19.2%)	135 (80.8%)	50 (29.9%)	27 (16.2%)	58 (34.7%)	167 (100.0%)	1.48	(0.875, 2.521)	0.145

*Significance code: "***", 0.001; "**" 0.01; "*" 0.05

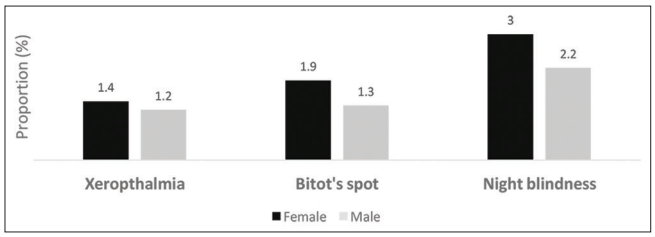

Figure 6: Prevalence of vitamin A deficiency seen in the PVTGs

country, which have shown 75%–94% anemia in under-five children.[28,29] Among the school-age children (5–14 years), the prevalence of anemia among females (77.3%) was found to be higher than males (66.9%) similar to earlier reports shown in female (57.8%) and male (42.1%) children of Kutia Kondh PVTG of Odisha[30] and 77.7% in the PVTG children aged 6 to 10 years in Karnataka.[31] This might be due to micronutrient deficiency, parasitic infection, bacteremia, and viral and intestinal helminth infections along with chronic blood disorders such as hemoglobinopathies, which are known to contribute to the severity of anemia in children.[32] As anemia in under-five leads to irreversible defects in motor and cognitive development, low immunity, and increased morbidity,[33] necessary policy decisions may be taken to reduce the burden of anemia among this group of population.

Anemia among adult

The prevalence of anemia observed in the present study was significantly higher (male: 78.5% and female: 93.1%) than the NFHS-4 study (male: 22.7% and female: 59.9%) conducted among the tribal of Odisha. Anemia among women in the reproductive age group (20 to 49 years) was seen to be significantly high compared with the younger age group (5 to 11) and their male counterparts. Anemia in women in the reproductive age group and in pregnant women increases the risk of miscarriages, stillbirth and low birth weight, premature birth, stunting, and wasting in the child.[34] The high prevalence of anemia in elderly women (92.5%) and men (82.9%) in the

present study is similar to the earlier study performed on the elderly population of four PVTGs of Odisha,[35] indicating a public health concern.

Vitamin A deficiency

Based on the clinical signs and symptoms, the prevalence of night blindness, xerophthalmia, and bitot's spot was found to be 2.6%, 1.3%, and 1.7%, respectively, which was lower than that observed in earlier studies on Bonda, Didayi, Juang, and Kandha PVTGs of Odisha[36] but can be considered a public health problem according to the WHO (2021).[37]

There are many programs from the Government of India, which aimed at eradicating malnutrition in children (Integrated Child Development Services, National Food Security Act, Mid-Day Meal Scheme), pregnant and lactating women (POSHAN Abhiyaan), and adolescent children (Rashtriya Kishor Swasthya Karyakram). Context-specific problems that possibly prevent effective implementation of these programs should be investigated, and steps should be taken through implementation research studies to improve the expected outcome from these programs. The results from these research studies can be used for effective implementation of the interventions at the grassroot level. Additionally, targeted interventions are urgently needed to be designed to address these issues and improve the overall health and well-being of PVTGs. Monitoring the growth and nutritional status of adolescents or women in the reproductive age group through regular anthropometric assessment in a surveillance mode should be attached to the ongoing government programs. This real-time knowledge will help in the necessary course correction for government programs targeting the improvement of the nutritional status of the vulnerable population. Intervention efforts should focus on poverty reduction, enhancing access to healthcare and education, promoting sustainable agriculture, and ensuring food security. By prioritizing the needs of PVTGs, India can work toward achieving the SDGs of ending poverty and promoting good health for all its population.

One of the main strengths of this study is its ability to generalize the findings to all the PVTGs of Odisha as the sampling has been performed in all PVTGs from all the respective MPAs located at the hard-to-reach habitations of the state. This study too has limitations. It does not explain PVTG-wise estimates of nutritional status. Noncompliance was observed during the sample collection among the under-five children, which is a common phenomenon for the subgroup of the population residing in hard-to-reach, forest-covered areas of Odisha. Moreover, local cultural ethos and restrictions against participation, especially for under-five children, were respected.

Conclusion

The findings of the study highlight the severe nutritional challenges faced by the PVTGs in Odisha, including high rates of undernutrition, anemia, and vitamin A deficiency. The study also shows that under-five children and women in reproductive age are the most vulnerable groups among PVTGs of Odisha. The study therefore calls for the immediate development and implementation of public health policies aiming at tackling the pressing nutritional status of the vulnerable community.

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Ethical approval and consent to participate

Research has been performed in accordance with the Declaration of Helsinki and has been approved by the Indian Council of Medical Research-Regional Medical Research Centre-Institutional Ethical Committee (ICMR-RMRC IEC). Reference number of the ethical approval obtained is ICMR-RMRC/IHEC-2018/015 dated July 30, 2018. Informed consent was obtained from each participant before conducting the interview.

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Conflicts of interest

There are no conflicts of interest.

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Supplementary Table

Supplementary Table 1: Sample distribution across PVTG tribes and micro-project areas

Micro-project area	PVTG	Primary sampling unit	Sampled population
Lodha Developmental Agency, Mayurbhanj	Lodha	2	102
Juang Developmental Agency, Keonjhar	Juang	2	109
Hill Kharia and Mankidia/Birhor Developmental Agency, Mayurbhanj	Hill Kharia and Mankidia or Birhor	2	77
Chuktia Bhunjia Developmental Agency, Koraput	Chuktia Bhunjia	2	59
Kutia Kandha Developmental Agency, Kalahandi	Kutia Kandha	2	87
Kutia Kandha Developmental Agency, Kandhamal	Kutia Kandha	2	65
Paudi Bhuyan Developmental Agency, Angul	Paudi Bhuyan	2	97
Paudi Bhuyan Developmental Agency, Sundargarh	Paudi Bhuyan	2	104
Paudi Bhuyan Developmental Agency, Deogarh	Paudi Bhuyan	2	112
Dongria Kondh Developmental Agency, Rayagada	Dongria Kondh	2	87
Dongria Kondh Developmental Agency, Rayagada	Dongria Kondh	2	58
Lanjia Saora Developmental Agency, Rayagada	Lanjia Saora	2	51
Saora Developmental Agency, Ganjam	Saora	2	99
Lanjia Saora Developmental Agency, Gajapati	Lanjia Saora	2	97
Didayi Developmental Agency, Malkangiri	Didayi	2	84
Bonda Developmental Agency, Malkangiri	Bonda	2	77
Saora Developmental Agency, Gajapati	Saora	2	100