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# Anthropometric Failure and its Associated Factors Among Tribal Preschool Children of West Bengal, India

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## ABSTRACT

**Background**

Children are at a unique transitional stage of physical and psychological development. The most common problem among preschool children in India is undernutrition. Therefore, the present study assesses the prevalence of undernutrition using the composite index of anthropometric failure (CIAF) and its association with socio-demographic variables among tribal preschool children in West Bengal, India.

**Methods**

The present study was conducted among 848 tribal preschool children (boys 430 and girls 418) aged 12-71 months from two districts (Jhargram and Paschim Medinipur) in West Bengal, India. World Health Organization (WHO) standard reference values (2006) were used to calculate Z-scores, and a standard cut-off value (≤2 SD) was used to assess the undernutrition. An odds ratio with 95% confidence intervals was used to assess the risk of developing anthropometric failure (AF).

**Results**

Overall, CIAF among studied children is 59%. The prevalence of CIAF with a significant association was observed in the lower age group ($\chi2=76.25$; $p<0.001$), children who suffered any illness in the last three months ($\chi2=6.43$; $p<0.05$), low birth weight children ($\chi2=7.57$; $p<0.01$), and breastfeeding children ($\chi2=38.61$; $p<0.001$). In the case of the age group, 12-23 months children show more than two times the risk of single AF (OR=2.78; 95% CI: 1.38-5.60), more than five times the risk of dual AF (OR=5.88; 95% CI: 2.27-15.29) and more than eleven times the risk of triple AF (OR=11.86; 95% CI: 4.01-35.08) compared to others.

**Conclusion**

Our results suggest that the lower age group, children who suffered any illness in the last three months, low birth weight, and breast-feeding children show a higher significant risk for CIAF. Also, the present study concluded that children increased their risk with increasing types of anthropometric failure (from single to multiple AF).

**Keywords**

Undernutrition; Composite Index of Anthropometric Failure (CIAF); Preschool children; West Bengal.

## INTRODUCTION

Annually, over 3.1 million child deaths occur worldwide as a result of undernutrition.[1,2] An earlier study reported that, worldwide, one in every three children under the age of five is malnourished.[3] According to the WHO (2020), malnutrition accounts for around 45% of child mortality under the age of five.[4] In India, undernutrition is a burden and a public health problem that increases childhood morbidity and mortality.[3] India has the highest prevalence of childhood undernutrition in the world.[5] So, early identification of childhood malnutrition improves overall health outcomes and decreases future financial burden.[6]

Under-five children are the most nutritionally vulnerable segment of any community, particularly tribal people. In India, preschool children received low priority in programs and policies.[7] In the preschool age group, children have special nutritional requirements due to their rapid growth and development.[8] According to the World Bank Report (2019), the under-five mortality rate in India is 34 per 1000 live births, whereas the mortality rate in West Bengal is

25 per 1000 live births.[3] According to NFHS 5 (2020-2021), in India, 35.5%, 32.1%, and 19.3% of children were stunting, underweight, and wasting, respectively, and similarly in West Bengal, 33.8%, 32.2% and 20.3% of children were stunting, underweight, and wasting, respectively.[9]

Anthropometry is a cost-effective, easily measured, non-invasive, and reliable method for evaluating the nutritional health of both children and adults.[10] In children, underweight (low weight for age), stunting (low height for age), and wasting (low weight for height) are the three most common anthropometric indicators of undernutrition.[11] These conventional indicators are considered to represent various aspects of nutritional status among children. However, estimates of these three conventional indicators in a population overlap and reflect independent values, making it impossible to provide an overall estimate of the population's undernourished children. So, it is difficult to choose the best indicator of the three conventional indices. To address these concerns, Peter Svedberg proposed an alternative single indicator (CIAF) to provide an overall estimate of undernutrition, which included all three conventional indicators and represented them under one umbrella.[12,13]

The CIAF is a single parameter that reflects the overall undernutrition of three conventional indices. In India, for the first time, Nandy et al[12] used the concept of CIAF on the data of NFHS-2 (1989-99). Thereafter, most of the studies have used CIAF to assess overall undernutrition. In different states of India, some previous studies have been observed on tribal children.[14-21] In West Bengal, some previous studies have been conducted on tribal children,[22-25] but most of the studies assess the prevalence of CIAF, and some studies focus on associated risk factors or socio-demographic factors. The current study assesses the prevalence of undernutrition using CIAF and identifies the association of CIAF with socio-demographic variables. Also, this study assesses the risk of increasing types of anthropometric failure (from single to multiple AF).

## METHODS

### Study Settings and Participants

The study surveyed tribal preschool children aged 12-71 months in three blocks of Paschim Medinipur and Jhargram districts, India, from April 2018 to March 2019. The study included 36 villages from Keshiary, Dantan I, and Nayagram blocks, covering 13 villages from Keshiary block, 8 from Dantan I block, and 15 from Nayagram block. According to the 2011 census, three districts contained 16,169 tribal children aged 0 to 6 years. The sampling procedure entails a 50% sample proportion and a 95% confidence level, with a margin of error of 3.3%. A total of 848 under-five children were selected from two ethnic groups (Santal and Bhumij) using stratified random sampling.

This area was selected because no previous anthropometric studies were found on the tribal children in this area. The Nayagram blocks were selected because they are the most populated tribal blocks in these districts, and almost 50% of the data was collected from the Jhargram district. The majority of the data is gathered from the Paschim Medinipur district's two nearest blocks. The present study focused on the Santal and Bhumij tribes, as they are the most populated tribal groups in the area, speaking Austroasiatic languages Santali and Mundari. Both tribes belong to the Proto-Australoid group.

The Santals, the largest tribe in Jharkhand and West Bengal, speak Santali, a Munda language family within the larger Austroasiatic language group. They celebrate the most popular festivals, i.e., Baha Parab, in their traditional attire. Despite facing caste prejudices and poverty, they are welcoming, hardworking, grateful, and joyful. They live in ecologically marginal areas with distinct dialects, cultures, folklore, and geographical isolation. The word "Bhumij" comes from the word "Bhumi" (land or soil), and the Bhumij are speakers of an Austroasiatic language. Each Bhumij group has its own exogamous sub-groups called "kili" named after various sources, including fauna, flora, heavenly bodies, and earth. Their unique culture reflects their deep connection to nature, spirituality, and community bonds.

The health of tribal communities, particularly Santal and Bhumij, is a concern due to socio-economic disparities, limited healthcare access, cultural beliefs, and environmental issues. Studying their health is crucial for promoting health equity, cultural sensitivity, community engagement, and evidence-based policymaking. Undernutrition is a pressing issue among tribal children, with the CIAF providing a comprehensive perspective on their nutritional status.

### Inclusion and Exclusion Criteria

The present study included only the Santal and Bhumij tribes of both boys and girls between the 12- and 71-months age groups. Those households that are directly or indirectly attached to agriculture or cultivation were included in this study. Physically challenged children and those children who failed to meet any of the inclusion criteria were excluded from the study. Parents who are not willing to participate with their children are also excluded.

### Data Types

The study collected socio-demographic, childbirth, illness, and breastfeeding data from mothers using a structured questionnaire, while birth certificates and immunization cards were used for birth date and weight. According to the WHO, low birth weight was defined as less than 2.5 kg of weight during birth.[26] One researcher (BM) measured the all-anthropometric measurements of the studied children and followed the standard procedures.[27] The ethical clearance was obtained from the departmental ethics committees, and this study followed the ethical guidelines of the Declaration of Helsinki.[28]

### Assessments of Nutritional Status

In the present study, stunting (low height for age), underweight (low weight for age Z-score), and wasting (low weight for height Z-score) were used to assess undernutrition.[11] The Z-score of three conventional indices was calculated in reference to WHO guidelines (2006), and undernutrition was defined at a cut-off level of less than two standard deviations (<-2 SD).[29] The Z-score

was calculated using the standard formula: Z-score=(X-Median of WHO, 2006)/(SD of WHO, 2006) (where, x=observed value of height or weight in children). For assessing CIAF, the latest modified CIAF model was used. The original CIAF model of Svedberg (2000) consisted of six sub-groups of anthropometric failure (A–F); later, Nandy et al[12] added one subgroup (Y). Thereafter, Kuiti and Bose (2018) added two new categories (G and H).[30]

Our study report (Table 1) includes one new category (I), i.e., stunted and wasted but not underweight. This new category was not reported in the previous study, but our study's children belong to this category. The CIAF category previously addressed all types of categories but did not address stunting and wasting. So, the present study included this rare category. In the CIAF category, stunting, underweight, wasting, and multiple failures were included in groups B–Y, and those children who did not have any anthropometric failures were included in group A. Also, the current study uses three types of AF, i.e., single, dual, and triple AF. Single AF means children suffered only one conventional index, i.e., stunting/underweight/wasting, dual AF means children suffered any two conventional indices, i.e., stunting and underweight/stunting and wasting/ underweight & wasting and triple AF means children suffered all three conventional indices (stunting, underweight, and wasting).

**Table 1.** *Category Wise Prevalence (%) of Composite Index of Anthropometric Failure (CIAF) among the Studied Tribal Preschool Children*

| Group Name | Categories | Boys (%) | Girls (%) | Overall (%) | Chi square ($\chi$2) |
|---|---|---|---|---|---|
| A | No failure | 172 (40.0) | 176 (42.1) | 348 (41.0) | |
| B | Wasting only | 26 (6.0) | 36 (8.6) | 62 (7.3) | |
| C | Wasting and underweight | 18 (4.2) | 23 (5.5) | 41 (4.8) | |
| D | Wasting, stunting and underweight | 75 (17.4) | 34 (8.1) | 109 (12.9) | |
| E | Stunting and underweight | 35 (8.1) | 44 (10.5) | 79 (9.3) | $\chi$2=19.22; df=6; $p$=0.004 |
| F | Stunting only | 102 (23.7) | 101 (24.2) | 203 (23.9) | |
| G | Stunting and over weight | - | - | - | |
| H | Overweight only | - | - | - | |
| I | Stunting and wasting only | 2 (0.5) | 4 (1.0) | 6 (0.7) | |
| Y | Underweight only | - | - | - | |
| | Total CIAF (B-Y) | 258 (60.0) | 242 (57.9) | 500 (59.0) | |

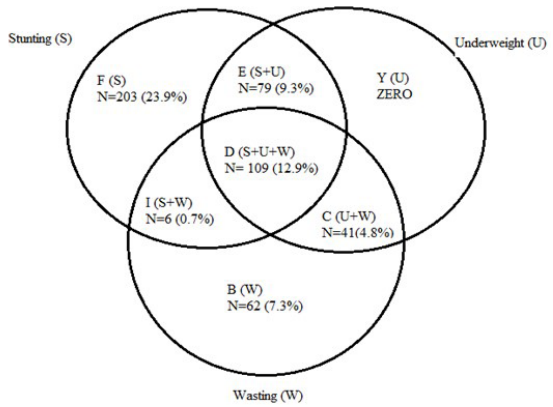
### Statistical Analysis

The data was analyzed using the statistical packages of the social sciences (SPSS, version 27.0). The chi-square test was carried out to determine the association between the categorical variables. Step-wise binary logistic regression (BLR) analysis was performed for each independent factor to assess the association with CIAF. Multinomial logistic regression (MLR) was used to determine the risk, which varies from single to multiple AF. Odds ratios (OR) with 95% confidence intervals (CI) were used to determine the magnitude of the association.

## RESULTS

Table 1 and Figure 1 represent the category-wise prevalence of CIAF among the participants. A total of 500 tribal preschool

**Figure 1.** *Category Wise Prevalence of Anthropometric Failure*



children (59%) had multiple failures, according to the CIAF. Of these, 348 (41%) were anthropometrically normal (group A), 265 (31.25%) had a single failure (group B+F+Y), 126 (14.9%) had a dual failure (group C+E+G+I), and 109 (12.85%) had a triple failure (group D). Out of the nine subgroups of anthropometric failure, Group F (stunting only) showed the highest prevalence (n=203; 23.9%), and Group I (stunting and wasting) showed the lowest prevalence (n=6; 0.7%) of undernutrition among studied children. The CIAF category and sex-wise statistical association were also observed ($\chi2=19.22$; $p\leq0.01$).

Table 2 shows the age-wise prevalence (%) of stunting, underweight, and wasting among the studied tribal preschool children.

**Table 2.** *Age Wise Prevalence (%) of Stunting, Underweight, Wasting and CIAF of Studied Tribal Preschool Children*

| Age Category in months | n | Stunting (<-2SD) | | Under weight (<-2SD) | | Wasting (<-2SD) | |
|---|---|---|---|---|---|---|---|
| | | Undernutrition | Normal | Undernutrition | Normal | Undernutrition | Normal |
| 12-23 | 205 | 117 (57.1) | 88 (42.9) | 87 (42.4) | 118 (57.6) | 88 (42.9) | 117 (57.1) |
| 24-35 | 179 | 107 (59.8) | 72 (40.2) | 60 (33.5) | 119 (66.5) | 53 (29.6) | 126 (70.4) |
| 36-47 | 140 | 60 (42.9) | 80 (57.1) | 30 (21.4) | 110 (78.6) | 26 (18.6) | 114 (81.4) |
| 48-59 | 180 | 67 (37.2) | 113 (62.8) | 33 (18.3) | 147 (81.7) | 26 (14.4) | 154 (85.6) |
| 60-71 | 144 | 46 (31.9) | 98 (68.1) | 19 (13.2) | 125 (86.8) | 25 (17.4) | 119 (82.6) |
| Total | 848 | 397 (46.8) | 451 (53.2) | 229 (27.0) | 619 (73.0) | 218 (25.7) | 630 (74.3) |
| | | $\chi2=41.06^{***}$ | | $\chi2=51.64^{***}$ | | $\chi2=54.19^{***}$ | |

$^{***}$means $p=<0.001$

The highest rates of stunting observed in the 24-35 months age group (59.8%), underweight, and wasting were observed in the 12-23 months age group (42.4%) and (42.9%), respectively. Using conventional indices, 46.8% were stunted, 27% were underweight, and 25.7% were wasted. In general, there was a decrease in all conventional indices with increasing age, and strong statistically significant associations were found with stunting ($\chi2=41.06$; $p<0.001$), underweight ($\chi2=51.64$; $p<0.001$), and wasting ($\chi2=54.19$; $p<0.001$).

Binary logistic regression determines CIAF-wise association and risk factors in Table 3.

The prevalence of CIAF shows decreasing trends with increasing age, and a statistically significant association was observed ($\chi2=76.25$; $p\leq0.001$). The lower age category (12-23 months age) shows a higher prevalence rate (76.6%) of CIAF than the other age categories. Sex-wise, boys show a higher prevalence of AF, but no significant association was found. Children who suffered any illness in the last three months show a higher AF (62.8%) than the others, and a significant association was observed ($\chi2=6.43$; $p\leq0.05$). Birth order, father, and mother education-wise, no significant association was observed with AF. Low-birth-weight children show high AF (68.8%), and a significant association was observed ($\chi2=7.57$; $p\leq0.01$). Breastfeeding children show a higher prevalence of CIAF than non-breastfeeding children, and a statistically significant association was observed ($\chi2=38.61$; $p\leq0.001$). Lower age groups, illness in the last three months, low birth weight, and breast-feeding children show a higher significant risk for CIAF. CIAF was significantly higher-risk in the 12-23 months age group (cOR=4.33; 95% CI: 2.73-6.87 and aOR=4.41; 95% CI: 2.39-8.14) and in the 24-35 months age group (cOR=3.61; 95% CI: 2.26-5.76 and aOR=4.07; 95% CI: 2.28-7.26). Children who suffered any illness in the last three months show a high-risk of CIAF (cOR=1.43; 95% CI: 1.08-1.88 and aOR=1.42; 95% CI: 1.05-1.91) compared to healthy children. Low-birth-weight children were significantly more likely to be CIAF (cOR=1.68; 95% CI: 1.16-2.44 and aOR=1.66; 95% CI: 1.11-2.47). Breastfeeding children shows a higher-risk of AF (cOR=2.41; 95% CI: 1.82-3.19) compared to those who do not breastfeed.

Socio-demographic factors wise, the prevalence of single, dual, and triple AF is shown in Table 4.

Overall, 31.3%, 14.9%, and 12.8% of children suffered single, dual, and triple AF, respectively. The prevalence of types of anthropometric failure (from single to multiple AF) with significant association was observed in the lower age group ($\chi2=94.81$; $p\leq0.001$), sex-wise ($\chi2=17.64$; $p<0.001$), children who suffered any illness in the last three months ($\chi2=10.05$; $p\leq0.05$), low birth weight children ($\chi2=28.48$; $p\leq0.001$), and breastfeeding children ($\chi2=45.78$; $p\leq0.001$). increased risk with increasing types of anthropometric failure (from single to multiple AF) through the multinomial logistic regression model. In the case of the age group, 12-23 months children show more than two times the risk of single AF (OR=2.78; 95% CI: 1.38-5.60), more than five times the risk of dual AF (OR=5.88; 95% CI: 2.27-15.29) and more than eleven times the risk of triple AF (OR=11.86; 95% CI: 4.01-35.08) compared to no-AF. 24-35 months children show more than three times the risk of single AF (OR=3.25; 95% CI: 1.69-6.25), more than four times the risk of dual AF (OR=4.59; 95% CI: 1.83-11.50) and more than seven times the risk of triple AF (OR=7.99; 95% CI: 2.80-22.76) than the other age groups. 36-47 months age groups show more than two times higher-risk of triple AF (OR=2.86; 95% CI: 1.07-7.65) than the others. Boys show more than two times higher-risk of triple AF (OR=2.72; 95% CI: 1.65-4.46). Children who suffered any illness in the last three months show a more than one-times higher-risk of single (OR=1.54; 95%

**Table 3.** *Prevalence of Composite Index of Anthropometric Failure and Binary Logistic Regression between Anthropometric Failure and their Risk Factors*

| Variables | Category | n | Preva-lence of AF (%) | No AF (%) | Chi square ($\chi 2$) | CIAF (Model 1) | | CIAF (Model 2) | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | cOR | 95% CI | aOR | 95% CI |
| Age group in months | 12-23 | 205 | 157 (76.6) | 48 (23.4) | $\chi 2=76.25^{***}$ | 4.33*** | 2.73-6.87 | 4.41*** | 2.39-8.14 |
| | 24-35 | 179 | 131 (73.2) | 48 (26.8) | | 3.61*** | 2.26-5.76 | 4.07*** | 2.28-7.26 |
| | 36-47 | 140 | 69 (49.3) | 71 (50.7) | | 1.29 | 0.80-2.05 | 1.35 | 0.81-2.25 |
| | 48-59 | 180 | 81 (45.0) | 99 (55.0) | | 1.08 | 0.70-1.68 | 1.15 | 0.73-1.80 |
| | 60-71 | 144 | 62 (43.1) | 82 (56.9) | | 1 | | 1 | |
| Sex | Boys | 430 | 258 (60.0) | 172 (40.0) | $\chi 2=0.39$ | 1.09 | 0.83-1.43 | 1.116 | 0.83-1.50 |
| | Girls | 418 | 242 (57.9) | 176 (42.1) | | 1 | | 1 | |
| Illness in last three months | Yes | 468 | 294 (62.8) | 174 (37.2) | $\chi 2=6.43^{*}$ | 1.43* | 1.08-1.88 | 1.42* | 1.05-1.91 |
| | No | 380 | 206 (54.2) | 174 (45.8) | | 1 | | 1 | |
| Birth order/parity no | 1 | 409 | 240 (58.7) | 169 (41.3) | $\chi 2=0.62$ | 1.13 | 0.72-1.77 | 1.053 | 0.64-1.72 |
| | 2 | 344 | 207 (60.2) | 137 (39.8) | | 1.20 | 0.76-1.90 | 1.187 | 0.73-1.94 |
| | >2 | 95 | 53 (55.8) | 42 (44.2) | | 1 | | 1 | |
| Father education | Illiterate | 380 | 215 (56.6) | 165 (43.4) | $\chi 2=4.71$ | .735 | 0.42-1.29 | 0.896 | 0.45-1.80 |
| | Primary | 99 | 67 (67.7) | 32 (32.3) | | 1.181 | 0.60-2.31 | 1.212 | 0.57-2.60 |
| | Secondary | 308 | 179 (58.1) | 129 (41.9) | | 0.783 | 0.44-1.38 | 0.812 | 0.42-1.56 |
| | Above | 61 | 39 (63.9) | 22 (36.1) | | 1 | | 1 | |
| Mother education | Illiterate | 432 | 245 (56.7) | 187 (43.3) | $\chi 2=4.36$ | 0.893 | 0.45-1.77 | 1.084 | 0.47-2.51 |
| | Primary | 103 | 70 (68.0) | 33 (32.0) | | 1.446 | 0.67-3.14 | 1.570 | 0.64-3.85 |
| | Secondary | 276 | 163 (59.1) | 113 (40.9) | | 0.984 | 0.49-1.98 | 1.036 | 0.47-2.30 |
| | Above | 37 | 22 (59.5) | 15 (40.5) | | 1 | | 1 | |
| Birth weight | LBW | 154 | 106 (68.8) | 48 (31.2) | $\chi 2=7.57^{**}$ | 1.68** | 1.16-2.44 | 1.66* | 1.11-2.47 |
| | NBW | 694 | 394 (56.8) | 300 (43.2) | | 1 | | 1 | |
| Breast feeding | Breast-feed | 447 | 308 (68.9) | 139 (31.1) | $\chi 2=38.61^{***}$ | 2.41*** | 1.82-3.19 | 0.957 | 0.63-1.46 |
| | NBF | 401 | 192 (47.9) | 209 (52.1) | | 1 | | 1 | |

*means $p<0.05$; *means $p<0.01$; ***means $p<0.001$
AF=Anthropometric failure; cOR=Crude odds ratio; aOR=Adjusted odds ratio; CI=Confidence interval

CI: 1.09-2.17) and triple AF (OR=1.84; 95% CI: 1.13-3.01) than healthy children. Low birth weight children suffered more than two times higher-risk of dual AF (OR=2.27; 95% CI: 1.34-3.85) and more than three times higher-risk of triple AF (OR=3.38; 95% CI: 1.93-5.92) than normal birth weight children.

## DISCUSSION

The current study clearly indicates that the overall prevalence of AF is 59%. The NFHS-5 report showed an overall CIAF of 52.2%. In West Bengal, the prevalence of AF among tribal children varies between 38.7%[22] and 69.1%,[24] and among tribal children in India, it varies between 48.6% 14 and 85%.19 An earlier and present study concluded that the rates of undernutrition in India are very high. The present study showed that 31.3%, 14.9%, and 12.8% of children suffered single, dual, and triple AF, respectively (Table 4 and Figure 2).

According to the previous and present study among the tribal children, single, dual, and triple anthropometric failures vary from 15.0-31.25%, 14.86-37.2%, and 1.9-36.0%, respectively.[14-17,19,20,24] According to the NFHS-5 (2020-2021) report, 23.9%, 23.1% and 5.2% had single, dual, and triple AF.[9] Thus, the present study represents a higher prevalence of multiple anthropometric failures (except dual AF) than the NFHS-5 report.

The highest rates of stunting observed in the 24-35 months age group (59.8%), underweight, and wasting were observed in the 12-23 months age group (42.4%) and 42.9%, respectively. The present study observed decreasing trends in all conventional indices with increasing age, and strong statistically significant associations were found with stunting ($\chi 2=41.06$; $p<0.001$), underweight ($\chi 2=51.64$; $p<0.001$), and wasting ($\chi 2=54.19$; $p<0.001$). Similar results were found in previous studies conducted on undernutrition among Santal and Bhumij children in West Bengal.[31,32]

The lower age category shows a higher prevalence rate of CIAF (76.6%) than the other age categories. The prevalence of CIAF shows decreasing trends with increasing age (from 76.6% to 43.1%), and a statistically significant association was observed ($\chi 2=76.25$; $p\leq 0.001$). The 12-23 months age group shows more than four times higher-risk of AF (cOR=4.33; and aOR=4.41; $p<0.001$) compared to other age groups among the studied children. So, the present study observed a higher-risk of AF in the

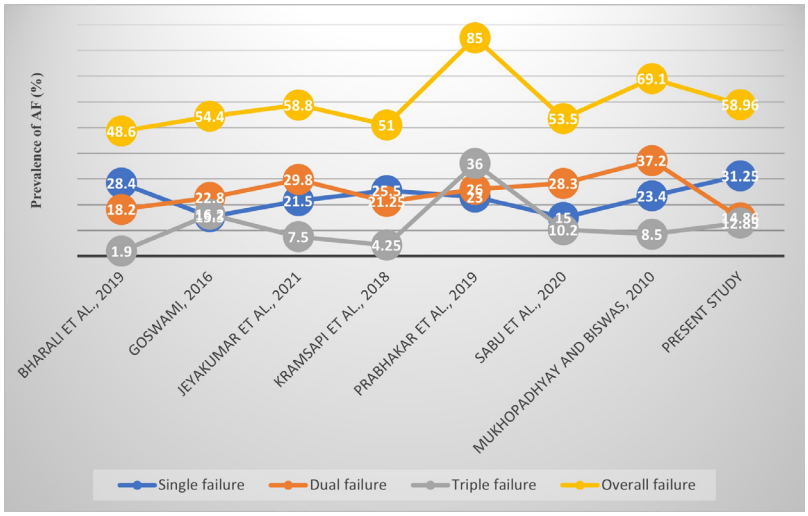
**Table 4.** *Prevalence of Composite Index of Anthropometric Failure and Binary Logistic Regression between Anthropometric Failure and their Risk Factors*

| Variables | Category | n | No AF | Types of AF | | | Chi square ($\chi 2$) | Multinomial Logistic Regression | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Single AF (%) | Dual AF | Triple AF | | Single AFOR (95% CI) | Dual AFOR (95% CI) | Triple AFOR (95% CI) |
| Age group in months | 12-23 | 205 | 48 (23.4) | 67 (32.7) | 45 (22.0) | 45 (22.0) | $\chi 2=94.81^{***}$ | 2.78** (1.38-5.60) | 5.88*** (2.27-15.29) | 11.86*** (4.01-35.08) |
| | 24-35 | 179 | 48 (26.8) | 71 (39.7) | 31 (17.3) | 29 (16.2) | | 3.25*** (1.69-6.25) | 4.59*** (1.83-11.50) | 7.99*** (2.80-22.76) |
| | 36-47 | 140 | 71 (50.7) | 39 (27.9) | 13 (9.3) | 17 (12.1) | | 1.15 (0.64-2.07) | 1.16 (0.47-2.89) | 2.86* (1.07-7.65) |
| | 48-59 | 180 | 99 (55.0) | 46 (25.6) | 25 (13.8) | 10 (5.6) | | 0.96 (0.57-1.61) | 1.76 (0.82-3.79) | 1.16 (0.42-3.18) |
| | 60-71 | 144 | 82 (56.9) | 42 (29.2) | 12 (8.3) | 8 (5.6) | | 1 | 1 | 1 |
| Sex | Boys | 430 | 172 (40.0) | 128 (29.8) | 55 (12.8) | 75 (17.4) | $\chi 2=17.64^{***}$ | 0.97 (0.69-1.35) | 0.84 (0.54-1.29) | 2.72*** (1.65-4.46) |
| | Girls | 418 | 176 (42.1) | 137 (32.8) | 71 (17.0) | 34 (8.1) | | 1 | 1 | 1 |
| Illness in last three months | Yes | 468 | 174 (37.2) | 161 (34.4) | 65 (13.9) | 68 (14.5) | $\chi 2=10.05^{*}$ | 1.54* (1.09-2.17) | 0.99 (0.64-1.54) | 1.84* (1.13-3.01) |
| | No | 380 | 174 (45.8) | 104 (27.4) | 61 (16.1) | 41 (10.8) | | 1 | 1 | 1 |
| Birth order/parity no | 1 | 409 | 169 (41.3) | 126 (30.8) | 70 (17.1) | 44 (10.8) | $\chi 2=6.28^{NS}$ | 1.07 (0.61-1.88) | 1.49 (0.68-3.28) | 0.68 (0.31-1.46) |
| | 2 | 344 | 137 (39.8) | 110 (32.0) | 46 (13.4) | 51 (14.8) | | 1.19 (0.68-2.09) | 1.32 (0.60-2.93) | 1.13 (0.53-2.40) |
| | >2 | 95 | 42 (44.2) | 29 (30.5) | 10 (10.5) | 14 (14.7) | | 1 | 1 | 1 |
| Father education | Illiterate | 380 | 165 (43.4) | 113 (29.7) | 55 (14.5) | 47 (12.4) | $\chi 2=13.12^{NS}$ | 0.80 (0.37-1.74) | 0.86 (0.33-2.25) | 1.82 (0.50-6.65) |
| | Primary | 99 | 32 (32.3) | 42 (42.4) | 12 (12.1) | 13 (13.1) | | 1.32 (0.58-3.02) | 0.76 (0.26-2.27) | 1.75 (0.43-7.03) |
| | Secondary | 308 | 129 (41.9) | 88 (28.6) | 46 (14.9) | 45 (14.6) | | 0.69 (0.34-1.42) | 0.75 (0.31-1.84) | 1.93 (0.56-6.69) |
| | Above | 61 | 22 (36.1) | 22 (36.1) | 13 (21.3) | 4 (6.6) | | 1 | 1 | 1 |
| Mother education | Illiterate | 432 | 187 (43.3) | 129 (29.9) | 61 (14.1) | 55 (12.7) | $\chi 2=12.90^{NS}$ | 1.35 (0.50-3.62) | 0.60 (0.20-1.77) | 2.03 (0.37-11.11) |
| | 1 to 5th | 103 | 33 (32.0) | 34 (33.0) | 16 (15.5) | 20 (19.4) | | 1.81 (0.63-5.16) | 0.96 (0.30-3.09) | 3.33 (0.58-18.96) |
| | 6th to MP | 276 | 113 (40.9) | 92 (33.3) | 39 (14.1) | 32 (11.6) | | 1.35 (0.53-3.44) | 0.60 (0.22-1.67) | 1.69 (0.32-8.86) |
| | Above | 37 | 15 (40.5) | 10 (27.0) | 10 (27.0) | 2 (5.4) | | 1 | 1 | 1 |
| Birth weight | LBW | 154 | 48 (31.2) | 37 (24.0) | 34 (22.1) | 35 (22.7) | $\chi 2=28.48^{***}$ | 1.01 (0.62-1.64) | 2.27** (1.34-3.85) | 3.38*** (1.93-5.92) |
| | NBW | 694 | 300 (43.2) | 228 (32.9) | 92 (13.3) | 74 (10.7) | | 1 | 1 | 1 |
| Breast feeding | Breastfeed | 447 | 139 (31.1) | 150 (33.6) | 80 (17.9) | 78 (17.4) | $\chi 2=45.78^{***}$ | 0.97 (0.60-1.57) | 1.01 (0.53-1.93) | 0.87 (0.44-1.75) |
| | NBF | 401 | 209 (52.1) | 115 (28.7) | 46 (11.5) | 31 (7.7) | | 1 | 1 | 1 |
| Overall | Overall | 848 | 348 (41.0) | 265 (31.3) | 126 (14.9) | 109 (12.8) | | | | |

*means $p<0.05$; +means $p<0.01$; ***means $p<0.001$
Single AF=children suffered stunting/ underweight/wasting; Dual AF=Children suffered stunting and underweight/ stunting & wasting/ underweight and wasting; Triple AF=Children suffered stunting and underweight and wasting

lower age group due to a lack of parents' care and low awareness of their child's health. The present study was conducted on agricultural people, and parents are always busy with agricultural work. Agriculture is the main source of income for their livelihood. Their parents engage in daily-wage labour, cultivating paddy crops twice a year and vegetables for the entire year. So, parents spend most of the day on agricultural land or outside the home, so they do not spend their time on their children's. Most of the time, children's elder brother, sister, or grandmother takes care of them and feeds them. Also, the present study observed a higher prevalence of illness and low birth weight, which is another reason for their undernutrition in lower age groups. Sex-wise, boys show a higher prevalence of AF (60%), but no significant association was found. In the case of the types of CIAF, boys suffered a higher value of multiple failures (17.4%) compared to girls, with significant statistical associations also observed ($\chi 2=17.64$; $p<0.001$). Also, boys show more than two times higher-risk of triple AF (OR=2.72; $p<0.001$) compared to girls. One study was conducted on tribal

**Figure 2.** *Prevalence (%) of Types of Anthropometric Failure among Previous and Present Studied Tribal Children*




children in Palghar district, Maharashtra, and found similar results: boys showed a high AF (51.8) compared to girls.[16]

In the present study, children who suffered any illness in the last three months showed a higher AF (62.8%) with a significant association observed ($\chi2=6.43$; $p\leq0.05$) and also showed a high-risk of CIAF (cOR=1.43 and aOR=1.42; $p<0.05$) compared to healthy children. Illness children's show a more than one-times higher-risk of single (OR=1.54; $p<0.05$) and triple AF (OR=1.84; $p<0.05$) than healthy children. Earlier studies reported that undernourished children are very prone to different types of illness than well-nourished children,[33,34] and undernutrition is highly associated with mortality and morbidity.[35,36]

Low-birth-weight children show high AF (68.8%), and a significant association was observed ($\chi2=7.57$; $p\leq0.01$). Low-birth-weight children were significantly more likely to be CIAF (cOR=1.68; $p<0.01$; and aOR=1.66; $p<0.05$). Low birth weight children suffered more than two times higher-risk of dual AF (OR=2.27; $p<0.01$) and more than three times higher-risk of triple AF (OR=3.38; $p<0.001$) than normal birth weight children. Similar results were observed in the Paniya and Kurichiya tribes in Wayanad district of Kerala, where reported LBW children show high AF (63.1%) with more than a one-time risk for AF (OR=1.86; $p<0.01$).[20]

The present study observed that breastfeeding children show a higher prevalence of CIAF (68.9%) than non-breastfeeding children, and a statistically significant association was observed ($\chi2=38.61$; $p\leq0.001$). Breastfeeding children shows a higher-risk of AF (cOR=2.41; $p<0.001$) compared to those children not breastfed. According to the WHO, breast feeding should be continued up to two years of age as it aids growth and development, protects children against many infectious diseases, and helps with survival.[37,38] The present study observed that tribal mothers did not have any proper knowledge of the time and duration of breast feeding. After one year of age, they feed their breastmilk in 2-3 times per day and feed cow milk or other boil food due to a lack of time or mothers spending daytime outside as agricultural labourers. As a result, their elder sister or brother is taking care of them and feeding them.

The present investigation shows the lower age group had a significantly higher association with types of anthropometric failure (from single to multiple AF) compared to other predictors ($\chi2=94.81$; $p\leq0.001$). In the case of the age group, 12-23 months-age children show more than two times the risk of single AF (OR=2.78; $p<0.01$), more than five times the risk of dual AF (OR=5.88; $p<0.001$), and more than eleven times the risk of triple AF (OR=11.86; $p<0.001$) compared to others. 24-35 months age children show more than three times the risk of single AF (OR=3.25; $p<0.001$), more than four times the risk of dual AF (OR=4.59; $p<0.001$), and more than seven times the risk of triple AF (OR=7.99; $p<0.001$) than the other age groups. 36-47 months age groups show more than two times higher-risk of triple AF (OR=2.86; $p<0.05$) than the others. This result clearly mentions increased risk with increasing types of AF. An earlier study reported that children from birth to the second year of age are in a crucial period for optimal growth and development.[39,40] So, a higher-risk of undernutrition among studied children of lower age may have effects on their growth and development.

### Strength of the Study

The CIAF is a tool that calculates the total number of undernourished children in a community compared to other conventional indicators. The CIAF enables in early identification of children with multiple anthropometric failures by categorizing undernourished

children into various groups. The present study investigated the association between CIAF and others factors (recent illness, birth order/parity number, parents' education, birth weight, and child feeding practices) in the under-five children. This study investigated the factors influencing the risk of various types of anthropometric failure.

### Limitations

This study has some limitations. Firstly, due to the cross-sectional nature of the study, it is not possible to make causal inferences. The survey's scope was restricted to tribal children from a specific region, making it impossible to generalize the findings to other groups or locations across the entire state or country. The study did not identify any additional risk factors for malnutrition beyond gender, age, and certain variables. Fourth, the children were not monitored or follow-up, so need for a longitudinal study for more comprehensive analysis.

## CONCLUSION

The study found that children with lower age groups, illness in the last three months, low birth weight, and breastfeeding are at a higher-risk of CIAF. The health and nutritional status of children are sensitive to lower age groups, particularly up to 2-years-old. Further research is needed on different tribes and regions of India to understand the prevalence of undernutrition and potential inter-ethnic and regional variations.

## INSTITUTIONAL REVIEW BOARD PERMISSION

This study has been approved by the Institutional Review Board (IRB).

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## CONFLICTS OF INTEREST

The author declare that he has no conflicts of interest.

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