

Assessments of Nutritional Status Based on Head Circumference among Tribal Preschool Children of Purulia district

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Abstract

Introduction: Malnutrition remains an important public health problem among preschool children in South Asia, including India. Early childhood is a critical period of rapid growth and development, particularly for brain growth. The Head circumference (HC) is an important anthropometric indicator to assess growth and nutritional status in children under five years of age, as it reflects brain and neurological development during early childhood. **Objective:** The present study is aimed to assess HC and examine age and sex related differences among tribal preschool children in Purulia district, West Bengal. **Methods:** A cross-sectional study was conducted among tribal children aged 2-4years in Purulia district during 2023 to 2024. HC was measured using standard anthropometric procedures. A total of 94 preschool children included in the present study. Nutritional status was assessed using the HC-for-age Z-score (HCAZ), with a Z-score below -2 SD is considered to be undernutrition, as calculated using WHO Anthro software. **Results:** The mean HC ranging from 45.92 cm to 47.63 cm and HC increased with advancement of age. The overall prevalence of undernutrition was 37.6%, 9.2% were classified as severely and 28.4% as moderately undernourished. A statistically significant difference in mean HC was also observed between boys and girls. **Conclusion:** The results indicated that a considerable prevalence of undernutrition is found among tribal preschool children in Purulia district. So, head circumference can serve as a useful anthropometric measure to monitoring growth and identifying children at risk of nutritional and developmental problems during early childhood.

Keywords: Children, Head circumference, Tribal, Undernutrition, Purulia, India

Introduction

The tribal population constituted an important and culturally diverse section of the Indian society, with distinctive social, economic, and cultural practices. Despite their rich cultural heritage, many tribal populations continue to experience socio-economically disadvantages and under access to adequate nutrition and healthcare facilities. Undernutrition remains an important public health challenge among tribal communities, particularly among preschool children (Aryan et al., 2024). In India, tribal populations account for approximately 8.6% of the total population of India (Bisai et al., 2014). Children living in economically disadvantaged environment are particularly vulnerable to nutritional disorder, which may adversely affect their physical growth and development. Early childhood is a crucial period of rapid physical and neurological growth. Adequate nutrition during this period is essential for normal growth, brain development, and overall health status. Poor nutritional status during childhood may impair physical growth and cognitive development and may increase susceptibility to infectious diseases (Mandal & Bose, 2010). In India, continues to carry a substantial burden of childhood undernutrition, making nutritional assessment among vulnerable populations is an important public health priority (Debsarma et al., 2021). Anthropometry is widely used to assess the childhood growth and nutritional status. Among the different anthropometric measures, head circumference (HC) is a simple, inexpensive, non-invasive method to assess health status of under-five children. It provides useful information about cranial growth and is closely related to brain development during this period (Biswas & Khatun, 2023). In general, low HC may indicate impaired growth and may be associated with nutritional deficiencies and developmental problems. Therefore, regular monitoring of HC measurement can be useful in identifying children who may require further nutritional or health awareness (Sonoko et al., 2023). Generally, HC is measured using a non-stretchable measuring tape placed around the maximum circumference of the head and standardized measurement techniques are important to ensure accurate and reproducible findings (Eaton-Evans, 2012). The use of age and sex specific HC-for-age Z-scores provides a standardized approach to evaluate growth and nutritional status of preschool children. The WHO Child Growth Standards (2007) have been widely used to assess optimum HC-for-age z-score and identifying moderate and severe undernutrition based on Z-score cut-offs (Maiti et al., 2012).

Previous studies have demonstrated substantial variation in HC and the prevalence of undernutrition among tribal children from different geographical areas of India. For example, Tigga et al. (2016) reported a high prevalence of undernutrition among tribal preschool children aged 2-5 years in North Bengal, with girls showing a slightly higher overall prevalence than boys. Similarly, Kshatriya et al. (2024) reported substantial differences in the prevalence of undernutrition among children belonging to the Bhil, Dhodia, and Kinnaura tribal communities of three states. Although several studies have examined HC and assessed nutritional status among tribal and rural children in different parts of India, limited information is available on tribal preschool children in Purulia district, West Bengal. The present study therefore focuses on HC measurement among tribal preschool children in Purulia district. In view of the above, present study aims to assess nutritional status using HC-for-age Z-scores and to examine variations in HC and undernutrition according to age and sex.

Materials and Methods

Area and people: A cross-sectional study was conducted in selected tribal dominated villages of Purulia district, West Bengal, from March 2023 to August 2024. Purulia is located approximately 295 km from Kolkata. The study included 194 tribal children aged 2–5 years, comprising 97 boys and 97 girls. For the assessment of undernutrition, children aged 24–59 months were considered. Participants were selected using a stratified random sampling method.

Sample size: Sample size was calculated by standard formula as under.

$$n = (z^2 pq) / e^2$$
$$= \frac{3.8416 \times 0.5 \times 0.5}{0.0064} = 0.9604 / 0.0064$$
$$\approx 150$$

where, value of z at 95% CI is 1.96, margin of Error = 8%, p = 50%. Q=50%

Anthropometric measurements: HC was measured by the most important effective method of Lohman et al (1988). The Maximum circumference, HC was measured with non-stretchable tape, the landmark was supraorbital ridge and occipital protuberance in front and back side of skull. Measurement error was taken as 0.1 cm. Age was obtained from their documents, such as Aadhaar cards, birth certificates, etc. and cross check with senior member of the household.

Assessment of Nutritional Status: Nutritional status was assessed based on head circumference-for-age z-score method according to WHO growth standards (2007). Children with a head circumference Z-score below –2SD were classified as moderately undernourished, while those children with a Z-score below –3SD were classified as severely undernourished. The SD denotes the age-specific standard deviation of head circumference based on the WHO reference standards (WHO, 2007).

Data analysis: Descriptive statistics were performed using SPSS version 26.0. Head circumference-for-age Z-scores were obtained using WHO Anthro software. Statistical significance was considered at $p < 0.05$.

Results

Table 1 presents the mean and standard deviation (SD) of HC by age and sex. The overall mean HC was 46.46cm among girls and 47.38 cm among boys. Across the age groups, mean HC was increased from 45.47 to 47.32cm in girls and from 46.46 to 47.93cm in boys (Figure-1). Both age and sex showed statistically significant effects on head circumference ($F = 15.92$ and 9.26 , respectively; $p < 0.001$). A significant sex difference in mean HC was observed across all age groups.

Table 1. Age and sex-specific mean head circumference of tribal preschool children

Age in months	Girls			Boys			t-value
	N	Mean	SD	N	Mean	SD	
24-35 (2 years)	29	45.47	1.23	25	46.46	1.28	2.88**
36-47 (3 years)	31	46.37	1.30	33	47.46	1.52	3.07**
48-59 (4 years)	37	47.32	1.41	39	47.93	1.19	2.02*
Total	97	46.46	1.51	97	47.38	1.44	4.50***
F-value	15.92***			9.26***			

***p<0.001, **p<0.01, *p<0.05,

Figure 1. Age and sex-specific mean head circumference of tribal preschool children

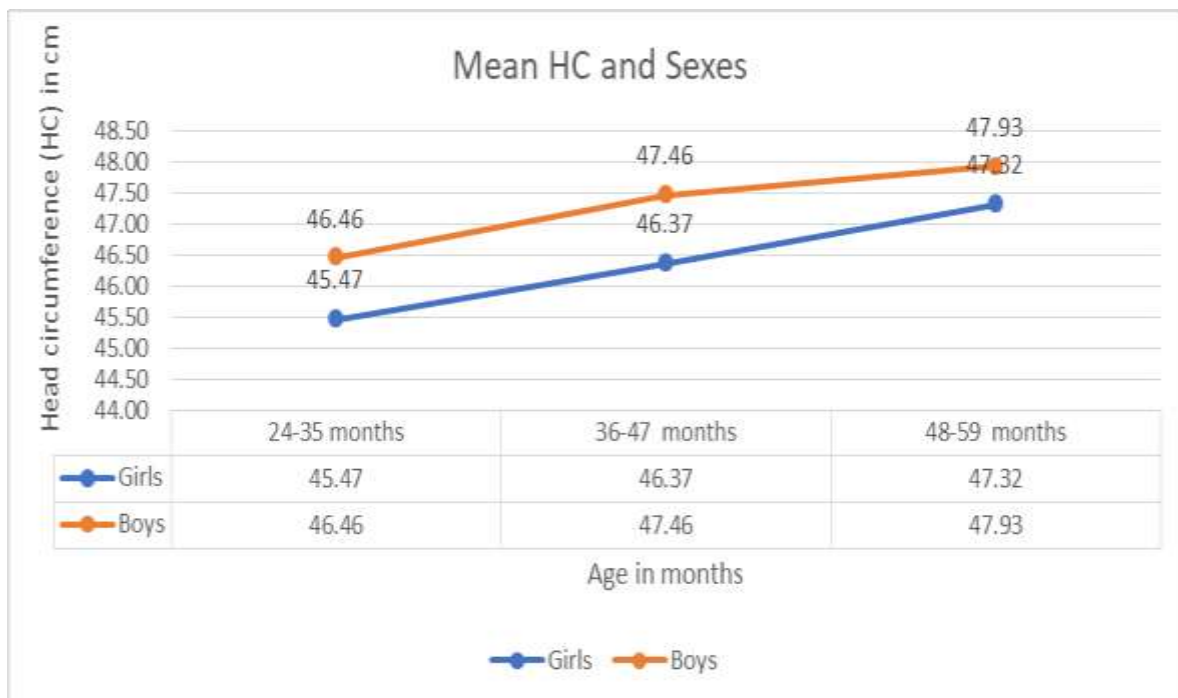
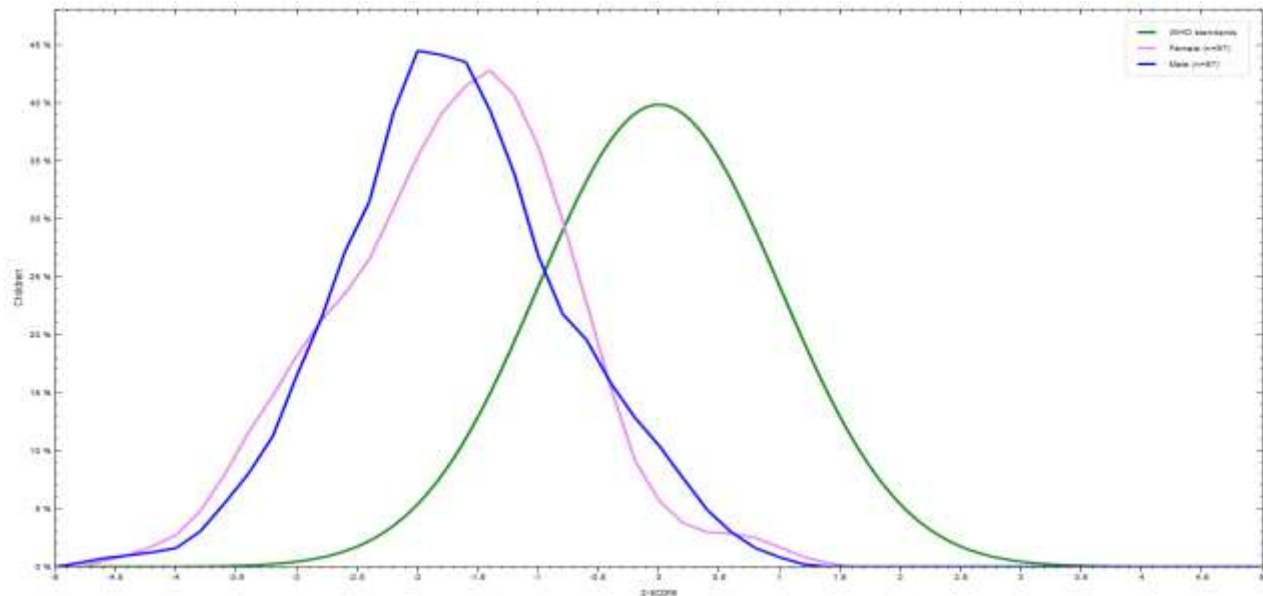


Table 2. Nutritional status of tribal preschool children of Purulia.

Age in months	Undernutrition	Sex				Total	
		Girls (n=97)		Boys (n = 97)			
		n	%	n	%	n	%
24-35	Normal	21	72.4	13	52.0	34	63.0
	Moderate (<-2SD)	5	17.2	10	40.0	15	27.8
	Severe (<-3SD)	3	10.3	2	8.0	5	9.3
36-47	Normal	18	58.1	22	66.7	40	62.5
	Moderate (<-2SD)	9	29	6	18.2	15	23.4
	Severe (<-3SD)	4	12.9	5	15.2	9	14.1
48-59	Normal	24	64.9	23	59.0	47	61.8
	Moderate (<-2SD)	10	27	15	38.5	25	32.9
	Severe (<-3SD)	3	8.1	1	2.6	4	5.3
Overall	Normal	63	64.9	58	59.8	121	62.4
	Moderate (<-2SD)	24	24.7	31	32.0	55	28.4
	Severe (<-3SD)	10	10.3	8	8.2	18	9.2

Table 2 present the nutritional status of tribal preschool children of Purulia. Overall, the prevalence of severe and moderate undernutrition was 9.2% and 28.4%, respectively. Among girls, 10.3% were severely undernourished and 24.7% were moderately undernourished, compared to 8.2% and 32.0%, respectively, among boys. Severe undernutrition was slightly more prevalent among girls, whereas moderate undernutrition was more common among boys. The prevalence of moderate undernutrition was particularly higher among boys at 2 and 4 years of age. The age and sex-wise distribution of undernutrition showed variations across the different age groups. Moderate undernutrition was highest among children aged 4 years (32.9%), followed by those aged 2 years (27.8%) and 3 years (23.4%). The severe undernutrition was more prevalent among children aged 2 and 3 years. Among children aged 3 years, the prevalence of severe undernutrition was 15.2% in boys and 12.9% in girls. Overall undernutrition was more prevalent among boys than girls at aged 3 years. For 2 years old children, the prevalence of undernutrition was 10.3% in girls and 8.0% in boys. At the age of 4 years, the prevalence of undernutrition was higher in girls (8.1%) compared to boys (2.6%). Figure 2 illustrates the distribution of HC-for-age Z-scores in relation to the WHO growth standards. The overall mean Z-score was negative in both boys and girls, indicating that HC was generally below the expected level for age according to WHO child growth standards.

Figure 2. Distribution of HC-for-Age Z-score against WHO standards



Discussion

HC is a simple, inexpensive, and non-invasive anthropometric method that can help to assess nutritional status and provide an suggestion of growth and development in preschool children. It can therefore be useful for identifying undernutrition, particularly in resource-limited settings. The present study found that mean HC increased with advancement of age, indicating the expected pattern of cranial growth during early childhood. Similarly, a comparable result has been reported in other studies among tribal and disadvantaged populations of India. Table 3 compares the prevalence of undernutrition as assessed based on height-for-age (HC) z-scores method as reported in many studies conducted across different regions of India. The prevalence of undernutrition varied considerably between studies, which may be attributed to differences in age ranges, population characteristics, sampling designs, sample size and reference standards used. Kshatriya et al. (2024b) reported considerable levels of undernutrition among children from the Bhil, Dhodia, and Kinnaura communities. In the Bhil community, 28.3% of both boys and girls were classified as malnourished. In the Dhodia community, the prevalence was 33.6% among boys and 31.3% among girls, while in the Kinnaura community, 13.5% of boys and 17.2% of girls were found to be malnourished. These findings indicate substantial variation in nutritional status across different tribal communities.

Similarly, Yeasmin et al. (2018), in a study of 497 girls and 538 boys from Rajshahi City, Bangladesh, reported moderate and severe HC based malnutrition among both sexes. Among boys, 33.3% were moderately and 6.3% severely malnourished, compared with 30.0% and 13.5%, respectively, among girls. Badami et al (2014) also reported that 30.86% of boys and 23.52% of girls had HC measurements below -2 SD, while 6.1% of boys and 4.70% of girls were below -3SD. Overall, 37.03% of boys and 28.23% of girls were classified as malnourished in their study conducted in an urban slum population. A study conducted among preschool children in Karbi Anglong, Assam, reported poor nutritional status in 49.10% of girls and 42.18% of boys (Mondal, 2019). Differences in the prevalence of undernutrition across these studies may be related to variations in socioeconomic conditions, dietary practices, ethnicity, age distribution, and living environments.

Table 3. Prevalence of undernutrition among tribal preschool children in various studies.

Sl. No.	Author(s) & Year	Study area / Population	Sample Size	Age Group	HC Assessment / Reference	Boys (%)	Girls (%)	Overall Prevalence (%)
1	Mandal & Bose (2010)	Hooghly, West Bengal	894	Preschool	HC-based cut-off points	62.80	64.90	63.87
2	Maiti et al. (2012)	Midnapore, West Bengal	1,060	1-3 years	WHO (2007) HCAZ	19.20	22.60	20.70
3	Sukanya et al. (2014)	Bagalkot, Karnataka	166	Preschool	HC-for-age	37.03	28.23	32.53
4	Tigga et al. (2016)	North Bengal, West Bengal	447	2-5 years	WHO HCAZ	53.85	58.16	56.15
5	Giri et al. (2018)	West Bengal	656	Preschool	HC-for-age	28.83	42.12	-
6	Sharma & Mondal (2019)	Karbi Anglong, Assam	490	Preschool	HC-for-age	42.18	49.10	46.12
7	Biswas & Khatun (2023)	West Bengal	782	24-60 months	WHO (2007) HCAZ	27.60	31.91	29.80
8	Kshatriya et al. (2024)	Bhil tribal children, Rajasthan	353	Preschool	WHO (2007) HCAZ	28.30	28.30	-
9	Kshatriya et al. (2024)	Dhodia tribal children, Gujarat	306	Preschool	WHO (2007) HCAZ	33.60	31.30	-

Sl. No.	Author(s) & Year	Study area / Population	Sample Size	Age Group	HC Assessment / Reference	Boys (%)	Girls (%)	Overall Prevalence (%)
10	Kshatriya et al. (2024)	Kinnaura tribal children, Himachal Pradesh	326	Preschool	WHO (2007) HCAZ	13.50	17.20	-
11	Mahapatra & Bose (2025)	West Bengal	848	12-71 months	WHO age and sex-specific HC Z-score	-	-	60.70
12	Present study	Purulia	194	24-59	WHO age and sex-specific HC Z-score	40.20	35.10	37.65

Note. HC = head circumference; HCAZ = head circumference-for-age Z-score; WHO = World Health Organization.

With respect to sex differences in HC, previous research has generally reported higher mean values among boys than girls. Debsarma et al (2021), for example, reported mean HC of 46.8 cm among boys and 45.6 cm among girls, with HC increasing gradually with age. A similar pattern was observed in the present study, where boys had a higher mean HC than girls, and mean HC increased with advancement of age.

Conclusion: HC is an important anthropometric measure for assessment of growth and reflecting aspects of brain development in young children. In the present study, a single measurement of HC was used to assess undernutrition. The mean HC of the tribal children was lower than the WHO reference standards, with 37.6% of children showing evidence of undernutrition, representing more than one-third of the study population. Although HC varied significantly with age and sex, the findings highlight the need for greater attention to the nutritional and health status of tribal preschool children. Regular growth monitoring, appropriate nutrition, and timely health interventions may help identify and address growth related problems at an early stage.

Ethical approval: Ethical approval for the study was obtained from the Institutional Ethics Committee of S.K.B. University. Informed consent was obtained from the parents or legal guardians of all participating children before data collection.

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