Original Article

Evaluation of Nutritional Status using Head Circumference among Bhil, Dhodia and Kinnaura tribal Preschool Children, India

Gautam Kumar Kshatriya[1], Pijush Kanti Roy[2], Saheli Biswas[2], Mahua Chanak[2], Kaushik Bose[3]

From, [1]Former Professor, Department of Anthropology, University of Delhi, New Delhi, India, [2]Research Scholar, [3]Professor, Department of Anthropology, Vidyasagar University, Midnapore, West Bengal-721102, India.

ABSTRACT

Background: Undernutrition is a major problem in developing countries, especially among tribal pre-school children. Many studies have been undertaken on preschool tribal children in different parts of India, but by considering different ecological zones, no previous studies have been taken into account for determining nutritional status using head circumference. Head circumference for age Z-score (HCAZ) is also a useful index for determining the nutritional status of pre-school children. **Objectives:** The aim of the study is to assess the nutritional status based on head circumference of preschool children of the Bhil, Dhodia and Kinnaura tribes. **Methods:** The present study was undertaken among 509 boys and 476 girls. Among which, 168 boys and 185 girls belonged to the Bhil tribe from Barmer district, 164 boys and 142 girls belonged to the Dhodia tribe from Valsad district, and 177 boys and 149 girls belonged to the Kinnaura tribe from Kinnaur district. WHO Child Growth Standards (2007) were utilized to determine Z-scores for head circumference for age (HCAZ). The standard formula was used to compute HCAZ: Z-score= (X- Median value of WHO 2007)/ standard deviation, WHO (2007). Moderately undernourished: <-2SD and severely undernourished: <-3SD were considered following the WHO standard (2007). **Results:** From this study, it was found that among Bhil preschool children, 28.3% of boys and girls are undernourished, 33.6% of boys and 31.3% of girls are suffering from malnutrition among Dhodia boys, and 13.5% of boys and 17.2% of girls are undernourished among Kinnaura tribe. **Conclusion:** Regular intervention programmes need to be done by the authority to spread awareness among the people of these tribal communities so that the health condition of preschool children improves.

Key words: head circumference, preschool children, Bhil, Dhodia, Kinnaura, Undernutrition

India's tribal population makes up 8.6% of the overall population (1). Because of the unavailability of sufficient food, they are more prone to undernutrition, which is recognised as a widespread health issue (2). Undernutrition has major long-term effects on children and negatively affects the development of the country. Undernutrition among preschoolers is one of the most concerning issues in developing countries, including India (3-7). Child growth is frequently used to evaluate a child's development, health, and nutrition, as well as to estimate the general nutritional condition and health of communities (8). According to (9), to assess the physical growth and nutritional status of children, the appropriate technique is anthropometry. It is a simple, easy-to-use, reliable, and non-invasive technique for determining a child's health and nutritional level. Head circumference (HC) measurement is not often used by several researchers, as based on this anthropometric variable, few studies have been done. HCAZ (head circumference for age) is also an important nutritional indicator that can be utilized to determine the prevalence of undernutrition (10).

Many researchers agree that HC is a useful indicator for evaluating children's growth and malnutrition (3, 11-15) and HC is also a simple anthropometric measurement (6) that helps to determine brain size and its development (16). In general, three anthropometric indicators are widely used to evaluate a child's nutritional status. These are stunting (low height-for-age), underweight (low weight-for-age) and wasting (low weight-for-height). Besides these, head circumference for age is also an important indicator for determining the nutritional status of children. Economic stagnation is directly linked to poor health and nutrition, and

Correspondence to: Mahua Chanak, Department of Anthropology, Vidyasagar University, Midnapore 721102, India. **Email:** mahua95@live.com

the developmental issues caused by poor health and nutrition restrict economic growth (7). Despite the existence of numerous intervention programmes in India, the outcomes regarding nutritional status remain unsatisfactory among preschool children. Variation in dietary habits leads to several diseases in the adult phase such as obesity, diabetes, high blood pressure (hypertension), and other heart diseases (5). In a slum area, undernutrition of preschoolers is caused by several factors such as a lack of adequate food supply, illiteracy, poor hygiene, and the socio-economic as well as cultural status of the community (17).

From the literature survey, it was observed that no previous research had examined the association between different ecological zones and head circumference measurements. Therefore, the present study was undertaken to assess nutritional status based on head circumference in three ecological settings (Desert ecology, Coastal ecology and Himalayan ecology). This is the uniqueness of the study.

MATERIALS AND METHODS

Study area and study population: The present study was conducted from 2001 to 2004. This cross-sectional study was carried out among 353 Bhil children (168 boys and 185 girls), 306 Dhodia children (164 boys and 142 girls) and 326 Kinnaura children (177 boys and 149 girls) of age group 0-5 years. For this study, three districts were chosen namely, Barmer, Valsad and Kinnaur to collect data on the Bhil, Dhodia and Kinnaura tribes. The data on three tribes was collected from village pre-school childcare centers (*Anganwadi).* Participants were selected based on the considered age group of 0-5 years. The ages of the participants were confirmed by records from health worker in *Anganwadi* as well as their parents. Only preschool children from tribal communities were included in the study, while others were excluded. One of the most important scheduled tribes in the state of Rajasthan is the Bhil of Barmer, Valsad district. The Barmer district is located between 24˚58' and 26˚32' north latitude and between 70˚05' and 72˚52' east longitude. Within Bhil, there are two sub-divisions: Bhil and Bhil Mina. Bhil Mina has a better financial situation than Bhil. The Bhil follow either a vegetarian or non-vegetarian diet, depending on the availability of food.Their staple food is bajra, pulses, and wheat. Bhil's primary occupation is farming. They speak Marwadi, Rajasthani, and Hindi together. In the Barmer district, data on Bhil children was collected.

The largest tribal group in Gujarat state is the Dhodia, who live in the Valsad district. The Valsad district is a coastal district that lies between 72˚43 and 73˚ east longitude and 20˚07 to 21˚5 north latitude. The majority of Dhodia in this district work in agriculture. Their language is a blend of Gujarati, Marathi and Konkani. The district's literacy rate was 82%. For the current review, information on Dhodia children

was gathered from Pardi, Umergaon and Valsad authoritative divisions. The Kinnaur district is located between 77˚45' and 79˚50' east longitude and 31˚05' and 32˚05' north latitude. The Kinnaura people also go by the names Kinnara and Kinnaurese. They understand Kinnauri. They smoke, consume local beer (also known as Chang), and are non-vegetarians. Agriculture, horticulture, trade, and raising sheep are their primary occupations. Data on Kinnaura was obtained from the administrative divisions of Kalpa and Pooh in the Himalayan district of Kinnaur.

Anthropometric measurements were taken using a non-stretchable plastic tape; the HC of children were measured using the accepted anthropometric techniques (18). To get the largest circumference with an accuracy of 0.1 cm, the measuring tape was lightly pressed over the glabella and moved to the opisthocranion region at the top of the occipital bone.

The 2007 World Health Organization (WHO) Child Growth Standards were utilized to determine Z-scores for head circumference for age (HCAZ). The standard formula was used to compute HCAZ: Z-score= (X- Median value of WHO 2007)/ Standard deviation, WHO (2007). To evaluate nutritional status, the following age- and sex-specific mid-year values of -2 SD and -3 SD of head circumference in accordance with WHO (2007) reference values for 0-5 year old preschoolers were used: Moderately Undernourished: <-2SD and Severely Undernourished: <-3SD. Preschool children having mean value of more than two standard deviations below the median value of reference were categorized as moderate undernutrition and when the mean value fell more than three standard deviations below the median value of reference, then it is considered as severe undernutrition. Out of 985 pre-school children, 780 were considered for the assessement of nutritional status because of the unavailability of cut-off points for 5+ year children recommended by WHO (2007).

Statistical analysis: With regard to age and sex in relation to the considered tribes, descriptive statistics such as mean and standard deviation (SD) were presented. Based on head circumference, the 'Z' scores were computed to assess the nutritional status. One way ANOVA was computed to test age variations, and chi-square test was performed to find out the association between sex and head circumference for Z-score (HCAZ) in each tribe. The Statistical Package for Social Sciences (SPSS) version 16.0 was used for all statistical analysis.

RESULTS

Mid-year HC values recommended by WHO (2007) which are presented in Table 1, based on that, nutritional status of preschool children was assessed.

Table 1: Age and sex wise cut-off points by World Health Organization (2007) for head circumference (in cm) for evaluation of nutritional status

Age(years)	Boys		Girls	
	-2SD (moderate)	-3SD(severe)	-2SD(moderate)	-3SD(severe)
0-1	40.9	39.7	39.6	38.3
1+	44.7	43.4	43.5	42.1
2+	46.1	44.8	45.1	43.7
3+	47.0	45.5	46.1	44.7
4+	47.5	46.1	46.8	45.4
5+	-	-	-	-

Table 2: Age and sex specific descriptive statistics and mean differences of head circumference and HCAZ (head circumference for age) among studied respondents (N=985); mean values and standard deviation (SD)

Bhil (Desert ecology)						
		Head Circumference (cm)			HCAZ	
Age(years)	N	Boys	N	Girls	Boys	Girls
		Mean±SD		Mean±SD	Mean±SD	Mean±SD
0-1	25	42.65±1.10	30	43.08±3.43	-0.53±0.90	0.68±2.64
1+	26	46.66±2.71	29	44.13±1.43	2.76±2.2	-1.50±1.04
2+	29	46.70±2.41	30	45.46±1.50	-0.52±1.81	-1.73±1.06
3+	30	46.85±1.29	33	48.66±3.63	-1.48±0.93	-0.24±2.56
4+	28	48.93±1.10	30	47.18±1.07	-1.06±0.75	-1.70±0.75
5+	30	49.37±1.01	33	48.68±1.44	-	-
Total	168	46.97±2.72	185	46.29±3.17	-0.22±2.05	-0.88±2.04
F-value	**50.06*****		**31.31*****		**36.58*****	**10.44*****
Dhodia (Coastal ecology)						
		Head Circumference (cm)			HCAZ	
Age(years)	N	Boys	N	Girls	Boys	Girls
		Mean±SD		Mean±SD	Mean±SD	Mean±SD
0-1	13	41.80±3.39	15	41.24±2.78	-1.23±2.78	-0.74±2.14
1+	24	45.11±1.97	24	43.42±1.23	1.49±1.61	-2.01±0.89
2+	30	46.67±1.17	18	45.45±1.01	-0.55±0.88	-1.74±0.72
3+	37	47.73±1.39	28	46.86±1.48	-0.84±0.99	-1.51±1.04
4+	24	48.02±1.49	14	47.49±1.47	-1.67±1.01	-1.48±1.03
5+	36	48.29±1.5	43	47.90±1.2	-	-
Total	164	46.85±2.48	142	45.88±2.68	-0.53±1.71	-1.55±1.23
F-value	**37.07*****		**63.02*****		**18.23*****	**2.76*****
Kinnaura (Himalayan ecology)						
		Head Circumference (cm)			HCAZ	
Age(years)	N	Boys	N	Girls	Boys	Girls
		Mean±SD		Mean±SD	Mean±SD	Mean±SD
0-1	22	42.99±2.52	14	40.74±3.59	-0.26±2.06	-1.12±2.76
1+	15	46.48±1.88	8	46.49±0.54	2.61±1.54	0.21±0.39
2+	16	48.08±1.74	21	46.75±1.33	0.51±1.31	-0.82±0.94
3+	48	48.84±1.29	39	47.95±1.33	-0.05±0.93	-0.74±0.93
4+	40	49.08±2.13	40	48.44±2.40	-0.96±1.44	-0.82±1.69
5+	36	49.5±2.0	27	48.6±1.5	-	-
Total	177	48.03±2.80	149	47.27±2.94	0.01±1.72	-0.76±1.50
F-value	**40.63*****		**37.56*****		**18.24*****	**1.06*****

***p<0.001, SD: Standard deviation, N: Number of Respondents.

Descriptive statistics (mean and SD) of head circumference have been presented in Table 2. Among Bhil preschooler boys, the mean value of head circumference increases with increasing age. But, among the girls increasing trend was observed upto 3+ years. Among Dhodia boys and girls, the increment of mean head circumference continues upto 2+ years and decrement was noticed from 3+ years respectively. The mean value of head circumference among Kinnaura boys and girls increases with increasing age. The overall mean HCAZ and standard deviation among Bhil boys (-0.22±2.05) & Bhil girls (-0.88±2.04), there is a significant age differences among both sexes in mean HCAZ. The overall mean HCAZ among Dhodia boys (-0.53±1.71) and girls (-1.55±1.23). Statistical sex differences were found among both sexes of Dhodia children. 0.01±1.72 and -0.76±1.50 are the overall mean of HCAZ among Kinnaura boys and girls. Statistical sex variation was found among both sexes. Among Bhil, Dhodia and Kinnaura preschool children, significant age differences were observed in both sexes in mean head circumference at $p<0.001$ (Bhil boys F value= 50.06; Bhil girls F value= 31.31; Dhodia boys F value= 37.07; Dhodia girls F value= 63.02; Kinnaura boys F value= 40.63; Kinnaura girls F value=37.56). Similar results were obtained in HCAZ (Head circumference for Age Z scores), where both sexes showed significant differences at $p<0.001$ among three tribal boys and girls (Bhil boys F value= 36.58; girls F value= 10.444; Dhodia boys F value= 18.23; Dhodia girls F value=2.76; Kinnaura boys F value=18.24; Kinnaura girls F value= 1.06).

The frequency and percentage of undernutrition based on head circumference by age and sex are presented in Table 3 among preschool children of the Bhil, Dhodia and Kinnaura tribes. Among Bhil preschool boys and girls, the maximum prevalence of undernutrition was observed in 3+ years (60.0%) and 1+ years (41.4%). Among Dhodia preschool boys, the maximum prevalence of undernutrition was found in 1+ year and 4+ years (41.7%), similarly among 4+ years girls, the maximum prevalence of undernutrition (35.7%) was observed. Like Dhodia boys, the maximum prevalence of undernutrition (20.0%) was found among 1+ and 4+ years Kinnaura boys and 0-1 year old girls are undernourished (50.0%). After combining the age groups in each tribe, it was found that Dhodia boys have the highest percentage of undernutrition based on head circumference which is 33.6%. Among the girls, 31.3% are undernourished which is the highest of these three studied tribal communities. The overall prevalence of undernutrition among Bhil boys and girls is similar (28.3%). The percentage of undernutrition among Dhodia children is 33.6% for boys and 31.3% for girls. 13.5% of Kinnaura boys and 17.2% of Kinnaura girls are undernourished.

By computing HCAZ, it was obtained that 10.9% of boys and 4.6% had severe malnutrition, and 17.4% of boys and 23.7% of girls had moderate malnutrition among Bhil preschool

Table 3: Prevalence of undernutrition based on age and sex of Bhil, Dhodia and Kinnaura preschool children

Bhil (N-290)				
Age(years)	**Boys**		**Girls**	
	N	**Malnourished (%)**	N	**Malnourished (%)**
0-1	25	1(4.0)	30	1(3.3)
1+	26	7 (26.9)	29	12 (41.4)
2+	29	10 (34.5)	30	10 (33.3)
3+	30	18 (60.0)	33	9 (27.3)
4+	28	3 (10.7	30	11 (36.7)
Total	138	39 (28.3)	152	43 (28.3)
Dhodia (N-227)				
0-1	13	5 (38.5)	15	4 (26.7)
1+	24	10 (41.7)	24	8 (33.3)
2+	30	10 (33.3)	18	6 (33.3)
3+	37	8 (21.6)	28	8 (28.6)
4+	24	10 (41.7)	14	5 (35.7)
Total	128	43 (33.6)	99	31 (31.3)
Kinnaura (N-263)				
0-1	22	3 (13.6)	14	7 (50.0)
1+	15	3 (20.0)	8	-
2+	16	1 (6.2)	21	3(14.3)
3+	48	4 (8.3)	39	4 (10.3)
4+	40	8 (20.0)	40	7 (17.5)
Total	141	19 (13.5)	122	21(17.2)

children. Among Dhodia preschool children, 8.6% of boys and 8.1% of girls are severely malnourished, and 32.0% of boys and 23.2% of girls are moderately malnourished. 4.3% of boys and 7.4% of girls are severely malnourished and 13.0% of boys and 12.0% of girls had severe malnutrition among Kinnaura preschool children which are presented in Table 4. By performing the Chi-square test to determine the association between HCAZ and sex, it was noticed that there was no statistical significance ($p>0.05$) in each tribe (Bhil, Dhodia and Kinnaura). There is no association between sex and HCAZ in three tribes.

DISCUSSION

The present study was undertaken among three tribes (Bhil, Dhodia and Kinnaura) of three different places (Barmer, Valsad and Kinnaur). It is very essential to study the growth and nutritional status of children because they are the future of a community as well as a nation. Determining the status of their health is something to be considered seriously to monitor and improve. Based on head circumference, evaluating nutritional status is another helpful tool for preschoolers. Many studies have been undertaken on preschool tribal children in different parts of India, but considering three

Table 4: Association between sex and head circumference for Z-score (HCAZ)

Bhil tribe					
Sex	**HCAZ**				**Chi-square (χ^2)**
	Severe N (%)	**Moderate N (%)**	**Normal N (%)**	**Total N (%)**	
Boys	15(10.9)	24(17.4)	99(71.7)	138(100)	5.13; p>0.05; NS
Girls	7(4.6)	36(23.7)	109(71.7)	152(100)	
Dhodia tribe					
Sex	**HCAZ**				**Chi-square (χ^2)**
	Severe N (%)	**Moderate N (%)**	**Normal N (%)**	**Total N (%)**	
Boys	11(8.6)	32(25)	85(66.4)	128(100)	0.13; p>0.05; NS
Girls	08(8.1)	23(23.2)	68(68.7)	99(100)	
Kinnaura tribe					
Sex	**HCAZ**				**Chi-square (χ^2)**
	Severe N (%)	**Moderate N (%)**	**Normal N (%)**	**Total N (%)**	
Boys	06(4.3)	13(9.2)	122(86.5)	141(100)	1.25; p>0.05; NS
Girls	09(7.4)	12(9.8)	101(82.8)	122(100)	

NS: Not Significant

different ecological zones, no previous studies have been taken into account for determining nutritional status using head circumference. In this regard, the present study has been done in three different ecological settings. In this study, the mean head circumference of Bhil, Dhodia, Kinnaura boys and girls is lower than the standard mean (WHO 2007), except in the age group of 0-1 year (Bhil girls). Comparisons of mean HC of the three tribes with WHO (2007) are presented in [**Figure 1], [Figure 2] and [Figure 3]**. The mean HC of studied Bhil boys and girls was higher in all ages than a previous study conducted by (7) but a showed lower mean value among 2+ year old boys than the previous studies (19,6). 2+& 3+ year old boys and 2+ year old girls had lower mean HC as compared to a previous study by (20). Only 3+ year old boys have a lower mean value when compared to other studies (21, 22). The mean HC of Dhodia boys and girls are higher than a study conducted by (19). Furthermore, 2+& 3+ year old Dhodia boys and 2+ year old Dhodia girls had lower mean HC as compared to findings to a study of (20). 4+ & 5+ year old boys have a lower mean HC than a study of (22). Additionally, 3+, 4+ and 5+ year old boys and girls showed lower mean value than study by (21). Like Bhil boys, 2+ years Dhodia boys also showed a lower mean HC than (6). The average HC of Kinnaura boys and girls was consistently higher at all ages compared to (7) which is similar to the findings for Bhil boys and girls. Additionally, the mean HC of Kinnaura boys and girls surpassed the measurements than

previous studies (19, 20, 22). Like Bhil and Dhodia boys, the mean value of HC among 2+ year old boys had lower mean than findings of a study by (6). From a study, conducted by (21), only 5+ year old had a higher mean HC than the present study.

Bhil boys and girls have similar prevalence rate i.e; 28.3%. Maximum 3+ year Bhil boys are undernourished (60%) and maximum 1+ year Bhil girls are undernourished (41.4%). The highest prevalence rate was found among 1+ year and 4+ years Kinnaura boys (41.7%) and in girls (35.7%) among 4+ years. Similarly, the maximum overall prevalence of undernutrition was noticed among 1+ and 4+ year Kinnaura boys, and 50.0% of Kinnaura girls of age group 0-1 are undernourished. The overall prevalence of undernutrition based on HC among Bhil, Dhodia and Kinnaura boys and girls is lower than some previous studies (7, 17, 19, 21, 22). But the present study's overall prevalence among Bhil and Dhodia boys and girls are higher than findings of a study by (20). Another study reported by (7), they observed that 28.83% boys and 42.12% girls are undernourished which is higher than the prevalence rate among Kinnaura boys and girls. But Dhodia boys have higher prevalence rate than the preschool children which was studied by (7). All most similar prevalence rate was observed between Bhil girls (28.3%) of the present study and preschool children (28.23%) as studied by (7). Among these tribes, Kinnaura boys and girls showed a
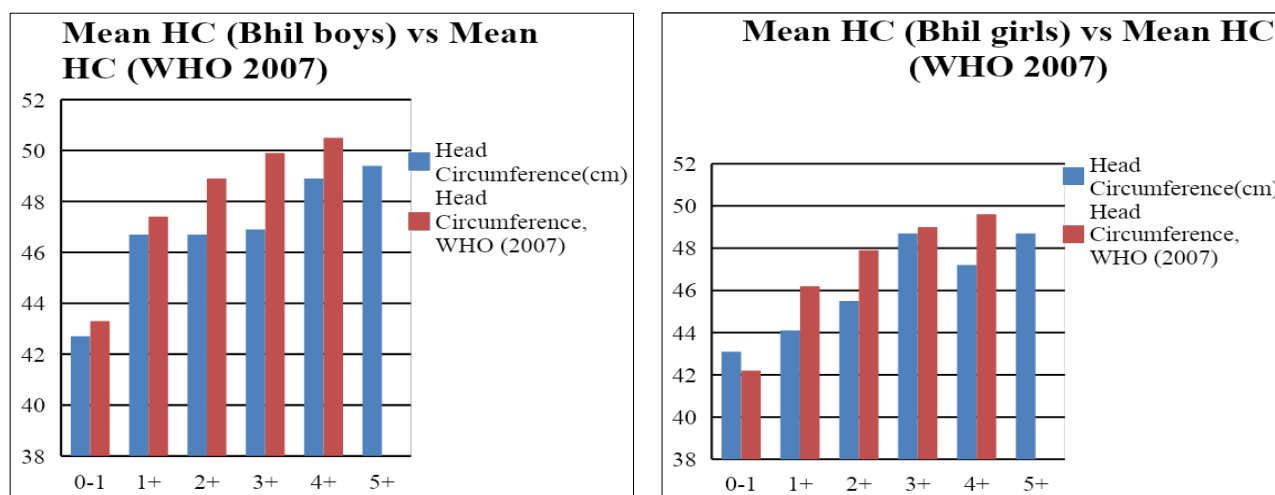
Figure 1: Comparison of mean HC of Bhil Boys and girls with World Health Organization standard (2007)
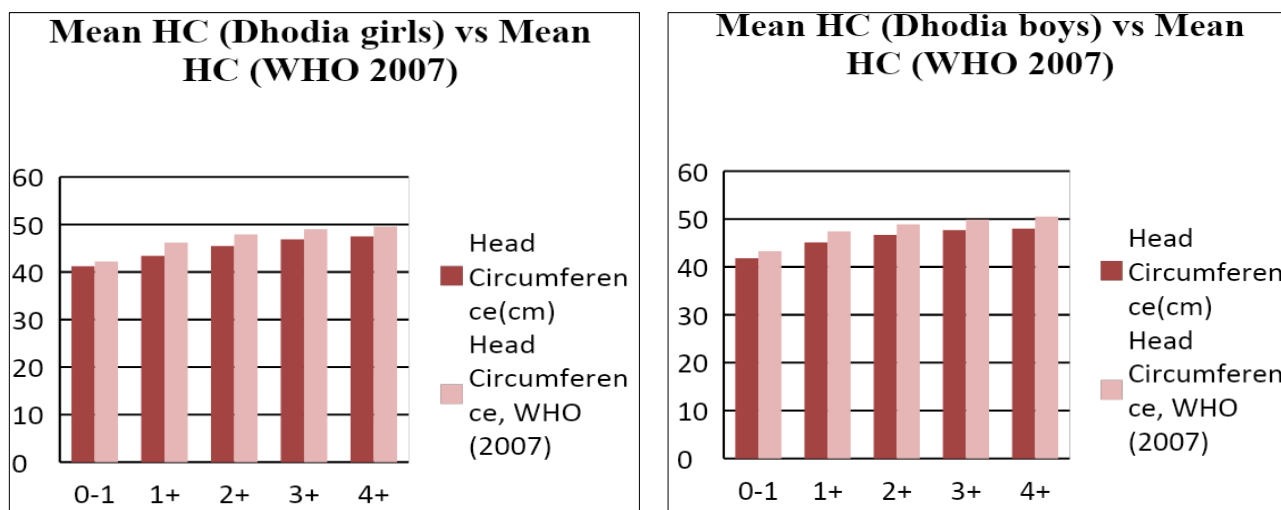

Figure 2: Comparison of mean HC of Dhodia Boys and girls with World Health Organization standard (2007)
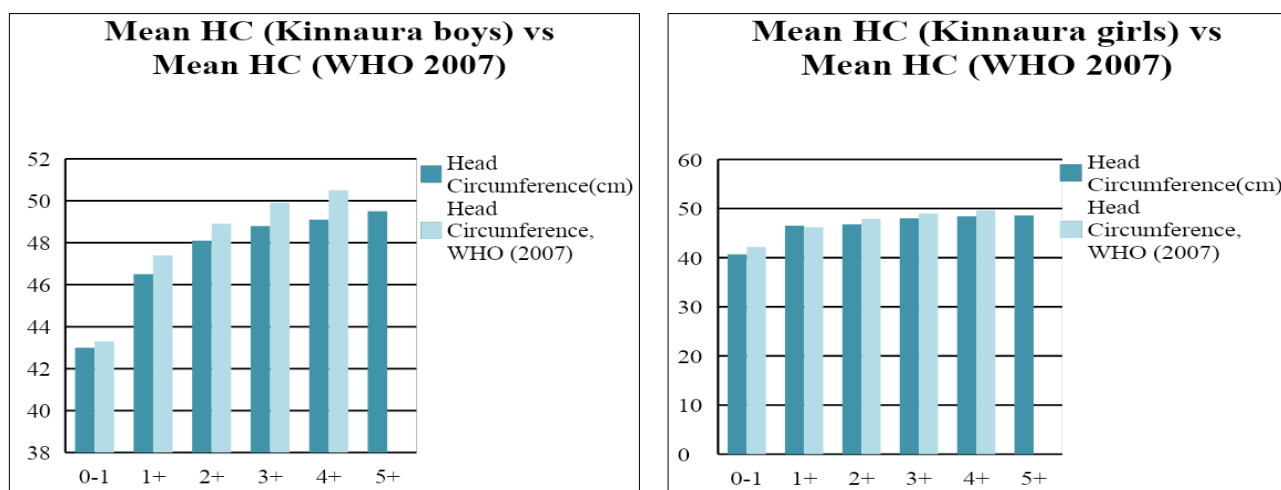

Figure 3: Comparison of mean HC of Kinnaura Boys and girls with World Health Organization standard (2007)

lower prevalence of undernutrition than Bhil and Dhodia communities. Previous research conducted by (23) on Bhil children in Madhya Pradesh revealed that there is an association between parents of lower income group category and prevalence of undernutrition.

They determine undernutrition on the basis of Stunting, Underweight and Wasting. Previously, no assessment of undernutition among the Bhil tribe had been conducted using nutritional indices, such as head circumference for age. From several studies, head circumference value is lower than the standard value of WHO 2007 (3, 20, 24). No association was found between HCAZ and sex (p>0.05). In contrast, (21) reported a significant association between HCAZ and gender at p<0.01. Present study also revealed that age variation in mean HC of both the sexes are statistically significant (boys: F= 50.06, p<0.001; girls: F= 31.31; p<0.001) among Bhil preschoolers. Statistical age difference was noticed among Dhodia and Kinnaura preschoolers (Dhodia boys: F= 37.07, p<0.001; Dhodia girls F: 63.02, p<0.001; Kinnaura boys F: 40.63, p<0.001; Kinnaura girls F: 37.56, p<0.001).

CONCLUSION

While considering the standard mean value (WHO 2007), it was observed that mean HC of all age groups of three tribes are below the standard value except one age group (0-1 year) among Bhil girls but Dhodia and Kinnaura preschoolers have lower mean value than standard reference. Undernutrition is more prevalent among Dhodia boys than girls but the undernutrition among Kinnaura girls is more prevalent than Kinnaura boys. Interestingly, the study found that the prevalence of undernutrition was similar among Bhil boys and girls. Furthermore, no association was observed between sex and Head circumference-for-Age Z-score (HCAZ) in the three tribes examined. This investigation does not reveal the current scenario of these tribes as the data was collected from 2001-2004. Apart from this, no associations were carried out with the nutritional status and socio-demographic factors in this study. This study mainly focused on the prevalence rate of undernutrition. So, in the future, it is necessary to study the factors which may or may not be associated with undernutrition among these tribes. Additionally, regular studies should be conducted to assess the nutritional status of preschool children in other tribal communities.

REFERENCES

1. Census of India. Office of the Registrar General and Census Commissioner. Ministry of Home Affairs, Govt. of India. 2011; Available from http://www.censusindia.gov.in.
2. Dey U, Bisai S. The Prevalence of under-nutrition among the tribal children in India: a systematic review. Anthropo Rev. 2019; 82(2):203-217.
3. Singh I, Grover K. Nutritional profile of urban pre-school children of Punjab. Anthropologist. 2003; 5(3):149-153.
4. Nandy S, Irving M, Gordon D, *et al*. Poverty, Child undernutrition and mortality: new evidence from India. Bull World Health Organ. 2005; 83(3):210-216.
5. Sahu SK, Kumar SG, Bhat BV, *et al*. Malnutrition among under-five children in India and strategies for control. J Nat Sc Biol Med. 2015; 6(1):18-23.
6. Tigga PL, Mondal N, Sen J. Head circumference as an indicator of undernutrition among tribal preschool children aged 2-5 years of North Bengal, India. Human Biol Rev. 2018; 5(1):17-33.
7. Giri SP, Biswas S, Bose K. Head Circumference Based Nutritional Status of Rural Bengalee Preschool Children from Sagar Island, West Bengal, India. Mankind Q. 2018; 58(4):599-610.
8. Bose K, Biswas S, Bisai S, *et al*. Stunting, underweight and wasting among Integrated Child Development Services (ICDS) scheme children aged 3-5 years of Chapra, Nadia District, West Bengal, India, Matern Child Nutr. 2007; 3(3):216-221.
9. World Health Organization. Physical Status: the use and interpretation of anthropometry. Technical Report Series. No. 854. WHO: Geneva. 1995.
10. Tiwari K, Goyal S, Malvia S, *et al*. Impact of malnutrition on head size and development quotient. Int J Res Med Sci. 2017; 5(7):3003-3006.
11. Anzo M, Takahashi T, Sato S, *et al*. The cross-sectional head circumference growth curves for Japanese from birth to 18 years of age: The 1990 and 1992-1994 national survey data. Ann Hum Biol. 2002; 29(4):373-388.
12. WHO Child Growth Standards. Head circumference-for-age, arm circumference for-age, triceps skinfold-for-age and subscapular skinfold-for-age. Methods and Development. Geneva: World Health Organization. 2007.
13. Casey PH. Growth of low birth weight preterm children. Semin Perinatol. 2008; 32(1):20-27.
14. Zaki ME, Hassan NE, El-Masry SA. Head circumference reference data for Egyptian children and adolescents. East Mediterr Health J. 2008; 14(1):69-81.
15. Ramirez AO, Kuhn EM, Sirinit J, *et al*. Head Circumference as An Indicator of Nutritional Status in Critically Ill Children under 2 Years of Age. OBM Integr Complement Med. 2022; 7(1):1-9.
16. Vernon PA, Wickett JC, Bazana PG, *et al*. The neuropsychology and psychophysiology of human intelligence. In: R.J. Sternberg (Eds.), Handbook of Intelligence Cambridge: Cambridge University Press; 2000. p. 245-264.
17. Sukanya BV, Baragundi MC, Surekharani CS, *et al*. Assessment of nutritional status of preschool children using head circumference. Int J Curr Med Appl Sci. 2014; 4(3):72-75.
18. Lohman TG, Roche AF, Martorell R. Anthropometric Standardization Reference Manual. Chicago: Human Kinetics Books; 1988.
19. Mandal GC, Bose K. Undernutrition among the rural preschool children (ICDS) of Arambag, Hooghly District, West Bengal, India, using new head circumference cut-off points. Int J Curr Res, 2010; 10(1):007-011.
20. Maiti S, Ali KM, Ghosh D, *et al*. Assessment of head circumference among pre-school children of Midnapore Town, West Bengal using WHO (2007) recommended cut-off points. Int J Prev Med. 2012; 3(10):742-744.
21. Yeasmin K, Yeasmin T. Assessment of Nutritional Status of Preschool Children: Head Circumference and Other Anthropometric Indices. Bangladesh Med Res Counc Bull. 2018; 44(3):152-159.

22. Sharma J, Mondal N. Assessment of Undernutrition using Head Circumference-for-Age among Karbi Preschool Children of Karbi Anglong, Assam, India. J Life Sci. 2019; 11(1-2):7-16.
23. Pradhan S, Sharma K. Nutritional Status of Bhil Tribal Children in Madhya Pradesh, India: A Cross Sectional Study. Stud Tribes Tribals. 2011; 9(1):37-40.
24. Singh S, Bisnoi I. Trend of growth in mid-arm circumference and head circumference of preschool female children of Faizabad District, U.P. Indian J Prev Soc Med. 2005; 36(1):143-146.