Anthropological Review • Vol. 80(2), 153–163 (2017)

DE GRUYTER OPEN

Anthropological Review
Available online at: https://doi.org/10.1515/anre-2017-0010

Nutritional status among children and adolescents aged 6–18 years of Kolam tribe of Andhra Pradesh, India

K. Bharthi[1], Manisha Ghritlahre[2], Subal Das[3], Kaushik Bose[4]

[1]Department of Sociology and Social Anthropology, College of Social Sciences and Humanities, Chamo Campus, Arba Minch University, Ethiopia, North Africa
[2]Department of Anthropology & Tribal Development, Guru Ghasidas Vishwavidyalaya, Bilaspur, Chhattisgarh, India
[3]Department of Anthropology & Tribal Development, Guru Ghasidas Vishwavidyalaya, Bilaspur, Chhattisgarh, India
[4]Department of Anthropology, Vidyasagar University, Medinipur, West Bengal, India

Abstract: Malnutrition has become one of the serious problems among children and adolescents internationally, especially in developing countries. India, a developing country covers 40% of undernourished children of the world. In India, tribal population is among the most deprived and undernourished people. The present study shows the prevalence of undernutrition among Kolam tribal children and adolescents by comparing different Body Mass Index (BMI) cut off points. Age and sex specific nutritional status of studied population shows 15.01% boys and 18.35% girls are in Chronic Energy Deficiency (CED) III category, 16.22% boys and 19.32% girls are in CEDII, 31.71% boys and 2.72% girls are in CEDI only 0.96% boys and 1.69% girls are in overweight category respectively. Undernutrition is not limited to young children, even adults are also severely underweight in developing countries. Health and nutrition of today's adolescent girls may have great impact on the quality of next generation. Proper nutritional programs and health policies are needed to be implemented among tribals to solve the problem of undernutrition and similar studies should be planned in other underprivileged sections worldwide.

Key words: undernutrition, health, nutrition, BMI, tribal, children, adolescent

Introduction

Malnutrition has become now one of the serious problems among children and adolescents internationally, especially in developing countries (Pelletier and Frongillo 2003). India a developing country covers 40% of undernourished children of the world and under nutrition is largely occurs due to insufficient availability of proper food (Dakshayani and Gangadhar 2015). Although so many developmen-

Original Research Article Received: January 7, 2017; Accepted for publication: April 18, 2017
DOI: 10.1515/anre-2017-0010

tal programs has been implemented in several areas in India during last two decades to solve the problem but those programs are not that much impressive, still children are facing problems of under nutrition (Grifiths and Bentley 2000). Like tribal women, schedule caste women are also facing problem of under nutrition. In Indian context tribal women followed by the scheduled caste women are also more likely to be undernourished (IIPS and ORC Macro 2000). In India, tribal population are among the most underprivileged and undernourished people (Bose and Chakraborty 2005). Urbanization, female literacy, access to health care, safe water and sanitation are the main causes to influence the child nutrition (Siddiq and Bhargava 1998). Under nutrition is more prevalent in those children whose mother's height is less than 145 cm or whose BMI is less than 18.5, than for other children (NFHS II 1999). Height is the most representative character to show overall growth and development during growing age (Waterlow and Schurch 1994). Babies born with low birth weight (LBW) are more vulnerable to illness in later childhood (Verboeff 2004). Undernutrition is widespread over 842 million people of all ages world-wide (FAO 2013). Around 243 severe underweight adults leave in developing countrites as compared to developed one (ACC/SCN 2000). Adolescent shows the biological growth, development and maturation in postnatal life of a person through which a child becomes an adult (Khan 2005). During the stage of adolescent, peak growth is observed in almost every system and organs of the body except brain and head (Tanner 1992). During adolescence more than 20% of adult bones masses and 50% of adult weight gained (Gang and Heald 1994). Rate of growth during adolescence is slower in the undernourished people than normal (Evelth and Tanner 1991). Nutritional status of the community can be easily observed through the nutritional status of adolescent girls of that community, who will be the future mother (Venkaiah 2002). In India, many adolescents are getting marry before completion of their growth and maturity and this proportion is very high (23.0%) (Agrawal 1974).An adolescent girl with low height-for-age (stunted) has more chances to become a short stature woman (Khan 2005). Poor anthropometric status shows maternal complication diminishing work capacity and high risk of mortality among adolescents and adults (Martorell et al. 1992; Rotimi et al. 1999; Spurr et al. 1977; WHO 1995). In India nearly all maternal nutrition developmental programs are also incorporated with child nutritional programs. All these programs are supervised under ministry of women, child and family welfare of the government of India. Reproductive age women and pre-school children are main focus of Integrated Child Development Scheme (ICDS) and reproductive child health programs or RCH (started in year 1998). In India the Integrated child development scheme (ICDS), launched in 1974, contributes to be the major interference programs to improve child health and welfare. There are eight types of services, provided by ICDS to children and mothers. These are supplementary feeding, immunization, health checkups, referral, nutritional and health education for mothers, micronutrients supplementation and introduction and introduction to child aged between 3 to 6 years. Along with ICDS and RCH programs, National Population Policy (NPP) launched in 2000, National Health Policy (NHP)

brought out in 2002. Objective of the present study is to determine the nutritional status of children and adolescents aged of 6–18 years based on their BMI of Kolam tribe.

Materials and methods

The study was based on community specific and cross sectional method. The study was conducted on a sample size of 827 children from 6 to 18 years of age group of which 413 are boys and 414 are girls in Kolam tribe of Adilabad district of Telangana state. Kolam tribe lives in the interior forests and hilly tracts of Adilabad district of Telangana state, India. As per 2011 census, 8.38% share of state tribal population consists of different tribal groups in Adilabad district with a sex ratio 956 females per males (ICMR 2014). They are totally depended on forest for their livelihood. Many children are doing work at home because they are not that much aware towards education. About 25% of the mandals in the scheduled area have been selected randomly taking into consideration the numerical predominance of the tribal population in the tribal sub-plan area and accordingly Utnoor, Narnoor and Jainoor mandals of Adilabad district were selected. Data on anthropometric measurements for children 6 to 18 years was collected from villages. The sample data for boys and girls satisfies the normal distribution and the variation in the sample size at each age group depends on the availability of the children at the time of data collection. The ages of the participants were recorded as per the records maintained by school management in the study villages. Data on anthropometric measurements were collected following the standard techniques of Weiner and Lourie (1969). Weight was measured to the nearest 0.1 kg with subjects dressed in light garments and without shoes using weighing machine (standard). Height was measured to the 0.1cm against a wall using anthropometric rod (Galaxy Informatics, New Delhi). The equipment was regularly checked for accuracy and the measurements were taken by trained anthropologists. Anthropometric measurements assess body size and composition, and reflect inadequate or excess food intake, insufficient exercise and disease (WHO, 1995). Data such as these on low birth weight, stunting, thinness and overweight are obtained from measurement of height and weight (WHO 1995). The ethical approval was obtained from competent before commencement of the study. Body Mass Index measures the nutritional status of an individual as well as of a population (lIPS Macro 2000; Shetty et al. 1996). Body Mass Index is calculated as the ratio of the weight in kilograms to height in meter squared (BMI = Weight (kg)/ Height (m^2)) (Garrow and Webster 1985). The values of body weight and stature were used to compute the body mass index. Nutritional status was evaluated using the age-sex specific cut-off points of BMI for children (Cole et al. 2000; 2007). The chronic energy deficiency (CED) grades III, II and I of thinness refer to severe, moderate and mild under nutrition respectively. Statistical analysis was performed using SPSS software (16.0 versions). Student'st-test, chi-square, and ANOVA were performed to test for age differences in means of weight, height and BMI.Chi-square is applied when two variables are selected from a single population; it shows whether there is significant association between the two variables. T-test assesses whether the means of two groups are statisti-

cally different from each other. ANOVA shows whether there are any statistically differences between the mean of three or more independent groups.

Measurement of under nutrition

The following are the commonly used indicators of undernutrition that are based on anthropometric data.

Weight-for-age: weight for age < –2 standard deviations (SD) of the Standards median in the reference population. It is also known as underweight shows acute malnutrition and give the current nutritional status. It occurs when a child's weight is below two standard deviation of the median in the reference population. Risk of Mortality is increased in those children who are at high risk of underweight (WHO 2010).

Height-for-age: height for age < –2 SD of the WHO Child Growth Standards median in the reference population. It is also known as stunting and indicator of chronic malnutrition among children which is the result of continuing nutritional deficiency and often results in delayed mental development, poor school performance and reduced intellectual capacity(WHO 2010).

Weight-for-height: weight for height < –2 SD of the Standards median in the reference population. It is the indicator of the acute malnutrition occurs due to insufficient food intake or a high incidence of infectious diseases, especially diarrhoea. It affects the immune system of child (WHO 2010).

These all indices are indicative of different types of under nutrition. Low height-for-age is result of poor environmental and social conditions and includes the effects of undernourishment since birth or even before birth. Low weight-for-height is indicator of current nutritional status. The indicator based on weight-for-age reflects both long-term undernutrition as well as short-term or current undernutrition. Child nutritional status is possible to compute *Z*-scores of the three nutritional indices weight-for-age, height-for-age and weight-for-height.

Results

Table 1 shows the overall mean and standard deviation of studied subjects. Overall mean and standard deviation of weight of boys and girls are 29.93(12.89) and 29.74(11.61) respectively. Similarly, Overall mean and standard deviation of height of boys and girls are 135.26(19.62) and 134.23(18.00) respectively. Overall mean and standard deviation of BMI of boys and girls are 15.61(3.82) and 15.52(2.75) respectively. It has been clear from the table that there is significant age difference.

Table 2 shows the age-sex specific nutritional status of studied subjects. Highest prevalence of CEDIII is found among 7* years of boys and girls that is 45.4% and 62.5% respectively. Highest prevalence of CEDII is found among 11 and 9 year of boys and girls that is 31.2% and 30% respectively. Highest prevalence of CEDI is found among 9 and 11 years of boys and 12 year of girls that is 40.6% and 46.8% respectively. Highest prevalence of normal is found among 17 and 16 year of boys and girls that is 76.6% and 60% respectively. And highest prevalence of over weight is found among the 12 and 7 year of boys and girls that is 6.2% and 18.7% respectively. It has been clear from the table that there is no age-

Table 1. Overall mean and standard deviation of studied subjects

Age (years)	Sex (n)	Body weight (kg)			Stature (cm)			BMI (kg/m²)		
		Mean	SD	*p*-value	Mean	SD	*p*-value	Mean	SD	*p*-value
6	Boys (31)	15.53	2.03	0.001	109.28	4.4	0.045	12.99	1.31	0.23
	Girls (32)	13.91	1.84		105.33	9.84		12.61	1.24	
7	Boys (33)	16.53	1.26	0.11	110.92	6.48	0.94	12.65	1.33	0.08
	Girls (32)	16.19	2.02		110.83	5.02		13.21	1.17	
8	Boys (32)	18.47	2.23	0.40	117.80	3.82	0.54	13.31	1.45	0.20
	Girls (32)	18.06	1.63		118.54	5.68		12.91	0.95	
9	Boys (32)	22.16	1.66	0.07	126.42	5.01	0.15	13.95	1.21	0.99
	Girls (32)	21.00	3.09		123.52	9.99		13.96	2.86	
10	Boys (32)	20.51	2.10	0.004	121.35	4.89	0.007	13.96	1.36	0.264
	Girls (32)	22.09	2.12		124.37	3.62		14.32	1.23	
11	Boys (32)	21.58	1.83	<0.001	126.54	3.93	<0.001	13.49	1.01	0.038
	Girls (32)	25.24	3.24		133.62	7.41		14.18	1.54	
12	Boys (32)	23.95	2.55	<0.001	124.71	15.39	<0.001	16.81	9.80	0.48
	Girls 32)	28.73	4.33		135.72	6.08		15.56	1.38	
13	Boys (32)	30.06	3.21	0.69	142.00	7.18	0.12	14.94	1.34	0.03
	Girls (32)	30.41	3.83		138.75	9.01		15.87	2.01	
14	Boys (32)	36.71	4.98	0.002	146.58	4.60	0.018	17.11	1.95	0.02
	Girls (32)	32.15	6.40		141.24	11.51		15.96	1.88	
15	Boys (32)	43.55	5.81	0.62	156.43	6.27	0.39	17.81	1.60	0.99
	Girls (32)	42.77	6.64		154.90	7.69		17.81	1.60	
16	Boys (32)	43.62	4.92	0.001	155.11	4.45	<0.001	18.21	2.00	0.88
	Girls (30)	39.16	5.39		146.85	5.31		18.13	1.84	
17	Boys (30)	50.47	5.20	<0.001	161.61	5.23	<0.001	19.43	1.95	0.29
	Girls (32)	43.23	5.78		151.69	3.91		18.83	2.48	
18	Boys (31)	48.87	6.03	0.51	162.10	7.03	0.33	18.63	1.613	0.91
	Girls (32)	47.81	6.52		160.36	7.19		18.59	1.75	

Table 2. Age specific prevalence of nutritional status (Thinness) of the studied subjects

Age (years)	Boys					Girls					$\chi^2_{df\ (p)}$
	CED III n (%)	CED II n (%)	CED I n (%)	Normal n (%)	Over-weight n (%)	CED III n (%)	CED II n (%)	CED I n (%)	Normal n (%)	Over-weight n (%)	
6	12 (38.7)	2 (6.45)	12 (38.7)	5 (16.1)	0	16 (50)	7 (21.8)	4 (1.5)	5 (15.6)	0	7.33;3 (0.06)
7	15 (45.4)	8 (24.2)	7 (21.2)	3 (9.0)	0	20 (62.5)	6 (18.7)	0	0	6 (18.7)	16.98;4 (0.002)
8	9 (28.1)	6 (18.7)	8 (25.0)	9 (28.1)	0	9 (28.1)	8 (25)	11 (34.3)	4 (12.5)	0	2.68;3 (0.44)
9	1 (3.1)	9 (28.1)	13 (40.6)	9 (28.1)	0	8 (25)	7 (21.8)	9 (8.1)	7 (21.8)	1 (3.1)	7.67;4 (0.10)
10	5 (15.6)	9 (28.1)	10 (31.2)	8 (25)	0	2 (6.2)	7 (21.8)	12 (37.5)	11 (34.3)	0	20.19;3 (0.53)

Age (years)	Boys					Girls					$\chi^2_{df\ (p)}$
	CED III n (%)	CED II n (%)	CED I n (%)	Normal n (%)	Over-weight n (%)	CED III n (%)	CED II n (%)	CED I n (%)	Normal n (%)	Over-weight n (%)	
11	8 (25)	10 (31.2)	13 (40.6)	1 (3.1)	0	3 (9.3)	9 (28.1)	10 (31.2)	10 (31.2)	0	10.08;3 (0.02)
12	1 (3.1)	6 (18.7)	19 (59.3)	4 (12.5)	2 (6.2)	0	5 (15.6)	15 (46.8)	12 (37.5)	0	7.56;4 (0.11)
13	6 (18.7)	6 (18.7)	11 (34.3)	9 (28.1)	0	4 (12.5)	8 (25)	8 (25)	12 (37.5)	0	1.5; 3 (0.66)
14	1 (3.1)	2 (6.2)	8 (25)	20 (62.5)	1 (3.1)	6 (18.7)	6 (18.7)	12 (32.5)	8 (25)	0	12.51;4 (0.01)
15	0	4 (12.5)	5 (15.6)	23 (71.8)	0	0	3 (9.3)	11 (34.3)	18 (56.2)	0	3.0; 2 (0.22)
16	0	4 (12.5)	11 (34.5)	17 (53.1)	0	0	9 (30)	3 (10)	18 (60)	0	6.46; 2 (0.04)
17	1 (3.3)	0	5 (16.6)	23 (76.6)	1 (3.3)	4 (12.5)	4 (12.5)	7 (21.8)	17 (53.1)	0	7.98; 4 (0.09)
18	3 (9.3)	1 (3.1)	9 (28.1)	18 (56.2)	0	4 (12.5)	1 (3.1)	11 (34.3)	16 (50)	0	0.44;3 (0.93)
Nutri-tional status	62 (15.0)	67 (16.2)	131(31.7)	149(36.1)	4 (0.9)	76 (18.3)	80 (19.3)	113 (2.7)	138(33.3)	7 (1.7)	5.14; 4 (0.27)

sex specific significant difference except in 7 year of boys and girls. It also shows overall age specific nutritional status of studied population in which 15.01% boys and 18.35% girls are in CED III respectively. 16.22% boys and 19.32% girls are in CEDII respectively. 31.71% boys and 2.72% girls are in CEDI respectively. 36.07% boys and 33.33% girls are normal respectively. 0.96% boys and 1.69% girls are in overweight respectively. It has been clear from the table there is no age specific significant difference.

Discussion

Figures 1 and 2 shows the comparative chart of mean height (cm) of present study males and females with national and international references which is less than the mean of height of other studies but there is significant association of present study with Indian Council Medical Research (ICMR 2010) mean height and it more reliable. The difference between lowest and highest annual increment in stature of boys is lower during 10 and 12 years of age group when compared with ICMR mean values. Lowest mean annual gain have occurred in between 9 years and 13 years among Kolam boys. However, a highest mean annual gain was reported during 15+ years of age group among boys and similarly, during 15+ among girls when compared with ICMR means standards. It is found that during 17 to 18 years of age group the annual mean increment among Kolam girls is found to be more when compared with Indian Academic Pediatrician (IAP 2015) mean standards. When both sexes were compared it is observed that the annual increment occurred at the same time of 15years of age group.

Figures 3 and 4 shows the comparative chart of mean weight (kg) of present study males and females with national and international references which is

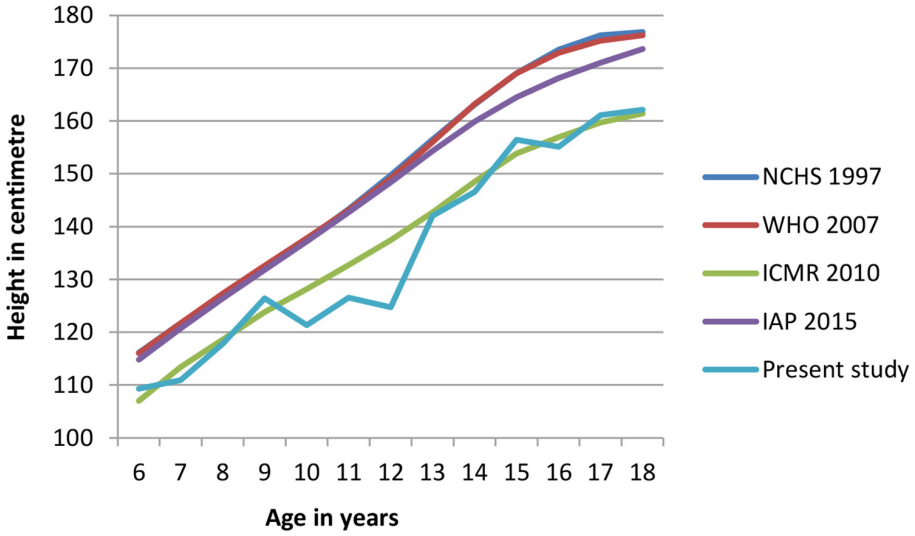

Fig. 1. Comparative chart of mean height (cm) of present study boys with National and International references

less than the mean of weight of other studies but there is significant association of present study with ICMR (ICMR 2010) mean weight and more reliable. The mean body weight of Kolam boys is found to be similar along with ICMR mean values from 6 to 9 years of age group. And almost similar from 6 to 12 years of age group with a slight deviation Body mass of Kolam boys showed

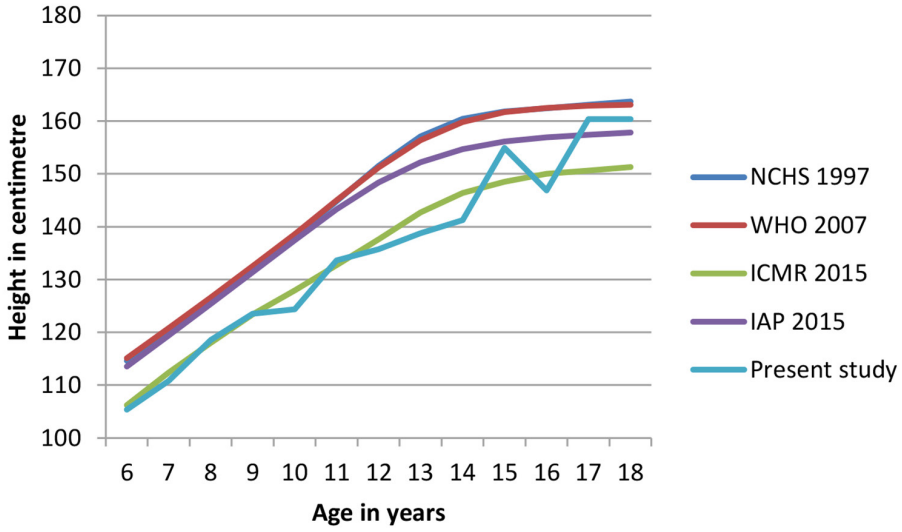

Fig. 2. Comparative chart of mean height (cm) of present study girls with National and International references

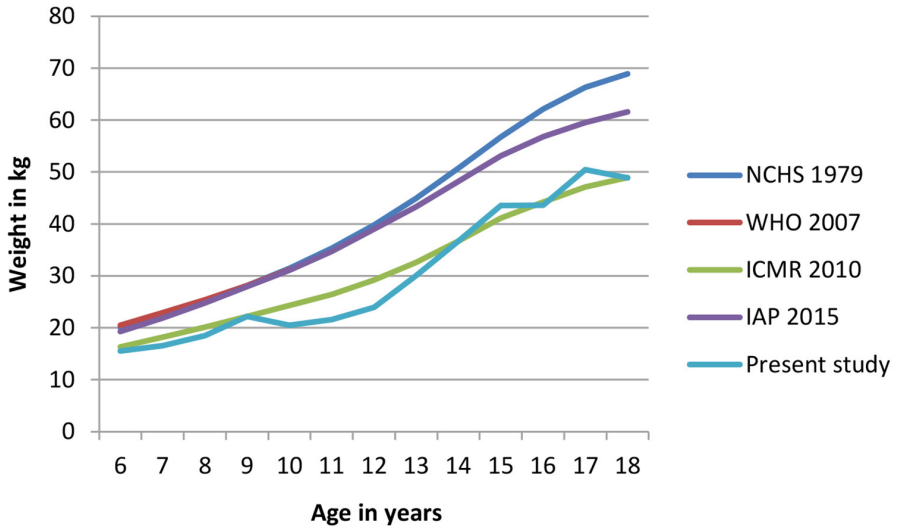

Fig. 3. Comparative chart of mean weight (kg) of present study boys with National and International references

* weight-for-age reference data are not available beyond age 10 because this indicator does not distinguish between height and body mass in an age period where many children are experiencing the pubertal growth spurt and may appear as having excess weight (by weight-for-age) when in fact they are just tall.

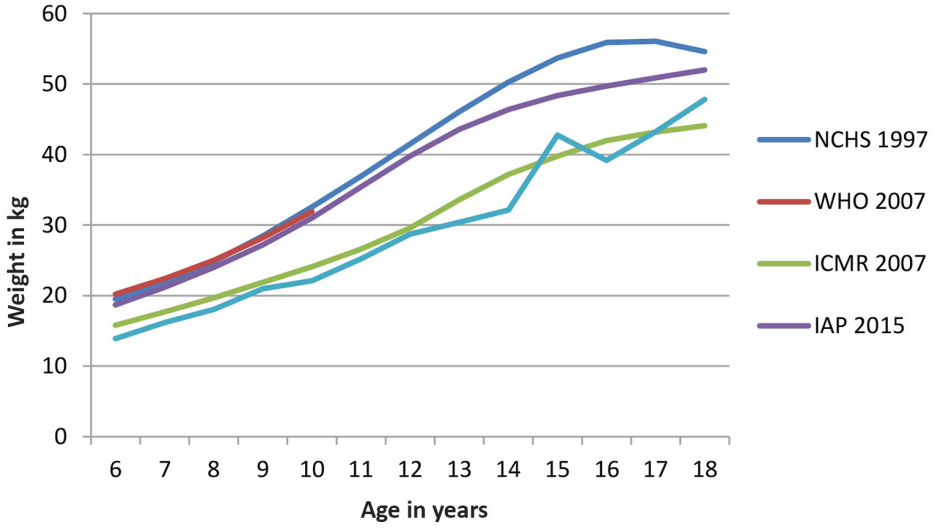

Fig. 4. Comparative chart of mean weight (cm) of present study girls with National and International references

* weight-for-age reference data are not available beyond age 10 because this indicator does not distinguish between height and body mass in an age period where many children are experiencing the pubertal growth spurt and may appear as having excess weight (by weight-for-age) when in fact they are just tall.

to a lowest difference of 1.65 kg at 10 years with a highest difference of 6.85 kg during 17 year followed by 15 years age group. A considerable deviation (–3.61) of total body mass is observed among 16 years of age group. However, an increase (+10.62 and +4.58) in the total body mass is reported among 15 and 18 years of age group.

Conclusion

It is apparent from the above discussion that growth pattern of Kolam population is found similar when compared by ICMR growth standards. However, a slight fluctuation has been observed among both the sexes during juvenile and adolescents stages. Particularly, the slight deviation among Kolam boys is observed during juvenile stage which can be accounted to constitutional growth delay. Contrary to this Kolam girls had experienced a decrease is the growth pattern during 13 and 14 years of age group. Overall age and sex specific nutritional status of studied population shows 15.01% boys and 18.35% girls are in CED III respectively, 16.22% boys and 19.32% girls are in CEDII respectively, 31.71% boys and 2.72% girls are in CEDI respectively, 36.07% boys and 33.33% girls are normal respectively and 0.96% boys and 1.69% girls are in overweight respectively. Poverty, socio-economic condition of family like poor house infrastructure, insufficient food, no sanitation, low income, low education, and these all reasons affects to nutritional status of an individual as well as of a population also. Immediate appropriate nutritional intervention programs are needed for implementation among this ethnic group. Thus, there is a clear need to focus health policies.

Acknowledgments

Authors wish to thank all the villagers, village head, children and all those who helped to get data and information and voluntarily participated in the present study.

Authors' contributions

KB, MG, SD and KB contributed equally to this manuscript.

Conflict of Interest

The authors state that there is no conflict of interests regarding the publication of this paper.

Corresponding author

Subal Das, Department of Anthropology and Tribal Development, Guru Ghasidas Vishwavidyalaya, Bilaspur, Chhattisgarh, India
e-mail address: dsubalvu@gmail.com

References

ACC/SCN 2000 Ending malnutrition by 2020. An agenda for changes in the millennium. Food Nutr Bull 21(3):70–73.

Agarwal, KN, Tripathi AM, Sen S, Kaliyar GP. 1974. Physical growth and adolescence. Indian Pediatr 11:93–97.

Bose K, Chakraborty F. 2005.Anthropometric characteristics and nutritional status based on body mass index of adult Bathudis. A tribal populationof Keonjhar District, Orissa, India. Asia Pac J Clin Nutr 14(1):80–82.

Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. 2000. Establishing a standard definition for child overweight and obesity worldwide: International survey. Brit Med J 320(7244):1240–43.

Cole TJ, Flegal KM, Nicholls D, Jackson AA. 2007. Body mass index cut offs to define thinness in children and adolescents: International survey. Brit Med J 335 (7612):194–97.

Dakshayani B, Gangadhar MR. 2015. Nutritional status of Hakkapikki and Iruliga-Tribal children in Mysore District, Karnataka. Ind J Res Anth 1(1): 15–24.

Eveleth PB, Tanner JM. 1990. Worldwide variation in human growth. 2nd edition. Cambridge: Cambridge University Press.

FAO 2013. The state of food insecurity in the world The multiple dimensions of food security. Rome: The Food and Agriculture Organization of the United Nations 1–52.

Garrow JS, Webster J. 1985. Quetelet's index (W/H^2) as a measure of fatness. Int J Obesity 9: 147–53.

Grifiths PL, Bentley MB. 2001. The nutrition transition is underway in India. J Nutr 131(10): 2692–700.

Gong, EJ, Heald FP. 1994. Diet, nutrition and adolescence. In: ME Shills, JA Dlson and M Shike, eds. Modern nutrition in health and disease. 8th edition. Philadelphia: Lea and Febiger. 759–69.

Hamill PVV, Drizd TA, Johnson CL, Reed RB, Roche AF, Moore WM. 1979. Physical growth: National Center for Health Statistics percentiles. Am J Clin Nutr 32(3):607–29.

Indian Council of Medical Research. 2010. Nutrient requirements and recommended dietary allowances for Indians. A Report of the Expert Group of Indian Council of Medical Research. Retrived from http://icmr.nic.in/final/rda-2010.pdf on 02/12/16

Indian Council of Medical Research. 2014. Tribal Health Bulletin 20 (Special issue), Jabalpur, India. 21(1) Retrived on 03/12/2016.

International Institute for Population Social Sciences (IIPS) and ORC Macro 2000 National Family Health Survey – 1998–99 Mumbai, India. Retrieved from http://www.dhsprogram.com/pubs/pdf/FRIND2/FRIND2.pdf on 03/12/16.

Rotimi C, Okosun I, Johnson L, Owoaje E, Lawoyin T, Asuzu M, Kaufman J, Adeyemo A, Cooper R. 1999. The distribution and mortality impact of chronic energy deficiency among Nigerian men and women. Eur J Clin Nutr 53(9):734–39.

Khalidar V. Yadav S, Agrawal KK, Tamboli S, Banerjee M. Cherian A, et al. 2015. Revised IAP Growth Charts for Height, Weight and Body Mass Index for 5- to 18-year-old Indian Children. Indian Pediatr 52:47–55.

Khan MR, Ahmed F. 2005. Physical status, nutrient intake dietary pattern of adolescent female factory workers in urban Bangladesh. Asia Pac J Clin Nutr 14(1):19.

Martorell R, Rivera JA, Kaplowitz H, Pollitt E. 1992. Long-term consequences of growth retardation during early childhood. In: M Hernández and J Argente, eds. Human growth basic and clinical aspects. Amsterdam: Elsevier Science Publishers BV. 143–49.

De Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. 2007. Development of a WHO Growth references for school-aged children and adolescents. Bull World Health Organ 85(9):660–67.

National Family Health Survey (NFHS-2), 1999 NFHS-2, 1998-99,International Institute of Population Sciences, Mumbai, India. 1–438. Retrieved from http://www.dhsprogram.com/pubs/pdf/FRIND2/FRIND2.pdf on 09/11/16

Pelletier DL, Frongillo EA. 2003. Changes in child survival are strongly associated with changes in malnutrition in developing countries. J Nutr 133(1):107–19.

Shetty PS, Henry CJ, Black AE, Prentice AM. 1996. Energy requirements of adults: an update on basal metabolic rates (BMR) and physical activity levels (PALs). Eur J Clin Nutr 23(1):S11–S23.

Siddiq O, Bhargava A. 1998. Health and nutrition in emerging Asia. Asian Dev Rev 10(1):31–71.

Spurr GB, Barac-Nieto M, Maksud MG. 1977. Productivity and maximal oxygen con-

sumption in sugar cane cottons. Am J Clin Nutr 30: 316–321.

Tanner JM. 1962. Growth at adolescence: with a general consideration of the effects of hereditary and environmental factors upon growth and maturation from birth to maturity. 2nd edition. Oxford: Blackwell Scientific Publications.

Verboeff FH, Le Cessie S, Kalanda BF, Kazemba PN, Broadhead RL, Brabin BJ. 2004. Post neonatal infant mortality in Malawi: The importance of maternal health. Ann Trop Paediatr 24(2):161–69.

Venkaiah K, Damayanti K, Nayak MU, Vijayaraghavan K. 2002. Diet and nutritional status of rural adolescents in India. Eur J Clin Nutr 56(11):1119–25.

Waterlow JC, Schurch B. 1994. Causes and mechanism of linear growth retardation: Proceeding of IDECG workshop. Eur J Clin Nutr 48(1):S1–S16.

Weiner JS, Lourie JA. 1969. Human Biology. Handbook no. 9, Oxford and Edinburgh: Blackwell Scientific Publication.

World Health Organization. 1995. Physical status: the use and Interpretation of anthropometry. Tech. Rep 854, Geneva, Switzerland: World Health Organization. 1–463. Retrieved from http://apps.who.int/iris/bitstream/10665/37003/1/WHO_TRS_854.pdf on 05/11/16.

World Health Organization. 2010. Nutrition Landscape Information System (NLIS) Country Profile Indicators Interpretation Guide, WHO Document Production Services, Geneva, Switzerland 1–38. Retrieved from http://apps.who.int/iris/bitstream/10665/44397/1/9789241599955_eng.pdf on 05/11/16. 20.01.16