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ASSOCIATION BETWEEN PHYSICAL GROWTH INDICATORS, NUTRITIONAL STATUS, SICKLE CELL ANAEMIA AND MALARIA AMONG SCHOOL GOING TRIBAL AND NON-TRIBAL CHILDREN OF URBAN JAGDALPUR, CHHATTISGARH

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ABSTRACT

This study was aimed to find out the prevalence of Malaria, Sickle cell anaemia and malnutrition and to investigate the complex interaction of these parameters among school going tribal and non-tribal children of malaria endemic area of district Jagadalpur, Chhattisgarh. In the present cross-sectional study, 277 (Tribal= 150; Non-tribal =127) school-going children aged 13-19 year were selected (using conventional method) from schools of Jagadalpur District of Chhattisgarh State. To find out current nutritional status among participants, an anthropometric approach was used and all measurements were taken using standard techniques and instruments. All participants were also screened for malaria infection using microscopy (100 X oil immersions) with well stained Giemsa smears (thick and thin). Sickle cell status was examined by haemoglobin electrophoresis methods. The Sahli's hemoglobinometer was used in examination of anaemia status of participants. Overall 72% of children were found malnourished, out of which 20 children had HbAS and only 1 child had sickle cell diseases (HbSS haemoglobin variant). As compared to state and nation level, the growth and nutritional status of the present sample was found to be poor with respect to weight, height, BMI and other anthropometric measurements. Among school-going tribal and non-tribal children, statistically significant differences ($p<0.05$) were observed in sitting height, skinfold thickness and body fat percentage. Difference in age-wise prevalence of malnutrition between tribal and non-tribal children were not significant ($p>0.05$). However, in their nutritional status a statistically significant difference ($p<0.05$) was found between Haemoglobin variants (AA, AS and SS). At the time of investigation none of the screened children had malaria infection. The findings of study support the contention that sickle cell carriers and patients have, to some extent, a protection against malaria infection. Complete blood profiles of screened participants indicated that7 6.5% of school-going children were anaemic, out of which 51.04% were girls and 37.6% boys. All parameters of health and nutrition show that the studied population requires more focus on improvement of their health and nutritional status, especially

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among sickle cell anaemic patients.

Key words: Body Mass Index, Hb % , HbAS, HbSS, HbAA and Malaria.

INTRODUCTION

India is among one of the developing countries with a large population of 1.2 billion (Census of India, 2011). There is wide population diversity on the basis of caste, class, ethnicity, religion, languages, residence status, education status, life standard, living pattern, etc. Worldwide, India accounts 17.5% (1, 21, 0569, 573) of the world's population, out of these 10, 4281,034 are classified as Scheduled tribe with 5, 2409,823 males and 5, 1871,211 females. The tribal population of India constituted 8.6% of total population of the country. The tribes of Chhattisgarh, like those from other parts of country, depend on the forest area, which provides them food and lively hood. But the civilization and developmental processes, have gradually invaded the forest area, depriving tribal community of their major means of sustenance. Thus the tribal populations are confronted with poverty, food insecurity, unemployment, poor health and poor state of nutritional, susceptibility to many vectors born diseases and several genetic disorders. Several studies, research communications and government reports show that malaria, genetic diseases (such as sickle cell anaemia), malnutrition and another common communicable and non-communicable diseases have significant role in increasing the rate of morbidity and mortality among tribes. In spite of efforts, like food security programme, nutritional rehabilitation programme, intervention programme for malaria and others, hundreds of children and tribal population die due to these diseases and malnutrition. Scanty information, data and research are available to understand the role of nutrition and its association with these diseases with respect to rate of mortality.

Many previous studies shows that large percentages of child deaths related to malaria are attributed to malnutrition and deficiencies of many micronutrients (Steketee, 2003). The nutritional status of individuals, strong burden of malaria and sickle cell anaemia influence each other (Nyakeriga et al., 2004, 2005; Hyacinth et al., 2013; Zaccheus et al., 2008; Hyacinth et al., 2010; Reed et al., 1987; Enwonwu and Lu, 1991; Gray et al., 1992; Kennedy et al., 2002). Nutritional status also influences susceptibilities to malaria and affect the course of infection (Shankar, 2002). Previous studies in developing countries indicate that the individuals generally fail to achieve their genetically determined potential growth because of poor diet and infections caused by many diseases (Ulijaszek, 1994). A lot of studies have already documented the presences of micro- and macro-nutrient deficiency among individuals with sickle cell anaemia and their possible association with their immune system, their nutrition and growth and their dietary habits allowances for age and sex (Bao et al., 2008; Fraker, et al., 2000; Heyman et al., 1985; Heyman et al., 1992; Leonard Zem et al., 1998; Nelson et al., 2002; Borel, et al.,1998; Buison et al., 2005; Serjeant et al., 2001, Silva and Viana, 2005; Prasad and Cossack ,1984; Waugh, 2005; William et al., 2004).

Kumar and Gautam (2015) found that the waist circumference, hip circumference, skinfold and body fat have significant stake in BMI; whereas the other somatometric and physiological characteristics had little role in deciding the BMI among bidi workers. Kumar and Gautam (2016) conducted nutritional study among Scheduled Caste women of Banda District where they found that, among educated women, the BMI is largely influenced by anthropometric (body weight, arm circumference, hip circumference, waist circumference) and physiological (body fat percentage, BMR, total energy expenditure and adiposity index) determinants whereas it was least influenced by socio-demographic variables.

In order to elucidate the complex web of interactions between nutritional status, sickle cell anaemia and malaria, a cross-sectional study was undertaken in Malaria endemic district of Jagdalpur of Chhattisgarh State. The present study aimed to investigate the prevalence and association between physical growth and nutritional status, malaria and sickle cell anaemia among school-going tribal and non-tribal children of Jagdalpur District. The present study also tries to find out the difference in physical growth and nutritional status among tribal and non-tribal individuals in the population under investigation.

MATERIALS AND METHODS

The present study was conducted during October 2016 - December 2016 in urban area of district Jagadalpur (Bastar, Chhattisgarh). It is geographically located at 19.070 North and 82.030 East. The district Jagadalpur has a tropical savanna climate, which provides enough breeding ground for Mosquitoes and Malaria transmission throughout the year. The majority of the population of the area belonged to tribal communities. They are endogamous groups of the population who marry within their community. This type of practice also enhances the probabilities of high prevalence of sickle cell anaemia and other genetic disorders among them. Major proportions of tribal as well as non-tribal population of studied area were engaged with their traditional jobs, agriculture practices, and daily wages jobs. So, they are more susceptible for malnutrition, specially their children and mothers. A large proportion of tribal individuals live in Malaria endemic area, so they were susceptible more to malaria infection and other communicable and non-communicable diseases. To fulfil the objectives of present study, the data were collected from school-going tribal and non-tribal children of 13+ years of age from schools of district Jagdalpur, Chhattisgarh. All information was recorded into pretested semi-structured interview schedule. The anthropometric and clinical measurements were done with pretested and lab certified instruments. To assess the clinical examination, blood samples were collected with approved technique by well trained technician of NIRTH. All the participants were weighted using digital weighing machine, heighted and other body length measurements were taken with the help of Galaxy Anthropometric rod, body circumference were taken by Scala girth measuring tape and all skinfold thickness were measured by Holtain skinfold dial callipers. For clinical examination, 4 ml. of whole blood sample was drawn with syringe through venepuncture, using antecubital vein and dispensed into EDTA, and was used for screening of Malaria, Sickle cell anaemia, level of Haemoglobin percentage and complete blood profile.

The infection of Malaria and its type among children were screened by microscopy with well stained Giemsa smears (thick and thin) using 100X oil immersion. Parasite densities were recorded as a ratio of parasite to white blood cell (200 WBCs) from thick smear.

The Haemoglobin variants of participates were determine using haemoglobin electrophoresis by cellulose acetate membrane. The percentage of haemoglobin was estimated by Sahli's hemoglobinometer.

Physical growth and nutritional status of tribal and non-tribal children were determined using anthropometrical indexes, body mass index, skinfold thickness, fat percentage, basal metabolic rate and resting metabolic rate. The collected data were processed and analysed with the help of SPSS V.16 and MS. Excel.

RESULTS

In a present cross sectional study 277 (Tribal= 150 ; Non-tribal =127) school-going children were screened and measured for their current health and nutrition status. Majority (72%) of them (non-tribal= 69.2% and tribal = 75%) were found malnourished. Analysis of t-test shows that significant statistical difference ($p<0.005$) exists between tribal and non-tribal school-going children in their physical growth and nutritional measurements like sitting height, skinfold measurements (biceps, triceps, sub-scapular, and supra-iliac) and in percentage of body fat. The average body weight was found to be 42.24±7.9 kg among tribal and 42.17±7 kg among non-tribal children. Similarly mean height was recorded as 155.3±8.86 cm among school-going tribal children and 154.7±8.8cm among non-tribal children. Further, as is clear from Table-1, among them no statistically significant difference ($p>0.05$) were estimated in mean BMI (17.61±2.6 of tribal and 17.44±2.5 of non-tribal), mean BMR (for tribal children 1292.4±162.7 kcal/m2/h and for non-tribal children 1308.3±131.4kcal/m2/h) and RMR (for tribal children 1305.6±142.6 kcal/m2/h for non-tribal children 1326.2±153 kcal/m2/h) of tribal and non-tribal children, respectively. Table 2 shows that statistically significant change ($p<0.05$) in level of nutritional status (malnutrition and nutritionally normal) existed between AS and SS haemoglobin screened children. Therefore, out of 274 children, 10.4% and 0.4% were screened with AS and SS haemoglobin variant, respectively. 71.0% of them were found malnourished. The prevalence of malnutrition as compared to nutritionally normal was significantly high in all screened type of haemoglobin variants. Age-wise prevalence of malnutrition is displayed in Figure 1. The age-wise prevalence of malnutrition was highest among 16 year old children of both non-tribal (31.8%) and tribal (31.2%) groups the prevalence decreased with increasing age. There were insignificant differences ($p>0.05$) in prevalence of malnutrition among tribal and non-tribal children. The distribution of current nutritional status among different schedule tribe is displayed in Figure 2. It was found that the prevalence of malnutrition was higher in Halba tribe (83.3%) followed by Bhatra (78%), Dhurwa (69.9%), Gond (64.7%) and Muria (62.6%), tribes. The percentage of nutritionally normal tribal children was highest in Muria (37.5%) followed by Gond (35.5%), Dhurwa (30.4%), Bhatra (22%) and Halba (16.7%) tribe.

The p-value indicates that there is a significant difference ($p<0.05$) in nutritional status between Halba tribe and Muria tribe. In the present study, all children were also screened for malaria infection but none of the participant had malaria infection. Consequently, the present findings were unable to show any association between malaria, sickle cell anaemia and nutritional status. On the basis of haemoglobin estimation, 76.5% of school-going children were found anaemic, out of them, 51.04% were girls and 37.6% boys. Among AS and SS children, the average volume of haemoglobin quantified among malnourished children was 9.92±1.6 g/dL and nutritionally normal children 10.0±2.3 g/dL. The Independent sample t-test shows the statistically insignificant difference ($p>0.05$) in haematological parameter like Hb %(-0.445), WBC (0.101), PLT (1.07), HCT (-1.2), MCV (-0.251) and RDW (0.023) between nutritionally normal and malnourished children (Table 3).

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Table-1: Independent Sample t-test for anthropometric measurements among tribal and non-tribal children

Measurements	Tribal (N=150)	Non-tribal (N=127)	p-value
Body weight	42.24±7.9	42.17±7.0	0.94
Height	155.3±8.86	154.7±8.8	0.57
Acromian Height	128.5±7.8	128.3±7.11	0.80
Sitting Height	78.6±6.1	80.2±4.8	0.022
Shoulder Height	53.75±6.0	54.3±6.4	0.397
Sitting Knee Height	46.45±4.10	45.6±3.8	0.11
Mid Upper-arm circumference	22.7±3.3	22.57±3.6	0.761
Neck circumference	30.07±3.8	30.16±3.5	0.846
Head circumference	53.04±4.1	52.5±5.1	0.393
Chest circumference	73.3±6.8	74.11±6.8	0.85
Waist circumference	68.9±8.5	68.8±8.2	0.93
Hip circumference	66.62±9.2	66.5±9.0	0.92
Biceps skinfold	6.3±3.03	7.4±3.0	0.004
Triceps skinfold	8.38±3.44	10.05±4.04	0.001
Sub-scapular skinfold	8.3±2.7	9.2±3.3	0.014
Supra-iliac skinfold	9.4+4.03	10.5±4.1	0.022
Calf skinfold	11.6±4.2	12.3±4.0	0.199
BMI	17.44±2.5	17.61±2.6	0.58
Fat%	16.59±6.4	18.78±6.5	0.006
BMR	1308.3±131.4	1292.4±162.7	0.36
RMR	1326.2±153	1305.6±142.6	0.24

Table-2: Association between sickle cell status and nutritional status

Sickle Cell Status	Screened children(%)	Nutritional status	
		Normal N (%)	Malnutrition N (%)
AA	244 (87.8%)	66 (26.6%)*	178(71.7%)*
AS	29 (10.4%)	9 (31.03%)*	20(65.5%)*
SS	1 (0.4%)	-	1(100%)
Total	274	74(27.8%)	1991.9%)

*Three screened children with HbAE were not included

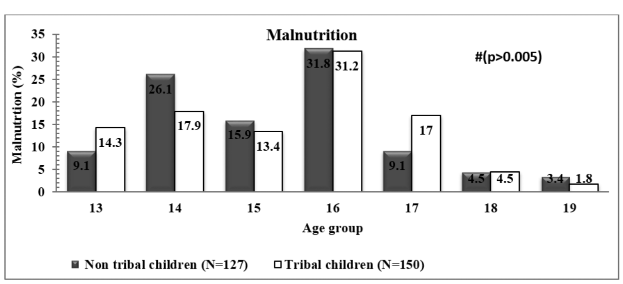

Figure-1: Age wise malnutrition among tribal children and non-tribal children

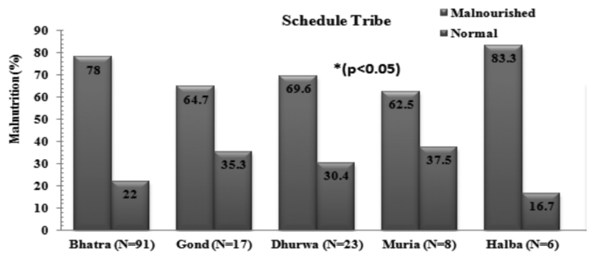

Figure 2: Caste wise distribution of nutritional status.

Table-3: Independent sample t-test for haematological parameters between AS and SS children with respect to nutritional status

Haematological parameters	Malnourished children (N=21)		Normal children (N= 9)		t-value	p-value
	Mean	SD	Mean	SD		
WBC	7.95	1.4	7.90	1.6	0.101	0.92
RBC	4.65	0.6	5.2	1.3	-1.981	0.05
PLT	318.7	66.1	292.8	80.6	1.07	0.28
HCT	34.7	7.2	37.90	7.88	-1.2	0.205
MCV	72.41	11.3	73.2	6.6	-0.251	0.803
RDW	30.60	10.9	30.5	12.7	0.023	0.98

*WBC: White Blood Cell; RBC: Red Blood Cell, HCT: Hematocrit:, MCV: Mean Corpuscular volume; PLT: Platelet; RDW: Red Blood Cell Distribution Width

DISCUSSION

The present study was aimed to find the prevalence and association between sickle cell anaemia, malaria and physical growth and nutrition status of children. It was also aimed at testing the hypothesis that sickle cell anaemia disease and its trait protected individuals from malaria infection. We also made an effort to find out the difference in physical growth and nutritional status between sickle cell carrier and disease children.

The prevalence of malnutrition was very high, i.e. 72%, and it was higher in tribal children as compared to non-tribal children. The prevalence of malnutrition among school-going tribal and non-tribal children was also higher than state, national level estimates and other tribal groups of India like Baiga children (males 55.8% and females 62.9% ; Chakma et al., 2006 and 2014); Bharia children (males 31.6% and females 39.4%; Dolla *et al*., 2006), Saharia children (female 42.4% and males 59.1%; Ghosh-Jerath *et al*., 2003). But the incidence was lower than Kathodia boys (90.0%; Adak *et al.,* 2006); Dongriakhonda girls (72.0%; Bulliyya, 2006), Kutia Khonds (88.9% ; Bulliya *et al.,* 2002), and Lanjiasaoras (89.4%; Bulliya *et al*., 2002).

Only 76.5% of school-going children were found to be anaemic and out of them 51.04% were girls and 37.6% boys. The average Hb% of screened AS and

SS children was found among malnourished children to be 9.92±1.6 g/dl and 10.0±2.3 g/dl. among nutritionally normal children. The present proportion of anaemia prevalence was lower than that of Andaman and Nicobr tribe (94.3%) (Rao *et al.,* 1998), Onge tribe (86.6%) (Rao *et al.,* 2006); Jenu Kuruna school going children (77.7%) (Prabhakar and Gangadhar, 2009), Bharia males (89.8%) (ICMR, 2010), Saharia females (90.1%) (Ghosh-Jerath *et al.,* 2013). But it was higher than Birhors (56.2%) (Chhotray, 2004) Chuktia Bhunjias (60.5%) (Chhotray, 2004); of Dongria Khond females (70.3%) (Bulliya *et al.,* 2004) and Juang of Muda speaking tribe (48.8%) (Chhotray, 2004).

Statistically significant change was found in the level of nutritional status between AA, AS and SS children. None of them was having malaria infection at the time of investigation.The prevalence of sickle cell anaemia of screened children was lower than many previously studied populations, such as tribes of Andhra Pradresh- Bagatha 12.4% (Babu *et al.,* 2002), Bagatha of Viskhapatnam 14.4% (Haritha *et al.,* 2014), Kolom of Adilabad 14.4% (Ramesh *et al.,* 1979), Koyadara of Godawari 24.2% (Sudhakarbabu *et al.,* 1980), Manne 23.4% and Pardhan 34.7% of Andhra Pradesh (Babu et al 2002), Irule 26.2% and Kurumba 22% of Niligri Hill (Saha *et al.,* 1976; Lehman and Cutbrush, 1952 and Mohanty *et al.,* 2010, respectivily), Moolu Kurumba 26.7% and Paniya 26.3% of Tamil Nadu (Mohanty *et al.,* 2010 and Lehmanna and Curtbrush, 1952, respectively), Bade hatra (16.3%), Bison horn (18.5%) Muria (15.9%), San Bhatra (19.3%), Hill Maria (20%) and Halba (27.2%) of Bastar. But on the other hand, the prevalence was found to be higher than Bastar tribes, viz. Dhurwa 3.45% (Negi 1976); Oraon 2.1%, Kawar 0.91% of Ambikapur and Kawar of Raipur 5.5% (Sathe et al 1987), Gond of Chindwara 4.3% (RMRCT Jabalpur, 2009), Yerukula 0.8% and Yerukula 1.7% of Andhra Pradesh (Goudand Rao, 1977, 1979 and 1980; Babu *et al.,* 1980); Toda of Nilgiri Hill 3.57% (LehmanandCutbrush 1952); Malayali 7.52% (Negi 1976); Kattunayakam of Wayanad of Kerala 3.8% (FerozeandAravinda 2001) and Oran of Jalpugri 0.9% (Saha *et al.,* 1988).

The findings of this study indicate that there is a significant difference between sickle anaemic and normal population in their rate of physical growth and nutrition. Among Sickle cell anaemic patients an increased demand for macro- and micro-nutrients deficiency is responsible for poor nutrition and physical and cognitive growth. The present findings also support this argument. Among sickle cell anaemic patients, deficiency of a variety of micronutrient is generally found, which include Iron, Zinc, Copper, Folic acid, Pyridoxine and Vitamin E, etc. Therefore, there is also a need to find out the deficiency of these micronutrients and its association with physical growth and nutritional status of sickle cell anaemic and non-sickle cell anaemic school-going children of the population under study for improving their health and nutritional status.

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