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Human Biology Review (ISSN 2277 4424) 3 (4) 2014
Original scientific paper (Thakur and Gautam pp 364-383)
Revised and Accepted on September 30, 2014

Prevalence of undernutrition among School going boys (5-18 years) of a Central Indian city (Sagar)

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Citation: Thakur R and Gautam RK. 2014. Prevalence of undernutrition among School going boys (5-18 years) of a Central Indian city (Sagar). Human Biology Review, 3 (4), 364-383.

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ABSTRACT

Indian children are susceptible to undernutrition because of wide spread disparity, poverty and illiteracy. Present study aimed to assess the prevalence of under nutrition among school-going boys and to compare the findings with international reference i.e. NCHS and WHO. A total of 300 boys of age group of 5–18 years were selected. Height-for-age, weight-for-age and body mass index for age were used to evaluate their nutritional status. Z- score and composite index of anthropometric failure were computed. The study reveals that age wise mean body weight, height and BMI has increased with age. Present studied boys were lighter in body weight and shorter in stature than the reference population (NCHS). Similarly Body mass index of the present studied boys indicate low mean BMI than the reference population (WHO). It was found that 6.3% of boys were stunted, 4.3% were underweight and 3% were undernourished, whereas as per composite index of anthropometric failure a total of 10% boys were undernourished. For better understanding about the situation of undernutrition among central Indian boys, the findings of present study are compared with other studies among Indian children and children of other developing nations and found that the incidences of undernutrition among present studied boys are significantly lower; still 10% boys were found undernourished which indicate that the nutritional programme like supplementary diet to pre-school children and mid-day-meal to school going children of primary standard need more attention evaluation and proper monitoring.

Keywords: *Stunting, wasting, undernourished, BMI, CIAF, Z-Score.*

INTRODUCTION

Undernutrition among children is common in India and other developing countries. Therefore, the prevalence of undernutrition is a significant area of concern and it is often considered as a major public health problem in developing countries (Ashworth 1996; Antwi 2008; Khor 2008). According to an estimate approximately 800 million individuals being reportedly undernourished worldwide and a little under one-third (258 million individuals) are concentrated in South Asia (Gaiha 1997).

Undernutrition continues to the principal cause of ill-health and premature mortality and morbidity among children of developing countries (Pelletier 1998; Nandy et al. 2005; Uthman and Aremu 2008). It has been estimated that approximately 70% of the world's malnourished children live in Asia, giving that region the highest concentration of worldwide childhood malnutrition (Khor 2005). Poverty is considered to be a major underlying cause of such widespread undernutrition (Vella et al. 1992; Sachs and McArthur 2005; Ramachandran 2007). In India, given its large population size and widespread poverty, a majority of individuals are undernourished and underprivileged (Ramachandran 2007; Antony and Laxmaiah 2008). Further, in the world, the occurrence of undernutrition is highest among Indian children (Bamji 2003) and it has been estimated that more than half of Indian children are undernourished (Measham and Chatterjee 1999).

A significant study carried out in India by the Indian Council of Medical Research (1972) also pointed to the various socio-economic factors that have important roles in the prevalence of undernutrition among children. This was further corroborated in the subsequent studies (Rajaram et al. 2003; Rao et al. 2004; Som et al. 2006, 2007).

Children are considered to be a very susceptible group and a limited number of studies have been carried out among those in the age group 5–18 years, especially in India. It has been opined that chronic undernutrition during this period is linked with slower cognitive development and serious health impairments in later life that subsequently reduce quality of life (Scrimshaw 1995). The prevalence of undernutrition during childhood is considered to have highly detrimental effects on health in those children, who survive to adulthood (WHO, 1995). Therefore, studies are needed to document the prevalence of undernutrition among such vulnerable children.

Central India is demographically lagging behind and prone to many ills including wide spread poverty and illiteracy; which lead to many health problems among different sections of population. Undernutirtion among children is one of such problem which has given least attention. Based on the above hypothesis, the present study is an attempt to assess

the prevalence of undernutrition among boys of age group of 5–18 years of age; and to compare the present findings with international reference data of NCHS and WHO.

Anthropometry is the universally applicable, inexpensive and non-invasive technique available to researchers for the assessment of the size and proportion of the human body (WHO 1995) and is a very useful tool in the assessment of growth and nutrition (Gorstein et al. 1994; Hamieda and Billot 2002). The technique of anthropometry has been successfully utilized by different researchers to assess and document the growth and nutritional status of various human communities, including those from India (Sharma and Sharma 1992; Bailey and Ferro-Luzzi 1995; Deurenberg-Yap et al. 2000; Mehta and Shringarpure 2000;Misra et al. 2001; Khongsdier 2002; Rao et al. 2006; Zerfu and Mekasha 2006; Gautam et al., 2006, Bharati et al. 2007; Semproli and Gualdi-Russo 2007; Gautam 2007a and 2007b; Bisai et al. 2008; Bose et al. 2008; Chowdhury et al. 2008; Olivieri et al. 2008; Mondal and Sen 2010a & b; Gautam et al., 2013). A sizeable number of these studies are on the assessment of nutritional status pertaining to children and adults.

In this investigation, Nutritional status of children were assessed through standardized indices like: body mass index, height for age, weight for age, Body mass index for age, Z-score and composite index of anthropometric failure (CIAF).

The three anthropometric indicators of childhood undernutrition are stunting (low height-for-age), underweight (low weight-for-age) and wasting (low weight-for-height). Recently a new composite index, namely the Composite Index of Anthropometric Failure (CIAF) has been proposed and utilized to study childhood undernutrition (Svedberg, 2000). Under nutrition in young children is conventionally determined through measurement of height. Stunting is an indicator of chronic undernutrition, the result of prolonged food deprivation and/or disease or illness. Wasting is an indicator of acute undernutrition, the result of more recent food deprivation or illness. Underweight is used as a composite indicator to reflect both acute and chronic under nutrition.

SUBJECTS AND METHODS

The sample for the present study was collected from ten schools of Sagar Town of Sagar district of Madhya Pradesh State of central India. The sample consists of 300 boys aged 5-18 years of age. Purposive sampling method is adopted for the selection of the school. Those schools were given priority which has good strength of boys belonging to 5-18 year of age. The subjects were selected purposively and due care was taken to include only those subjects who were physically and mentally normal and did not suffer from any apparent illness, which may reflect their normal process of growth and development. The anthropometric

measurements were taken during the month of September to December 2013. Before taking measurements the ethical consent were obtained from the school authorities, as the subject were minor.

Age estimation: In connection with the studies like present one, the information on correct age of children is extremely important. If the age of children is doubtful the result is completely misleading. For the present study, age was ascertained in completed year of each subject through school admission records. If the sample was 5 year and 6 month old, it refers to 5 year, at the same time, if he refers to 5 year 7 months, and then the age was rounded up to 6 year.

Anthropometric measurements: Height and weight were taken on each child following the standard procedure as described by Gibson (1990). The measurements were taken with all possible caution maintaining uniformity and accuracy in the techniques, after undergoing extensive training. Portable digital weighing machine and anthropometer rod were used to measure the children. After taking measurement, the data was entered into an excel worksheet, where the data was filtered and cross checked to remove the errors, some of the calculation for indices were done in Excel worksheet. All the anthropometric measurements taken were weighted with TEM (Technical Error of Measurement). After that the data was transferred to SPSS file for its further calculations and analysis.

Z-Score: *Z* -scores is a statistical measure to support the anthropometric findings, it has been widely used to assess the nutritional status such as under nutrition (e.g., underweight, stunting and wasting) and over nutrition. In the present investigation, for calculation of Z-score, age wise mean and SD is considered as reference because every population may vary in their growth and nutritional pattern because of their unique genetic and environmental setup. Therefore, considering the reference of other populations i.e. National (Indian/Chinese)/Continental (Asia/African/European) or International (WHO/NCHS) for calculation of Z-score may mislead the result.

Composite index of anthropometric failure: Z-score provides information about stunting, underweight and wasting, which is based on indices of height-for-age (stunting), weight-for-age (underweight) and weight for height (wasting). None of these three index is able to provide a comprehensive estimate of the number of undernourished children in a population; some children who are stunted will also have wasting and/or be underweight; some children who are underweight will also have wasting and/or be stunted; and some children who have wasting will also be stunted and/or underweight. To solve this problem Svedberg (2000) have suggested a new index known as Composite Index of Anthropometric

Failure (CIAF) in which children with wasting, stunting or who are underweight, they all are considered as undernourished, or to be in a state of "anthropometric failure". This index incorporates all undernourished children.

Svedberg's model identifies six groups of children and Nandy et al. (2008) made seven groups of children and here we made eight groups of children.

Group	Description (state of nutrition)	Underweight	Stunting	Undernourished
A	No failure	No	No	No
B	Underweight only	Yes	No	No
C	Underweight and stunting	Yes	Yes	No
D	Underweight, stunting, and Undernourished	Yes	Yes	Yes
E	Under weight and undernourished	Yes	No	Yes
F	Stunting and undernourished	No	Yes	Yes
G	Stunting only	No	Yes	No
H	Undernourished only	No	No	Yes

RESULTS

Age wise mean and standard deviation of body weight and height of the boys studied alongwith NCHS (National centre for health statistics) reference data and difference between the NCHS data and present study are presented in Table 1. It was found that mean body weight and height had increased with age. Lowest weight 15.3 kg was found for 5 years of age and highest weight 52 kg was found for boys of 18 years of age. Similar results was found for stature; lowest mean height 103.4 cm was recorded for 5 years of boys and highest mean height 166.1cm was found for 18 years of age.

Height for Age: Age wise mean of height of present studied boys were compared with NCHS (National center for Health Statistics) data as shown in Table 1 and Figure 1. It is apparent that the present studied boys have short stature than the reference population (NCHS). During early childhood the difference is less but after 13 year of age; it started increasing and the difference had widened; as apparent from the boys of 5 year of age. The average difference between reference population and present studied population is 6.5 cm; whereas for boys of 13 year of age, this difference is 11.3 cm. Further, the highest difference in mean of height was found 12.7 cm for boys of 15 year of age. In this way, it can be concluded that the boys of central India, in general have short stature at all ages as compared to NCHS reference data.

Table 1. Age wise mean of body weight and height among school going boys of central India and their comparison and difference with NCHS reference data.

Age	N	Height (cm)				Body weight (Kg)			
		Mean	SD	NCHS	Difference	Mean	SD	NCHS	Differences
		Present study				Present study			
5	20	103.4	6.7	109.9	6.5	15.3	2.1	18.7	3.4
6	22	108.4	6.6	116.1	7.7	16.6	2.0	20.7	4.2
7	23	112.9	7.3	121.7	8.8	18.3	2.8	22.9	4.6
8	23	118.7	7.8	127.0	8.3	19.5	3.1	25.3	5.8
9	23	122.7	9.4	132.2	9.5	21.9	5.0	31.4	9.5
10	23	129.6	5	137.5	7.9	24.8	3.5	35.3	10.5
11	22	134.9	6.3	143.3	8.4	27.4	4.4	39.8	12.4
12	22	141.5	11	149.7	8.2	30.7	7.4	45.0	14.3
13	20	145.2	5.3	156.5	11.3	33.8	5.7	50.8	17.0
14	22	151.0	8.9	163.1	12.1	37.3	7.3	56.7	19.4
15	20	156.3	8	169.0	12.7	40.0	6.9	62.1	22.1
16	20	161.2	7.3	173.5	12.3	46.3	5.7	62.7	16.4
17	20	164.0	11	176.2	12.2	51.1	7.8	66.3	15.2
18	20	166.1	5.8	176.8	10.7	52.0	6.4	68.9	16.9

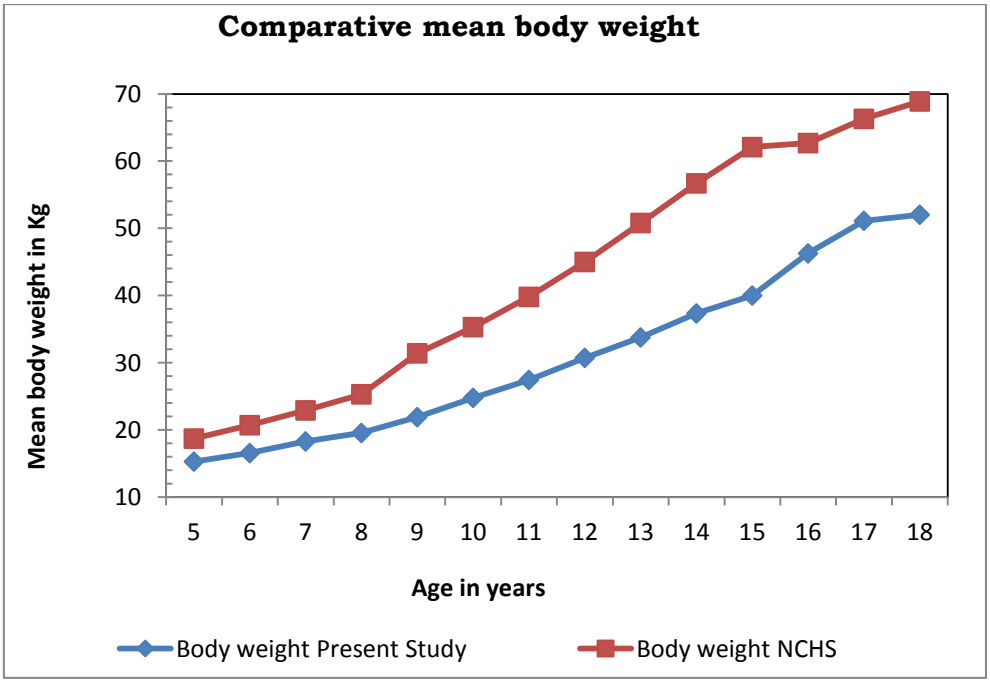

Figure 1. Comparative line graph of mean weight for age among school going boys of 5 to 18 year of age of central India and NCHS.

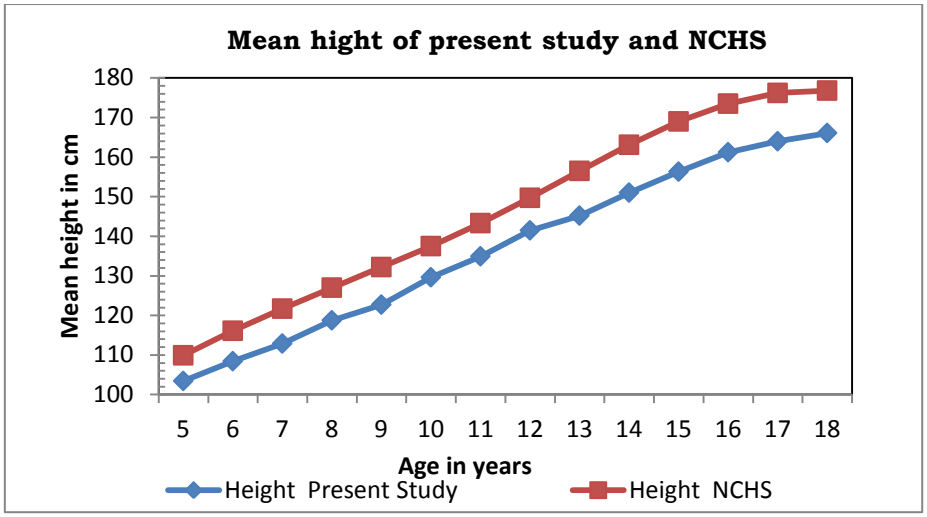

Figure 2. Comparative line graph of mean height for age among school going boys of 5 to 18 year of age of central India and NCHS.

Table 2. Age wise mean and Standard deviation of Body mass index (BMI) among school going central Indian boys alongwith comparison and difference with WHO reference data

Age	Present study			Mean BMI (WHO)	Difference
	N	Mean BMI	SD		
5	20	14.2	0.8	15.3	1.0
6	22	14.1	1.0	15.3	1.2
7	23	14.3	1.0	15.5	1.2
8	23	13.8	1.6	15.7	1.9
9	23	14.4	1.8	16.1	1.7
10	23	14.7	1.4	16.4	1.8
11	22	15.0	1.4	16.9	2.0
12	22	15.1	1.8	17.5	2.4
13	20	15.9	1.9	18.2	2.3
14	22	16.2	1.7	19.0	2.8
15	20	16.3	1.8	19.8	3.5
16	20	17.8	1.2	20.5	2.7
17	20	19.0	1.9	21.1	2.2
18	20	18.8	1.9	21.7	2.9

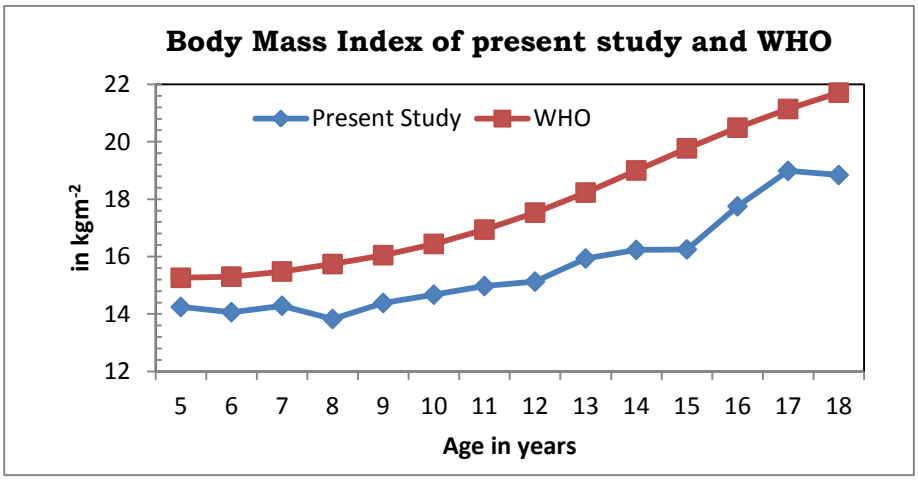

Figure 3. Comparative line graph of body mass index for age among school going children of 5 to 18 year of age.

Weight for Age: Age wise mean body weights of present studied boys are compared with NCHS (National center for Health Statistics) data as shown in Table 1 and Figure 2. It is apparent that the present studied boys have low mean body mass than the reference population (NCHS). During early childhood the difference is less but after 8 year of age it started increasing and the difference had broadened; as evident from boys of 5 year of age, the average difference between reference population and present studied population is 3.4 kilogram (kg) which increased with an increment of 1 kg per annum. For children of 9 year of age the average difference was found 9.5 kg and; the highest difference in mean body weight was found 22.1 kg for boys of 15 year of age. In this way, it can be concluded that the boys of central India have low body weight at all ages and it increases as they grow.

Body Mass Index: The body mass index (BMI) is accepted as one of the best indicators of the nutritional status. It is also considered as appropriate tool for assessment of nutritional status in a country with immense diversity like India. Therefore in the present study, body mass index was calculated to assess the nutritional status. Age wise mean body mass index of studied boys are presented in Table 2. The lowest mean BMI was found 13.8 Kg m^{-2} for boys of 8 years of age, whereas 14.2 Kg m^{-2} for boys of 5 year of age. The highest mean BMI was 19 Kg m^{-2} for boys of 17 years of age; whereas 18.8 Kg m^{-2} for boys of 18 year of age. It is evident that the mean BMI had increased with age, except for 8 and 18 year of age. The highest SD recorded is ±1.9 for 13, 17 and 18 year of age, whereas lowest SD is ±0.8 for 5 year of age.

Table 3: Distribution of boys according to Z-score for Height for age, Weight for age and BMI for age

Z-Score	Height for age		Weight for age		BMI for age	
	N	%	N	%	N	%
-3	1	0.3	1	0.3	2	0.7
-2	18	6.0	12	4.0	7	2.3
-1	74	24.7	76	25.3	76	25.3
0	112	37.3	127	42.3	129	43.0
1	71	23.7	56	18.7	60	20.0
2	21	7.0	23	7.7	22	7.3
3	3	1.0	5	1.7	3	1.0
4	-	-	-	-	1	0.3
Total	300	100.0	300	100.0	300	100.0

Table 4. Nutritional status among school going boys aged 5-18 years

Category	**N**	% of Boys
Stunted	19	6.3
Under Weight	13	4.3
Undernourished	9	3.0
CAIF	30	10.0

Table 5. Subgroups of anthropometric failure among school going girls aged 5-18 years.			
Group Name	**Description**	**N**	**%**
A	No failure	270	90.0
B	Underweight only	3	1.0
C	Underweight and stunting	7	2.3
D	Underweight, stunting, and Undernourished	1	0.3
E	Under weight and undernourished	2	0.7
F	Stunting and undernourished	0	0.0
G	Stunting only	11	3.7
H	Undernourished only	6	2.0
	CIAF	30	10.0

Body mass index for age: Age wise mean BMI of present studied boys is compared with WHO (World health organization) data as shown in Table 2 and Figure 3. It is apparent that the present studied boys have low mean BMI than the reference population (WHO). During early childhood the difference is less but after 11 year of age, it starts increasing and the difference had widened as they grow. Among the boys of 5 year of age the average difference between reference population and present studied population is 1 kg m^{-2}. Highest difference in mean BMI was found 3.5 kg m^{-2} for boys of 15 year of age. In this way, it can be concluded that the school going boys of central India have low BMI at all the ages and it increases as they grow.

Stunting: In the present investigation it was found that 6.3% boys were stunted, they are below – 2 Z-score, approximately 93% boys were found normal in their growth for height (Table 3 and Figure 4).

Wasting: It is evident from Table 3, a total of 4.3% boys were underweight. They fall below -2 Z-score, whereas 25.3% boys were categorized below -1 of Z-score; and approximately, 94% boys were found normal in their growth for weight (Table 4 and Figure 4).

Undernourished: Table 3 reveals that 3% boys are undernourished those belong below -2 of Z-score, 25.3% boys are -1 of Z score and 96 % boys have normal nutritional status.

Composite Index of Anthropometric Failure (CIAF): Table 4 reveals that of stunting, underweight and under nourished and CIAF among aged 5-18 years of boys. It is apparent that 6.3% of boys were stunted, 4.3% were underweight and 3% were undernourished, in this way, a sum of 10% boys are under CIAF or it can be concluded that the prevalence of under nutrition among studied population was 10%.

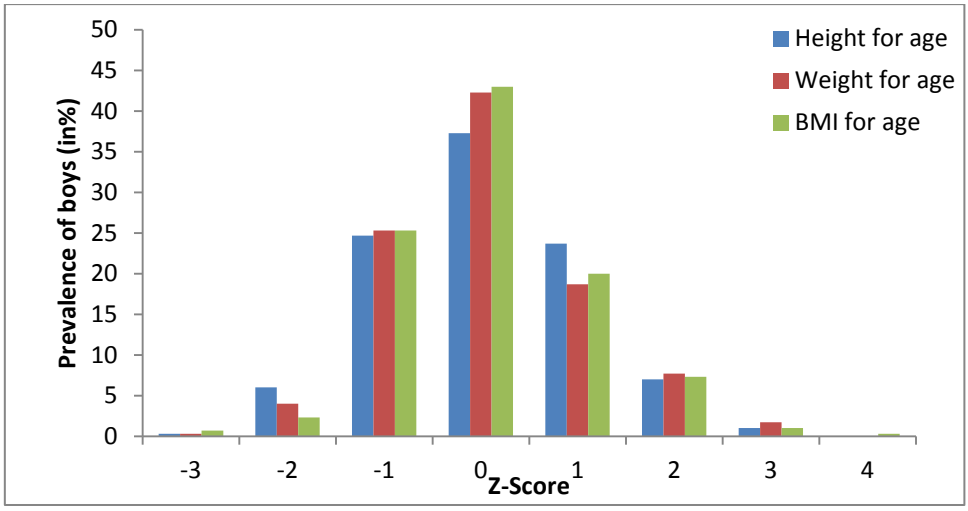

Figure 4. Height for age Z-score among school going boys of 5-18 year of age

Table 5 and figure 7 shows the proportions of boys in each of the eight subgroups with undernourished children, group A consist of no failure is 90%. Group B constitute underweight only, which was 1 %. Group C constitute underweight and stunting, it was 2.3%. Group D constitute underweight, stunting and undernourished which were 0.3%, Group E constitute underweight and undernourished which were 0.7%, Group F constitute stunting and undernourished there were no boys under this category, Group G constitute only stunting, it was 3.7%, Group H constitute only undernourished which were 2%, and total CIAF were 10% boys.

DISCUSSION

India is a land of youths and children. According to population reference bureau (2013) a total of 30% population in India are <15 year of age. Undernutrition among children is wide spread in the country. The assessment of undernutrition in the present study was based on indices of height-for-age (stunting), weight-for-age (underweight) and weight for height (wasting). Conventionally, these indices reflect certain distinct biological process and determining appropriate nutritional interventions (WHO 1995). The indices of height-for-age and weight-for-age reflect chronic and acute undernutrition, respectively. The weight-for-age index is used to observe underweight and it is composite measure documenting both chronic and acute undernutrition (Mishra et al. 1999). In the present study, the interpretation of three indexes was done in context of international reference population to determine the prevalence of undernutrition, as recommended by the World health organization (WHO) (Dibley et al. 1987). The justification for use of a reference population is the empirical finding that well-nourished children in all communities follow very similar growth patterns (Habicht et al. 1974). The nutrition foundation of India also advocated the use of the WHO standard to be

applicable to Indian children. Hence the reference values from the National Centre of Health Statistics (NCHS) (WHO 1983) have used in the present investigation. To determine the nutritional status of children, the WHO has recommended the use of Z-score indicators (Waterlow et al. 1977; Dibley et al. 1987). The severity of undernutrition is assessed by utilizing the Z score. The boys with Z-score -2 were classified as suffering from stunting, underweight and wasting.

The children suffering from stunting may be underweight and/or wasted. Similarly, the children suffering from wasting may be stunted and/or underweight. Further, a child can be stunted, underweight as well as wasted. In such a condition, there are chances of under reporting. None of three indices is able to provide a comprehensive estimate of the number of undernourished children in a population. To solve this problem Svedberg (2000) have suggested a new index known as composite index of anthropometric failure (CIAF) in which children with wasting, stunting or who are underweight are all considered undernourished, or to be in a state of "anthropometric failure". This index incorporates all undernourished children, be they wasted and/or stunted and/or underweight. For present investigation, CIAF is computed. It was found more appropriate alongwith height-for-age (stunting), weight-for-age (underweight) and weight for height (wasting).

Hence, in the present study compound techniques of assessment of undernutrition were used to find out the prevalence of undernutrition among central Indian boys and the technique was found useful.

In the first step, the age wise mean of body weight, height and BMI is compared with the international reference data of NCHS and WHO. In the second step, indices of height-for-age, weight-for-age and weight for height were computed to find out the prevalence of three distinct biological processes i.e. stunting, underweight and wasting. And, finally the undernourished boys were assessed by CIAF.

For better understanding of the global scenario of stunting, underweight and wasting among children Nandy and Miranda (2008) have used (DHS) data (ORCMacro, 2006) of seven countries to compare the CIAF with conventional indicators of stunting, wasting and underweight. The rates of undernutrition according to each indicator were calculated from z-scores provided for children aged 0-35 months by them. They found that the rates of stunting and wasting are highest in India and Ethiopia; and lowest in Bolivia and Peru. Further, underweight is highest in India and Nepal, and lowest in Bolivia and Peru. The CIAF, which they have used to assess overall undernutrition, shows India and Ethiopia have the highest prevalence rates. The difference between the CIAF and underweight is more than 10% points

in almost every case. Other studies among Indian children corroborate this finding as Mondel and Sen (2010) have reported that among the children of 5-12 years of age of three communities of North Bengal the incidences of stunting, underweight and wasting were quite higher: Rajbanshi (35.85%, 37.40% and 13.60%), Bengali Muslim (33.70%, 43.80% and 26.61%) and Tea-labourer (41.67%, 50.85% and 23.46%). Chowdhury et al. (2008) were reported that the incidences of stunting and underweight among Santal children of Purulia district of West Bengal were 17.62% and 33.70% respectively. Similarly, Joseph et al. (2002) have reported 9.40% stunting and 31.20% underweight among children of Karnataka. Further the prevalence of stunting was reported 50% among the Kamar tribe of Chhattisgarh (Mitra et al. 2007), 54% among Oraon of North Bengal and tribal children of Bihar (Mittal and Srivastava 2006, Rao and Vijay 2006) and 45.80% among the children of West Bengal (Som et al. 2006).

The incidences of undernutrition obtained in the present study were found to be distinctly lower than those among tribal children of Madhya Pradesh (51.60% stunting, 61.60% underweight and 32.90% wasted) as documented by Rao et al. (2005) and among children of Rajasthan (53.00% stunting, 60.00% underweight and 28.00% wasted) as reported by Singh et al. (2006). Similarly, the incidences of wasting in present studied boys were found to be lower than the values reported from West Bengal (13.94%) and Assam (14.42%) by Som et al. (2006). In this way, the incidences of stunting, underweight and wasting among the boys of central India were found (6.3%, 4.3% and 3%) distinctly lower than all previous studies among the Indian children of different ethnic origin, socio-economic and geo-climatic conditions.

The prevalence of undernutrition observed in the present study was further compared with other reported values from various developing nations. It was found that the incidences of stunting and underweight among central Indian children is lower than those reported from Malaysian children (29.2% stunting, 26.1% underweight) by Marjan et al. (1998), Pakistani children (29.5% underweight) by Mian et al. (2002), Tibetan children (24.7% underweight) by Dang et al. (2004), Tanzanian children (31.6% stunting; 14.6% underweight and 2.9% wasted) and Kenyan children (4.5% wasted; 14.9% underweight; 30.20% stunted) (Matee et al. 1997; Chesire et al. 2008). Here, it should be noted that only wasting among Tanzian children is slightly lower than present one.

In the similar way, the prevalence of stunting was significantly lower among central Indian boys than those reported from children of Bangladesh (44%), Tibet (41.4%) and Indonesia (55%) by Rahman and Chowdhury (2007), Dang et al. (2004), and Hadju et al.

(1995), respectively. A similar result was reported in wasting and underweight (6% and 27%) among Kenyan children (Ngare and Muttunga 1999).

Finally, it leads to conclude that the overall situation of nutrition of children is improving. But, at the same time, it is also true that in most of the previous studies, the reference population used for estimation of stunting, underweight and wasting was international population (WHO/NCHS), whereas in present one we have used mean and SD of same population as reference to avoid genetic and environmental error. The second reason of such vast difference is the age group of children studied. In most of the previous studies, the age group was different for example the findings of Nandy and Miranda (2008) is based on children of 0-35 month of age; Mondel and Sen (2010) have studied the children of 5-12 years of age which lead to conclude that in early age of life the incidence of stunting, underweight and wasting were higher. Further, in the present study, it was found that in later age 12+ years, the difference in mean body weight, height and BMI had widened.

Another explanation of such vast difference in findings of present and previous studies is due to the difference in area and population. The country has wide diversity, especially in socio-economic and geo-climatic condition. And, beyond that there is wide ethnic variation. The tribal and rural children are obviously deprived section and the incidence of stunting, wasting and undernutrion is higher among them; whereas the present boys were drawn from the schools of a city. Then, this discussion leads to conclude that the cities are better place for children; where they have access to nutritious food and good health. And, it is true also; as most of the rural and tribal areas are depriving in many basic civic amenities viz. safe drinking water, proper communication and transport facilities, health services, schooling, sports etc. which have adverse impact on the growth and nutritional status of the children.

Conclusion

The Present studied boys are lighter in body weight and shorter in stature than the reference population (NCHS). During early childhood the difference was less but after 8 year of age, it starts increasing and the difference had widened at adolescence and later on. Similarly, in stature the difference had widened after 11 years of age. Further, the body mass index of the present studied boys indicates low mean BMI than the reference population (WHO). During early childhood the difference is less but after 13 year of age it starts increasing and the difference has widen.

On the basis of Z-score, it was found that 6.3% of boys are stunted, 4.3% are underweight and 3% were undernourished, in this way, the prevalence of under nutrition

among studied population was found a sum of 10% as they fall under CIAF or composite index of anthropometric failure. The findings of present study are compared with previous studies conducted among Indian children, as well as children of other developing countries and it was found the incidence of stunting, wasting and undernutrition is significantly lower among central Indian boys.

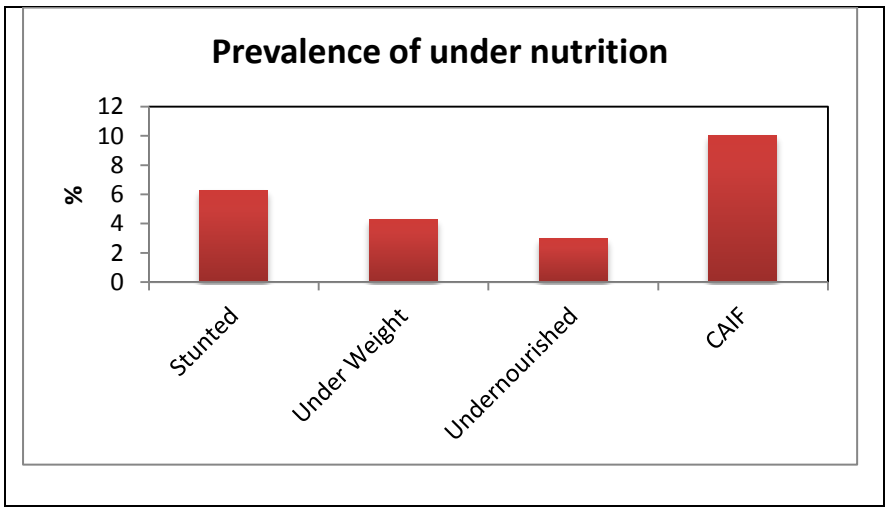

Figure 5. Nutritional status among school going boys aged 5-18 years

It should be noted that for calculation of Z-score inspite of international reference (NCHS and WHO); age wise mean and SD is considered as reference to avoid over reporting as well as to minimize the error of genetical and ecological differences; still 10% children are found undernourished is a matter of great concern.

The incidence of undernutrition among boys indicate that the nutritional programme like supplementary diet to pre-school children and mid day meal to school going children of primary standard need more attention, proper evaluation and monitoring.

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