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Nutritional status among boys and girls of a central Indian Town (Sagar)

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ABSTRACT: The prevalence of undernutrition is a significant area of concern in many developing countries, where it is a major public health problem. The aim of the study was to assess the prevalence of undernutrition among school-going boys and girls of central Indian city Sagar, MP. A total of 612 individuals (312 girls and 300 boys) aged 5–18 years were examined and compared to the NCHS reference data. The nutritional status was assessed using following anthropometric indicators: body height and weight, body mass index (BMI) and composite index of anthropometric failure (CIAF). It was found that girls were heavier (1 kg) and taller (2–5 cm) than boys up to 15 and 13 years of age, respectively. After that, boys became taller with 1 to 13 cm. The mean BMI of boys was higher to girls up to 10 year of age after that the trend was reversed. Comparison of the present findings with NCHS reference data revealed that Indian girls and boys were lagging behind. The difference in body weight between the reference data and the present sample was around 5 to 6 kg. The pattern of difference in body height revealed small amount during early childhood (6.6.cm and 9.6 cm in girls and boys 5 years of age). This difference more than doubled at the age of 14 years in girls 16.7 cm and in boys 17.5 cm ($p<0.01$). Similar pattern was found for BMI with 6.5 kg/m^2 and 6.3 kg/m^2 in 14 years old girls and 16 years old boys ($p<0.01$). Z-score values of weight-for-age, height-for-age and BMI-for-age revealed that that boys were more likely to be stunted than girls whereas girls were more likely to be underweight and undernourished than boys. In terms of CIAF 10.6% girls and 10% boys were undernourished. The results of the present study indicate that there is great need for implementation of health programmes to eliminate gender inequalities and improve children's health.

KEY WORDS: undernutrition, stunting, underweight, z-score, composite index of anthropometric failure

Introduction

The prevalence of undernutrition is a significant area of concern in many developing countries, where it is often considered as a major public health problem (Khor 2008). Of the approximately 800 million individuals being reportedly un-

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dernourished worldwide, almost one-third (258 million individuals) are living in South Asia (Gaiha 1997).

Undernutrition continues to the principal cause of ill-health and premature mortality and morbidity among children living in developing countries (Nandy et al. 2005). 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 wide spread undernutrition (Ramachandran 2007). In India, given its large population size and widespread poverty, a majority of individuals are undernourished and underprivileged (Ramachandran 2007).

Moreover, India shows the highest occurrence of childhood undernutrition in the world (Bamji 2003) and it has been estimated that more than half of Indian children are undernourished (Measham and Chatterjee 1999).

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 (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 (Marjan et al. 1998; Dang et al. 2004; Adak et al. 2006, Gautam et al. 2006, Mitra et al. 2007; Som et al. 2006; Gautam 2007a, 2007b, 2007c and 2008; Bisai et al. 2008; Nandy and Miranda 2008; Chesire et al. 2008; Mondal and Sen 2009 and 2010; Gautam and Thakur 2009; Thakur and Gautam 2014). A sizeable number of these studies are on the assessment of nutritional status pertaining to children.

Many studies have also pointed out to many socio-economic and socio-demographic variables that can play significant roles in the prevalence of undernutrition (Hien and Kam 2008). Such variables include family size, number of siblings, residence, family income and education. 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 to play in the prevalence of undernutrition among children. This was further corroborated in subsequent studies (Som et al. 2006 and 2007). A major issue that exists in India is discrimination against the female child, and it has been observed that girls in India were more affected by undernutrition than boys (Bose et al. 2007).

Children are considered to be a very susceptible group and a limited number of studies have been carried out in India among school age children 5–18 years. There is evidence 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 intensity of undernutrition among such vulnerable cohort of boys and girls from the developing countries.

There are few comparative studies on the prevalence of undernutrition among boys and girls residing in the same geo-

graphical and ecological region, identical amenities and infrastructural facilities. However, socio-economic parameters such as parents' education, dietary habits, living standard may differ between them. An increase in family size and number of siblings can lead to a lower allocation of food and resources to children, especially to girls. Thus, increase in family size and number of siblings can have the potential to play a negative role in the prevalence of undernutrition (Hien and Hoa 2009).

Based on the above observations, the present study attempted to assess the prevalence of undernutrition among school going children 5–18 years old and using the NCHS reference data.

Materials and Methods

The sample for the present study was collected from fourteen government schools out of which 7 were primary, 3 were middle, 1 high school and 3 higher secondary schools of the city of Sagar district of Madhya Pradesh State of Indian Union. The sample consisted of 612 individuals (312 girls and 300 boys) aged 5–18 years of age, representing the same socio-economic status and family background. Purposive sampling method was used for the selection of the school and the priorities were given to schools which had good strength of girls and boys aged 5–18 years. Eligible criteria were age, physically and mentally normal health status and lack of apparent illness, which may affect normal process of growth and development.

The anthropometric measurements were taken from September 2013 to February 2014. As the samples were drawn from the schools, prior written consent was obtained from District Education Officer (DEO) and the Principle/Head Master/Mistress of schools, who were immediate guardian of the students.

Chronological age was ascertained in completed year of each subject through school admission records and grouped into age categories using the mean age of the annual cohort. If the subject was 5 year and 6 month old, it referred to 5 year old group, at the same time the subject of 5 year 7 month old was classified to the age group of 6 year.

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 scale and anthropometer rod were used to measure the various anthropometric measurements. A semi-structured schedule was used to collect the information about socio-economic status and family background. A detailed description of the study is available elsewhere (Thakur and Gautam 2014).

After collecting data, the three conventional anthropometric indicators of childhood undernutrition were used: low height-for-age (stunting), low weight-for-age (underweight) and low BMI-for-age (undernourished or thinness) following calculation procedure provided by Thakur and Gautam (2014).

The severity of undernutrition was assessed by utilizing the z-score. Subjects with z-score –2 were classified as suffering from stunting, underweight and wasting.

For computation of composite index of anthropometric failure (CIAF), models developed by Svedberg's (2000) and Nandy et al. (2008) were used. Svedberg's model identifies six groups of

Table 1. Description of nutritional status: underweight, stunting and undernourished using the composite index of anthropometric failure (CIAF) and as adopted in the present study

Group	Description	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

children and Nandy et al. (2008) made seven groups of children. In the present study eight groups of children were distinguished as it is shown in Table 1.

All the analyses were done using MS-Excel and SPSS (trial version) software. Descriptive statistics were calculated and the Student *t*-test was used to establish whether significant differences existed between groups. The level of statistical significance was set at $p<0.01$.

Results

Table 2 shows descriptive statistics for body weight, height and body mass index across age groups for boys and girls separately. Girls were heavier than boys up to 9 years of age. Soon after reaching the age of 9 years, boys became heavier than girls. Girls were also taller than boys up to 12 years of age and after 13 years of age, boys exceeded girls becoming sig-

Table 2. Means and standard deviations of body weight, body height and body mass index by age and sex

Age	Sample size		Body weight (in kg)				Height (in cm)				BMI (in kgm^{-2})			
	Boys	Girls	Boys		Girls		Boys		Girls		Boys		Girls	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
5	20	20	15.3	2.11	15.3	1.5	103.4	6.7	105.8	6.3	14.2	0.8	13.7	1.1
6	22	24	16.5	2.00	17.6	2.5	108.4	6.6	111.7	7.4	14.1	1.0	14.1	0.9
7	23	22	18.3	2.76	19.2	3.4	112.9	7.3	117.3	6.7	14.3	1.0	13.8	1.3
8	23	21	19.5	3.14	20.8	3.9	118.7	7.8	120.4	6.9	13.8	1.6	14.2	1.5
9	23	28	21.9	5.02	22.6	3.1	122.7	9.4	125.5	6.0	14.4	1.8	14.3	1.1
10	23	21	24.8	3.52	25.0	3.8	129.6	5.0	130.7	6.4	14.7	1.4	14.6	1.1
11	22	23	27.4	4.41	28.6	6.1	134.9	6.3	137.2	7.9	15.0	1.4	15.1	2.0
12	22	23	30.7	7.36	33.2	6.4	141.5	11.0	142.4	7.2	15.1	1.8	16.3	2.6
13	20	22	33.8	5.71	35.8	6.5	145.2	5.3	144.6	7.2	15.9	1.9	17.0	2.3
14	22	21	37.3	7.26	34.7	6.3	151.0	8.9	145.1	6.4	16.2	1.7	16.4	2.0
15	20	20	40.0	6.93	41.0	6.2	156.3	8.0	151.4	5.2	16.3	1.8	17.8	2.2
16	20	20	46.3	5.69	40.2	7.8	161.2	7.3	148.6	5.6	17.8	1.2	18.2	3.3
17	20	25	51.1	7.84	45.3	6.6	164.0	11.0	153.2	6.5	19.0	1.9	19.2	2.1
18	20	22	52.0	6.38	43.7	5.1	166.1	5.8	153.0	6.3	18.8	1.9	18.7	2.0

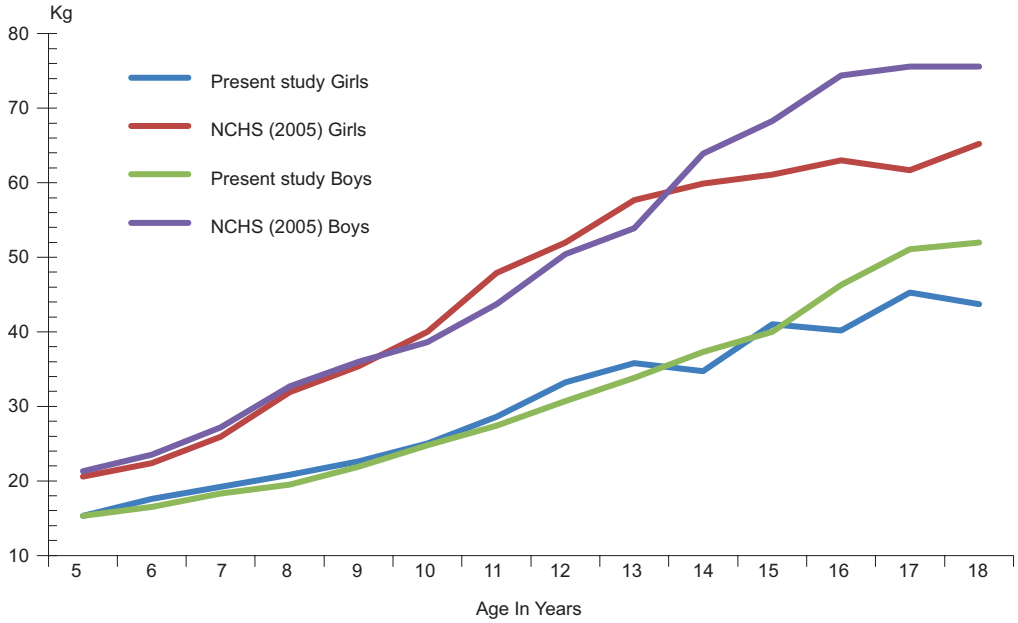

Fig. 1. Weight-for-age profiles of boys and girls from the present study plotted on the NCHS reference data

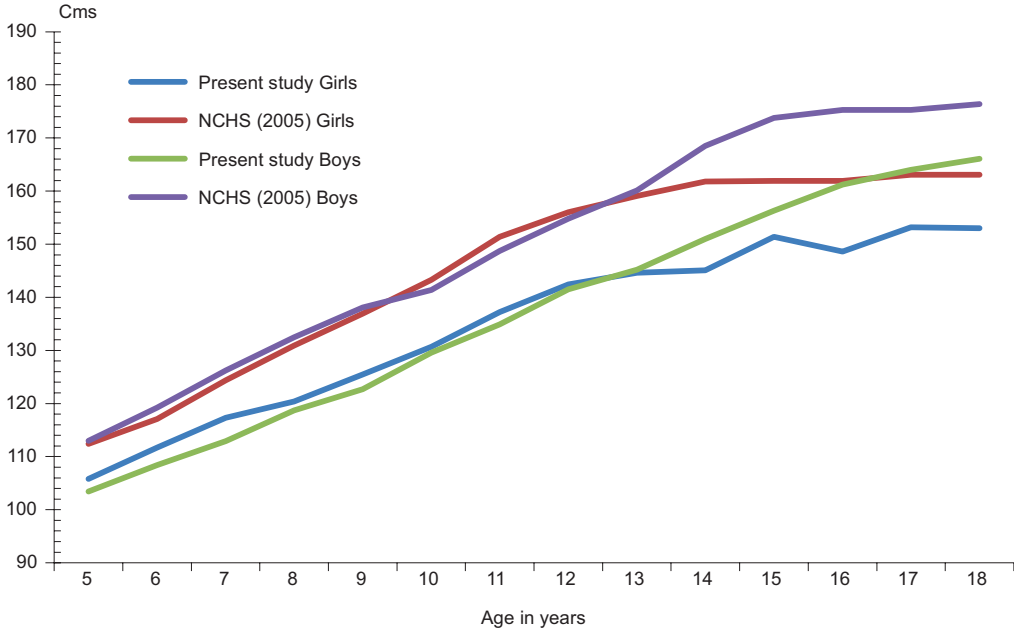

Fig. 2. Height-for-age profiles of boys and girls from the present study plotted on the NCHS reference data

Table 3. Weight-for-age, height-for-age and body-mass-index-for age of boys and girls from the present study and NCHS

Age	Body weight (kg)						Body height (cm)						BMI (kg/m²)					
	Girls			Boys			Girls			Boys			Girls			Boys		
	Present Study	NCHS (2005)	t-test	Present Study	NCHS (2005)	t-test	Present Study	NCHS (2005)	t-test	Present Study	NCHS (2005)	t-test	Present Study	NCHS (2005)	t-test	Present Study	NCHS (2005)	t-test
5	15.3	20.6	8.1	15.3	21.3	8.9	105.8	112.4	4.2	103.4	113.0	6.1	13.7	16.1	6.4	14.2	16.5	6.5
6	17.6	22.4	6.7	16.5	23.5	11.6	111.7	117.1	3.2	108.4	119.2	7.3	14.1	16.2	6.7	14.1	16.4	7.5
7	19.2	25.9	7.8	18.3	27.2	12.3	117.3	124.4	4.7	112.9	126.2	8.2	13.8	16.6	8.5	14.3	17.0	9.5
8	20.8	31.9	7.7	19.5	32.7	11.4	120.4	130.9	6.5	118.7	132.5	7.7	14.2	18.3	7.0	13.8	18.4	8.8
9	22.6	35.4	11.6	21.9	36.0	11.3	125.5	136.9	8.6	122.7	138.1	7.7	14.3	18.7	12.0	14.4	18.7	8.9
10	25.0	40.0	9.2	24.8	38.6	12.5	130.7	143.3	7.7	129.6	141.4	9.7	14.6	19.3	11.2	14.7	19.1	9.7
11	28.6	47.9	10.3	27.4	43.7	11.3	137.2	151.4	7.9	134.9	148.7	8.5	15.1	20.7	9.3	15.0	19.6	9.6
12	33.2	52.0	10.8	30.7	50.4	9.8	142.4	156.0	8.3	141.5	154.8	5.3	16.3	21.2	7.4	15.1	20.7	9.8
13	35.8	57.7	11.5	33.8	53.9	8.9	144.6	159.1	8.7	145.2	160.1	10.3	17.0	22.7	8.6	15.9	20.7	6.9
14	34.7	59.9	14.8	37.3	63.9	11.9	145.1	161.8	11.1	151.0	168.5	8.3	16.4	22.9	11.4	16.2	22.3	10.7
15	41.0	61.1	9.2	40.0	68.3	14.7	151.4	161.9	7.9	156.3	173.8	9.4	17.8	23.2	7.4	16.3	22.5	12.3
16	40.2	63.0	10.8	46.3	74.4	15.1	148.6	161.9	9.8	161.2	175.3	8.1	18.2	24.0	6.7	17.8	24.1	13.0
17	45.3	61.7	9.2	51.1	75.6	11.0	153.2	163.1	7.0	164.0	175.3	4.4	19.2	23.1	6.7	19.0	24.5	9.3
18	43.7	65.2	11.5	52.0	75.6	13.0	153.0	163.1	7.2	166.1	176.4	7.1	18.7	24.4	8.9	18.8	24.2	9.9

All the differences between present study and NCHS are statistically significant as indicated by value of Student *t*-test at $p<0.01$).

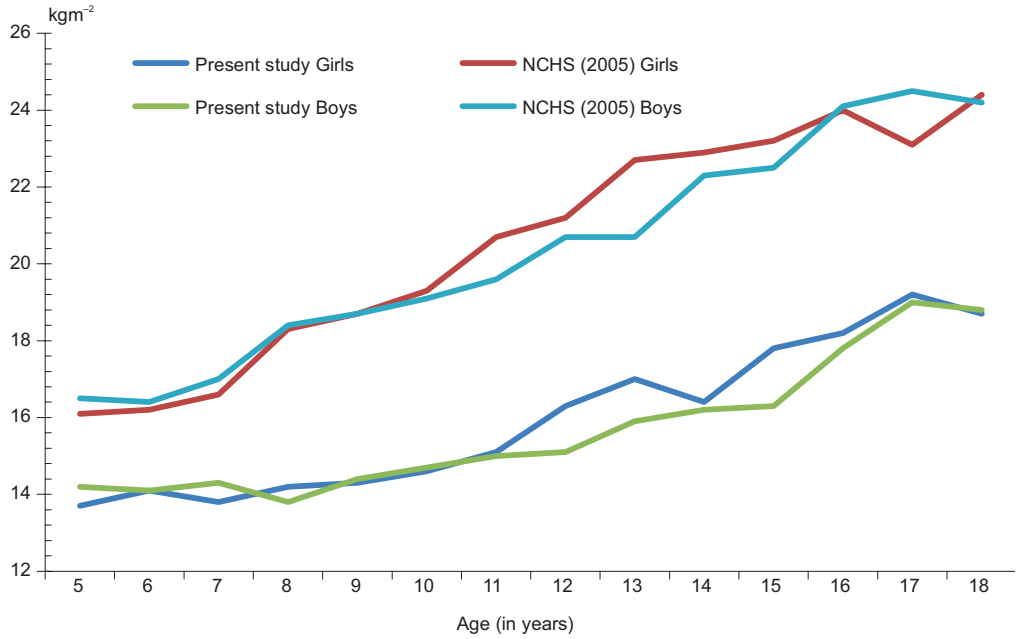

Fig. 3. Body mass index-for-age profiles of boys and girls from the present study plotted on the NCHS reference data

nificantly taller than girls. Similarly for BMI, lowest BMI was 13.7 kg/m^2 for girls aged 5 years and 14.1 kg/m^2 for boys at 6 years of age. The highest BMI was 19 kg/m^2 and 19.2 kg/m^2 in boys and girls at 17 years of age.

The statistical comparative analysis of the present body weight, height and BMI with NCHS (National Center for Health Statistics) data is shown in Table 3 and Figure 1, 2 and 3. Generally, Indian girls and boys were found thinner than the reference population (NCHS). The pattern indicated small difference in early childhood and continuously increasing differences from 8 years of age onward. The difference in body mass between reference population and the present sample was around 5 to 6 kg which increased with an increment of 1.5 to 5 kg per annum. Highest difference in mean body weight was found 25.2 kg for girls 14years of age and 28.3 kg for boys 15 years of age ($p<0.01$).

It is apparent (Table 3, Figure 2) that the present studied girls and boys had shorter stature than the reference data (NCHS). During early childhood the difference was small but after the 13 years of age it had further widen. As apparent, at age 5 years, the difference between the reference data and the present population was 6.6 cm and 9.6 cm for girls and boys. At 14 years of age, this difference was 16.7 cm and 17.5 cm in girls and boys and statistically significant at $p<0.01$.

Comparative data of NCHS and the present study for BMI are shown in Table 3 and Figure 3.

It is apparent that the pattern of differences between the present and the NCHS data is similar to the one above described. During early childhood, the

amount of difference was small, at 5 years of age, the difference was 2.4 kg/m^2 for girls and 2.3 kg/m^2 for boys; but after the age of 10 years it started increasing up to 18 years of age. The greatest difference in mean BMI was found for girls of 14 years old (6.5 kg/m^2) and boys of 16 years old (6.3 kg/m^2) ($p<0.01$).

In the present study, significant difference (chi-square=1.4; df=6; $p<0.05$) was found in stature of boys and girls, for further elucidation height-for-age (z-score) was computed. It was found that 6.3% boys and 5.4% girls were stunted (they fell below –2 SD). Similarly 1% girls and boys were taller than normal height as they fall +3 SD. Remaining children were normal in height-for-age. As evident from the chi-square test girls were less stunted than boys (Table 4).

The weight-for-age z-score analysis revealed lack of statistically significant difference between boys and girls (chi-square=2.7; df=6; $p>0.05$). It was found that 4.3% boys and 5.7% girls were underweight as they fell below –2 SD. Similarly 1.7% boys and 2.2% girls were overweight as they fell +3 SD. As apparent from the chi-square test this difference was significant (Table 4).

The BMI-for-age z-score analysis revealed similar pattern as describe previously with 3% boys and 4.1% girls being undernourished (falling below –2SD). Similarly 1.3% boys and 1% girls were overweight as they fell +3 SD. The remaining children were normal in BMI-for-age (Table 4).

Table 5 presents the age specific percentile distribution (10th, 25th, 50th, 75th, 90th and 99th) of body height, weight and BMI separately for girls and boys.

The findings did not reveal significant differences between boys and girls in the prevalence of various nutritional status indicators (chi-square=3.3; df=3; $p>0.5$) (Figure 4). The prevalence of stunted girls was 5.4% and boys were 6.3%; 5.8% girls and 4.3% boys were underweight, similarly 4.2% girls and 3% boys were undernourished. In this way, 10.6% boys and 10% girls were under composite index of anthropometric failure, that is boys were more stunted than

Table 4. Distribution of z-scores for height-for-age, weight-for-age and BMI-for-age among boys and girls from the present study

z-score	Height-for-age				Weight-for-age				BMI-for-age			
	Boys		Girls		Boys		Girls		Boys		Girls	
	N	%	N	%	N	%	N	%	N	%	N	%
–3	1	0.3	1	0.3	1	0.3	2	0.6	2	0.7	2	0.6
–2	18	6.0	16	5.1	12	4.0	16	5.1	7	2.3	11	3.5
–1	74	24.7	75	24.0	76	25.3	72	23.1	76	25.3	73	23.4
0	112	37.3	128	41.0	127	42.3	134	42.9	129	43.0	129	41.3
1	71	23.7	72	23.1	56	18.7	64	20.5	60	20.0	71	22.8
2	21	7.0	17	5.4	23	7.7	17	5.4	22	7.3	23	7.4
3	3	1.0	3	1.0	5	1.7	7	2.2	3	1.0	3	1.0
4									1	0.3		
Total	300	100	312	100	300	100	312	100	300	100	312	100
	χ^2=1.4				χ^2=2.7				χ^2=2.7			

χ^2 value for height-for-age is significant at $p<0.05$, df=6
χ^2 value for weight and BMI are insignificant at df=6 and df=7

Table 5. Percentile values of body height, body weight and BMI by sex and age

Age	Girls						Boys					
	Percentiles						Percentiles					
	10th	25th	50th	75th	90th	99th	10th	25th	50th	75th	90th	99th
	Height (cm)											
5	96.4	101.0	104.7	110.5	115.6	117.4	95.7	98.3	101.9	106.8	112.4	122.2
6	101.8	108.3	111.2	117.9	121.7	123.9	101.0	102.7	107.4	114.6	118.5	121.5
7	109.1	112.4	117.6	120.8	124.2	136.5	104.9	106.2	113.0	118.5	122.5	126.2
8	111.6	115.7	119.5	126.1	129.1	137.3	105.9	112.7	118.7	125.5	127.6	130.6
9	117.4	120.4	125.2	130.2	131.7	142.7	108.9	113.9	123.9	128.9	133.4	146.1
10	122.1	128.1	131.5	133.2	140.2	143.4	122.7	125.1	129.5	133.5	137.0	138.1
11	128.1	131.0	138.5	140.7	148.2	157.0	124.4	131.9	134.3	139.5	144.4	145.5
12	133.0	137.4	140.9	147.7	153.4	158.7	126.4	129.8	143.1	149.7	157.2	164.0
13	134.0	141.0	144.8	148.7	155.4	158.5	138.4	141.4	144.3	148.0	153.7	154.1
14	136.9	139.6	146.5	149.4	153.2	159.4	138.8	145.1	151.0	158.8	163.6	166.0
15	144.1	147.9	150.3	156.1	159.3	160.2	142.7	151.9	158.6	161.9	166.1	168.4
16	139.0	145.5	149.1	153.5	154.9	156.3	151.2	155.4	163.0	166.3	172.1	173.7
17	143.9	147.8	152.8	158.2	162.0	166.9	143.9	161.8	167.5	171.6	174.5	175.1
18	145.1	147.9	153.4	156.7	161.4	165.9	158.5	161.4	166.5	169.3	173.4	181.2
	Body weight (kg)											
5	12.5	14.6	15.5	16.3	16.8	18.1	13.0	13.7	15.1	16.0	18.0	21.9
6	14.6	15.6	18.0	19.8	20.8	20.9	13.7	15.1	16.4	18.3	19.5	20.5
7	14.9	16.2	18.8	21.5	23.5	27.7	14.5	15.9	18.6	20.1	22.5	23.0
8	16.4	18.6	20.0	22.5	25.9	33.3	14.9	18.0	19.0	21.7	24.7	25.0
9	18.6	20.6	22.7	24.1	26.0	32.9	16.5	18.1	21.4	22.9	30.4	35.8
10	20.0	22.3	25.1	27.6	29.7	35.4	19.5	22.5	24.2	27.5	29.5	32.1
11	21.9	24.3	27.8	31.8	39.8	44.0	21.1	24.2	27.4	29.2	35.1	35.7
12	24.9	26.8	32.8	38.1	43.9	45.6	21.9	23.8	30.9	36.4	41.7	48.5
13	25.8	31.2	35.9	40.6	44.1	49.6	27.5	29.6	32.5	37.3	44.4	48.2
14	28.2	30.8	32.7	39.7	45.0	47.9	28.2	31.5	36.5	42.0	48.8	55.2
15	32.6	37.1	40.9	44.0	51.3	55.5	30.6	33.3	42.3	45.1	48.2	49.0
16	29.1	35.8	40.4	42.4	53.2	62.5	39.8	41.5	46.5	50.5	55.7	57.2
17	35.7	39.5	47.5	49.7	54.6	57.5	38.6	43.5	52.4	57.9	60.5	64.1
18	36.4	38.9	45.0	47.6	49.0	52.3	44.5	47.8	49.9	57.8	60.9	67.3
	BMI (kg/m^2)											
5	12.3	12.9	13.9	14.5	15.6	15.9	13.4	13.7	14.2	14.9	15.4	15.5
6	12.8	13.4	13.9	15.0	15.4	15.8	12.7	13.1	14.2	14.9	15.4	15.6
7	12.4	13.0	13.6	14.8	15.4	16.4	13.2	13.8	14.1	15.0	15.7	16.4
8	12.4	13.5	13.9	15.1	17.2	17.8	12.1	12.8	13.5	15.0	16.6	17.1
9	12.5	13.7	14.6	15.1	15.4	16.1	12.8	13.1	14.0	14.9	16.8	20.4
10	13.3	13.9	14.5	15.1	16.5	17.2	12.7	13.4	14.8	15.7	16.9	17.4
11	12.4	14.1	14.8	16.6	17.8	19.7	13.2	13.9	14.7	15.9	17.2	17.6
12	13.3	14.3	16.7	17.2	20.2	21.8	12.6	14.0	15.1	15.9	18.1	19.5
13	14.1	15.1	16.7	18.8	21.1	21.7	13.8	14.7	15.4	17.3	18.9	20.7
14	13.4	15.0	16.0	17.8	19.1	20.8	14.2	14.7	16.4	17.0	18.8	20.4
15	15.5	16.3	17.7	19.0	21.1	22.7	14.1	15.3	16.3	17.8	18.6	19.2
16	14.8	15.7	17.5	18.9	24.9	26.7	16.2	16.9	17.6	18.2	20.0	20.8
17	16.4	17.5	19.0	21.2	22.2	22.9	16.0	17.6	19.3	20.0	21.2	23.3
18	15.4	17.6	18.5	19.9	21.7	22.5	16.9	17.5	18.5	19.9	22.9	23.4

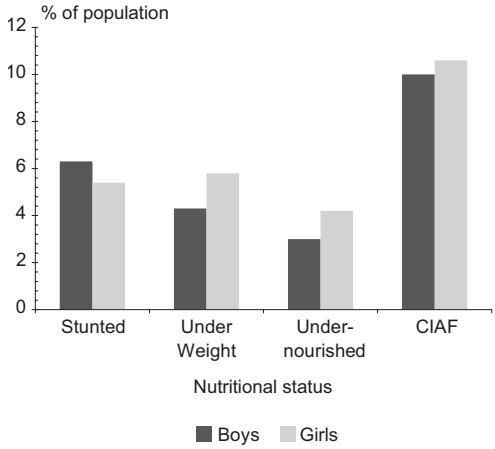

Fig. 4. Distribution of undernourished status indicators among school aged boys and girls from the city of Sagar (MP), India

girls; whereas, girls were more underweight and undernourished than boys.

Comparison of CIAF between girls and boys revealed insignificant difference (chi-square=6.7; df=8; $p>0.5$). Table 6 and Figure 5 revealed that 89.4% girls and 90% boys were falling under no failure, at the same time 10.6% girls and 10% boys were under CIAF. Furthermore, 3.7% boys and 2.9% girls were only stunted (the highest proportion in the subgroup). Similarly, 2.6% girls and 2.3% boys were underweight and stunted, whereas, 2.2% girls and 2% boys were only undernourished. There was no difference in subgroup D, which was considered most crucial in all subgroups.

Discussion

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 determine appropriate nutritional interventions (WHO 1995). The indices

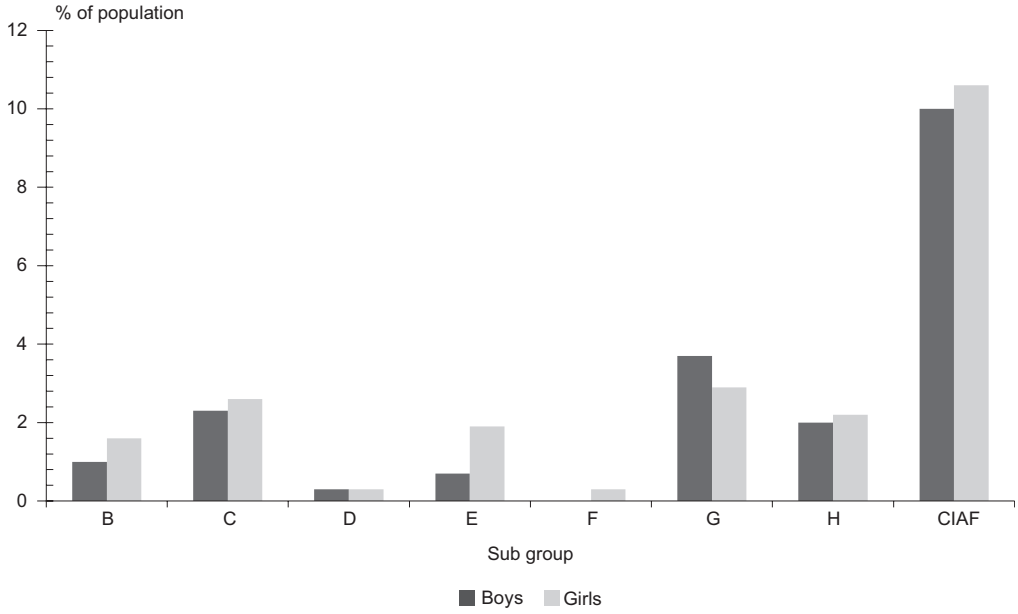

Fig. 5. Distribution of CIAF and its component among school going boys and girls from the city of Sagar (MP), India

Table 6. Distribution of school going boys and girls as per different state of undernutrition and composite Index of anthropometric failure (CIAF)

Group	Description	Boys		Girls	
		N	%	N	%
A	No failure	270	90.0	279	89.4
B	Underweight only	3	1.0	5	1.6
C	Underweight and stunting	7	2.3	8	2.6
D	Underweight, stunting, and Undernourished	1	0.3	1	0.3
E	Under weight and undernourished	2	0.7	6	1.9
F	Stunting and undernourished	0	0.0	1	0.3
G	Stunting only	11	3.7	9	2.9
H	Undernourished only	6	2.0	7	2.2
	CIAF	30	10.0	33	10.6

χ^2=6.7, df=8, insignificant

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 a 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 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, 2005) were 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). The severity of undernutrition was assessed by utilizing the z-score. The boys with z-score –2 were classified as suffering from stunting, underweight and wasting.

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. Furthermore, 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. Undernutrition among children is one of such problem which has given least attention (Thakur and Gautam 2014).

To understand 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. 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 as-

sess 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 (35.8%, 37.4% and 13.6%), Bengali Muslim (33.7%, 43.8% and 26.6%) and Tea-labourer (41.7%, 50.8% and 23.5%). Chowdhury et al. (2008) were reported that the incidences of stunting and underweight among Santal children of Purulia district of West Bengal were 17.6% and 33.7% respectively. Similarly, Joseph et al. (2002) have reported 9.4% stunting and 31.2% 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) 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 (51.6% stunting, 61.6% underweight and 32.9% wasted) as documented by Rao et al. (2005) and among children of Rajasthan (53% stunting, 60% underweight and 28% wasted) as reported by Singh et al. (2006). Similarly, the incidences of wasting in present studied boys and girls 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 and girls of central India were found distinctly lower than all previous studies among the Indian children of different ethnic origin, socio-economic and geo-climatic conditions.

In the present study, compound techniques of assessment of undernutrition were used to find out the prevalence of undernutrition among central Indian girls and boys.

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) (Chesire et al. 2008). Here, it should be noted that only wasting among Tanzanian children is slightly lower than present one.

In the similar way, the prevalence of stunting was significantly lower among central Indian children 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.

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 popula-

tion (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 and girls were drawn from the Government 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.

In present study, it was found that the girls are slightly more undernourished as compared to boys. In almost all Indian populations, boys have a better access to food and basic amenities than girls and there is pronounced preference for the male child (Kishor 1993). Numerous studies have also reported discriminations in diet and basic amenities against the girl child (Borooah 2004). Studies documenting nutritional status in India have further observed that girls were more affected by undernutrition than boys (Bose et al. 2007). Present study further corroborates these findings. Hence, inspite of other multisectoral effort to rid of from the problem of undernutrition, there is great need, to eliminate, the wide prevalent gender discrimination especially in states like Madhya Pradesh (Central India).

Conclusion

It can be concluded that the school going boys and girls of Sagar have significantly lower body weight, BMI and short stature at all the ages as compared to NCHS (2005) reference data. Boys are likely to be more stunted than girls whereas girls are more likely to be underweight and undernourished than boys. As per CIAF, girls are likely to be slightly more undernourished (10.6%) than boys (10%). The results of the present study indicate that there is great need for implementation of health programmes to eliminate gender inequalities and improve children's health.

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Authors' Contributions

The idea and vision behind the theme of paper was given by RKG, who has pivotal role in analysis and presentation of data. He trained RT for field work and data collection. He thoroughly edited and revised the paper before and after review. RT has executed the task; she obtained consent and collected data. She did analysis in the supervision of RKG. She prepared first draft of the paper and assisted RKG in revision of the manuscript. In this way, both authors were involved in data collection, analysis and drafting the manuscript and approved the final manuscript.

Conflict of interest

The authors declare that there is no conflict of interest.

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