



REFERENCE VALUES OF BODY FAT INDICES FOR SEMI URBAN CHILDREN AND ADOLESCENT OF BENGALEE ETHNICITY

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Abstract

Childhood overweight and obesity is a pandemic worldwide with a large population being affected in developed and developing countries. Increased prevalence of obesity defined by the use of body mass index has drawn attention towards direct measurement of body fat. To create gender specific percentile for body fat percentage (BF %), Total body fat mass (TBFM) and fat mass index (FMI) for screening adiposity of eastern Indian children and adolescent are the objectives of this study. The present study was conducted among 2869 school children having 6-18 years. BF % was calculated on the basis of anthropometric indices, Body mass index (BMI) consideration of age and sex. TBFM was obtained from body weight and BF% ($TBFM = [BF\% \times \text{body weight}] / 100$). FMI was obtained by dividing body fat mass with square of the height ($FMI [kg/m^2] = \text{body fat mass [kg]} / \text{height}^2 [m]$). In order to define clinically and epidemiologically useful cutoffs we adopted cutoffs -85th percentile to define the lower limit of over fat, 95th percentile as lower limit of obese and 2nd percentile as upper limit of under fat. These have been designed to yield similar proportions of overweight/over fat and obese children to the International Obesity Task Force (IOTF) body mass index cutoffs. Significant differences were noted for BF%, TBFM and FMI between boys and girls from 12 years onward where girl values were significantly higher than boy's counterpart. The median BF% increased little (22%) from 6-18 years of age in boys compared with that of girls (45%). The median values of TBFM and BFI increased rapidly with advancing age of boys and girls though the rate of increment was higher in girls than boys' counterpart. Direct measurement of adiposity, the component of overweight represents a significant advance over BMI. Percentile values being developed in this study would be useful in assessment of under-fat, over -fat and obese.

Key words: Children, adolescent, body fat percentage, body fat mass, body fat mass index

Introduction

Obesity is a universal disease of increasing prevalence with alarming proportions worldwide. It is also not uncommon in countries having illustration of hunger and chronic malnutrition as main public health problems (Silva et al., 2012). The incidence of obesity has increased rapidly over the past three decades, with the World Health Organization (WHO) recently issuing a warning that in the near future, obesity and diabetes will become serious issues even for developing countries (Prentice, 2005). Excess body fat is associated with heart disease, stroke, high blood pressure, type2 diabetes, abnormal blood lipid levels and the metabolic syndrome.

Childhood overweight and obesity is a virulent disease worldwide with a large population being affected in the developed countries (deOnis, 2012). The prevalence of obesity is also rising in developing countries (Wang and Lobstein, 2006). In India children prevalence of overweight has been reported to range of 9 to 27.5% and that of obesity from 1 to 12.9% (Wang and Lobstein, 2006; Khadikar et al., 2011). Many studies have increasingly emphasized the importance of body fat and central obesity in determining cardio metabolic risk in children and adolescents (Ribeiro et al., 2004). The lack of representative body composition reference values has limited their potential application in clinical and research settings.

The National Institute for health (NIH) and the World Health Organization (WHO) adopted similar body weight guideline for overweight and obesity (deOnis, 2012). Values of body weight adjusted for height referred to as body mass index (BMI). BMI in excess of 25 and 30 are considered to indicate over weight and obesity respectively. BMI tends to ignore the distinction between fat and fat free mass (Krebs et al., 2000). Thus BMI percentile change may not accurately reflect changes in adiposity in children over time as BMI does not take actual body composition in to account (Schutz et al., 2002). Fat mass index (FMI) can be potentially used as an indicator of adiposity as a substitute of BMI and is calculated by dividing total body fat mass with square of height (Pelts et al., 2010; Vanltallie et al., 1990).

Among the methods used to assess body fat, anthropometric indicators stand out and because they are inexpensive and noninvasive and have good accuracy, are recommended by the WHO for assessing the nutritional status and health risk of population (Tarnus et al. 2006). Body fat percentage (BF %) is usually assessed by anthropometry by measuring skin folds (Silva et al., 2012). The correct measurement of skin folds demands substantial time and requires a high degree of training and expertise of evaluators (Gore et al., 1996). This impairs the use of these measures in multidisciplinary epidemiological surveys that collect large amounts of data about a given population (Azevedo et al., 2005). Clinical studies have developed equations to assess BF% by means of anthropometric indicators of obesity, such as body mass index (BMI) and waist circumference (WC) which are more easily collected than skin folds (Deurenberg et al., 1991; Gallagher et al., 2000).

The obesity epidemic, at one time confined to adults, has now on track to affect the pediatric age range and shows the very sign of rapid escalation (Lobstein et al., 2004). Therefore it needs to generate a reference database for proper body fat composition of Indian children and adolescents for early detection of adiposity and thereby assessing cardio metabolic

risk. There is no reference data for body fat of Bengali Indian children and adolescents. Thus objective of the current study was to provide gender and age specific reference value for body fat indices.

Materials and Methods

Study subject: The present study was conducted among school children of 6-18 years studying in 8 schools in Hooghly district during their school hours. Prior permission in black and white of school authorities was taken. Written consent from the parents of the students chosen for this experiment was obtained. The subjects of this study were chosen at random irrespective of socioeconomic status and religion so that reflection of an overall picture of body composition could be achieved. All students who were willing to participate in the study were included in the study. They were invited to answer the questionnaires, which dealt with background information such as age, activity and illness. The students suffering from acute diseases or history of chronic or metabolic bone disease, physical disabilities and treatment with drugs influencing body composition such as cortisone treatment were excluded.

Measurement of body weight: Body weight was measured using bathroom scale accurate to 0.5kg. The scale was kept on a flat surface and adjusted with '0' mark. Now the subject was requested to step on it in bare feet. Weights were taken in light cloth. Weight was recorded to the nearest 0.5kg.

Measurement of body height: Height was measured using anthropometric rod. Height of the subject was recorded without footwear and expressed to the nearest 0.1cm.

Estimation of body mass index (BMI): BMI was calculated from the height and weight using following equation: $BMI (kg / m^2) = \text{weight (kg)} / \text{height}^2 (m)$. Weight status was determined using BMI.

Estimation of body fat percentage (BF%): BMI strongly correlate with BF% estimated by bioelectrical impedance. This relationship was curvilinear in nature and was significantly influenced by age and gender. Thus age and gender should be considered when BMI was used to predict body fat percentage (Ranasinghe et al., 2013). Body fat percentage was calculated on the basis of BMI on consideration of age and gender using Deurenberg equation (Deurenberg et al., 1991)).

Body fat% = $(1.51 \times BMI) + (0.70 \times \text{age in year}) - (3.6 \times \text{gender}) - 1.4$

[Where male = 1; female = 0]

Estimation of total body fat mass (TBFM): Body fat mass was obtained by multiplying body fat percentage by weight and then dividing by 100.

Body fat mass (kg) = $[BF\% \times \text{body weight (kg)}] / 100$

Estimation of fat mass index (FMI): FMI was obtained by dividing total body fat mass with square of the height.

$FMI (kg/m^2) = \text{body fat mass (kg)} / \text{height}^2 (m)$

Determination of body fat percentile: 5th, 10th, 25th, 50th, 75th, 85th and 95th percentiles values for BF%, TBFM and FMI were calculated for both boys and girls subject using ms excel. To evaluate the usefulness of BF%, TBFM and FMI subjects were classified into three group; group1:<85th percentile, group2: between 85th to 95th percentile; group3: >95th percentile with respect to their age and gender (Khadikar et al.2013). The 85th percentile and 95th percentile define lower limit of over fat and obese respectively (McCarthy et al., 2006).

Statistical analysis: The parameters taken were analyzed statistically to find out the mean and standard deviation. Student t test was used to estimate the significance of differences in means between the sexes at each age group. $P < 0.05$ was consider as significant. Reference graph for all body fat indexes were drawn from original percentile with the help of MS Excel.

Result

The number of subjects in reference data base according to age and gender is listed in table -1.

Table-1: Age wise distribution of children and adolescent boys and girls

Age (year)	Boys	Girls
6	60	60
7	60	60
8	130	81
9	146	64
10	184	82
11	179	76
12	342	116
13	235	151
14	178	141
15	118	85
16	50	54
17	50	50
18	52	65
Total	1784	1085

Mean BF%, body fat mass (BFM) and FMI of children and adolescent boys and girls were represented in table-2, table-3 and table-4 respectively. All the parameters increased gradually with advancing age. All the values were significantly higher in girls in respect to their boy's counterpart from 12 year onwards though a significant difference was also noted at 6 year of age.

Table-2: Mean body fat percentage of children and adolescent on the basis of age and gender.

Age(year)	Body fat percentage		
	Boys	Girls	p
6	14.19 \pm 2.88	17.65 \pm 2.31	<0.001
7	15.77 \pm 3.58	16.66 \pm 2.40	>0.05
8	14.00 \pm 4.06	14.92 \pm 4.30	>0.05
9	13.66 \pm 3.83	14.34 \pm 2.95	>0.05
10	14.36 \pm 3.83	15.02 \pm 2.94	>0.05
11	14.68 \pm 3.65	16.28 \pm 2.61	>0.05
12	14.07 \pm 4.20	17.01 \pm 2.84	<0.001
13	14.04 \pm 3.48	18.19 \pm 2.05	<0.001
14	15.13 \pm 4.03	16.68 \pm 2.80	<0.001
15	15.78 \pm 5.16	21.62 \pm 3.52	<0.001
16	15.28 \pm 5.23	22.95 \pm 3.52	<0.001
17	17.20 \pm 3.15	24.10 \pm 2.84	<0.001
18	17.31 \pm 3.40	25.60 \pm 2.70	<0.001

*Data represent mean \pm SD

Table-3: Mean body fat mass of children and adolescent on the basis of age and gender

Age(year)	Body fat mass (kg)		
	Boys	Girls	p
6	2.63 \pm 1.25	2.99 \pm 0.952	>0.05
7	3.28 \pm 1.58	3.34 \pm 0.953	>0.05
8	3.29 \pm 2.01	4.00 \pm 2.551	<0.05
9	3.50 \pm 2.00	3.71 \pm 1.790	>0.05
10	4.25 \pm 2.26	4.69 \pm 1.720	>0.05
11	4.80 \pm 3.32	5.03 \pm 1.861	>0.05
12	4.98 \pm 2.80	5.93 \pm 2.200	<0.001
13	5.57 \pm 2.45	6.92 \pm 2.032	<0.001
14	6.94 \pm 3.29	8.11 \pm 2.350	<0.001
15	8.15 \pm 4.24	9.97 \pm 3.441	<0.001
16	7.86 \pm 2.89	10.92 \pm 3.361	<0.001
17	9.86 \pm 3.01	12.40 \pm 3.170	<0.001
18	10.68 \pm 3.59	13.83 \pm 2.951	<0.001

*Data represent mean \pm SD

Table-4: Mean value of body fat mass index of children and adolescent on the basis of age and gender

Age(year)	Body fat mass index (kg/m ²)		
	Boys	Girls	p
6	1.990 \pm 0.755	2.413 \pm 0.617	<0.002
7	2.272 \pm 0.983	2.573 \pm 0.614	>0.05
8	2.117 \pm 1.542	2.524 \pm 1.781	>0.05
9	2.128 \pm 1.432	2.230 \pm 1.210	>0.05
10	2.404 \pm 1.500	2.760 \pm 1.180	>0.05
11	2.478 \pm 1.463	2.585 \pm 1.140	>0.05
12	2.417 \pm 1.670	2.881 \pm 1.281	<0.02
13	2.438 \pm 1.420	3.175 \pm 1.140	<0.001
14	2.826 \pm 1.740	3.651 \pm 1.300	<0.001
15	3.153 \pm 2.450	4.347 \pm 1.740	<0.001
16	2.970 \pm 1.430	4.818 \pm 1.771	<0.001
17	3.632 \pm 1.440	5.207 \pm 1.500	<0.001
18	3.757 \pm 1.620	5.791 \pm 1.410	<0.001

*Data represent mean \pm SD

Body fat percentile was represented in table-5 and figure-1. The boys showed a relatively flat 50th percentile varying between 14 and 16% body fat over the entire age range with peak at age 17 year. At early childhood (6 and 7 year of age) body fat percentage was more and then decreased. From 8 year BF% increased gradually with advancing age. Similar pattern was noted for BF% in girls but rate of increment was higher than boy's counterpart. 50th Percentile of BF% of girl was varying in between 18 % and 25% over the entire age range with peak at 18 year of age.

Table-5: Percentiles for body fat percentage among boys and girls aged 6-18 years

Age (year)	Percentiles							
	5	10	25	50	75	85	90	95
BOYS								
6	10.35	11.22	12.78	14.21	15.289	16.05	16.37	18.83
7	11.28	11.85	13.19	14.73	17.50	21.27	21.90	22.43
8	9.66	10.88	11.46	13.02	14.58	17.98	19.47	22.64
9	9.35	10.15	11.36	13.18	14.66	16.40	18.05	20.49
10	9.83	10.45	11.65	13.25	16.20	19.29	20.74	21.78
11	10.06	10.52	11.77	13.92	16.63	19.17	20.19	21.27
12	9.33	10.00	11.19	13.18	16.23	18.06	20.19	22.24
13	9.40	10.01	11.48	13.50	16.35	17.85	19.33	20.18
14	10.00	10.42	11.94	14.29	18.02	20.61	21.20	22.36
15	10.41	11.12	12.30	14.29	17.35	21.06	22.34	24.05
16	11.28	11.59	12.92	14.88	17.49	18.51	19.48	20.74
17	13.60	13.78	14.74	16.57	19.03	21.30	22.30	22.93
18	13.78	13.82	15.01	16.44	19.49	20.47	21.68	23.41
GIRLS								
6	15.23	15.34	15.69	18.14	18.87	19.26	19.62	20.95
7	14.24	14.33	14.92	16.36	18.17	19.18	20.72	21.61
8	10.05	10.86	11.70	13.55	17.06	19.12	20.98	23.58
9	11.03	11.66	12.00	14.00	16.25	17.15	18.25	20.25
10	11.48	11.97	12.94	14.13	16.24	18.18	19.45	20.55
11	13.24	13.48	14.48	15.50	17.66	18.68	18.87	21.57
12	13.76	14.13	14.96	16.21	18.57	20.36	20.78	22.11
13	14.68	15.19	16.31	17.48	19.87	20.63	21.37	23.28
14	15.29	16.07	17.66	19.56	21.25	22.49	23.61	24.66
15	17.10	17.46	18.96	20.94	24.10	26.09	27.54	27.91
16	19.00	19.67	20.47	22.32	23.57	26.18	27.43	30.37
17	20.82	21.36	22.22	22.90	25.60	27.17	28.14	29.76
18	21.27	22.03	23.06	25.21	28.27	28.71	28.92	30.02

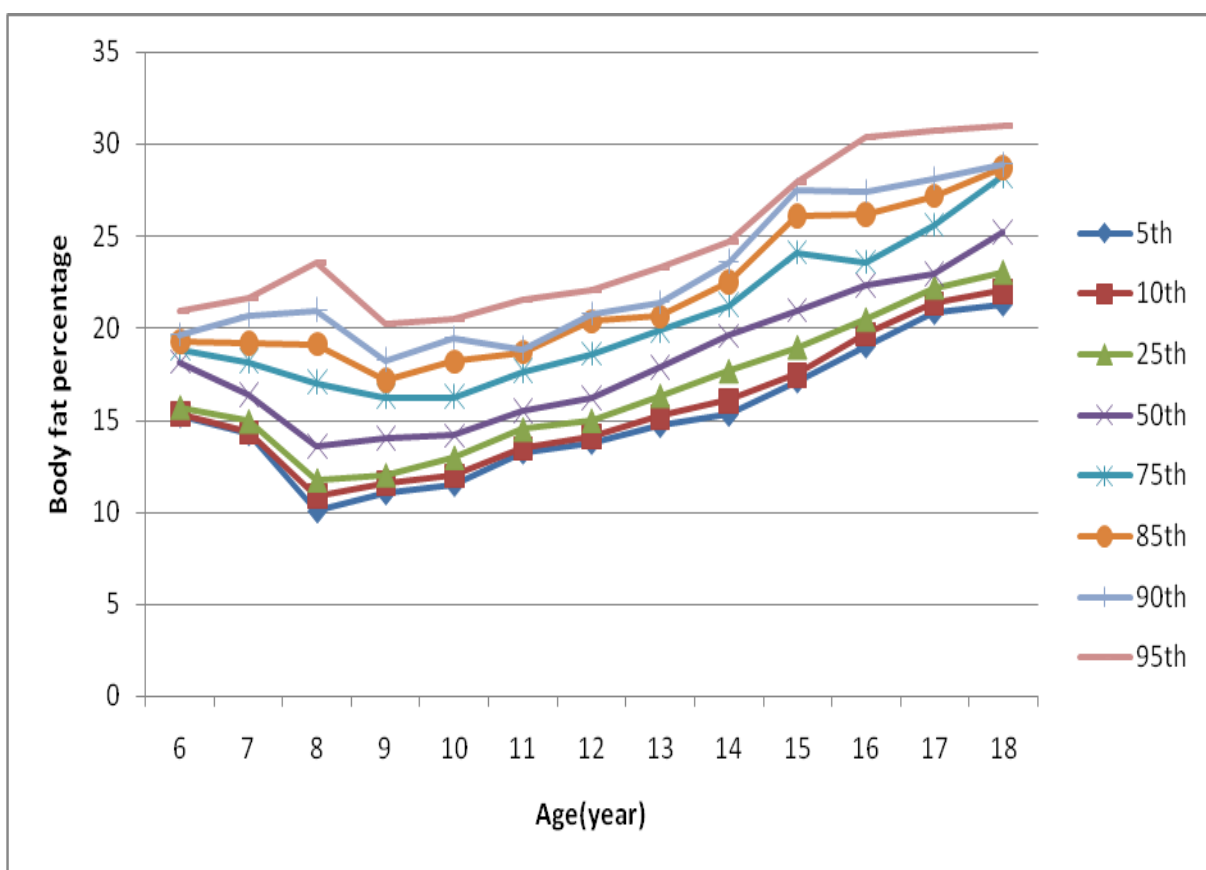
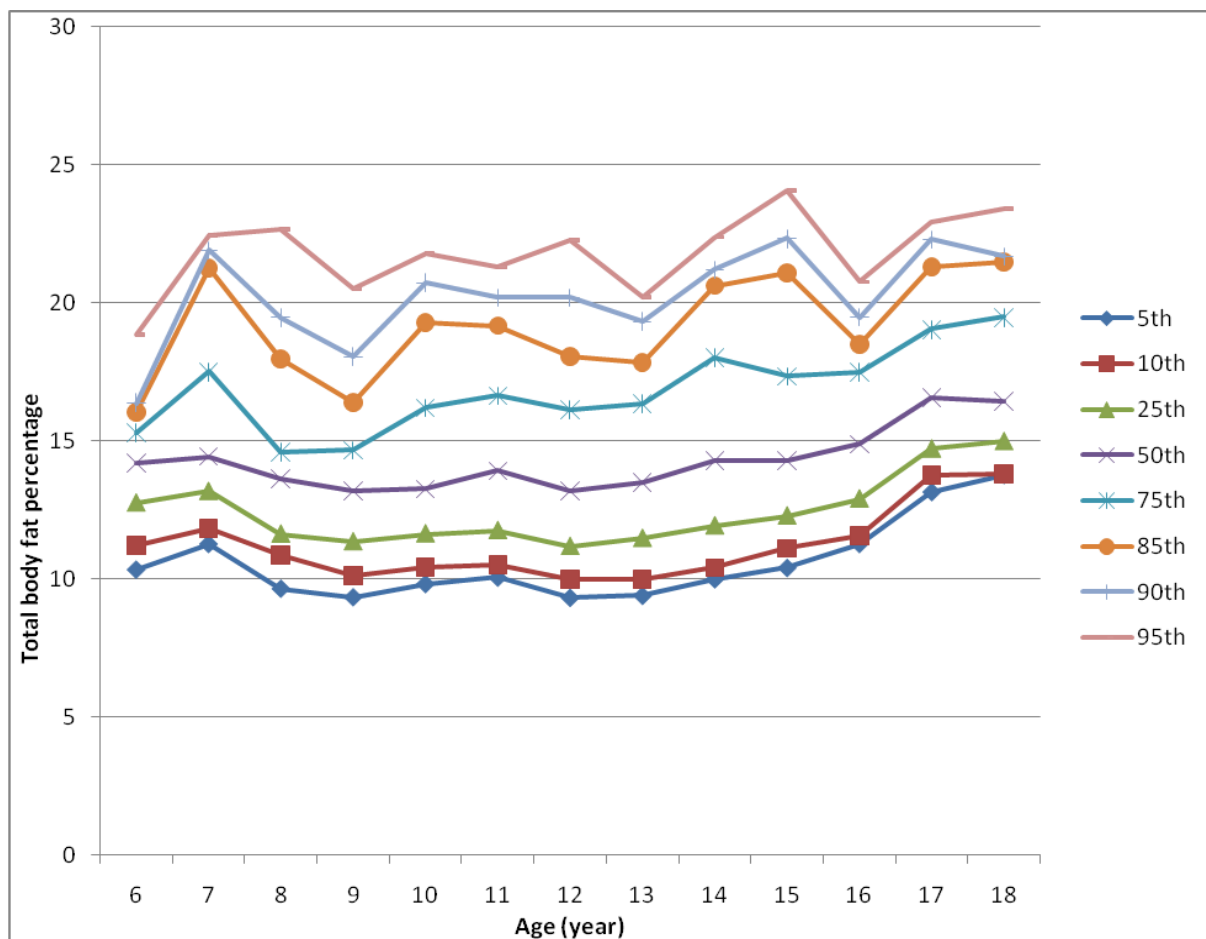


Fig.1: Percentile curves of body fat percentage for Indian boys and girls. Data from 1784 boys and 1085 girls aged 6-18 years.

Percentile of body fat mass was represented in table-6 and figure-2. In boys case, the pattern was similar with BF%. 50th percentile was varying in between 2.49 and 9.43 over the entire age range with peak at 17 year of age. 50th

percentile of girls was varying in between 2.72 and 13.52 over the entire age range. Body fat mass had increased gradually with advancing age and attained a peak value at 18 year.

Table-6: Percentiles for total body fat mass among boys and girls aged 6-18 years

Age (year)	Percentiles (kg)							
	5	10	25	50	75	85	90	95
BOYS								
6	1.26	1.73	2.03	2.49	2.93	3.21	3.30	3.57
7	1.79	2.23	2.75	3.23	4.29	5.82	6.57	6.80
8	1.57	1.80	2.18	2.74	3.52	4.50	5.98	7.08
9	1.67	1.98	2.37	3.06	3.71	4.66	5.45	7.28
10	1.98	2.20	2.63	3.32	4.93	7.43	8.30	9.00
11	2.32	2.52	3.02	4.13	5.84	7.31	8.36	9.28
12	2.20	2.52	3.14	3.88	6.00	7.64	8.89	10.71
13	2.49	2.77	3.75	5.15	6.88	8.06	8.93	10.63
14	3.15	3.42	4.40	6.04	8.66	10.61	11.85	13.52
15	3.66	4.29	5.11	6.66	8.85	11.98	13.17	15.39
16	4.41	4.62	5.87	6.91	7.71	10.71	11.54	12.81
17	6.62	6.76	7.63	9.66	10.80	13.29	14.62	16.06
18	7.59	7.72	8.20	9.43	12.59	14.00	15.18	17.49
GIRLS								
6	2.18	2.22	2.54	2.72	3.19	3.45	3.61	4.39
7	2.10	2.11	2.18	2.82	3.29	3.83	4.41	4.75
8	1.80	1.93	2.30	3.12	4.59	6.24	7.03	9.43
9	1.95	2.26	2.52	3.02	4.80	5.49	6.05	7.77
10	2.27	2.32	2.97	3.54	4.79	5.91	6.49	7.80
11	3.03	3.19	3.70	4.61	5.91	6.39	6.66	9.43
12	3.40	3.71	4.28	5.34	7.72	8.38	8.97	9.42
13	4.23	4.53	5.44	6.46	7.99	8.78	9.57	11.20
14	4.74	5.46	6.23	7.86	9.56	10.59	11.34	12.35
15	5.99	6.38	7.25	9.11	11.88	14.28	15.67	16.56
16	7.70	8.11	8.38	9.90	12.74	13.41	14.52	17.89
17	8.57	9.14	10.61	11.28	13.48	16.07	16.88	18.50
18	9.27	9.99	11.53	13.52	16.77	17.46	18.23	18.50.

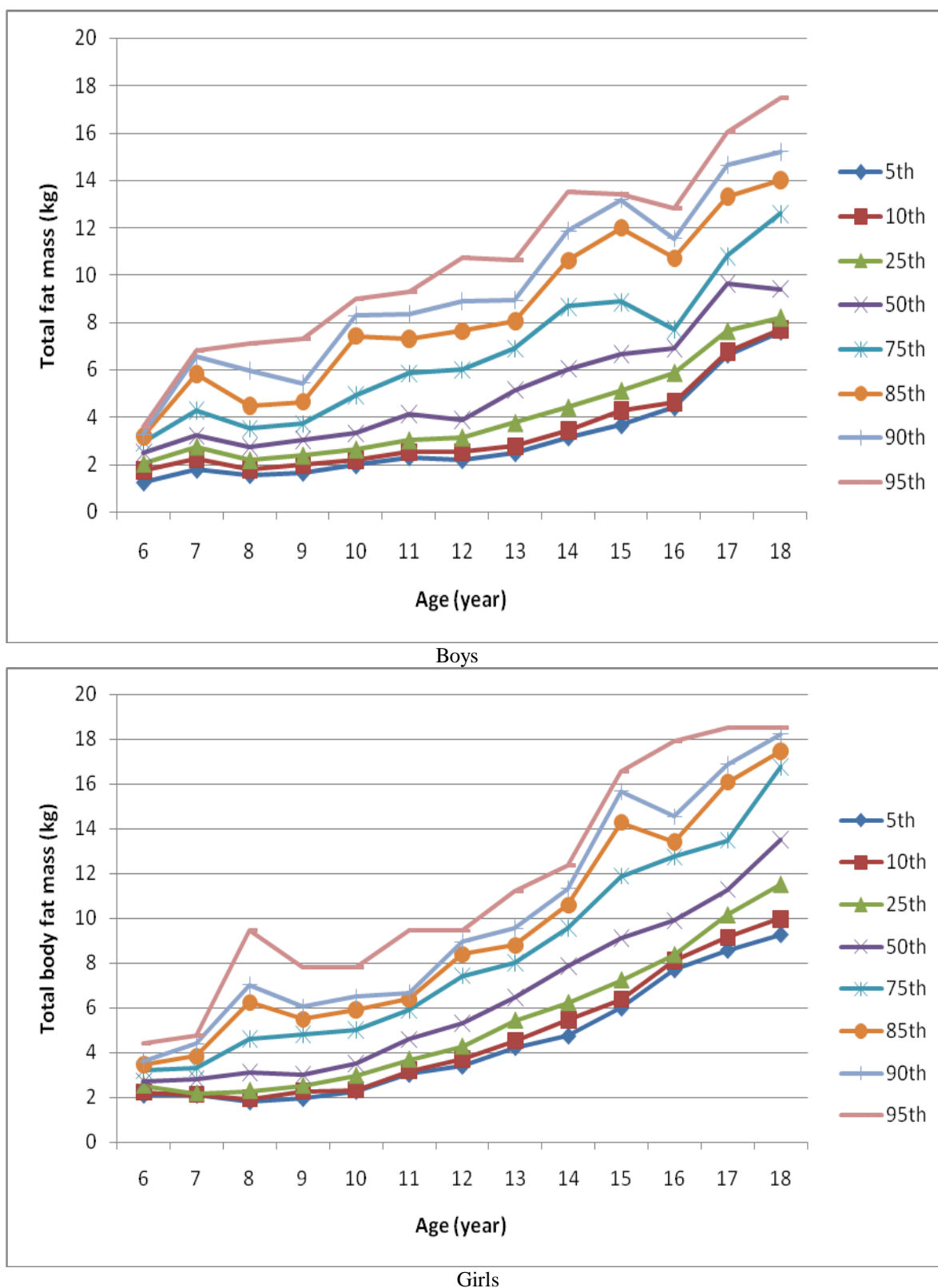


Fig. 2: Percentile curves of body fat mass of Bengali children and adolescents. Data from 1784 boys and 1085 girls aged 6-18 years.

FMI for boys and girls were represented in table-7 and figure-3. 50th percentile showed similar pattern with respective BF%.

Table-7: Percentiles for total body fat mass index among boys and girls aged 6-18 years

Age (year)	Percentile values (kg/m ²)							
	5	10	25	50	75	85	90	95
BOYS								
6	1.148	1.301	1.622	1.938	2.196	2.385	2.469	2.590
7	1.373	1.488	1.772	2.129	2.851	3.989	4.204	4.386
8	1.173	1.354	1.531	1.827	2.150	2.846	3.515	4.553
9	1.106	1.254	1.495	1.891	2.248	2.705	3.175	3.934
10	1.238	1.359	1.609	1.971	2.725	3.846	4.113	4.469
11	1.330	1.422	1.688	2.196	2.922	3.690	4.024	4.391
12	1.232	1.365	1.601	2.076	2.885	3.428	4.118	4.836
13	1.289	1.414	1.733	2.217	2.994	3.447	3.921	4.208
14	1.458	1.547	1.893	2.489	3.584	4.451	4.662	5.090
15	1.594	1.752	2.036	2.554	3.453	4.708	5.184	5.855
16	1.729	1.780	2.083	2.542	3.300	3.712	4.064	4.565
17	2.510	2.564	2.818	3.410	4.379	5.191	5.478	5.724
18	2.609	2.620	2.964	3.402	4.428	4.783	5.239	5.925
GIRLS								
6	1.819	1.841	1.920	2.515	2.708	2.812	2.913	3.313
7	1.672	1.700	1.829	2.150	2.607	2.872	3.330	3.595
8	1.140	1.305	1.489	1.933	2.932	3.612	4.289	5.331
9	1.319	1.445	1.530	2.023	2.651	2.928	3.281	3.982
10	1.394	1.504	1.730	2.164	2.618	3.223	3.655	4.050
11	1.561	1.702	1.959	2.245	2.941	3.328	3.924	4.694
12	1.881	1.974	2.193	2.546	3.283	3.902	4.056	4.563
13	2.091	2.228	2.544	3.012	3.688	3.962	4.235	4.987
14	2.227	2.445	2.919	3.543	4.148	4.624	5.073	5.516
15	2.715	2.823	3.306	3.996	5.232	6.095	6.769	6.947
16	3.124	3.341	3.756	4.333	5.189	5.631	6.086	6.469
17	3.871	4.068	4.388	4.654	5.779	6.493	6.947	7.750
18	3.995	4.277	4.674	5.562	6.957	7.170	7.274	7.324

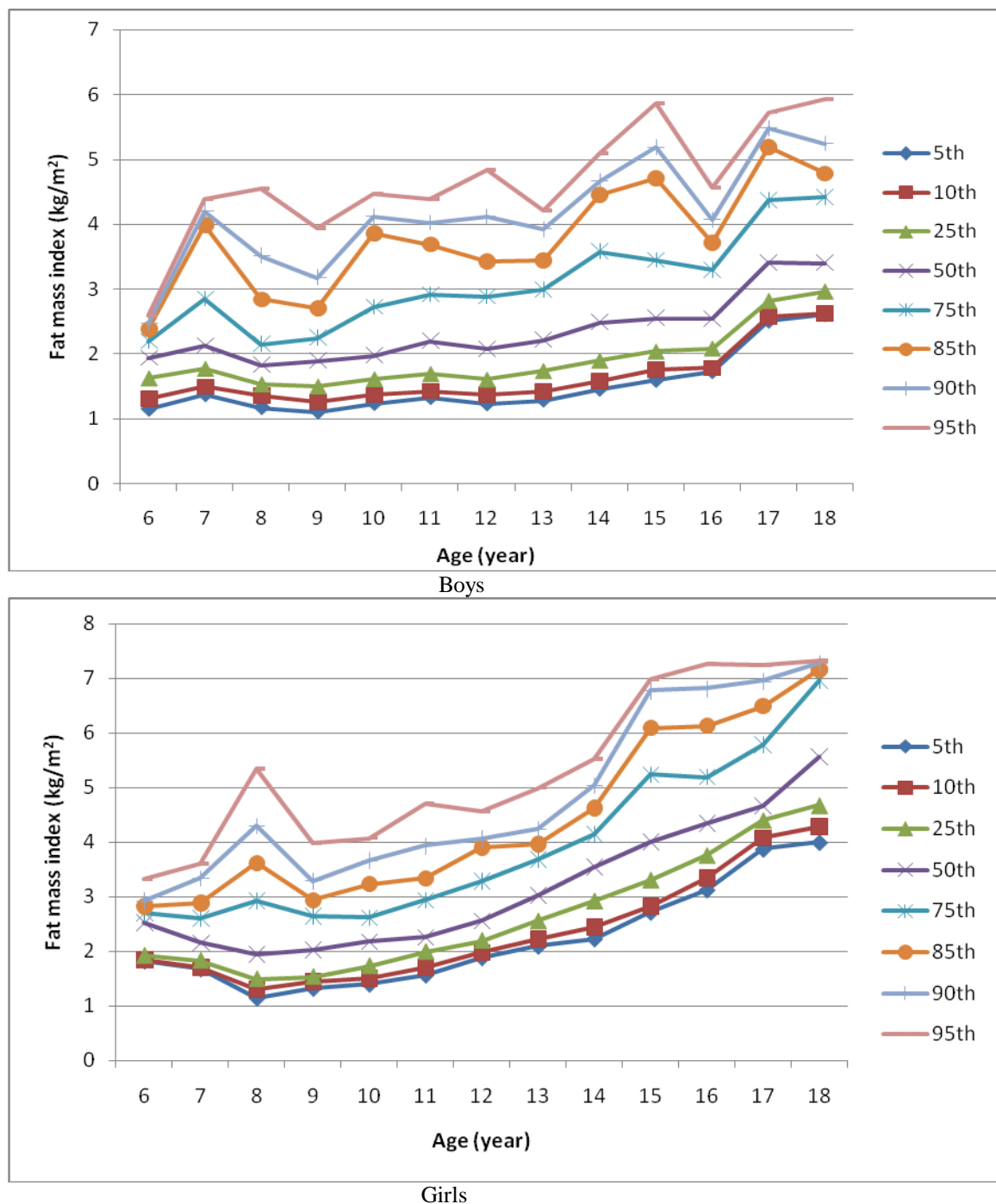


Fig. 3: Fat mass index percentile curves for Indian boys and girls. Data from 1784 boys and 1085 girls aged 6-18 years. Median values of body fat indices of Bengali children and adolescents were compared with western Indian results obtained by Khadikar et al. (2013). Body fat indices of Bengali children and adolescents is much lower than Western Indian values particularly for girls.

Table-8: Comparison of age wise median value of body fat percentage of present work and work of Khadikar et al.

Age (year)	Median body fat percentage of boys		Median body fat percentage of Girls	
	Khadikar et al.	Present work	Khadikar et al.	Present work
6	13.51	14.21	17.78	18.14
7	14.35	14.73	19.63	16.36
8	15.25	13.02	21.74	13.55
9	16.14	13.18	23.98	14.00
10	16.95	13.25	26.00	14.13
11	17.61	13.92	27.94	15.50
12	18.04	13.18	29.44	16.21
13	18.28	13.50	30.85	17.48
14	18.27	14.29	32.09	19.56
15	18.14	14.29	33.25	20.94
16	17.98	14.88	34.02	22.32
17	17.84	16.57	34.59	22.90
18	17.70	16.44	35.18	25.21

Table-9: Comparison of age wise median value of body fat mass index of present work and work of Khadikar et al.

Age (year)	Median body fat percentage of boys		Median body fat percentage of Girls	
	Khadikar et al.	Present work	Khadikar et al.	Present work
6	1.74	1.94	2.30	2.52
7	1.89	2.13	2.57	2.15
8	2.06	1.83	2.93	1.93
9	2.23	1.89	3.38	2.02
10	2.40	1.97	3.84	2.16
11	2.56	2.20	4.37	2.25
12	2.71	2.08	4.85	2.55
13	2.84	2.22	5.24	3.01
14	2.93	2.49	5.58	3.54
15	3.02	2.55	5.85	4.00
16	3.10	2.54	6.02	4.33
17	3.18	3.40	6.11	4.65
18	3.27	3.40	6.17	5.56

Table-10: Comparison of age wise median value of total body fat mass of present work and work of Khadikar et al.

Age (year)	Median body fat percentage of boys		Median body fat percentage of Girls	
	Khadikar et al.	Present work	Khadikar et al.	Present work
6	2.13	2.49	2.79	2.72
7	2.48	3.23	3.61	2.82
8	3.00	2.74	4.58	3.12
9	3.62	3.06	5.75	3.02
10	4.32	3.32	7.07	3.54
11	5.07	4.13	8.50	4.61
12	5.82	3.88	9.91	5.34
13	6.46	5.15	11.19	6.46
14	6.99	6.04	12.33	7.86
15	7.46	6.66	13.31	9.11
16	7.95	6.91	14.11	9.90
17	8.45	9.66	14.58	11.28
18	8.97	9.43	15.44	13.52

Discussion

The present cross –sectional study was conducted in West Bengal, the eastern province of India and all the children were selected from Government schools. Three body fat indices namely BF%, TBFM and FMI of selected subjects were studied. There were no considerable differences of body fat index in childhood between boys and girls. Significant difference was noted from 13 years of age. From 8th year and with the advancing of age, BF% started to increase gradually both in boys and girls but the rate of increment was higher in girls than boys counterpart.

In case of boys, with the advancing of age starting from 8th year TBFM increased and attained a peak level at 17th year. Similar pattern was noted in girls but peak level was obtained at 18th year. Age wise increment rate in boys was less than girl's counterpart.

FMI of boys and girls was shown similar pattern of change like BF%.

Construction of local reference values to measure adiposity may be much more helpful than using international norm or charts obtained from other population. Comparing our reference median with another Indian data from Pune city (Khadikar et al.2013) showed significant differences in percentile values particularly in the age between 10-16 years though pattern of curves were similar.

Moreover, although the WHO or NCHS references can give a good measure of body fat and may be used for risk assessment, they cannot always be reliably applied to all ethnic populations as our result regarding BF% differ significantly with data of NCHS. Therefore construction of local reference is of utmost importance.

In the present study, we have developed age and sex specific reference percentiles for body fat percentage, total body fat mass and fat mass index for children and adolescent of Bengalese ethnicity. The strength of our study is its large sample size. We suggested that 85th percentile cutoff may be used to define moderate body fat while 95th percentile to define excess body fat.

Our study is the first large-scale study, establishing percentile of body fat indexes in children and adolescent in Bengalese ethnicity. We suggest that these data may be used for interpretation as an individual's result for decision making for epidemiological studies and for probable use by health policy makers. These reference percentiles may be used to assess children adiposity in both clinical and survey setting.

Conclusion

We present new reference body fat percentile data on semi urban children and adolescent of Bengali ethnicity. These reference data base for composition of body fat may be useful for early detection of adiposity and thereby cardio-

metabolic risk. These percentile values may be used not only to determine nutritional status but also serve in the comparisons with other ethnic group both in India and abroad.

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