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Regional Adiposity, Body Composition and Central Body Fat Distribution of 10–16 Years Old Bengalee Boys of Nimta, North 24 Parganas, West Bengal, India

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A B S T R A C T

A cross-sectional study of 502 Bengalee boys aged 10–16 years of Nimta, North 24 Parganas, West Bengal, India, was undertaken to study regional adiposity, body composition and central body fat distribution. The subjects were classified into seven age groups: 10–10.9 years (n=74), 11–11.9 (n=53), 12–12.9 (n=87), 13–13.9 (n=116), 14–14.9 (n=58), 15–15.9 (n=57), 16–16.9 (n=57). In general, there was a significant linear increasing trend from 10 to 16 years for all the anthropometric variables. There was a net increase of 30.5 cm and 22.8 kg in mean height and weight, respectively, between 10 and 16 years of age. Mean BMI increased by 3.7 kg/m^2 during the same period. Among circumferences, the largest increase was in hip followed by chest while the smallest increase was in mid upper arm, between 10 and 16 years of age. Subscapular skinfold showed the largest increase followed by abdomen and suprailiac skinfolds, while the increase was least in forearm skinfold. Significant linear increasing trend was observed for all the body composition measures. The largest increase in percent of body fat (PBF) was observed between ages 10 and 11 years while mean fat mass (FM), fat free mass (FFM) and fat mass index (FMI) increased the most between 14 to 15 years. However, an overall decreasing trend was observed, in mean waist-to-hip ratio (WHR) from 10 to 16 years. Boys aged 10 years had the highest mean WHR while those aged 15 years had the lowest mean WHR. There was an increase in mean WHR among 16 years old boys.

Key words: *anthropometry, body composition, regional adiposity, central body fat, Bengalee boys, adolescents, Nimta, West Bengal, India*

Introduction

Recent studies worldwide have investigated regional adiposity, body composition and body fat distribution among children and adolescents[1–5]. There have been numerous studies on the growth of Indian children[6–16], but most of them have investigated height and weight only. None of these studies have dealt with body composition and central body fat distribution. Therefore, there are no population based data available on body composition and central body fat distribution of Bengalee boys. The present study was undertaken to study variations in regional adiposity, body composition and central body fat distribution among 10–16 year old Bengalee boys of Nimta, North 24 Parganas, a suburb of Kolkata, India. This paper presents unique anthropometric and body composition data on Bengalee boys that will be useful as a comparative database for other population studies in India and elsewhere.

Material and Methods

Subjects

Data were collected during the period July–September, 2000, from a boys secondary school in Nimta, North 24 Parganas, West Bengal. The school is situated in an urban area within the North Dum Dum Municipality about 20 km from Kolkata city center. Permission was obtained from the school authorities prior to the com-

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mencement of the study. All subjects completed a questionnaire. Verification of age and ethnicity were done from the school records as well from the answers to specific questions in the questionnaire. A total of 502 students, aged 10–16.9 years were randomly selected and studied. The subjects were classified into seven age groups: 10–10.9 years (n=74), 11–11.9 (n=53), 12–12.9 (n=87), 13–13.9 (n=116), 14–14.9 (n=58), 15–15.9 (n=57), 16–16.9 (n=57).

Anthropometric measurements

All anthropometric measurements were made by trained investigators following the standard techniques[17]. Body mass index (BMI) was computed using the standard equation:

$$\text{BMI} = \text{Weight (kg)} / \text{Height}^2 \text{ (m}^2\text{)}$$

Estimation of body composition

There are no ethnic specific equations to estimate percent of body fat (PBF) for Bengalees. Therefore, skinfold equations of Slaughter et al.[18] for predicting body fat in boys aged 8–18 years were utilized to estimate PBF. These equations provide more accurate estimates of PBF than most currently available, since they take into consideration the use of a multicomponent approach to body composition and account for the chemical immaturity of children[18].

$$\text{PBF} = 0.735 \times [\text{Triceps skinfold (mm)} + \text{Medial calf skinfold (mm)}] + 1.0$$

Fat mass (FM), fat free mass (FFM), fat mass index (FMI) and fat free mass index (FFMI) were estimated using standard formulae.

$$\text{FM (kg)} = (\text{PBF} / 100) \times \text{Weight (kg)}$$

$$\text{FFM (kg)} = \text{Weight (kg)} - \text{FM (kg)}$$

$$\text{FMI (kg/m}^2\text{)} = \text{FM} / \text{Height}^2$$

$$\text{FFMI (kg/m}^2\text{)} = \text{FFM} / \text{Height}^2$$

Arm muscle area (AMA) and arm fat area (AFA) were calculated from mid upper arm circumference (MUAC) using the standard equations:

$$\text{AMA} = [(\text{MUAC} - \pi\,(\text{Triceps skinfold})]^2 / (4 \times \pi)$$

$$\text{AFA} = (\text{Triceps skinfold} \times \text{MUAC} / 2) - [\pi \times (\text{Triceps skinfold})^2] / 4$$

Central body fat distribution

Waist-Hip ratio (WHR) was used as a measure of central body fat distribution. WHR was computed using the standard formula:

$$\text{WHR} = \text{Waist circumference (cm)} / \text{Hip circumference (cm)}$$

Results

The means and standard deviations of the anthropometric characteristics of the Bengalee boys are presented in Table 1. In general, there was a significant linear increasing trend from 10 to 16 years for all the anthropometric variables. There was a net increase of 30.5 cm and 22.8 kg in mean height (Figure 1) and weight (Figure 2), respectively, between 10 and 16 years of age. Mean BMI increased by 3.7 kg/m^2 between 10 (15.0 kg/m^2) and 16 (18.7 kg/m^2) years.

Among circumferences, the largest increase was in hip (+18.3 cm, Figure 3) followed by chest (+15.8 cm) while the smallest increase was in mid upper arm (+5.7 cm), between 10 and 16 years of age. Increase in abdomen (+11.7 cm) and waist (+11.7 cm) circumferences during the same period was similar. Subscapular skinfold (Figure 4) showed the largest increase (+ 6.1 mm) followed by abdomen (+6.0 mm) and suprailiac (+5.9 mm) skinfolds, while the increase was least in forearm skinfold (+0.7 mm).

The means and standard deviations of body composition and central body fat distribution variables and indices are presented in Table 2**.** Significant linear increasing trend was observed for all the body composition measures. The largest increase in PBF (+1.6 %) was observed between ages 10 and 11 years (Figure 5) while mean FM (+1.2 kg), FFM (+4.2 kg) and FFMI (+1.0 kg/m^2) increased the most between 14 to 15 years. However, an overall decreasing trend was observed, in mean WHR (Figure 6) from 10 to 16 years. Boys aged 10 years had the highest mean WHR (0.873) while those aged 15 years had the lowest mean WHR (0.804). There was an increase in mean WHR among 16-year-old boys (mean = 0.818).

TABLE 1
ANTHROPOMETRIC CHARACTERISTICS OF THE BENGALEE BOYS ACCORDING TO THEIR AGES

Variable	Age (years)						
	10–10.9 (n=74)	11–11.9 (n=53)	12–12.9 (n=87)	13–13.9 (n=116)	14–14.9 (n=58)	15–15.9 (n=57)	16–16.9 (n=57)
Height (cm)	128.6 (7.4)	132.0 (8.2)	138.0 (8.7)	145.5 (8.0)	153.3 (8.9)	157.6 (7.4)	159.1 (8.1)
Weight (kg)	25.0 (4.0)	27.5 (5.1)	30.9 (5.9)	34.9 (7.0)	38.8 (7.5)	44.1 (8.0)	47.8 (8.0)
Body Mass Index (kg/m^2)	15.0 (1.3)	15.7 (1.9)	16.1 (2.0)	16.4 (2.2)	16.3 (1.9)	17.7 (2.9)	18.7 (2.0)

TABLE 1
CONTINUED

Variable	Age (years)						
	10–10.9 (n=74)	11–11.9 (n=53)	12–12.9 (n=87)	13–13.9 (n=116)	14–14.9 (n=58)	15–15.9 (n=57)	16–16.9 (n=57)
				Circumferences (cm)			
Mid-upper arm	17.1 (2.0)	17.6 (1.7)	18.4 (1.9)	19.4 (2.5)	19.6 (2.0)	21.3 (2.7)	22.8 (3.1)
Chest	60.5 (3.7)	63.3 (4.3)	65.5 (4.6)	69.0 (6.3)	71.2 (6.1)	75.3 (7.2)	76.3 (6.8)
Waist	52.7 (3.3)	54.3 (4.0)	55.8 (4.1)	58.9 (5.6)	61.3 (5.7)	62.7 (7.2)	64.4 (6.4)
Abdominal	56.2 (4.1)	58.0 (4.4)	59.4 (4.7)	62.2 (5.8)	64.6 (6.1)	66.0 (7.3)	67.9 (7.0)
Hip	60.5 (5.0)	64.4 (5.2)	67.5 (5.1)	70.9 (6.2)	73.5 (6.2)	78.0 (6.3)	78.8 (6.8)
Mid-Thigh	33.9 (4.7)	35.4 (5.0)	37.3 (3.7)	38.4 (4.7)	40.2 (4.0)	42.7 (4.8)	44.7 (5.8)
Calf	23.3 (2.5)	24.5 (2.4)	25.6 (2.4)	27.1 (2.9)	28.3 (2.4)	29.3 (2.8)	29.9 (3.0)
				Skinfolds (mm)			
Chest	4.4 (1.0)	5.1 (2.0)	5.5 (1.7)	6.1 (3.8)	6.3 (3.2)	6.8 (6.8)	7.4 (4.1)
Midaxillary	4.8 (1.2)	5.1 (1.8)	5.7 (1.8)	6.9 (3.2)	7.0 (2.4)	7.5 (5.5)	8.6 (4.1)
Subscapular	5.7 (1.3)	6.4 (2.2)	7.1 (2.2)	8.7 (4.2)	9.3 (3.7)	10.1 (7.2)	11.8 (4.9)
Suprailiac	5.7 (2.1)	7.8 (5.0)	8.6 (2.9)	9.1 (4.9)	9.5 (4.3)	10.2 (7.0)	11.6 (5.4)
Abdomen	6.5 (1.8)	7.8 (4.4)	8.8 (3.4)	10.2 (5.8)	10.0 (5.1)	10.7 (7.7)	12.5 (6.1)
Biceps	4.0 (1.0)	4.5 (1.5)	4.7 (1.2)	4.8 (1.5)	4.6 (1.7)	5.0 (2.7)	5.6 (2.6)
Triceps	5.7 (1.5)	6.6 (2.3)	6.6 (1.6)	7.2 (2.7)	7.3 (2.4)	7.5 (3.6)	8.4 (3.0)
Forearm	3.9 (0.8)	4.4 (0.9)	4.5 (0.9)	5.0 (1.7)	5.2 (1.8)	4.5 (1.1)	4.6 (1.2)
Anterior thigh	9.4 (3.1)	11.2 (3.7)	11.8 (3.3)	12.1 (4.1)	12.0 (4.1)	13.4 (7.9)	14.7 (6.2)
Medial calf	6.1 (1.6)	7.5 (2.5)	7.5 (2.1)	8.3 (2.4)	8.4 (2.2)	9.1 (4.8)	9.8 (3.9)

(standard deviations are presented in parentheses)

Fig. 1. Mean height by age.

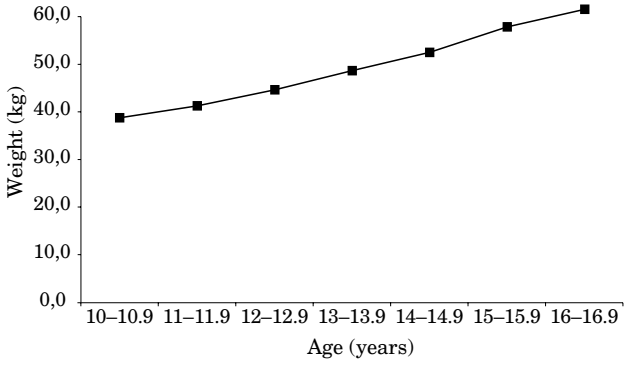

Fig. 2. Mean weight by age.

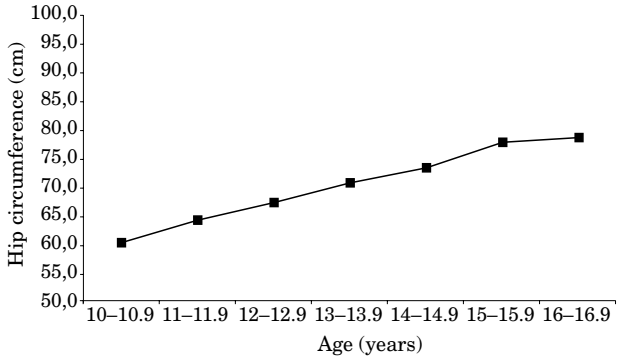

Fig. 3. Mean hip circumference by age.

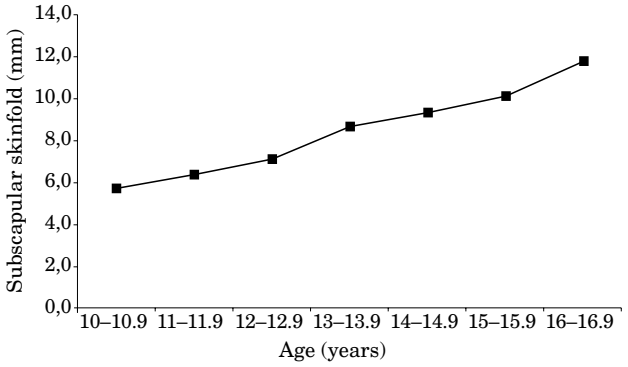

Fig. 4. Mean subscapular skinfold by age.

TABLE 2
BODY COMPOSITION AND CENTRAL BODY FAT DISTRIBUTION OF THE BENGALEE BOYS ACCORDING TO THEIR AGES

Variable	Age (years)						
	10–10.9 (n=74)	11–11.9 (n=53)	12–12.9 (n=87)	13–13.9 (n=116)	14–14.9 (n=58)	15–15.9 (n=57)	16–16.9 (n=57)
				Body composition			
Percent Body Fat (%)	9.7 (2.2)	11.3 (3.4)	11.4 (2.6)	12.4 (3.4)	12.5 (3.0)	13.2 (6.0)	14.3 (5.0)
Fat Mass (kg)	2.5 (0.9)	3.2 (1.5)	3.6 (1.2)	4.4 (2.0)	4.9 (1.9)	6.1 (4.4)	7.0 (3.2)
Fat Free Mass (kg)	22.5 (3.3)	24.3 (4.1)	27.3 (4.9)	30.5 (5.6)	33.8 (6.2)	38.0 (5.6)	40.7 (6.2)
Fat Mass Index (kg/m^2)	1.5 (0.4)	1.8 (0.7)	1.9 (0.6)	2.1 (0.8)	2.1 (0.7)	2.5 (1.8)	2.7 (1.2)
Fat Free Mass Index (kg/m^2)	13.6 (1.1)	13.9 (1.6)	14.3 (1.7)	14.3 (1.7)	14.3 (1.5)	15.3 (1.7)	16.0 (1.5)
Arm Muscle Area (mm^2)	1883.7 (439.8)	1938.5 (337.5)	2133.5 (480.7)	2380.2 (650.3)	2420.3 (513.1)	2889.0 (674.1)	3301.4 (818.9)
Arm Fat Area (mm^2)	470.4 (168.3)	554.6 (235.8)	576.1 (160.7)	660.6 (281.6)	677.9 (253.4)	778.3 (476.1)	924.3 (399.3)
				Central body fat distribution			
Waist-Hip Ratio	0.873 (0.040)	0.845 (0.052)	0.828 (0.040)	0.832 (0.044)	0.834 (0.059)	0.804 (0.054)	0.818 (0.044)

(standard deviations are presented in parentheses)

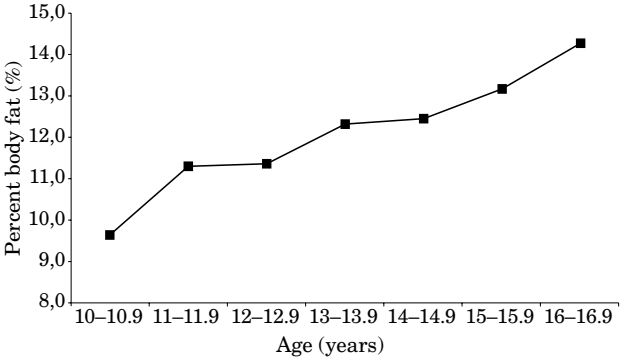

Fig. 5. Mean percent body fat by age.

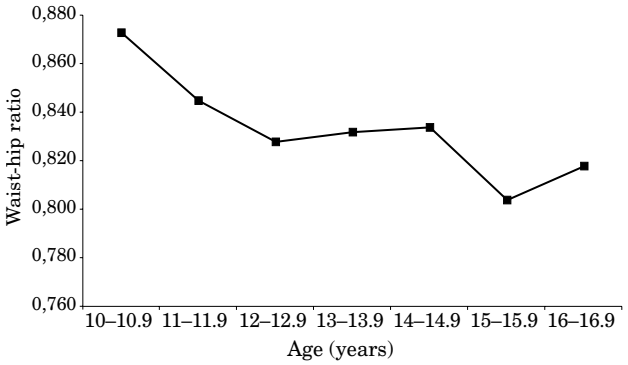

Fig. 6. Mean waist-hip ratio by age.

Discussion

The material presented in this paper constitutes the most comprehensive information on regional adiposity, body composition and central body fat distribution of Bengalee boys to date. The only previous extensive anthropometric studies on Bengalee boys were undertaken by Hauspie et al.[13], Pakrasi et al.[15] and De Onis et al.[16]. However, none of these investigations had reported data on body composition and central body fat distribution. Mean values of height and weight of the Bengalee boys reported in the present study are, in general, similar to these three earlier studies.

The present investigation reported a consistent increasing trend in regional adiposity (circumferences and skinfolds) and body composition from 10 years to 16 years of age. Recent studies have also observed similar findings among children in Baharain[1,5], Jamaica[3], Malawi[19] and Japan[20]. These studies have also reported a consistent increasing trend with age. The present study therefore indicated that among Bengalee boys:

1) There is consistent fat deposition at various sites, between 10 and 16 years of age
2) There is no stagnation in total fat deposition, from 10 to 16 years.

With respect to central body fat distribution, it was found that, in general, there was a decreasing trend with age, in mean WHR. This was because increase in hip circumference was greater than waist circumference, resulting in lower WHR. This indicated a differential pattern and intensity of fat deposition at these two levels. However, there was an increase in mean WHR at 16 years of age. A study among Jat Sikh boys of India[21] also found that there was an initial decrease followed by an increase in mean WHR from 11 to 18 years of age. Similar results among 12–19 year old girls were also reported from Baharain[5]. It is well known that android or male-type adiposity is characterized by greater WHR. One of the probable reasons for the increase in WHR at 16 years among Bengalee boys could be that hormones that influence body fat distribution begin acting more pronouncedly at this age. Since WHR is influenced by age as well as sex[22], similar studies should be undertaken on Bengalee girls. More importantly, longitudinal investigations of regional adiposity, body composition and WHR are needed to understand the dynamics of the changes in them from childhood until and beyond adolescent age. Such studies are lacking from India[23–24]. Although nutritional status of Bengalee adolescents has been reported in a recent study[25], information on the health implications of adiposity and body composition with respect to chronic diseases are lacking. It has now been well established[26] that adiposity patterns at adolescent determine the health risks in later life. Future studies among Bengalee adolescents should investigate this issue. Appropriate health promotion programmes can be formulated and implemented among this ethnic group to reduce the risk of adiposity-related chronic diseases during middle and old age.

In conclusion, the present study demonstrated that there was a consistent increase in regional adiposity and body composition with age, among 10–16 year old urban Bengalee boys. However, there was a decrease in mean WHR.

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SASTAV TIJELA I REGIONALNA RASPODJELA MASNOG TKIVA KOD BENGALSKIH DJEČAKA U DOBI OD 10–16 GODINA IZ NIMTE, ZAPADNI BENGAL, INDIJA

S A Ž E T A K

U cilju istraživanja sastava tijela i regionalne raspodjele masnog tkiva provedeno je presječno istraživanje 502 dječaka, dobi 10–16 godina, iz Nimte, Zapadni Bengal, Indija. Sedam dobnih skupina sastavljeno je na sljedeći način: 10–10.9 godina (n=74), 11–11.9 (n=53), 12–12.9 (n=87), 13–13.9 (n=116), 14–14.9 (n=58), 15–15.9 (n=57), 16–16.9 (n=57). Općenito je ustanovljen značajni linearni rast srednjih vrijednosti svih promatranih antropometrijskih varijabli s godinama starosti. Tako razlika u visini tijela između krajnjih dobnih skupina (tj. 10 i 16 godine života) iznosi 30.5 cm, dok ta razlika u masi tijela iznosi 22.8 kg. Indeks tjelesne mase povećao se za 3.7 kg/m^2 u istom dobnom rasponu. Među mjerama opsega najveći porast u dobi između 10 do 16 godina pokazao je opseg bokova, a potom opseg prsnog koša, dok je najmanji rast zabilježen za opseg nadlaktice. Od kožnih nabora, subskapularni kožni nabor pokazao je najveći rast, a za njime abdominalni te suprailijačni kožni nabori. Značajno linearno povećanje uočeno je kod svih mjera sastava tijela. Tako je najveći rast u postotku masnog tkiva tijela (PBF) zabilježen u dobi između 10 i 11 godina starosti, dok su se prosječne vrijednosti mase masnog tkiva (FM), bezmasne mase tijela (FFM) i indeksa mase masnog tkiva (FMI) najviše poveća između 14 i 15 godina starosti. S druge strane, prosječna vrijednost omjera opsega struka i bokova (WHR) općenito se smanjivala od 10 do 16 godina starosti te su dječaci stari 10 godina imali najvišu, a oni stari 15 godina najnižu vrijednost. Kod 16-godišnjaka zabilježen je, međutim, porast srednje vrijednosti WHR u odnosu na skupinu 15-godišnjaka.