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Pattern of Growth Among Boys during Adolescence: A Profile from An Urban Region in South India

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This study aimed to assess the growth pattern of adolescent boys in Mysore city in south India. In this cross sectional study anthropometric profile of 1083 boys aged 10-18years was measured and compared to 50th centiles of W.H.O standards for height and weight and the measurement of MUAC and SFT were compared to NHANES standard. Self-reporting questionnaire to obtain data related to family socioeconomic status and personal information was implemented. The increase in height exhibited linearity from 10 to 18 years of age, mean height was 141.8±1.56 cms in boys aged 10years while boys aged 18 year had a mean height of 172.2± 7.15 cms The mean weight at age 10 was 31.7± 3.10 kgs and at 18 years the mean body weight was 58.6± 9.04 kg . In this study population the mean BMI was15.63±2.21 at the age 10 and increased to 19.71 ± 2.42 at age 18th year The mean MUAC at the age 10 was 19.6±1.72 cm and skin fold at triceps was 11.07±3.5 mm. These participate boys were shorter and lighter in all the stages of adolescences as compared to reference, although the difference for height was smaller than that seen for weight BMI, of boys in all age groups was lower as compare to the W.H.O references.

Key words: Adolescent age, Boys, Anthropometric profile, Growth, India.

Adolescence is the period in human life that encompasses 11-19 years of age, during which children attain maximum height and weight together with psychological and social developments (W.H.O 2006, Spear 1996, Zia-ud-Din, 2003). At the end of adolescence, boys appear more masculine and girls feminine. This period is important since it provides an opportunity for growth and maturity for children to emerge as young adults. Because of the various events unfolded during adolescence, it is considered to present series of nutritional challenges that may affect their nutritional status(Story, 2005, Mukhopadhyay, 2005).Spatial differences are known to occur in the extent of growth during adolescence; both linear growth and gain in weight vary. The major influencing factors that affect growth are environmental factors and the genetic profile (Haboubi, 2009).

In India, this age group forms 21.4 % of the total population (National Youth Policy, 2002). Past fertility decline in India has reduced the proportion of young people (NFHS III), however more than 200 million are projected to be in this age group, thus this group still merits separate attention. (Iyer UM, 2011)Anthropometric measurements provide reliable informatio and are

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sensitive indicators of health and well being of individuals from all age groups (Onis, 2001). Growth Monitoring is a screening tool to diagnose nutritional, chronic systemic and endocrine disease at an early stage. It has been suggested that growth monitoring has the potential for significant impact on mortality even in the absence of nutrition supplementation or education (Khadilkar, 2007).Hence provincial data regarding the growth profile of children both boys and girls are useful in understanding the nutritional status of children (Bener, 2005). Interest in the growth and development of girl child in general has lead to the accumulation of sufficient database; however sporadic information regarding boys is available (Agarwal, 2001; Tiwari 2007). Especially from South India research reports regarding growth pattern of boys is truly thin. Therefore, it was proposed to obtain anthropometric data on a substantial population of boys' aged 10- 18years across the economic groups from an urban region of south India.

MATERIALS AND METHOD

A cross sectional study was carried out in Mysore city, one of the major cities of Karnataka from South India. Schools offering primary and higher primary education (6^{th} to 10^{th} standard) and pre-university colleges offering 11^{th} and 12^{th} standard courses were selected so as to include one each of government and a reputed private institute. 1083 boys studying in 6^{th} to 12^{th} standards (10 to 18 years) were contacted, purpose and protocols of the study was explained. A written consent was obtained from the parents of the wards; children whose parents agreed for their participation were included for the study. Approval for the study was granted by Human Ethics Committee, University of Mysore.

A self reporting questionnaire was developed in English language for obtaining family data relating to socioeconomic status and personal information; the questionnaire was translated in to the regional language (Kannada- a Dravidian language of south India) with the help of a language expert. The questionnaires were provided to boys depending on the language with which they felt comfortable to answer.

A socio economic scale was developed for this group taking into account parent's educational and occupational level, type of house, type of house hold valuable articles like refrigerator, TV, computer and possession of vehicles- two and four wheeler, each variable was scored based on their intra variable characteristics. A sum of the total scores (< 22 highest) was divided into four quadrants, the highest quadrant was > 18, designated as high socioeconomic the next in the lower orders were designated as upper-middle (12 – 17), middle (7 – 11) and low (< 06) socio economic groups.

The schedule for anthropometric assessment included measurements of height, weight, mid upper arm circumference (MUAC) and triceps skin fold thickness (SFT).

Cross sectional study: Each subject (1083) included for the study was measured for their body dimension and body mass, the procedures for measurements were adopted as given in Jelliffe. Height was measured in centimeters using portable height measuring rod, with an accuracy of 0.1 cm.A battery operated digital balance (Glan electronic personal scale) was used to record body weight, the balance was checked for its accuracy each time before use. A flexible fiber glass tape having a scale with 10 divisions per centimeter was used to measure MUAC. Fat fold at triceps was measured using (SLIM GUIDE) caliper. The data obtained was analyzed using SPSS statistical package (ver. 15).

RESULTS

Table 1 presents the family characteristics and subjective profile of the participants; it is evident that 31.2, 43.8 and 25.0 percent of boys were in pre adolescence, adolescence and post adolescence stages. Hinduism was the major religion followed by Muslims and Christianity. The table also reveals the socio economic status of the families; 10.5% of the families were from low SES, the middle, upper middle and the high income together formed 89.5% of the selected population. 64.7 % families resided in own houses. With respect to diet pattern of the families, 67.2% were non vegetarians and others practiced vegetarianism.

Table 2 presents the mean anthropometric profile of boys from 10 to 18 years. It is worthwhile to mention that, percent participation of boys from all age categories was good except for those in 10 years. The observed values are compared to 50^{th} centiles of W.H.O (2007) standards for height and weight[42]. The measurement of MUAC and SFT were compared to NHANES standard. The increase in height exhibited linearity from 10 to 18 years of age, mean height was 141.8±1.56 cms in boys aged 10years while boys aged 18 year had a mean height of 172.2± 7.15 cms. The mean weight at age 10 was 31.7± 3.10 kgs and at 18 years the mean body weight was 58.6± 9.04 kg, hence there was a difference of 27 kg by the end of post adolescence stage. When the body weights were compared to the age related values from W.H.O (34.5±1.27 and 68.1±0.50kg) the selected boys appeared to be lighter by 3 kgs at 10 years and 10 kg at 18^{th} year of age. (Table 2).

The mean MUAC at the age 10 was 19.6±1.72 cm and skin fold at triceps was 11.07±3.5 mm. These measures were slightly higher than the standard .there was a linear increase, and remained higher than that standard values .BMI, of boys in all age groups was lower as compare to the W.H.O references .In this study population the mean BMI was15.63±2.21 at the age 10 and increased to 19.71 ± 2.42 at age 18^{th} year.

Figs. 1-3 present growth charts of boys using height, weight and BMI according to centile values. The size of study population was substantial and more than 90% of boys belonged to middle and high income groups, it was considered worthwhile to develop centile values and compare to W.H.O standards. It is evident from figure 1, that, the 50^{th} centile curve for height of the study population was closer to the standard curve and exhibited a similar trend; Curves for 85^{th} and 95^{th} centiles of the study population were considerably higher to the 50^{th} centile of the standard.

Similarly, a centile group for weight was developed. The 50^{th} centile curve of the study population had essentially similar trend to that of the W.H.O curve, but was slightly lower, 85th centile was found to be closer to the50th centile of W.H.O. The 95^{th} centile curve was markedly above.

Centile curve for BMI exhibited a different trend; the 50^{th} and 85^{th} centile curves for the study population fell to either side of the 50^{th} centile essentially at equidistance. The 95^{th} centile curve occupied the highest position on the graph.

Table 1: Family profile of selected adolescent boys

General Profile		Total	Adolescent stages		
			Pre-Adolescence	Adolescence	Post-Adolescence
Religion	Hindu	743 (70.0)	229 (68.6)	306 (66.8)	203 (76.0)
	Christian	96 (9.0)	30 (9.1)	55 (12.0)	11 (4.1)
	Muslim	135 (12.7)	46 (13.8)	63 (13.8)	25 (9.4)
	Others	88 (8.3)	28 (8.4)	33 (7.2)	28 (10.5)
SES	Low	108 (10.5)	40 (12.3)	41 (9.2)	27 (10.7)
	Middle	482 (47.1)	158 (48.6)	205 (45.2)	119 (48.4)
	Upper Middle	232 (22.7)	66 (20.3)	119 (26.2)	48 (19.4)
	High	202 (19.7)	61 (18.8)	89 (19.6)	51 (20.8)
Type ofdiet	Vegetarian	343 (32.8)	104 (31.3)	154 (34.1)	85 (32.2)
	Non-Vegetarian	704 (67.2)	228 (68.7)	297 (65.9)	179 (67.8)

Figures in parentheses present percentage

Table 2. Mean anthropometric profile of adolescent boys according to age and in comparison with the international standards

Age groups	No. boys	Height (cms)		Weight (kg)		MUAC (cms)		Skin Fold at Triceps (mm)		BMI	
Yrs		Standard	Actual	Standard	Actual	Actual	Standard	Actual	Standard	Actual	Standard
10	14	141.8±1.56	142.7±4.10	34.5±1.27	31.7± 3.10	19.6±1.72	18.00	11.70±3.50	10.00	15.63± 2.21	16.97± 0.18
11	173	146.3±1.58	145.3± 6.24	38.3±1.20	34.8± 7.11	20.7±3.13	18.30	12.50±5.29	11.00	16.39±2.63	17.48±0.17
12	151	152.4±1.95	149.8± 7.42	42.9±1.42	37.3± 7.94	21.4±2.86	19.50	13.23±5.80	11.00	16.50±2.66	18.10±0.18
13	158	159.6±2.19	155.7± 6.82	48.0±1.52	41.5± 6.81	21.4±2.51	21.10	12.22±4.96	10.00	17.11± 2.30	18.75±0.21
14	161	166.9±1.65	164.7± 8.17	53.5±1.42	48.8± 8.68	22.4±3.27	22.30	11.65±5.75	9.00	17.96± 2.76	19.44±0.20
15	153	171.9±0.96	168.9± 7.95	58.7±1.27	54.2± 11.91	23.5±3.91	23.70	12.39±6.68	8.00	18.93± 3.50	20.18±0.19
16	129	174.5±0.50	171.3± 6.47	62.8±1.02	56.5± 12.12	24.8±3.41	24.90	13.30±6.91	8.00	19.03± 3.33	20.86±0.19
17	109	176.8±0.20	171.9± 6.32	65.9±0.70	59.7± 12.19	27.6±3.30	25.80	13.26±5.72	8.00	20.12± 3.57	21.52±0.16
18	33	177.1±0.20	172.2± 7.15	68.1±0.50	58.6± 9.04	25.9±2.48	26.40	13.27±5.60	9.00	19.71± 2.42	22.15±0.18

Fig. 4 and 5 presents the mean differences in height and weight of boys at three stages of adolescence as compared to those for reference standards. The participate boys were shorter and lighter in all the stages of adolescences as compared to reference, although the differences for height was smaller than that seen for weight. An exercise was performed to over ride the body weight, MUAC and SFT of boys at every age over the respective heights distributed into 10th, 50th, 85th and 95th centiles respectively .This was essentially out of an academic interest to compare the body weight, MUAC and SFT for height in different centile.

It can be seen that boys at 11 years falling into 95th centile of height were heavier by 20Kgs as against those in 10th centile. All the other parameter like MUAC and SFT were also markedly higher. This can be a reference to compare the parameters for the respective height for age. It is relevant to mention that boys in 10th and 18th years were few and distribution into different centiles gave rise to single digit number, therefore, these two groups (10-18 years) were eliminated.

DISCUSSION

Literature provides ample references about the growth pattern of children during the adolescence (Iyer, 2011). Geographical distribution in differences of stature is widely known, and is an important criterion for identifying the nutritional status of the population -(Satyanarayana,1980; Rao, 2000; Ghalib, 2009). It is also well documented that tall individuals with ideal body weights have better work performance and earning capacity (Umesh, 2002; Norgan, 2000). Therefore the nation's development has a direct relation with the nutritional status and stature of the population.

Adolescence is a terminal stage which provides a unique opportunity to children for expressing maximum growth (The World Bank Group 2003. Database regarding growth and development of population in general and children in particular is valuable for every nation to offer needed support to monitor the wellbeing of the population (Smith, 2006;. Longo-Mbenza, 2007. Kelishadi, 2008). Population studies covering large size sample contributing worthwhile information about stature and growth pattern is a treasure.

Table 3: Mean weight, muac and sft in selected boys according to height at different centiles

Age	10th centile			50th centile			85th centile			95th centile		
(Yrs)	Weight	MUAC	SFT	weight	MUAC	SFT	weight	MUAC	SFT	weight	MUAC	SFT
11	Height =136.9			Height =145.0			Height =151.0			Height =157.0		
	29.7	18.9	8.6	32.9	20.0	11.4	41.6	23.4	16.8	49.9	26.0	23.72
12	Height =140.5			Height =149.5			Height =158.0			Height =163.6		
	31.2	19	9	36.4	21.0	11.6	45.7	24.0	19.4	53.4	26.8	24.4
13	Height =147.5			Height =155.5			Height =163.0			Height =168.4		
	36.7	19.9	8.4	40.5	21.1	11	49.8	23.5	17	60.1	26.3	22.8
14	Height =158.5			Height =164.8			Height =172.9			Height =177.6		
	42.3	20.5	7.8	47.1	22.0	10	60.3	25.4	17.8	66.3	29.0	23
15	Height =164			Height =169.0			Height =176.2			Height =181.7		
	46.5	21.2	7	52.5	23.0	10.5	68.2	27.2	18.2	82.2	29.9	26.2
16	Height =162.5			Height =170.5			Height =178.8			Height =180.25		
	48.6	22.5	8	53.7	24.5	11.4	69.1	28.16	20.2	82.7	31.9	28.4
17	Height =163.9			Height =172.0			Height =178.5			Height =182.0		
	50.8	23.3	8.6	57.45	25.0	12.16	72.0	28.8	19.4	84.4	31.5	24.2

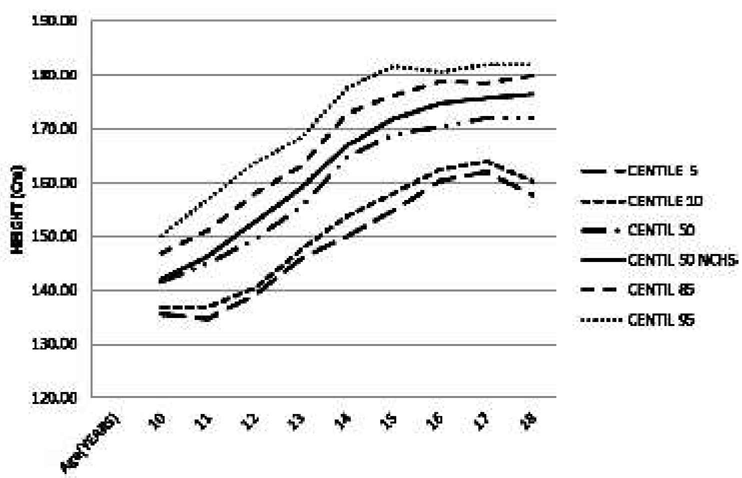

Fig. 1. Height in centilles of the boys aged 10 to 18 years as compared with W.H.O data

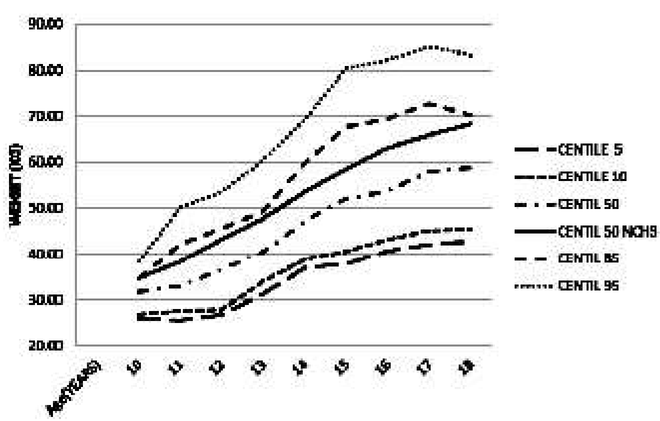

Fig. 2. Weight in centilles of the boys aged 10 to 18 years as compared with W.H.O data

The present study contributes valuable database regarding the growth profile of south Indian adolescent boys.

We observed a mean gain of 30 cms in height during the entire period of 8 years of adolescence. Comparison of height recorded from the selected boys to those of W.H.O values revealed better linear growth in the selected children in view of the fact that a mean difference of one centimeter appeared to exist in height between selected boys and W.H.O values at age 10 and 11 years (Table 2) .Nevertheless, with increase in age the differences in height widened and at 17 and 18 years, the mean difference in height was 5.0cms less, the participants boys were shorter. The mean height at 10th and 18th year was 142.7±4.10 and 172.1±7.15 cms respectively in the participant boys as against 141.8± 1.56 to 177.1 ±0.20cms of the W.H.O data. Although, the selected boys belonged to affordable section of the population had less linear growth as compared to international standards by 4.9 cms at the end of

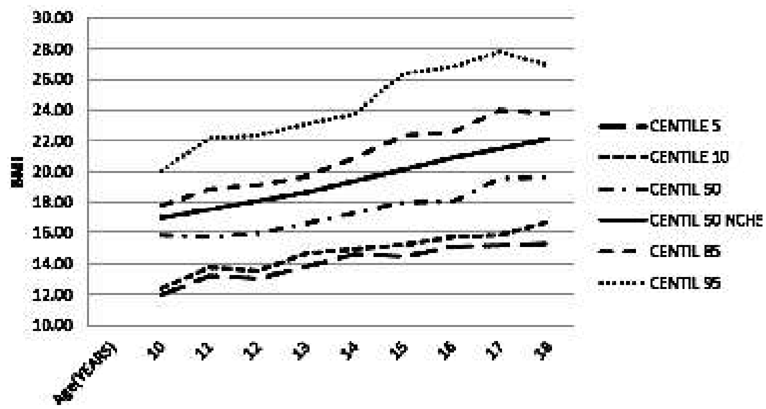

Fig. 3. BMI in centilles of the boys aged 10 to 18 years as compared with W.H.O data

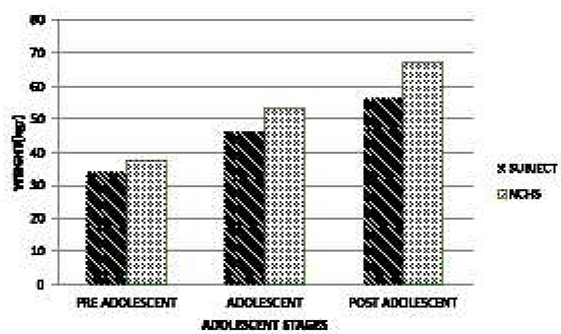

Fig. 4: Comparison of mean weight with nchs in 3 stage of adolescence

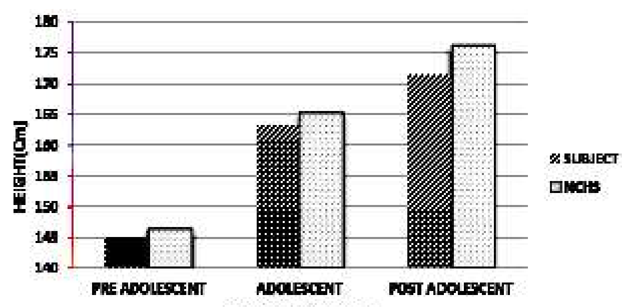

Fig. 5. Mean height compare with nchs in 3 stage of adolescence

adolescence period. At each point of comparison, boys were shorter by 1-2cms. Similarly, the boys were lighter by 3 to 7 kgs at every age point.

It could be right to mention that the selected boys belonged to middle and high income families possessed growth potential to the nearest to those of W.H.O at 50th centiles. The changes in MUAC and SFT due to increase in age was also linearly proportional; however, the observed values of MUAC and SFT of the selected boys were higher than those of the standard NHANES values. MUAC in participant boys was higher at ages 10 to 12 years which eventually decreased such that at the end of 18 years MUAC was essentially similar to the standard values. Similarly the values for SFT were also markedly higher for the participating boys as compared to the NHANES values. In comparison to the other measurements, SFT was markedly higher in the participants, mean SFT at 10th year was 11.70± 3.50 mm and continued to be higher during the entire period of adolescence. At 18th year mean SFT was 13.27±5.60mm as against 8.0mm for NHANES, it accounts for a mean increase in SFT by 1.57mm during adolescence period. On the other hand, the SFT standard values of NHANES exhibited a different trend, at 10th year SFT was 10 mm and increased to 11mm during 11 and 12 years thereafter declined to 8 mm at 15th year and remained constant thereafter. The difference in the SFT profile observed in the present study could be argued on the basis of the genetic predisposition of Indians towards higher proportion of body fat[27,28]. Since the boys selected for study were from middle and high income categories, there is a possibility for higher body fat content. The inference that the participant boys were shorter and lighter to their respective WHO standards at the three stages was typical to the developing countries (Sinnapah, 2009). In accordance to other reports we also observed a general tendency of being shorter and lighter (Fig. 4 &5), however, the pattern may differ when it is compared with the varying growth potentiality of the adolescence.

BMI is an index used to screen the proportion of body mass to linear height, evidently if the ratio is higher than the acceptable range indicates excess fat. It has been a useful measure of growth in children; W.H.O has provided a reference scale of BMI for comparisons (WHO 2007). Similar to the observations made with height and weight the mean BMI for the selected boys was lower than that of the W.H.O values. Although the differences in the values were small, at each point of comparisons, the selected boys had lower BMI as compared to the W.H.O standards. Unlike the height and weight, BMI exhibited marked differences between the observed and standard values. The selected boys had considerably lower BMI at age 10 and continued to be lower throughout the adolescent stages. The BMI although increased linearly with age the increase was less steep, after 16th and 17th year of age there was an obvious drop in BMI. Our results clearly indicate that the selected children attained linear growth very well while a catch up of weight was poor; this resulted into low profiles of BMI.

It was proposed to develop centile curves by distributing the participating boys into 5thto 95th centiles according to their height and weight for age and compared to 50th centiles of WHO (Fig. 1). It is evident that pattern of growth in selected boys was similar to 50th centiles of W.H.O; it was encouraging that boys at Ten year were as tall as the 50th centiles of American counterparts, but thereafter the height faltered by 1.3cms and declined thereafter. The values for the 85th and 95th centiles were markedly higher than those of the 50th centiles of the W.H.O (Fig. 1).

The glaring fact is that the Indian boys are markedly lighter than those of the American counterparts (Fig. 2). Weight distribution of boys from different age categories at 50th centiles indicated markedly lower mean values, although a linear relationship could be observed for weight for age. The mean increase at every age point was lower in participant boys (mean weight change was 1.5 to 4 kgs) as compared to those from W.H.O (mean weight change was 3 to 6 kgs). The weight corresponding to 85th and 95th centiles were markedly higher than that of 50th centile of W.H.O. It is apparent that the standard weights (W.H.O) at every age point appeared to fall between the 50th and 85th centiles of the participant boys. It is well recognized that Indian children in general and adolescents in particular are lighter and shorter than the American counterparts (Bhalla, 2011). The exercise performed indicates that it is worthwhile to have a local standard for comparisons, since the growth trend in selected boys coincides with the growth pattern of international standards. Therefore the present data at 60th centiles may be similar to those of the 50th centile of W.H.O.

BMI centiles of the study group was compared with W.H.O standard at 50th centile (Fig. 3). An essentially similar picture could be seen, i.e. 50th centile values of the present data were slightly lower to those of W.H.O values, indicating low gains in body mass among the selected children. However, the W.H.O values (50th centile) were markedly lower to the 85th centiles of the present data, it is therefore obvious that W.H.O values at 50th centiles could coincide with 60 or 65th centiles of the selected population. The selected boys had 15.8 BMI at 10th and increased to 19.6 at 18th year as against the W.H.O BMI values which varied from 16.9 to 22.0.

It was considered useful to present mean weight, MUAC and skin fold measurements of the boys falling into 10th, 50th, 85th and 95th centiles of height for age (Table 3).

It provides a guiding line to expect the approximate values of these parameters when height and age is known .They were considered useful to compare independently weight or other measurements corresponding to height at a given centile. This provides evidence that Indian children possess the capacity to grow as tall and as heavy as the American counterpart, however the proportion is small. The data for adolescence in 85th and 95th centiles were heavier and their BMI ranged between 22.0 and 25.0.

CONCLUSION

The present investigation provides substantial data regarding the growth pattern of adolescent boys during 10 to 18 years of age. It is evident that boys belonging to middle and high income families express their growth potentiality as close as to the WHO reference standards. In general there was a mean difference in height and weight varying from + 0.9 cm at 10th year to – 4.9 cms at 18th year. It is encouraging that boys at 10th year were as tall as 50th centile of WHO standard. A constant weight difference was noted during the entire period of adolescence. At 10th year the weight was 2.8kg less than the standard and at 18th year the boys were lighter by 9.5 kgs. However, when the boys were distributed into 85th and 95th centiles, the mean height was much higher to the 50th centiles, and the BMI was normal varying from 22.0 to 25.o. the MUAC and SFT were essentially similar to the NHANES

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