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Physical Dimensions and Dietary Intake of Boys from Military Training School

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ABSTRACT:

This study deals with assessment of anthropometric characteristics and dietary intake of boys undergoing military training. 90 boys aged 13-16 yrs were purposively chosen. Body fat was calculated based on skinfolds at biceps, triceps, subscapular and suprailiac. 24 hour's food intake data was collected for consecutive 3 days and energy and energy yielding nutrients were computed. Comparisons were done using 't' test. Correlations were derived using Pearson's Product Moment Coefficient of Correlation. Boys aged 13-14 and 15-16 yrs were found heavier than the standards for age and height. Body mass index correlated significantly with weight and body fat % (r = 0.5211 to 0.9235, $p<0.01$). Waist hip ratio increased with age and showed direct relationship with weight (0.1264, $p>0.05$ for 13-14; 0.4262, $0.01<p<0.05$ for 14-15 and 0.5447, $p<0.01$ for 15-16 yrs). Waist height ratio was found below 0.5. Conicity index correlated strongly with age, weight, waist hip ratio, waist circumference and body fat %. Body fat % of subjects ranged between 10.34 to 13.42 and correlated more strongly with mid upper arm fat area and mid upper arm fat index (r = 0.8600 to 0.9611, $p<0.01$). Energy intake of subjects was deficient and protein intake was excess than recommended dietary allowances ($p<0.01$). Energy intake showed strong positive relationship with weight, body mass index, mid upper arm muscle circumference and mid upper arm muscle area. It is concluded that various anthropometric measurements are correlated and dietary intake has clear impact on body dimensions and composition.

Keywords: *Anthropometry, Body fat, Conicity index, Energy intake, Protein intake.*

INTRODUCTION

Nutrition is a fundamental pillar of human life, health and development across the entire life span. From earliest stage of fetal development, at birth, and through infancy, childhood, adolescence and on into adulthood, proper food and good nutrition are essential for survival, physical growth, mental development, performance, productivity, health and well-being. Growth is a major factor which influences food needs of the children and adolescents. The child's diet also determines how well a child can grow (Ghai et al., 2004).

Underweight among school age children is commonly associated with low dietary intake and excessive energy expenditure whereas obesity is a result of excessive consumption of energy and low energy expenditure through sedentary life. The growth and development of children and adolescents is majorly dependent upon dietary intake. Physical growth of children is reflected by different anthropometric measurements especially weight and height. On the other hand, children's height and weight are good index for recognizing the nutritional status.

The physical growth of children and adolescents are reflected by different anthropometric measurements especially weight and height. The physical dimensions of the body are much influenced by nutrition in growing period of school age. Poor health and nutritional status affect work capacity as well as cognitive functions. And it is this age group that is a dynamic period of growth and development as children undergo physical, mental, emotional and social changes (Bharati et al., 2005).

Anthropometry provides non-invasive, easy and cheap but yet valuable information on nutritional status. Anthropometry is the measurement of certain parameters of the human body. It is frequently used to assess nutritional status in young children and adolescents[3]. Anthropometry has also been used to study the growth and development of school-aged children and adolescents. Mid upper arm circumference (MUAC) is an indicator of the amount of fat and muscle in the upper arm. Skinfold thickness measurements, taken at various places on the body, provide an estimate of the thickness of subcutaneous fat among children (WHO, 1995). Two people at the same height and same body weight may look completely different from each other because they have a different body composition. Active and leaner children have a body fat percentage lower than those who are physically inactive and fattier. Waist circumference remains the simplest clinical measure of childhood central obesity. It provides a better estimate of visceral adipose tissue than body mass index (BMI) (Muhammad et al., 2011).

Physical exercise is any bodily activity that enhances or maintains physical fitness and overall health and wellness. Frequent and regular physical exercise boosts the immune system, and helps prevent the "diseases of affluence" such as heart disease, cardiovascular disease, Type 2 diabetes and obesity. Physical exercise improves mental health, helps prevent depression, helps to promote or maintain positive self-esteem, and can even augment an individual's body image, which again is also linked with higher levels of self-esteem (Bailey, 2006).

It has been proved that exercising leads to better physical ability later in life and an overall development of the individual. The sound health in young children can be achieved at school level by starting regular training. Sports training schools and military training schools can be best choice to attain sound physical dimensions[5]. The main motto of military school is to imbibe soldierly qualities i.e.; physical fitness, self reliant, National love, discipline, and overall development of the children. It is with this background the proposed study has been carried out to assess anthropometric characteristics and dietary intake of military school boys.

MATERIALS AND METHODS

Study area: The study was conducted in Nagpur city, Maharashtra State, INDIA.

Sample population: 90 (ninety) boys (age group 13 to 16 yrs) were purposively selected from a very highly reputed military school of Nagpur, Maharashtra State, India. Mean age was found to be 13.47±0.51, 14.40±0.50 and 15.3±0.45 yrs and duration of military training was 3-5 yrs for subjects classified under age groups 13-14, 14-15 and 15-16 yrs.

Anthropometric measurements: Measurements of height, weight and shoulder width and body circumferences like chest, waist, hip, thigh, calf, wrist and mid upper arm were taken.

Height was measured using a stadiometer and weight was recorded using platform weighing balance. All body circumferences were measured using a plastic non stretchable tape.

Body mass index (BMI), Body surface area (BSA) (Mostellar, 1987), Waist hip ratio (WHR) (Bamji et al., 2004) and waist height ratio (WHtR) (Lazarus et al., 1996) were calculated. The conicity index (Taylor et al., 2000) was calculated as follows---

Conicity index = waist circumference ÷ [0.109 X (SQRT of weight (kg) ÷ height)] where waist circumference and height were measured in meters.

Skinfold measurements at four sites - biceps, triceps, subscapular and suprailiac were measured using a standard digital skinfold calipers (Fat Track). All skinfolds were measured on right side of the body in triplicate to avoid any bias reading; means were derived and taken as final reading. Prediction of body density and body fat % from skinfold thickness is an acceptable method for the assessment of body composition in childhood and adolescence. Body density of subjects was calculated using prediction equation of Durnin and Rahaman (1967) based on total of biceps, triceps, subscapular and suprailiac. Body fat % of subjects was calculated using equation of Siri (1961). Lean body mass of subjects was derived using equation of Katch and Mcardle (1983).

Arm anthropometry based on mid upper arm circumference (MUAC) and triceps, was assessed in terms of mid upper arm muscle circumference (MUAMC), mid upper arm muscle area (MUAMA), mid upper arm fat area (MUAFA) and mid upper arm fat index (MUAFI) using equations of Frisancho (1974) and Rovner and Zemel (2009).

Dietary intake: Food intake data of each subject was collected using 24 hour's dietary recall method. This was done to collect the data for consecutive three days. Energy, carbohydrate, protein and fat content of three day's diets were calculated using food composition tables (Gopalan et al., 2004).

Statistical analysis: Mean (M) and standard deviation (SD) were derived. Comparisons between the groups were done using 't' test. Correlations (r) were derived using Pearson's

Product Moment Coefficient of Correlation. Level of significance was tested at both 5 % & 1 % levels.

RESULTS AND DISCUSSION

Anthropometric measurements of subjects are presented in Table I.

Table I: Anthropometric measurements of subjects (M ± SD)

Variables	Age groups (years)			t values for comparison between age groups		
	13-14 (n=30)	14-15 (n=30)	15-16 (n=30)	13-14 and 14-15	13-14 and 15-16	14-15 and 15-16
Height (cm)	159.73 ± 7.71	166.21 ± 10.08	171.69 ± 8.77	11.15*	29.56*	14.02*
Weight (cm)	41.2 ± 7.74	45.29 ± 5.47	53.56 ± 4.09	5.49*	25.39*	15.14*
BMI (kg/m^2)	16.03 ± 2.14	16.19 ± 3.12	18.15 ± 3.47	0.17	13.14*	11.43*
Shoulder width (cm)	39.40 ± 1.68	40.04 ± 3.92	43 ± 3.23	3.17*	29.99*	16.89*
Chest circumference(cm)	71.29 ± 5.86	74.84 ± 9.13	78.89 ± 7.72	6.51*	20.76*	10.15*
Waist circumference (cm)	66.47 ± 7.05	68.08 ± 13.64	73.48 ± 10.58	1.75	14.66*	9.23*
Hip circumference (cm)	79.89 ± 6.08	80.9 ± 9.73	87.14 ± 8.31	1.28	19.62*	14.50*
Thigh circumference (cm)	41.31 ± 3.75	42.84 ± 5.29	45.78 ± 4.91	4.38*	19.63*	12.68*
Calf circumference (cm)	29.75 ± 2.46	30.74 ± 3.15	32.95 ± 3.32	4.67*	20.45*	14.19*
Wrist circumference (cm)	15.22 ± 0.99	15.49 ± 1.34	16.81±1.45	2.66*	23.99*	18.80*

MUAC (cm)	21.64 ± 2.09	22.36 ± 3.03	24.83 ± 3.10	3.53*	22.59*	16.13*
Biceps (mm)	2.97 ± 2.21	2.41 ± 1.78	2.49 ± 1.75	4.95*	3.78*	1.26
Triceps (mm)	6.7 ± 3.65	6.63 ± 4.25	8.49 ± 5.04	0.75	6.60*	6.96*
Subscapular (mm)	4.7 ± 2.25	4.46 ± 2.04	6.54 ± 4.31	2.46●	9.07*	10.83*
Suprailiac (mm)	5.81 ± 3.79	5.01 ± 3.36	6.33 ± 3.96	3.76*	2.84*	6.76*
Body surface area (m^2)	1.35 ± 0.16	1.44 ± 0.22	1.59 ± 0.18	6.69*	29.27*	16.91*
Waist: height ratio	0.42 ± 0.04	0.41 ± 0.06	0.43 ± 0.06	3.21*	4.30*	6.25*
Conicity index	1.2074 ± 0.08	1.2029 ± 0.17	1.2115 ± 0.08	0.53	0.81	1.03
Waist: hip ratio	0.8313 ± 0.05	0.8340 ± 0.08	0.8410 ± 0.06	0.59	2.60●	1.42
MUAMC (mm)	195.15 ± 18.77	202.10 ± 21.83	221.65 ± 24.40	4.97*	22.80*	16.91*
MUAMA (mm^2)	3058.4 ± 621.1	3287.0 ± 769.3	3955.8 ± 864.2	4.74*	21.99*	16.07*
MUAFA (mm^2)	419.0 ± 352.5	464.8 ± 458.1	683.0 ± 624.1	0.66	8.58*	7.49*
MUAFI	11.46 ± 9.06	10.76 ± 9.05	13.49 ± 10.08	2.24●	3.63*	5.75*
Body fat %	11.48 ± 6.31	10.34 ± 6.67	13.42 ± 6.24	3.50*	5.97*	9.46*
Lean body mass (kg)	36.14 ± 5.46	40.02 ± 8.62	46.00 ± 8.27	7.89*	27.95*	15.58*

MUAC-Mid upper arm circumference; MUAMC- Mid upper arm muscle circumference; MUAMA- Mid upper arm muscle area; MUAFA- Mid upper arm fat area; MUAFI- Mid upper arm fat index

* - Significant at both 5 % and at 1% levels ($p<0.01$).

● - Significant at 5 % level but insignificant at 1 % level ($0.01<p<0.05$).

't' values without any mark indicate insignificant difference at both 5% & 1% levels ($p>0.05$).

Boys were found taller than standards for height for age (t = 3.48, 4.97 and 4.88, respectively for 13-14, 14-15 and 15-16 yrs, $p<0.01$). Boys from age groups 13-14 and 15-16 yrs were found heavier than the standards for age and height ($p>0.05$). In contrast, 13-14 yrs boys were unable to meet the standards of body weight ($p>0.05$). Growth of subjects in terms of height and weight was highly significant ($t = 11.15$ to 29.56 for height and 5.49 and 25.39 for weight). Age wise increment in height and weight was highly significant in all groups indicating growth spurt. However, differences were greater between 13-14 and 15-16 yrs groups.

Age wise rise in the mean BMI values was noticed. Insignificant differences existed between age groups 13-14 and 14-45 yrs for BMI ($t = 0.17$, $p>0.05$). Differences were highly significant between age groups 14-15 and 15-16 as well as between 13-14 and 15-16 yrs for BMI ($p<0.01$). Interpretation of BMI was done in terms of Z scores. A negative Z score for BMI was obtained for 15-16 yrs boys (-1SD). Boys from age groups 13-14 and 14-15 yrs had Z scores in the range of 1 SD to 2 SD and hence categorized as normal as far as their BMI for age is concerned. Positive correlations ($p<0.01$) existed between BMI and weight for all groups under present study (r 0.8954 to 0.9265). Body mass index was highly correlated with body fat % ($r = 0.5211$ to 0.8664, $p<0.01$). Similar findings were postulated by Bray et al. (2001) among 10 yr old children.

Mean values for body surface area were 1.35, 1.44 and 1.59 m^2 for boys from age groups 13-14, 14-15 and 15-16 yrs, respectively. Significant increase in body surface area with age was noticed among boys indicating growth spurt.

Age wise increase in measurements of shoulder width, chest circumference, waist circumference, hip circumference, thigh circumference, calf circumference, wrist circumference and MUAC was noticed (Table I). Differences for body circumferences were significant between age groups 14-15 and 15-16 as well as between13-14 and 15-16 ($p<0.01$). Wrist circumference and MUAC correlated well with body weight in all age groups ($r = 0.5748$ to 0.9308, $p<0.01$). Increment in body circumference measurements was more from age of 14 yrs. As per the percentile data of Kurian et al. (2011), mean values of waist circumference of subjects from all three age groups under this study were near to 50^{th} percentile. WHR was also found to be increasing with the age. It showed direct relationship with weight in all three age groups (0.1264, $p>0.05$ for 13-14; 0.4262, $0.01<p<0.05$ for 14-15 and 0.5447, $p<0.01$ for 15-16 yrs).

Significant differences between age groups were noticed for WHtR (t = 3.21, 4.30 and 6.25, respectively for 13-14, 14-15 and 15-16 yrs, p<0.01). Conicity index of subjects ranged from 1.2029 to 1.2115. Waist: hip ratio for 13-14, 14-15 and 15-16 yrs subjects was found to in the range of 0.8313 to 0.8410. WHtR has been proposed as an alternative measure for assessing central fatness in children (Weili et al., 2007). Mean WHtR values of subjects from all age groups were found to be well below 0.5. However, subjects from age group 14-15 yrs had lower mean value of WHtR than subjects from age group 13-15 yrs. Mccarthy and Ashwell (2006) also reported decrease of waist: height ratio with age.

Slight insignificant decrease in mean value of conicity index of 14-15 yrs subjects as compared to 13-14 yrs subjects was noticed (p>0.05) which could be attributed to higher body weight of 13-14 yrs subjects and/or more height of 15-16 yrs subjects. Conicity index correlated well with body weight and body fat content, however, correlations became stronger with age (r = 0.0074 to 0.5651 for weight and 0.0395 to 0.3759 for body fat %). Correlations between conicity index and waist hip ratio were significantly higher (r = 0.8880 to 0.9672, p<0.0)1 in subjects from all three age groups than were correlations between conicity index and waist circumference (r = 0.6353 to 0.8405, p<0.01) or between conicity index and BMI (r = 0.0200 to 0.5753) or between conicity index and MUAC (r = 0.0475 to 0.6157). Relationship of conicity index with BMI and MUAC was however, age related. Results clearly showed that conicity index performs well as an index of central adiposity in children and adolescents between age group 13-16 yrs.

Mean tricep measurements (6.33 to 8.49 mm) of subjects from all groups were found greater than biceps, subscapular and suprailiac measurements. Boys presented a decrease of biceps, triceps, subscapular and suprailiac until 14-15 yrs, then an increase of triceps, subscapular and suprailiac was considerable at 15-16 yrs. Triceps and subscapular measurements in subjects from all three age groups demonstrated direct relationship with weight (r = 0.5002 to 0.6561 and 0.5703 to 0.6698, respectively, p<0.01). Similarly, these two skinfold measurements also showed positive and significant correlations (p<0.01) with MUAC (r = 0.4521, 0.7903 and 0.6226 between triceps and MUAC and r = 0.4673, 0.7299 and 0.7218 between subscapular and MUAC, respectively, for subjects from 13-14, 14-15 and 15-16 yrs age groups). Triceps skinfold reflected a significant positive correlation with BF % in all three groups (r 0.8821 to 0.9026, p<0.01) thereby indicating triceps skinfold as one of the strongest predictor of body fat content. The cutoff point in % BF for overweight and obesity in children and adolescents has not been clearly established. Suggested cutoff point of 20% BF for obesity by Ara et al. (2004) which was found to be much higher than a body fat % values of 10.34 to 13.42 % for subjects under this study. Ara et al. (2004) noticed body fat % as 20.48 in physically active pre-pubertal boys. It is postulated that higher the fat fold higher the weight (Mckeang, 1991). Findings of the present study go well with this wherein body fat % and lean body mass reflected a direct relationship with weight.

Body fat % ranged between 10.34 to 13.42 and lean body mass ranged between 36.14 to 46 kg. Differences in increment of both these values were high and significant (t = 3.50 to 27.95, p<0.01). Body fat % and lean body mass showed direct relationship with weight (r = 0.7057 and 0.9398 for 13-14, 0.7623 and 0.9770 for 14-15 and 0.5335 and 0.9018 for 15-16 yrs, respectively, p<0.01). Body fat % reflected positive relationships with BMI (r = 0.5211 to 0.8664, p<0.01); wrist circumference (r = 0.6358 to 0.7434, p<0.01) and WHR (r = 0.1599 to 0.2944, p>0.05).

Mean MUAMC, MUAMA and MUAFA showed age related increment (Table I). Between group differences for MUAMC and MUAMA were significant (p<0.01). Increase of MUAFA from age 13-14 to 14-15 was insignificant (t = 0.66, p>0.05). MUAC and arm fat area measurements showed positive and significant correlations with weight (r = 0.3879 to 0.9308, p<0.01). Arm fat area measurements are most suitable for adiposity screening in prepubertal and pubertal boys (Candido et al., 2011). For the present investigation, MUAFA and MUAFI correlated more strongly with body fat % as compared to MUAC (r = 0.8600 to 0.9611, p<0.01). With increase in age correlations of MUAMC and MUAMA with body fat % were more significant and prominent.

Data on mean daily intake of energy and energy giving nutrients is presented in Table II.

Table II: Data on daily intake of energy and energy giving nutrients of subjects (M ± SD)

Variables	Age groups (years)			t values for comparison between age groups		
	13-14 (n=30)	14-15 (n=30)	15-16 (n=30)	13-14 and 14-15	13-14 and 15-16	14-15 and 15-16
Energy (kcal)	2513 ± 171	2447 ± 332	2581 ± 42	**1.69**	**1.90**	**3.16***
Carbohydrate (g)	402 ± 43.01	388 ± 59.62	423 ± 72.98	**3.91***	**5.29***	**6.12***
Fat (g)	69 ± 7.73	67 ± 14.18	65 ± 8.31	**1.13**	**2.31**	**0.27**
Protein (g)	71 ± 6.85	73 ± 11.08	76 ± 11.90	**0.99**	**13.46***	**12.32***

* - Significant at both 5 % and at 1% levels (p<0.01).

't' values without any mark indicate insignificant difference at both 5% & 1% levels (p>0.05).

Mean daily energy intake of subjects from all age groups was found to be less than recommended dietary allowances (RDAs) of NIN/ICMR (2009) (p>0.05). No greater variations were noticed between subjects from age groups 13-14 and 15-16 yrs for mean daily intake of energy. Carbohydrate intake of subjects showed significant variations among all three age groups (p<0.01). Not many variations were noticed for mean fat intake of subjects from all groups. Age wise increase in the amount of protein consumption was noticed. Subjects exceeded their requirements for protein intake. Even though dietary intake of children under present study was found to be satisfactory, lesser intake of energy among subjects than RDAs could be attributed to increased energy demands for daily activities and growth. Energy % derived from carbohydrate, fat and protein ranged between 63.43 to 65.56, 22.67 to 24.71 and 11.30 to 11.93, respectively. Protein intake of subjects from all age groups was found to be more than RDAs (p<0.01), however, variations between age groups 13-14 and 15-16 as well as between 14-15 and 15-16 were significant for protein intake ($p<0.01$). Younger subject's daily fat consumption was higher than the older ones.

Energy intake had better relationship ($0.01<p<0.05$) with weight, BMI and MUAC than with body fat %, conicity index and WHR in all subjects ($p>0.05$). Correlations of energy intake with triceps and subscapular skinfolds were found to be age dependent which indicates positive effect of dietary intake of food on weight gain.

Arm anthropometry measures especially MUAMC and MUAMA showed very strong and positive relationship with intake of energy among subjects from age groups 13-14 and 14-15 yrs ($r = 0.5664$ to 0.5743, $p<0.01$); however, no such observations were seen for subjects from age group 15-16 yrs.

It is concluded that various anthropometric measurements are correlated and dietary intake has clear impact on body dimensions and composition. Nutrition not only plays a role in growth and development in school going children and adolescents but it also helps to maintain body weight & other dimensions. For children and adolescents, the diet must therefore provide the optimal mixture of macro nutrients to fuel their special needs.

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