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MATURITY GRADIENTS AND FRAME SIZE AMONG ADOLESCENT BOYS OF YAMUNANAGAR (HARYANA)

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ABSTRACT

The present study aims to evaluate growth pattern, maturity gradients and frame size among 200 adolescent boys, ranging in age from 11to 18 years and belonging to District Yamunanagar, Haryana. Humerus bicondylar as well as femur bicondylar diameters were taken on each subject using standard techniques. Both the diameters showed an increasing trend with the advancing age with maximum annual gain during 14 to 15 years (0.39 cm)for Humerus bicondylar diameter and during13 to 14 years (0.36cm) for femur bicondylar diameter . Comparison of mean values of both the diameters expressed in percentage of their adult values amongst themselves indicated that it was femur bicondylar diameter which surpassed in maturity to humerus diameter up to 16 years, whereafter , humerus bicondylar diameter was ahead in its maturity status. Results of the study have also been compared with the existing studies. According to standards given by Metropolitan Life Insurance Company (1983) for American men based on the humerus bicondylar diameter as per their body size (height), the frame size was termed as 'small' (<6.4 cm), 'medium' (6.4 to 7.2cm) and 'large' (> 7.2 cm) When compared with these standards, boys of the present study showed 'medium' frame size with their mean values varying between 6.50 and 6.64 cm.

Key Words: Frame size, maturity gradients, humerus bicondylar diameter, adolescents

INTRODUCTION

Regular anthropometric assessment of populations is necessary to provide key information on their health status. The, bodily proportions of a child change with the advancing age .An estimation of this change provides a measure of maturity. Different bodily dimensions grow at different rates and the sequence of their reaching maturity status also differs with respect to different segments. Human beings follow a cephalo-caudal gradient of growth, the pattern of growth common to all mammals. A special feature of the human pattern is that between birth and puberty the legs grow relatively faster than other post-cranial body segments (Bogin

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et al. 2010). A maturity gradient exists in lower and upper limbs running from advanced maturity distally to delayed maturity proximally.

Weight and height are the most commonly used measurements to monitor growth status of children and adolescents. Frame size is a descriptive term for skeletal size that together comprises the body's supportive structure (Himes, 1991). Skeletal dimensions contribute to the frame size of an individual and are important components of height and weight. The importance of frame size lies while considering overweight, the health consequences of a given high level of weight for height are more severe for individuals with relatively smaller skeletal frame and muscularity (fat free mass) compared to individuals whose fat free mass is relatively large. A variety of body breadths have been suggested as measures of frame size i.e. shoulder breadth, hip breadth, chest breadth , wrist breadth, elbow breadth, knee breadth and ankle breadth (Grant, 1980; Frisancho and Flegel, 1983; Garn *et al.*, 1983; Frisancho, 1984, Himes and Bouchard, 1985).However, categorization of frame size is most frequently made by using measures of elbow breadth.

Metropolitan Life insurance (1983) published height weight tables based on pooled data from approximately 4.2 million insurance policies in the United States and Canada.and frame size was determined according to elbow breadth (bicondylar breadth of the humerus), and the elbow reference values were obtained from the 25th and 75thpercentiles within height categories for United States adults participating in the First Health and Nutrition Examination Survey (HANES 1). Frisancho and flegel (1983) published that elbow breadth can be used as an indicator of frame size as it is least affected by age and adiposity. Moreover, it has been validated and has reference standards. Small, medium and large categories were established depending on whether the elbow breadths were below 15^{th}, below the 15^{th} and 85^{th} or above 85^{th} sex, age and race specific percentile for elbow breadth derived from the HANES –I of 1971to 1974.For males of 18-24 years a value ≤ 6.7 was small ;> 6.7 and < 7.5 was medium and > 7.5 was large. Frisancho(1990) gave classification of frame size based upon a new index called frame Index 2 derived from measurements of elbow breadth, height and age. To determine frame size three categories of small, medium and large corresponding to values below 25^{th}, from 25^{th} to 75^{th} and above 75^{th} sex and age specific percentiles of frame index 2 were determined.

A review of literature reveals very few recent studies on growth gradients as well as on frame size of adolescents (Singh *et al.* 2007; Khariyal *et al.* 2012; Debashis, 2014; Harashawaradhana, 2015). Therefore, it is imperative to examine maturity gradients and monitor the frame size of adolescent boys of Yamunanagar to augment data in this direction.

MATERIAL AND METHODS

The present cross-sectional study has been conducted on a sample of 200 adolescent semi rural boys, ranging in age from 11to 18 years and residing in various villages of Tehsil Bilaspur and Chhachhurauli in District Yamunanagar. The subjects were

selected from the four schools, two from each Tehsil. The data were collected from Government model Sanskriti senior secondary school, Bilaspur; New Happy public school, Bilaspur and Government senior secondary school and college, Chhachhrauli and Guru Nanak Public School, Chhachhrauli in September and October, 2010. Humerus and Femur bicondylar diameters were taken on each subject following techniques given in (Weiner and Lourie, 1981).Additional information was also obtained from each subject on age, caste, family composition, family income, educational and occupational background and dietary habits through personal interview based on schedule Date of birth of each subject was recorded from school registers to know the exact age. The age was then converted into decimal age following decimal age calendar given by Tanner *et al.,* (1966). The sample boys were divided into eight age groups each of the magnitude of one year. Only apparently healthy children without any history of chronic illness were included in this study. A 24 hour dietary recall method was used to record their dietary pattern. The general information about the socio-economic status of the subjects was measured in terms of educational and occupational status of their parents through interview schedule. The findings revealed that only 8.50% fathers and 18% of mothers were illiterate. Rest of the parents were literate and had obtained education through various levels: up to Primary level(20.00% fathers and 24.50% mothers), middle school (24.50% fathers, 22.00% mothers), high and higher secondary school (33.50% fathers and 30.00% mothers), and graduation/post graduation (13.50% fathers and 5.50% mothers). Majority (83%) of the mothers were housewives. Most of the fathers were engaged in agriculture (39%); 21.50% were shopkeepers; 17% were in service; 13% were laborers and 9% were skilled workers. They all belonged to low middle socio-economic group. No attempt was made to exclude any subject on the basis of their parental attributes. The staple diet of respondents consisted of wheat, rice, pulses, and seasonal vegetables. Cauliflower, brinjal and cabbage along with potatoes were most frequently eaten vegetables. The number of meals varied from two to three meals a day depending upon the schools. While the students of government schools were taking midday meal at the school as it was provided by school, they ate three meals a day. The boys who were studying in the private school were taking two meals and had some snacks during lunch time. Generally, all the boys had chapattis or paranthas with pickle in the morning but at dinner time they had rice or chapatti with dal and only a few used to take milk before they sleep.

RESULTS

Descriptive statistics for humerus bicondylar diameter of semi rural adolescent boys of District Yamunanagar have been given in table 1. The mean values for this diameter showed an increase with the advancing age .From the distance curve (Fig. 1) as well as from the table, it is evident that the maximum gain has been observed between 14 to 15 years (0.39 cm). The minimum value was observed at 13 years i.e. 5.62 cm and the maximum value of 6.64cm was witnessed at 18 years. The overall gain over the period of eight years is 1.02 cm. or 17.94%.

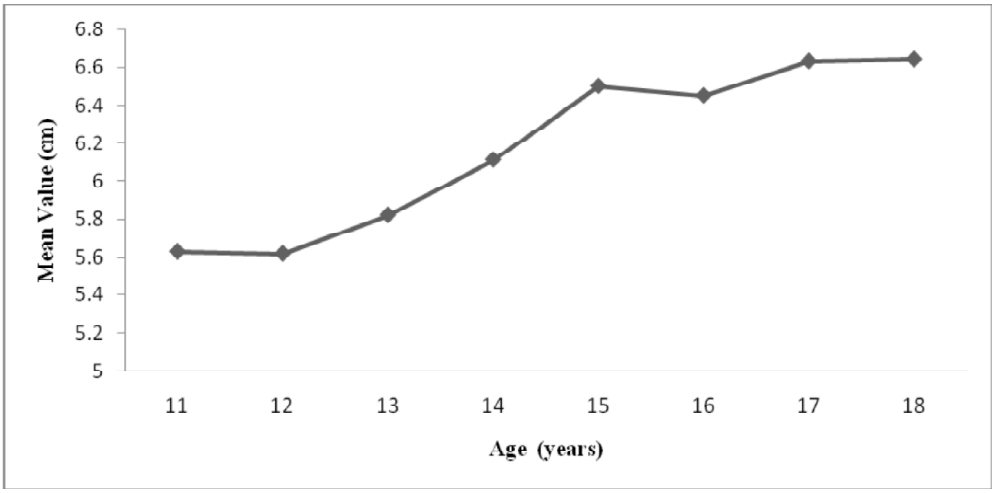

Figure 1: Distance curve for Humerus bicondylar diameter of adolescent boys of District Yamunanagar

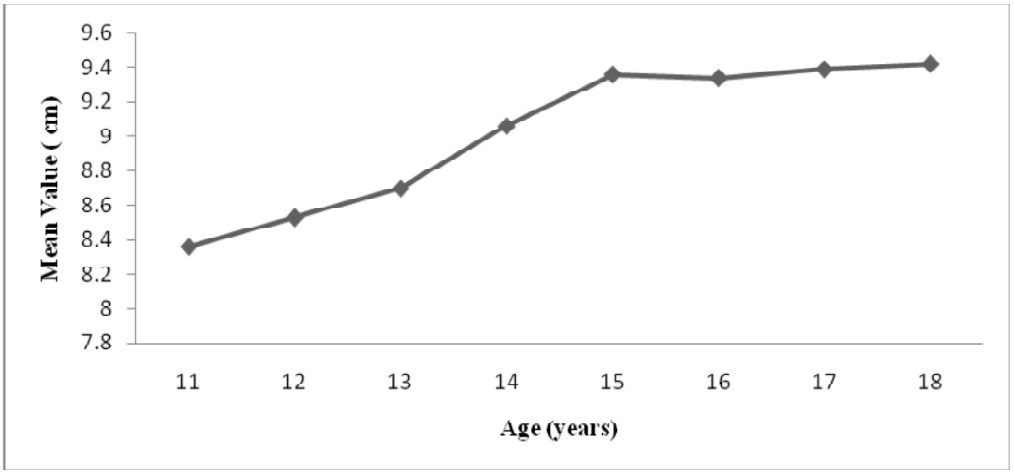

Figure 2:. Distance curve for Femur bicondylar diameter of adolescent boys of District Yamunanagar

Table 2 presents descriptive statistics for femur bicondylar diameter of semi rural adolescent boys of District Yamunanagar.Starting with an initial value of 8.36 cm. at 11 years , this diameter reaches its adult value of 9.42 cm. at 18 years, thereby, showing a maximum gain of 0.36cm.between 13 and 14 years.The distance curve shows a steep rise from 13 to 15 years indicating accelerated growth during this period. The overall gain over the period of eight years is 1.06 cm. or 12.68%.

The percentage of adult value attained by adolescent boys of Yamunanagar at each age for humerus bicondylar and femur bicondylar diameters is presented in table 3. Comparison of mean values of both the diameters expressed in percentage of

their adult values amongst themselves indicate that it is femur bicondylar diameter which surpasses in maturity to humerus diameter up to 16 years, whereafter, , humerus bicondylar diameter is ahead in its maturity status.

DISCUSSION

It is well documented that different parts of our body grow at different rates and the sequence of their reaching adult size also differs from one segment to another. The bodily proportions of a child change with the advancing age .An estimation of this change provide a measure of maturity. In general, head is at all ages in advance of the trunk, which in turn is advance of the limbs. Similarly, many studies have shown that a maturity gradient exists in lower and upper limbs running from advanced maturity distally to delayed maturity proximally with the fact that girls are more advanced to maturity than boys (Tanner, 1962;1978; Marshal, 1977; Nath and Chacko, 1988; and Singh and Sidhu, 1981; Nath, 1987; Kaur *et al.,* 2000 and Singh, 2000; Singh, 2007). As explained by Tanner (1978) the origin of growth gradient has its basis in the embryonic limb buds due to difference in the concentration of some chemical substance deposited differentially in the three segments of the extremities. Moreover, changes in the sensitivity of bone growth plates to growth promoting and inhibiting factors at different times during development, and at different sites of the skeleton, are also known to be responsible for differential growth of body segments (Kajantie, 2003; Serrat *et al.,* 2007).

The results of the present study clearly demonstrate that femur bicondylar diameter is ahead in its maturity status till 16 years as compared to humerus bicondylar diameter but at 17 years femur bicondylar diameter lags behind, thereby, indicating comparatively faster rate of growth of humerus bicondylar after 16 years among adolescent boys of Yamunanagar. Our results are in consensus with the findings reported by Singh *et al.* (2007) among Spitian boys. In their study femur bicondylar diameter was ahead in maturity till 15 years whereafter, humerus diameter took the lead. Kharyal *et al.* (2012) in their study on Garhwali and Jaunsari Rajput females revealed the existence of both cephalo-caudal and caudo-cephalic directions of maturation for upper arm length, forearm length, head length and stature. Harashawaradhana (2015) reported that among Jain adolescents of Delhi, almost all the body measurements exhibited an accelerated growth from 11 to 18 years, being the adolescent period and most of the body dimensions exhibited the existence of cephalo-caudal gradients.

Skeletal dimensions contribute to the frame size of an individual and are important components of height and weight. Many studies have proposed various body breadth measures such as biacromial diameter, bicristal diameter elbow breadth , wrist breadth ankle breadth and knee breadth to estimate frame size(Grant, 1980; Frisancho and Flegel, 1983; Garn *et al.,* 1983; Frisancho, 1984). Out of all these breadths, elbow breadth or humerus bicondylar breadth has been most frequently used. Facchini *et al.* (2003 published that although elbow breadth did not exhibit highest correlation with muscularity indices among non-Caucasian populations,

its constantly lower association with adiposity indexes shows that it is a better index of frame size as compared to biacromial and bicristal breadth.

Metropolitan life insurance in (1983) published weight for height tables on pooled data from the United states and Canada and also determined frame size on the basis of elbow breadth. It made three categories of skeletal frame as small, medium and large for use in insurance purposes. The persons falling with the range of25th and 75th centiles within height categories for U. S. adults of participating in first Health and Nutritional Examination Survey were referred to as being medium, those below 25th centile as small and above 75th centile as large. For men of 18-24 years, a value of ≤ 6.4 indicated small frame size; medium had a range of 6.4to 7.2 and large was ≤ 7.2.

When compared with the standards for frame size given by Metropolitan Life Insurance Company for 18 -24 years men, the adolescent boys at 18 years exhibit a value of 6.64 cm. thereby, confirming to medium frame size. In fact they attain a value of 6.50at the age of 15 years which grows to 6.64 cm at 17 years indicating a tendency towards medium frame size after the adolescent spurt. Using the same standards Singh *et al.* (2007) designated Spitian young adults between 18 to 20 years s on the 'borderline' between the small and medium frame size. Thus, the Spitians are lightly built than the boys of Yamunanagar. Frame size is genetically determined but environmental factors modify it and bring about the differences in different ethnic groups.

Frisancho (1990) gave classification of frame size based upon a new index called frame Index 2 derived from measurements of elbow breadth, height and age. To determine frame size categories of small, medium and large sex specific percentiles of frame index 2 were determined. Debaashis (2014) conducted a study on frame size of Khasi boys using this classification, designated 85% adolescents in Small frame size category .and attributed it to poor muscles at arm because of poor consumption of nutrients required for muscular development. Chumlea et.al. (2002) studied relations between frame size, body composition and bone mineral status among men and women and concluded that frame size was closely associated with fat free mass and total body fat than with bone mineral content and bone mineral density.

Table 1: Descriptive statistics for Humerus-bicondylar diameter according to age among adolescent boys of District Yamunanagar

AGE (Years)	*N*	*MEAN*	*S.D.*	*S.E. of MEAN*	*C.V.*	*RANGE*	
						(Min)	*(max)*
11	25	5.63	0.61	0.12	10.81	5.00	8.00
12	25	5.62	0.51	0.10	9.12	4.70	6.80
13	25	5.82	0.43	0.09	7.44	4.40	6.50
14	25	6.11	0.45	0.09	7.38	5.00	6.80
15	25	6.50	0.47	0.09	7.19	5.30	7.00
16	25	6.45	0.41	0.08	6.34	5.80	7.30
17	25	6.63	0.35	0.07	5.34	6.00	7.40
18	25	6.64	0.47	0.09	7.09	5.50	7.80

Table 2: Descriptive statistics for Femur- bicondylar diameter according to age among adolescent boys of District Yamunanagar

AGE (Years)	*N*	*MEAN*	*S.D.*	*S.E. of MEAN*	*C.V.*	*RANGE*	
						(Min)	*(max)*
11	25	8.36	0.62	0.12	7.41	7.20	10.00
12	25	8.53	0.62	0.12	7.25	7.50	9.80
13	25	8.70	0.52	0.10	5.95	7.80	9.60
14	25	9.06	0.68	0.14	7.54	7.50	10.40
15	25	9.36	0.84	0.17	9.03	7.50	12.00
16	25	9.34	0.54	0.11	10.58	8.40	10.50
17	25	9.39	0.33	0.06	3.50	8.50	10.00
18	25	9.42	0.54	0.11	5.78	8.50	10.70

Table 3: Maturity gradients for Humerus and Femur bicondylar diameters among adolescent boys of District Yamunanagar Haryana.

Age group/anthropometric variables	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
Humerus bicondylar	84.79	84.64	87.65	92.02	97.89	97.14	99.84	100
Femur bicondylar	88.75	90.55	92.36	96.18	99.36	99.15	99.68	100

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