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ADIPOSITY MEASURES AND CARDIOVASCULAR FUNCTIONS AMONG PREADOLESCENT AND ADOLESCENT FEMALES OF SOLAN DISTRICT, HIMACHAL PRADESH

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The study aims to see the age related changes in anthropometric and physiological characteristics and association between adiposity measures and cardiovascular functions among preadolescent and adolescent females of mid altitude Himalayas. Growth pattern diverge at time of preadolescence and adolescence. The present study was conducted by cross-sectional method among 125 growing Rajput females ranging from 9 years to 16 years of Solan district, Himachal Pradesh. The adiposity was assessed by body mass index (BMI), waist-to-hip ratio (WHR) and grand mean thickness (GMT). There is an increase in BMI with age in the present study and the highest mean value is found at the age of 16. As far as correlation between cardiovascular functions and adiposity measure are concerned there is a significant correlation between blood pressure with BMI, GMT and WHR till 12 years, but in the later years no such pattern was observed.

Keywords: Anthropometry, Rajput females, Body Mass Index.

Introduction

Many changes both structural and functional in the human body are witnessed with the increasing age. These changes could be attributed to growth and development which starts right from conception and also due to environmental conditions such as nutritional pattern, physical activity level, health status etc experienced by the human body. Increasing body fatness is accompanied by profound changes in physiological functions. These changes are to a certain extent, associated with the regional distribution of adipose tissue. Body fatness and its distribution is a useful epidemiological and clinical marker of health risks among humans. Adiposity is the result of an excessive number and/or size of white adipose cells. At an individual level, a combination of excessive caloric intake and a lack of physical activity are thought to explain most cases of adiposity (Lau *et al.* 2007). A limited number of cases are due primarily to genetics, medical reasons, or psychiatric illness (Bleich *et al.* 2008). Anthropometry is widely accepted tool for measuring adiposity of the human. Studies in this regard reveal that BMI, WC, WHR, GMT are good indicators for adiposity measures of the preadolescent and adolescent females. According to Barness *et al.* (2007) adiposity is a leading preventable cause of death worldwide, with increasing prevalence in adults

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and children, and is viewed as one of the most serious public health problems of the 21st century. Excessive body weight is associated with various diseases, particularly cardiovascular diseases, diabetes mellitus type 2, obstructive sleep apnea, certain types of cancer, and osteoarthritis (Haslam *et al.* 2005). It has been very recently observed by Kotchen *et al.* (2008) that blood pressure levels and the prevalence of hypertension are related to adiposity, the main components of adiposity being BMI, waist/hip ratio, waist/height ratio (WHtR) and percent body fat.

Taking the above issues into consideration, the present study on the association of different anthropometric parameters of adiposity and blood pressure was designed in the Solan district of Himachal Pradesh.

Materials and Methods

Keeping in mind the objective of the study, data on anthropometric and physiological measurements were collected by using cross- sectional method on 125 preadolescent and adolescent females in the age groups 9 to 16 years of Solan district, Himachal Pradesh. The data was collected from the schools in that area; besides some data was also collected from home visits. Age was recorded by the verbal/recall response of the subjects. An exhaustive proforma was catered to obtain general data of the population under study. The general information collected from the mating pattern (constructed using maternal and paternal subcastes) established the fact that the Rajputs follow the rule of caste endogamy and sub-caste exogamy. Different body measurements were taken on each individual such as height vertex, body weight, mid upper arm circumference, waist circumference, maximum hip circumference, skinfold thickness at biceps, triceps, subscapular, suprailiac, calf posterior, blood pressure both systolic and diastolic, heart rate, pulse rate and breath holding time. These measurements were taken according to the standard recommendations of Weiner and Lowrie (1981). For assessing the adiposity measures of preadolescent and adolescent females various anthropometric indices were adopted like body mass index, waist-hip ratio and grand mean thickness and statistical methods were used to calculate mean, standard deviation, t-test value and correlation to draw meaningful conclusions. Mean standard deviation and t-value were used to assess the changes in successive ages, while an attempt has been made to correlate adiposity measures with blood pressure. The statistical data was analyzed by SPSS version 15 evaluation product package and excel program itself.

Results

The basic information of the Rajput females of the Solan district, Himachal Pradesh (Table 1) indicates a gradual increase in mean stature, body weight with age. The increase in height vertex from 9 to 12 years was found to be statistically significant

and increase in body weight from 13 to 14 years and 14 to 15 years was also found to be statistically significant. An increasing trend was observed in mid upper arm circumference though at 12 years a slight decreasing pattern was observed.

TABLE1: BASIC DATA OF RAJPUT FEMALES IN DIFFERENT AGE GROUPS.

Variables Age(yrs)	*N*	*Height (cm) Mean±SD*	*t- value*	*Weight(kg) Mean±SD*	*t-value*	*MUAC(cm) Mean±SD*	*t- value*
9	8	123.0±4.06		18.9±2.90		16.1±1.0	
10	8	128.2±4.24	2.488*	22.6±4.75	1.875	19.1±9.1	.937
11	12	135.8±6.78	2.799*	26.7±5.4	1.742	17.4±1.7	.633
12	13	141.0±5.95	2.070*	27.6±6.0	0.468	17.0±1.4	.605
13	9	143.9±5.70	1.114	31.0±5.5	1.601	17.3±1.5	.367
14	25	150.0±5.98	2.671*	36.5±5.3	2.679*	19.6±1.6	3.778***
15	16	152.2±10.90	.858	41.5±4.3	3.198**	20.0±3.2	.533
16	34	154.8±5.55	1.108	44.0±5.4	1.624	21.9±1.7	2.728**

*p<0.05 **p<0.01 ***p<0.001;
MUAC- Mid Upper Arm Circumference

Table 2 displays various adiposity measures among Rajput females in different age group. In this table BMI and WC showed an increasing trend with age but WHR and GMT does not show consistent pattern in subsequent age groups. The maximum mean value of waist-hip-ratio was found at 10 years (.879cm). The increase in body mass index and waist circumference and grand mean thickness from 14 to 15, 15 to 16 were found to be statistically significant.

TABLE 2: ADIPOSITY MARKERS: BMI, WHR, WC, GMT OF THE SUBJECTS

Variables Age(yrs)	*N*	*BMI (kg/m^2) Mean±SD*	*t-value*	*WHR Mean±SD*	*t-value*	*WC (cm) Mean±SD*	*t-value*	*GMT (mm) Mean±SD*	*t-value*
9	8	12.6±1.7		.83±.08		50.1±2.6		7.1±1.5	
10	8	13.6±2.3	1.188	.88±.21	.614	55.2±11.2	1.246	6.0±1.8	1.312
11	12	14.3±1.4	.842	.85±.13	.325	54.7±4.9	.133	6.9±2.0	1.051
12	13	13.8±1.5	.894	.80±.11	1.183	54.2±7.9	.183	6.9±1.4	.096
13	9	14.9±1.8	1.497	.78±.04	.576	55.4±4.9	.410	6.3±2.2	.738
14	25	16.1±1.5	2.070	.78±.07	.339	59.6±3.8	2.622*	7.2±2.1	1.109
15	16	18.0±2.2	3.198**	.77±.06	.566	62.4±3.4	2.351*	7.3±2.2	.077
16	34	18.3±1.5	.529	.74±.10	1.108	84.4±4.9	.069	9.0±2.1	2.556*

*p<0.05 **p<0.01 ***p<0.001; BMI- Body Mass Index; WHR- Waist- Hip Ratio; WC- Waist Circumference; GMT- Grand Mean Thickness.

Table 3 displays mean values of various physiological variables along with their standard deviation among Rajput females of different age group. An increasing trend was observed in systolic blood pressure and breath holding time. A fluctuation in diastolic blood pressure, heart rate and pulse rate was found with advancing

TABLE3: PHYSIOLOGICAL VARIABLES OF THE SUBJECTS.

Variables Age(yrs)	*N*	*SBP(mmhg) Mean±SD*	*t-value*	*DBP(mmhg) Mean±SD*	*t-value*	*HR(b/min) Mean±SD*	*t-value*	*PR(p/min) Mean±SD*	*t-value*	*Breath holding time(sec) Mean±SD*	*t-value*
9	8	100.5±6.7		72.0±6.2		80.6±6.3		77.5±4.8		14.6±3.7	
10	8	108.0±11.5	1.60	72.1±7.2	.037	81.5±5.3	.301	76.6±4.4	.378	21.2±7.9	2.114
11	12	109.7±8.3	.384	68.6±6.1	1.187	76.5±7.2	1.674	73.4±7.3	1.105	16.1±5.4	1.764
12	13	105.8±9.6	1.095	66.3±4.6	1.058	81.2±8.1	1.507	78.2±7.2	1.652	21.8±13.1	1.430
13	9	115.7±8.0	2.536*	66.2±9.7	.028	77.6±7.0	1.079	75.7±7.2	.816	22.2±10.8	.016
14	25	104.4±21.3	1.533	70.4±7.9	1.266	79.7±4.9	.996	75.8±6.1	.054	25.9±11.2	.858
15	16	112.6±9.6	1.446	72.4±9.3	.742	76.2±3.6	2.452*	72.9±3.8	1.691	25.8±10.9	.032
16	34	114.7±14.4	.527	71.7±7.3	.307	72.9±7.1	1.735	69.2±6.2	2.207*	27.8±11.4	.612

*p<0.05 **p<0.01 ***p<0.001
SBP- Systolic Blood Pressure
DBP-- Diastolic Blood Pressure
HR- Heart Rate
PR- pulse Rate

age. The increase in systolic blood pressure from 12 to 13 years was statistically significant and the maximum mean value was found at 13 years of age.

Table 4 shows the correlation coefficient of blood pressure with body mass index, waist hip ratio and grand mean thickness of Rajput females with advancing age. In this table attempt was made to correlate the various adiposity measures and blood pressure in different age groups and it is concluded that correlation vary from variable to variable in all the groups. There is a significant correlation between blood pressure with body mass index, grand mean thickness and waist hip ratio till 12 years but in later years no such pattern was observed.

TABLE 4: CORRELATION COEFFICIENT OF BLOOD PRESSURE WITH BMI, WHR, GMT OF THE SUBJECTS.

Variable		*BMI(kg/m^2)*		*WHR*		*GMT(mm)*	
Age(yrs)	*N*	*SBP*	*DBP*	*SBP*	*DBP*	*SBP*	*DBP*
9	8	.541	.273	.758*	.452	.964**	.736*
10	8	.154	.348	.059	.365	.267	.534
11	12	.852**	.420	.492	.124	.233	.291
12	13	.617*	.535	.039	.042	.571*	.576*
13	9	.645	.353	.181	.155	.350	.365
14	25	.131	.040	.173	.061	.048	.051
15	16	.378	.095	.083	.003	.341	.107
16	34	.038	.066	.133	.101	.093	.121

*p<0.05 **p<0.01 ***p<0.001
BMI- Body Mass Index
WHR- Waist- Hip Ratio
GMT- Grand Mean Thickness

Discussion

The variables considered in this present study show an increasing trend from 9 to 16 years but all parts of the body do not grow at the same rate. Some body parts or dimensions increase more than others during the adolescent period (Tanner 1962). Mean value of height vertex (stature) increased among the growing Rajput females of the Solan district of the Himachal Pradesh. Similar findings were observed by Sinha and Kapoor (2009) where there was an increase in stature of adolescent girls aged 11-17 years. It is observed that there is an increase in body weight from 9 years to 16 years in the present study. Similar study that the trend of body weight increases with increasing age among adolescent girls was conducted by Talwar *et al.* (2012). According to the study conducted by Tyagi *et al.* (2005) the increase in weight with age could be due to imbalance of energy in favour of energy intake. The circumference measurement that is mid upper arm circumference show gradual increase with age which indicates muscular development and the similar results is found by Nadia *et al.* (2009), where the mean mid upper arm circumference (MUAC) and arm muscle area (AMA) for girls gradually increased with age up to 17 years.

BMI and GMT of skinfold do not show steady increase with age. There is fluctuation, but a definite trend of increase witnessed would entail this due to increase in fat mass. This increase in fatness established the fact that there continues to be increase in fat content in females throughout life. The fluctuation could be a reflection of fluctuation for fat stores as fat is depleted incase of faster growth phase (Kapoor et al 1998; Parizkova 1977; Sinha and Kapoor 2006). There is an increase in BMI from 9 years to 16 years in the present study on preadolescent and adolescent girls of Solan, Himachal Pradesh with a slight dip from 11 years to 12 years. Waist/hip ratio (WHR) is used as index of obesity and regional fat distribution in epidemiological studies. The decreases of mean of waist-hip ratio in the age group 9 years-16 years among the growing Rajput females implies gynoid fat distribution during the growing period. During adolescence, there is widening of the pelvis resulting into broader hips relative to their waist (Malina 1974).

With age physiological fitness also starts stabilizing. But in the present study there is relative decline in heart rate and pulse rate. Comparatively higher heart rate and pulse rate at an earlier age could be imputed to higher metabolic rate as well as relatively low blood pressure. Breath holding time displays a steady increase with age.

An attempt was made to correlate the various adiposity measures and cardiovascular functions in different age groups and it was concluded that the correlations vary from variable to variable in all the groups. The correlation coefficients reflect an inconsistent pattern. As far as correlations between cardiovascular functions and adiposity measure are concerned there is significant correlation between blood pressure and BMI, GMT and WHR till 12 years, but in later years no such pattern is observed. Earlier study by Deshmukh *et al.* (2006) which consistent with the present findings that strong correlation between systolic blood pressure and diastolic blood pressure with body mass index and regional adiposity.

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