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ASSESSMENT OF THE RELATION BETWEEN AGE AT MENARCHE, ANTHROPOMETRIC PARAMETERS AND INTELLIGENCE QUOTIENT IN MASHHAD, IRAN

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ABSTRACT

The present study was initiated to derive an indirect method for estimating body fat mass (BFM) and to evaluate the correlation between indirect anthropometric techniques for this estimation and to examine the relation of these parameters and of IQ to age of menarche.

A total of 578 adolescent girls of ten junior highschools in five educational districts of Mashhad, participated in a cross sectional study during autumn 2000. The data were gathered through questionnaires, interview, measurement of anthropometric parameters including: weight, height, BMI (Body Mass Index), TSF (Triceps Skin Fold) thickness, SSSF (Sub-Scapular Skin Fold) thickness, MUAC (Middle Upper Arm Circumference), and measurement of IQ by Raven test.

We demonstrated that anthropometric parameters for estimating BFM correlated well with each other. Age at menarche did not correlate with BFM measured by anthropometric parameters when studied at the onset of menarche, but it did well correlate negatively with these indices if studied any time postmenarche, regardless of the interval between the onset of menarche and the present age ($p<0.001$).

IQ correlated negatively to the age at menarche ($p< 0.001$). These findings implicate that BFM does not trigger puberty onset in healthy girls, but it does accumulate with a faster rate in the postmenarcheal period so that girls who have an earlier menarche have a higher weight and BMI and greater skinfold thickness than those who enter the menarcheal stage at a later time, and that mental development and physical growth are parallel processes, so that a slower mental development would be expected when physical growth is delayed.

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INTRODUCTION

There have been conflicting statements in the literature pertaining to the relation of age at menarche and body fat mass. There is a general tendency to relate the early onset of menarche to a higher BFM[1] but some researchers did not find such a relation between age at menarche and BFM; instead, they reported that BFM was negatively related to the rate of pubertal development toward menarche.[2]

Similarly the anthropometric parameters have usually been accepted as accurate predictors of BFM,[3] even though some have confined their use to epidemiologic studies. Doubt has arisen in regard to the value of these indices because of less accuracy as compared with radiologic assessment, but

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in the absence and unaccessibility of expensive radiologic methods, there is little doubt in the value of these parameters, especially in the auxologic fields.

Anthropometric measurements are reliable indicators of nutritional status,[4] in pathologic[5] and nonpathologic[6] conditions, during famine,[7] and in noninvasive assessment of biological maturation.[8] 85th and 95th percentile of BMI and TSF thickness have been accepted as reference data for obesity by some authors.[9]

Two hypotheses motivated this study. First, whether obesity results in early onset menarche; the concern is about the effect of unopposed estrogen for a long period as a risk factor of endometrial and breast cancer;[10,11] and the second, whether the delayed menarche is associated with a lower intelligence quotient, a matter of concern for parents because of its probable associated problems and disorders.

The present study was initiated to derive an indirect method for estimating body composition in young adolescent girls of junior high schools, at the expected age of menarche, and to evaluate the correlation between anthropometric indices for this estimation and to assess the relation of these parameters and of intelligence quotient to age at menarche.

SUBJECTS AND METHODS

Five hundred and seventy eight junior high school girls participated in a cross sectional study during autumn 2000. The data were gathered on adolescent girls aged 11 to 15 years old, from ten junior high school of five different educational districts of the city (Mashhad). The five districts varied in socio-economic and cultural status. From each district, two schools were chosen by counseling with educational experts so that the schools were of various demographic regions of the district. Four to five classes were chosen by random in each school and all the students in each class filled in the questionnaires, through which the data were gathered on age (exact birth date), any special disease, any drug consumed continuously, type and duration of exercise performed weekly, the final average grades of two previous years and parent's height and weight.

The main criteria for entry to the study, other than age, were having no specific disease, no family history of disorders and doing no continuous exercise affecting the normal pattern of growth.

Of a total number of five hundred and ninety six girls who filled in the questionnaires, 18 girls were omitted at the time of final calculations and analyses, although they all were permitted to participate in the next part of the study (measuring the anthoropometric parameters and IQ scores), for moral reasons.

The subjects were divided into 3 groups:

Group A: Those who experienced menarche at the most recent time (not further than the previous five months, a short time interval through which full accelerated growth presumbly has not occurred yet). They were 260 girls.

Group B: Those who had not entered the menarcheal stage up to the time of this study. These were 230 girls.

Group C: Those who experienced menarche at any time before five months prior to the study. They were 88 girls.

The purpose of this division was to compare the different variables before menarche, just at the onset of menarche and some time later in the postmenarcheal stage. Calculations and analyses were performed, in addition to each individual group, for groups A&C mixed together for complementary data permitting further comparison.

The research was performed under the supervision of the Educational Department of the city. All the subjects participated voluntarily in the study.

Qualitative data were gathered through questionnaires as discussed. The anthropometric methods used have been reported in detail elsewhere.[12] Briefly, each subject was measured wearing minimal clothes, with no shoes. Weight was measured to ± 0.2 kg with a standard physician's office scale (Soehnle scale) previously examined against known weights; and height to ± 0.5 cm, with a tape and a height-bar fixed on the wall, with subject standing with back, buttocks and heels together pressed to the wall.

The MUAC was assessed in cm on the right arm midway between the olecranon and the tip of the acromion process of the scapula, using standard, nonstretchable tailor's tape measure, read to the nearest 5 mm. TSF thickness was measured in mm to the nearest millimeter at the same point with German Perfecta caliper. SSSF was determined at the endpoint of the scapula in a 45° angle based on the horizontal level.

MUAC, TSF and SSSF thicknesses were measured three times and the means of three readings were taken. All measurements were done by the present researcher to standardize the method.

BMI was calculated as body weight in kg divided by square of height in meters.

The results on BMI and TSF were compared with the 85th and 95th percentiles for age and sex, using standard tables.[13] Adolescents at risk of overweight were defined as BMI >85th percentile and <95th percentile and obesity defined as BMI >95th percentile.

IQ was determined by Raven's test, with careful considering of all standard rules of the test, pertaining to the physical conditions, the test time and adjustment of the scores for age.

Menarche

To obtain information about the menarcheal age, all girls were individually visited and interviewed directly at the school during autumn 2000 by the researcher. Most girls, including all girls in group A, remembered their menarche date. If they did not remember it, the researcher related the

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event of menarche to the time lag before or after an important happening, like final exams at the end of their school year, their birthday or the summer vacation. At the time of interview the mean age ±SD of the girls was 13.05±0.75 yr.

Statistical analysis

Multiple regression analyses were used to investigate the relationship of age at menarche - as the dependent variable - to body indexes, and IQ.

In comparing different variables between the study groups one - way analysis of variance (ANOVA) with repeated measures was used. t-Test was used for the comparison of means. The Pearson correlation was applied to the different variables, after the adjustment of age and age of menarche. The level of significance for all statistical tests was set at 0.05. Level 0.01 was also reported whenever found. Statistical calculations were performed using SPSS.[9]

RESULTS

Mean age at menarche was 12.77 yr ± 0.70, 95% CI = 12.68-12.85, for group A and 12.65 ±0.81, 95% CI = 12.58-12.71, for groups A&C.

The subjects were adjusted for age and according to the statistical tests the mean age was equal between all groups.

The means of the other independent variables were significantly different between groups A and B, as shown in Table I, along with the means ±SD for all variables.

The correlation between age at menarche and anthropometric parameters and IQ is demonstrated in Table II.

The correlation between BMI and age at menarche was not significant in group A, while in groups A&C mixed together, BMI was negatively correlated to age at menarche (r= -0.20, $p<0.001$).

IQ was negatively correlated to age at menarche (r=-0.26, $p<0.001$ in group A and r= -0.33, $p<0.001$ in groups A & C).

The results were the same with multivariate analysis in the relation of age at menarche to BMI and IQ.

Of the anthropometric parameters used in this study, BMI, weight, and TSF had the highest significance in correlation with age at menarche; while MUAC and SSSF had no significant correlation with age at menarche.

The frequency of the normal range of BMI, usually referred to as 50th and 75th percentile, in group A was more than 1.5 fold as compared with group B (62.97%, versus 39.12%).

Adolescents at risk of overweight (defined as BMI >85th percentile but less than 95th percentile) in group A were twice as many as in group B (8.1% versus 3.9%), while the prevalence of obesity (namely BMI>95th percentile) was not so different in these two groups (3.8% versus 2.6%).

Similarly, 7% of cases in group A and 1.5% of cases in group B had TSF >85 percentile, while 3.1% of cases in group A and 2.6% of cases in group B had TSH >95th percentile.

Table I. Mean±SD of age, anthropometric parameters, IQ, and age of menarche in the study groups.

Anthropometric Parameter	Study groups A (n= 260)	B (n= 230)	C (n= 88)	Difference of means between groups A and B
Age (yr)	13.10±0.71	12.90±0.70	13.62±0.65	NS
Weight(kg)	43.81±7.44	38.20±6.93	49.53±8.89	$p<0.001$
Height(cm)	152.73±5.42	148.10±6.31	155.40±5.25	$p<0.001$
BMI(kg/m²)	18.74±2.73	17.40±2.74	20.60±30.04	$p<0.001$
MUAC(cm)	22.42±2.52	20.73±2.41	23.94±3.02	$p<0.001$
TSF(mm)	18.20±3.05	17.01±3.01	20.60±40.86	$p<0.001$
SSSF(mm)	15.52±2.69	14.20±3.01	17.10±3.01	$p<0.001$
IQ*	99.93±14.51	96.34±14.35	100.40±18.34	$p<0.05$
Age at menarche(yr)	12.77±0.70	-	12.02±0.85	-

n, Number of cases in each group

NS, Not significant

*IQ was measured in 184, 132 and 38 cases in groups A, B and C, respectively.

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Table II. Correlation between age of menarche and anthropometric parameters and IQ.

			Weight	Height	BMI	MUAC	TSF	SSSF	IQ
Group A	Age of menarche	r	-0.04	-0.11	-0.02	-0.05	-0.01	-0.08	-0.26
		p	NS	NS	NS	NS	NS	NS	<0.001
		n	260	260	260	260	260	260	184
Groups A&C	Age of menarche	r	-0.16	-0.04	-0.20	-0.08	-0.16	-0.05	-0.33
		p	<0.05	NS	<0.001	NS	<0.05	MS	<0.001
		n	348	348	348	348	348	348	222

r: Pearson correlation coefficient
p: Two tailed test
n: Number of cases
NS: Not significant

The underweight girls in group A were less than half of the underweight girls in group B (25.4% versus 54.4%).

A significant correlation between measurements of these parameters was demonstrated in all groups as shown in Table III.

The highest correlations were steadily obtained between age and age of menarche ($p<0.001$), while there was no correlation between age and BMI in any single or mixed group(s). Similarly, we did not find any correlation between IQ and BMI.

Of note was the observation that height correlated directly and significantly with age before menarche ($p<0.001$ in group B), but the level of significance was lower at the onset of menarche ($p=0.05$ in group A) and somewhat later in the postmenarcheal period. There was no important correlation between height and age.

DISCUSSION

Age at menarche as calculated in this study (12.77 yr) is higher than that reported from Spain (12.31yr)[14] and China (12.50yr),[15] but lower than that reported from Shiraz, southern Iran (12.91yr).[16]

In previous studies, whether they found a relation be-

Table III. Correlation between different anthropometric parameters in groups A, B and C (n= 578).

		BMI	MUAC	TSF	SSSF
BMI	r	1.00	0.68	0.75	0.74
	p	<0.001			
MUAC	r	0.68	1.00	0.64	0.64
	p	<0.001			
TSF	r	0.75	0.64	1.00	0.81
	p	<0.001			
SSSF	r	0.74	0.64	0.81	1.00
	p	<0.001			

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tween age of menarche and BFM or did not, the interval between menarche and the performance of the study was not taken into account or mentioned. The discriminative aspect of our study was emphasis on this interval which would permit comparison of the two situations: correlation between menarcheal age and BFM, A) at the nearest time interval of menarche onset (group A) and B) regardless of this time interval (group A&C). The present study was similar to the previous studies in the latter situation, in which we found a significant correlation between age of menarche and BMI, in both the Pearson correlation and multivariate analysis through which the effect of other confounding factors, such as age, is eliminated or attenuated.

In other words, when the relation of menarcheal age to BMI is assessed in adolescent girls regardless of the time elapsed since the onset of menarche, these two variables do correlate well with each other. These findings coincide with the results of the study carried out in Shiraz (1999),[16] as well as Frisch et al's study.[17]

Therefore one can conclude that fat mass accumulates in the body with a faster rate after the onset of menarche, so that at a special point of time, in which all the subjects are examined, the lower the age at menarche, the greater the fat mass accumulation.

The variety of BMI in the study groups indicates that in girls entered in the menarcheal stage, the percentage of normal range of BMI is obviously higher than those who didn't experience menarche, and overweight adolescents more likely experience menarche at a lower age, while the obese ones do not.

Accordingly, while body fat mass doesn't trigger the onset of menarche, it does have an important role in puberty as a common or alternative factor.

The relation between IQ and age of menarche was not discussed in the previous studies as largely as the relation between body composition and age of menarche was. Some authors concluded that early onset menarche was associated with a higher verbal IQ. We demonstrated a significant inverse relation between IQ and age at menarche in all groups, which reveals a strong relation between intellectual development and physical growth. The similar high level of significance ($p<0.001$) obtained in the multivariate analysis in this relation confirms our findings. It seems that mental development has a slower rate when physical growth is delayed, because the lower the age of menarche the higher the intelligence quotient.

The significant correlation between various anthropometric parameters implicates a real relation between these indices, and although their accuracy is not confirmed in our study, they can be used as well established indirect auxologic techniques for estimating BFM.

Based on the findings pertaining to height and age at menarche explained in the results, it is concluded that the growth rate of height is accelerated before menarche, but not after it.

The stronger and more significant relation of age at menarche to age, compared with the relation of menarcheal age to BMI, reveals the importance of age as a general item including the process of adolescence and puberty and menarche.

In conclusion, anthropometric indices can be used in epidemiologic studies. BFM is not a determinative factor for initiation of menarche, but it can be considered a co-factor for the onset of it.

The rate of body fat mass accumulation in the postmenarcheal period is faster, so that the longer the period past the onset of menarche, the greater the body fat mass and BMI. Conversely, height growth has a faster rate in the premenarcheal period.

The inverse (negative) significant relation between age at menarche and IQ indicates that mental development occurs in association with physical growth and delayed menarche is associated with slower mental development.

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