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Age at Menarche and its Nutrition-Related Factors among School Girls in Shiraz, Southern Iran

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ABSTRACT

Background: Menarche is an important period in the health of adolescent girls, and different factors, including genetic and environmental factors affect the age of menarche. The aim of the present study was to determine the age at menarche and its nutrition-related factors in school girls in Shiraz, southern Iran.

Methods: In a cross-sectional study, 481 adolescent girls aged 10-13 years were enrolled based on a two-stage cluster random sampling. Weight, height and body mass index (BMI) were assessed. Z-scores for weight-for-age (WAZ), height-for-age (HAZ), and BMI-for-age (BMIZ) were determined based on World Health Organization standards. Associations between food intake and anthropometric measures and menarche age and also between anthropometric measures and menarche age were tested using Pearson correlation and linear regression, respectively

Results: Mean age at menarche was 12.27±0.73 years. A significant correlation was observed between the age of menarche and cheese, dairy, legume, and egg consumption. Logistic regression analyses showed z-scores significantly for WAZ (-0.64, -0.24), HAZ (-0.70, -0.37), and BMIZ (-0.59, -0.16) as strong predictors for age at menarche.

Conclusion: HAZ, WAZ, and BMIZ and consumption of cheese, dairy, legume, and egg had significant inverse associations with menarches' age.

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Introduction

Maturity is an important period in girls' puberty, a time interval between childhood and adolescence which begins with the appearance of secondary sexual characteristics and continues until complete sexual development and reproductive capacity (1, 2). Physical changes associated with maturation result from the hypothalamic-pituitary-gonadal axis reaction, which is silent in infancy and, following a relatively silent period of childhood, it is initiated by increasing the normal secretion of the gonadotropin-releasing hormone at the end of the first decade of life (3, 4).

Classically, in girls, the process of puberty is 4.5 years. Generally, the first indication of maturation is growth acceleration; accompanied by germination of breast, followed by the emergence of plaque hair, maximizing the growth rate, and menarche (5, 6). The onset of menarche is affected by various genetic and environmental factors. The average age of the menarche differs from country to country due to ethical variations (3, 7, 8). In western societies, the

age of menarche decreased about 0.3 year per decade from the 19th century to the 21st century, which may have been due to improved nutritional status and socioeconomic conditions, exposure to endocrine disrupters such as exogenous estrogen, or other environmental factors (3, 7, 8).

Causal relationship between anthropometric indices and early menarche is discussed, and obesity is known as a risk factor for early menarche. Early menarche is a risk factor for metabolic syndrome, type 2 diabetes mellitus, cardiovascular disease, breast cancer, and all-cause mortality (9, 10). Studies in Korea have revealed the relationship between obesity and age in menarche, but studies in the United States show that the age of menarche is not diminished despite the increase in BMI, and BMI is not related to menarche (11).

Dietary intakes are also determinant of menarche age. Nutritional conditions and body structure play an important role in determining body fat as a factor in puberty, especially early onset of menarche in obese girls (12, 13). Based on evidence, consumption of fruits and vegetables is associated with increasing menarche age and consumption of prepared foods is associated with decreasing menarche age in adolescents (14, 15).

The effect of different factors influencing menarche is still a matter of debate. For instance, some studies documented evidences on which menarche age is not related to nutrition (16). Due to the importance of the age of the menarche and the factors affecting it and lack of sufficient information in this regard, the present study was conducted to determine the relationship between dietary intakes and anthropometric indices with menarche age in girls aged 10 to 13 years in Shiraz, southern Iran.

Materials and Methods

This cross-sectional study was conducted on adolescent girls living in Shiraz, Iran. According to a previous study (1), 95% confidence level (CI), and 80% test power, the sample size was calculated at least 470 students. Four hundred and eighty one girls from middle schools of Shiraz were enrolled in this study via two stage cluster random sampling from February through March 2014. First, the list of all public primary and middle schools of district 4 in Shiraz (based on educational division) was extracted from the Vice Consul of Education, and then schools were selected randomly. In the second stage, single intact classes from each school were sampled at random. Inclusion criteria were female students living in Shiraz who passed at maximum six months from their first menstruation, not taking any medications (other than nutritional supplements), not following any special diet, and absence of chronic diseases.

Objectives of the study were explained to students, briefly. The eligible students were given consent form to take home and complete if their parents consented to their participation. The study was conducted according to the guidelines of Helsinki Declaration and was approved by the Ethics Committee of Shiraz University of Medical Sciences. Socio-demographic information (age, mother and father's education and occupation, total household income, household size, and birth rank), maternal age of menarche, physical activity, and nutritional supplements usage were gathered by direct interview. The age of menarche was recorded with precision of one month as described before (17).

Anthropometric measurements were carried out according to standard procedures. Weight was assessed to the nearest 0.1 kg on a Seca electronic scale, with light clothing and no shoes. For height measurement, students were asked to stand straight next to the wall without shoes. The height was determined to the nearest 0.1 cm by using a stadiometer. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters (kg/m^2). Waist circumference was measured with a cloth measuring tape placed in midpoint between the lower margin of the last palpable rib and the top of the iliac crest. Hip was measured at the widest circumference over the buttocks to the nearest 0.1 cm.

Growth parameters [z-scores for weight-for-age (WAZ), height-for-age (HAZ), and BMI (BMIZ)] were calculated based on World Health Organization (WHO) standards (18). Waist-to-hip ratio (WHR) was calculated as waist circumference in centimeters divided by hip circumference in centimeters. BMIZ and WHR can be served as an indicator of general adiposity and central adiposity, respectively. Physical activity (PA) of participants was assessed by asking about frequency and duration of physical activities including games. Low, moderate, and high physical activity was defined for no physical activity, less than 100 min/week, and more than 100 min/week.

Family welfare status was recorded based on household assets, such as car possession, private room for children as well as having computer, and being on a vacation trip last year, and categorized as low and high. During an interview, food intake was assessed by Food Frequency Questionnaire (FFQ) (19), which contained semi-quantitative information on major food groups (milk/yogurt, cheese, dried yogurt, dairy, nuts, legumes, soy, fish, poultry, red meat, organ meat, eggs). Also, supplement use was

questioned by asking if the participants were using any sort of nutritional supplements including iron, zinc, calcium, multivitamin, folic acid, vitamin C, and vitamin D.

Data analysis was performed using Statistical Package for Social Sciences (SPSS, version 16 (Chicago, IL, USA). Associations between demographic characteristics and anthropometric measures and menarche age were examined by ANCOVA test with physical activity as the covariate. Pearson correlation was used to examine the associations between food intake and anthropometric measures and menarche age. The relationship between anthropometric measures and menarche age was tested with linear regression analysis in crude model and after adjustments for maternal menarche age and physical activity. A two-tailed P-value<0.05 was considered statistically significant.

Results

Four hundred and eighty one female students aged 10-13 years participated in this study. The mean age of the students was 12.27±0.73 years old. All of them were students of primary and middle schools, and the mean age at menarche was 11.80±0.84 years. The socio-demographic characteristics of the students were shown in Table 1. Older students had lower HAZ (P<0.001), WAZ (P<0.001), and BMIZ (P<0.001). There were no significant differences in anthropometric variables and menarche age between girls with different paternal education but HAZ was significantly higher in girls whose mother had academic education (P=0.03) and menarche age was significantly higher in girls whose mother had not academic education (P=0.01).

Anthropometric variables and menarche age showed no significant difference regarding family welfare state. WAZ (P=0.01) and BMIZ (P<0.001) were higher significantly in girls consuming supplements, but menarche age was higher significantly in girls not consuming supplements (P<0.001). Physical activity had no correlation with menarche age and demographic measurements except for HAZ which showed a positive association with the level of physical activity.

Examining the associationof food intake with anthropometric measures and menarche age showed positive correlations of HAZ with consumption of

Table 1: Association between demographic characteristics, supplemental use, and physical activity with anthropometric measures and menarche age[1].

Variable	No	HAZ	WAZ	BMIZ	WC	WHR	Menarche age
Age (y)							-
10	30	0.93±0.98	0.98±1.0	0.83±1.1	74.9±10.0	0.86±0.05	
11	126	0.49±0.86	0.54±0.92	0.47±0.92	72.8±9.3	0.85±0.06	
12	240	0.16±0.82	0.38±0.87	0.33±0.93	74.0±9.4	0.84±0.05	
13	85	-0.15±0.81	0.02±1.0	-0.001±1.1	74.0±9.5	0.84±0.05	
P value[2]		<0.001	<0.001	<0.001	0.6	0.1	
Paternal education							
High school	379	0.24±0.87	0.39±0.95	0.34±0.99	73.7±9.3	0.84±0.05	11.8±0.87
College	98	0.27±0.91	0.41±0.96	0.34±1.0	73.7±9.8	0.84±0.06	11.9±0.77
P value		0.7	0.8	1.0	0.9	0.8	0.4
Maternal education							
High school	424	0.20±0.87	0.38±0.95	0.34±0.99	73.7±9.3	0.84±0.05	11.8±0.7
College	53	0.47±0.97	0.47±1.0	0.32±1.1	73.9±10.5	0.84±0.06	11.5±1.6
P value		0.03	0.5	0.9	0.8	0.9	0.01
Family welfare							
Low	254	0.19±0.92	0.40±0.99	0.37±1.0	73.8±9.7	0.84±0.05	11.8±0.94
High	227	0.29±0.84	0.39±0.92	0.31±0.99	73.5±9.0	0.84±0.05	11.8±0.73
P value		0.18	1.0	0.6	0.8	0.8	0.9
Supplement use							
Yes	259	0.25±0.88	0.51±0.93	0.51±0.92	74.4±10.0	0.85±0.05	11.6±0.73
No	222	0.23±0.89	0.30±0.96	0.20±1.0	73.1±8.9	0.84±0.05	11.9±0.92
P value		0.7	0.01	<0.001	0.1	0.2	<0.001
Physical activity							
Low	209	0.18±0.88	0.31±0.94	0.27±0.97	73.4±8.8	0.84±0.05	11.8±0.92
Moderate	121	0.15±0.89	0.42±0.92	0.44±0.94	73.7±9.3	0.84±0.05	11.8±0.73
High	150	0.38±0.86	0.48±0.99	0.35±1.07	73.9±10.2	0.84±0.06	11.8±0.85
P value		0.03	0.2	0.5	0.8	0.6	0.7

[1]Data are means±SD. [2]Associations were examined by ANCOVA with physical activity as the covariate. WAZ:Weight-for-age; HAZ:height-for-age; BMIZ:body mass index-for-age; WC: waist circumference; WHR: waist-to-hip ratio.

cheese, dairy, legumes, and eggs, while BMIZ had an inverse correlation with consumption of organ meats, and WHR had no significant correlation with food group consumption. The menarche age was inversely correlated with consumption of cheese, dairy, legumes, and eggs (Table 2).

To identify if anthropometric measures had associations with menarche age, logistic regression analysis was performed. HAZ, WAZ, and BMIZ had inverse associations with menarche age. After adjustment for maternal menarche age and physical activity, the beta coefficient value remained significant and became stronger (Table 3).

Discussion

The main objective of the present cross sectional study was to explore the association between dietary intake and anthropometrical measurements with age of menarche in adolescent girls. According to the findings of this study, HAZ, WAZ, and BMIZ had significant inverse associations with menarches' age. Consumption of cheese, dairy, legumes, and eggs was also inversely associated with the age of menarche.

In this study, the mean age of menarche was 12.27±0.73 years; such a result is consistent with the findings of a study conducted in Shiraz earlier (12.9 years) (20). Age at menarche among girls from different areas varies greatly; In Iran, the mean of menarche age in different regions is as follows: Zanjan (12.6 years) (3), Sabzevar (12.5 years) (5), Qom (12.3 years) (1), and Mazandaran (12.5 years) (21). In other neighbor countries, the mean age of the menarche is as follows: Kuwait (12.4 years) (22), Turkey (12.7 years) (23), and India (12.6 years) (24).

In general, higher age at menarche is common in the areas located in lower or higher latitudes, while lower age at menarche is more common in temperate regions and regions closer to the coast (16). Yet, the reasons for these variations are not fully understand. Age at menarche is affected by several factors such as genetic, racial, social factors, nutritional status, geographic location, and lifestyle variations, and it cannot be attributed to certain factors (16, 25).

The results of this study showed that maternal education has association with the age of menarche; the mean age at menarche was lower in girls whose mothers had a college-based education. Contrary with present findings, Maddah et al. (26) reported high maternal education is a risk factor for early menarche. Although in the present study, anthropometric indices other than HAZ (WAZ, BMIZ, WC and WHR) were not significantly different by maternal education levels, studiesconducted in western countries (27-29)

Table 2: Correlation between food intake and anthropometric measures and menarche age.

Serving size per day	HAZ	P value	BMIZ	P value	WHR	P value	Menarche age	P value
Milk/yogurt	0.08[1]	0.08	-0.004	0.9	-0.08	0.09	-0.06	0.2
Cheese	0.12	0.01	0.02	0.7	0.01	0.8	-0.14	0.002
Dried yogurt	0.05	0.3	-0.09	0.06	-0.09	0.06	-0.04	0.4
Dairy	0.11	0.01	-0.02	0.7	-0.08	0.09	-0.10	0.02
Nuts	0.05	0.2	-0.02	0.6	-0.05	0.3	-0.05	0.3
Legumes	0.10	0.03	-0.01	0.8	-0.06	0.2	-0.14	0.002
Soy	-0.02	0.6	-0.07	0.1	-0.08	0.07	-0.05	0.3
Fish	<0.001	1.0	-0.09	0.06	-0.09	0.06	0.009	0.8
Poultry	0.02	0.6	-0.04	0.4	-0.06	0.2	-0.04	0.4
Red meat	0.04	0.4	0.008	0.9	-0.04	0.3	0.03	0.6
Organ meat	0.05	0.3	-0.09	0.04	-0.05	0.2	-0.08	0.1
Eggs	0.11	0.01	-0.06	0.2	-0.07	0.1	-0.12	0.01

[1]Correlation coefficient. HAZ:Height-for-age; BMIZ:body mass index-for-age; WHR:waist-to-hip ratio.

Table 3: Regression analysis of menarche age and anthropometric measures.

Menarche age	HAZ	WAZ	BMIZ	WC	WHR
Crude	-0.28[1] (-0.36-0.19)	-0.21 (-0.29-0.14)	-0.18 (-0.26-0.11)	-0.002 (-0.01-0.01)	-1.28 (-2.69-0.14)
P value	<0.001	<0.001	<0.001	0.7	0.08
Adjusted[2]	-0.53 (-0.70-0.37)	-0.44 (-0.64-0.24)	-0.37 (-0.59-0.16)	-0.50 (-2.52 -1.52)	-0.01 (-0.02-0.01)
P value	<0.001	<0.001	0.001	0.6	0.1

[1]B Coefficient (95% CI).[2] Adjusted for maternal menarche age and physical activity. WAZ:Weight-for-age; HAZ:height-forage; BMIZ:body mass index-for-age; WC: waist circumference; WHR: waist-to-hip ratio.

reported that higher maternal education is associated with higher BMI and WHR in adolescent girls.

This inconsistency is probably due to the difference in the age of marriage between parents in western cultures and Iran. In Iran, the average age of marriage is lower than that in western societies. The age of marriage may have an effect on the relationship between parent's education and the age at menarche of children. However, the age of the menarche is influenced by several factors, and therefore cannot be simply explained by a factor (30, 31).

In prior studies, household economic statue was one of the factors influencing the age of menarche; a better household economic status would reduce the mean age at menarche (6, 11). Nevertheless, in the present study, there were no significant differences in the age at menarche between good and poor household economic status, which may be as a result of the variation in the questionnaires used to assess household welfare state between different studies.

Regarding the findings of this study, there was a significant correlation between daily consumption of food and mean age at menarche. In line with our results, a study conducted in Turkey reported that among girls whose menarche age was on overage 12.4 years, significant inverse correlations were found between total dairy and cheese consumption (23). In the current study, total dairy intake, cheese, legumes and eggs were found to be significantly correlated with HAZ, which was used in this study as an indicator of growth. Based on evidence, these food groups, as rich sources of calcium and protein, are positively correlated with the bone mineral content of girls and can promote their growth and accelerate the menarche age (32).

In the present study, HAZ, WAZ, and BMIZ were predictor of menarche age, which is similar to a study in USA that proposed American lifestyle and diet to be effective in reducing the age of puberty. These findings can be explained by the fact that obesity and increased BMI can accelerate puberty (33). There are limitations to this study. Due to small sample size, the participants of this study may not have been a good representative of Shiraz female adolescents. There are also limitations with food frequency questionnaire technique such as uncertainty in recalling the consumed food items and their portion sizes.

Conclusion

Overall, results of this study showed that adolescent girls with better nutritional status are more likely to be at risk of early onset of menstruation (menarche). Future prospective studies are needed to investigate the relationship between nutritional status and clinical consequences of early versus late menarche.

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Conflict of Interest

None declared.

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