http:// ijp.mums.ac.ir
Original Article (Pages: 10583-10593)

Association of Dietary Pattern and Body Size with Early Menarche among Elementary School Girls in West of Iran

Akram Rahimi[1], MehrAli Rahimi[2], Abdolreza Norouzy[3], Habibollah Esmaily[4], Peyman Eshraghi[5], Seyed Amir Reza Mohajeri[6], *Mohsen Nematy[7]

[1]MSc, Department of Nutrition, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran. [2]MD, Endocrinologist, Kermanshah University of Medical Sciences, Kermanshah, Iran. [3]Associate Professor, Department of Nutrition, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran. [4]PhD, Health Sciences Research Center, Department of Biostatistics and Epidemiology, School of Health, Mashhad University of Medical Sciences, Mashhad, Iran. [5]MD, Pediatric Endocrinologist, Pediatric Research Center, Mashhad University of Medical Sciences, Mashhad, Iran. [6]School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran. [7]Associate Professor, Department of Nutrition, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.

Abstract

Background: The average age at menarche (AAM) has declined around the world, which is widely attributed to improvements in nutrition. This study was conducted to investigate the association between dietary patterns and early menarche (<12 years) among elementary school girls.

Materials and Methods: This case-control study was carried out on 400 elementary school girls (200 early menarche and 200 premenarche) who were aged 12 years old and over, in Kermanshah, Iran, 2015. The participants were selected by cluster sampling from three areas of Kermanshah city. Body mass index (BMI) was calculated, and information on dietary intake was investigated by using a semi-quantitative food frequency questionnaire, which consists of 160 items and were filled by students' parents. Logistic regression was performed to find a relationship between dietary patterns and risk of early menarche.

Results: The means age for the case and control groups (n=200, n=200) were 12.06±0.1 5 years and 12.0 6±0. 10 years, respectively. Four major dietary patterns of meat, western, vegetarian, and traditional were identified. After adjusting for the confounding factors, vegetarian (OR: 0.01; 95%CI: 0.003-0.02; P<0.001), and traditional (OR: 0.13; 95%CI: 0.06-0.26; P<0.001), dietary patterns were found to be negatively associated with early menarche whereas the highest tertile of meat dietary pattern (OR:1.21; 95%CI: 0.64-2.29; P<0.009), and BMI (OR: 3.36; 95%CI: 1.72-6.54) were positively associated with early menarche. Western diet showed no relationship with early age at menarche (P>0.05).

Conclusion: Based on the results, dietary patterns and body size were found to be related to early menarche among elementary school girls.

Key Words: Early menarche, Dietary patterns, Food frequency questionnaire, Factor analysis.

*Please cite this article as: Rahimi A, Rahimi M, Norouzy A, Esmaily H, Eshraghi P, Mohajeri SAR, Nematy M. Association of Dietary Pattern and Body Size with Early Menarche among Elementary School Girls in West of Iran. Int J Pediatr 2019; 7(12): 10583-593. DOI: **10.22038/ijp.2019.43390.3618**

Corresponding Author:

Mohsen Nematy (M.D), Department of Nutrition, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.

Email: nematym@mums.ac.ir

Received date: Aug.23, 2019; Accepted date: Nov.22, 2019

1- INTRODUCTION

Menarche, defined as the first menstrual cycle in a woman's life, is a significant event in the reproductive life of a woman (1). Over the period of the twentieth century, age at the onset of menarche has declined from over the age of 16 years to below 13 years in industrialized countries, and similar trends are evident in the contemporary developing countries (2-4). Early menarche (at <12 years of age) may be associated with health problems in later life such as short stature, breast cancer (5-7), type 2 diabetes (8), fertility impairment(9), cardiovascular diseases (10), non-alcoholic fatty liver disease (11), obesity (12), and psychological disorders (13, 14). Numerous studies have suggested that, while the timing of menarche is largely under genetic control, environmental factors such as dietary intake may accelerate or delay age at menarche (AAM) (4).

The occurrence of late menarche in girls who have experienced several caloric restrictions (undernutrition) (4, 15, 16), and early menarche in those with a high intake of energy were observed (12, 17-21). Higher intake of meat and animal protein led to earlier menarche while the highest intake of vegetable protein was associated with later menarche (22). The relation between early onset of menarche and intake of certain nutrients, including low fiber, monounsaturated fatty acids (23-25), high calcium (4, 26), vitamin A (18), and sugar-sweetened beverages (15) have also been reported.

On the one hand, these studies support the importance of childhood diet as a modifiable factor in menarcheal age which may potentially be controlled to enhance survival in later adulthood. On the other hand, these single food items and nutrients cannot contribute separately to the risk of early menarche since the inter-correlations of foods or nutrients influence their bioavailability and absorption. Furthermore, dietary pattern might better reflect real-world conditions of food and nutrient intake on the timing of menarche (27, 28). Discrepancies between the Western and Eastern dietary pattern, study design and methodology such as observation of children's eating habits (29), as well as a combination of three-day dietary record and food frequency questionnaire (FFQ) for the measurement of dietary intake (7, 30) make the comparison of studies difficult. Taking into account dietary patterns, differences in methodology, and Eastern dietary factors which influence the age of menarche development, this study was carried out to investigate the relationship between dietary patterns and early menarche among elementary school girls in Kermanshah, Iran.

2- MATERIALS AND METHODS

2-1. Study design and population

This case-control study was performed on 400 elementary school girls (200 early menarche and 200 premenarche girls) in Kermanshah, Iran, from 2015 to 2016.

2-2. Methods

According to school-based, multistage cluster random sampling, 10 schools of three districts in Kermanshah city, West of Iran were selected. Girls in grade 5 and 6 who had experienced menarche before the age of 12 years were identified by collaboration with health educators at schools and were recruited as case group and then control group was recruited among premenarche students. Case and control groups were two age-matched groups of early menarche and premenarch. The parents of both case- and control-group subjects were invited to fill in questionnaires. Evaluation of the students whose parents signed the consent form started after explaining the purpose of the research project.

2-3. Measuring tools

Monthly dietary intake of students was assessed using a validated 160-item semi-quantitative food frequency questionnaire (FFQ), which was designed and validated by the Department of Nutrition of the School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran (31). The students'parents were asked to report the frequency of consumption of each food during the previous month using a 9-point scale (i.e., never or less than once a month, monthly [1 to 3 times a month], weekly [once a week, 2-4 times a week, and 5 to 6 times a week], and daily [once a day, 2-3 times a day, 4-5 times a day, and 6 times or more a day]). Moreover, portions were classified in three sizes of small (half of the determined average use or less), medium (equal to the determined average use), and large (one and a half times more than average use or more).

In order to analyze the completed FFQs, we cooperated with a team of software designers. First, we scanned all pages of the FFQ, and then the first software rode the selected choices on the scanned pages of the FFQ and delivered an external file with TXT format. This software was written with Delphi7 programming software (32). Then, we needed the second software to could analyze the data resulted from the first software and export these data into SPSS (version 16.0) as: (1) the consumed food items, (2) the amount of consumed food item, and (3) the amounts of consumed energy, macronutrients, fiber, and some micronutrients (e.g., vitamin A, vitamin E, folate, and potassium). This second software was written with Microsoft visual basic 2008 (VB 9.0) programming software (33). Weights of students were measured to the nearest 0.1 kg with digital scale (Seca 813, Germany); while the subjects were minimally clothed and were not wearing shoes. Height was measured to the nearest 0.1 cm, while the subjects were standing and not wearing shoes, by using a measuring tape with wall attachment (Seca 206, Germany) with the shoulders in normal position. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m2), and interpreted according to BMI-for-age z score (5-19 years) as follows (34): Overweight: > +1SD, Obesity: > +2SD, Thinness: < -2SD>, and Sever Thinness: < -3SD. These measurements were done by a trained master of nutrition student studying at Department of Nutrition of Mashhad University of Medical Sciences, Mashhad, Iran.

2-4. Ethical consideration

This study was approved by the ethics committee of Mashhad University of Medical Sciences (approved by the Ethics Committee: 920991). Informed consent was obtained from the participant children and their parents.

2-6. Inclusion and exclusion criteria

Students who experienced menarche before 12 years old and remembered the exact age at menarche were entered to case group whereas others who had not undergone menarche were involved in control group. The exclusion criteria for both groups were following a specific diet due to medical or other reasons, having diseases such as thyroid disorders or polycystic ovary syndrome, being treated with growth hormone or Gonadotropin-releasing hormone (GnRH) agonist.

2-7. Data Analyses

Kolmogorov-Smirnov test was used to evaluate the normality of data. Independent t-test, the Mann-Whitney and Chi-square tests were performed to scrutinize differences among normal quantitative data, abnormal quantitative data and qualitative data respectively. Qualitative data are expressed as frequency (%), and quantitative data as mean ± standard deviation (SD). To identify dietary patterns 160 food items in

FFQ were classified into 39 predefined food groups. The basis for this classification was the similarity of nutrients of food items. Several foods that could not be appropriately combined with others were defined in their own groups, and then factor analysis was used to identify major dietary patterns based on the 39 food groups. In this analysis varimax rotation was used to create a simple and differential varimax. Factors (dietary patterns) were extracted on the basis of scree plot test and eigen values>1. Consequently, dietary patterns were calculated according to consumed food items placed in these patterns. Each participant received a factor score for each identified pattern, afterward they were categorized by tertiles of dietary pattern scores (35). We used multivariate logistic regression to evaluate the relationship between dietary patterns and the risk of early menarche. Firstly, we obtained unadjusted ORs, and then we adjusted for energy, height, weight, BMI, and heredity (mother's age at menarche). In all the multivariate models, the first tertiles of dietary patterns score were considered as reference. SPSS software version 16.0 was used for all the statistical analyses.

3- RESULTS

A total of 400 students were recruited, 200 children in each of the case and control groups. The mean age of the case and control groups (n=200, n=200) were 12.06±0.1 5 years and 12.0 6±0. 10 years, respectively. We did not observe any significant differences in mean age between the two groups. Mean age at menarche was 10.81±0.52 years in early menarche participants, and the mean age at menarche in mothers of these girls was 12.70±1.27 years and in mothers of premenarche girls was 13.45±1.11 years, which were significantly different. On average, early menarche girls weighed more, were taller, and had greater BMIs (40.0% were normal, 37.5% overweight, and 18.5% obese) than the premenarche ones (P<0.001). BMI was significantly related to the age at onset of menarche (**Table.1**). We observed obese girls reached menarche earlier than the girls with normal BMI (odds ratio [OR]: 3.36; 95% confidence interval [CI]: 1.72-6.54); while thin girls had delay in menarche compared to those with normal BMI (OR: 0.30; 95% CI: 0.13-0.68).

Table-1: Anthropometric measurement of the case and control groups*

Variables		Case (n=200)	Control (n=200)	P-value
Age (year)		12.06±0.1 5#	12.0 6±0. 10	0.82
Weight (kg)		51.97±10.06	43.60±11.22	<0.001
Height (cm)		155.32±6.63	149.30±7.16	<0.001
Body mass index (kg/m^2)	Underweight	8(4.0%)	36(18.0%)	<0.001
	Normal	80(40.0%)	109(54.5%)	
	Overweight	75(37.5%)	40(20.0%)	
	Obese	37(18.5%)	15(7.5%)	

Significance level <0.05. *From independent t-test for quantitative variables and Chi-square for qualitative variables. #Data is mean ± standard deviation, except for body mass index. Case group: early menarche girls, Control group: premenarche girls.

Four major dietary patterns were derived using factor analysis. The four patterns are exhibited in **Table.2**. The first pattern was defined as meat diet pattern, which is characterized by high loadings for poultry, pizza, fish, organ, red and processed meat, and stews. The second pattern, which loaded heavily on snacks, sugars, desserts, processed meat, condiments, high-fat dairy, and pickle, was labeled as Western dietary pattern. The third pattern was named traditional diet pattern because it has high loadings of legumes, omelets, broth**,** potato, egg, and stews. The last pattern was considered vegetarian and had a positive loading factor on tomato, carrot, vegetables, fruits, and nuts.

Table-2: Factor loadings and the explained variances for the four major dietary patterns extracted by factor analysis*

	Dietary patterns			
Food groups	Meat	Western	Traditional	Vegetarian
Poultry	0.75			
Pizza	0.64			
Fish	0.59			
Red meat	0.55			
Stews	0.54		0.32	
Processed meat	0.34	0.4		
Organ meat	0.26			
Snacks		0.7		
Sugars		0.5		
Desserts		0.5		
Condiments		0.4		
High-fat dairy products		0.38		
Pickle		0.2		
Legumes			0.63	
Omelet			0.61	
Broth			0.56	
Potato			0.51	
Egg			0.40	
Tomato				0.76
Carrot				0.62
Vegetables				0.56
Fruits				0.30
Nuts				0.23
Percent of variance explained	16/57	5/4	4/68	4/36

[a]. Factor loadings <0.2 were omitted for simplicity. Total variance explained by four factors: 31.03

Table.3 presents the ORs and their 95% CIs for early menarche by the tertile of factor scores for each dietary pattern. After adjusting for potential covariates, the high risk of early menarche was found to be associated with the meat diet pattern (the highest vs. the lowest quintiles: OR: 1.21; 95%CI: 0.64-2.29). The factor scores for vegetarian dietary pattern (the highest vs. the lowest tertile: OR: 0.01; 95%CI: 0.003-0.02), and the traditional diet pattern (the highest vs. the lowest tertile: OR: 0.13; 95%CI: 0.06-0.26) were negatively related to the risk of early menarche. No association was found between Western dietary pattern and early menarche.

Table-3: Multivariate adjusted odds ratios for early menarche across tertiles of dietary pattern scores (based on 400 subjects)*

Dietary pattern	Tertile			P-value
	T1	T2	T3	
Meat diet pattern				
†Model 1	1.00	0.50(0.31-0.82)	0.83(0.51-1.35)	0.01
‡Model 2	1.00	0.48(0.25-0.89)	1.21(0.64-2.29)	0.009
Western diet				
†Model1	1.00	0.92(0.57-1.49)	0.71(0.44-1.16)	0.36
‡Model2	1.00	0.90(0.47-1.72)	0.67(0.34-1.31)	0.47
Traditional diet				
†Model1	1.00	0.40(0.24-0.66)	0.13(0.07-0.22)	<0.001
‡Model2	1.00	0.46(0.23-0.90)	0.13(0.06-0.26)	<0.001
Vegetarian diet				
†Model1	1.00	0.07(0.03-0.14)	0.01(0.006-0.03)	<0.001
‡Model2	1.00	0.05(0.02-0.13)	0.01(0.003-0.02)	<0.001

*Values are OR (95% CI). † Without adjusting for confounding factors ‡ adjusted for total energy intake, weight, height, body mass index, and heredity, birth weight.

4- DISCUSSION

The present study was a case-control study to explore the association between dietary patterns and body size with early menarche (<12 years) among elementary school girls. We identified four major dietary patterns in this population using exploratory factor analysis: meat, Western, traditional, as well as vegetarian. Further analyses suggested that these major dietary patterns are related to early or late menarche. After adjusting for confounding variables, the meat dietary pattern was associated with high risk of early menarche, whereas the traditional and vegetarian dietary patterns were associated with low risk of early menarche, and we found no significant association between the Western dietary pattern and early menarche. These four dietary patterns contributed to 31.03% of the dietary variation which is similar to those of previous studies that identified 3 dietary patterns and 4 components from food frequency data contributed to 47.3% and 29.2% of the dietary variation, respectively (36). Nutrition is one of the most important environmental factors affecting the mechanism of menarche due to its impact on hormone levels in long and short term. In the long term, diet contributes to body size and development leading to menarche and it acts at a critical state to accelerate the timing of menarche in the short term (37, 38). We observed the meat diet pattern loaded for red meat, poultry, fish, organ stew and processed meat was positively associated with earlier age at menarche. Previous studies have demonstrated that consuming red meat and other animal proteins (6, 22) can promote early AAM through the excessive energy intake and subsequent overweight or estrogenic action that accelerates pubertal development. Several studies also suggested that meat or protein intake had a menarche-promoting effect. Berkey et al. studied 67 Caucasian girls born in Boston in the 1930s and 1940s. They assessed diet retrospectively at ages 1–2, 3–5, and 6–8 years. Finally, they observed a negative association between mean AAM and animal protein intake at the ages of 3–5 and 6–8 years (6). These results were closely comparable to those obtained by Rogers et al. who conducted a study on 3,298 British girls who participated in the Avon Longitudinal Study of Parents and Children, to investigate the relationship between dietary intake throughout childhood and AAM. They found that high intake of protein and meat at the ages of 3 and 7 years was associated with earlier menarche (7). Similarly in a cohort study Jansen et al. reported that girls who consumed red meat ≥ 2 times/day had a significantly earlier age at menarche compared to those who consumed red meat < 4 times/week (39). They indicated the frequency of intake of red meat was inversely related to the onset of menarche. Gunther et al. investigated whether protein intake at 12 and/or 18–24 months might be associated with pubertal timing. They noted that higher animal protein intake at the age of 5–6 years may lead to an earlier age at the onset of pubertal growth spurt, peak height velocity, and menarche/voice break (22). Animal proteins can stimulate insulin growth factor 1 (IGF-1) which stimulates the adipocyte proliferation and differentiation. However, other nutrients exist in animal foods, for instance micronutrients and fat might contribute to the timing of menarche (36).

In a contrary way, Cheng et al. deduced an association between a diet lower in total animal protein and earlier age at menarche. This discrepancy was attributed to the Nutritional geometry (NG) methodology to analyze the relation of macronutrients to pubertal timing unlike the regression models in other studies (40). Our findings hold that the western diet pattern which is heavy in processed meats, fatty dairy products, snacks, desserts, pickle and condiments (high in sugar) was not associated with early AAM after adjustment for confounders. Similarly, in a cross-sectional study of 17,602 Shanghai children, Chen et al. concluded that an unhealthy diet including snacks, desserts and fried food was not associated with precocious puberty after adjustment for age, BMI and socioeconomic factors (41). Although a western diet provides a higher dietary energy intake leading to obesity and putting on weight as a risk factor for earlier AAM, recent studies have shown that dietary composition particularly fat was not related to early occurrence of menarche (30). Moreover, greater dairy fat intake (4), and animal fat were found to be related with late menarche. However, the data on this impact are controversial and its mechanism is still unknown (36, 42). Carwile et al. predicted the effect of sugar-sweetened beverage (SSB) consumption on age at menarche and found menarche occurred 2.7 months earlier in girls consuming >1.5 servings of SSBs per day than girls consuming ≤ 2 times weekly. Likewise, they observed association between earlier age of menarche and added but not total sugar (15). The current findings showed that the traditional diet pattern including legumes, omelets, broth**,** potato, egg, and stew items which is rich in red and white meat, vegetable, meat analogues, beans was associated with lower risk of early menarche before and after adjustment for confounders, whereas in a cross-sectional study, traditional diet pattern was not found to be statistically related to sexual development (41). Kissinger reported that although higher intake of meat resulted in 6 month earlier age at menarche in comparison with vegetarians, total intake of protein was not related to early occurrence of menarche (43).

Additionally, it was found girls who had a mixed diet experienced menarche late (13.2 years) compared with those receiving a meat diet (12.7 years) (30), also meat analogues and legumes postpone the time of menarche (43). We found a delay of menarche in girls who had a vegetarian diet which loaded heavily on fruits, vegetables and nuts. Roselland et al. in a large retrospective study of UK vegetarians found no difference in AAM between life-long vegetarians and those becoming vegetarian as adults (44). In 1991, de Ridder et al. examined the relationship between dietary components and physical or hormonal sexual maturation in 63 girls, they found that higher intake of vegetable proteins was associated with later breast development and menarche, although fiber intake was more important (23). Berkey et al., predicted a positive relationship between mean AAM and vegetable protein intake at the age of 3–5 years (6). Correspondingly, Gunther reported higher intake of vegetable proteins at the ages of 3–4 and 5–6 years was associated with delayed puberty (22). The negative association between vegetarian dietary pattern and menarche ascribed to two phytoestrogens, lignin, and flavonol (36). Moreover, Dietary fiber may prevent early AAM through its effect on estrogen metabolism. Dietary fiber may diminish estrogen reabsorption in the gut, and thus, protects against excessive estrogen supply and early onset of menarche (1, 25, 45).

In this study, we found the opposite relationship between the age at menarche and BMI. The association between body size and menarche is often assessed using BMI as a measure of body fat. The relationship between BMI and menarche has been shown in several studies (12, 17-20). In a cross-sectional study of 11-15 year-old Iranian school girls published in 2010, Dahri et al. observed that BMI was related to early menarche. The mean AAM in overweight and obese girls was12.2±0.07 and 13.1±0.07 years, respectively (46).

The link between early onset of menstruation and high BMI is associated to the ability of leptin to stimulate pulsatile secretion of GnRH, fat tissue to produce leptin, and leptin to communicate to the hypothalamus that critical amount of fat has been accumulated and menarche can start. Thus, AAM is negatively correlated with leptin concentration (1). The strength of current study is the evaluation of dietary patterns as an important factor affecting on the age of menarche while previous studies focused mainly on intake of certain nutrients, but not eating patterns, on the timing of menarche. Another strong point is controlling more confounders such as BMI, dietary energy intake, height, weight, mothers' age of menarche (heredity), and birth weight compared to earlier studies. Also, it is a case-control study to predict the nutritional causes of early menarche despite recent studies designed as a cross-sectional study that could not prove the casual relationship between dietary pattern and menarche. Several limitations should be mentioned. Although BMI and weight were controlled, it would be better for us to consider waist circumference and % body fat as confounding factors. Additionally, dietary patterns have been assessed only according to dietary intake not dietary habits such as time and number of meals and snacks that play salient role to predict dietary patterns.

Also, the result of dietary pattern assessment mostly depends on population studied and discrepancies with regardsto race, culture and geographical districts have been reported. We plan to carry out further study among inhabitants dwelling in different regions with different race and culture. Moreover, the factor analysis method has limitations due to the theoretical or optional decisions that a researcher makes which can influence on the findings of research. Finally, the possibility of recall bias to evaluate dietary patterns by FFQ- assessment should not be overlooked.

4-1. Study strength and limitation

The strength of current study is the evaluation of dietary patterns as an important factor affecting on the age of menarche while previous studies focused mainly on intake of certain nutrients but not eating patterns on the timing of menarche. Another strong point is controlling more confounders such as BMI, dietary energy intake, height, weight, mothers' age of menarche (heredity), and birth weight compared to earlier studies. Also, it is a case-control study to predict the nutritional causes of early menarche in spite of recent studies designed as a cross-sectional study that could not prove the casual relationship between dietary pattern and menarche. Several limitations should be mentioned. Although BMI and weight was controlled, it would be better for us to consider waist circumference and % body fat as confounding factors. Additionally, dietary patterns have been assessed only according to dietary intakes not dietary habits such as time and number of meals and snacks that play a salient role to predict dietary patterns. Also, the result of dietary pattern assessment mostly depends on population studied and discrepancies with regards to race, culture and geographical districts have been reported. We plan to carry out further study among inhabitants dwelling in different regions with a different race and culture. Moreover, the factor analysis method has limitations due to the theoretical or optional decisions that a researcher makes which can influence on the findings of research. Finally the possibility of recall bias to evaluate dietary patterns by FFQ-assessment should not be overlooked.

5- CONCLUSION

In conclusion, this study concentrated on the role of 4 dietary patterns and body size in early menarche. There was not any relationship between traditional dietary pattern and early menarche. Both vegetarian and traditional dietary patterns were associated negatively with early menarche, while the highest tertile of meat diet and BMI were positively related to early age at menarche. Further studies are required to confirm these findings.

6- ACKNOWLEDGEMENT

This article was derived from a thesis project by the first author. The authors would like to thank Nutrition Department, School of Medicine, Mashhad University of Medical Sciences, Iran for the financial support (approved by the Ethics Committee: 920991), and the participants for their time, effort, and cooperation.

7- CONFLICT OF INTEREST: None.

8- REFERENCES

1. Yermachenko A, Dvornyk V. Nongenetic determinants of age at menarche: a systematic review. BioMed research international. 2014;2014:371583.

2. Parent AS, Teilmann G, Juul A, Skakkebaek NE, Toppari J, Bourguignon JP. The timing of normal puberty and the age limits of sexual precocity: variations around the world, secular trends, and changes after migration. Endocrine reviews. 2003;24(5):668-93.

3. Ong KK, Ahmed ML, Dunger DB. Lessons from large population studies on timing and tempo of puberty (secular trends and relation to body size): the European trend. Molecular and cellular endocrinology. 2006;254-255:8-12.

4. Wiley AS. Milk intake and total dairy consumption: associations with early menarche in NHANES 1999-2004. PloS one. 2011;6(2):e14685.

5. Koprowski C, Ross RK, Mack WJ, Henderson BE, Bernstein L. Diet, body size and menarche in a multiethnic cohort. British journal of cancer. 1999;79(11-12):1907-11.

6. Berkey CS, Gardner JD, Frazier AL, Colditz GA. Relation of childhood diet and body size to menarche and adolescent growth in girls. American journal of epidemiology. 2000;152(5):446-52.

7. Rogers IS, Northstone K, Dunger DB, Cooper AR, Ness AR, Emmett PM. Diet throughout childhood and age at menarche in a contemporary cohort of British girls. Public health nutrition. 2010;13(12):2052-63.

8. Lim JS, Lee HS, Kim EY, Yi KH, Hwang JS. Early menarche increases the risk of Type 2 diabetes in young and middle-aged Korean women. Diabetic medicine : a journal of the British Diabetic Association. 2014.

9. McKibben SL, Poston DL, Jr. The influence

of age at menarche on the fertility of Chinese women. Social biology. 2003;50(3-4):222-37.

10. Wu X, Cai H, Kallianpur A, Gao YT, Yang G, Chow WH, et al. Age at menarche and natural menopause and number of reproductive years in association with mortality: results from a median follow-up of 11.2 years among 31,955 naturally menopausal Chinese women. PloS one. 2014;9(8):e103673.

11. Mueller NT, Pereira MA, Demerath EW, Dreyfus JG, MacLehose RF, Carr JJ, et al. Earlier menarche is associated with fatty liver and abdominal ectopic fat in midlife, independent of young adult BMI: The CARDIA study. Obesity (Silver Spring, Md). 2015;23(2):468-74.

12. Bratberg GH, Nilsen TI, Holmen TL, Vatten LJ. Early sexual maturation, central adiposity and subsequent overweight in late adolescence. a four-year follow-up of 1605 adolescent Norwegian boys and girls: the Young HUNT study. BMC public health. 2007;7:54.

13. Trepanier L, Juster RP, Marin MF, Plusquellec P, Francois N, Sindi S, et al. Early menarche predicts increased depressive symptoms and cortisol levels in Quebec girls ages 11 to 13. Development and psychopathology. 2013;25(4 Pt 1):1017-27.

14. Alcala-Herrera V, Marvan ML. Early menarche, depressive symptoms, and coping strategies. Journal of adolescence. 2014;37(6):905-13.

15. Carwile JL, Willett WC, Spiegelman D, Hertzmark E, Rich-Edwards J, Frazier AL, et al. Sugar-sweetened beverage consumption and age at menarche in a prospective study of US girls. Human reproduction (Oxford, England). 2015;30(3):675-83.

16. Bonjour JP, Chevalley T. Pubertal timing, bone acquisition, and risk of fracture throughout life. Endocrine reviews. 2014;35(5):820-47.

17. Kaplowitz PB. Link between body fat and the timing of puberty. Pediatrics. 2008;121 Suppl 3:S208-17.

18. Maclure M, Travis LB, Willett W, MacMahon B. A prospective cohort study of nutrient intake and age at menarche. The American journal of clinical nutrition. 1991;54(4):649-56.

19. Adair LS. Size at birth predicts age at menarche. Pediatrics. 2001;107(4):E59.

20. Rosenfield RL, Lipton RB, Drum ML. Thelarche, pubarche, and menarche attainment in children with normal and elevated body mass index. Pediatrics. 2009;123(1):84-8.

21. Lei Y, Ma J, Hu P, Dong B, Zhang B, Song Y. The status of spermarche, menarche and corresponding relationships with nutritional status among students of 13 ethnic minorities in Southwest China in 2014. Zhonghua yu fang yi xue za zhi [Chinese journal of preventive medicine]. 2019;53(5):492-6.

22. Gunther AL, Karaolis-Danckert N, Kroke A, Remer T, Buyken AE. Dietary protein intake throughout childhood is associated with the timing of puberty. The Journal of nutrition. 2010;140(3):565-71.

23. de Ridder CM, Thijssen JH, Van 't Veer P, van Duuren R, Bruning PF, Zonderland ML, et al. Dietary habits, sexual maturation, and plasma hormones in pubertal girls: a longitudinal study. The American journal of clinical nutrition. 1991;54(5):805-13.

24. Koo MM, Rohan TE, Jain M, McLaughlin JR, Corey PN. A cohort study of dietary fibre intake and menarche. Public health nutrition. 2002;5(2):353-60.

25. Hughes RE, Jones E. Intake of dietary fibre and the age of menarche. Annals of human biology. 1985;12(4):325-32.

26. Chevalley T, Rizzoli R, Hans D, Ferrari S, Bonjour JP. Interaction between calcium intake and menarcheal age on bone mass gain: an eight-year follow-up study from prepuberty to postmenarche. The Journal of clinical endocrinology and metabolism. 2005;90(1):44-51.

27. Schulze MB, Hoffmann K, Kroke A, Boeing H. Dietary patterns and their association with food and nutrient intake in the European Prospective Investigation into Cancer and Nutrition (EPIC)-Potsdam study. The British journal of nutrition. 2001;85(3):363-73.

28. Michels KB, Schulze MB. Can dietary patterns help us detect diet-disease associations? Nutrition research reviews. 2005;18(2):241-8.

29. Hill P, Wynder EL, Garbaczewski L, Helman P, Hill M, Sporangisa J, et al. Diet and menarche in different ethnic groups. European journal of cancer. 1980;16(4):519-25.

30. Meyer F, Moisan J, Marcoux D, Bouchard C. Dietary and physical determinants of menarche. Epidemiology (Cambridge, Mass). 1990;1(5):377-81.

31. Ghazizahedi S, Nouri M, Norouzy A, Nemati M, Safarian M, Mohajeri SAR, et al. Scientific: Validity and Reproducibility of Iranian Food Frequency Questionnaire. Nutrition And Food Sciences Research. 2014; 1(1): 16.

32. Mosallaei Z, Mazidi M, Safariyan M, Norouzy A, Mohajeri SAR, Esmaily H, et al. Dietary intake and its relationship with non-alcoholic fatty liver disease (NAFLD). Mediterranean Journal of Nutrition and Metabolism. 2015;8(2):139-48.

33. Nematy M, Nouri M, Ghazizahedi S, Norouzy A, Mohajeri S, Shalaei N, et al. Validity and reproducibility of Iranian food frequency questionnaire. Switz Res Park J. 2013;102:2137-46.

34. BMI-for-age (5-19 years). World Health Organization. Available at: https://www.who.int/growthref/who2007_bmi_for_age/en/.

35. Safarian M, Ghayour-Mobarhan M, Esmailie H, Nematy M, Razavi A. Investigation of dietary patterns, healthy eating index and traditional risk factors of cardiovascular disease in 35-65 years old adults of Mashhad. medical journal of mashhad university of medical sciences. 2013;56(4):226-35.

36.Chang Chen, Yao Chen, Yunting Zhang, W anqi Sun, Yanrui Jiang, Yuanjin Song, et al. Association between Dietary Patterns and Precocious Puberty in Children: APopulation-Based Study. International Journal of Endocrinology, vol. 2018, Article ID 4528704, 7 pages, 2018.

37. Soliman A, De Sanctis V, Elalaily R. Nutrition and pubertal development. Indian journal of endocrinology and metabolism. 2014;18(Suppl 1):S39-47.

38. Sanchez A, Kissinger DG, Phillips RI. A hypothesis on the etiological role of diet on age of menarche. Medical hypotheses. 1981;7(11):1339-45.

39. Jansen EC, Marin C, Mora-Plazas M, Villamor E. Higher Childhood Red Meat Intake Frequency Is Associated with Earlier Age at Menarche. The Journal of nutrition. 2016.

40. Cheng HL, Raubenheimer D, Steinbeck K, Baur L, Garnett S. New insights into the association of mid-childhood macronutrient intake to pubertal development in adolescence using nutritional geometry. British Journal of Nutrition. 2019:1-21.

41. Chen C, Chen Y, Zhang Y, Sun W, Jiang Y, Song Y, et al. Association between dietary patterns and precocious puberty in children: a population-based study. International journal of endocrinology. 2018;2018.

42. Carwile JL, Willett WC, Wang M, Rich-Edwards J, Frazier AL, Michels KB. Milk Consumption after Age 9 Years Does Not Predict Age at Menarche. The Journal of nutrition. 2015;145(8):1900-8.

43. Kissinger D, Sanchez A. The association of dietary factors with the age of menarche. Nutrition Research. 1987;7(5):471-9.

44. Rosell M, Appleby P, Key T. Height, age at menarche, body weight and body mass index in life-long vegetarians. Public health nutrition. 2005;8(07):870-5.

45. Cheng G, Remer T, Prinz-Langenohl R, Blaszkewicz M, Degen GH, Buyken AE. Relation of isoflavones and fiber intake in childhood to the timing of puberty. The American journal of clinical nutrition. 2010;92(3):556-64.

46. Dahri M, Safarian M, Hajifaraji M, Houshiar Rad A, Abadi A. The Association of Overweight and Obesity with Menarche Age and Nutritional Status in Girls Aged 11-15 in Mashhadâ. medical journal of mashhad university of medical sciences. 2010;53(4):245-53.