



Age at Menarche and Its Related Factors Among Students of Qaen, Eastern Iran: A School-Based Cross-Sectional Study

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Abstract

Background: Age at menarche is the key indicator of puberty in females and the reflector of populations' health that different hereditary and environmental factors can affect it.

Objectives: This study was conducted to determine the age at menarche and its relationship with body mass index (BMI) and demographic factors among students of Qaen, Eastern Iran.

Methods: This cross-sectional study was conducted on 400, 10 -16-year-old students of Qaen located at the East of Iran, in 2016. The participants were selected by the random multistage sampling of students in elementary and secondary schools that were eligible to participate in the study. Data collection was carried out through interviews and a checklist including demographic and menarche information as well as height and weight measurements in schools. The data were analyzed using SPSS V.18 by Pearson's correlation, t-test, and multiple linear regression.

Results: The mean age of students was 13.86 ± 1.10 years, mean BMI was 20.38 ± 2.72 kg/m² and the mean age at menarche was 12.78 ± 1.23 (95% CI: 12.66 - 12.90) years. There was an inverse correlation between the age at menarche and BMI ($r = -0.123$, $P = 0.014$) while the height ($r = 0.195$, $P = 0.0001$), maternal age ($r = 0.223$, $P = 0.0001$), and sleep duration ($r = 0.156$, $P = 0.002$) were directly related to age at menarche. No significant relationship existed between age at menarche and weight of students ($P = 0.86$).

Conclusions: The mean age at menarche of students was as average as Iranian studies. Lower age at menarche was significantly correlated with higher BMI.

Keywords: Age at Menarche, Body Mass Index, Menarche, Iran

1. Background

The onset of menstruation and the age which the first menstrual period occurs is considered as the age at menarche, which is an important sign of the puberty in females and a health and socioeconomic status index of societies (1-3). Heredity is the most important factor for determining puberty and age at menarche, which is confirmed by studies that examine the relationship between age of puberty in mother and daughter or sisters (4). However, in addition to inheritance, other factors which have been different and sometimes contradictory in studies also affect the onset time and the progress of puberty. These factors include economic and social status, public health, location and geographical location, nutrition, exposure to light, mental status, chronic diseases, and environmental stimuli (5-7).

The results of studies have shown that during the last decades, the age of puberty and the occurrence of menar-

che has been reduced in various developed and developing societies, due to improved nutrition and hygiene and improved economic and social status (8, 9). Early age at menarche among females puts them at risk of accelerating skeletal maturity and shortening height in adulthood. Due to the rapid closure of epiphyseal plates in bones, early onset of sexual activity and social and psychological problems are also among other important complications of early puberty (6, 10, 11). According to the studies, early menstruation at an early age is a risk factor for cardiovascular problems, metabolic syndrome, and breast and ovarian cancer, and is associated with an increase in the prevalence of painful menstruation and adolescence pregnancy (1, 6, 10).

The results of some studies have indicated that obesity is one of the causes of early puberty and early menstruation in a person with no specific disease (12). However, in some studies, the effects of overweight and obesity in

accelerating the onset of menarche and signs of puberty have been refused (1, 13). In the Sharifi et al.'s study (11) a significant inverse correlation was observed between age at menarche and body mass index (BMI), however, there wasn't any significant correlation in the Demerath et al.'s study (14).

2. Objectives

Due to the importance of evidence about age at menarche, as an important health indicator for future planning, also, the increasing in weight and decreasing in age at menarche of adolescents in societies and different results of studies about the relationship between BMI and age at menarche, the present study was conducted to determine age at menarche and its relationship with BMI and demographic factors among 10 - 16-year-old students in the city of Qaen, Eastern Iran.

3. Methods

3.1. Study Design and Population

The present study was a cross-sectional study and study population was all girl students studying at elementary and secondary schools in the city of Qaen in East of Iran in 2016. The sample size was estimated based on the mean estimating formula ($n = z^2 s^2 / d^2$) and results of the Sharifi et al.'s study (15); 400 girls were selected by multistage sampling. First, the city of Qaen was divided into five geographical regions (North, South, East, West, and Center), and then in each stratum from the list of girls' schools, an elementary school, and a secondary school were selected randomly. Then in the selected schools, for each desired grade, one class was randomly chosen. All students in the class who remembered the time of menarche and their menstruation had started 6 months ago, were included in the study. The presence of any underlying and systemic diseases that affect the growth of the individual (such as chronic heart disease, diabetes, thyroid, and hormonal disorders), use of hormonal weight-reducing or increasing drugs, and the presence of diseases such as polycystic syndrome, because of the possibility of relation with obesity or effect on incidence of puberty symptoms, were among the exclusion criteria (4, 10).

3.2. Data Collection

Before gathering the data, the objectives of the study were described to students and their parents. It was also assured that all information would remain secret to the researchers and consent was obtained from the parents of students. The present study was approved by the

Ethics Committee of Birjand University of Medical Sciences (ethics code: IR.BUMS.REC.1394.86). Data collection were done by interviewing, measuring height and weight, and completing a checklist including demographic questions (including age, studying grade, maternal age, birth order, family size and duration of sleep); questions about the age at menarche was conducted by two midwives in schools. A part of the checklist was due to measuring height and weight for calculating BMI using standard and identical tools including the German Seca portable digital scale along with a graded vertical bar for measuring weight and height, where the weight was measured in light clothing, without shoes, and accuracy of 100 g and height according to an upright position and bare-footed and accuracy of 0.5 cm.

3.3. Statistical Analysis

Finally, after gathering the data, they were transferred to SPSS (PASW Statistics for Windows, version 18.0, Chicago: SPSS Inc., USA), and in addition to representing descriptive statistics, they were analyzed by Pearson's correlation coefficient, independent *t*-test, and multiple linear regression, at the level of $\alpha = 0.05$.

4. Results

From 400 female students participating in this study, 34 (8.5%) were elementary school students and 366 (91.5%) were secondary school students, with the mean age of 13.86 ± 1.10 years old, and with the minimum age of 10 and the maximum age of 16 years. In this study, most of the students (29%) were the first child of the family and most of the families (31.8%) were five persons. On average, the duration of each student's sleep was 7.78 ± 1.82 hours per day and the mean maternal age was 42.63 ± 5.92 years.

The onset of menstruation and menarche for 22.8% of the students was in the spring, 43.3% in the summer, 22% in the autumn and 12% in the winter, and the mean age at menarche was 12.78 ± 1.23 years (95% confidence interval: 12.66 - 12.90). The mean BMI was 20.38 ± 2.72 kg/m² (Table 1).

According to the results of Pearson's correlation, there was an inverse and significant relationship between age at menarche and BMI ($r = -0.123$, $P = 0.014$). Thus, with the increase in BMI, the age at menarche decreased. Also, there was a positive significant relationship between the age at menarche and height, birth order, maternal age, family size, and duration of sleep; and with the increase of each of these variables, the age at menarche also increased, however, there was no significant relationship between age at menarche and weight ($P = 0.86$) (Table 2).

Table 1. Description of Age at Menarche, BMI, Height and Weight in Students

Variable	Mean	Standard Deviation	Minimum	Maximum
Age at menarche	12.78	1.23	9	16
Body mass index (kg/m ²)	20.38	2.72	14.69	36.16
Height (cm)	157.84	6.75	132.5	176
Weight (kg)	50.75	7.13	35.1	75.5

Table 2. The Correlation Between Age at Menarche and BMI, Height, Weight, Birth Order, Maternal Age, Family Size, and Sleep Duration in Students

Variable	Body mass index	Height	Weight	Birth Order	Maternal Age	Family Size	Sleep Duration
Correlation with age at menarche (r)	-0.123	0.195	0.009	0.132	0.232	0.177	0.156
P value	0.014	0.0001	0.864	0.008	0.0001	0.0001	0.002

The mean age at menarche was 11.29 ± 0.76 years in the elementary school students and 12.92 ± 1.17 years in the secondary school students; this difference was significant with independent *t*-test ($P = 0.0001$). To predict the age at menarche, using the variables studied in this study, multiple linear regression was performed. After entering the variables by forwarding method, regression coefficients were significant for the variables of height ($P = 0.001$), sleep duration ($P = 0.012$), and maternal age, ($P = 0.0001$), and these three variables could explain 9.6% of age at menarche variance ($R^2 = 0.096$) (Table 3).

5. Discussion

Based on the results of the present study, there was a significant inverse correlation between age at menarche and BMI, so that by increase of BMI, the age at menarche decreased, which was consistent with the results of studies by Farahmand et al., in Tehran (16), and Mohamad et al., in Kish Island (17). In the studies of other countries, Wronka in Poland (7), Cho et al., in South Korea (3), and Harris et al., in Canada (8) confirmed this inverse relationship. However, this relationship was not significant in the study by Keshavarzi and Azad-bar study in Kermanshah (2) and the Demerath et al., study in the United States (14).

The reason of this relationship is not completely clear, however, some studies have found it necessary to have a certain percentage of body fat or specific weight and height for menarche occurrence, and believe that thin people catch these necessary values later and have later menarche (18, 19). Other studies consider this as a result of hormonal changes in obese people (20, 21), and some have mentioned the role of childhood obesity in early menarche and obesity in adulthood (22, 23). Due to the importance of obesity and overweight as a major risk factor for non-communicable diseases and complications of early menarche as a risk factor for some diseases such as breast can-

cer and cardiovascular disease (24-26), planning for suitable interventions for prevention and treatment of obesity and overweight in childhood and adolescence is more necessary.

According to the results, the mean age at menarche in students of Qaen in eastern Iran was 12.78 years, which was similar to the menarche age of girls in Mashhad (27). Various studies in Iran have reported the mean age at menarche in Isfahan as 12.65 (28) and 12.6 in Tehran (16), which has been less than the present study. In the study of girls in Rasht (29) and Kish Island (17), the mean age at menarche was 12.99 and 12.85 years respectively, which is more than this study. According to the meta-analysis implemented by Bahrami et al. (30), which reported the mean age at menarche in Iran as 12.81 years, it can be said that the age at menarche in girls of Qaen is as the country average.

In the studies of different countries, the mean age at menarche has been 12.4 in European girls (31), 12.96 in Indonesia (9), 12.9 in Korea (3), and 12.54 in the United States (32). Given the many hereditary, geographical, cultural, and socioeconomic factors affecting the age at menarche, the observed differences can be justified, although different methods of data collection and implementation of studies can also affect these differences.

The concern about the age at menarche in different societies is its decreasing trend as a risk factor for breast cancer and cardiovascular disease (24-26). However, due to the lack of a similar study in the city of Qaen, it was not possible to compare the results and to investigate the trend of menarche age, however, the study of Mohammad et al., reported the mean age at menarche in the eastern regions of Iran in 1990 as 13.81 and 13.67 in 1999, which is more than the present study (33). The lower mean age at menarche in elementary school students, in comparison to secondary school students in the present study, can also be indicative of a decreasing trend in age at menarche. Studies in different parts of the world have confirmed the decline of age at

Table 3. Multiple Linear Regression to Estimate the Age at Menarche in Terms of Height, Sleep Duration, and Maternal Age in Students

Variable	Regression Coefficient (B)	t	P Value	Model
Constant (a)	5.634	3.998	0.0001	Dependent variable: Age at menarche; $R^2 = 0.096$; $F = 14.088$; $P = 0.0001$
Height (cm)	0.03	3.453	0.001	
Sleep duration (h)	0.083	2.533	0.012	
Maternal age (y)	0.04	3.975	0.0001	

menarche and have mentioned it as a result of changes in lifestyle, industrialization, and the improvement of the socioeconomic status of the societies and the promotion of nutrition and public health (3, 8, 14, 32, 33).

The results of this study showed that there was a significant positive correlation between age at menarche and height of students, which was also significant in the regression model, after adjusting for other variables, and with increasing age at menarche, the height also increased. It seems that the results of various studies in this area have been different with regard to the height measured before or after the menarche. In the studies of Farahmand et al., in Tehran (16), and Hossain et al., in Bangladesh (34), in which height was measured after the menarche, as in the present study, there was a positive correlation between age at menarche and height. However, in studies of Krzyzanowska et al. (23), and Freedman et al. (35), which the height was measured before reaching the menarche, this relationship was negative, and the taller girls had reached the menarche earlier. Although this association has not been significant in some studies (22, 36), it seems that girls who have reached the menarche age sooner and reach sexual maturity, skeletal maturation also occurs earlier in them and their maximum growth is seen earlier as the reason of the closure of epiphyseal growth plates (35, 37). Therefore, girls who have reached menarche earlier than their peers are more likely to be higher in adolescents; however, girls who later reach menarche will be higher due to more longitudinal growth in long bones (38, 39).

In the present study, there was no significant relationship between age at menarche and weight of students, which was consistent with the results of most studies in Iran (11, 16, 36). Kim et al. (38), in a study on Korean girls aged 10 to 18, concluded that girls who had reached menarche were significantly heavier than girls who had not reached menarche. In the Krzyzanowska et al.'s study on British girls (23), there was a negative relationship between age at menarche and childhood weight, and heavier girls had reached menarche sooner.

In the present study, the age at menarche had a significant relationship with the birth order of students and the family size, and with the increase in the birth order and the number of family members, the age at menarche was in-

creased, which was similar to the study of Krzyzanowska et al., in the United Kingdom (23). This relation could be due to a lower social economic level, a crowded family, and less attention to children in more populous families.

According to the results, age at menarche was significantly and directly related to the maternal age. As the maternal age increased, the age at menarche also increased. In the Cho et al.'s study in South Korea (3), there was a direct relationship between maternal age and age at menarche. Due to limited articles in this field, the study of the validity and cause of this relationship requires further studies.

Another important factor for the students' menarche age was the duration of their sleep in a day. Thus, age at menarche increases with sleep increasing. Murata and Araki (40) also reported a positive relationship between age at menarche and sleep duration in a study of Japanese girl students and mentioned the reduced the duration of sleep as one of the factors affecting the early menarche in societies. It seems that further studies, especially longitudinal ones, are needed in order to better understand the effect of the duration of sleep on age at menarche.

One of the most important limitations of this study is its cross-sectional nature, the self-reported age at menarche, and its recall bias. For further investigation of the factors affecting the age at the menarche and confirming the causal relationships, longitudinal studies are suggested in the future.

5.1. Conclusions

In conclusion, the findings showed that in this study, the mean age at menarche was 12.78 years which was as average as Iranian studies. There was a significant correlation between age at menarche and BMI, and lower age at menarche was related to higher BMI.

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Footnotes

Authors' Contribution: Study concept and design: Amir Tiyuri, Malaknaz Ghannadkafi and Asma Tiyuri; acquisi-

tion of data: Asma Tiyuri and Najmeh Bahramian; analysis and interpretation of data: Amir Tiyuri and Asma Tiyuri; drafting of the manuscript: Asma Tiyuri, Malaknaz Ghanadkafi, Amir Tiyuri and Najmeh Bahramian; critical revision of the manuscript for important intellectual content: Asma Tiyuri and Amir Tiyuri; study supervision: Malaknaz Ghannadkafi and Amir Tiyuri.

Conflict of Interests: The authors declare no conflict of interest.

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References

- Charkazi A, Shahnazi H, Kouchaki GM, Nazari N, Ekrami Z, Samimi A. [Menarche at age and its relation with current health and socioeconomic status in Aq Qala city's girls, 2009]. *Health Syst Res*. 2010;**6**(3):532-9. Persian.
- Keshavarzi F, Azad-Bar M. [Investigation of age at menarche and its relation with height, weight, (BMI) body mass index and socioeconomic status in secondary schools in Kermanshah]. *Sci J Kurdistan Univ Med Sci*. 2001;**5**(20):1-5. Persian.
- Cho GJ, Park HT, Shin JH, Hur JY, Kim YT, Kim SH, et al. Age at menarche in a Korean population: Secular trends and influencing factors. *Eur J Pediatr*. 2010;**169**(1):89-94. doi: [10.1007/s00431-009-0993-1](#). [PubMed: [19504269](#)].
- Farahmand M, Ramezani F, Azizi F. [The influence of serum lipoproteins and body mass index on the age of menarche]. *Iran J Endocrinol Metab*. 2009;**11**(4):415-21. Persian.
- Amigo H, Vasquez S, Bustos P, Ortiz G, Lara M. Socioeconomic status and age at menarche in indigenous and non-indigenous Chilean adolescents. *Cad Saude Publica*. 2012;**28**(5):977-83. [PubMed: [22641520](#)].
- Oh CM, Oh IH, Choi KS, Choe BK, Yoon TY, Choi JM. Relationship between body mass index and early menarche of adolescent girls in Seoul. *J Prev Med Public Health*. 2012;**45**(4):227-34. doi: [10.3961/jpmph.2012.45.4.227](#). [PubMed: [22880154](#)]. [PubMed Central: [PMC3412985](#)].
- Wronka I. Association between BMI and age at menarche in girls from different socio-economic groups. *Anthropol Anz*. 2010;**68**(1):43-52. [PubMed: [20954455](#)].
- Harris MA, Prior JC, Koehoorn M. Age at menarche in the Canadian population: Secular trends and relationship to adulthood BMI. *J Adolesc Health*. 2008;**43**(6):548-54. doi: [10.1016/j.jadohealth.2008.07.017](#). [PubMed: [19027642](#)].
- Batubara JR, Soesanti F, van de Waal HD. Age at menarche in Indonesian girls: A national survey. *Acta Med Indones*. 2010;**42**(2):78-81. [PubMed: [20513931](#)].
- 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 Mashhad]. *Med J Mashhad Univ Med Sci*. 2010;**53**(4):245-53. Persian.
- Sharifi N, Najaf S, Tadayon M, Haghighi Zadeh MH. [Relationship between some anthropometric indices with Menarche age of girls in Ahvaz]. *J Ilam Univ Med Sci*. 2014;**22**(2):50-6. Persian.
- Khakbazan Z, Niroomanesh S, Mehran A, Magidi Ahie A. [Age at menarche and its relationship with body mass index]. *Hayat*. 2006;**11**(4):55-62. Persian.
- Heger S, Korner A, Meigen C, Gausche R, Keller A, Keller E, et al. Impact of weight status on the onset and parameters of puberty: Analysis of three representative cohorts from central Europe. *J Pediatr Endocrinol Metab*. 2008;**21**(9):865-77. [PubMed: [18924580](#)].
- Demerath EW, Towne B, Chumlea WC, Sun SS, Czerwinski SA, Remsburg KE, et al. Recent decline in age at menarche: The Fels Longitudinal Study. *Am J Hum Biol*. 2004;**16**(4):453-7. doi: [10.1002/ajhb.20039](#). [PubMed: [15214063](#)].
- Sharifi N, Najaf S, Tadaun Najaf Abadi M, Rashidi H, Haghighi Zadeh MH. [Pattern of puberty in girls lives in Ahvaz, Iran]. *Iran J Obstet Gynecol Infertil*. 2013;**16**(77):16-22. Persian. doi: [10.22038/ijogi.2013.2102](#).
- Farahmand M, Ramezani Tehrani F, Azizi F. Whether age of menarche is influenced by body mass index and lipoproteins profile? A retrospective study. *Iran J Reprod Med*. 2012;**10**(4):337-42. [PubMed: [25246895](#)]. [PubMed Central: [PMC4165951](#)].
- Mohamad K, Jamshidi L, Nouri Jelyani K. Is age of menarche related with body mass index? *Iran J Public Health*. 2013;**42**(9):1043-8. [PubMed: [26060666](#)]. [PubMed Central: [PMC4453884](#)].
- Frisch RE, Revelle R. Height and weight at menarche and a hypothesis of critical body weights and adolescent events. *Science*. 1970;**169**(3943):397-9. doi: [10.1126/science.169.3943.397](#). [PubMed: [5450378](#)].
- Sherar LB, Baxter-Jones AD, Mirwald RL. The relationship between body composition and onset of menarche. *Ann Hum Biol*. 2007;**34**(6):673-7. doi: [10.1080/03014460701660502](#). [PubMed: [18092210](#)].
- Chen EC, Brzyski RG. Exercise and reproductive dysfunction. *Fertil Steril*. 1999;**71**(1):1-6. doi: [10.1016/S0015-0282\(98\)00392-6](#). [PubMed: [9935107](#)].
- Cheng G, Buyken AE, Shi L, Karaolis-Danckert N, Kroke A, Wudy SA, et al. Beyond overweight: nutrition as an important lifestyle factor influencing timing of puberty. *Nutr Rev*. 2012;**70**(3):133-52. doi: [10.1111/j.1753-4887.2011.00461.x](#). [PubMed: [22364156](#)].
- Freedman DS, Khan LK, Serdula MK, Dietz WH, Srinivasan SR, Berenson GS, et al. The relation of menarcheal age to obesity in childhood and adulthood: The Bogalusa heart study. *BMC Pediatr*. 2003;**3**:3. [PubMed: [12723990](#)]. [PubMed Central: [PMC156622](#)].
- Krzyzanowska M, Mascie-Taylor CG, Thalabard JC. Biosocial correlates of age at menarche in a British cohort. *Ann Hum Biol*. 2016;**43**(3):235-40. doi: [10.3109/03014460.2015.1059890](#). [PubMed: [26226971](#)].
- Key TJ, Verkasalo PK, Banks E. Epidemiology of breast cancer. *Lancet Oncol*. 2001;**2**(3):133-40. doi: [10.1016/S1470-2045\(00\)00254-0](#). [PubMed: [11902563](#)].
- Lakshman R, Forouhi NG, Sharp SJ, Luben R, Bingham SA, Khaw KT, et al. Early age at menarche associated with cardiovascular disease and mortality. *J Clin Endocrinol Metab*. 2009;**94**(12):4953-60. doi: [10.1210/jc.2009-1789](#). [PubMed: [19880785](#)].
- Titus-Ernstoff L, Longnecker MP, Newcomb PA, Dain B, Greenberg ER, Mittendorf R, et al. Menstrual factors in relation to breast cancer risk. *Cancer Epidemiol Biomarkers Prev*. 1998;**7**(9):783-9. [PubMed: [9752986](#)].
- Kordi M, Mohamadirizi S, Shakeri MT. [Investigating the age of menarche, dysmenorrhea and menstrual characteristics in high school girl students in Mashhad city in year 2011]. *Iran J Obstet Gynecol Infertil*. 2013;**15**(33):10-8. Persian.
- Hasanzadeh Kashani H, Kavosh MS, Keshteli AH, Montazer M, Rostampour N, Kelishadi R, et al. Age of puberty in a representative sample of Iranian girls. *World J Pediatr*. 2009;**5**(2):132-5. doi: [10.1007/s12519-009-0026-1](#). [PubMed: [19718536](#)].
- Asgharnia M, Faraji R, Sharami H, Yadak M, Oudi M. A study of menarcheal age in northern Iran (Rasht). *Oman Med J*. 2009;**24**(2):95-8. doi: [10.5001/omj.2009.22](#). [PubMed: [22334852](#)]. [PubMed Central: [PMC3273943](#)].
- Bahrami N, Soleimani MA, Chan YH, Ghajazadeh M, Mirmiran P. Menarche age in Iran: A meta-analysis. *Iran J Nurs Midwifery Res*. 2014;**19**(5):444-50. [PubMed: [25400670](#)]. [PubMed Central: [PMC4223959](#)].

31. Meulenijzer E, Vyncke K, Labayen I, Meirhaeghe A, Beghin L, Breidenassel C, et al. Associations of early life and sociodemographic factors with menarcheal age in European adolescents. *Eur J Pediatr*. 2015;**174**(2):271–8. doi: [10.1007/s00431-014-2376-5](https://doi.org/10.1007/s00431-014-2376-5). [PubMed: [25070467](https://pubmed.ncbi.nlm.nih.gov/25070467/)].
32. Anderson SE, Dallal GE, Must A. Relative weight and race influence average age at menarche: Results from two nationally representative surveys of US girls studied 25 years apart. *Pediatrics*. 2003;**111**(4 Pt 1):844–50. doi: [10.1542/peds.111.4.844](https://doi.org/10.1542/peds.111.4.844). [PubMed: [12671122](https://pubmed.ncbi.nlm.nih.gov/12671122/)].
33. Mohammad K, Zeraati H, Majdzadeh S, Karimloo M. [Evaluating the trend of change in the mean onset age of menarche in Iranian girls]. *J Reprod Infertil*. 2006;**6**(5):523–31. Persian.
34. Hossain MG, Islam S, Aik S, Zaman TK, Lestrel PE. Age at menarche of university students in Bangladesh: Secular trends and association with adult anthropometric measures and socio-demographic factors. *J Biosoc Sci*. 2010;**42**(5):677–87. doi: [10.1017/S0021932010000210](https://doi.org/10.1017/S0021932010000210). [PubMed: [20529410](https://pubmed.ncbi.nlm.nih.gov/20529410/)].
35. Freedman DS, Khan LK, Serdula MK, Dietz WH, Srinivasan SR, Berenson GS. Relation of age at menarche to race, time period, and anthropometric dimensions: The Bogalusa Heart Study. *Pediatrics*. 2002;**110**(4):e43. doi: [10.1542/peds.110.4.e43](https://doi.org/10.1542/peds.110.4.e43). [PubMed: [12359816](https://pubmed.ncbi.nlm.nih.gov/12359816/)].
36. Pejhan A, Moghaddam HY, Najjar L, Akaberi A. The relationship between menarche age and anthropometric indices of girls in Sabzevar, Iran. *J Pak Med Assoc*. 2013;**63**(1):81–4. [PubMed: [23865138](https://pubmed.ncbi.nlm.nih.gov/23865138/)].
37. Biro FM, McMahon RP, Striegel-Moore R, Crawford PB, Obarzanek E, Morrison JA, et al. Impact of timing of pubertal maturation on growth in black and white female adolescents: The National Heart, Lung, and Blood Institute Growth and Health Study. *J Pediatr*. 2001;**138**(5):636–43. doi: [10.1067/mpd.2001.114476](https://doi.org/10.1067/mpd.2001.114476). [PubMed: [11343036](https://pubmed.ncbi.nlm.nih.gov/11343036/)].
38. Kim JY, Oh IH, Lee EY, Oh CM, Choi KS, Choe BK, et al. The relation of menarcheal age to anthropometric profiles in Korean girls. *J Korean Med Sci*. 2010;**25**(10):1405–10. doi: [10.3346/jkms.2010.25.10.1405](https://doi.org/10.3346/jkms.2010.25.10.1405). [PubMed: [20890418](https://pubmed.ncbi.nlm.nih.gov/20890418/)]. [PubMed Central: [PMC2946647](https://pubmed.ncbi.nlm.nih.gov/PMC2946647/)].
39. Onland-Moret NC, Peeters PH, van Gils CH, Clavel-Chapelon F, Key T, Tjønneland A, et al. Age at menarche in relation to adult height: the EPIC study. *Am J Epidemiol*. 2005;**162**(7):623–32. doi: [10.1093/aje/kwi260](https://doi.org/10.1093/aje/kwi260). [PubMed: [16107566](https://pubmed.ncbi.nlm.nih.gov/16107566/)].
40. Murata K, Araki S. Menarche and sleep among Japanese schoolgirls: An epidemiological approach to onset of menarche. *Tohoku J Exp Med*. 1993;**171**(1):21–7. doi: [10.1620/tjem.171.21](https://doi.org/10.1620/tjem.171.21). [PubMed: [8122255](https://pubmed.ncbi.nlm.nih.gov/8122255/)].