Iranian J Publ Health, Vol. 42, No. 9, Sep 2013, pp. 1043-1048

Original Article

Is Age of Menarche Related with Body Mass Index?

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(Received 17 Mar 2013; accepted 20 Jul 2013)

Abstract

Background: Prediction of the onset of menstruation (menarche age) using height, weight and Body Mass Index (BMI) is a major health procedure. The present study was conducted to determine the relationship between anthropometric indices and menarche age in 488 girls 11-17 years in southern Iran (Kish Island) in 2011.

Methods: Data was collected using questionnaires as well as measurements of the children's height and weight. This data was analyzed using *t*-test and logistic regression.

Results: Median age of menarche of menstruated girls as inferred from the age of menarche cumulative distribution was 12.9 years. Mean (SD) BMI in menstruated and non-menstruated girls were 21.97 (4.5) and 19.17 (3.7), respectively. Mean (SD) weight and height of the menstruated girls were 53.65 (12.3) kg and 156.06 (5.5) cm, respectively which are higher than respective figures of the non-menstruated participants 43.70 (10.7) kg and 150.21 (6.3) cm, respectively. Our results revealed a significant correlation between BMI and menarche age.

Conclusion: Menarche age and BMI are significantly correlated with higher BMI related to lower menarche age.

Keywords: Menarche, Adolescents, Body mass index

Introduction

Puberty is an ordinary situation to adolescence and the progress of secondary sexual characteristics leads to the total differentiation between male and female. Also, the final height and posture of the male and female adolescents are determined in this period (1). The menarche age is often considered for various reasons. It is one of the major indices of the female fertility which includes the period up to the menopause (2). There have been studies on the role of height, weight, and body structure on the menarche age; however, there is a variation on the role of such factors (3-5). Some researchers believe that some body fat is necessary in female adolescents and there is a minimum weight requirement for starting the menstruation (1). Higher food consumption which is often a result of the improved socioeconomic status is among factors leading to the lowered age of menstruation, as witnessed in the present century (6). The menarche and puberty age are lowered in Iran (2). Overweight and increased Body Mass Index (BMI) have been among the major changes in girls (7) and most likely being important factors affecting the menarche age. Menarche age is related to incidence risk of diseases such as breast cancer, obesity, and endometer cancer (8-10).

The purpose of present study was to investigate the relationship between menarche age and BMI in adolescent girls 11-17 years of age in Kish Island, Iran 2011.

Materials and Methods

The study sample consisted of 488 adolescent girls 11-17 years old was the entire population of the secondary school girls in Kish Island, Iran, in 2011.

Data Collection Instruments

Data was collected by measuring height (cm), weight (kg) and consequently calculation of BMI by dividing weight (kg) into squared height (m). The menarche age was ascertained and recorded using self or parental report. For measuring the weight with an accuracy of 0.1 kg, minimal clothes and no shoes were required. A portable scale (made in Germany by SOEHNLE) was calibrated daily with a standard scale and used for measuring weight. The participants' heights were measured by a plastic measuring tape attached to a wall; the participants were required to put their legs straight together, keep their arms to their sides and keep their knees, shoulders and back of their head all in the same direction; a ruler touching the top of their head and the measurement was recorded with an accuracy of 0.5 cm.

Statistical analysis

Data are presented as mean (SD) for numerical or N (%) for categorical variables. Two-sample independent *t*-test was applied for comparing weight, height, and BMI of menarche and non-menarche groups. The odd of menarche was estimated using three different logistic regression models. Model 1, estimates the effect of weight on menarche while adjusting for age. Similarly, the adjusted effects of height and BMI were estimated in Models 2 and 3, respectively. To be able to compare the effects of weight, height, and BMI, we also fitted logistic regressions to the standardized values of these factors. Pearson correlation coefficients between age and the above mentioned factors were also calculated. This will help us to identify a factor with minimal correlation with age as the most effective factor predicting menarche. All statistical analyses were conducted in R (version 2.15.4) statistical software (11).

Ethics

All parents gave written consent for participation in the study. The Ethical Committee of Tehran University of Medical Sciences approved the study protocol.

Results

Totally, 488 girls (all students) participated. Overall 26.4% were none menstruated and 73.6% had experienced their menarche. Results of our analyses are presented in Tables 1-3 and Figure 1. Table 1 shows the sample proportion of menarche at any given age indicating the cumulative distribution of age of menarche. Median menarche age as interpolated using a logistics curve was 12.85 years. Of course this estimation is based on the definition of age which is defined as the number of birthdays a person has experienced. So, ½ years has already been added to this interpolation (Fig. 1).

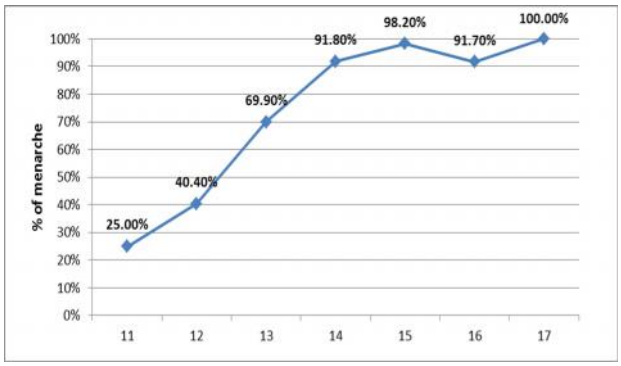

Fig. 1: Cumulative distribution of proportion of menarche by age

Table 1: Cumulative distribution of age of menarche (Kish Island, Iran 2011)

Age	N	Number of menarche	% of menarche
11	8	2	25.0
12	99	40	40.4
13	166	116	69.9
14	146	134	91.8
15	55	54	98.2
16	12	11	91.7
17	2	2	100.0

Note that since the age distribution of menarche is almost symmetric, such median can be considered as the mean age of menarche as well. Table 2 shows that BMI of the menstruated girls were within range of 18.9-22.3 kg/m while in non-menarche group ranges between 17.7 and 19.5. Table 2 also shows that generally, in each age group of menarche, children are heavier, taller, and fatter than non- menarche. In fact, apart from age group 11, all differences between the above two groups regarding the above characteristics were highly statistically significant. Table 3 shows the results of three different logistic regression models fitted to data predicting age adjusted effects of variables weight, height, and BMI (Models 1-3). As indicated in Table 3 (Model 1), adjusting for age, every 1 unit (kg) increment of weight increases the odds of menarche by about 7% ($P<$ 0.001). Based on Model 2, adjusting for age, every 1 unit (cm) increment of height increases the odds of menarche by about 13% ($P<$ 0.001). Finally, according to Model 3, again adjusting for age, every 1 unit (kg/m2) increment of BMI increases the odds of menarche by 18% ($P<$ 0.001). In order to compare the adjusted effects of weight, height, and BMI; new logistic regression models were fitted to the standardized values of these factors. Results of these models also indicated (not shown) that by every standard deviation unit increment of weight, height, and BMI, the odds of menarche become 2.5, 2.13, and 2.10 folds respectively.

Table 2: The mean Weight, Height, and BMI by age separated for menarche and non-menarche groups

Age	Weight (Mean (SD))			Height (Mean (SD))			BMI (Mean (SD))		
	Menarche	Non-menarche	*P**	Menarche	Non-menarche	*P*	Menarche	Non-menarche	*P*
11	44.8 (3.2)	39.9 (7.3)	0.359	153.9 (1.0)	148.3 (8.7)	0.175	18.9 (1.1)	17.7 (1.8)	0.437
12	50.0 (7.9)	42.3 (11.2)	<0.001	153.1 (4.9)	148.7 (6.0)	<0.001	21.3 (2.9)	18.9 (3.9)	0.001
13	52.4 (11.6)	45.3 (10.9)	<0.001	155.3 (5.6)	151.8 (5.4)	<0.001	21.6 (4.1)	19.6 (4.0)	0.003
≥14	55.2 (13.2)	46.1 (7.8)	0.012	156.9 (5.4)	153.5 (7.2)	0.026	22.3 (4.9)	19.5 (2.6)	0.032

P values calculated using two independent sample *t*-test

Table 3: Results of three Logistic Regression models

Variables	Model 1 (Age & Weight)		Model 2 (Age & Height)		Model 3 (Age & BMI)	
	OR (95% CI)	*P**	OR (95% CI)	*P*	OR (95% CI)	*P*
Age	3.09 (2.30 – 4.14)	<0.001	2.91 (2.17 – 3.89)	<0.001	3.36 (2.51 – 4.49)	<0.001
Weight	1.07 (1.05 – 1.10)	<0.001				
Height			1.13 (1.08 – 1.18)	<0.001		
BMI					1.18 (1.10 – 1.27)	<0.001

P values calculated using logistic regression model

Discussion

In this cross sectional study conducted in Kish Island, in the southern province of Iran, most menstruated girls were in the age range of 12-14 years old (91.8%).

As indicated in Table 1 and Fig. 1, the median age at menarche in Kish Island is 12.85 years which is lower than previous studies in Iran, showing a clear decreasing trend of menarche age.

In our data analyses we found some interesting results as indicated in Table 3. It has been found that the effect of age on menarche is more pronounced when estimating the BMI effect (Model 3; OR=3.36; 95% CI (2.51, 4.49)) as compared to the other two models. The reason for such phenomenon is that the BMI is less correlated with age (r=.18) than weight and height (with r=.26, and r=.35, respectively of Pearson correlation with age). Also, we found that height is most correlated with age. It is quite natural that with increasing age, height increases. After height, weight is more correlated with age. Although the correlation between BMI and age is not quite high, it is the most important factor and its impact on menarche is highly significant (Table 3).

Median menarche age was 12.85 years (Fig. 1), which is lower in comparison with countries such as Bangladesh (15.8), Congo (13.83), Ghana (13.98), Tanzania (15.21) and Senegal (16.1) (12). It is however, similar to countries such as America (12.8), Greece (12.0) and Italy (12.2) (12). Although the timing of puberty is related to the genetic factors, other factors such as geographical location, common health status, nutrition and socioeconomic status affect the onset of menstruation and its progression. Since data collections procedures vary in different studies and consequently could affect the results, therefore interpretation and comparison of such findings require some caution. The results of the present study when compared with the other Iranian studies indicate that the menarche age in girls in Kish Island is similar to those in the northern and central parts of Iran (3, 4). However, they all show a decreasing trend in the menarche age throughout the last 20 years, as in countries similar to America, Europe and Asia (2, 4, 13-15). There are many studies showing the decreasing trend of the menarche age in the last 100 years; one such study is Anderson and colleagues' study in the US, investigating the changes of the menarche age, which showed that the mean menarche age in American girls had decreased from 12.75 to 12.54 in a 20-year time span (16). Also, the mean menarche age had decreased within the past 40 years, attributing the reduction to girls' increasing obesity (17). Other researchers also attribute this to other factors including social, economical, health and nutritional improvement (6). In the present study, the weight of the menstruated girls in Kish Island, Iran was 51.43±10.73 kg, which is higher than the respective figures in other parts of Iran (18). It seems that lifestyle, health services, familial economic improvements, low physical activity and overconsumption of fast food and regionally particular nutrition are among the factors leading to the heavier weight of the participants in present study. Although the mechanisms involved in the negative correlation between obesity and menarche age are not well recognized, it is suggested that many endocrine factors are alleged to affect the speed of sexual puberty and fat accumulation in the body (9). Firsch believes that in order to start menstruation, girls need to achieve a minimum weight of 47.8 kg; and more importantly, their body fat should amount to 23.7% (from 16%) (19). Therefore, the puberty starts earlier in medium-obese girls (with 20 to 30% overweight than normal) than in girls with normal weight; in contrast, girls with malnutrition will experience a delay in menstruation (12). Several studies indicate that the childhood obesity is a predictor of early puberty (20). In the present study, the menstruated girls had higher weight than the non-menstruated ones. This is in line with some earlier studies as well (5, 21, 22). The increase in the body fat mass can be a significant message to cause the secretion of Leptin, stimulating the hypothalamus and consequently the over-secretion of GnRH. Moreover, GnRH stimulates the hypophysis-ovarian axis and initiates the speeding up puberty (23). Mean height of the participants in the present study was 156.06±11.35 cm, which is close to fig-

ures obtained in studies of other Iranian regions. The height of the menstruated girls was significantly taller than the non-menstruated ones. This finding is in line with earlier studies (18, 21, 22). Taller girls (148.60 cm) experience menstruation earlier than shorter ones (135 cm) in California (17). The interesting point is that girls with earlier puberty have shorter height in adulthood in comparison with those with delayed puberty, indeed the former experience speeded development and enjoy a taller height at puberty (24). It was observed that the menstruated girls' BMI was significantly higher than the non-menstruated girls' BMI; this is also congruent with other studies (18, 21, 22, 25, 26). In the present study, 62.2% of the menstruated girls had a BMI of above 18.5, indicating that physical condition is in agreement to a previous study by Einy and colleagues in Iran, the menarche age of girls with higher BMI, was lower than those with normal or lower BMI (27).

Conclusion

The results of the present study indicate that menarche age in Iran is experiencing a decreasing trend and parallel to this trend, the height, weight, and BMI is on the rise for children and adolescents in this country as well. In addition BMI of the child was shown to be positively associated with the odds of menarche. It is recommended implementation of educational plans to enhance the knowledge of the adolescent girls on their habits of nutrition and providing them with the appropriate eating patterns.

Ethical Considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors.

Acknowledgements

We would like to express our gratitude to the office of Education of Kish Island for their assistance and cooperation during this research. The authors declare that there is no conflict of interest.

References

1. Bazrafshan H, Behnampour N, Sarabandi F, Mirpour S (2012). Association between puberty and weight, height and body mass index in a developing community. *J Pak Med Assoc*, 62(5):454-7.
2. Mohamad K, Zeraati H, Majdzadeh R, Karimloo M (2005). To investigate the menarcheal age mean of Iranian girls. *Iranian Journal of Barvari and Nabarvari*, 4: 523-30 (In Persian).
3. Gharravi AM, Gharravi S, Marjani A, Moradi A, Golalipour MJ (2008). Correlation of age at menarche and height in Iranian student girls living in Gorgan-northeast of Iran. *J Pak Med Ass*, 58(8): 426-9.
4. Ayatollahi SM, Dowlatabadi E, Ayatollahi SA (2002). Age at Menarche in Iran. *Ann Hum Biol*, 29(4): 355-62.
5. Zhu HJ, Pan H, Zhang DX, Wu QY, Zhang K, et al (2010). Effect of body weight on the onset of puberty of female children and adolescents. *Zhongguo Yi Xue Ke Xue Yuan Xue Bao*, 32(1): 25-8.
6. Whincup PH, Gilg JA, Odoki K, Taylor SJ, Cook DG (2001). Age of menarche in contemporary British teenagers: survey of girls born between1982 and 1986. *BMJ*, 322(7294): 1095-6.
7. Demerath EW, Towne B, Chumlea WC, Sun SS, Czerwinski SA, et al (2004). Recent decline in age at menarche: the Fels Longitudinal Study. *Am J Hum Biol*, 16(4): 453-7.
8. Braithwaite D, Moore DH, Lustig RH, Epel ES, Ong KK, et al (2009). Socioeconomic status in relation to early menarche among black and white girls. *Cancer Causes Control*, 20(5): 713-20.
9. Van Lenthe FJ, Kemper CG, Van Mechelen W (1996). Rapid maturation in adolescence results in greater obesity in adulthood: the Amsterdam Growth and Health Study. *Am J Clin Nutr*, 64(1): 18-24.
10. McPherson CP, Sellers TA, Potter JD, Bostick RM, Folsom AR (1996). Reproductive fac-

tors and risk of endometrial cancer. The Iowa Women's Health Study. *Am J Epidemiol*, 143(12): 1195-202.
11. R Core Team R (2012). A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org.
12. Thomas F, Renaud F, Benefice E, De Meeüs T, Guegan JF (2001). International variability of ages at menarche and menopause: patterns and main determinants. *Hum Biol*, 73(2): 271-90.
13. Hwang JY, Shin C, Frongillo EA, Shin KR, Jo I (2003). Secular trend in age at menarche for South Korean women born between 1920 and 1986: the Ansan Study. *Ann Hum Biol*, 30(4): 434-42.
14. Park MJ, Lee IS, Shin EK, Joung H, Cho SI (2006).The timing of sexual maturation and secular trends of menarcheal age in Korean adolescents. *Korean J Pediatrics*, 49: 610-616.
15. Chumlea, WC, Schubert CM, Roche AF, Kulin HE, Lee PA, et al (2003). Age at menarche and racial comparisons in US girls. *Pediatrics*, 111(1): 110-13.
16. Anderson SE, Dallal GE, Must A (2003). Relative weight and race influence average age at menarche: results from two nationally representative surveys of US girls studied 25 years apart. *Pediatrics*, 111(4 Pt 1): 844-50.
17. Kaplowitz, P (2006). Pubertal development in girls: secular trends. *Curr Opin Obstet Gynecol*, 18(5): 487-91. Review.
18. Khakbazan Z, Niroomanesh SH, Mehran A, Majidi-Ahi A (2005).To investigate the menarcheal age and it, relation with body mass index. *Iranian J Hayat*, 11(3-4): 55-62 (In Persian).
19. Frisch RE, McArthur JE (1974). Menstrual Cycles: Fatness as a Determinant of Minimum Weight for Height Necessary for Their Maintenance or Onset. *Sci*, 185(4155): 949-951.
20. Davison KK, Susman EJ, Birch LL (2003). Percent body fat at age 5 predicts earlier pubertal development among girls at age 9. *Pediatrics*, 111(4 Pt 1): 815-21.
21. Kim JY, Oh IH, Lee EY, Oh CM, Choi KS, et al (2010).The Relation of Menarcheal Age to Anthropometric Profiles in Korean Girls. J *Korean Med Sci*, 25(10): 1405-1410.
22. Goon DT, Toriola AL, Uever J, Wuam S, Toriola OM (2010). Growth status and menarcheal age among adolescent school girls in Wannune, Benue State, Nigeria. *BMC Pediatr*, 10: 60.
23. Cole TJ (2003). The secular trend in human physical growth: a biological view. *Econ Hum Biol*, 1(2): 161-8.
24. Biro FM, McMahon RP, Striegel-Moore R, Crawford PB, Obarzanek E, et al (2001). 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*, 138(5): 636-43.
25. Cho GJ, Park HT, Shin JH, Hur JY, Kim YT, et al (2010). Age at menarche in a Korean population: secular trends and influencing factors. *Eur J Pediatr*, 169(1): 89-94.
26. Rigon F, Bianchin L, Bernasconi S, Bona G, Bozzola M, et al (2010). Update on age at menarche in Italy: toward the leveling off of the secular trend. *J Adolesc Health*, 46(3): 238-44.
27. Einy E, Mehrabi U, Azizi F (2006). Comparison of menarcheal age between two generation of women (Tehran lipid and glucose study). *Iranian J Ghazvin Medical Sciences University*, 2(39): 35-40 (In Persian).