

Body mass index and age of menarche in young girls

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Abstract

Background Currently the age at onset of menarche is earlier than in the past. Nutritional status has an important role in the onset of menarche. Past studies have shown an association between body mass index (BMI) in young girls and earlier onset of menarche.

Objective To assess an association between BMI and age at onset of menarche.

Methods This cross-sectional study was conducted in young girls aged 10 to 15 years from Immanuel Elementary and Junior High School, Medan in June 2010. We used purposive sampling to recruit subjects. After subjects underwent height and weight measurements, we calculated their BMIs. The association between BMI and initial age of menarche was assessed by Chi square test ($P < 0.05$ with a 95% confidence interval).

Results Eighty-five subjects participated in this study. There were 44 subjects in the 5th-85th percentile of BMI (normoweight), 19 subjects with 85th-95th percentile of BMI (overweight) and 12 subjects in the > 95th percentile of BMI (obese). All obese subjects had an earlier onset of menarche at ages 10-11 years, compared to that of non-obese subjects ($P = 0.0001$).

Conclusion Young girls with BMI > 95th percentile had an earlier age at onset of menarche than young girls with lower BMIs. [Paediatr Indones. 2012;52:309-12].

Keywords: BMI, menarche, young girl, puberty, nutritional status

Puberty is the event that occurs between childhood and adulthood, involving physical, psychological, behavioral and social changes.¹⁻³ In young girls, puberty is marked by the emergence of secondary sexual characteristics, including breast development, weight gain, height growth, and menarche.^{4,5} Menarche is the first menstruation in a young girl.^{5,6} Menstruation is cyclical bleeding from the uterus that occurs periodically. It is a sign that reproductive organs have become active.⁷⁻⁹ In the past century, the age at menarche has decreased gradually, especially in the United States and Europe.^{10,11} It is thought that menarche is influenced by genetics, nutrition, environment, and economic status.¹¹ In recent years, the age of menarche has decreased in developing countries.^{12,13} Genetic factors have influenced the onset of menarche, but environmental changes and improved education and nutrition, resulting in better physical development, have all led to rapid improvement of social and economic factors.¹⁴ In the 1800s to the mid-1900s, there was an earlier onset of menarche, indicating good nutrition and health in young girls. An earlier onset of menarche has more

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often been observed in obese girls, compared to that of thin girls.^{14,15} According to a US national survey that compared BMI in young girls from the 1960s to the 1980s, there was an increase in obesity cases over a 25-year period.¹⁶

Methods

This cross-sectional study was performed to assess the association between BMI and initial age of menarche in girls. Subjects were girls who have experienced menarche aged 10-15 years from the Immanuel Elementary and Junior High School in Medan in June 2010. We excluded girls with malnutrition, hormonal drugs use, and chronic illnesses.

Body height was measured by a 2m metal microtoir with 0.5 cm precision. Subjects were asked to remove their shoes, stand with buttocks and heels against the wall and look straight ahead during height measurement. Body weight was measured by Camry's counterscale with 0.5kg precision. Subjects removed their shoes and wore only their school uniform during

weight measurements. BMI was calculated as body weight (kg) divided by the square of body height (m²), then compared to the Centers for Disease Control (CDC) 2000 BMI charts for girls aged 2-20 years. Breast development was assessed by Tanner criteria.¹⁷ We collected data about menarche from the questionnaires fulfilled by the subjects.

Data was analyzed by SPSS version 16.0 and Microsoft Excel 2007. We evaluated the association between BMI and the age of menarche by Chi square test with a 95% confidence interval and significance of P<0.05.

Results

Eighty-five subjects participated in this study. There were 44 subjects with 5th-85th percentile of BMI (normoweight), 19 subjects with 85th-95th percentile of BMI (overweight) and 12 subjects with >95th percentile of (obese). The characteristics of subjects are shown in **Table 1**.

We used the Tanner criteria to evaluate puberty level, including breast development. There was no

Table 1. Baseline characteristics of subjects

Characteristics	5 th -85 th percentile (n=44)		85 th -95 th percentile (n=29)		> 95 th percentile (n=12)	
Mean BMI, km/m ² (SD)	20.4	(2.66)	23.6	(1.53)	27.5	(1.33)
Mean age, years (SD)	12.3	(14.70)	12.6	(14.26)	12.8	(14.39)

Table 2. Association of BMI and Tanner stage

BMI percentile	Tanner Stage		95% CI	P value
	M ₂ n (%)	M ₃ n (%)		
5 th -85 th (n = 44)	20 (45.5)	24 (54.5)	-0.80 to 0.30	0.34
85 th -95 th (n = 29)	12 (41.4)	17 (58.6)	-0.68 to 0.52	0.44
>95 th (n = 12)	4 (33.3)	8 (66.7)	-0.16 to 1.49	0.10

Note: M₂: breast Tanner stage II; M₃: breast Tanner stage III

Table 3. Association between BMI and age of menarche

BMI percentile	Age of menarche, years			Total	95% CI	P value
	10-11	>11-12	>12-13			
5 th -85 th , n (%)	10 (23)	34 (77)	0 (0)	44	-9.00 to -5.97	0.0001
85 th -95 th , n (%)	8 (28)	20 (69)	1 (3)	29	-8.00 to -5.96	
>95 th , n (%)	12 (100)	0 (0)	0 (0)	12	-7.00 to -4.95	
Total	30	54	1	85		

significant difference in breast development among girls with 5th-85th percentile of BMI (normoweight), 85th-95th percentile of BMI (overweight), and >95th percentile of BMI (obese) (Table 2).

The association between BMI and age of menarche in girls is shown on Table 3. Age of menarche was significantly different among the three BMI groups.

Discussion

We observed a significant difference in age of menarche among young girls with different BMIs. Girls with BMI >95th percentile (obese) had a younger age of menarche at 10-11 years old (100%), compared to girls with BMI 85th-95th percentile (overweight) at 11-12 years old (69%) and girls with BMI 5th-85th percentile (normoweight) at 11-12 years old (77%).

Improved nutrition has been assumed to be the most important trigger for accelerated pubertal onset. An early study linking nutrition and puberty based on longitudinal anthropometric data from 181 girls collected between 1929 and 1950, postulated that a critical weight threshold seemed to exist at the time of menarche.¹⁸ More recently, it has been observed that the ratio of body weight to height, calculated as the BMI, rises constantly during the prepubertal years of childhood.^{19,20}

A cross-sectional study of 1,840 healthy school girls aged 10-15 years conducted in 2006-2007 found that the age of menarche did not accelerate, even in a childhood population of greater than 10% obesity prevalence. Nevertheless, a negative correlation of BMI with age of menarche exists.²¹ The results of a cross-sectional study in 954 girls at elementary schools in Catalonia, Spain supported the hypothesis that height velocity reaches a peak 1 year before menarche, but height velocity stops increasing within 1 year after menarche. The change in weight velocity revealed no obvious growth spurt at age of menarche.²²

Tanner criteria measures the development of breast and pubic hair. Breast Tanner stage I is defined as pre-puberty, stage II is defined as breast budding and the growth of areola, stage III is defined as larger breasts and more diffuse areola, stage IV is defined as the second bulging of the areola and papilla, and stage V is defined as adult size.^{1,17}

Our subjects were in breast Tanner stages II and III, and staging was not significantly different among the three BMI groups. Since all subjects had already experienced menarche, the effect of BMI on sexual maturity could not be assessed, as we did not know subjects' BMI at the time of menarche. Also, we were unable to assess stage of pubic hair development, as subjects refused to be examined. Several studies have used Tanner criteria to measure breast and pubic hair development in determining stage of puberty.^{1,23,25,26}

The Third National Health and Nutrition Examination Survey showed that the onset of menarche in American girls was about 12.1 years, but according to other studies, the onset of menarche in the young girls was about 15 years of age.^{23,24} This difference may be caused by poorer nutrition.

Other factors influencing menarche are genetic and environmental factors. Several studies have reported on the genetic influence on age at menarche, varying between 53% and 70%.²⁷ Tissue trans estrogen receptor exposure to estrogen, a genetic trait, influences menarche.^{28,29} In addition, the timing of menarche is influenced by the duration of total exposure to estrogen in the tissue.²⁹ We did not assess genetic factors affecting age of menarche.

In conclusion, we observed that BMI influenced the onset of menarche. Obesity was associated with an earlier age of menarche in young girls.

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