PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
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OPEN ACCESS Pakistan Journal of Nutrition

ISSN 1680-5194
DOI: 10.3923/pjn.2017.351.358

Research Article
Relationship Between Somatotype and Age at Menarche Among Adolescent Girls in Yogyakarta Province, Indonesia

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Abstract

Background and Objective: Differences in the body size, shape and composition of girls before and after menarche may due to differences in age at menarche. The aim of the present study was to determine age at menarche and its relationship to somatotype components among adolescent girls in Yogyakarta province, Indonesia. **Materials and Methods:** A cross-sectional study of 401 urban and rural junior high school girls (aged 13-15 years) was selected using stratified random sampling. A structured questionnaire was used to obtain information on age at menarche and other relevant data. Ten anthropometric measurements were collected and Heath-Carter somatotypes were determined. The correlation between somatotype component and age at menarche was analysed using Pearson correlation analysis. **Results:** The mean age at menarche was 12.01±0.89 years for urban girls and 12.97±0.91 years for rural girls ($p<0.01$). The results suggested that age at menarche differed between urban and rural girls; urban girls were heavier and more endomorphic than rural girls. Statistical analysis revealed that age at menarche was negatively correlated with endomorphy and mesomorphy components ($r = -0.22$ and $r = -0.123$, respectively), but positively correlated with ectomorphy component ($r = 0.207$). **Conclusion:** The findings indicated that age at menarche increases with increasing ectomorphy, but decreases with endomorphy and mesomorphy components. Thus, girls with high endomorphy and mesomorphy attained menarche earlier than did girls with high ectomorphy.

Key words: Age at menarche, somatotype, endomorph, mesomorph, ectomorph

Received: January 20, 2017 Accepted: March 23, 2017 Published: April 15, 2017

Citation: Neni Trilusiana Rahmawati, Janatin Hastuti and Rusyad Adi Suriyanto, 2017. Relationship between somatotype and age at menarche among adolescent girls in Yogyakarta province, Indonesia. Pak. J. Nutr., 16: 351-358.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Menarche represents a significant period in the life of female adolescents. Menarche is marked by changes body size, shape and composition. Age at menarche is also an important risk factor for many diseases, with early onset and delayed onset of menarche contributing to increased disease risk[1]. Age at menarche appears to have declined in recent decade; in Indonesia, the menarcheal age declined from 13.07 years in 1982-11.69 years in 2005[2]. Age at menarche is thought to be highly correlated with somatotype in early and late adolescence. Somatotyping is the most recent development in the 25 century, history of morphological taxonomy and constitutional investigation. Physicians have been prominent in the history of constitutional investigation, particularly in studies of interrelations of morphology and susceptibility to disease[3]. Somatotype assessment of adolescents has met with varying degree of success and with some problems[3]. In addition, cultural biases may prohibit taking somatotype photographs of adolescents, especially girls[4].

Buffa *et al*.[5] found that the body dimensions of adolescent girls increase primarily in relation to sexual maturation. These changes occur late in the sequence of changes associated with sexual maturation. The mean age at menarche varies from one setting to another and is known to be a sensitive indicator of various characteristics of a population including socio-economic status, nutritional status, geographical location and environmental conditions[4,6]. Malina *et al*.[4] stated that there is no trend for girls to achieve peak motor performance before, at or after menarche. The researchers also suggested that at 12-13 years age, girls are both farther along in the adolescent growth spurt and closer to sexual maturity than boys and this difference may contribute to higher correlations between somatotype ratings in early and late adolescence[4]. Kaur and Pathak[7] revealed that menarche a significant impact on the somatotype of adolescents, with large changes in their endomorphy and ectomorphy in relation to their mesomorphy values. Lee *et al*.[8] also reported that menarcheal age exhibits a positive relationship with height and in inverse relationship with Body Mass Index (BMI) and waist circumference in late adolescent girls (16-18 years old) in Seoul.

Somatotype has been used in its original and modified forms, in a variety of ways to note similarities and differences among diverse groups or populations. Differences in physique exist among populations in due to differences in geography and socio-economic status as well as cultural variance. Children exhibit different somatotype patterns relative to adults. Although there are some changes in somatotype between 6 and 12 years of age, there are greater changes during adolescence and into adulthood[3,9].

Many studies have evaluated the relevance of somatotype and variations in body measurements[6, 8-17], furthermore there have been many studies on the impact of height, weight, Body Mass Index (BMI) and body structure or anthropometrics on menarche[1,6,8,18-20]. In Indonesia, however, studies related to body size or shape are limited and information on the relationship between age at menarche and somatotype is lacking. Therefore, in the present study, somatotypes and their relationship to age at menarche among adolescent girls was examined in Yogyakarta province, Indonesia.

The aim of the study was to determine the age at menarche and its relationship to somatotype components among adolescent girls in Yogyakarta province, Indonesia. Information on the correlations between somatotype and age of menarche are limited.

MATERIALS AND METHODS

Participants: A cross-sectional study was conducted on junior high school girls in Yogyakarta province between July and August, 2015 using stratified random sampling. Four hundred and one girls, aged 13-15 years old were selected. Participants were allocated into two groups, an urban (Yogyakarta) and a rural (Bantul) group.

The first sample included a group of 203 girls aged 13-15 years old from urban Yogyakarta. Yogyakarta is one of the largest cities in Indonesia and is known to be a centre of classical Javanese fine art and culture. Yogyakarta is located in South-Central Java and is surrounded by the province of Central Java and the Indian Ocean to the South. The city is located at 7°47'S 10°22'E. All of the study participants were born and lived in this city. The second sample included a group of 250 rural Bantul girls aged 13-15 years old. Bantul is a village located approximately 30 km South of Yogyakarta. All of the girls were born in and lived in this village.

The primary occupations of fathers in urban areas were employees (41.7%) and civil servants (14.7%) and occupations of mothers were housewives (54.1%), employees (16.6%) and entrepreneurs (15.5%). In the rural areas, the primary occupations of the fathers were labourers (33.3%), entrepreneurs (25.8%) and employees (24.6%) and mothers were housewives (57.1%), entrepreneurs (13.4%), laborers (10.5%) and employees (10.5%). The professional occupations of the parents in these two groups differed markedly.

All of the subjects were physically and mentally normal and did not suffer from any apparent illness at the time of data collection. The date of birth of each student was recorded from school registers verified by the students. Parents were informed in writing about the study and agreed verbally for their daughters to be interviewed. Age at menarche was calculated from the date of birth to the date of the first menstrual period. Ethics approval was obtained from the Ethics Committee of Universitas Gadjah Mada (No. KE/FK/832/EC/2015).

Measures: In addition to obtaining somatotype components, 10 anthropometric measurements were collected, including height, weight, diameters of humerus and femur, circumferences of the upper arm and calf and measurements of the triceps, subscapular, subscapular and calf skinfolds using the International Standards for Anthropometric Assessment[21].

Specifically designed questionnaires were used to elicit information from participating subjects concerning age, sex, date of birth, medical history and parents' occupations, education and income statuses. Because all of the children came from Islamic families, they could not to be examined, while wearing minimum clothing during the examination, the girls wore their traditional scarf and long skirt. We measured the weight of their clothing and subtracted this weight from the body weight of each child (400 g)[22]. Weights were measured to an accuracy of 0.1 kg and the girls wore no shoes when measured. The weights presented in the results table are corrected for clothing weight. The BMI was calculated by dividing the weight (kg) into squared height (m^2).

The somatotype components of the individual subjects were calculated according to the Heath-Carter anthropometric method with "Stature-corrected endomorphy", using the following[7] Eq. 1 and 2:

$$\text{Endomorphy} = -0.7182+0.1415\,(X)-0.00068\,(X^2)+0.0000014\,(X^3) \quad (1)$$

Where:

$$X = \begin{bmatrix} \text{Triceps skinfold (mm)}+ \\ \text{subscapular skinfold (mm)}+ \\ \text{supraspinal skinfold (mm)}\times \\ 170.18/\text{stature (cm)} \end{bmatrix}$$

$$\text{Mesomorphy} = \begin{bmatrix} [\{0.858\times\text{humerus breadth (cm)}\}+ \\ \{0.601\times\text{femur breadth (cm)}\}+ \\ \{0.188\times\text{corrected arm girth (cm)}\}+ \\ \{0.161\times\text{corrected calf girth (cm)}\}]- \\ \{\text{stature}\times 0.131\}+4.5 \end{bmatrix} \quad (2)$$

Where:

Corrected arm girth = Upper arm girth (cm)-triceps skinfold (mm)/10

Corrected calf girth = Calf girth (cm)-calf skinfold (mm)/10

Ectomorphy: Three different Eq. 3-5 were used to calculate ectomorphy according to the stature-weight ratio (HWR), that is stature/cube root of weight:

- If HWR is $\geq$40.75, then in Eq. 3:

$$\text{Ectomorphy} = 0.732\times\text{HWR}-28.58 \quad (3)$$

- If HWR is <40.75 but >38.25, then in Eq. 4:

$$\text{Ectomorphy} = 0.463\times\text{HWR}-17.63 \quad (4)$$

- If HWR is $\leq$38.25, then in Eq. 5:

$$\text{Ectomorphy} = 0.1 \quad (5)$$

Statistical analysis: The data were analyzed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA) and a significance level of 5% was used for all analyses. Descriptive statistics were applied to calculate the mean and standard deviations for height, weight, BMI, somatotype components and age at menarche. A test of normality (Kolmogorov Smirnov) for the subjects' measurements indicated that all of the variables exhibited normal distributions. Therefore, correlations between the somatotype component and age at menarche were analyzed using the Pearson correlation analysis.

The differences in age at menarche, height, weight, BMI and somatotype components according to geographic region (urban and rural) were analyzed using ANOVA. For comparisons according to age at menarche, because the data were not equally distributed between the two areas, statistical analysis was only used to identify the mean and standard deviation.

RESULTS

The mean age at menarche differed significantly between urban (12.01$\pm$0.89 years) and rural girls (12.97$\pm$0.91 years). The body weights and Body Mass Index (BMI) of urban girls were significantly higher than those of their rural counterparts; however, the heights of urban girls were not significantly different from those of rural girls (Table 1).

The results revealed that the endomorphy components of urban girls was significantly higher than those of rural girls ($p<0.05$). This study supported the existence of differences among girls of different areas. The overall results revealed that

Table 1: Mean and standard deviation of height, weight, Body Mass Index (BMI), somatotype and age at menarche of girls in Yogyakarta province, Indonesia

Variables	Urban (N = 175) Mean±SD	Rural (N = 226) Mean±SD	p-value
Age at menarche (years)	12.01±0.89	12.97±0.91	0.005**
Height (cm)	153.22±5.68	152.40±5.14	0.132
Weight (kg)	47.74±9.74	45.92±8.62	0.049*
BMI (kg m^{-2})	20.30±3.65	23.39±4.78	0.000**
Somatoype			
Endomorphy	5.30±1.48	4.81±1.26	0.000**
Mesomorphy	4.37±1.76	4.21±1.45	0.300
Ectomorphy	2.71±1.57	2.85±1.46	0.342

*p<0.05, **p<0.01

Table 2: Mean and Standard Deviation (SD) of height, weight, Body Mass Index (BMI) and somatotype according to age at menarche of girls in both groups in Yogyakarta province, Indonesia

Age at menarche groups (years)	N		Height (cm)	Weight (kg)	BMI (kg m^{-2})	Somatotypes		
						Endomorphy	Mesomorphy	Ectomorphy
Bantul								
10	7	Mean	153.77	48.82	23.65	5.51	4.19	2.26
		SD	4.71	2.57	3.95	0.44	0.65	0.58
11	37	Mean	153.01	47.84	24.57	4.98	4.47	2.46
		SD	3.92	6.75	3.85	1.32	1.18	1.20
12	87	Mean	152.12	46.40	23.68	5.01	4.39	2.63
		SD	5.45	7.23	4.17	1.23	1.40	1.49
13	76	Mean	152.50	44.76	23.05	4.56	3.96	3.26
		SD	5.28	10.78	5.71	1.29	1.65	1.52
14	19	Mean	151.57	43.57	21.05	4.33	3.82	3.20
		SD	5.61	8.90	4.71	1.07	1.40	1.35
Yogyakarta								
10	11	Mean	152.55	48.30	22.65	5.80	5.36	1.55
		SD	538.00	6.59	3.66	1.32	1.62	1.11
11	35	Mean	154.00	48.39	20.84	5.84	4.44	2.46
		SD	6.02	9.92	3.12	1.45	1.43	1.48
12	78	Mean	152.94	47.50	20.05	5.22	4.25	2.80
		SD	5.86	8.72	3.51	1.53	1.89	1.62
13	47	Mean	153.09	46.95	19.50	4.85	4.17	3.07
		SD	5.46	11.44	3.36	1.27	1.52	1.54
14	4	Mean	155.11	54.44	23.22	5.97	5.79	2.08
		SD	10.22	7.34	8.96	2.24	3.52	1.33

urban girls were heavier and more endomorphic relative to rural girls (Table 1). Table 2 presents mean and standard deviation of height, weight, Body Mass Index (BMI), somatotype components according to age at menarche in both areas.

The coefficients of correlation indicated that age at menarche was negatively associated with BMI, endomorphy and mesomorphy components and positively correlated with ectomorphy ($p<0.05$).

The mean somatotype based on the age at menarche groups is presented in Fig. 1. In urban girls, the endomorphy value was greater in earlier menarche, whereas the ectomorphy value was lower. However, in rural girls, the mean mesomorphy and ectomorphy components decreased at 14 years of age at menarche. The result also revealed that girls who had early menarche exhibited higher values of endomorphy, but lower values of ectomorphy compared with girls who experienced late menarche both in Yogyakarta and Bantul.

Figure 2 presents the distribution of the mean somatotype components based on age at menarche among girls in Yogyakarta province on somatochart. In contrast to the cross-sectional data for adolescent girls in Sirmaur district, Himachal Pradesh presented by Kaur and Pathak[7], in whose study the mean somatotype fell in the endomorphic ectomorph sector, the girls in the present study were more endomorphic and less ectomorphic. The majority of girls tend toward the endomorph mesomorphic sector on the somatochart, however, urban girls tended to be more endomorphic, mesomorphic and less ectomorphic than rural Bantul girls. The mean somatotype of rural girls changes from mesomorphic endomorph at 10-12 years of age at menarche

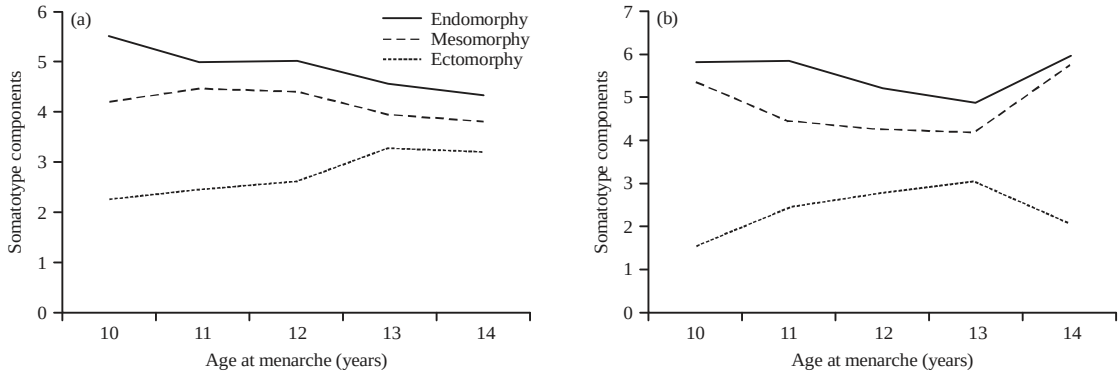

Fig. 1(a-b): Distribution of somatotypes among girls in (a) Rural and (b) Urban areas

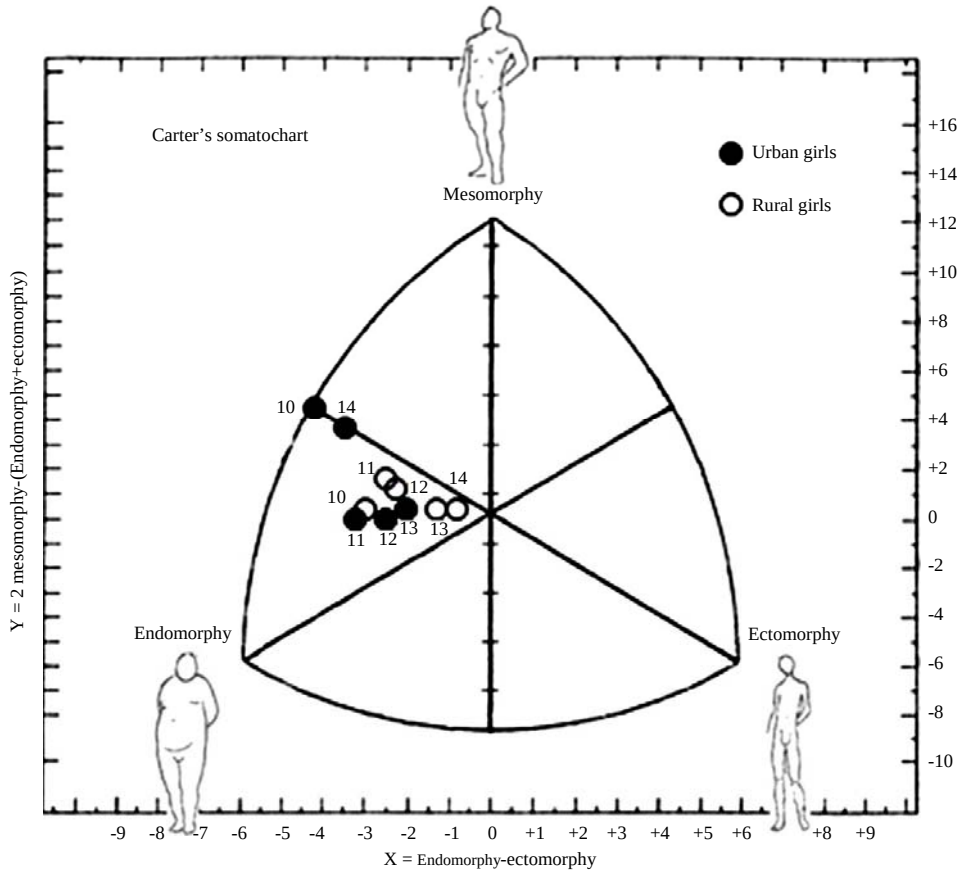

Fig. 2: Distribution of the mean somatotype components based on age at menarche among girls in urban and rural areas, Yogyakarta, Indonesia

to central endomorph at 13-14 years of age at menarche. However, the mean somatotype of urban girls changes from endomorph mesomorph at 10 years of age at menarche to meso-endomorph at 11-13 years of age at menarche and back to endomorph mesomorph at 14 years of age at menarche.

DISCUSSION

In this study, the mean of age at menarche was 12.49 years. This age is younger than the age at menarche reported in Nigeria[11] and the age at menarche reported in Bangladesh, >30 years ago which was 12.86 years[1]. However,

Table 3: Pearson correlation between height, weight, Body Mass Index (BMI) and somatotype to age at menarche

Variables	Age at menarche	p-value
Height	-0.030	0.555
Weight	-0.097	0.052
BMI	-0.111	0.026*
Somatotypes		
Endomorphy	-0.222	0.000**
Mesomorphy	-0.123	0.014*
Ectomorphy	0.207	0.000**

*p<0.05, **p<0.01

the age of menarche in this study was 8 months older than the age of menarche for girls living in the same city Yogyakarta, >10 years ago which was 11.69 years[2]. However, the older age of menarche is not surprising given the influence of nutrition and standard of living on menarche, it may be reflected in the low socio-economic status of these areas.

The mean age of menarche was significantly younger in urban girls (12.01±0.89 years) than in rural girls (12.97±0.91 years). This result was supported by the study of Mpora *et al.*[14] on girls in Northern Uganda, which suggested that age at menarche differed among urban and rural school girls and was dependent on the current nutritional status. In the study, the researchers reported that urban girls experienced earlier menarche than rural girls. One possible explanation is that the majority of urban girls have parents of a higher social-economic class than rural girls. Moreover, maternal educational levels and occupations may significant influence on the socio-economic level of girls. However, this explanation is contradicted by a study of Padez[23] on female university students in Portugal, which suggested no association between a girl's age at menarche and her parent's education and occupations.

The present study revealed that age at menarche was significantly correlated with endomorphy (r = -0.222), mesomorphy (-0.123) and ectomorphy (r = 0.207). These results suggested that age at menarche is significantly affected by somatotype components among girls in Yogyakarta province (Table 3).

In endomorphy, correlation analysis revealed that age at menarche was negatively associated with the endomorphy component of somatotype. Age at menarche increased with decreasing endomorphy components, girls with high endomorphy attained earlier menarche than girls with lower endomorphy. These finding is consistent with reports from Kaur and Pathak[7] who investigated the relationship between somatotype variation and the sexual maturation of adolescent girls in Sirmaur district, Himachal Pradesh. The results revealed that menarche has a substantial impact on somatotype (physique) of adolescent girls, with both the endomorphy and ectomorphy values exhibiting greater changes relative to the mesomorphy values. Endomorphy described as relative fatness or leanness is derived from the sum of three skinfolds[3]. Similar findings were suggested by Al-Awadhi *et al.*[6], with an inverse association between age at menarche and obesity or overweight among adolescent girls in Kuwait. Some studies have also suggested that early sexual maturation is associated with increased body mass index, anthropometric index and fatness[8,19,24].

In mesomorphy, the second component refers to the relative musculoskeletal development adjusted for stature[3] and is described as expressing fat-free mass relative to stature. In girls, mesomorphy appears to decline with age, whereas, mesomorphy increases with age in males, which is especially apparent in late adolescence. Correlation analysis revealed that age at menarche was negatively associated with the mesomorphy component of somatotype. Similar to endomorphy, the mesomorphy component increased with decreasing menarcheal age, girls with higher mesomorphy attained earlier menarche than girls with lower mesomorphy. Similar trends have been reported by Kaur and Pathak[7], who suggested that girls who experienced menarche exhibited high values for endomorphy and mesomorphy and that menarche has a significant impact on the somatotype of adolescent girls. Gakhar and Malik[25] reported that the mesomorphy component is influenced by the physical activity of individuals. Moreover, lower physical activity decreases mesomorphy values. Because mesomorphy is with respect to stature, it is possible that girls with earlier menarche are taller than those with late menarche.

In ectomorphy, the third component of physique, ectomorphy refers to the relative linearity of an individual's physique[3]. Pearson correlation analysis revealed that age at menarche was positively correlated with ectomorphy (p<0.05). In contrast to endomorphy and mesomorphy components, girls with lower ectomorphy attained earlier menarche than girls with higher ectomorphy (Table 3). Kaur and Pathak[7] reported that the ectomorphy values were higher for menstruating girls than for non-menstruating girls, suggesting that menarche has a significant impact on the somatotype of adolescent girls, with both the endomorphy and ectomorphy values undergoing greater changes relative to the mesomorphy values.

In BMI, care must be taken when interpreting the BMI values of children and adolescents as an indicator of fatness. Malina *et al.*[4] stated that BMI is reasonably well correlated with total body fat and the percentage body fat in heterogeneous samples, but exhibits limitations. Table 3 demonstrates that BMI was negatively associated with

menarche age, consistent with a study by Hossain *et al.*[1], found that age at menarche was negatively associated with weight and BMI. Thus, higher BMI values are correlated with earlier menarche. There are several explanations for this association, but the specific mechanisms remain unclear. Pejhan *et al.*[19] also reported that age at menarche and BMI are significantly correlated with higher BMI values correlated with a younger menarche age. According to Cheng *et al.*[26], higher levels of prepubertal BMI lead to an increase in the production and availability of oestrogen through various mechanisms, thereby predisposing individuals to early menarche. Another explanation suggested that early menarche is associated with higher levels of oestrogen, which increases fat deposition in peripheral adipose tissue [27]. Cole[28] stated that the increase in body fat mass can be a significant signal to induce the secretion of leptin, stimulating the hypothalamus and leading to the over-secretion of GnRH. The GnRH stimulates the hypophysis-ovarian axis and initiates acceleration of puberty[19]. However, this study did not investigate these physiological characteristics.

CONCLUSION

In summary, the relationships between somatotype and age at menarche are significant. In general, endomorphy and mesomorphy exhibit a small negative association with age at menarche, whereas ectomorphy a small positive association. Significant differences in somatotype were evident for only endomorphy, which exhibit a higher prevalence among urban girls relative to rural girls. Urban girls were heavier and more endomorphic than rural girls. These findings indicated that age at menarche increases with decreasing endomorphy and mesomorphy components, thus girls with high endomorphy and mesomorphy attained menarche earlier than girls with lower endomorphy and mesomorphy. Furthermore, girls with lower ectomorphy attained menarche earlier than did girls with higher ectomorphy.

SIGNIFICANCE STATEMENTS

The strength of this study is the demonstration of significant correlation between body type/somatotype and age at menarche. This study will be helpful in the evaluation of menarche, given that the progression of maturation is important for assessing the growth and health of adolescents.

This study may help researchers examine critical areas of somatotype or body type and physical maturation that many researchers were not previously able to explore. This information may be useful in epidemiologic studies of the cultural differences of maturation and growth patterns.

ACKNOWLEDGMENTS

The authors would like to thank the students, directors and teachers of SMP Negeri 2 Yogyakarta and SMP Negeri 4 Sewon Bantul, Indonesia. We want to express thanks also to our students of Medicine Faculty, Universitas Gadjah Mada for their kind help in collecting data. The research was supported by the Faculty of Medicine, Universitas Gadjah Mada (Community Fund Budget Year 2015).

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