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Journal of Biosocial Science / FirstView Article / March 2013, pp 1 - 13
DOI: 10.1017/S0021932013000060, Published online: 12 March 2013

Link to this article: http://journals.cambridge.org/abstract_S0021932013000060

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ADULT ANTHROPOMETRIC MEASURES AND SOCIO-DEMOGRAPHIC FACTORS INFLUENCING AGE AT MENARCHE OF UNIVERSITY STUDENTS IN MALAYSIA

MD. GOLAM HOSSAIN*1, AI-SZE WEE†, MAEIRAH ASHAIE† AND T. KAMARUL†

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Summary. Early onset of menarche has been shown to be associated with breast cancer and ischaemic heart disease. Studies on age at menarche of the Malaysian population are poorly documented. This study aimed to determine the influence of anthropometric and socio-demographic factors on the age at menarche of university students in Malaysia. Data were obtained in 2010–11 from 961 students between the ages of 18 and 25 years from the University of Malaya using stratified sampling, and multiple regression analysis was applied. Sixty-three per cent of students reached menarche at the age of 12 or 13 years, with the mean and median of age at menarche being 12.45 ± 1.17 and 12.01 years, respectively. Menarcheal age was positively associated with height (p < 0.05) and negatively associated with BMI (p < 0.001). Students from urban areas attained menarche earlier than those from rural areas (p < 0.05). Students from small-sized families attained menarche earlier than those from larger families (p < 0.05). First-born students experienced menarche earlier than those who were seventh-born or later. Obese and overweight students reached menarche earlier than students who were underweight or of normal weight (p < 0.01). The variations in age at menarche among the Malaysian ethnic groups were statistically insignificant. The results suggest that heavier and first-born students from small families are more likely to attain menarche earlier than their counterparts.

Introduction

Menarche is the onset of menstruation and is considered to be the central event of female puberty. Early onset of menarche has been reported to be a positive indicator of breast cancer (Kelsey, 1993; Kotsopoulos et al., 2005; Shin et al., 2011; Dogan

1 Corresponding author. Email: hossain95@yahoo.com
et al., 2011), pelvic inflammatory disease and spontaneous abortion (Helm et al., 1996) and cardiovascular disease (Cooper et al., 1999; Lakshman et al., 2009). Also, early menarche may be a risk factor for lower lung function and asthma in adulthood (Macsali et al., 2011). On the other hand, delayed menarche may be associated with an increased risk of irregular menstrual cycles and low peak bone mass (Anai et al., 2001).

The age at menarche (menarcheal age) is defined as the occurrence of the first menstrual cycle. The age at menarche varies from population to population and is associated with several factors such as anthropometric measures, physiological strength (ability of a person to exert force on physical objects using muscles), nutritional status, ethnic group, geographical location, life-style (expressed as both work and leisure behaviour patterns and activities, attitudes, interests, opinion, values and allocation of income of an individual) and other socioeconomic and demographic factors (Shangold et al., 1989; Georgiadis et al., 1997; Bharati & Bharati, 1998; Laitinen et al., 2001; Okasha et al., 2001; Padez, 2003; Ersoy et al., 2004; Chavarro et al., 2004; Wronka & Pawlińska-Chmara, 2005; Gharravi et al., 2008; Hossain et al., 2010; Goon et al., 2010; Cho et al., 2010; Adali & Koc, 2011). It is apparent that these factors have undergone drastic changes over time, resulting in alteration in the age of menarche. This is reflected by the gradual decline in the average age of menarche globally (Zegeye et al., 2009; Cabanes et al., 2009).

Okasha et al. (2001) suggested that the relationship between menarcheal age and adult anthropometric measures may be important in understanding the significance of the effects of menarcheal age on disease in later life. Special attention should be given to university female students considering their potential influence on the family and their contribution to the nation’s workforce and productivity. Due to their unique role in the population, it is therefore important to investigate the relationship between the age at menarche of university students and their anthropometric measures and socio-economic and demographic factors.

Some researchers have investigated the association of university students’ age at menarche with anthropometric measures and socio-demographic factors for different countries (Okasha et al., 2001; Padez, 2003; Chavarro, 2004; Gharravi et al., 2008; Hossain et al., 2010). The multi-ethnic population of Malaysia, consisting mainly of Malays, Chinese and Indians, is ideal to reflect the centralized geographical location between the Far East and the Indian Peninsula. However, studies on this have not been well documented and analysed (Tan et al., 1983; Lee et al., 2006). The aim of the present study was to look at the association between age at menarche of university students in Malaysia and their anthropometric measures and socio-demographics profiles.

**Methods**

A total number of 961 healthy university female students were enrolled in the present study. The participants were Malaysian citizens and aged from 18 to 25 years. The samples were collected from the student’s residing hall of the University of Malaya, Malaysia, from July 2010 to April 2011 using stratified random sampling with a proportional allocation technique.

The University of Malaya, being one of the largest universities in Malaysia, was a good site to conduct this study since the students were of multi-ethnicity and originated
from all over the country. In addition, because the university is a government-owned institution and therefore admissions to any degree course are based on government agency selection criteria (which are based on pure merit, quota for the underprivileged etc.), enrolled students represent Malaysian families of varying socioeconomic status. Thus the study sample was representative of the average young women living in the country. The subjects were from three major ethnic groups: Malays, 769 (80%); Chinese, 120 (12.5%); and Indians, 72 (7.5%).

The subjects were interviewed by a single interviewer. A standardized questionnaire was used to collect socioeconomic and demographic information from each subject. Age at menarche was estimated by the recall method and based on the age at menarche given by the study subjects. Subjects reported their age at menarche on the basis of their last birthday. The same interviewer also took the anthropometric measurements. Body height was measured as the distance from the highest point of the top of the head in the mid-sagittal plane to the floor by anthropometer, and body weight was taken with thin clothing using a weighing scale. Body mass index (BMI) was derived, defined as the ratio of weight in kilograms to height squared in metres.

Statistical analysis

Descriptive statistics were used to calculate the mean and standard deviations for age at menarche. The Probit model was used to estimate median age at menarche (Table 2). Subjects were classified into three main ethnicities: Malays, Chinese and Indians. Analysis of variance (ANOVA) was used to find the differences in age at menarche among the ethnicities. The standard assumptions of ANOVA (normality and homogeneity of group variances) were checked using the normal probability plot and the Levene test, respectively. The post hoc compression (LSD) test was utilized to find pair-wise differences among the group’s data.

Multiple linear regression analysis was used to find the relationship between age at menarche and several quantitative and ordinal variables such as height, BMI, parents’ education level and family income, as modelled below:

\[
AAM = \beta_0 + \beta_1 FE + \beta_2 ME + \beta_3 Ht + \beta_4 BMI + \beta_5 FI + \varepsilon,
\]

where AAM (age at menarche) is the response variable, and FE (father’s education), ME (mother’s education), Ht (height), BMI (body mass index) and FI (family income) are predictors.

The estimated regression model was:

\[
AAM' = 11.90 - 0.037 FE - 0.066 ME + 0.014 Ht - 0.064 BMI - 0.004 FI.
\]

The important assumption of multiple regression analysis is that the predictor variables must be independent of each other to avoid multicollinearity problems. The multicollinearity problems that would otherwise result in inaccuracies should first be removed. A statistical tool (Variance Inflation Factors, VIF) can be used to detect the multicollinearity caused by the predictor variables (Chatterjee & Hadi, 2006). In the present study, the relationship between the predictor variables was examined using VIF as follows: (1) if \(0 < VIF < 5\), there is no evidence of a multicollinearity problem;
(2) if \(5 \leq \text{VIF} \leq 10\), there is a moderate multicollinearity problem; and (3) if \(\text{VIF} > 10\), there is a serious multicollinearity problem of variables. These showed no multicollinearity problem among predictors (Table 3).

To determine the relationship between menarcheal age and body size, the sample was again subdivided into four groups according to the most widely used categories of BMI for adults: underweight (\(\text{BMI} \leq 18.5 \text{ kg/m}^2\)), normal weight (\(18.5 < \text{BMI} < 25 \text{ kg/m}^2\)), overweight (\(25 \leq \text{BMI} < 30 \text{ kg/m}^2\)) and obese (\(\text{BMI} \geq 30 \text{ kg/m}^2\)) (Flegal et al., 2005; Subramanian et al., 2009).

Finally, Student’s t-test was utilized for comparison of mean values between two groups: residence (urban and rural), father’s occupation (professional and non-professional) and mother’s occupation (housewife and employed). Statistical analysis was carried out using SPSS software (version 15.0). A value of \(p < 0.05\) was regarded as statistically significant in the analysis.

**Results**

The age at menarche of 961 healthy university students was investigated in this study. The range of menarcheal age was 9 to 16 years. Most of the students (91.2%) reached menarche between 11 and 14 years of age, with more than 63% of the students attaining menarche between 12 and 13 years of age. A minority of students (3.8%) experienced menarche at the early age of between 9 and 10 years. Similarly, only a small number of students (4.9%) experienced a delayed menarche (between 15 and 16 years) (Table 1).

The average and median age at menarche of university students in Malaysia was \(12.45 \pm 1.17\) years (95% CI for mean: 12.38–12.53 years) and 12.01 years, respectively. Individually, Malay female students experienced menarche at \(12.45 \pm 1.16\) years (95% CI for mean: 12.37–12.53 years) and a median at 11.99 years. Chinese female students experienced menarche later than Malays and Indians (12.55 \(\pm\) 1.29 years, 95% CI for mean: 12.32–12.78 years, and median 12.74 years). On the other hand, Indian female students attained menarche earlier than both Malays and Chinese students (12.35 \(\pm\) 1.19 years, 95% CI for mean: 12.07–12.63 years, and median 11.90 years) (Table 2).

**Table 1.** Frequency distribution of age at menarche, Malaysian university students, 2010–11

<table>
<thead>
<tr>
<th>Age at menarche (years)</th>
<th>(n)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>4</td>
<td>0.4</td>
</tr>
<tr>
<td>10</td>
<td>33</td>
<td>3.4</td>
</tr>
<tr>
<td>11</td>
<td>139</td>
<td>14.5</td>
</tr>
<tr>
<td>12</td>
<td>356</td>
<td>37.0</td>
</tr>
<tr>
<td>13</td>
<td>257</td>
<td>26.7</td>
</tr>
<tr>
<td>14</td>
<td>125</td>
<td>13.0</td>
</tr>
<tr>
<td>15</td>
<td>42</td>
<td>4.4</td>
</tr>
<tr>
<td>16</td>
<td>5</td>
<td>0.5</td>
</tr>
<tr>
<td>Total</td>
<td>961</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Analysis of variance (ANOVA)

One-way ANOVA was applied to find the variation of menarcheal age between the ethnic groups. The normality and homogeneity of the ethnic group were checked using the normal probability plot and the Levene test prior to the ANOVA analysis. The normal probability plot showed that the data followed a normal distribution. The Levene test showed that the data were homogeneous. Therefore, the data satisfied the standard assumption of the ANOVA model. The ANOVA results demonstrated that variation in age at menarche among the ethnic groups was statistically insignificant ($p > 0.05$).

---

Table 2. Descriptive statistics of age at menarche by ethnic group, Malaysian university students, 2010–11

<table>
<thead>
<tr>
<th>Ethnic group</th>
<th>$n$ (%)</th>
<th>Mean</th>
<th>SD</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malay</td>
<td>769 (80)</td>
<td>12.45</td>
<td>1.16</td>
<td>12.38–12.53</td>
</tr>
<tr>
<td>Chinese</td>
<td>120 (12.5)</td>
<td>12.55</td>
<td>1.29</td>
<td>12.32–12.78</td>
</tr>
<tr>
<td>Indian</td>
<td>72 (7.5)</td>
<td>12.35</td>
<td>1.19</td>
<td>12.07–12.63</td>
</tr>
<tr>
<td>Total</td>
<td>961</td>
<td>12.45</td>
<td>1.17</td>
<td>12.38–12.53</td>
</tr>
</tbody>
</table>

Table 3. Multiple regression analysis of influence of body measurements and socio-demographic factors on age at menarche, Malaysian university students, 2010–11

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>$p$-value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>11.90</td>
<td>&lt;0.001</td>
<td>9.569–14.206</td>
</tr>
<tr>
<td>Father's education</td>
<td>-0.037</td>
<td>ns</td>
<td>-0.194–0.119</td>
</tr>
<tr>
<td>Mother's education</td>
<td>-0.066</td>
<td>ns</td>
<td>-0.230–0.097</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>0.014</td>
<td>&lt;0.05</td>
<td>0.007–0.028</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>-0.064</td>
<td>&lt;0.001</td>
<td>-0.088–0.041</td>
</tr>
<tr>
<td>Family income</td>
<td>-0.004</td>
<td>ns</td>
<td>-0.108–0.100</td>
</tr>
</tbody>
</table>

Table 4. Difference in age at menarche by parents’ occupation and residence, Malaysian university students, 2010–11

<table>
<thead>
<tr>
<th>Mother's occupation</th>
<th>$n$ (%)</th>
<th>Mean</th>
<th>SD</th>
<th>Mean difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housewife</td>
<td>609 (69)</td>
<td>12.49</td>
<td>1.192</td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>273 (31)</td>
<td>12.40</td>
<td>1.098</td>
<td>0.09</td>
</tr>
<tr>
<td>Father's occupation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional</td>
<td>433 (49.4)</td>
<td>12.51</td>
<td>1.173</td>
<td></td>
</tr>
<tr>
<td>Non-professional</td>
<td>444 (50.6)</td>
<td>12.42</td>
<td>1.185</td>
<td>0.09</td>
</tr>
<tr>
<td>Residence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>531 (57.3)</td>
<td>12.50</td>
<td>1.160</td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>396 (42.7)</td>
<td>12.37</td>
<td>1.187</td>
<td>0.13*</td>
</tr>
</tbody>
</table>

**5% level of significance.

Analysis of variance (ANOVA)
Multiple regression analysis

The coefficients of the regression model showed that the age at menarche of students was positively associated with their height ($p < 0.05$) and negatively associated with their BMI ($p < 0.001$). There was neither significant association between menarcheal age of students with their parents’ education nor family income. These results suggest that heavier female students reached menarche earlier than those who were thinner.

Post hoc compression test

The post hoc compression (LSD) was used to find the pair-wise differences in age at menarche among the family size (number of sibling groups) and birth order groups. In this study, 49% of participants came from large families with five or more children and 2.7% of students were from small families with one or two children. The LSD test demonstrated that Malaysian university students from large families attained menarche significantly later (12.54 ± 1.13 years) than those from smaller families (12.38 ± 1.13 years, $p < 0.05$, medium sized family with three or four children; 12.08 ± 1.13 years, $p < 0.01$, small family with one to two children) (Fig. 1). In addition, students who were born seventh or in later position (birth order) (6.2%) experienced a later menarche (12.88 ± 1.26 years) than those born in an earlier position (12.47 ± 1.19 years, $p < 0.05$, for fourth to sixth birth order (25.4%); 12.47 ± 1.21 years, $p < 0.05$, for second to third birth order (31.2%); and 12.43 ± 1.10 years, $p < 0.01$, for first-born (37.1%)) (Fig. 1).

The respondents were classified into four groups according to their categorized BMI. More than 68% of students were of normal weight, 20.1% underweight, 8.5% overweight and only 3.1% obese. The pattern of age at menarche decreased along with increased body size (Fig. 2). The LSD test indicated that the age at menarche of overweight and obese students was significantly earlier than that of underweight and
normal weight students \( (p < 0.001) \). These results suggest that heavier students attained menarche earlier than thinner students.

The mean values of BMI and age at menarche by ethnic group are depicted graphically in Fig. 3. Age at menarche showed a negative association with BMI by ethnic
Female Indian students' BMI values were larger than those of Chinese and Malays; and they reached menarche earlier. Conversely, Chinese female students reached menarche later than Indians and Malays and they were thinner (Fig. 3).

**Student’s t-test**

Student’s *t*-test was used to test for significant differences in age at menarche between two groups. It was interesting to note that the mothers of approximately 70% of university students in Malaysia were housewives and that 57.3% of students were from rural areas. Students from urban environments reached menarche earlier (*p* < 0.05) than their counterparts from rural areas. There was no significant relation between parents’ occupations and their daughter’s menarcheal age.

**Discussion**

The data used in this study were collected from female university students covering three major ethnic groups living in urban and rural areas of Malaysia. Tan *et al.* (1983) investigated the association between age at menarche and socioeconomic and demographic factors of adult females in Peninsular Malaysia. Their data were obtained from the Malaysian Family Life Survey conducted in 1967–77. Their main focus was on socioeconomic and demographic factors as predictors, and they found that age at menarche was associated with age at first marriage and age at first birth. More recently, Lee *et al.* (2006) studied menstrual disturbance among secondary school girls in Malaysia. Although previous studies have looked into socioeconomic conditions and their influence on menarche, as far as the authors of this paper are aware, the present study may be the first to investigate the association of age at menarche with anthropometric measures and socio-demographic factors of young females in modern-day Malaysia. Furthermore, while the data obtained during the era when Malaysia was an undeveloped nation may be valid, the changes in the country’s economic prowess and socio-demographic conditions have had a major impact on Malaysian society, thus rendering previous published data obsolete.

In the present study, the average age at menarche of Malaysian female students was found to be 12.45 years, and median 12.01 years. The range of menarcheal age was from 9 to 19 years, and more than 63% of female students reached menarche at between 12 and 13 years of age. This information is relatively consistent with other studies on Malaysian girls. A study on Malaysian adolescent females living in Negeri Sembilan, Malaysia, reported their average menarcheal age to be 12.3 years (Lee *et al.*, 2006), close to the value of 12.5 years found for adolescent females in the USA by Anderson *et al.* (2003). In other countries, age of menarche has been found to vary slightly: in Canada, 12.72 years (Al-Sahab *et al.*, 2010); in Portugal, 12.32 years (Padez, 2003); in Iran, 12.20 years (Gharrravi *et al.*, 2008); and in China, 12.76 years (Song *et al.*, 2011). Amongst the less developed countries, age of menarche appears to be later than in Malaysian females: in Indonesia, 12.96 years (Batubara *et al.*, 2010); in Bangladesh, 13.12 years (Hossain *et al.*, 2011); in Nigeria, 12.9 years (Lawan *et al.*, 2010) and in Ethiopia, 15.8 years (Zegeye *et al.*, 2009).
The present study found no significant differences between ethnic groups, although Indian students experienced menarche earlier. The subjects in the present study were born and grew up in the same environment in Malaysia, in order to fit the hypothesis that environment is an important factor for age at menarche. The study showed that Malaysian Chinese females experienced menarche at a similar age (12.55 years) as Chinese females in China (12.76 years, Song et al., 2011), but Malaysian Indian females attained menarche earlier (12.35 years) than Indian females in India (12.80 years, Sanyal & Ray, 2008).

Age at menarche and adult anthropometric measures

The coefficients of regression analysis showed that age at menarche increased with increased height and decreased BMI, that is, heavier students attained earlier menarche than thinner students. Also, the post hoc (LSD) test demonstrated that obese and overweight students reached menarche earlier than underweight and normal weight students. Indian students were heavier than Chinese students, and had an earlier menarche (Fig. 3). Adult body size was the best predictor of early onset of menarche. In a South Asian study, Hossain et al. (2010) reported that taller and heavier university students in Bangladesh attained menarche earlier than shorter and thinner females. Similar findings were found by Ersoy et al. (2004), who reported an inverse relationship between age at menarche and post-menarcheal weight and BMI of Turkish students. The present results also corroborate the study of Okasha et al. (2001), who reported that age at menarche of students at the University of Glasgow was positively associated with height and negatively associated with weight and BMI. The results of the present study are also in agreement with that of an Iranian study (Gharravi et al., 2008), which reported that age at menarche of university students in Iran was positively associated with height.

Age at menarche and socioeconomic status

Regression coefficients in the present study demonstrated that there was no association between menarcheal age of university students and their parents’ educational levels and occupations. To the authors’ knowledge, there have been no comparable studies on this in Malaysia to date. However, a similar study conducted on female university students in Portugal (Padez, 2003) found no association between a student’s age at menarche and their parents’ educational levels and occupations. However, in a similar study at a Bangladeshi University, the mother’s educational level and occupation (and not the father’s) was found to have a significant influence on their daughter’s age at menarche (Hossain et al., 2010). An American study also found that parents’ education was not a predictor of early age at menarche amongst the American population, either Black or White (Braithwaite et al., 2009). The present study found that economic status (family income) did not have a significant effect on age at menarche. This result was in agreement with an Iranian study, which reported that there was no significant difference in menarche age in the different socioeconomic classes of Iranian university students (Gharravi et al., 2008). Most studies conducted in different nations have found that socioeconomic factors are important predictors of age at menarche. Females from families of high socioeconomic status attained menarche earlier than those from families with lower
socioeconomic status (Tan et al., 1983; Abioye-Kuteyi et al., 1997; Ersoy et al., 2004; Chavarro et al., 2004; Wronka & Pawlińska, 2005; Wronka, 2010; Hossain et al., 2010).

The present study demonstrated that female university students from urban areas of Malaysia experienced menarche earlier than those from rural locations. Similar findings have been reported from Portugal (Padez, 2003), Spain (Marrodán et al., 2000), Bangladesh (Hossain et al., 2010), Iran (Delavar & Hajian-Tilaki, 2008), China (Song et al., 2011) and Turkey (Adalı & Koc, 2011).

Age at menarche and demographic factors

The present study demonstrated that family size (number of siblings) and birth order were important predictors of age at menarche amongst Malaysian female students. Students from large families with five or more children attained menarche later than those from small families. Moreover, students who were born earlier in the family had an earlier menarche than those who were born in seventh or later position (birth order). These results are in agreement with the findings of Padez (2003), who reported that family size and birth order were important indicators for menarcheal age of university students in Portugal. In addition, Chavarro et al. (2004) reported that age at menarche was positively associated with family size in a study of students at the National University of Colombia, USA. However, Hossain et al. (2010) found that there was no association between age at menarche and family size (number of siblings) and birth order in Bangladeshi university students. These differences may be reflective of the disparity in the socioeconomic backgrounds of these two countries. It could be that an increase in the size of a family may result in lesser appropriation of wealth. However, this does not explain why similar finding was not found in countries such as Bangladesh.

Conclusion

This study investigated the relationship between age at menarche and some selected anthropometric measures and socio-demographic factors of 961 healthy university students in Malaysia. It demonstrated that adult body size is an important indicator of age at menarche. Also, family size and birth order are equally important demographic predictors of menarcheal age. Other possible influences include birth weight (Silva et al., 2002; Terry et al., 2009), mother’s BMI (Keim et al., 2009), childhood living conditions (Kac et al., 2000), food habits in childhood (Windham et al., 2004), physical activity, lifestyle factors and nutrition (Merzenich et al., 1993), waist circumference and maternal menarcheal age (Cho et al., 2010). However, bearing in mind that the sample population may still be biased due to the demographics of the sample site, more research is required to further investigate the relationship between age at menarche and anthropometric measures and socio-demographic factors of Malaysians. This may include recruitment from more universities and various parts of Malaysia.

Acknowledgments

The authors gratefully acknowledge the authority of Students’ Residence Hall (College), University of Malaya, for giving permission to take data from female students. The
research is approved by the ethical committee of the institution. There was no grant, technical or corporate support for this research project. All authors declared that there were no conflicts of interests in relation to this study.

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