

Article

Familial Factors Associated with Age at Menarche: Evidence from Mothers, Sisters, and Female Students in Elementary School in Surabaya

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A B S T R A C T

Age at menarche is an important marker of reproductive health and varies widely among individuals. Familial factors, especially maternal and sibling age at menarche, have been identified as strong predictors that influence the onset of puberty in girls. This study aimed to analyze the association between familial factors and the age at menarche among students, their mothers, and older sisters. A cross-sectional study was conducted on 52 female students from an elementary school in Surabaya who had already experienced menarche. Data were collected using structured questionnaires and analyzed using the Chi-square test. The results showed a significant association between the students' age at menarche and the age at menarche of their mothers and/or older sisters ($p = 0.008$). Students whose mothers and/or older sisters experienced menarche at an earlier age tended to reach menarche earlier as well. This pattern suggests a hereditary influence within families, indicating that maternal and sibling menarcheal history contributes substantially to determining menarcheal timing among female elementary students. These findings reinforce the role of familial factors in the biological regulation of pubertal onset.

I. INTRODUCTION

Age at menarche is a key indicator of reproductive maturation in females and varies considerably across populations. A global downward trend in menarcheal age has been reported over the last century, including in Indonesia, where girls now experience menarche earlier than previous generations (Susanto et al., 2019; WHO, 2020). National and regional studies have shown that the average age at menarche among Indonesian girls has shifted from around 13–14 years in previous decades to approximately 11–12 years in recent years (Rahmawati et al., 2021; Sari & Anggraini, 2022). This generational shift indicates not only the influence of hereditary factors but also changing lifestyle and environmental conditions that affect reproductive development. This trend is clinically relevant, as early menarche has been linked to increased risks of breast cancer, obesity, type 2 diabetes, and psychosocial challenges in later life (Karapanou & Papadimitriou, 2010; Villamor & Jansen, 2016). These risks highlight the importance of identifying the factors that influence the timing of menarche.

Among the determinants, familial factors are recognized as significant contributors. Several studies have demonstrated that the age at menarche of mothers and older sisters is strongly correlated with that of their daughters and younger siblings (Towne et al., 2005; Yermachenko & Dvornyk, 2014). This intergenerational pattern emphasizes that reproductive development is not an isolated event but rather follows a biological and familial continuum. Daughters who have mothers or older sisters with an early menarche tend to reach menarche earlier as well, indicating that familial factors shape the onset of puberty through shared hereditary and environmental mechanisms. These similarities reflect how family history can be used as an important predictor of reproductive maturity and potential health risks later in life.

Familial factors may act through both biological and environmental pathways. Biologically, familial resemblance in menarcheal timing can arise from inherited hormonal regulatory patterns, especially those involving the hypothalamic–pituitary–gonadal (HPG) axis. Families may share physiological predispositions that influence gonadotropin release, estrogen sensitivity, and metabolic function, all of which affect the onset of menstruation (Day et al., 2017; Anderson et al., 2019). Environmentally, members of the same family often share similar nutritional habits, lifestyle patterns, and psychosocial environments, which may further reinforce these familial tendencies (Kaprio et al., 1995; Rahmawati et al., 2021). Thus, familial factors encompass both hereditary characteristics and shared living conditions that jointly contribute to menarcheal timing.

Comparing the age at menarche among female students, their mothers, and their older sisters provides a clear picture of this intergenerational influence. When daughters experience menarche at a younger age than their mothers or sisters, it may indicate the combined effect of inherited predispositions and changing environmental exposures across generations. Conversely, if the pattern remains similar, it reinforces the dominance of familial influences over external factors. Therefore, analyzing these relationships helps to understand how family history predicts the reproductive development of the next generation.

In Indonesia, however, studies examining the association between familial factors and menarcheal age remain limited. Most previous research has focused on general determinants such as nutritional status or lifestyle, while few have compared menarcheal age across generations within the same family. Understanding these familial relationships is essential for early detection of reproductive health risks and can assist in developing educational strategies for parents and daughters. This is particularly relevant among elementary school students, who represent the early adolescent stage when pubertal changes begin to emerge. Exploring familial patterns in this age group allows for better anticipation of early puberty and provides opportunities for timely preventive actions.

Despite the global evidence, few studies in Indonesia have explored intergenerational patterns of menarcheal age within families. In light of these findings, this study aimed to analyze the association between familial factors and age at menarche among female students in Surabaya by comparing their menarcheal age with that of their mothers and/or older sisters. The findings are expected to enhance understanding of familial influences on pubertal timing and support the design of family based reproductive health education to promote healthy development among school aged girls.

II. METHODS

This study employed a cross sectional design conducted at an elementary school in Surabaya. The study population consisted of female students who had already experienced menarche, along with data on their mothers' and/or older sisters' age at menarche. A total of 52 participants were selected using a total sampling technique. The inclusion criteria were female students in grades IV to VI who were present at the time of data collection, agreed to participate, had obtained parental consent, and had already experienced menstruation (menarche). The exclusion criteria were students who did not complete the questionnaire in full or whose mothers had passed away.

Data were collected through structured questionnaires distributed to the students and their parents. Information regarding mothers' and/or older sisters' age at menarche was obtained through recall interviews conducted with parents. Because not all participants had older sisters, two types of comparisons were made: (1) between the students and their mothers, and (2) between the students, their mothers, and their older sisters when available. Data were analyzed using descriptive statistics to present the distribution of age at menarche across generations. The Chi-square test was used to examine the association between female students' age at menarche and that of their mothers and/or older sisters, with a significance level set at $p < 0.05$. Statistical analysis was performed using SPSS version 25.0. This study obtained ethical approval from the Ethics Committee of the Faculty of Medicine, Universitas Airlangga. Written informed consent was obtained from the parents or guardians of all participants.

III. RESULT

3.1 Characteristics of respondents

Table 1. Characteristics of respondents

Variable	Category	Frequency (n)	Percentage (%)
Grade	4	6	13.5
	5	21	40.4
	6	24	46.2
Age (years)	10	4	7.7
	11	32	61.5
	12	16	30.8
Age at menarche – students	8	2	3.8
	9	7	13.5
	10	26	50.0
	11	15	28.8
	12	2	3.8
	11	7	13.5
Age at menarche – mothers	12	24	46.2
	13	13	25.0
	14	3	5.8
	15	3	5.8

	11	12	19.2
Age at menarche – sisters	12	12	21.2
	Not applicable*	27	59.6

A total of 52 female students participated in this study. The majority were in the upper grades of elementary school, mostly aged 11 years, which represents the early adolescent period when the onset of menarche generally begins. This age group reflects a transition phase from childhood to puberty, making it relevant for observing early reproductive development. The data show a noticeable difference in the age at menarche between generations. Most students reported experiencing menarche at 10 years, whereas their mothers commonly experienced it at 12 years, suggesting that the younger generation tends to reach menarche earlier than their parents. This pattern indicates a possible intergenerational shift influenced by both hereditary and environmental factors. Older sisters demonstrated an intermediate pattern, with menarche typically occurring at 11 to 12 years, further supporting the gradual trend toward earlier menarche across generations. More than half of the respondents did not have older sisters. However, among those who did, the distribution of menarcheal age among sisters showed a range similar to their mothers, which helps illustrate how familial and environmental influences may overlap within the same household. Overall, these findings highlight a consistent pattern of declining menarcheal age in the younger generation.

3.2 Comparison of Menarche Age Among Students, Mothers, and Sisters

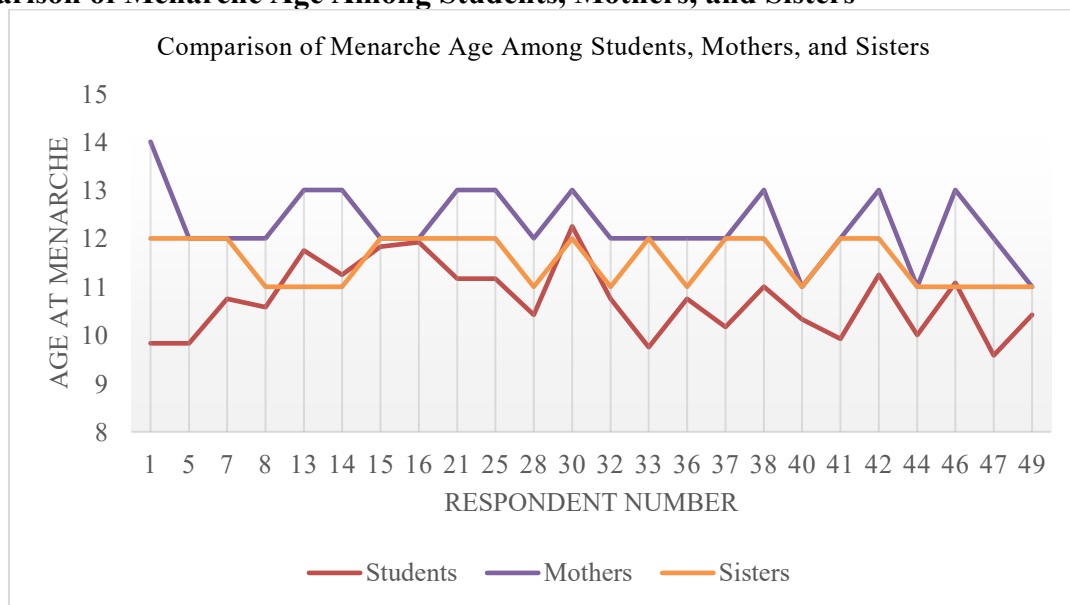


Figure 1. Comparison of Menarche Age Among Students, Mothers, and Sisters

Figure 1 illustrates the comparison of menarcheal age among female students, their mothers, and older sisters. Since not all respondents had an older sister, only 24 students were included in this comparison. Overall, the figure shows a generational decline, with most students experiencing menarche at a younger age than their mothers, and in several families, even approaching or younger than their older sisters. This pattern reflects a gradual shift toward earlier menarche across generations. Although the overall trend indicates a younger onset in the current generation, individual variations were still observed. In some families, the daughters' age at menarche was similar to or slightly older than that of their older sisters. These variations suggest that, besides hereditary influences, other modifiable factors such as nutritional status, physical activity, media exposure, and lifestyle may contribute to differences in menarcheal timing within families. Such nuances help illustrate how familial and environmental factors interact in shaping the onset of puberty among school aged girls.

3.3 Comparison of Menarche Age Among Students and Mothers

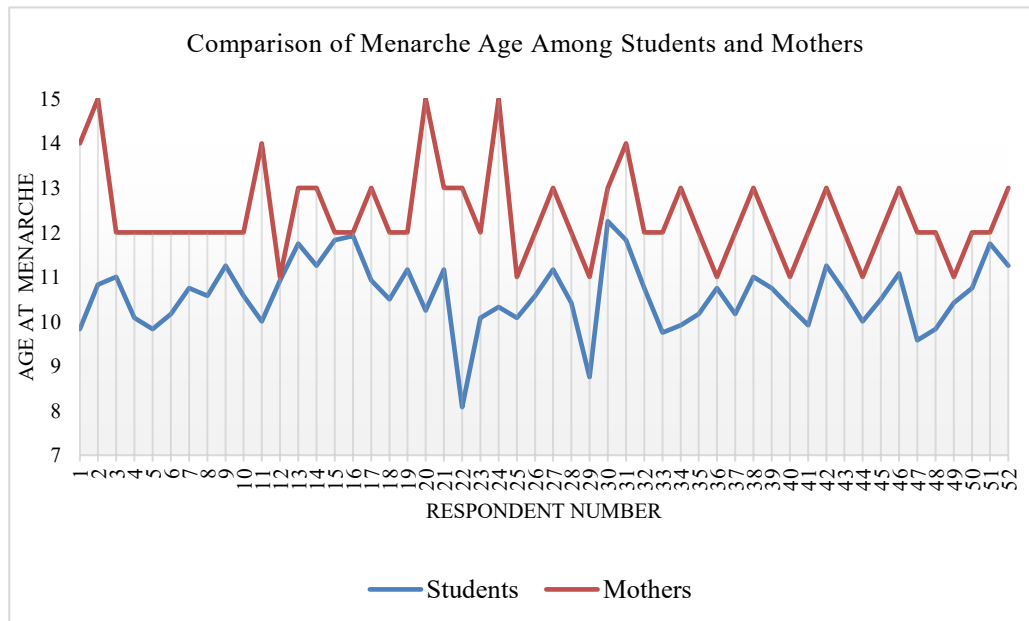


Figure 2. Comparison of Menarche Age Among Students and Mothers

Figure 2 illustrates the comparison of menarche age between female students and their biological mothers, based on 52 respondent pairs. The blue line represents students menarche age, while the red line represents mothers menarche age. The graph indicates that most students experienced menarche earlier than their mothers, as shown by the predominance of the blue line below the orange line. This pattern suggests a generational trend toward earlier menarche in younger cohorts, consistent with findings reported in previous studies. The figure also shows that early menarche in students (<11 years) was often associated with mothers who had relatively early menarche for their generation, implying a potential genetic contribution. However, this relationship was not consistent across all respondents. In several cases, students menarche age was equal to, or even later than, that of their mothers. These variations highlight the multifactorial nature of menarche, in which genetic inheritance interacts with environmental influences such as nutrition, physical activity, media exposure, and psychosocial conditions.

IV. DISCUSSION

4.1 Characteristics of respondents

The respondents in this study were 52 female students who had already experienced menarche. Most of them were in the sixth grade and were around 11 years old, representing the early adolescent stage when secondary sexual characteristics typically begin to develop. This age group is consistent with the transition period of puberty in girls, which generally occurs between 10 and 13 years of age. According to the World Health Organization (2020), early adolescence marks a critical stage of biological, psychological, and social change, where menarche becomes a key indicator of reproductive maturation.

The majority of respondents in this study were from an urban school environment, which may influence both lifestyle and nutritional patterns. Students living in cities are often exposed to higher calorie foods, more sedentary activities, and greater access to media all of which have been associated with earlier onset of menarche (Lee et al., 2021). The findings from this study showed that most students

experienced menarche at 10 years of age, while their mothers reported menarche at an average of 12 years. This two year difference reflects a generational decline consistent with trends observed in Indonesia and other developing countries (Susanto et al., 2019).

More than half of the respondents reported not having an older sister. Among those who did, most older sisters reached menarche at 12 years, similar to the mothers' age at menarche. These intergenerational patterns suggest that while hereditary factors may influence the timing of menarche, environmental changes between generations can accelerate its onset. The earlier occurrence of menarche in the daughters compared to their mothers and older sisters may therefore represent an interaction between familial predisposition and external determinants such as diet, physical activity, and exposure to endocrine disrupting chemicals.

Overall, the characteristics of respondents in this study reflect the broader demographic shift toward earlier puberty among Indonesian adolescents. The younger menarcheal age observed in this study highlights the need for greater awareness of adolescent reproductive health and the importance of early health education for both parents and children. Recognizing the influence of familial and lifestyle factors can help guide public health strategies to promote balanced growth and development in the adolescent population.

4.2 Comparison of Menarche Age Among Students, Mothers, and Sisters

In this study, the age at menarche was compared among female students, their mothers, and older sisters. The students reached menarche at around 10 years of age on average, while their mothers most frequently reported menarche at about 12 years. Older sisters, when present, showed an intermediate pattern of approximately 11–12 years. This generational difference implies a decline in menarcheal age among younger females and is aligned with recent findings in Indonesia and beyond (Sasmito et al., 2023). Among the 24 respondents who had older sisters and whose data were complete, the pattern remained consistent: daughters tended to experience menarche earlier than their older sisters and mothers. This observation supports previous research indicating significant intergenerational transitions in menarcheal age. For example, Lee et al. (2024) found that Korean females born between 1927 and 2004 experienced a decline in mean menarcheal age from 16.92 to 12.45 years ($p < 0.001$) as birth year increased.

The statistical test conducted in this study—Chi-square test—demonstrated a significant association between the students' age at menarche and that of their mothers and/or older sisters ($p = 0.008$). This significance underlines that familial factors are strongly linked to menarcheal timing, consistent with findings from Lestari et al. (2024) which reported similarity in menarcheal age between mothers and daughters in an Indonesian setting. However, the generational decline observed cannot be explained by familial factors alone. Environmental and lifestyle factors must be taken into account. For instance, Christanti, Syafiq & Fikawati (2024) in DKI Jakarta reported an average menarcheal age of 11.74 years among junior high school girls and found a significant association between low dietary fibre intake and earlier menarche ($p = 0.006$) in their logistic regression analysis. Furthermore, a global review by Okagbue & Heggie (2024) demonstrated widespread declines in menarcheal age across developing countries from 1976 through 2023, affirming the presence of secular trends that go beyond familial inheritance.

In the urban Indonesian context, the younger age at menarche among daughters might reflect improved nutrition, greater body mass index (BMI), and less physical activity compared to previous generations factors known to accelerate puberty onset. The decline of approximately two years observed in this study echoes the regional trend where “Generation Alpha” in Jember Regency reportedly experienced

menarche earlier than Generation X, Y, and Z (Sasmito et al., 2023). In summary, the comparison between students, their mothers, and older sisters in this research illuminates a clear intergenerational shift toward earlier menarche. It underscores the importance of considering both inherited predispositions and modifiable environmental exposures when discussing pubertal timing. These findings highlight the need for early reproductive health education and family-based interventions to address potential risks associated with early menarche in the younger generation.

4.3 Comparison of Menarche Age Among Students and Mothers

The comparison between female students and their mothers revealed a notable generational difference. Students in this study experienced menarche at an average age of 10 years, whereas their mothers reported menarche at around 12 years. This two-year difference supports previous Indonesian cohort data showing a secular decline in menarcheal age from 14.39 years among women born in 1944 to 13.18 years among those born in 1988 (Achmad et al., 2015). Statistical analysis using the Chi-square test confirmed a significant association between the students' age at menarche and their mothers' age at menarche ($p = 0.008$). This finding indicates that maternal menarcheal timing can act as a predictive factor for daughters' pubertal onset. Similar results were observed in other regional studies, where the distribution of menarcheal age between mothers and daughters showed close similarity (Lestari et al., 2024; Towne et al., 2005).

Beyond the familial link, environmental and lifestyle transitions appear to accelerate this generational shift. An Indonesian meta-analysis reported a consistent downward trend in menarcheal age, with an estimated decrease of 0.0245 years annually (Abdul Wahab et al., 2018). Recent studies have also associated earlier menarche with higher body mass index, improved nutritional status, lower physical activity, and increased exposure to endocrine-disrupting chemicals (Lee et al., 2024; Christanti et al., 2024). These findings suggest that while heredity provides a biological foundation, environmental changes enhance hormonal activation and advance the onset of puberty. In this context, the two-year difference observed between mothers and daughters in this study may reflect both inherited predisposition and environmental modulation. Students inherit their mothers' biological baseline but experience pubertal onset earlier due to nutritional and lifestyle changes typical of urban settings. This aligns with findings from Sasmito et al. (2023), who reported that younger generations in Indonesia experience menarche significantly earlier than preceding cohorts.

These observations have meaningful implications for reproductive and public health. Earlier menarche is linked to increased lifetime risks of obesity, type 2 diabetes, and breast cancer (Karapanou and Papadimitriou, 2010; Villamor and Jansen, 2016). Awareness of maternal menarcheal age may therefore help predict risk for early puberty in daughters. Early preventive efforts particularly those focused on nutrition, physical activity, and family-based reproductive health education are essential to support balanced growth and development among young girls.

V. CONCLUSION

This study demonstrated a significant intergenerational association in age at menarche among female students, their mothers, and, when available, their older sisters. The students experienced menarche at a younger age averaging 10 years compared to their mothers, who generally reached menarche at 12 years, while older sisters showed an intermediate pattern of 11 to 12 years. This two-year difference between generations clearly indicates a downward shift in the timing of menarche, reflecting the ongoing secular trend observed in both Indonesian and global populations. The significant correlation ($p = 0.008$) between students' and mothers' menarcheal ages reinforces the influence of familial factors, particularly hereditary predisposition, in determining the onset of puberty. Nevertheless, the earlier menarche among daughters compared to their mothers and older sisters suggests that familial

inheritance alone cannot fully explain this pattern. Environmental determinants such as improved nutritional intake, increased body mass index, reduced physical activity, and greater exposure to digital media likely accelerate the physiological maturation process.

Taken together, these findings emphasize that the timing of menarche is the result of a complex interaction between genetic and environmental influences. The generational decline observed in this study mirrors broader socio-nutritional and lifestyle changes that accompany modernization and urbanization. Understanding these intergenerational differences is crucial for anticipating potential health consequences, as earlier menarche has been linked to increased risks of obesity, metabolic disorders, and reproductive health complications in adulthood.

From a public health perspective, awareness of familial patterns and lifestyle influences should be strengthened through early reproductive health education, particularly within families. Parents play a central role in guiding adolescents to adopt balanced dietary habits, maintain adequate physical activity, and develop a healthy understanding of puberty. Such preventive efforts are essential to promote optimal growth, protect long-term reproductive health, and support the well-being of the next generation of Indonesian girls.

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