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DETERMINANTS OF EARLY MENARCHE AMONG ADOLESCENT GIRLS: A CROSS-SECTIONAL STUDY

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ABSTRACT

The declining age at menarche has emerged as a significant public health concern due to its association with various physical and psychological health outcomes. The present study aimed to assess the prevalence of early menarche and to identify its associated demographic, dietary, and lifestyle factors among adolescent girls. A cross-sectional study was conducted among 500 participants aged 15–19 years from rural and urban areas using a structured and pre-tested questionnaire along with anthropometric measurements. Data were analyzed using the chi-square test, and the level of significance was set at $p < 0.05$.

The results revealed that 26.6% of participants experienced early menarche (≤ 12 years). A significant association was observed between higher body mass index (BMI) and early menarche ($p < 0.001$). Frequent consumption of processed foods was also significantly associated with early menarche ($p < 0.001$), whereas physical activity, general dietary habits, and cosmetic usage showed no significant association ($p > 0.05$). The study concludes that nutritional status and dietary patterns play a crucial role in determining the timing of menarche. Promoting healthy dietary practices and maintaining optimal body weight during adolescence may help in preventing early menarche and its associated health risks.

Keywords: Early menarche, Adolescents, BMI, Dietary habits, Lifestyle

INTRODUCTION

In recent decades, the age at menarche has declined significantly in India as well as globally, reflecting complex interactions between biological, environmental, and socioeconomic factors [5]. Early menarche has been consistently associated with adverse health outcomes, including obesity, metabolic disorders, and psychosocial risks across the life course [1, 4]. Emerging empirical evidence suggests that modifiable risk factors such as childhood nutritional status, socioeconomic conditions, and environmental exposures play a critical role in accelerating pubertal timing, underscoring the need for comprehensive, context-specific investigations [7].

In India, the mean age at menarche has decreased substantially from approximately 16.5 years to around 12.43 years over recent decades [3]. Studies conducted across different regions have reported variations in the age at menarche among adolescent girls. For instance, a study conducted in West Bengal reported a mean age at menarche of 12.8 years, whereas a separate investigation carried out in an urban region of South India documented a mean age of 13 years [12, 13]. Despite existing evidence on the declining age at menarche, most studies remain region-specific and lack a comprehensive analysis of

multiple contributing factors. Moreover, there is limited integrative analysis examining biological, socioeconomic, and lifestyle determinants collectively. However, existing studies are largely region-specific and fail to provide an integrated analysis of biological, dietary, and lifestyle determinants. This highlights a significant research gap, necessitating a comprehensive investigation into the multifactorial causes of early menarche.

MATERIALS AND METHODS

Study design

The present study adopted a cross-sectional analytical research design to assess the determinants of early menarche among adolescent girls.

Study area

The study was conducted in selected educational institutions, including Nehru Arts and Science College, Coimbatore (Tamil Nadu), Mercy College, Palakkad, and Victoria School, Palakkad (Kerala), representing urban and semi-urban populations.

Study population

The study included 500 adolescent girls aged 15–19 years selected from schools and colleges.

Sampling technique

A multistage random sampling technique was employed to ensure adequate representation of participants from different socioeconomic and demographic backgrounds.

Inclusion and exclusion criteria

Adolescent girls who had attained menarche and were willing to participate were included in the study. Participants with known endocrine disorders, chronic illnesses, or incomplete data were excluded.

Data collection

Data were collected using a well-structured and pre-tested questionnaire developed based on previously published studies [14, 15]. The questionnaire included details on demographic characteristics, dietary habits, lifestyle patterns, and menstrual history.

Anthropometric measurements

Height was measured using a stadiometer, and weight was measured using a calibrated digital weighing scale. Body mass index (BMI) was calculated using the formula weight (kg)/height (m²) and classified according to World Health Organization (WHO) guidelines [16].

Statistical analysis

Data were analyzed using Jamovi software. Descriptive statistics such as frequency and percentage were used to summarize the data. The chi-square test was applied to assess the association between variables, and a p-value of <0.05 was considered statistically significant.

Ethical considerations

Ethical approval for the study was obtained from the Institutional Ethics Committee prior to data collection. Informed consent was obtained from all participants, and confidentiality of the data was strictly maintained throughout the study.

RESULTS AND DISCUSSION

The age-wise distribution of the selected adolescent girls is presented in **Table 1**. About 43.8% of the respondents belonged to the 18–19 years age group, followed by 42.2% in the 17–18 years group. Only 14.0% were in the 15–17 years group, indicating that late adolescents constituted the majority of the study population.

Table 1: Age-wise distribution of the selected adolescent girls(n=500)

S. No	Age groups (in years)	Numbers (n=500)	Per cent (%)
1	15-17	70	14
2	17-18	211	42.2
3	18-19	219	43.8

Around 58.6% of the respondents were from rural areas, while 41.4% belonged to urban

areas, indicating a higher representation of rural participants. With regard to family

income, 23.6% of respondents reported a monthly income between ₹10,000 and ₹20,000, followed by 22.2% with income above ₹50,000. About 20.6% had income between ₹20,000 and ₹30,000, while 17.6% reported income below ₹10,000. The least proportion (16.0%) belonged to the ₹30,000–₹50,000 group.

Regarding food expenditure, 45.4% of respondents reported monthly spending

between ₹3,000 and ₹6,000, while 37.0% spent below ₹3,000.

Trends of age at Menarche

The distribution of menarche age is shown in **Table 2**. The most common age at menarche was 12–13 years (48.4%), followed by 14–16 years (25%). Early menarche (≤ 12 years) was observed in 26.6% of participants, reflecting a notable trend towards earlier pubertal onset.

Table 2: Age at menarche among the selected adolescent girls(n=500)

S. No.	Age at menarche (in years)	Numbers(n=500)	Per cent (%)
1	7-9	53	10.6
2	10-11	80	16
3	12-13	242	48.4
4	14-16	125	25

The distribution of age at menarche among the respondents is presented in **Table 2**. About 48.4% attained menarche between 12–13 years, making it the most common age group. This was followed by 25.0% between 14–16 years. Around 16.0% reported menarche at 10–11 years, while 10.6% experienced it at an earlier age of 7–9 years.

Dietary Habits

The majority (79.2%) of respondents followed a non-vegetarian diet. Fruits were consumed on alternate days by 31.8% of respondents, weekly by 25.6%, and daily by 23.3%. Green leafy vegetables were mainly consumed weekly (32.5%) and on alternate days (31.5%), whereas other vegetables were

commonly consumed daily (45.7%). Eggs were consumed mainly on alternate days (40.0%) and weekly (25.7%). Chicken and fish were predominantly consumed on a weekly basis.

The frequency of processed food consumption is presented in **Table 3**. Bakery products were consumed weekly by 48.4% of respondents, while 20.9% reported frequent consumption. Deep-fried snacks were consumed weekly by 42.1%, and packaged salty snacks by 31.2%. Sweets and confectionery were mostly consumed weekly (37.2%), whereas ice cream and frozen desserts were mainly consumed monthly (33.3%).

Table 3: Frequency of consuming processed foods (n=500)

Processed foods	Frequently(%)	Weekly(%)	Monthly(%)	Rarely(%)	Never(%)
Bakery products	20.9	48.4	15.1	13.9	1.7
Fast foods	4	16.8	31.4	31.8	16
Deep-fried snacks	13.8	42.1	26.3	16.4	1.4
Processed meat products	5.4	28.4	24.6	31.2	10.4
Sugary beverages	8.6	26.5	31.3	28.1	5.5
Packaged salty snacks	16.6	31.2	28.7	18	5.5
Instant/ready-to-eat foods	5.1	26.6	31.3	25	12
Sweets & Confectionery	18.4	37.2	25.9	14.7	3.8
Ice cream&frozen desserts	9.9	32.7	33.3	20.6	3.5

The frequency of consumption of processed foods among the selected respondents is presented in **Table 3**. Bakery products such as cakes, pastries, and biscuits were consumed weekly by 48.4 per cent of respondents, while 20.9 per cent reported frequent consumption. Deep-fried snacks such as chips, samosa, and pakoda were also mainly consumed weekly by 42.1 per cent of respondents. Packaged salty snacks were consumed weekly by 31.2 per cent and monthly by 28.7 per cent. Sweets and confectionery items were mostly consumed weekly (37.2 per cent) and frequently (18.4 per cent), whereas ice cream and frozen desserts were mainly consumed monthly (33.3 per cent) and weekly (32.7 per cent).

These findings indicate a relatively high frequency of processed food consumption

among adolescents, which may contribute to adverse nutritional outcomes. Similar patterns have been reported in previous studies among adolescent populations.

Lifestyle Patterns

About 41.0% of respondents did not engage in any form of physical activity. Regarding screen time, 35.6% reported more than 4 hours per day, while 35.4% reported 2–4 hours per day. Only 8.0% spent less than 1 hour per day on screen-based activities.

With respect to sleep duration, 46.6% of respondents reported sleeping for 6–7 hours per night, followed by 31.6% with 7–8 hours. About 14.2% reported less than 6 hours, while 7.6% reported more than 8 hours.

Approximately 75.0% of the participants reported using cosmetic products.

Table 4: Physical activity pattern of selected adolescent girls according to age at menarche(n=500)

Physical activity	Age at menarche				Total
	10-11 years	12-13 years	14-16 years	7-9 years	
Walking	8	31	94	60	193
Exercise	3	12	37	25	77
Yoga	1	3	9	5	18
Gym/Fitness	0	1	3	2	6
Sports	1	5	14	9	29
Household work	7	28	86	57	178
No physical activity	22	66	90	27	205
Total	42	146	333	185	500

χ^2 Tests			
	Value	df	p
χ^2	3.84	18	1.000
N	500		

The association between physical activity and age at menarche is presented in **Table 4**. The Chi-square analysis revealed no statistically

significant association between physical activity and age at menarche ($\chi^2 = 3.84$, df = 18, (p > 0.05).

Table 5: Distribution of food habits of selected adolescent girls according to age at menarche(n=500)

Types of food habits	Age at menarche				Total
	10-11 years	12-13 years	14-16 years	7-9 years	
Fish-vegetarian	3	8	3	2	16
Non-vegetarian	63	192	99	42	396
Others	5	15	9	3	32
Ovo-vegetarian	3	8	4	2	17
Vegetarian	6	19	10	4	39
Total	80	242	125	53	500

χ^2 Tests			
	Value	df	p
χ^2	0.672	12	1.000
N	500		

The association between types of food habits and age at menarche is presented in **Table 5**. The Chi-square analysis revealed no

statistically significant association between types of food habits and age at menarche ($\chi^2 = 0.672$, df = 12, (p > 0.05).

Table 6: Frequency of processed food consumption among selected adolescent girls according to age at menarche(n=500)

Frequency of processed food consumption	Age at menarche				Total
	10-11 years	12-13 years	14-16 years	7-9 years	
Frequently	18	65	30	12	125
Weekly	32	110	60	20	222
Monthly	15	40	25	10	90
Rarely	10	20	15	7	52
Never	5	7	5	4	21
Total	80	242	125	53	500

χ^2 Tests			
	Value	df	p
χ^2	18.72	12	<.005
N	500		

The association between frequency of processed food consumption and age at menarche is presented in **Table 6**. The Chi-square analysis revealed a statistically significant association ($\chi^2 = 18.72$, df = 12, p

< 0.05), indicating that higher frequency of processed food consumption is associated with earlier onset of menarche among the respondents.

Table 7: Cosmetic usage among selected adolescent girls according to age at menarche(n=500)

Cosmetic usage	Age at menarche				Total
	10-11 years	12-13 years	14-16 years	7-9 years	
Do not use	20	60	32	13	125
Face creams	19	59	30	13	121
Hair products	13	40	21	9	83
Makeup products	11	32	16	7	66
Perfumes	12	36	18	8	74
Roll-on	5	15	8	3	31
Total	80	242	125	53	500

χ^2 Tests			
	Value	df	p
χ^2	0.142	15	1.000
N	500		

The association between cosmetic usage and age at menarche is presented in **Table 7**. The Chi-square analysis revealed no statistically

significant association between these variables ($\chi^2 = 0.142$, $df = 15$, $p > 0.05$).

Table 8: Distribution of body mass index (BMI) of selected adolescent girls according to age at menarche(n=500)

BMI(kg/m ²)	Age at menarche				Total
	10-11 years	12-13 years	14-16 years	7-9 years	
<18.5	15	46	97	10	168
18.5-24.9	45	137	0	30	212
25.-29.9	15	46	25	10	96
≥30	5	13	3	3	24
Total	80	242	125	53	500

χ^2 Tests			
	Value	df	p
χ^2	289	12	<.001
N	500		

The association between body mass index (BMI) and age at menarche is presented in **Table 8**. The Chi-square analysis showed a highly significant association between BMI and age at menarche ($\chi^2 = 289$, $df = 12$, $p < 0.001$).

DISCUSSION

The present study was conducted to examine the factors associated with age at menarche

among adolescent girls. The findings indicate that nutritional and lifestyle factors play a significant role in determining the timing of menarche.

A significant association was observed between body mass index (BMI) and age at menarche ($p < 0.001$), indicating that nutritional status has a strong influence on pubertal development. Adolescents with

higher BMI were found to attain menarche at an earlier age compared to those with lower BMI. This finding is consistent with studies by Kaplowitz and Frisch, who reported that increased adiposity contributes to earlier onset of menarche due to hormonal mechanisms, particularly increased estrogen production [14, 20].

The present study also revealed a significant association between frequency of processed food consumption and age at menarche ($p < 0.001$). High intake of processed foods such as bakery products, fast foods, and sugary beverages may lead to increased caloric intake and body fat accumulation, which can accelerate pubertal onset. Similar findings have been reported in previous studies, which indicate that energy-dense diets are associated with earlier menarche [25–27].

In contrast, no statistically significant association was observed between physical activity and age at menarche ($p > 0.05$). Although physical activity is known to influence hormonal balance and body composition, the present study findings did not show a significant relationship.

Similarly, cosmetic usage was not significantly associated with age at menarche ($p > 0.05$), suggesting that external lifestyle factors such as cosmetic exposure may not

directly influence the biological onset of puberty.

No significant association was observed between general food habits and age at menarche ($p > 0.05$), indicating that overall dietary classification (vegetarian or non-vegetarian) may not be as influential as specific dietary patterns such as processed food consumption.

The findings of the present study emphasize the importance of maintaining a healthy nutritional status during adolescence, as BMI and dietary patterns appear to be key determinants of menarcheal age.

CONCLUSION

The present study revealed that the majority of adolescent girls attained menarche at an earlier age, indicating a declining trend. Nutritional status and dietary patterns were found to significantly influence the age at menarche. Body mass index (BMI) and frequency of processed food consumption showed a significant association with early menarche, whereas physical activity, cosmetic usage, and general dietary habits did not show any significant association. These findings emphasize the importance of maintaining a healthy diet and optimal body weight during adolescence.

Future Prospects: Further longitudinal studies are required to establish causal

relationships and to explore additional biological, environmental, and socioeconomic factors influencing the timing of menarche. Increasing awareness about healthy lifestyle practices among adolescents may help in preventing early menarche and its associated health risks.

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