

DOI: <https://dx.doi.org/10.18203/2320-1770.ijrcog20262537>

Original Research Article

Assessing impact of BMI on menstrual patterns in adolescent girls in an urban area of Amravati district, Maharashtra, India

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Received: 26 May 2026

Revised: 04 July 2026

Accepted: 08 July 2026

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ABSTRACT

Background: Adolescence marks a critical transitional phase characterized by significant physical, mental, emotional, and hormonal changes, including the onset of the menstrual cycle. The nature of the menstrual cycle established during this time can profoundly influence reproductive health later in life. Regular menstruation is a sign of good health and normal development of an adolescent. A paradigm shift is noted in the pattern of lifestyle, habits, diet, sleep and physical activity since childhood and is known to affect menstrual health in young girls. Body mass index (BMI) has got a great impact on menstrual functions. However, this part of women's health is mostly neglected or not talked about.

Methods: An observational, prospective study was conducted for a period of six months in four schools in an urban area in Maharashtra. This study enrolled 276 school girls in the age group of 12-16 years. Using structured questionnaires and anthropometric measurements, their BMI and menstrual patterns were assessed and statistically analysed.

Results: Adolescent girls who had higher BMI experienced earlier onset of menstruation, irregular cycles and heavy menstrual bleeding as compared to the normal BMI participants and the difference was statistically highly significant. However, the duration of menstrual flow or the severity of dysmenorrhoea had no significant association with BMI in our study population.

Conclusions: Maintaining a normal BMI through healthy lifestyle practices since early adolescence is crucial for promoting reproductive well-being among young girls. It also plays a vital role in preventing complications such as infertility and endocrine and gynaecological disorders in future.

Keywords: Adolescence, Body mass index, Menstrual pattern, Menstrual irregularity

INTRODUCTION

The World Health Organization (WHO) defines adolescence as the period between the ages of 10 and 19 years.¹ It is the transitional phase of growth and development from childhood to adulthood, marked by significant physical, sexual, psychological, and social changes. This age range represents a critical time for establishing good health and well-being.¹

Adolescence also marks a critical period for reproductive health. Menstruation is said to be the fundamental aspect of female reproductive health; regular menstruation every month is considered a sign of good health and normal development of an adolescent. Irregularities in this regular rhythmic cycle indicate abnormality in the normal functioning of the hypothalamic-pituitary-ovarian (HPO) axis and impacts overall pubertal, physiological, and psychosocial development of adolescent females. There

are a number of medical, genetic, and hormonal conditions that can affect the regularity of a normal menstrual cycle.²

The seemingly minor alterations in menstrual pattern, like irregular cycles, dysmenorrhea, and premenstrual symptoms, may also greatly affect the day-to-day activities and emotional and social well-being of the adolescent girls.³ However, this part of a woman's health is mostly neglected or not talked about either because of a lack of awareness or openness to discuss these problems. In recent years emphasis has been shifted to the correlation between menstrual problems and changes in lifestyle, habits, sleep patterns, and nutrition in adolescent years.

Body mass index (BMI) has been noted to have a great impact on menstrual functions even in adolescents. BMI is a numerical value derived from a person's weight and height used to assess if they are underweight, normal weight, overweight, or obese.⁴ Both obese and underweight girls are likely to have menstrual irregularities as compared to those with a normal BMI. These irregularities are common and can serve as early warning signs of underlying nutritional or endocrine disorders if properly analysed and recognized. Obesity disturbs the delicate balance of sex steroid hormones, leading to menorrhagia, polymenorrhoea, oligomenorrhoea, and premenstrual syndrome. Similarly underweight often results in delayed menarche, dysmenorrhea, irregular cycles and anovulation.

Understanding how BMI and maintaining a healthy weight collectively influence menstrual patterns plays a vital role in preventing future complications such as infertility and endocrine and gynaecological disorders if diagnosed early. By focusing on early detection and assessment, this research aims to encourage educators, policymakers, and healthcare workers to integrate menstrual health education with nutritional programs for young girls.

The objective of this particular study was to bridge a noticeable gap by studying and closely examining the effect of BMI on menstrual patterns in adolescent girls. The majority of studies in the past focus on the correlation between BMI and menstrual disorders in reproductive-age group females when they present mostly with infertility. This study targeted adolescent girls who usually do not disclose menstrual problems due to either ignorance or embarrassment. Making them aware regarding menstrual health and maintaining a healthy normal body weight in accordance with one's height will avoid future complications, thus building a strong foundation.

Study objectives

To estimate the prevalence and types of menstrual abnormalities among adolescent girls aged 12-16 years. To categorize the participants based on BMI categories. To analyse the association between BMI and menstrual patterns.

METHODS

This observational study was conducted in the department of obstetrics and gynecology, Dr PDMMC, Amravati for a period of six months from June 2025 to November 2025. The data was collected from four schools selected by simple random sampling located in the urban area of Amravati district, Maharashtra. Permission for data collection was obtained from the respective school principals. Considering the prevalence of menstrual irregularity in obese adolescent girls as 22.5% from previous study, the sample size at 95% CI and 5% error and 80% power came out to be 276.³

The participants in the study were school girls aged 12 to 16 years selected randomly. Prior to data collection, informed consent was obtained from the parents or teachers, and assent was obtained from the participants.

Data was collected using a pre-designed and pre-tested questionnaire. The questionnaire included sections on demographic details and menstrual history, covering aspects such as age at menarche, date of last menstruation, cycle length, duration and amount of menstrual flow and presence of dysmenorrhea.

All participants underwent measurement of height (in meters) using a stadiometer and weight (in kilograms) using a well calibrated weighing machine. The same equipment was used for all the participants to avoid bias. Body Mass Index (BMI) was calculated using the formula:

$$\text{BMI} = \text{Weight (kg)} / \text{Height}^2 (\text{m}^2)$$

Participants were categorized based on the WHO classification of BMI as follows: underweight: BMI <18.5, normal weight: BMI 18.5-24.9, overweight: BMI 25-29.9, obese: BMI ≥30.⁵

On the basis of gynaecological definitions recommended by FIGO, each participant's menstrual characteristics were noted and categorized. A normal menstrual cycle has a frequency of 24 to 38 days and lasts 4.5-8 days, with 20 to 80 mL of blood loss.⁶ The normal cycle-to-cycle variation over 12 months is 2-20 days. If the variation is more than 20 days, it is labelled as irregular. The normal menstrual cycle frequency is 24-38 days. Cycles less than 24 days are called as frequent or "polymenorrhoea", while more than 38 days are labelled infrequent or "oligomenorrhoea". Menstruation lasting more than 8 days is considered prolonged, while less than 4.5 days is considered shortened. Blood flow less than 20 ml is termed light or hypomenorrhea, and more than 80 ml is heavy or menorrhagia.⁷ The severity of dysmenorrhea was classified using the numerical rating scale as either mild (1-3), moderate (4-7), or severe (8-10).⁷

Exact volume measurements of menstrual flow are difficult to determine outside research settings; therefore, detailed questions regarding the frequency of sanitary

product changes during each day, the passage and size of any clots, the need to change sanitary products during the night, interference with normal activities, and a “flooding” sensation were considered.⁸

The data was entered in MS Excel and analysed using SPSS software version 16. Mean, percentages were calculated, and a chi-square test of significance was applied to test association between BMI and various menstrual patterns. $P < 0.05$ was considered as statistically significant.

RESULTS

A total of 276 adolescent girls from classes 8th to 10th participated in the study conducted across four schools in the urban area of the Amravati district of Maharashtra. The percentage of students who participated in this survey from four randomly selected schools were 18.8%, 13.8%, 15.9%, and 51.4%, respectively.

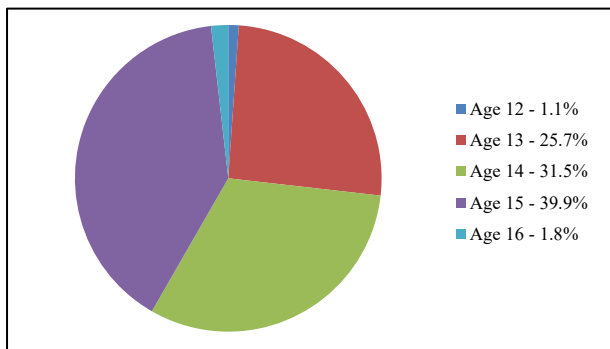


Figure 1: Distribution of participants according to age.

The highest proportion 110 (39.9%) participants in this study were of age 15 years, followed by 87 (31.5%) of age 14 years, 71 (25.7%) of age 13 years, and the rest 8 (2.9%) were of ages 12 and 16 years. The mean age was found to be 14.1 years (Figure 1).

Table 1: Distribution of participants according to age at menarche.

Age at menarche	Frequency	Percentage
Less than 12	89	32.2
More than 12	187	67.8
Total	276	100

In our study, 187 girls (67.8%) attained menarche after the age of 12 years while 89 girls (32.2%) before 12 years. None of the girls had primary amenorrhoea. The mean age at menarche was 12.0 years (Table 1).

The frequency distribution of participants in our study according to their BMI was calculated. Out of 276 participants, 148 (53.62%) were found to be underweight, while 115 (41.67%) belonged to the normal BMI, and 13

(4.71%) belonged to the overweight category, respectively. None of the participants was found to be obese. The mean BMI was 18.66 (Figure 2).

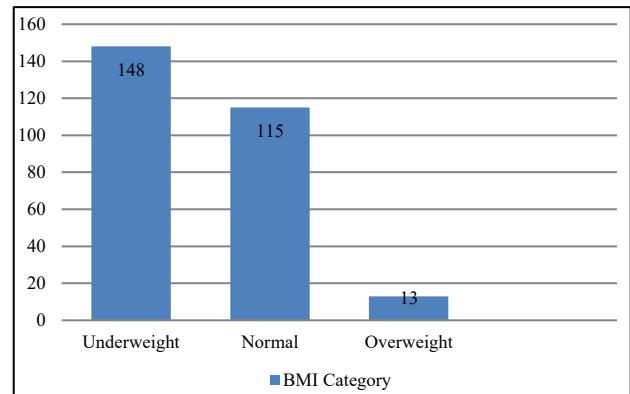


Figure 2: Distribution of participants according to BMI.

After an assessment of the menstrual patterns in the participants, it was seen that out of 276 participants, 90 (32.6%) reported irregular menstrual cycles, while 186 (67.4%) had regular cycles. In terms of menstrual duration, 257 (93.1%) adolescent girls experienced a normal duration, with only 16 (5.8%) and 3 (1.1%) reported prolonged and short periods respectively. The highest proportion of participants 211 (76.4%) reported a moderate flow during menstruation, followed by 47 (17.0%) presenting with heavy flow and a smaller number 18 (6.5%) with light flow. Regarding dysmenorrhea, no pain or mild pain was reported by 66 (23.9%) girls, while more than half of the respondents 151 (54.7%) experienced moderate pain and the rest 59 (21.4%) experienced severe pain.

Table 2: Distribution of participants according to menstrual pattern.

Menstrual pattern characteristics	Category	N	%
Regularity	Regular	186	67.4
	Irregular	90	32.6
Duration	Short	3	1.1
	Normal	257	93.1
	Prolonged	16	5.8
Flow	Light	18	6.5
	Moderate	211	76.4
	Heavy	47	17.0
Dysmenorrhea	No pain/mild	66	23.9
	Moderate	151	54.7
	Severe	59	21.4

The participants in underweight, normal and overweight BMI categories were classified based on individual menstrual pattern characteristics and the age at menarche. Chi square value and p value was calculated in each

category to determine whether any significant association existed between BMI and menstrual irregularities.

With respect to age at menarche, participants were categorized into those attaining menarche before 12 years of age and those after 12 years. In underweight and normal BMI categories, the age at menarche was found to be commoner after 12 years, however all 13 overweight participants attained menarche earlier than 12 years. The association between BMI category and age at menarche was found to be statistically highly significant ($\chi^2=32.96$, $p=0.000$).

Menstrual regularity was analysed as regular and irregular cycles and compared in all categories of BMI. In the underweight category, 101 (68.24%) participants reported regular cycles, whereas 47 (31.76%) reported irregular cycles. Among normal BMI participants, 84 (73.04%) had regular cycles and 31 (26.96%) had irregular cycles. Only 1 participant in the overweight group reported regular cycles, while 12 (92.31%) had irregular cycles. The association between BMI and menstrual regularity was statistically highly significant ($\chi^2=22.80$, $p=0.000$).

The duration of menstruation was classified as short, normal or prolonged. In the underweight group, 3 (2.03%) participants had short duration, 139 (93.92%) had normal duration, and 6 (4.05%) had prolonged duration of menstrual flow. In the normal BMI group, the majority 106 (92.17%) reported normal duration and only 9 (7.83%) reported prolonged duration. Among overweight

participants, 12 (92.31%) had normal duration of flow and only one reported prolonged duration. The association between BMI and duration of menstrual flow was not statistically significant ($\chi^2=4.29$, $p=0.368$).

The menstrual flow was categorized as light, moderate, and heavy. Among underweight participants, 13 (8.78%) reported light flow, 116 (78.38%) reported moderate flow, and 19 (12.84%) reported heavy flow. In the normal BMI group, 4 (3.48%) participants had light flow, 92 (80.00%) had moderate flow, and 19 (16.52%) had heavy flow. Among overweight participants, 1 (7.69%) reported light flow, 3 (23.08%) reported moderate flow, and 9 (69.23%) reported heavy flow. The association between BMI and amount of menstrual flow was found to be statistically highly significant ($\chi^2=30.27$, $p=0.000$).

Dysmenorrhoea experienced by the participants was categorized as no pain or mild pain, moderate pain, and severe pain. In the underweight group, 39 (26.35%) participants experienced no pain or mild pain, 81 (54.73%) had moderate pain, and 28 (18.92%) had severe pain. Among normal BMI participants, 26 (22.61%) reported no pain or mild pain, 61 (53.04%) reported moderate pain, and 28 (24.35%) reported severe pain. In the overweight group, 1 (7.69%) participant reported no pain or mild pain, 9 (69.23%) reported moderate pain, and 3 (23.08%) reported severe pain. Though moderate dysmenorrhoea was more common across all categories of BMI, the association was not statistically significant ($\chi^2=3.35$, $p=0.501$).

Table 3: Comparison of BMI categories with age at menarche and menstrual abnormalities.

Menstrual pattern characteristics	Category	Underweight (148) (%)	Normal (115) (%)	Overweight (13) (%)	Chi-square value	P value
Age at menarche (years)	Less than 12	35 (23.65)	41 (35.65)	13 (100.0)	32.96	0.000
	More than 12	113 (73.35)	74 (64.34)	0 (0.00)		
Regularity	Regular	101 (68.24)	84 (73.04)	1 (7.69)	22.80	0.000
	Irregular	47 (31.76)	31 (26.96)	12 (92.31)		
Duration (days)	Short	3 (2.03)	0 (0.00)	0 (0.00)	4.290	0.368
	Normal	139 (93.92)	106 (92.17)	12 (92.31)		
	Prolonged	6 (4.05)	9 (7.83)	1 (7.69)		
Flow	Light	13 (8.78)	4 (3.48)	1 (7.69)	30.27	0.000
	Moderate	116 (78.38)	92 (80.00)	3 (23.08)		
	Heavy	19 (12.84)	19 (16.52)	9 (69.23)		
Dysmenorrhoea	No pain/mild	39 (26.35)	26 (22.61)	1 (7.69)	3.350	0.501
	Moderate	81 (54.73)	61 (53.04)	9 (69.23)		
	Severe	28 (18.92)	28 (24.35)	3 (23.08)		

The above observations in our study indicate that BMI has a statistically significant association with age at menarche, menstrual regularity, and amount of menstrual flow. However, BMI does not show a statistically significant association with the duration of menstrual flow or the severity of dysmenorrhoea in our study population (Table 3).

DISCUSSION

Menstrual abnormalities remain a significant public health concern during the period of adolescence, with prevalence rates varying globally. A woman's menstrual cycles are influenced by various factors including genetics, hormonal changes, medical conditions and BMI. Body mass index

acts as a significant factor and determinant of women's health.⁹ A magnitude of menstrual disorders related to abnormal BMI among young women has been noted, which could have long-term effects on obesity, chronic illness, infertility, and future reproductive health risks.¹⁰ Realizing this fact, the present investigation was carried out to determine the prevalence of menstrual disorders amongst the young adolescent girls.

Our study included participants in the age group of 12-16 years of which the majority were of 14 and 15 years and mean age of the girls was found to be 14.15 years. In a similar study conducted by Dars et al on girls aged 12-18 years, the mean age of the girls was found to be 14.96±1.5 years.¹¹

Onset of menarche is generally between 11-15 years.⁴ Variation is seen from girl to girl depending upon genetics, hereditary pattern, nutrition, and physiological growth.¹² In our study, 67.8% attained menarche after the age of 12 years and the mean age at menarche was found to be 12.0 years. This finding aligns with the study conducted by Kural et al where the average age at menarche was 12.4 years.¹³

The frequency distribution of participants in our study according to their BMI showed that the majority belonged to the underweight category 148 (53.62%) while 115 (41.67%) belonged to the normal BMI, and 13 (6%) belonged to the overweight category, respectively with a mean BMI of 18.66 kg/m². None of the participants was found to be obese. However, a study by Dars reported 69% participants in normal BMI category, 27% in underweight and only 4% in overweight category.¹¹ The mean BMI in their study was 19.65±2.41 kg/m².

It was observed that out of 276 participants, 186 (67.39%) had regular cycles while 90 (32.60%) reported irregular menstrual cycles. In terms of menstrual duration, most of the adolescent girls 257 (93.1%) experienced a normal duration, with only a few reporting short or prolonged periods. When considering menstrual flow, the highest proportion of participants 211 (76.4%) reported a moderate flow, followed by those with heavy flow, 47 (17.0%), and a smaller number with light flow, 18 (6.5%). Regarding dysmenorrhea, more than half of the respondents experienced moderate pain 151 (54.7%), while no pain or mild pain 66 (23.9%) was reported by 66 (23.9%) girls and severe pain was experienced by the rest 59 (21.4%) girls.

Lakkawar conducted a similar study on 200 medical students and reported 71% girls with normal cycles and 29% with abnormal cycles. The mean duration of the cycle was reported to be of 4.25±0.5 days. Moderate blood loss was reported by 79% of correspondents, 5% had heavy blood loss and 10.5% had scanty flow. Dysmenorrhea ranged from mild to moderate degree in 46% and of severe degree in 30% of the participants.¹⁴ These findings were similar to those noted in our study.

Comparison of various categories of BMI with the onset of menarche in our study reflected that all the overweight girls attained menarche before 12 years as compared to the underweight and normal BMI girls and the association was found to be statistically highly significant. This observation aligns with the study conducted by Marques et al.¹⁵ In their study, 37.3% of the females who had their menarche before 12 years of age were overweight whereas only 18.5% of those who had their menarche after 12 were overweight.

Menstrual regularity showed a significant association with BMI in our study. A higher percentage of underweight (68.24%) and normal BMI (73.04%) participants reported regular menstrual cycles, whereas 92.31% of overweight participants experienced irregular cycles. The association between BMI and menstrual regularity was statistically highly significant. Similarly in a study conducted by Agrawal et al irregular menstrual cycles were found to be significantly higher in overweight girls as compared to underweight and normal BMI participants.¹⁶

The majority of participants across all BMI categories in our study group reported a normal duration of menstruation and the duration of menstrual flow did not show a statistically significant association with BMI. The lack of significance in this parameter indicates that duration of menstruation may be influenced more by individual physiological or genetic factors than by body weight alone.

In the present study, the amount of menstrual flow was found to be significantly associated with overweight BMI. Heavy menstrual bleeding was reported among 69.23% of overweight participants, whereas moderate flow was found in 78.38% of underweight and 80.0% in normal BMI groups. Itriyea also found obesity in adolescence to be associated with greater menstrual cycle irregularity and the polycystic ovary syndrome (PCOS), which can result in infrequent or absent menstrual periods, and heavy menstrual bleeding.¹⁷

Dysmenorrhea did not show a statistically significant association with BMI in the present study. Although moderate pain was more commonly reported across all BMI categories, the distribution of pain severity did not differ significantly. This suggests that menstrual pain may be influenced by factors other than BMI, such as prostaglandin levels, pain perception, stress, and lifestyle factors.

CONCLUSION

Adolescent girls with higher BMI tend to attain menarche earlier and are more likely to experience irregular cycles and heavier menstrual flow. On the other hand, menstrual duration and the severity of menstrual pain do not appear to be strongly affected by body weight. Both undernutrition and overnutrition can affect hormonal balance, making BMI management an important aspect of

menstrual health education for adolescents. Increasing the understanding of menstrual patterns among adolescents, clarifying their ignorance and encouraging them to seek timely medical care is essential. Overall, maintaining a healthy weight from early adolescence plays an important role in supporting regular and healthy menstrual cycles and also has a positive impact on future fertility.

The strength of this study is that it addresses an important reproductive health issue affecting adolescent girls with special focus on modifiable risk factors like BMI. Seminars conducted during survey also increased awareness regarding menstruation among the participants.

We would like to recommend that health education sessions on menstrual hygiene, menstrual pattern and warning signs should be regularly conducted in schools to create awareness and abolish taboos among adolescent girls. Similarly nutritional counselling, promotion of maintaining a healthy lifestyle, regular physical exercise and stress management should be emphasized from early age. Early diagnosis and referral to healthcare professionals for persistent menstrual related problems can prevent serious reproductive and endocrine complications in future.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Mahalle J, Bhuyar S, Deotale M. Assessing impact of BMI on menstrual patterns in adolescent girls in an urban area of Amravati district, Maharashtra, India. Int J Reprod Contracept Obstet Gynecol 2026;15:3078-83.