Section: Physiology

Original Research Article

A STUDY ON THE CORRELATION BETWEEN BODY MASS INDEX AND THE AGE AT MENARCHE AMONG YOUNG FEMALES.

Aagy Susan Joseph[1], Seema Bhorania[2], Jiya Michael[3]

[1]*Assistant Professor, Department of Physiology, Believers Church Medical College Hospital, Thiruvalla, India.*
[2]*Professor, Department of Physiology, Topiwala National Medical College, Mumbai, India.*
[3]*Associate Professor, Department of Physiology, Believers Church Medical College Hospital, Thiruvalla, India.*

Received *: 06/01/2025*
Received in revised form *: 23/02/2025*
Accepted *: 11/03/2025*

Corresponding Author:
Dr. Aagy Susan Joseph,
Assistant Professor, Department of Physiology, Believers Church Medical College Hospital, Thiruvalla, India.
Email: aagyjoseph@gmail.com

DOI: 10.70034/ijmedph.2025.1.250

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (1); 1341-1345

ABSTRACT

Background: The altering trend observed in the age at menarche among girls is being globally addressed. Researchers from over the world continue to intrigue the relationship of anthropometric measurements to menarcheal age. The timing of menarche is influenced by genetics, social status and nutritional status (e.g., height, weight and body mass index [BMI]) and impacts future health (e.g., obesity and breast cancer). A high or low BMI can be a risk factor for menstrual disorders including irregular menstrual cycles, absence of menstruation and menstrual pain. The study aims to evaluate the correlation between BMI and the age at menarche among young females and to determine the correlation with the length of the cycle and duration of the menses.

Materials and Methods: A cross-sectional study was conducted among 90 randomly selected female medical students who gave history of regular menstrual cycle. Data on age at menarche, duration of menses, length of the cycle, history of dysmenorrhea, were collected using a questionnaire. Height and weight were assessed, and BMI was calculated. Subjects were classified into four groups, underweight (<18.5), normal (18.5 - 24.99), overweight (25 - 29.99), obese (≥30) according to WHO standards. Data was analysed and presented as mean, median, and standard deviation. Statistical analysis was done using SPSS software. A P value <0.05 was considered significant.

Results: The mean age of attaining menarche among the study participants was 12.50±1.432 years. Based on the BMI distribution, the majority of participants had a normal BMI category of 45 (50%) with mean BMI of 22.29±5.019. The mean BMI increased while the mean age of attaining menarche decreased (p<0.001). The menstrual cycle length was significantly prolonged while the duration of cycle was significantly reduced in overweight and obese groups in comparison with normal BMI class (p<0.05).

Conclusion: The present study suggests that females with higher BMI had an early menarche. The study also reveals that as BMI increases, females tend to have a longer menstrual cycle with shorter duration of menses. Consequently, adolescent girls have to be given healthy and balanced nutrition, which leads to maintenance of their normal BMI and regulates their menstrual cycle.

Keywords: Body Mass Index, Menarche, Menstrual Cycle, Correlation.

INTRODUCTION

Menstruation is one of the most important changes during adolescent years. It occurs once a month as a regular rhythmic period and remains as a normal physiological phenomenon from menarche to menopause.[1] Menstrual disorders are frequent among adolescent girls as they are closely coupled with the processes involved in the pubertal development of females. The menstrual cycle is an essential indicator of a women's reproductive health and of her endocrine functions.[2] Age at menarche seems to be associated with menstrual patterns. The mean age at menarche varies from one setting to

another and is known to be a sensitive indicator of various characteristics of population including nutritional status, geographical location, environmental conditions, psychological factors, socioeconomic status, body weight and height, nutrition, body fat and exercise.[3] Genetic factors probably account for approximately 10% to 15% of the observed variation in age at menarche while nutritional status is one of the most important non genetic determinant.[4] The rate of decline in the age of menarche is about 2–3 months per decade in developed countries and 6 months per decade in developing countries. The prevalence of overweight, obesity and abdominal obesity are increasing among people aged 15 years or older. This finding has been attributed to an increased standard of living among the population.[5] The percentage of fat in the human body can be predicted by using the Body Mass Index (BMI). Fat is one of the compounds in the body that has an influence in the production of androgens and estrogens, where one of the dominant factors causing menstrual disorders is the hormone estrogen. Estrogen levels that continue to increase indirectly can cause androgen hormones to increase. An increase in the androgen hormone level can interfere with follicular development so that follicular maturation cannot occur. A limited mass of fat in the body can also cause levels of the androgen hormone to be aromatized into the hormone estrogen to decrease, thereby causing irregular menstrual cycles.[6,7] Age at menarche appears to have been declining in recent decades in western industrialized countries because of several plausible factors one of which is the increasing rates of childhood obesity which has been postulated to be the prime factor. Girls who have their first menstruation earlier tend to have shorter and more irregular menstrual cycles, bleeding between cycles, and are at a higher risk of suffering from primary dysmenorrhea.[8] Early age at menarche has been linked to several adverse health effects during childhood such as eating disorders and depression; and during adulthood such as type 2 diabetes, metabolic syndrome, breast cancer, cardiovascular disease and overall mortality.[9] Estimating age at menarche is also critical for patient education and may guide the clinical evaluation to identify deviations from normal. The changing trends in the prevalence of childhood obesity, early puberty and menarche, and ethno-racial differences in the effect of BMI on the reproductive characteristics of young females around the world, warrant continuous evaluation.[10] Some studies observed that younger age at menarche is related to higher BMI. This association is controversial; however, obesity during adolescence is associated with earlier menarche. Many studies have been conducted earlier to address the problems related to menstrual abnormalities in young students, yet few reports are available on the relationship between menstrual problems and BMI.

MATERIALS AND METHODS

Study design and settings

The present study was a cross sectional study conducted in the Department of Physiology at Topiwala National Medical College, after obtaining institutional ethical clearance certificate. It was done among 90 randomly selected second and third year female MBBS students. Experiment protocol was explained to all the subjects and written informed consent was obtained.

Inclusion Criteria

- Female students of age more than 18 years who had given written informed consent were included in the study.
- Healthy females who have a regular menstrual cycle were included.

Exclusion Criteria

- First year MBBS students.
- Subjects on oral contraceptive pills or any hormone replacement therapy.
- History of smoking, alcohol or drug addiction.

The subjects found eligible for the study were given a questionnaire to collect information regarding their age in completed years, age at Menarche, duration of menses, length of the cycle, history of dysmenorrhea.

Measurement of Anthropometric Parameters

Anthropometry measurements were obtained in subjects wearing light clothes and bare feet.

Weight – It was measured by using Krup's weighing machine with light clothing and without shoes. Body weight was recorded in Kg on empty bladder and before lunch on a standard weighing scale. The weight measurement was recorded to nearest 0.1 Kg.

Height – The subjects were asked to stand against the wall on which a measuring scale was inscribed. While taking the reading, they stood barefoot on a flat floor with feet closed and parallel to each other with heels, buttocks, occiput touching wall firmly. Head was held erect and subjects were asked to look at the front. Highest point on the vertex was marked on the wall by a ruler and then height was measured to nearest 0.1 cm.

Body Mass Index (BMI) – BMI was calculated from quetelet's index.

BMI = Weight in Kg / (Height in meter)^2

Subjects were classified into four groups based on their BMI according to WHO standards.

BMI	Class
< 18.5	Underweight
18.5 – 24.99	Normal
25 – 29.99	Overweight
>30	Obese

Statistical Analysis: Data was analysed and presented as mean, median, standard deviation. Statistical analysis was done using SPSS software. Chi square test was performed for analysis of statistical relationship between BMI and menstrual

parameters like the age at menarche, duration of menses and length of cycle. A p-value of < 0.05 was considered statistically significant.

RESULTS

The range of research subjects was 18 to 20 years and was dominated by the age of 19 years amounting to 55(61.1%) participants. (Table 1) Based on the BMI distribution, it can be seen that the majority of research subjects had a normal BMI category of 45 (50%). Almost 20(22.2%) were having low BMI, which implies that the girls were undernourished. (Table 2) The age of onset of menarche ranged from 9 years to 16 years. The mean length and duration of menstrual cycle among the study participants was 29.78±2.796 and 4.24±1.006 respectively. (Table 3) As the mean BMI increased, the mean age of attaining menarche in the study participants decreased and this difference was considered statistically significant (p<0.001). The menstrual cycle length was significantly prolonged in over- weight and obese groups, 30.44±3.812 and 33.22±1.986 respectively when compared to normal and under- weight groups, 29.49±2.312 and 28.35±1.663 respectively. The duration of cycle significantly reduced in over-weight and obese groups, 3.97±0.939 and 3.44±0.882 respectively when compared to normal and under- weight groups, 4.56±1.056 and 4.10±0.718 respectively. There was significant alteration in menstrual cycle length and duration of cycle when compared with mean BMI with p<0.001 and 0.004 respectively. (Table 4)

Table 1: Distribution of subjects based on age

Age (Years)	Frequency N=90	Percentage (%)
18	13	14.4
19	55	61.1
20	22	24.4

Table 2: Distribution of subjects based on BMI

BMI	Frequency N=90	Percentage (%)
<18.5 (Underweight)	20	22.2
18.5 to 24.99 (Normal)	45	50.0
25.0 - 29.99 (Overweight)	16	17.8
≥30 (Obese)	9	10.0

Table 3: Range, mean and SD of demographic and menstrual features

	Minimum	Maximum	Mean	Std. Deviation
Age	18	20	19.10	0.619
BMI	14.6355	35.2095	22.290247	5.0189987
Age of Menarche in years	9	16	12.50	1.432
Length of the cycle	24	36	29.78	2.796
Duration of the cycle	2	6	4.24	1.006

Table 4: Comparison of demographic and menstrual features with BMI classes

BMI class		Age	BMI	Age of Menarche (years)	Length of the cycle	Duration of the cycle
<18.5 (n=20)	**Mean**	19.05	17.199275	14.30	28.35	4.10
	SD	0.686	1.0393453	00.923	1.663	0.718
	Median	19.00	17.378973	14.00	28.00	4.00
18.5 to 24.9 (n=45)	**Mean**	18.93	20.702101	12.53	29.49	4.56
	SD	0.495	1.3368773	0.815	2.312	1.056
	Median	19.00	20.545694	13.00	30.00	5.00
25.0 - 29.99 (n=16)	**Mean**	19.19	26.798885	11.31	30.44	3.97
	SD	0.655	1.3746028	0.602	3.812	0.939
	Median	19.00	26.370238	11.00	30.00	4.00
≥30 (n=9)	**Mean**	19.89	33.528890	10.44	33.22	3.44
	SD	0.333	1.6033743	0.882	1.986	0.882
	Median	20.00	33.606385	10.00	33.00	3.00
p value		**0.073**	**0.316**	**<0.001**	**<0.001**	**0.004**

DISCUSSIONS

Menstruation is one of the most important changes during adolescent years. It occurs once a month as a regular rhythmic period and remains as a normal physiological phenomenon from menarche to menopause. It is considered as an indicator of women's health, so adolescent girls need to have an understanding of menstruation patterns and the factors that may contribute to menstrual disorders or

changes such as age, activities, and BMI. It is essential to increase their understanding of menstruation, appropriate management for it, and clarify the ignorance of menstruation issues.[11] The age range of the study participants was 18 to 20 years and with the majority at the age of 19 years in 55(61.1%) participants. The mean age was 19.10±0.619. Age of onset of menarche is generally between 11 and 15 years. Slight variations in the age of menarche may occur depending on their hereditary pattern and nutritional status. In the present study, the age ranged from 9 to 16 with the mean age of 12.50±1.432 years. The mean age at menarche among adolescent girls of urban and rural schools in the study conducted by Biradar AM et al,[12] was about 13.6 ± 1.2 years. Mean age of participants was 20.7 years and at mean age of 12.5 years they attained menarche in the study done by Kharb A et al,[13] Asrullah M et al,[14] observed that the age at menarche has significantly declined from 14.4 years of age in the 1940s to 13.4 in the 1990s. The study also found that age at menarche was inversely associated with BMI (β: -0.30 kg/m2, 95%CI: -0.37, -0.22). Based on the BMI distribution, the majority of participants had a normal BMI category of 45 (50%) with mean BMI of 22.29±5.019. Biradar AM et al,[12] found that 48.3% of the study participants had normal BMI; however, 29.8%, 15.4%, 5.8% and 0.7% were underweight, severely underweight, overweight, and obese respectively. Fat accumulation alters many endocrine functions which are alleged to affect the speed of sexual puberty (Leptin, GnRH). Research revealed that females with higher BMI tend to have anovulatory cycle (Insulin, Sex hormone binding globulin, Estrogen). Obesity was also associated with a chronic systemic inflammatory response that also affects ovarian function.[11] In the present study as the mean BMI increased, the mean age of attaining menarche in the study participants decreased and this difference was considered statistically significant (p<0.001). Similar study by Kharb A et al,[13] found that girls who had either low or high BMI attained menarche at a higher age, but the difference was not significant (p = 0.142). Marques P et al,[15] observed that the girls who had reached menarche, in particular those aged 13–14 years, were significantly taller (p < 0.01) and had higher BMI (p < 0.01) than girls in the same age group who had not reached menarche. The menstrual cycle length was significantly prolonged in over- weight and obese groups while the duration of cycle was significantly reduced in over- weight and obese groups in comparison with BMI classes this was considered significant (p<0.05). Alam T et al,[16] in their study found that the age at menarche was significantly early in overweight and obese groups and the menstrual cycle length and duration of menses was significantly prolonged in overweight and obese groups when compared to control as well as under- weight groups. This was comparable to the present study. Singh M et al,[17] in their study when assessed for duration of menstrual cycle and duration (days) blood flow and intermenstrual period were negatively associated with subjects with BMI <18.5 and these observations were statistically significant. In contrast to the present study, Marques P et al. found no significant association between BMI and menstrual cycle variables. Similarly, Tang Y et al,[18] also found no significant differences in the length of menstrual cycles and menses in women of different BMI groups. In their study by Dehkordi SJ et al,[19] the association between age at menarche and height (p<0.001) and weight (p=0.007) were significant, while there was no relationship between age at menarche and body mass index (p=0.91).

CONCLUSION

BMI plays a very vital role for menstrual cycle regularity. Irregular menstrual cycles including the length of cycles and menses, and heavy menstrual blood loss are linked to many gynaecological diseases. Obesity has been reported to be associated with irregular menstrual cycles. Consequently, adolescent girls have to be given healthy and balanced nutrition, which leads to maintenance of their normal BMI and regulates their menstrual cycle.

Financial support and sponsorship: Nil

Conflicts of interest: There are no conflicts of interest.

REFERENCES

1. Johnston-Robledo I, Chrisler JC. The menstrual mark: Menstruation as social stigma. The Palgrave handbook of critical menstruation studies. 2020:181-99.
2. Shea AA, Vitzthum VJ. The extent and causes of natural variation in menstrual cycles: Integrating empirically-based models of ovarian cycling into research on women's health. Drug Discovery Today: Disease Models. 2020 Dec 1; 32:41-9.
3. Leone T, Brown LJ. Timing and determinants of age at menarche in low-income and middle-income countries. BMJ Global Health. 2020 Dec 1;5(12):e003689.
4. Lui JC, Palmer AC, Christian P. Nutrition, Other Environmental Influences, and Genetics in the Determination of Human Stature. Annual Review of Nutrition. 2024 May 17;44.
5. Eckert-Lind C, Busch AS, Petersen JH, Biro FM, Butler G, Bräuner EV, Juul A. Worldwide secular trends in age at pubertal onset assessed by breast development among girls: a systematic review and meta-analysis. JAMA pediatrics. 2020 Apr 1;174(4):e195881-.
6. Wawrzkiewicz-Jałowiecka A, Lalik A, Soveral G. Recent update on the molecular mechanisms of gonadal steroids action in adipose tissue. International Journal of Molecular Sciences. 2021 May 14;22(10):5226.
7. Bianchi VE, Bresciani E, Meanti R, Rizzi L, Omeljaniuk RJ, Torsello A. The role of androgens in women's health and wellbeing. Pharmacological research. 2021 Sep 1; 171:105758.
8. Núñez-Troconis J, Carvallo D, Martínez-Núñez E. Primary Dysmenorrhea: pathophysiology. Investigación Clínica. 2021 Dec 1; 4:378-406.
9. Cheng TS, Ong KK, Biro FM. Adverse effects of early puberty timing in girls and potential solutions. Journal of

Pediatric and Adolescent Gynecology. 2022 Oct 1;35(5):532-5.
10. Tenedero CB, Oei K, Palmert MR. An approach to the evaluation and management of the obese child with early puberty. Journal of the Endocrine Society. 2022 Jan 1;6(1):bvab173.
11. Adyani K, Fannanah M, Realita F. Factors that Influence the Decrease in Age at Menarche: Literature Review. Jurnal MID-Z (Midwifery Zigot) Jurnal Ilmiah Kebidanan. 2024 May 31;7(1):1-0.
12. Biradar AM, Yaliwal RG, Kori SS, Sangolli LS, Shirgur SS, Mathapati SS. A Prospective Cross-Sectional Study to Assess the Association of Age of Menarche with Body Mass Index in Adolescent Girls of Urban and Rural Schools of Vijayapura, North Karnataka. Journal of Krishna Institute of Medical Sciences (JKIMSU). 2020 Jul 1;9(3).
13. Kharb A, Dey R, Singh VK. Correlation of Body mass index with premenstrual syndrome and age at menarche in medical students. National Journal of Physiology, Pharmacy and Pharmacology. 2022;12(1):30-3.
14. Asrullah M, L'Hoir M, Feskens EJ, Melse-Boonstra A. Trend in age at menarche and its association with body weight, body mass index and non-communicable disease prevalence in Indonesia: evidence from the Indonesian Family Life Survey (IFLS). BMC Public Health. 2022 Mar 31;22(1):628.
15. Marques P, Madeira T, Gama A. Menstrual cycle among adolescents: girls' awareness and influence of age at menarche and overweight. Revista Paulista de Pediatria. 2022 Jan 5;40:e2020494.
16. Alam T, Jiwane R, Choudhary AK, Kishanrao S. Relationship between body mass index (BMI) and the age at menarche among young girls. IOSR Journal of Dental and Medical Sciences [Internet]. 2015 Jul:79-83.
17. Singh M, Rajoura OP, Honnakamble RA. Menstrual patterns and problems in association with body mass index among adolescent school girls. Journal of family medicine and primary care. 2019 Sep 30;8(9):2855-8.
18. Tang Y, Chen Y, Feng H, Zhu C, Tong M, Chen Q. Is body mass index associated with irregular menstruation: a questionnaire study?. BMC women's health. 2020 Dec; 20:1-6.
19. Dehkordi SJ, Amiri M, Kheiri S, Lotfizadeh M. The association between age at menarche and anthropometric factors. Journal of Multidisciplinary Care. 2024 Mar 15;12(4):183-8.