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Relationship between Body Mass Index (BMI) and the Age at Menarche among Young Girls

Tanwir Alam[1], Rekha Jiwane[2],Arbind Kumar Choudhary[3*],
SadawarteSahebrao Kishanrao[4].
[1,2,3,4]*Department of Physiology, People's College of Medical Sciences and Research Centre, Bhopal.*
***Corresponding author:**Dr.Arbind Kumar Choudhary
Assistant Professor
Email: arbindchoudhary111@gmail.com
Ph: 8435969782, 07555131, Fax: 07554005112

Abstract: *The prevalence of childhood obesity, early menarche and racial differences in the effect of BMI on the reproductive characteristics of young females are showing a changing trend globally, that needs to be continuously evaluated.This study intends to determine the relationship between age at menarche and anthropometric measurements BMI among adolescent girls in Bhopal region. The present study was carried out on healthy female students of MBBS First year (n=50) in the age group of 18-25 years with regular menstrual cycle. The subjectswere classified into 4 groups, normal (n=25,BMI=18.50-25Kg/m^2), underweight (n=5, BMI≤ 18.50Kg/m^2),overweight (n = 11, BMI=25-30Kg/m^2) and obese(n=9, BMI≥30 Kg/m^2).The present study showed thatthe age at menarche was significantly prolonged in under-weight group when compared to control over-weight and obese groups and it was significantly early in over-weight and obese groups when compared to control and under- weight group. The menstrual cycle lengthandduration of menses was significantly prolonged in over weight and obese groups when compared to control as well as under- weight groups. However there was significant alteration between normal and underweight group.This study suggests that there is an inverse association between age at menarche and obesity or overweight. Girls with higher BMI experience significantly longer menstrual cycle and menses compared to their normal weight counterparts.The relationship between BMI and age at menarche occurs regardless of socio-economic status.In cases of better nutrition and more weight (Obese) the mean age at menarche is earlier as compared to cases of under-nutrition and less weight.*
Key word: *Body mass index(BMI), Menarche, Menstrual cycle, Nutrition.*

I. Introduction

Menstrual cycle is a repetitive phenomenon occurring during the reproductive life of a female that involves structural, functional and hormonal changes in the reproductive system. The active reproductive life of female starts with the onset of this cyclical phenomenon that is menarche and ceases with the onset of menopause. Menstruation is caused by the reduction of estrogen and progesterone, especially progesterone at the end of the monthly ovarian cycle and influenced by the gonadotrophins through the hypothalamo-pituitary activity [1]. Menarche is an important milestone in the development of female adolescent unlike otherpubertal changes that are gradual and continuous menarche is a distinct event with a sudden and dramatic onset. It is considered a distinct benchmark for sexual maturation. It is also considered as an indicator of quality of life of a population since a number of biological & socio-economic factors influence[2].The average age at menarche ranges from 12 – 15 years among different populations [3].It is a sensitive marker of various population indices including diet patterns, socioeconomic status, geographical location and environmental conditions [4]. High BMI (obesity) in childhood has been linked to the risk of early onset of puberty and menarche [5]. This has been identified as the prime factor in the decline in the onset of puberty and eventually menarche in industrialized nations and other regions with improving nutritional and socioeconomic statuses. 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 [6]. Hence, we aim to investigate possible variations in the influence of BMI on the age at menarche as well as duration of menstrual cycle and menses in young girls in central India Bhopal.

II. Materials And Methods

The present study was carried out on healthy female students of MBBS First year (n=50) in the age group of 19-25 years with regular menstrual cycle. Subjects with irregular cycles, gynecological disorders, anemia, history of drug intake affecting menstrual cycle or history of chronic diseases will be excluded from the study. Study protocol will be explained to the subjects and informed consent will be taken from each of them

Cross-sectional data on age of menarche and duration of menstrual cycle and other relevant details were obtained through self-administered questionnaires. Ethical clearance was taken to perform this study in the department of Physiology of People's College of Medical Science and Research Centre, Bhopal (PCMS/OD/2015/1069; IEC-2015/3).

Measurement of anthropometric parameters

1. Height (m): It is measure with subject without shoes .The heels are placed together with buttocks, scapula, and head is positioned in contact with the vertical bar.
2. Body weight (Kg): is record by weighing scale with the subject without shoes with empty bladder.
3. Waist circumference (cm) measured in standing position with arms at sides, done with minimal clothing with tailors measuring tape to the nearest 0.1 cm in a perpendicular to the long axis immediately superior to iliac crest.
4. Hip circumferences (cm): measures in standing position with minimal clothing's by measuring tape to the nearest 0.1 cm at maximal extension of at the level of trochanter.

Measurement of Body mass index (BMI): BMI was calculated by BMI = weight (kg)/height (m^2).According to WHO recommendation [7]; Groups are classified as

Group 1 - Normal (n=25, BMI=18.50-25Kg/m^2),
Group 2 - Underweight (n=5, BMI≤ 18.50Kg/m^2),
Group 3- Overweight (n = 11, BMI=25-30Kg/m^2) and
Group 4- Obese (n=9, BMI≥30 Kg/m^2).

Statistical analysis

Data are expressed as Mean ± standard deviation (SD) and each parameter had six observations. All data were analyzed with the SPSS for windows statistical package (version 20.0, SPSS Institute Inc., Cary, North Carolina. Statistical significance between the different groups was determined by one way-analysis of variance (ANOVA) followed by Tukey's multiple comparison tests when the groups showed significant difference and the significance level was fixed at $p< 0.05$.

III. Results

Effect of body mass index (BMI) on age at menarche

The data are summarized in (Figure: 1) with mean ±SD.The age at menarche was significantly prolonged in under-weight group when compared to control , over- weight and obese groups and it was significantly early in over-weight and obese groups when compared to control and under- weight group. However, there was significant alteration in age of menarche between obese and over- weight group.

Effect of body mass index (BMI) on menstrual cycle length

The data are summarized in (Figure: 2) as mean ± SD. There was no any significant alteration in menstrual cycle lengthamongunder- weight groups and control groups. The menstrual cycle lengthwas significantly prolonged in over- weight and obese groups when compared to control as well as under- weight groups. However there was significant alteration in menstrual cycle length between normal and under- weight group.

Effect of body mass index (BMI) on duration of menses

The data are summarized in (Figure: 3) as mean ± SD. The duration of menses was similar between control and under- weight groups. The duration of menses was significantly prolonged in over- weight and obese groups when compared to control as well as under- weight groups. However there was significant alteration in duration of menses between normal and under- weight group.

IV. Discussion

Our results confirm the findings of other previous studies. AL-Awadhi N et al [8]conducted a cross-sectional study on adolescent girls in Kuwait and reported an inverse association between age at menarche and obesity or overweight .This study found that there was gradual decrease in the age of menarche in case of over-weight and obese girls, lowering of age at menarche with an increase in weight isalso observed by Raji et al [9] and Goon et al [10] in Nigeria, Trentham-Dietz et al[11], Bagga and Kulkarni [12] in India, . In this study, wealso investigated the influence of BMI on the age at menarche as well as the duration of menstrual cycle in young girls in Central India. There was significant difference observed in the age at menarche between the over-weight, under-weight and obese subject. The association between high BMI, menstrual cycle length and menses was statistically significant. The median age at menarche is 14 years (11–18 years) worldwide [13].Previous

studies have shown a distinct inverse association between early pubertal development, age at menarche and BMI. Girls with higher BMI attain menarche earlier than their normal weight counterparts [14]. In accordance with these observations; we observed a similar relationship between BMI and age at menarche that was statistically significant. The mean age at menarche for the underweight subjects in the present study was lower than that of subjects with normal weights. This is similar to findings by other authors in Nigeria [9, 10]and other countries [11].Tunau et al [15] reported age at menarche of 15.32 years among rural secondary school girls in Sokoto. This may be much higher than the found in the present study because their subjects had a comparably lower mean weight as against the present study. We observed no significant difference in the menstrual cycle length and duration of menses between the normal and under-weight participants. Girls with higher BMI experience significantly longer menstrual cycle and menses compared to their normal weight counterparts. The effect of BMI on age at menarche and the relationship between early onset of menarche and the duration of menstrual cycles and menses later in life may not be causal. These associations may be modified by ethnoracial differences. Further investigations may resolve these differences in relation to the reproductive characteristics of young [16]. Pejhan A[17] conducted a study for establishing the relationship between menarche age and anthropometric indices of girls in Sabzevar, Iran, and found that the menarche age and body mass index are significantly related, the higher the BMI, the lower was the menarche age. Body fat and obesity influence the menstrual cycle leading to cycle irregularities [18]. Overweight and obese young females are at a greater risk of experiencing longer and infrequent periods [19]. High BMI and sedentary behaviours may influence the level and equilibrium of endogenous hormones required for optimal menstrual function, thus resulting in irregular menstrual patterns [20]. Hormonal factors such as insulin and sex hormone binding globulin (SHBG) may affect the association between obesity and irregular menstrual cycle [21]. Our findings are consistent with the above reports. The overweight and obese participants in this study had a significantly longer average duration of menstrual cycle correlated with prolong menstrual cycle and menses compared to their normal weight counterparts.Wronka [22] reported the inverse correlation between BMI values and age at menarche, while studying the relationship between BMI and age at menarche, considering the socio-economic status of the participants. In groups of the same socio-economic status the highest BMI value was always observed in girls with early age at menarche and the lowest BMI in those with late age at menarche. The maturation rate had also statistically significant effect on the prevalence of underweight, overweight and obesity. The early maturing girls presented a lower prevalence of underweight and higher prevalence of overweight and obesity than average and late maturating girls. The relationship between BMI and age at menarche occurs regardless of socio-economic status. Early age at menarche, together with other indicators of early biological maturity, has been shown to be associated with increased adult BMI [23]. It is acknowledged that the present study had limitations for not assessing variables like socioeconomic profile.

V. Conclusion

This study suggests that there is an inverse association between age at menarche and obesity or overweight. Girls with higher BMI experience significantly longer menstrual cycle and menses compared to their normal weight counterparts.The relationship between BMI and age at menarche occurs regardless of socio-economic status.In cases of better nutrition and more weight (Obese) the mean age at menarche is earlier as compared to cases of under-nutrition and less weight.

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Conflict of interest : The authors declared no conflict of interest.

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Table: Groups and body mass index (BMI) as per WHO recommendation.

	Normal (18.50-25)	**Under weight (≤ 18.50)**	**Over weight (25-30)**	**Obese (≥30)**
BMI(kg/m^2)	21.80±2.75	15.25±2.20^{*a,c,d}	28.52±2.12^{*a,b,d}	36.20±2.50^{*a,b,c}
Age(years)	21.70±2.24	21.45±2.08	21.92±2.60	21.80±2.40
Number of participant	25	5	11	9

Table legend: Classification of groups on the basis body mass index (BMI)as per WHO recommendation. *significance at p≤ 0.05, where, a – compared with normal, b- compared with underweight, c- compared with overweight, d- compared with obese.

Figure: 1

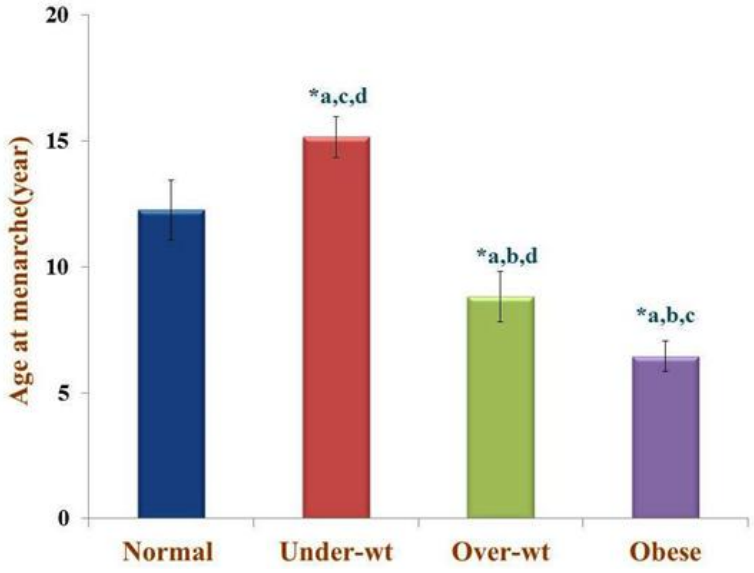

Figure:2

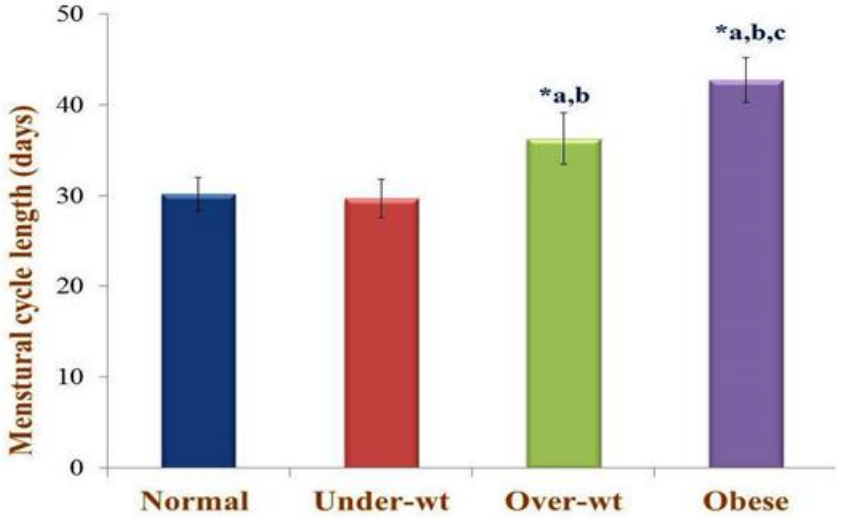

Figure:3

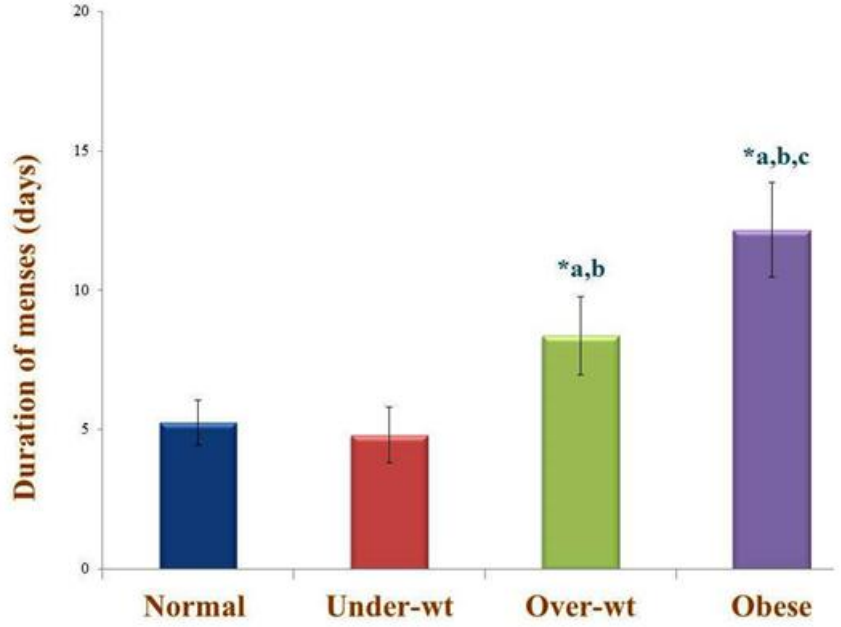

Figure legend

Figure 1: Effect of body mass index (BMI) on age at menarche, *significance at p≤ 0.05, where, a – compared with normal, b- compared with underweight, c- compared with overweight, d- compared with obese.

Figure 2: Effect of body mass index (BMI) on menstrual cycle length, *significance at p≤ 0.05, where, a – compared with normal, b- compared with underweight, c- compared with overweight, d- compared with obese.

Figure 3: Effect of body mass index (BMI) on duration of menses, *significance at p≤ 0.05, where, a – compared with normal, b- compared with underweight, c- compared with overweight, d- compared with obese.