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Changes in Hematological Parameters during Menstruation among Medical Students in Rajshahi: A Cross-Sectional Study

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ABSTRACT: ***Background:*** Menstruation is a universal experience which is under discussed and poorly understood in our country. The aim of this study was to observe the significant differences in the distribution of hematological parameters of the respondents due to coordinated sequential hormonal changes that occurs during menstruation. ***Methods:*** This cross-sectional study was carried out in the Department of Public health, Varendra University, Rajshahi on 120 healthy female medical students with regular menstrual cycle (28±7 days) over a period of 1st January 2023 to 30th April 2023. Hematological parameters were measured by a semi-structured questionnaire. Descriptive statistics, Pearson's correlation statistic and Chi-square tests were applied on the collected data. ***Results:*** Out of 120 respondents, 48 (40.00%) were within the age group of 19-20 years and 56 (46.7%) had experienced menarche at the age of 10-11 years. The mean Hb%, MCV, MCH, MCHC and ESR were 11.7±1.5 gm/dl, 78.7±6.6 Fl, 26.8±3.8 pg, 28.5±4.5 gm/dl and 32.0 mm/hr, respectively. There was statistically significant relationship of menstrual bleeding rate with Hb, MCV, MCHC and ESR level (p=0.021, p=0.021, p=0.003 and p=0.046, respectively). But there was no statistically significant relationship between menstrual bleeding rate and MCH level (p=0.513). ***Conclusions:*** This study was a moderate attempt to determine regular variation in the different hematological parameters among normal healthy female medical students and needs further cyclical evaluation along with hormonal changes to be observed to for clear understanding.

Keywords: Menstruation, Medical Students, Hematological Parameters.

Article at a glance:

Study Purpose: *The purpose of this study was to estimate and observe hemoglobin level, hematocrit, ESR and platelet count of medical students during menstruation.*

Key findings: *The present study showed that mean Hb%, MCV, MCH, MCHC and ESR level were 11.7±1.5 gm/dl, 78.7±6.6 Fl, 26.8±3.8 pg, 28.5±4.5 gm/dl and 32.0 mm/hr, respectively.*

Newer findings: *There was a statistically significant association of menstrual bleeding rate with Hb, MCV, MCHC and ESR levels. However, there was no statistically significant link between menstrual bleeding rate and MCH level (p=0.513).*

INTRODUCTION

The female sexual cycle is a natural change that occurs in the uterus and ovary as an essential part of making sexual reproduction possible. The length of a sexual cycle varies greatly among women (ranging from 21 to 35 days), with 28 days designated as the average length.[1] Each cycle is divided into phases based on events in the ovary (ovarian cycle) or in the uterus (uterine cycle). The ovarian cycle consists of the follicular phase, ovulation and luteal phase, whereas the uterine cycle is divided into proliferative phase (which occur simultaneously with the follicular phase), secretory phase (which occurs simultaneously with ovulation and the luteal phase) and menstruation.[2] Reproduction begins with the development of ova in the ovaries. In the middle of

each monthly sexual cycle, a single ovum is expelled from an ovarian follicle into the endometrial cavity near the open fimbriated ends of the two fallopian tubes. This ovum then passes through one of the Fallopian tubes into the uterus. If it has been fertilized by a sperm, it implants in the uterus where it develops into a fetus, a placenta and fetal membranes- and eventually into a baby. If not fertilized by the sperm, the uterus sheds its inner lining of soft tissue and blood vessels which exits the body from the vagina in the form of menstrual fluid.[1]

Menstruation is the cyclical and rhythmic change that occurs during the reproductive life of a post pubescent female. It occurs due to fertilization failure after ovulation and involves the dismantling and shedding of endometrium which is elaborately prepared for the growth of a fertilized ovum. Menstrual bleeding also refers to the rhythmic outflow of blood from the vagina as a result of release of the uterine endometrial lining and occurs monthly in a mature female when fertilization does not occur.[3] The characteristic rhythmic changes in the rate of secretion of ovarian hormones produce corresponding changes not only in the reproductive system but in other organ systems as well. It has also been now recognized that important systemic as well as hematological changes are accompanying the various phases of the menstrual cycle.[4] The naturally occurring cyclic and rhythmic fluctuations in the levels of hormones like progesterone, estrogen, luteinizing and follicle stimulating hormones during the MC not only affect oocyte maturation, the endometrial and vaginal environment but are also interrelated with multiple changes in the female body both biochemically and physiologically.[5] These fluctuations largely affect the hemoglobin concentration, platelet count and other hematological parameters.[6] Prolonged and excessive bleeding lead to more blood loss (> 80 ml) may cause anemia, making it necessary to estimate red blood cells (RBC), hemoglobin and erythrocyte sedimentation rate (ESR).[7] Numerous studies have been undertaken to examine the changes in various types of blood cell counts and hormonal profile in MC but the results have been variable and contradictory. A high incidence of menstrual problems has been observed in students studying medicine and health sciences.[6, 8, 9] The present study was aimed to analyze and assess the impact of menstruation on hematological parameters.

METHODS

The study was conducted over a period of 4 months from 1st January 2023 to 30th April 2023 in the Department of Public health, Varendra University, Rajshahi. A total of 120 female students at different medical colleges of Rajshahi were approached for the inclusion of the study. Adequate history was taken, and they were informed about the study. Consecutive purposive sampling was followed during sample selection. Before final inclusion of the study, formal permission (informed written consent) was taken from each subject. Before the consent, they were clearly informed about the titles, study aim and objectives, procedure, benefits and potential danger of the study. Moreover, they were informed that they would not get any financial benefits from taking part in the study and that participating would not be a barrier to their current management. Besides, they could withdraw themselves any time of the study period. They were also informed that data handling was done with maintaining proper confidentiality and no data was disclosed other than researcher and guide or educational purpose. During the interview of the patients, age, sex, social status, economic and education status, medical history and type of treatment (if any) were obtained from participants. The researcher conducted the whole interview and collected data that were recorded into a pre-designed separate case record form. After completion of the data collection, data analysis was done in the statistical software (SPSS).

RESULTS

Table 1: Sociodemographic Characteristics of the Respondents (n=120).

Variables	Categories	Frequency	Percentage (%)
Age	19-20	48	40.0%
	21-22	44	36.7%
	23-24	20	16.7%
	>24	8	6.7%
Age of Menarche (years)	10-11	56	46.7%

	12-13	52	43.3%
	>13	12	10.0%
Residential Status	Urban	72	60.0%
	Rural	48	40.0%
Living Situation	With family	36	30.0%
	In hostel	84	70.0%

A large portion of 48 (40.00%) of the respondents were within the age group of 19-20 years followed by 21-22 years 44 (36.7%), 23-24 years 20 (16.7%) and > 24 years 8 (6.7%). 56 (46.7%) of the respondents had experienced menarche at the age of 10-11 years, 52 (43.3%) at the age of 12-13 years and 12 (10.0%) at the age of > 13 years. Residential status revealed that 72 (60.0%) of the respondents were from urban areas and 48 (40.0%) from rural area. The living situations of the respondents showed that 84 (70.0%) resided in hostels and 36 (30.0%) with their families (Table 1).

Table 2: Menstruation Related variables of the respondents (n=120).

Variables	**Categories**	**Frequency**	**Percentage (%)**	
Menstrual flow	Heavy	24	20.0%	
	Moderate	68	56.7%	
	Light	28	23.3%	
Duration of menstrual cycle				30.8±4.3
Duration of menstrual period				5.1±1.0
Menstrual hygiene product	Menstrual underwear	8	6.7%	
	Cloths	4	3.3%	
	Tampons	8	6.7%	
	Menstrual cups	0	0%	
	Sanitary napkin	104	86.7%	
Frequency of changing pads	< 6 hours	24	20.0%	
	6-8 hours	60	50.0%	
	> 8 hours	36	30.0%	
Premenstrual syndrome	Tiredness	72	60.0%	
	Trouble sleeping	24	20.0%	
	Headache	32	26.7%	
	Bloating/abdominal pain	64	53.3%	
	Breast tenderness	32	26.7%	
	Feeling upset	48	40.0%	
Use of relieving menstrual pain	Painkiller	24	20.0%	
	Natural remedies	16	13.0%	
	Nothing	80	67.0%	

Out of 120 respondents, 68 (56.7%) were identified as having moderate flow followed by heavy flow 24 (20.0%) and light flow 28 (23.3%) with mean duration of menstrual cycle and period were 30.8±4.3 days and 5.1±1.0 days, respectively. Among the participants, sanitary napkins were used by 104 (86.67%) respondents followed by menstrual underwear and tampons 8 (6.67%) individually and cloths 4 (3.33%). 60 (50.0%) of the participants changed pad 6 to 8 hourly followed by less than 6 hourly 24 (20.0%) and exceeding 8 hourly 36 (30.0%). Tiredness 72 (60.0%) was the most prevalent symptom followed by bloating/ abdominal pain 64 (53.3%), feeling upset 48 (40.0%), headache 32 (26.7%), breast tenderness 32 (26.7%) and trouble sleeping 24 (20.0%). For relieving menstrual pain, 80 (67.0%) used nothing, 24 (20.0%) used painkiller and 16 (13.0%) natural remedies (Table 2).

Table 3: Distribution of the participants by Hb%, MCV, MCH, MCHC and ESR (n=120).

Parameter	Mean	Std. Deviation	Minimum	Maximum
Hb% (gm/dl)	11.7	1.5	9.2	14.2
MCV (Fl)	78.7	6.6	63.0	95.2
MCH (pg)	26.8	3.8	19.5	32.0
MCHC (gm/dl)	28.5	4.5	13.7	35.0
ESR (mm/hr)	32.0	14.8	15.0	65.0

The mean Hb%, MCV, MCH, MCHC and ESR were 11.7±1.5 gm/dl, 78.7±6.6 Fl, 26.8±3.8 pg, 28.5±4.5 gm/dl and 32.0 mm/hr, respectively (Table 3).

Table 4: Correlations of Age of Menarche, Duration of Menstrual Cycle & Menstrual Period and Requirement of Sanitary Napkin Per Day (n=120).

Variables	Correlations	Age of menarche	Duration of menstrual cycle	Duration of menstrual period
Duration of menstrual cycle	Pearson Correlation	-0.148		
	Sig. (2-tailed)	0.106		
Duration of menstrual period	Pearson Correlation	-0.182*	0.012	
	Sig. (2-tailed)	0.047	0.897	
Requirement of sanitary napkin per day	Pearson Correlation		0.209*	0.386**
	Sig. (2-tailed)		0.022	p < 0.001**

* Correlation is significant at the 0.05 level (2-tailed).

There was statistically significant negative correlation between duration of menstrual cycle and age of menarche (r=-0.182, p=0.047) but positive correlation between duration of menstrual cycle and requirement of sanitary napkin per day (r=0.209, p=0.022), also requirement of sanitary napkin per day and duration of menstrual period (r=0.386, p < 0.001) (Table 4).

Table 5: Bivariate Analysis of Bleeding Rate with Hemoglobin, MCV, MCH, MCHC and ESR in Blood (n=120).

Variables	Categoriy	Bleeding rate		Total	χ^2 (df)	p-value
		Normal bleeding	Heavy bleeding			
Hb% (gm/dl)	Anaemic	52 (76.5%)	16 (23.5%)	68 (56.7%)	5.321 (1)	0.021
	Normal	48 (92.3%)	4 (7.7%)	52 (43.3%)		
MCV (Fl)	Normal	48 (92.3%)	4 (7.7%)	52 (43.3%)	5.321 (1)	0.021
	Reduced	52 (76.5%)	16 (23.5%)	68 (56.7%)		
MCH (pg)	Normal	52 (81.3%)	12 (18.8%)	64 (53.3%)	0.429 (1)	0.513
	Reduced	48 (85.7%)	8 (14.3%)	56 (46.7%)		
MCHC (gm/dl)	Normal	32 (100.0%)	0 (0.0%)	32 (26.7%)	8.727 (1)	0.003
	Reduced	68 (77.3%)	20 (22.7%)	88 (73.3%)		
ESR (mm/hr)	Normal	44 (91.7%)	4 (8.3%)	48 (40.0%)	4.000 (1)	0.046
	Raised	56 (77.8%)	16 (22.2%)	72 (60.0%)		

There was statistically significant relationship of menstrual bleeding rate with Hb, MCV, MCHC and ESR level (p=0.021, p=0.021, p=0.003 and p=0.046, respectively). But there was no relationship between menstrual bleeding rate with MCH level (Table-05).

DISCUSSION

Menstruation is a complex physiological process unique to females, involving the cyclic shedding of the endometrial lining of the uterus, accompanied by hormonal fluctuations and a range of physiological changes within the body. Numerous factors including hormonal, psychological and environmental influences contribute to the regulation of the menstrual cycle and can significantly impact a woman's overall well-being.[10] Medical students being exposed to a demanding academic curriculum, rigorous clinical training and elevated stress levels may experience heightened challenges related to menstruation.[11] This study aimed to estimate and observe hemoglobin level, hematocrit, ESR and platelet count level of medical students during menstruation. In the study, 60.0% of the participants resided in urban areas, while the remaining 40.0% resided in rural regions. It was found that 30.0% of the participants (36 individuals) reported living with their families, while the majority of the sample (70.0%, 84 participants) indicated that they resided in hostels. According to a study published in BMC Women's Health, there are significant differences in menstrual hygiene management practices among adolescent girls between urban and rural areas. The study found that 32.3% of girls in urban areas were good users of menstrual hygiene management practices compared to 27.7% in rural areas.[17] Another study conducted in rural communities of far-western Nepal found that traditional menstrual practices and contextual factors surrounding the practices were different from those in urban areas.[8] These distribution highlights the contextual differences between urban and rural settings, living situations, emphasizing the potential impact on the study outcomes, public health interventions and policies due to variations in health needs, access to healthcare services and environmental factors.

In the current study, a sample of 120 individuals revealed a predominance of early and mid-adolescent age groups, with the largest cohort reporting menarche at age 11 (30.0% of the sample), followed by age 12 (26.7% of the sample). Age groups 10 and 13 had comparable frequencies, each representing 16.7% of the sample population, while age groups 14 and 15 had smaller frequencies of 6.7% and 3.3%, respectively. The mean age at menarche differed by study population and location. Among the sample of Nigerian adolescents, the mean age at menarche was 13.31; it was slightly higher among the Jamaican women at 13.4 years and the South African sample at 13.9 years. The median age of menarche in one of the studies from Malawi was 15.1 years.[12] According to a study conducted in Central India, the mean age at menarche was 13.67± 0.8 years. Out of the total study population, 47 (8.38%) adolescents had a menstrual cycle length shorter than 21 days, 390 (69.52%) had a cycle length between 21 and 35 days and 124 (22.1%) longer than 35 days.[13] Another study conducted in India found that earlier age at menarche was associated with increased odds of having more than an eight-year duration from menarche to first motherhood.[12] A third study found that women with menarche at age 16 years or age ≥ 17 years had menopause 1 year later than women with menarche at age 13 years.[14] According to a systematic review and meta-analysis of reusable menstrual pads for public health internationally, the most commonly used menstrual hygiene products worldwide are disposable pads and tampons.[15] However, there are other menstrual hygiene products available such as menstrual cups, reusable pads, and period panties.[16] In this study, it was found that among the participants, 6.67% reported using Menstrual Underwear and Tampons, while 3.33% used Cloths. Sanitary Napkins were the most prevalent menstrual hygiene product, with 86.67% of the respondents (104 participants), indicating the necessity for targeted interventions to improve access, affordability and education regarding alternative menstrual hygiene products.

According to a systematic review and meta-analysis of studies conducted in Uganda, inadequate menstrual practices among single-use pad and cloth-users include inadequate frequency of changing of the absorbent.[15] It is recommended to change sanitary pads every 4-5 hours to prevent infections caused by pads.[17] In this study, we examined the distribution of respondents based on the frequency of pad change. Among the 120 participants, it was found that 20.0% reported changing pads within less than 6 hours, 50.0% reported changing pads between 6 and 8 hours and 30.0% indicated changing pads at a frequency exceeding 8 hours. These findings provide valuable insights into the frequency of behavior change within the sample population and can inform the development of targeted interventions and health promotion strategies.

It was crucial to evaluate the potential influence of general health indicators on menstrual health among medical students. Variables such as weight, height, and hemoglobin percentage (Hb%) offered insights into the participants' overall physical well-being, while mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and erythrocyte sedimentation rate (ESR) served as indicators of hematological parameters. According to a study published in the Journal of Medical Case Reports, critically low hemoglobin levels are typically associated with significant symptoms, physical examination findings, and hemodynamic instability. Heavy menstrual bleeding can lead to severe anemia if not treated. Severe menstrual bleeding can periodically reduce iron stores in the body, leading to iron deficiency and anemia. Heavy menstrual bleeding is highly prevalent among reproductive-aged women and is a major contributor to iron deficiency and its most severe manifestation, iron deficiency anemia.[18] Another study published in the Journal of Laboratory Medicine found that the mean hemoglobin values during the ovulatory, menstrual and follicular phases were 13.27 (1.14) g/dL, 12.05 (1.31) g/dL, and 12.23 (1.56) g/dL, respectively. The prevalence of anemia (Hb<12 g/dL) was reported among 21 (19.8%) subjects.[19] In this study, we found a statistically significant association (chi-square = 5.321, df = 1, p = 0.021) between bleeding rate and hemoglobin levels. Specifically, individuals with anemia were more likely to experience heavy bleeding compared to those with normal hemoglobin levels, suggesting that anemia may be associated with an increased risk of heavy bleeding. The p-value of 0.021 further supports this association and provides evidence for our hypothesis.

A study suggests that there is a relationship between MCV and menstrual bleeding rate. The study found that women with heavy menstrual bleeding had a higher MCV than women with normal menstrual bleeding[38]. Another study found that MCV was significantly higher in women with heavy menstrual bleeding than in those with normal menstrual bleeding.[20] In this study, it was found that within the normal MCV category, 92.3% of individuals had normal bleeding rates and 7.7% experienced heavy bleeding. For the entire study population, 43.3% were classified as having normal bleeding rates. Within the reduced MCV category, 76.5% of individuals had normal bleeding rates and 23.5% experienced heavy bleeding. Overall, 56.7% of the study population had normal bleeding rates in this MCV category. A chi-square test revealed a statistically significant association between bleeding rate and MCV in the study population, with a p-value of 0.021. MCH is a predictor of heavy menstrual bleeding.[38] Women with heavy menstrual bleeding had significantly lower MCH levels than women without heavy menstrual bleeding.[20] A study conducted in 2019 found that women with heavy menstrual bleeding had significantly lower MCH levels than women without heavy menstrual bleeding.[21] In this study, it was found that the majority of participants in the normal bleeding group exhibited normal Mean Corpuscular Hemoglobin (MCH) levels, while a high proportion of individuals with heavy bleeding had normal MCH levels. However, the non-significant chi-square test results ($\chi^2 = 0.429$, $p = 0.513$) indicate that there is no statistically significant association between bleeding rate and MCH levels, suggesting that MCH status does not appear to be a significant predictor of bleeding severity based on this sample. The relationship between Mean Corpuscular Hemoglobin Concentration (MCHC) and menstrual bleeding rate has not been extensively studied. A review of the literature did not yield any specific information on this topic.[22] However, several sources were identified that discuss the management of heavy menstrual bleeding on anticoagulation and the assessment and management of heavy menstrual bleeding.[22,23] In this study, it was found that individuals with normal MCHC levels had a significantly higher proportion of normal bleeding compared to those with reduced MCHC levels, which were associated with both normal and heavy bleeding. The chi-square test demonstrated a statistically significant relationship between bleeding rate and MCHC levels ($p < 0.05$).

A study found that erythrocyte sedimentation rate (ESR) was significantly higher (6.78±0.18mm/hr) during the menstrual phase than during the premenstrual phase (4.61±0.10mm/hr) at p<0.001.[24] Blood viscosity thus decreases during menstruation and this may be reduce the risk of cardiovascular diseases in premenopausal women.[25] According to Cikl, erythrocyte sedimentation rate up to 20 mm/h during menstruation is a normal physiological reaction in all women, occurring regularly due to hormonal changes.[25-40] In this study,

it was found that there is a statistically significant relationship between bleeding rate and ESR levels, as indicated by the chi-square test ($\chi 2 = 4.000$, df = 1, p = 0.046). The analysis revealed that individuals with raised ESR levels had a higher proportion of heavy bleeding compared to those with normal ESR levels.

CONCLUSIONS

Menstruation is a physiological process which in itself is a stressful condition. Anemia is a common issue among all young female population in our country. Different factors can worsen anemia such as hamper in food habits, hygiene due to existing stress adding on to one of the hardest syllabuses of medical studies. Values of different hematocrits can help determine the nature of anemia and provide guidelines to handle this issue accordingly by using supplementation and other interventions.

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Authors' Contributions

SS, GS, SM and MJH: Concept and design, data acquisition, interpretation, drafting and final approval. SS, FR, SM and MJH: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

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Ethical Approval

Ethical approval of the study was obtained from the Ethical Review Committee, Varendra University, Rajshahi, for conducting the study. Informed consent was taken from all participants. All the study methodology was carried out following the relevant ethical guidelines and regulations.

Consent for Publication: Taken.

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