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The impact of stress on menstrual cycle changes around examination time among medical college students: a multicentric study

Wassan **Nori** [1,*], Ban H. **Hameed** [1], Rafal Mustafa **Murshid** [2], Wisam **Akram** [1]

[1] Department of Obstetrics and Gynecology, Mustansiriyah University, Baghdad, Iraq.
[2] Department of Obstetrics and Gynecology, College of Medicine, University of Anbar, Ramadi, Iraq.

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***Corresponding author:** Wassan **Nori**, Associate Professor, M.D. Department of Obstetrics and Gynecology, Al-Yarmouk Teaching Hospital, Mustansiriyah University, Al-Amin Street, Al-Saydyia, Baghdad, Iraq.
Email: Dr.wassan76@uomustansiriyah.edu.iq.
ORCID: 0000-0002-8749-2444.

ABSTRACT

Objective. Stress was linked to many menstrual cycle (MC) abnormalities, especially during stressful periods like exams. Medical students are known to experience higher stress levels compared to other disciplines. This study primarily examined the impact of stress on MC parameters. Secondly, to verify predictors linked to stress and successful stress-coping strategies among students to mitigate stress-related MC changes.

Materials and Methods. A cross-sectional study enrolled medical college students via an online survey by Google Forms. Three data sets were collected: demographics, menstrual history, and socio-behavioural factors. 361 participants were grouped into 2: Group A, who experienced no change in MC, and Group B who did. Chi-square and odds ratio (OR) compared groups.

Results. 87.7% of participants were 22-24 years old. MC history and menstrual changes at the exam were all statistically significant across groups. In contrast, sleep and diet were not. Stressful life events and asking for medical advice were statistically significant. Reduced blood loss had highest odds for exams-related stress: OR:10.85, 95%CI 5.41 to 21.75, followed by reduced MC length: OR: 9.91, 95%CI 4.91 to 4.29. Most reliable coping strategy was asking for medical advice: OR: 2.68; 95%CI 1.68 to 4.29.

Conclusions. Exam-related stress was more evident in students with abnormal menstrual history manifested as dysmenorrhea and reduced cycle length. Most reliable stress predictors were reduced blood loss and cycle length. Identifying students most likely to suffer exam-related stress and the most effective stress-coping strategies are vital to support female students and help them achieve academic success.

INTRODUCTION

Menstruation is considered a normal physiological event in a woman's life, and it is the hallmark of normal health in terms of regularity, amount, and premenstrual symptoms preceding the menstrual periods. Normal menstrual cycle length is between 21 and 35 days, and the menstrual flow is between 2 and 7 days. Alteration of periods' normality, as well as premenstrual physical and psychological

changes, possess a significant impact on a woman's life and her productivity at levels of academic achievements, social life, and work [1].

Menstrual cycle (CM) abnormalities can be attributed to a wide variety of influencers, including stress and psychological impacts as academic, emotional, and physical intensities [2]. There are also socio-behavioural changes, such as dietary and sleep changes, caffeine, smoking, and drugs, which have a bidirectional impact on MC function. Additionally, the medical diseases and metabolic disorders that affect MC include polycystic ovarian syndrome (PCOS) as the most important moderator [1-3] and body weight changes with its detrimental effects on MC [3, 4]. A number of researchers studied the MC changes at the time of an exam to clarify the effects of the exam as a stressful event on women's performance. Some studies discussed that dysmenorrhea, lengthened cycles, were more frequently reported; others discussed oligomenorrhea as the most frequently reported symptom [4, 5]. An earlier study from Iraq reported that oligomenorrhea and menorrhagia were the most frequent MC abnormalities among medical college students [6]. Changes in food habits can be integrated with menstrual abnormalities, as highlighted by many studies that evaluated the impact of changing diet at stressful times, such as exams on the MC changes, and how lack of physical activity can exacerbate those changes [7]. Others looked into food types, particularly junk food consumption, and how they may be associated with MC rather than dietary habits [8].

Sleep health is a crucial variable for reproductive health [9]. Additionally, it should be optimized at the time of the exam to achieve the best academic results. According to the recommendations, sleeping hours should be between 7 and 9 hours per night [10]. However, deviation-reduced sleeping hours and poor sleep quality have been associated with poor performance at exams, depression, and obesity, with their detrimental effects on MC regularity and health [11]. Stressful life events experienced by the students lead to increasing levels of procrastination, with lower problem-solving abilities and an increase in negative stable attributions [12]. Support in terms of familial, social, and academic support can have a major role in modifying stress and alleviating its adverse effects on academic achievements, added to diverse coping strategies to reduce exam-related stress [13]. Despite extensive work regarding MC changes in stress, little is known about targeting specific MC changes; understanding these changes and how they adversely impact student reproductive health and overall resilience is crucial to developing successful stress-coping strategies.

This study primarily aimed to describe the impact of exam-related-stress on the menstrual cycle and various modifiable social-behavioural parameters associated with those changes. The secondary aim is to appraise successful stress predictors and coping strategies to mitigate their impact and enhance academic performance and success among Iraqi female medical students.

PATIENTS AND METHODS

Study design and setting

A cross-sectional multicentric study was conducted in major medical colleges in our country with an overall number of students of more than 2,000 to recruit female students through an online questionnaire for three months, from June to September 2024. Medical colleges have the highest academic level: they involve six grades. The first three years are basic sciences; the other three are clinical sciences, including hospital training. The study protocol was approved by the University Ethics Committee/College of Medicine (IRB Approval 2024-070, on May 27, 2024).

Study sampling and participants

The study employed stratified random sampling to recruit all female medical students in the last three years and newly graduated who completed the survey in full and agreed to participate. To avoid incomplete or duplicated responses, the questions were assigned as required so that submission was only accepted after completing all questions. The initial responses had 390 participants.

An exclusion was made for students beyond the required academic years and those who suffered chronic medical conditions and ongoing drug therapy. The final number of participants included in the analysis was 361.

Sample size calculation

The online Rao soft sample size calculator [14]. The sample size was calculated based on a response rate of 50%, a confidence interval of 98%, and a margin of error of 5%, with a total population of about 2,000. The sample size required was 350, and the final responses included were 361.

Recruitment method

Participants were recruited through an online questionnaire conducted via Google Forms distributed via social media platforms (WhatsApp and Telegram Applications) over three months from June to September 2024.

The questionnaire targeted current and recent graduates who studied obstetrics and gynaecology and cooperated with their teachers. Written informed consent was obtained from all participants following the Helsinki Declaration. It was emphasized that participation was entirely voluntary, and the anonymity and confidentiality of the data were assured, with the right to withdraw at any stage retained.

Data collection

The study tool (questionnaire) was developed after an extensive literature review and was tested by a pilot study from experts in the field before launching. According to their input, technical issues were addressed, and the original questionnaire was revised and distributed online in both English and Arabic for improved clarity and accessibility. The questionnaire consisted of three main sections, with several questions included in each section.

The first section involved the demographic variables studied, which are the students' age, age at menarche, academic year, marital status, and body mass index (BMI). Any history of chronic diseases and chronic drug use.

The second section included questions on menstrual cycle abnormalities, which include any history of menstrual abnormality, history of polycystic ovarian syndrome, amenorrhea (cessation of periods for 3 months), abnormalities around time of exam concentrating on the length of the cycle (normal, longer or shorter than before exam), amount of blood loss (normal, more than or less than previous periods) and dysmenorrhea (as no pain, mild or severe pain) around time of exam (around time of exam indicating 2 to 3 months before and after).

In our survey, we used MC definitions adopted by the International Federation of Obstetrics and Gynecologists (2018) to keep MC parameters consistent across all participants [1].

The third section involves socio-behavioural variables, which are dietary habits changes (no change, reduced or increased food intake), sleep pattern (no change, reduced sleep, poor sleep, and no sleep), stressful life events other than exam present or no, the medical branch of the exam (surgery, medicine, paediatrics, obstetrics and gynaecology, basic sciences and no change), asking for medical advice or not and taking medications or not. **Figure 1** illustrates the study sampling.

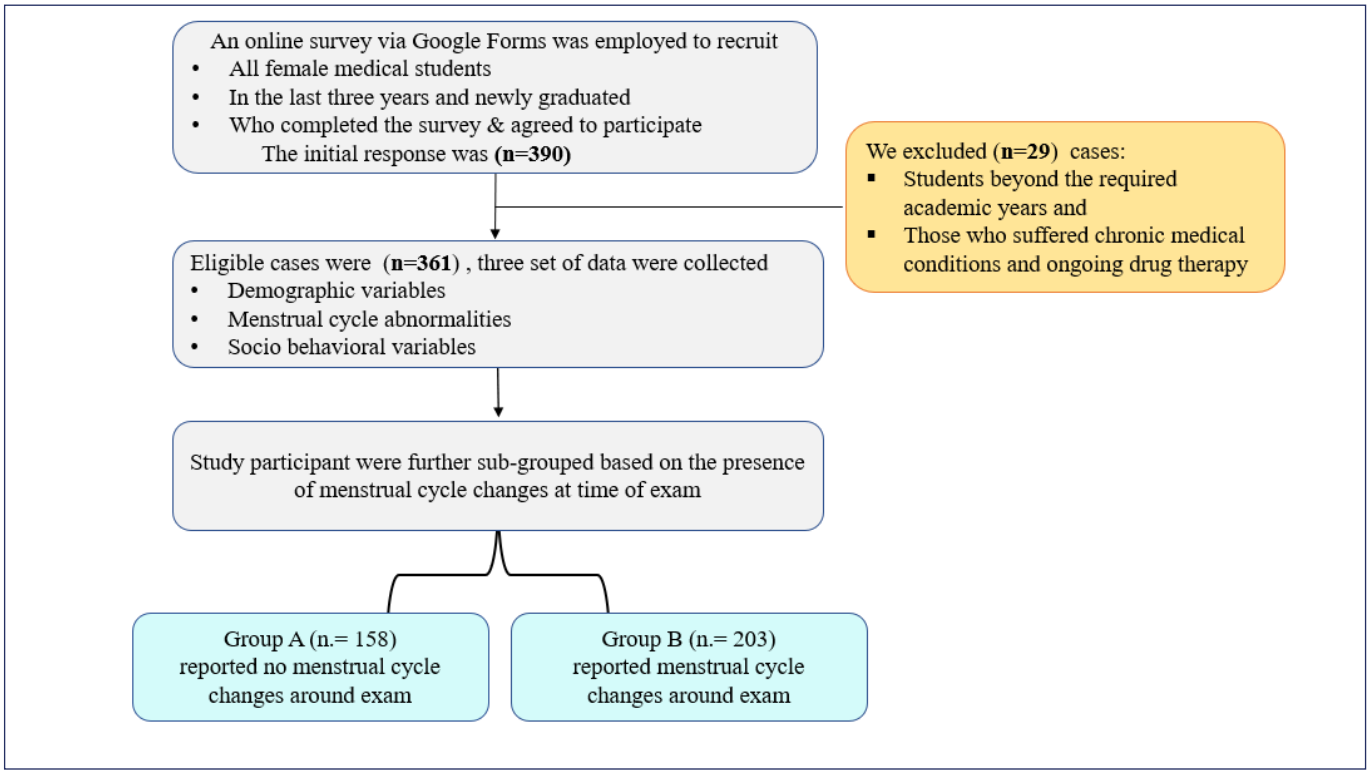

Figure 1. *Study flow chart.*

Statistical analysis

Descriptive statistics (numbers and percentages) were used to express the demographic criteria of the study population. The chi-square test detected the difference in categorial factors in study parameters. Logistic regression analysis was conducted to calculate the Odds ratio (OR) and respective 95% confidence intervals (CI) for various parameters and verify their impact on MC changes. The statistical analysis was conducted via Microsoft Excel 2016, Statistical Packages of Social Sciences-SPSS (2019), and MedCalc® Statistical Software version 22.016. The significance level was set at a P-value < 0.05 for all tests.

RESULTS

The demographic variables of the participants (n = 361) are demonstrated in **Table 1**, which revealed that 87.7% of participants were 22-24 years old; age at menarche was 12 and 13 years in 60.1%. The participants were mainly from the 6th grade (55.1%) and the 5th year (23.3%). More than 97% were unmarried. Regarding BMI, normal BMI constituted the majority (60.9%), overweight 33.8%, and the least were underweight (5.3%). **Figure 2** shows the distribution of participants based on the universities.

The study participants were sub-grouped based on the menstrual cycle (MC) changes around the exam: Group A (n = 158) reported no MC changes, while Group B (n = 203) experienced MC changes with a prevalence of 56.23% of MC changes among the whole study participants.

In **Table 2** the factors associated with MC abnormalities among the two groups were compared. A prior history of menstrual cycle abnormalities (72.41%), a history of PCOS diagnosis (21.18%), and a history of amenorrhea (14.77%) were significantly higher among Group B with P-value of 0.0005, 0.03, and 0.008, respectively.

The frequently reported MC changes around the exam time among Group B were sub-categorized as follows: normal MC length was reported at 38.42%, compared to 29.06% *vs* 32.51% of cases who reported longer and shorter MC; p = 0.0001, respectively. The amount of blood loss was normal among 37.93%, p = 0.0001 of the participants, while 34.98% *vs* 27.92% of the participants suffered increased and reduced blood loss than normal MC, p = 0.005, respectively.

Table 1. *The demographic criteria of the participants.*

Variables	Categories	Numbers	Percentages
Age (years)	20	3	1%
	21	14	3.8%
	22	94	26.1%
	23	147	40.8%
	24	75	20.8%
	25	20	5.4%
	26	8	2.1%
Age at menarche (years)	9	2	0.5%
	10	70	19.5%
	11	45	12.5%
	12	128	35.4%
	13	89	24.7%
	14	20	5.4%
	15	2	0.5%
	16	5	1.5%
Academic years	4th	14	3.8%
	5th	84	23.3%
	6th	199	55.1%
	Graduated	64	17.8%
Marital status	Unmarried	351	97.2%
	Married	10	2.8%
	Divorced	0	0%
Body Mass Index (BMI); Kg/m^2	Underweight < 18.5	19	5.3%
	Normal weight: BMI of 18.5 to 24.9	220	60.9%
	Overweight > 24.9	122	33.8%

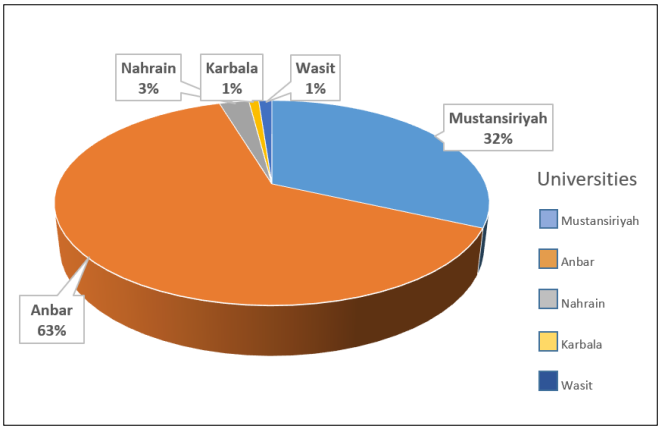

Figure 2. *Distribution of study participants based on universities' participation.*

Dysmenorrhea: a significant number of participants experienced severe and moderate dysmenorrhea, 41.87% *vs* 40.89%; p = 0.008, respectively.

Table 2. *Comparing the MC abnormalities among the two groups (n = 361) in respect to menstrual history and menstrual parameters around examination times categorized according to groups.*

Parameters	Categories	Group A n = 158 (%)	Group B n = 203 (%)	Total n = 361 (%)	P-value
Prior history of MC abnormality					
Any prior history of menstrual abnormality	Yes	135 (85.44%)	147 (72.41%)	282 (78.12%)	0.0005
	No	23 (14.56%)	56 (27.59%)	79 (21.88%)	
History of PCOS Diagnosis	Yes	23 (14.56%)	43 (21.18%)	66 (18.28%)	0.03
	No	135 (85.44%)	160 (78.82%)	295 (81.72%)	
Amenorrhea (3 months)	Yes	11 (6.96%)	30 (14.77%)	41 (11.36%)	0.008
	No	147(93.04%)	173(85.22%)	320 (88.64%)	
Prior history MC abnormality around exam time					
A. Does MC length change at the time of the exam	Normal (no change)	131 (82.91%)	78 (38.42%)	209 (57.89%)	0.0001
	Longer than normal MC	13 (8.23%)	59 (29.06%)	72 (19.94%)	
	Shorter than normal MC	14 (8.86%)	66 (32.51%)	80 (22.16%)	
B. Amount of blood loss at the time of the exam	Normal (no change)	125 (79.11%)	77 (37.93%)	202 (55.96%)	0.0001
	More than normal MC	12 (7.59%)	71 (34.98%)	83 (22.99%)	
	Less than normal MC	21 (13.29%)	55 (27.09%)	76 (21.05%)	
C. Dysmenorrhea around the time of the exam	No pain	45 (28.48%)	35 (17.24%)	80 (22.16%)	0.005
	Moderate pain	45 (28.48%)	83 (40.89%)	128 (35.46%)	
	Severe pain requires bed rest	68 (43.04%)	85 (41.87%)	153 (42.38%)	

MC: menstrual cycle changes; Group A showed no menstrual cycle changes. Group B showed menstrual cycle changes.

Examining the socio-behavioural changes among students that associate MC at the time of the exam was clarified in **Table 3**.

There was no statistical difference between the two groups concerning dietary changes, sleep disturbances, stressful life events, and the type of medical branch being examined, with a P-value of 0.45, 0.67, 0.064, and 0.058, respectively. The changes in dietary and sleep patterns were more significant among Group B. Stressful life events were reported among the two groups but were higher in Group A (70.89 *vs* 59.61%), respectively. The medical branch that was frequently reported among Group B was the surgical branch, followed by the medical branch (34.3 *vs* 32.1%); p = 0.0001, respectively.

Coping with stress strategies used by the students showed meaningful differences for seeking medical advice, reported in 77.22% *vs* 57.14%; p = 0.0007 of Group A and Group B, respectively. Using medication to reduce exam-related stress was reported in 27.22% *vs* 22.17%; p = 0.32 of Group A and B, respectively. All students (100%) sought support, primarily from family 72%, followed by friends 15%, and academic staff 12%, as illustrated in **Figure 3**. In **Table 4** a calculation of the OR and associated 95% CI was made to show predictors for the stress on MC changes. The strongest predictors were reduced blood loss, OR 10.85 (95%CI 5.41 to 21.75, p < 0.0001), followed by reduced MC length OR = 9.91 (95%CI 4.91 to 19.98; p < 0.0001). Based on the menstrual history, the best predictor was a positive history of amenorrhea with an OR of 6.65 (95%CI 1.27 to 5.62; p = 0.009). All tested parameters had a

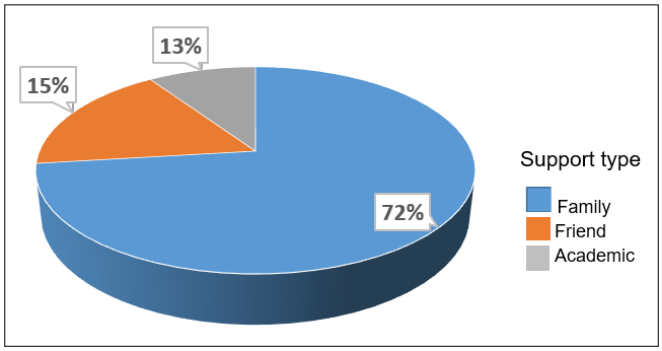

Figure 3. *Type of support received by the female student during the exam.*

Table 3. *Examining the socio-behavioural changes and coping strategies among students that associate MC at exam time.*

Socio-behavioural variables	Categories	Group A (n = 158) (%)	Group B (n =203) (%)	Total (%)	P-value
Dietary changes					
Are there any changes in dietary habits?	No change	45 (28.48%)	50 (24.63%)	95 (26.31%)	0.45
	Reduced food intake	51 (32.28%)	78 (38.42%)	129(35.73%)	
	Increased food intake	62 (39.24%)	75 (36.95%)	137(37.95%)	
Sleep changes					
Sleep disturbances	No change	14 (8.86%)	22 (10.84%)	36 (9.97%)	0.67
	Reduced sleep	77 (48.73%)	89 (43.84%)	166(45.98%)	
	Poor sleep	57 (36.06%)	74 (36.45%)	131(36.29%)	
	No sleep	10 (6.33%)	18 (8.87%)	28 (7.76%)	
Stress					
Stressful life events	Yes	112 (70.89%)	121(59.61%)	233(64.54%)	0.02
	No	46 (29.11%)	82 (40.39%)	128(35.46%)	
Which medical branch carries the highest stress at exam time	Surgery	58 (36.71%)	76 (34.44%)	134(37.12%)	0.058
	Medicine	50 (31.64%)	65 (32.02%)	115(31.86%)	
	Paediatrics	19 (12.03%)	18 (8.87%)	37 (10.25%)	
	OBG	1 (0.63%)	8 (3.94%)	9 (2.49%)	
	Basic sciences	2 (1.27%)	0 (0.00%)	2 (0.55%)	
	No change	28 (17.72%)	36 (17.73%)	64 (17.73%)	
Coping with stress					
Asking for medical advice around exams	Yes	122 (77.22%)	116 (57.14%	238(65.93%)	0.0007
	No	36 (22.78%)	87 (42.86%)	123(34.07%)	
Do you take medication	Yes	43 (27.22%)	45 (22.17%)	88 (24.38%)	0.32
	No	115 (72.78%)	158 (77.83%	273(75.62%)	

MC: menstrual cycle changes; Group A showed no menstrual cycle changes. Group B showed menstrual cycle changes.

statistically significant odd ratio except moderate dysmenorrhea with OR of 1.69 (95%CI 0.98 to 2.92). The socio-behavioural changes' best predictor was stressful life, which had an OR of 1.91 (95%CI 1.23 to 2.96; p = 0.003). None of the other examined parameters were significant. Coping with stress strategies showed that asking for medical advice was a strong predictor for stress on MC with an OR 2.68 (95%CI 1.68 to 4.29; p < 0.0001), while taking medication failed to have statistical value.

DISCUSSION

The analysis confirmed that examination-related stress was more evident in students with abnormal menstrual history and is more likely to be manifested as dysmenorrhea and reduced cycle length. None of the socio-behavioural changes (sleep and diet) were significant among the groups that showed and those that did not show MC changes. The most reliable predictors for examination-related stress were reduced menstrual blood loss and reduced cycle length. All socio-behavioural changes were non-statistically significant. The most effective stress-coping strategy was seeking medical advice.

The study highlighted that MC changes had a prevalence of 56.23% among the whole study participants. Dysmenorrhea was the most frequently reported (77.7%), followed by changes in blood loss (44.4%) with a P-value of 0.005 and 0.0001, respectively.

In **Table 5**, a summary of some of the reported MC changes across different countries was highlighted [4, 5, 15-17]. The discrepancy can be attributed to racial, genetic, socio-behavioural, and dietary factors. A prior history of MC abnormalities, amenorrhea,

Table 4. *The logistic regression was employed to calculate the OR and associated 95%CI to show predictors for stress on MC changes.*

Parameters	Categories	Wald	Odd ratio	95% CI	P-value
Menstrual cycle history					
History of MC changes: reference group (no history of changes)	Yes	11.64	2.61	1.50 to 4.53	0.0006
History of PCOS: reference group (no history of PCOS)	Yes	4.59	1.86	1.05 to 3.27	0.03
History of amenorrhea: reference group (no amenorrhea history)	Yes	2.67	6.65	1.27 to 5.62	0.009
Menstrual cycle variables					
Change in MC length: reference group (no change in MC length)	Reduced	41.06	9.91	4.91 to 19.98	< 0.0001
	Increased	43.75	9.21	4.77 to 17.77	< 0.0001
Changes in blood loss: reference group (no changes in blood loss)	Reduced	45.16	10.85	5.41 to 21.75	< 0.0001
	Increased	24.81	4.34	2.44 to 7.74	< 0.0001
Dysmenorrhea: reference group (no pain)	Moderate	3.55	1.69	0.98 to 2.92	0.058
	Severe	10.49	2.58	1.45 to 4.59	0.001
Socio-behavioural changes					
Change in diet intake: reference group (No change)	Reduced	3.19	1.63	0.95 to 2.78	0.07
	Increased	1.92	1.45	0.86 to 2.45	1.16
Sleep disturbances: reference group (No change)	Reduced	0.56	0.75	0.36 to 1.57	0.45
	Poor sleep	0.33	0.80	0.38 to 1.7	0.56
	No sleep	0.06	1.15	0.41 to 3.19	0.79
Stressful life events: reference group (positive stressful life events)	No	2.88	1.91	1.23 to 2.96	0.003
Stress coping strategies					
Asking for medical advice; Reference group (not taking)	Yes	17.24	2.68	1.68 to 4.29	< 0.0001
Taking medication; Reference group (no drug intake)	yes	0.7402	1.24	0.76 to 2.0	0.74

MC: menstrual cycle; 95%CI: 95% confidence interval.

and PCOS was significantly higher among Group B in univariant analysis. During stressful conditions, such as examinations, students with a positive history of MC changes will be more likely to experience those changes or even experience an exacerbation during stress owing to hormonal imbalance. This highlights a relationship between pre-existing MC health and the probability of reporting MC changes at stressful times. Earlier studies aligned with our results. Academic stress tends to exacerbate changes in PCOS cases, as high as 80% [3, 18].

In bivariate analysis (logistic regression model), the validity of those parameters was emphasized. Reduced blood loss during the menses, reduced MC length, and increased MC length had the highest OR in predicting MC changes among students at examination time, with OR of 10.85, 9.91, and 9.21, respectively.

The socio-behavioural variables (diet, sleep) showed a higher trend in Group B, which fails to have statistical value in univariate analysis, further confirmed by multivariant analysis with an OR of less than two and a P-value of 0.05. These results contradict earlier studies in the field that discussed an association between those variables with MC changes and exam-related stress. One study discussed higher food intake during menstruation, while another showed that fasting led to an alteration in the MC pattern [19, 20]. Higher food intake can affect the body fat composition and sex hormones by triggering a proinflammatory state, which affects the MC even in the absence of stress. In contrast, healthy food habits with high vegetable and fruit consumption have a positive influence on menstrual periods and pain owing to anti-inflammatory properties [7].

Table 5. *A summary of some of the reported MC changes across different countries was highlighted.*

Country	Sampling size	Prevalence	Most reported change	Authors, years
Iraq	361	56.23%	Dysmenorrhea	Current study
Saudi Arabia	450	48.2%	Dysmenorrhea	Alhammadi *et al.* [4], 2022
Egypt	366	33.32%	Reduced blood loss	Abdella *et al.* [15], 2016
Ethiopia	620	32.6%	Dysmenorrhea	Zeru *et al.* [16], 2021
Nepal	253	64.2%	Dysmenorrhea	Thapa *et al.* [17], 2015
India	300	35.72%	Oligomenorrhea	Kumar *et al.* [5], 2018

Changes in sleep patterns were also linked to MC irregularity in terms of poor quality of sleep or reduced sleep hours [9, 21]. Although the exact triggers are not well understood, sleep disturbances are quite common in women with MC changes. Some postulated that sleep disturbances might affect the gonadal hormones section manifested as irregular cycles [22]. The integrity of the HPA axis (hypothalamic-pituitary-adrenal) is mainly dependent on a circadian rhythm, which will be lost among those with sleep disturbance, consequently impacting gonadal hormone secretion [23].

The discrepancy in this study's result regarding diet and sleeping patterns compared to other studies could be attributed to multiple factors. One possible cause is that these variables were overshadowed by others that had more impact on the MC function [24]. Another possibility is that the impact of those two variables may be complex and multifaceted and involve an indirect pathway that can not be measured by immediate outcome [9, 19, 24]. Many studies stressed the impact of socio-behavioural parameters on reproductive and menstrual health. It is worth noting that some females may experience minimal or no changes or alterations in MC function, which indicates that there is an individual variation of response to a stressful situation [25].

Although stress had no statistical difference on univariant analysis, it showed a significant impact on multivariant analysis with an OR of 1.9 and a P-value of 0.003. Many studies increasingly recognize the impact of stress on MC wellness among medical students who were exposed to higher levels of stress (academic stress, psychological and financial stressors) compared to students in other disciplines [13, 25].

Annarahayu *et al*.'s meta-analysis declared that women experiencing stress are at higher risk (1.8% higher) to have irregular menses compared to women without stress [26].

The integrity of the HPA and hypothalamic-pituitary-gonadal axis (HPG) is vital to ensure MC cyclicity. Upon exposure to stressful life events, such as exams, the HPA will be activated, causing more stress hormones to release, such as cortisol. Consequently, the normal function of the HPG axis is inhibited, creating a functional hypothalamic dysfunction manifested as amenorrhea and reduced MC blood loss. Another proposed mechanism is the reduced luteal phase progesterone secretion in response to stress [1, 27].

The analysis showed that the surgical and medical branches were the most frequently reported branches of stress compared to other branches but without statistical value [28]. This aligns with earlier studies reporting high clinical stress rather than basic sciences [29].

Among the coping strategies to face stress, group A students were statistically higher in seeking medical advice; this was further verified in multivariant analysis with an OR 2.68 and P-value < 0.0001. This was in line with other studies which discussed that this strategy is highly valued for stress management and is used more frequently by females [30, 31]. In contrast, group B students had a trend of higher medication intake, which failed to reach statistical value. Earlier work showed that medication intake to reduce stress is not common among medical students, and it does not show a good association with stress management [32, 33].

Seeking advice from a medical professional may offer a tailored coping strategy. When paired with medication, it adds a more holistic patient approach by addressing the stress of psychological and physical symptoms [34]. It is essential to consider advanced coping strategies, such as cognitive therapy, meditation, and coaching. Increasing public awareness and education regarding them is essential for promoting their use [35].

It is noteworthy that all participants seek support from either a family member, a friend, or an acade-

mic member. This coping strategy is quite common, especially among female students who experience high-stress levels [36, 37]. A study from Iraq examined the role of mother support during exams. It declared that the mother's education level and personal history of menstrual abnormalities affected dysmenorrhea and premenstrual syndrome incidence and, consequently, academic performance and grading score [38]. Overall, fostering and promoting a supportive environment, whether at home or college, is vital to reducing exam stress and improving students' well-being and success.

We have to acknowledge the study limitation; being a cross-sectional study hinders the establishment of cause-and-effect links between study variables. Study variables were self-administered, so it is prone to recall bias and subjective interpretation. Moreover, previous studies had reported higher perceived stress levels during the luteal phase, which is a notable limitation of the current study that was not addressed. The socio-behavioural changes that this study focused on are multifaceted aspects and may not have been fully captured by the research tool. The multicentric design of the study enhances results generalization. However, the diversity of environmental factors might modulate stress and coping strategies. Thus, they may be a potential source of bias. There is a broad spectrum of coping mechanisms that might be more effective than the limited range considered in this study. The effect of other hormone that might contribute to irregular cycle was not addressed such as prolactin and cortisol [39-41]. Prolactin is one of stress related hormones, once it increased, it will suppers GnRH secretion thus subsequently reduces LH and FSH hormones. A state of anovulatory cycle will be created leading to irregular cycle or even amenorrhea. Hyperproteinemia is often linked to stress and pituitary disrobers [42, 43].

This was the first multicentric study in our country to address examination-related stress on MC changes in a large population. One of the key strengths is the holistic approach adopted; not only are menstrual variables addressed, but socio-behavioural patterns are also used to have a deeper insight into students' well-being. Furthermore, the analysis has extended to evaluate coping strategies that help students manage the stressors perceived to optimize academic performance.

To address study confounders, we focused on the 4^{th}-6^{th} year and graduated students to reduce age-related diversity and capture mature students. Additionally, an exclusion was made for students with chronic illness or those on chronic therapies. The questionnaire was designed in a way that makes the submission incomplete before all the questions are answered to limit incomplete or missing data.

The clinical impact of this study is critical as it provides the foundation for supporting female students during stressful periods and ultimately reaching their potential and academic success.

CONCLUSIONS

In conclusion, the current study investigated menstrual changes among female students in major medical colleges. It was shown that all menstrual history parameters, menstruation variables, and the presence of stress were significant. None of the socio-behavioural variables were meaningful. Reliable stress predictors were reduced menstrual blood loss and reduced cycle length.

Identification of students most likely to suffer stress and predictors for exam-related stress helps develop preventive measures and fosters supportive intervention and guidance to enhance females' academic performance. Future research is warranted to examine the long-term impact of exam-related stress on women's menstrual and psychological health and to explore more effective stress-coping strategies.

COMPLIANCE WITH ETHICAL STANDARDS

Authors' contribution

W.N., B.H.H.: Conceptualization, validation, visualization, writing – original draft. R.M.M.: Supervision, writing – review & editing. W.A.: Methodology.

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None.

Study registration

N/A.

Disclosure of Interests

The authors declare that they have no conflict of interests.

Ethical approval

The Mustansiriyah University ethics committee approved this study (IRB Approval 2024-070, on May 27, 2024).

Informed consent
All patients gave their singed consent for publishing the images' used

Data sharing
Data are available under reasonable request to the corresponding author.

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