



Stress-induced menstrual disorders in adolescents during the Ukrainian war: cross-sectional study

Nikitina I. Mykolayivna, MD, PhD, Favor T. Adebusey, MBBS*, Wireko A. Awuah, MBBS, Sinkina A. Anatoliivna, MD, PhD, Babar T. Volodymyrivna, MD, PhD, Herasymenko S. Fedorivna, MD, PhD, Toufik Abdul-Rahman, MBBS

Objective: The objective was to investigate the peculiarities of menstrual cycle changes in teenagers exposed to a devastating war for an extended period.

Methods: A cross-sectional study of 120 Ukrainian girls aged 9–18 asked to complete a survey about their menstrual cycle status 3–6 months after the war began. Other examination methods used included anthropometry, laboratory, and instrumental studies.

Results: The frequency of menstrual cycle disorders in the study group was 65.8% ($n = 79$). The following menstrual cycle disorders were most frequently reported; dysmenorrhea 45.6% ($n = 36$), excessive menstruation during puberty 27.8% ($n = 22$), and secondary amenorrhea 26.6% ($n = 21$). The 52.5% ($n = 63$) of those examined had pathological menarche. The 81.7% ($n = 63$) of respondents reported a change in eating habits in the previous few months. The 61.9% ($n = 39$) of these children had dys hormonal disorders or met the criteria for metabolic syndrome.

Conclusion: Adolescent females under stress warrant a quick assessment of their psychoemotional and metabolic conditions. The protection from future menstruation and reproductive illnesses depends on this tactic. By diagnosing these conditions promptly and well-managed, adolescent females may maintain good physical and emotional health.

Keywords: menstrual disorder, psychoemotional disorder, reproductive function, stress, war

Background

The United Nations (UN) reports that from the start of Russian aggression against Ukraine until 3 January 2023, there have been 6919 mortalities and 17 994 injuries. Uncomfortably, young individuals made up a sizeable majority of those killed—roughly 1000 of them were under 18 years^[1]. Only occurrences that have been verified and recognized are included in the figures, which amount to an average of more than three children every day. Fourteen million Ukrainians are said to have fled their homes because of the war, either seeking safety abroad or in other regions of Ukraine^[1–3]. By December 2022, the UN predicted that an astonishing 18 million Ukrainians would require humanitarian assistance. A sizable portion of the population—~8 million individuals—have been forced to flee the country due to ongoing

Sumy State University, Sumy, Ukraine

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*Corresponding author. Address: Faculty of Medicine, Sumy State University, Sanatorna Street, 31, Sumy, Sumy Oblast 40000, Ukraine. Tel.: +380 639 759910. E-mail: Favouadebusoye@gmail.com (F.T. Adebusey).

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HIGHLIGHTS

- Menstrual cycle disorders are prevalent among adolescent girls, with dysmenorrhea, excessive menstruation during puberty, secondary amenorrhea, and pathological menarche being the most common conditions.
- Higher maternal education is associated with better self-control during the menstrual cycle.
- A significant number of adolescent girls experience menstrual disorders due to ongoing stress, limited physical activity, and eating disorders.
- Secondary amenorrhea affects 26.6% of the adolescent population, which is higher than the typical 3–4% of reproductive-age women affected. This may be caused by stress-related anovulation and may lead to infertility, long-term mental health problems, and lower quality of life.

violence. Similarly, 6.5 million Ukrainians are internally displaced, especially in the country's eastern regions where conflict has been particularly violent^[2,3] (Fig. 1). This is due to widespread rocket attacks on essential infrastructure, which have left entire villages without heat or electricity. By 10 January 2023, 7.9 million Ukrainians had also applied for asylum in Europe, primarily – women and children. Poland, the Czech Republic, and Germany have taken in the majority of Ukrainian refugees in Europe^[4].

War harms an individual's mental and physical health due to disturbances in sleep and rest, as well as changes in eating habits and physical activity. This is because the human body is constantly prepared to «defend or run» during war. Stress is a

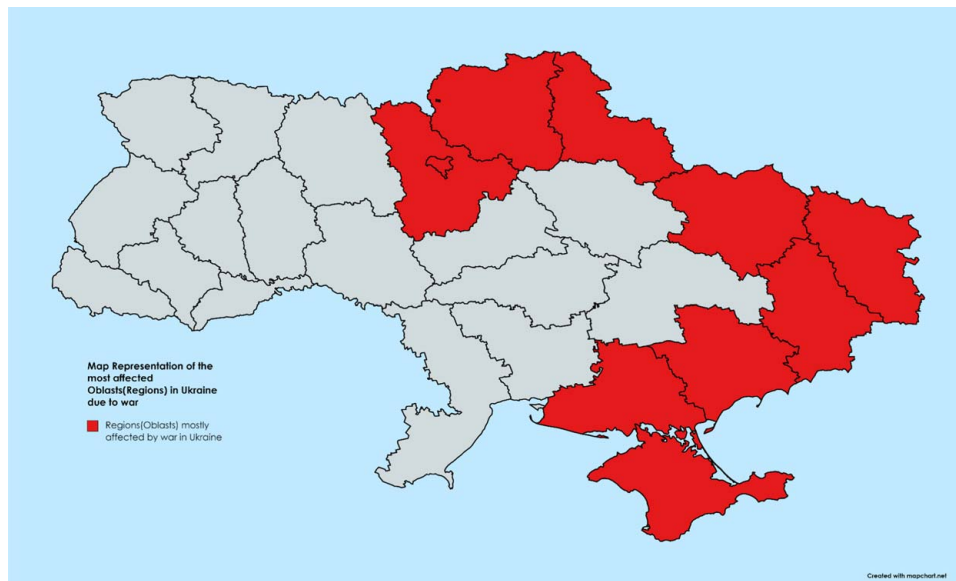


Figure 1. Map Representation of the most affected Oblasts (Regions) in Ukraine due to war. The majority of the cities that have been severely impacted are in the country's eastern and north-eastern regions. Created with Mapchart.net^[2].

protective response to external stimuli that enables us to adapt to changes through the active release of adrenal gland chemicals such as adrenaline and cortisol. Females, especially adolescents, are more susceptible to stress than their male counterparts as estrogen activates the hypothalamic-pituitary-adrenal system^[5,6]. Adolescence's formative years significantly impact a female's future mental health and ability to procreate. Due to the insufficient development of the majority of adolescent females' reproductive systems, gynecological issues in the adolescent period have a different course than those in adults, as well as several pathological conditions that are not typical of adult females. Gynecological conditions that emerge during puberty considerably worsen the obstetric and postnatal challenges that cause female infertility^[5] (Fig. 2). During puberty, the body has fewer adaptive resources available, making it more vulnerable to environmental effects such as short-term and long-term stressors. Negative factors easily disrupt the unstable balance of the hypothalamic-pituitary system. Both the follicular apparatus of the ovaries and the receptor apparatus of the uterus can be damaged due to injuries and intoxications, as well as hormonal regulation violations^[6,7].

Most Ukrainian children and adolescents were separated from their families, maltreated, sexually assaulted, and deported forcibly during the war^[7]. Children and adolescents who suffer acute stress, malnutrition, and infectious diseases due to military conflicts are more likely to develop chronic noncommunicable diseases such as diabetes mellitus, cardiovascular diseases, chronic lung diseases, and reproductive disorders^[8–10].

In Ukraine, limited data exist on the effects of war on Ukrainian adolescents during the war. This study was conducted to examine the prevalence of menstrual disorders (MDs), pathological menarche (PM), and metabolic syndrome (MetS) in Ukrainian adolescent females who have experienced violence during the war, aiming to assess the impact of violence on their reproductive and metabolic health.

Methods

A cross-sectional study of 120 Ukrainian females between the ages of 9 and 18 who have experienced violent regions were examined. Examination methods applied included anamnesis collecting, psychoemotional state assessment, anthropometry, laboratory, and instrumental examinations. A survey was also disseminated (with a 100% response rate) on the socio-demographic context, menstrual cycle characteristics, and height and weight measurements. BMI was classified based on the standards published by the International Working Group on Obesity. The Sumy State University Ethics Committee waived ethical approval for this study, as the research was deemed to pose minimal risk to participants.

Each participant was provided details about the objectives and procedures of the study, and either their legal guardian or, if they were 18 years of age or older, gave written informed permission. Nontransferability, confidentiality, and anonymity of data were all ensured. Female students were asked to provide anonymous responses to questions about their lifestyle, sociodemographic details, and overall health and well-being. The menstrual disorder of teenagers questionnaire was used to compile data concerning their menstrual cycles. The menstrual cycle was classified according to its regularity (regular or irregularity), duration (six or more days), presence or absence of menstrual cramps or dysmenorrhea, the impact of dysmenorrhea on absences from school, and use of analgesia for dysmenorrhea (yes or no). Girls were also asked if they used the beginning of their menstruation as a substitute for their own cycle monitoring (yes or no). Participants who experienced dysmenorrhea reported having painful menses after the war started. The many variables affecting the menstrual cycle have already been discussed.

PM was defined as the onset of menarche later than 3 years old and the onset of menstrual function early (up to 10 years) or late (beyond 15 years). All patients diagnosed with PM had their menarche during the war, as documented in their medical

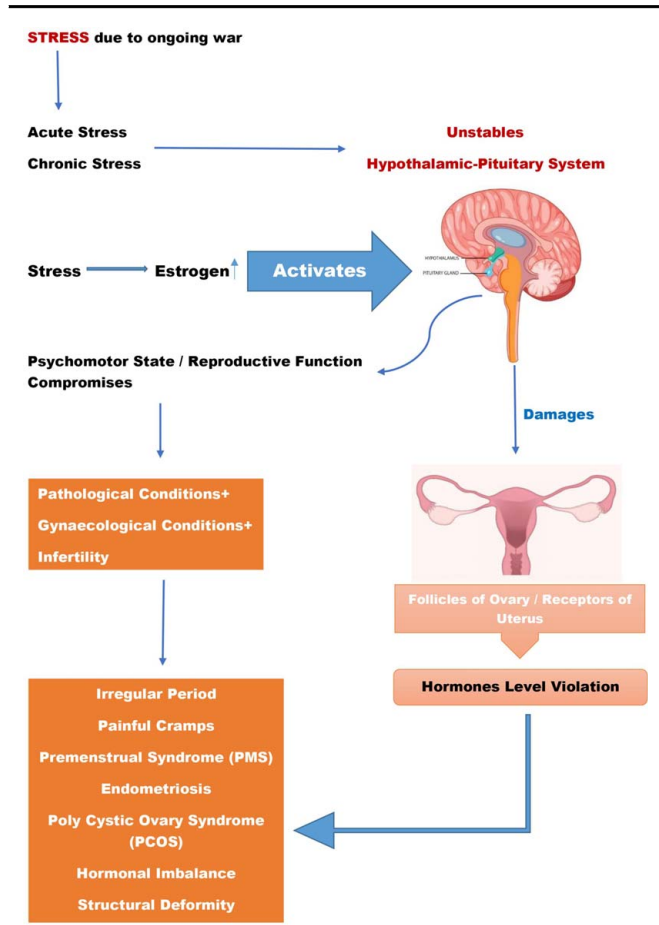


Figure 2. Schematic diagram of war-induced stress leading to menstrual disorders [4–6,13,14]

records. Patients with PM were further evaluated by a gynecologist to confirm the diagnosis. Measurements were taken using recognized anthropometry methods. Each participant was instructed to take off their shoes and dress comfortably while a skilled researcher measured their height and weight. Weight (kg) was established using portable electronic scales with a precision of 0.1 kg.

Obesity BMI; arterial hypertension arterial pressure (BP); hyper-dyslipidemia serum levels of triglycerides, total cholesterol (cholesterol), low-density lipoprotein, and high-density lipoprotein; insulin resistance, homeostasis model assessment index; hyperglycemia fasting blood glucose were the criteria for identifying the components of MS, according to the recommendations of the International Diabetes Federation, 2007^[9]. The lipid profile threshold values were: triglycerides 1.7 mmol/l, high-density lipoprotein 1.03 mmol/l, cholesterol 4.25 mmol/l, low-density lipoprotein 2.75 mmol/l. Blood glucose levels greater than 5.6 mmol/l were considered hyperglycemia during fasting. When the homeostasis model assessment index level was more significant than 2.5, insulin resistance was diagnosed. Polycystic ovary syndrome (PCOS) was diagnosed according to the Rotterdam criteria (2003): oligo – or anovulation (≤ 6 menstrual periods per year); clinical or laboratory hyperandrogenism (hirsutism/acne) and/or hyperandrogenemia (increased levels of free testosterone in the blood); polycystic ovaries during

transvaginal ultrasound (≥ 20 follicles 2–9 mm in size in each ovary). Statistical processing and analysis of the obtained data were performed using «Microsoft Excel» programs using the methods of mathematical statistics and the software package Statistica 8.0. Charts and diagrams were built using «Microsoft Excel». Mathematical processing of indicators was performed using the methods of variation statistics for comparing inhaled sets by averages using the student’s *t*-test. A descriptive analysis of variables was performed and odds ratios (OR) and 95% CI were determined.

The study has been reported by the strengthening the reporting of cohort, cross-sectional and case-control studies in surgery (STROCSS) guidelines^[11]. Informed consent was obtained from all patients before inclusion in the study. Patients were provided with a detailed explanation of the study aims and methods and were allowed to ask questions. Written consent was obtained from each patient who agreed to participate in the study.

Results

The average age of the girls was 15.5 ± 1.6 years, 57.7% were between 15 and 18 years old. Most of the girls were from families where the mother and father had less than or equal to 9 years of education (61.8 and 60.0%, respectively), and the parents were married (62.9%). The average age at menarche of the examined patients was 12.4 years (mean age of PM was 14.5 years), and the average BMI was 22.0 kg/m².

It was established that the frequency of menstrual cycle disorders in the examined group was 65.8% ($n = 79$). Among the disorders of the menstrual cycle, the following were most often noted: dysmenorrhea – 45.6% ($n = 36$), excessive menstruation during puberty – 27.8% ($n = 22$), secondary amenorrhea (SA) – 26.6% ($n = 21$). PM was noted by 52.5% ($n = 63$) of the examined. The 81.7% ($n = 63$) of respondents noted a change in eating behavior over the past few months. More than half of these children had dyshormonal disorders or met the criteria of MetS – 61.7% ($n = 74$) (Table 1).

Higher maternal education was associated with better self-control during the menstrual cycle in the sample cohort (OR 1.60; 95% CI: 1.15–2.17). Females with menarche before the age of 12 were more likely than girls with menarche before that age to have menstrual periods longer than 6 days (OR 1.73; 95% CI: 1.19–2.51), as well as dysmenorrhea (OR 1.87; 95% CI: 1.11–3.16). A considerable amount of MDs against ongoing stress was one of the subjects’ issues. Such a high prevalence of this issue may be primarily due to a hormonal reaction to stress, as well as limited motor activity brought on by prolonged shel-

	The number of examinees $n = 120$	
	abs	%
Frequency of menstrual disorders	79	65.8
Secondary amenorrhea	21	26.6
Excessive menstruation during puberty	22	27.8
Pathological menarche	63	52.5
Dysmenorrhea	36	45.6
Metabolic syndrome	74	61.7

tered accommodation, a lack of usual physical activity, sports, eating disorders with irregular eating, overeating high-calorie food, or fast food after being starved for an extended period of time. A detailed analysis of medical records from adolescents with confirmed MetS revealed this population's high prevalence of menstrual irregularities. Among MDs in girls with MetS and obesity, oligomenorrhea prevailed – 36.5% ($n=27$). Secondary amenorrhea was noted in 28.3% ($n=21$) of girls with MetS. Excessive menstruation was observed much more often in girls with MetS – 17.6% ($n=13$) and dysmenorrhea in 17.6% ($n=13$). The presented MDs were significantly different from the parameters of girls with normal weight with high reliability ($P < 0.05$).

Discussion

MDs refer to various conditions that can affect a woman's menstrual cycle. These conditions include premenstrual syndrome, excruciating cramps, and heavy or irregular periods (PMS)^[12]. They may also include more serious conditions like endometriosis and PCOS^[13,14] (Fig. 2). Various complex aetiologies, including hormone imbalances, reproductive system structural issues, and specific medical conditions may cause MDs. A common health issue for women in war-torn places is atypical menstruation, precipitated by stress^[15]. A significant percentage of females experience SA, a widespread problem with reproductive health. It is described as a female who has previously experienced regular menstrual cycles ceasing to do so. SA was found to be relatively common in our adolescent sample, affecting 26.6% of the population. This is astronomically high, compared to the typical 3–4% of reproductive-age women affected^[14]. The higher rate of SA in our sample cohort may be caused by stress-related anovulation. This condition, also known as functional hypothalamic amenorrhea, frequently causes SA. Similar to the effects of mental stress, intense exercise, malnutrition, and chronic illnesses, it is caused by reproductive dysfunction. SA is a serious illness that may result in infertility, long-term mental health problems, and a lower quality of life. It may also precipitate bone mineral density loss and increase the risk of osteoporosis. Additionally, SA may indicate underlying severe conditions such as pituitary tumors, thyroid issues, and PCOS. To avoid further issues, it is crucial to identify and manage SA as soon as feasible^[14,15].

In contrast to the 7–15% projected prevalence in a study by Fiala *et al.*^[16] our study observed that 27.8% of the sample population reported experiencing heavy menstruation during puberty. War-related stress may increase the probability of developing heavy menstrual bleeding. Stress factors associated with war can increase cortisol levels, disrupting the body's estrogen and progesterone ratio and causing irregular uterine bleeding. Moreover, it may be difficult for individuals to receive the best medical care for the underlying diseases that cause substantial bleeding during a war since they are dispersed and lack access to healthcare.

When a female experiences PM, her first menstrual cycle begins at a very young age. Individuals surmounting 52.5% (with a mean age of 14.5 years) in our sample were identified to have the said condition, which is comparable to 48% of rural Bangladeshi adolescent females who experienced first menstrual cycles that were abnormal and associated with stress and poor living conditions^[17]. Wartime stress may increase levels of stress

hormones like cortisol, which can disturb the body's normal estrogen and progesterone ratio and hasten menarche. Additionally, displacement and lack of access to healthcare may also contribute to PM as it may make it difficult for individuals to receive proper medical treatment for underlying aetiologies of the early onset of menarche^[17].

In a recent study of adolescent schoolgirls in Ghana, dysmenorrhea, a condition characterized by intense pain during menstruation, it has affected 68.1% of the participants^[18]. According to the study, this high prevalence may be precipitated by the participants' high-stress levels. This correlation is strengthened by the fact that 45.6% of the individuals in our sample population reported having dysmenorrhea, demonstrating a strong correlation between the condition and stress. War stress may still worsen this issue by altering hormone levels and the typical regularity of the menstrual cycle. Dysmenorrhea has a significant detrimental impact on the body and the mind. In addition to resulting in pain, discomfort, weariness, and mental suffering if left untreated, it also raises the risk of infection and other harmful effects. It might also be a symptom of more serious underlying conditions, including endometriosis, uterine fibroids, or adenomyosis. Therefore, dysmenorrhea must be treated early and effectively to prevent any issues in the future^[18].

The high prevalence of MetS in our sample population (61.7%), in light of the numerous studies showing a strong association between stress and MetS, is a further cause for concern^[18,19]. Stress brought on by conflict may raise cortisol levels, which may disrupt the body's glucose and insulin balance and cause hyperglycemia. Additionally, poor nutrition and restricted access to healthcare during war can aggravate MetS's development. The risk of infection and other issues, as well as heart disease, stroke, diabetes, and emotional discomfort, rises when MetS is left untreated. MetS has a significant psychological and physical impact^[20]. Moreover, more serious underlying medical conditions like obesity, PCOS, and thyroid disorders may exhibit symptoms similar to MetS. Therefore, it is crucial to successfully manage MetS as soon as possible to avoid further complications and sequelae.

Provided that 65.8% of the adolescents in this study had MDs, their menstrual cycle has likely been considerably changed or disturbed. Compared to earlier studies on the consequences of war by Hannoun *et al.*^[15], who reported that 35% of women polled had menstruation irregularities due to stressors linked with war, our findings are astronomically high at 65.8%. This issue must be addressed since the high occurrence of MDs in Ukraine highlights the devastating effects of the conflict and that related stressors significantly impact the menstrual cycle.

Additionally, studies have indicated that those who live in areas affected by armed conflict have a higher prevalence of eating disorders due to the stress of war. According to Antoine *et al.*, stress from war has a substantial role in the development of eating disorders. This was demonstrated in a sample of 300 Lebanese students, 71% of whom admitted to having food issues during war^[21]. According to Wiksten *et al.*, 68% of adolescent females with menstrual abnormalities are also known to have eating disorders, demonstrating an association between menstrual issues and other eating disorders^[22]. This may aid in explaining why a rise in MDs was noted in the war-torn Ukrainian population, where an alarmingly high percentage (81%) of adolescent girls experienced eating disorders. One of the most common eating disorders, anorexia nervosa, can cause

drastic weight and fat loss, which can interfere with the menstrual cycle and cause amenorrhea (the lack of monthly cycles) and oligomenorrhea (infrequent or light menstrual periods)^[22]. Bulimia nervosa, an eating disorder comprising purging behaviors, may disrupt the menstrual cycle and cause hormonal imbalances^[23]. Further, the psychological stress of battle may cause MDs to emerge on their own. Because of the effects of eating disorders and stress-related to the conflict, people who live in war-affected areas may suffer substantial harm to their physical and mental health. This issue calls for a comprehensive strategy that tackles both the physiological and psychological effects of conflict-related pressures. Medical care, counseling, support services, dietary assistance, education and awareness campaigns, and access to healthcare are all examples of interventions. Given the adolescent population's unique needs and diverse cultural backgrounds, these interventions should be performed in conjunction with local healthcare organizations and providers. It is also crucial to address the root causes of the war and displacement to relieve stress effectively. The study emphasizes the need for further therapies to address the issue of MDs linked to conflict in young people. Understanding the specific causes and risk factors for these illnesses in the context of stress associated with armed conflict is vital, as is the development of interventions, including counseling, medical care, and support systems to aid persons suffering from war-related MDs.

The study's limitations were its inability to conduct random sampling and the under-representation of adolescent girls in Ukraine (fewer participants relative to adolescent females affected by the war). Volunteer bias may result in underestimation or overestimation of prevalence estimates while affecting the associations between MD and war-related stress to a lesser extent.

Conclusion

Adolescent females under stress require a quick assessment of their psychoemotional and metabolic conditions. The protection from future menstruation and reproductive illnesses depends on this tactic. By having these conditions quickly diagnosed and well-managed, adolescent females may maintain good physical and emotional health.

Ethical approval

It was waived for the study at Sumy State University.

Parental consent for minors

Written informed consent was obtained from the patient's parents/legal guardian for publication and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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Author contribution

All authors contributed to the concept and review of the manuscript. All authors approved the final version of the manuscript.

Conflicts of interest disclosure

The authors declare that they have no financial conflict of interest with regard to the content of this report.

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1. Name of the registry: NA.
2. Unique Identifying number or registration ID: NA.
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