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HORMONE IMBALANCE AS A MANIFESTATION OF STRESS IN THE FORMATION OF OLIGOMENORRHEA IN TEENAGE GIRLS

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Summary

Stress is currently the most significant factor contributing to reproductive function disorders and has become a major public health problem in the 21st century. Stress is implicated in the development of oligomenorrhea (OM), particularly in the context of the ongoing full-scale war in Ukraine.

The aim *of the study was to determine the characteristics of the content of steroid hormones, including stress-related hormones, in adolescent girls with OM.*

Materials and methods. *A total of 193 girls aged 12-18 years with OM were observed and stratified into groups according to OM duration. Hormonal assessment included serum measurements of estradiol (E_2), testosterone (T), cortisol (C), 17-hydroxyprogesterone (17-OH), dehydroepiandrosterone sulfate (DHEA-S), and sex steroid-binding globulin (SSBG). The ratios of C/DHEA-S and the free T index were also calculated.*

Written informed consent for all medical procedures was obtained from each participant or their parents/guardians. The study protocol was approved by the Bioethics and Deontology Committee of the State Institution «Institute for Children and Adolescents Health Care of the National Academy of Medical Sciences of Ukraine» (protocol No. 7 dated 25.11.2024).

Statistical analysis was performed using the computer program Statgraphics Plus. Results were analyzed by one-way analysis of variance. Differences were considered significant at $p < 0.05$. Data are presented as mean ± standard deviation (SD) and frequency counts. The significance of differences between groups was assessed using Fisher's exact test, the Wilcoxon–Mann–Whitney test, and the χ^2 test.

The study was conducted according to the research plan entitled «Study of the mechanisms of comorbid pathology formation in adolescent girls with menstrual disorders (primary oligomenorrhea and abnormal uterine bleeding)» (state registration number: 0121U114425).

Results. *At OM onset, nearly 20% of participants exhibited low E_2 levels. With increased disease duration (years 2-3), the proportion of adolescents with low E_2 decreased while those with elevated E_2 increased. E_2 is known to influence reproductive potential and correlate with mood alterations; a parallel trend was observed for C. Conversely, DHEA-S levels rose with prolonged OM duration. Early in OM progression, characteristic findings include low E_2, C, and DHEA-S levels, accompanied by increased C/DHEA-S ratios, suggesting diminished adaptive capacity. With extended OM duration, the proportion of girls exhibiting elevated free T, 17-OH, DHEA-S, and T/E_2 ratios increased, indicative of emerging polycystic ovary syndrome (PCOS). The percentage of adolescents with elevated C/DHEA-S ratios declined, whereas low ratios became more prevalent. Significant positive correlations were observed between C and T ($r = 0.31$; $P < 0.001$), DHEA-S and C ($r = 0.46$; $P < 0.0001$), and free T and DHEA-S ($r = 0.44$; $P < 0.0005$).*

Conclusions. *The findings do not support an association between OM development and dysregulation of adrenal–gonadal interactions, which govern menstrual function regulation and are linked to stress responses and maladaptation.*

Keywords: *Oligomenorrhea, Adolescent Girls. Steroid Hormones. Stress.*

Introduction

Adolescence represents a transitional stage between childhood and adulthood, characterized by biological, psychological, and sociological changes. One of the key biological events in adolescent girls is the onset of menstruation. The initiation of menstruation marks a new phase in a girl's life. The menstrual cycle is a natural physiological process, which ceases only during pregnancy, breastfeeding, and menopause.

The endocrine system plays a crucial role in regulating menstrual cyclicity. Any disturbance or functional impairment of the hypothalamic–pituitary–ovarian (HPO) or hypothalamic–pituitary–adrenal (HPA) axes may lead to menstrual dysfunction. Menstrual disorders are among the most frequent gynecological complaints and may persist from menarche to menopause [1]. The global prevalence of irregular menstrual cycles ranges from 14.2% to 27%, depending on geographic and demographic factors. These disturbances can significantly affect the overall health and well-being of adolescent girls [2, 3]. The menstrual cycle plays a critical role in reproductive function and is regulated by reproductive hormones that operate through the integration of the HPO and HPA axes. The duration of the menstrual cycle is reflective of a woman's fertility status. Studies have shown that shorter cycles are associated with earlier onset of menopause, while prolonged cycles (lasting more than 45 days) may increase the risk of developing type 2 diabetes and coronary heart disease [4, 5, 6].

Menstrual cycle regularity is a key indicator of reproductive health, and it results from a finely tuned interaction between the hormonal system and various organ systems. Steroid hormones serve as essential regulators of a wide range of physiological processes. Their biosynthesis is a complex, multistep pathway involving the coordinated action of numerous substrates and enzymes.

These hormones are vital not only for reproductive capability – including normal human development, sexual differentiation, secondary sexual characteristics, and sexual behavior – but also for cardiovascular health, metabolic regulation, and brain function [7, 8, 9, 10].

A cycle length of 25-35 days is a reliable predictor of ovulation in adult women; however, cycle length in adolescents is a poor marker of ovulation [11]. Cohort studies conducted in France and Japan have shown that the interval between menarche and the onset of regular menstruation has increased despite a decline in the age of menarche. These studies indicate that a five-year interval after menarche is typically required for most adolescent girls to achieve regular menstruation. Irregular menstruation following menarche is generally attributed to the absence of positive feedback from estrogens on pituitary hormones. An immature hypothalamic–pituitary–ovarian (HPO) axis may result in oligomenorrhea and anovulatory cycles. Earlier menarche and delayed onset of regular menstruation increase susceptibility to anovulatory cycles and, consequently, hormonal imbalances during adolescence [12, 13, 14]. Literature reports the percentage of ovulatory cycles relative to the time since menarche: 15-18% of girls exhibit ovulatory cycles within one year of menarche; this increases to 40% by two years, 50% by three years, and approximately 70-75% by seven years post-menarche [11]. Menstrual irregularity during adolescence may result from stress, a process in which steroid hormones play a significant role. Disruption of menstrual rhythm poses risks to both the physical and mental health of adolescents. According to the literature, the primary causes of oligomenorrhea are neuroendocrine immaturity (HPO axis) and elevated androgen levels in serum [12]. However, there is a paucity of studies examining the specific interactions between sex steroids and adrenal hormones in adolescent oligomenorrhea, particularly with varying durations of the disorder.

The early postmenarcheal period may represent a critical window of opportunity during which preventive measures are essential to safeguard reproductive health in adulthood.

The aim of this study was to characterize the steroid hormone profile, including stress hormones, in adolescent girls with oligomenorrhea.

Materials and methods

A total of 193 patients with oligomenorrhea (OM), aged 12-18 years, were examined and divided into groups based on menstrual age. In all participants, menstrual cycle disorders first appeared within the first postmenarcheal year. The first group comprised 31 girls who sought medical assistance during the first year after menarche. The second group included 44 adolescents with OM duration of up to 2 years, the third group consisted of 59 patients with OM lasting up to 3 years, and the fourth group included 59 patients in whom OM persisted for more than 3 years. Hormonal status assessment involved determination of serum estradiol (E_2), testosterone (T), cortisol (C), and sex steroid-binding globulin (SSBG) by enzyme immunoassay using a Rayto RT-2100C photometer and kits from Best Diagnostic, Kyiv. Dehydroepiandrosterone sulfate (DHEA-S) and 17-hydroxyprogesterone (17-OH) levels were measured using ELISA kits from ELISA, Germany.

Blood samples for steroid hormone analysis were collected from the cubital vein at 8 a.m. after an overnight fast. Samples were stored at –20 °C until analysis.

The comparison group consisted of 35 girls of the same age with a normal menstrual cycle. Examinations were conducted on days 4-6 of the menstrual cycle.

Written informed consent for all medical procedures was obtained from each participant or their parents/guardians. The study protocol was approved by the Bioethics and Deontology Committee of the State Institution «Institute for Children and Adolescents Health Care of the National Academy of Medical Sciences of Ukraine» (protocol No. 7 dated 25.11.2024).

Statistical analysis was performed using the computer program STATGRAPHICS Plus. Results were analyzed by one-way analysis of variance. Differences were considered significant at $\rho < 0.05$. Data are presented as mean ± standard deviation (SD) and frequency counts. The significance of differences between groups was assessed using Fisher's exact test, the Wilcoxon–Mann–Whitney test, and the χ^2 test.

The study was conducted according to the research plan entitled «Study of the mechanisms of comorbid pathology formation in adolescent girls with menstrual disorders (primary oligomenorrhea and abnormal uterine bleeding)» (state registration number: 0121U114425).

Results and discussion

Analysis of steroid hormone levels revealed distinct features in their concentrations depending on the duration of OM. The average levels of certain steroid hormones demonstrated significant differences both in comparison with normative values and between the study groups (Table 1).

The estradiol (E_2) content did not show statistically significant differences either between the groups or in comparison with the control group. In contrast, the levels of testosterone (T), free T, and the T/E_2 ratio increased significantly with the prolonged course of OM. Cortisol (C) concentrations, on the other hand, decreased with longer disease duration and differed significantly from those in the comparison group. Literature reports suggest that androgens may suppress the hypothalamic–pituitary–adrenal (HPA) axis response to stress [15]. An increase in dehydroepiandrosterone sulfate (DHEA-S) levels was observed with the progression of the disorder, which may be interpreted as a compensatory protective response to anxiety associated with amenorrhea. It is currently being discussed that DHEA-S may exert neuroprotective and rejuvenating effects (hence its reference as the «youth hormone»), given that chronic stress is associated with sustained elevations in glucocorticoids, potentially leading to neurodegeneration in specific brain pathways. However, these hypotheses remain insufficiently substantiated [16].

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Table 1

Average morning values of steroid hormones, SSBG in adolescent girls with OM

Hormons	Statistical indicator	I gr.	II gr.	III gr.	IV gr.	All	Comparison group (control)
T, nmol/l	n M±SD Me	31 2,08±1,60[1)] 1,61	44 2,27±1,23[1),2)] 2,08	59 2,64±1,23[3)] 2,62	59 2,69±1,15[4)] 2,59	193 2,47±1,29 2,38	35 2,85±1,21 2,78
E_2, nmol/l	n M±SD Me	30 0,35±0,33 0,23	43 0,30±0,21 0,24	57 0,38±0,27 0,3	58 0,37±0,34 0,25	188 0,35±0,29 0,25	35 0,34±0,21 0,30
T/E_2, units	n M±SD Me	30 8,45±5,63[1)] 8,56	42 9,45±6,26 7,41	57 9,76±8,20 7,64	58 13,46±12,19[4)] 9,67	187 10,63±9,07 8,08	35 10,54±7,58 8,35
T/C, units	n M±SD Me	27 0,006±0,004 0,005	39 0,007±0,004 0,005	51 0,007±0,005 0,006	55 0,007±0,003 0,007	174 0,007±0,004 0,006	30 0,007±0,006 0,006
Free T index	n M±SD Me	15 4,54±4,50 3,82[1)]	33 8,36±7,86 5,42[1),2)]	34 9,14±7,94 6,05[1),3)]	36 10,37±9,45 8,69[1),4)]	118 8,66±7,39[1)] 5,48	30 4,43±2,0 4,12
C, nmol/l	n M±SD Me	29 434.27±200,91 419,5	39 376,2±150,83[1),2)] 378,9	52 447,16±272,79 397,15	55 413,0±168,39[1),4)] 390,9	175 416,69±206,60[1)] 387,5	35 491,76±217,63 424,0
DHEA-S, µmol/l	n M±SD Me	15 5,19±3,04 4,8	30 5,70±2,86 5,31	34 6,82±3,96 5,77	41 8,23±4,11[1),4)] 8,07	120 6,79±3,79 5,7	27 6,31±2,84 5,29
C/ DHEA-S, units	n M±SD Me	15 114,28±55,64[1)] 127,88	28 81,28±43,94[2)] 74,96	30 85,94±74,45[3)] 63,95	40 71,74±59,84[4)] 54,80	113 83,16±60,79 65,07	27 86,66±45,50 77,12
17-OH, nmol/l	n M±SD Me	15 3,06±1,83[1)] 2,74	27 2,67±2,23[1)] 1,86	31 3,29±2,56[1)] 2,8	35 3,44±2,24[1)] 2,53	108 3,15±2,27[1)] 2,36	20 5,43±3,93 4,1
SSBG, nmol/l	n M±SD Me	15 53,81±29,15[1)] 49,88	33 43,14±30,78[1)] 30,0	34 41,86±24,63[1)] 37,29	36 39,57±22,21[1),4)] 36,48	119 43,15±26,35[1)] 36,22	30 63,18±20,59 59,0

Note:[1)] P <0,05-0,0004 – in relation to control
[2)] P <0,03-0,01 – comparing groups 1 and 2
[3)] P <0,04-0,01 – comparing groups 1 and 3
[4)] P <0,005-0,004 – comparing groups 1 and 4

Dysfunction of the HPA system may not be clearly reflected in the basal level of C; rather, the C/DHEA-S ratio is considered a more sensitive indicator. C and DHEA-S are the two most prominent hormones involved in the physiological response to stress, emotional regulation, and behavioral functioning, and their ratio is crucial for maintaining the balance of the stress system. It is regarded as a marker of endocrine imbalance. The C/DHEA-S ratio was dependent on menstrual age and significantly decreased as menstrual age increased. Thus, the stress response to menstrual dysfunction was more pronounced at the onset of the disorder and indicated a dissociation in the production of C and DHEA-S, which may contribute to the development of various conditions, including psychopathological disorders. As the disorder persists, the activity of the HPA axis undergoes changes. In cases of prolonged OM, a decrease in the C/DHEA-S ratio – used as an alternative index of adrenal cortex activity and cortisol exposure – may reflect the formation of a compensatory protective response to the chronic stressor of menstrual dysfunction. In this case, the reduction in the ratio occurs primarily due to increased levels of DHEA-S, which, on the one hand, may offer neuroprotection against the adverse effects of glucocorticoids and, on the other, may contribute to the development of symptoms associated with post-traumatic stress disorder.

Thus, the activity of the HPA axis, as reflected by the cortisol to DHEA-S ratio, is an important factor associated with the body's adaptive responses to stress.

The analysis of relationships between steroid hormones revealed that estradiol (E_2) levels positively correlated with testosterone (T) (r=0.28; P<0.004) and DHEA-S (r=0.28; P<0.003). A positive correlation was also established between C and T (r=0.31; P<0.001), and T and DHEA-S (r=0.46; P<0.0000), which may indicate the activation of both the hypothalamic–pituitary–gonadal (HPG) and hypothalamic–pituitary–adrenal (HPA) systems in adolescent girls specifically in response to menstrual dysfunction. Normally, the HPG and HPA axes interact through a feedback loop, especially under stress. However, during adolescence, these two systems tend to function in a synchronized, bidirectional manner, where activation of one axis modulates the effect of the other, thereby maintaining homeostasis. [17, 18].

Individual analysis of steroid hormone levels revealed considerable variability. Among girls with a menstrual age of up to one year, reduced E_2 levels were most frequently observed (Fig. 1), indicating a diminished capacity to cope

with stress at the early stage of the disorder. As the duration of OM increased, the percentage of adolescents with low E_2 levels significantly decreased, particularly during the third year of the disorder ($P < 0.006$), followed by a subsequent increase. Hyperestrogenic forms of OM were identified in 6.7% to 14% of cases.

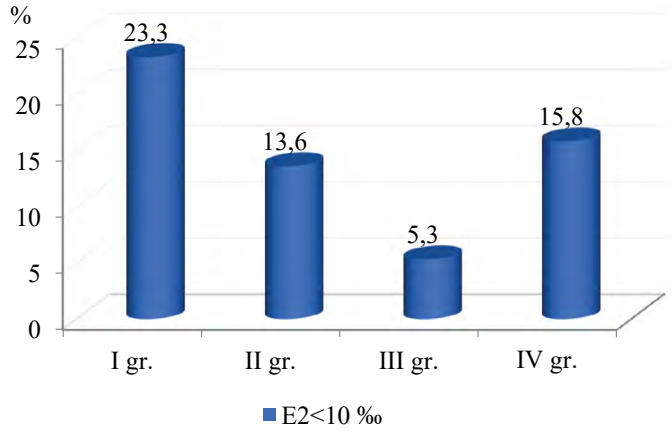

Fig. 1. Percentage of girls with estradiol levels < 10 percentile.

Baseline total testosterone (T) levels exceeded the 75th percentile in 7% to 12% of girls with OM. The free T index surpassed normative values in more than half of the patients (Fig. 2).

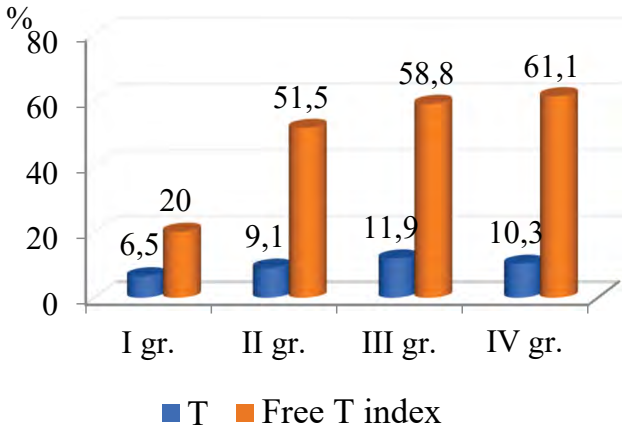

Fig. 2. Percentage of patients with T content and free T index value above 75 percentile.

The T/E_2 ratio, an indicator of hyperandrogenism, was markedly elevated (above the 90th percentile) in 13.8% of all patients. This was most commonly observed in girls with prolonged OM (more than 3 years), with statistically significant differences compared to Group I ($P < 0.0001$) and Group III ($P < 0.005$) (Fig. 3).

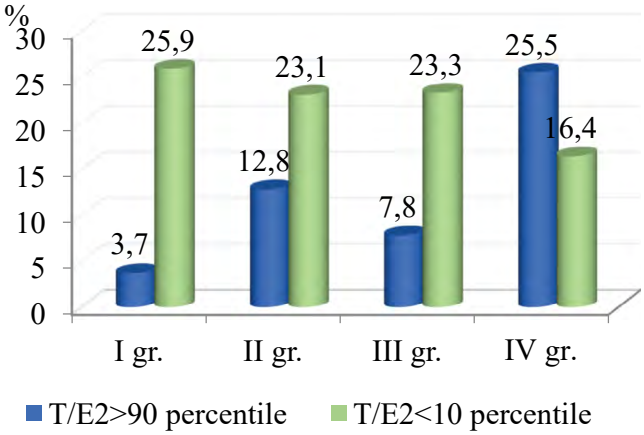

Fig. 3. Percentage of patients with changed T/E2 ratio.

A comparison between the clinical manifestations of hyperandrogenism (hyperandrogenic dermopathy – hirsutism, acne vulgaris, striae, oily seborrhea) and laboratory findings revealed that girls exhibiting hormonal deviations toward increased androgen levels were 1.3 times more likely to present with hyperandrogenic dermopathy. However, in some cases of hirsutism, androgen levels remained within the reference range. This suggests that the

clinical presentation of hyperandrogenism may, in certain instances, be more sensitive than laboratory markers [21].

In addition to the ovaries, the adrenal glands also contribute to the production of 17-hydroxyprogesterone (17-OH), which is considered not only a marker of hyperandrogenic states but also of physiological stress [22]. In 85-89% of patients with OM, 17-OH levels remained within the reference range. Notably, with increased duration of OM, elevated levels of 17-OH rose by 1.5-fold, while low concentrations decreased by 2.8-fold.

Elevated C levels were most frequently observed during the first year following menarche. As the menstrual disorder persisted, the percentage of patients with elevated cortisol levels decreased by 1.8-3.3 times (Fig. 5). This decline was statistically significant in girls from Groups I and II ($P < 0.05$).

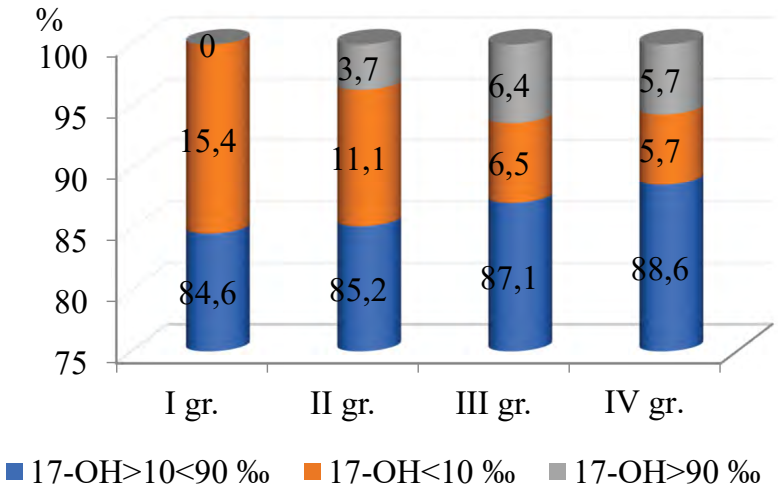

Fig. 4. Percentage of adolescents with different values of 17-OH.

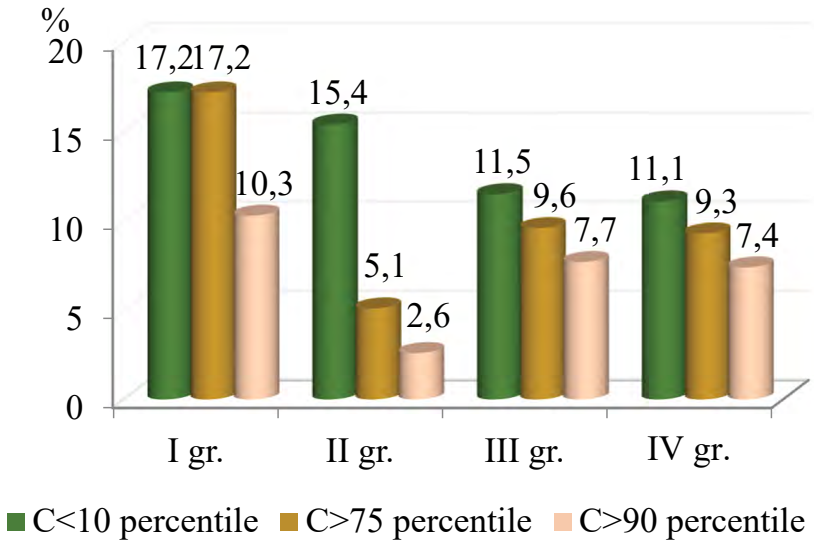

Fig. 5. Percentage of patients with different cortisol levels.

A decrease in C levels was observed, on average, in 13.2% of patients with OM. According to literature sources, reduced circulating cortisol concentrations may serve as a predictor for the development of post-traumatic stress disorder symptoms [10]; in this context, menstrual dysfunction may act as the stressor.

Dehydroepiandrosterone (DHEA) is the most abundant hormone in the peripheral circulation and serves as a precursor for the synthesis of various steroids. . In addition to testosterone and dihydrotestosterone, the primary circulating androgens in females include DHEA and its sulfated form, DHEA-S. DHEA-S is more prevalent due to its longer half-life and lower metabolic clearance compared to DHEA [23, 24]. Both DHEA and DHEA-S exhibit antiglucocorticoid properties, enabling them to counterbalance the effects of cortisol and offer protection against its prolonged action in stressful situations [25, 26, 27]. With increasing duration of OM, DHEA-S concentrations rose, whereas the proportion of patients with low DHEA-S levels declined (Fig. 6).

Analysis of the C/DHEA-S ratio revealed significant differences associated with the duration of the disorder (Fig. 7). In the early stages of OM, over 50% of adolescents exhibited an elevated C/DHEA-S ratio, primarily due to a reduction in DHEA-S. The interaction between cortisol and DHEA-S plays a vital role in maintaining the homeostasis of the stress response system. Disruption in the coordinated secretion of these hormones may impair the body's ability to effectively cope with stress.

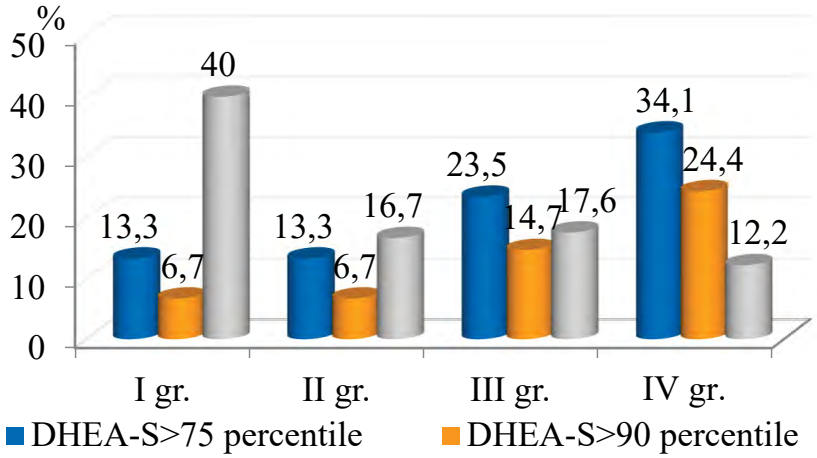

Fig. 6. Percentage of girls with OM and different levels of DHEA-S.

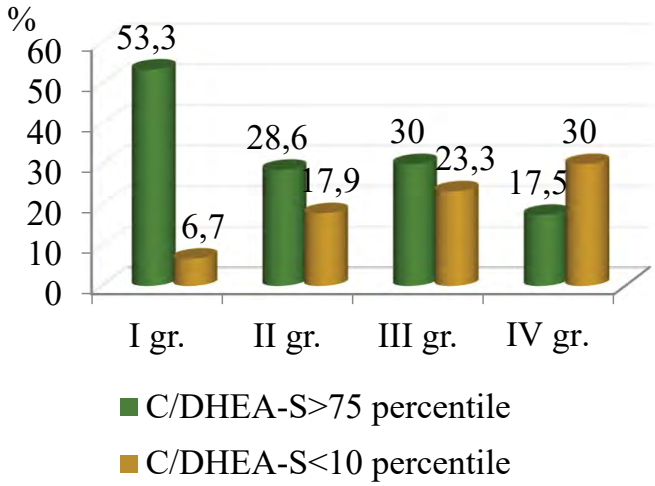

Fig. 7. Percentage of adolescent girls with different levels of the C/DHEA-S ratio.

In summary, menstrual disorders of the oligomenorrhea (OM) type are associated with dysregulation of both the hypothalamic-pituitary-adrenal and hypothalamic-pituitary-gonadal axes.

The menstrual cycle represents a vital biological rhythm regulated by the complex interaction of numerous hormones, including steroid hormones. Menstrual disorders constitute a significant clinical issue that demands a multifaceted approach [4, 28]. It is well established that any disturbances in steroid hormone secretion can lead to menstrual cycle irregularities. The sensitivity of the organism involves not only fluctuations in reproductive steroid levels but also in adrenal steroids, which are intricately linked to stress response mechanisms. These hormonal imbalances may result in marked alterations in emotional regulation, cognitive functioning, and behavioral patterns in adolescent girls. Early detection of menstrual irregularities is essential to reduce the risk of future reproductive dysfunction. A stable menstrual cycle is largely determined by the balance of reproductive and adrenal steroid hormones. Cycle irregularity often reflects disturbances in hormonal status and may itself act as a stressor for the adolescent organism. Nearly all steroid hormones contribute, to varying degrees, to the physiological responses to stress in the adolescent body.

The literature suggests that estrogens modulate neural processes involved in the regulation of stress responses, cognitive performance, and emotional balance. Low estradiol levels are associated with diminished stress resilience [19, 29]. . The highest proportion of girls with reduced E_2 concentrations was observed at the onset of OM. As the duration of the disorder increased, the prevalence of low E_2 levels declined. A similar trend was observed for cortisol levels. In contrast, DHEA-S levels tended to rise with prolonged duration of the disorder.

At the onset of the disorders of OM type, low levels of E_2, C, DHEA-S, along with elevated values of the C/DHEA-S ratio are commonly observed. These findings may indicate a reduction in adaptive capacity, often referred to as «adrenal fatigue»—a term popularized to describe physiological maladaptation to chronic stress exposure [30]. As the duration of OM increases, the proportion of adolescents with low E_2 and C levels decreases,, while the percentage of patients with elevated concentrations of free T, 17-OH, DHEA-S, and T/E_2 index increases. These hormonal changes are indicative of a pathophysiological shift toward polycystic ovary syndrome (PCOS)-like features. Concurrently, the percentage of adolescents with a high C/DHEA-S ratio decreases, whereas the proportion of those with a low ratio increases. The interplay between

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cortisol and DHEA-S is a key component of the stress regulation system [31]. Traditionally, hormones of the HPG and HPA axes – namely, testosterone and cortisol – are thought to exert inhibitory or opposing effects on each other, and prior to puberty, these systems are often described as functionally competitive. However, during adolescence, they begin to operate in a coordinated manner, functioning synergistically to maintain physiological homeostasis [32]. Support for the coupling hypothesis is provided by strong positive correlations observed between C and T ($r=0.31$; $P<0.001$), between DHEA-S and C ($r=0.46$; $P<0.000$) and between free T and DHEA-S ($r=0.44$; $P<0.0005$). The C/DHEA-S ratio most accurately reflects the extent of «functional» hypercortisolemia. Notably, this ratio declines as the duration of OM increases. The upregulation of DHEA-S synthesis may suggest a compensatory protective role against the neurotoxic effects of glucocorticoids.

Collectively, these findings underscore the significant role of androgens in the pathogenesis of OM. The complexity of hormonal interactions identified in this study highlights pathogenetic characteristics of OM that evolve over time and must be considered in the development of individualized therapeutic strategies.

Conclusion

1. Menstrual dysfunction is closely associated with stress-related conditions. The interplay between sex and adrenal hormones plays a significant role in the pathogenesis of oligomenorrhea, influencing the clinical course of the disorder.

2. The levels of stress-related hormones vary considerably depending on the duration of OM. At the initial stage of the disorders of OM type, low levels of E_2, C, and DHEA-S, along with elevated values of the C/DHEA-S ratio, are characteristic, indicating reduced adaptive capacity. As OM persists, the proportion of girls with elevated concentrations of free T, 17-OH, DHEA-S, T/E_2 ratio increases, reflecting features typical of PCOS.

3. The C/DHEA-S ratio, which reflects the functional status of the HPA axis, demonstrates specific patterns depending on the duration of OM. With prolonged OM, the percentage of adolescents with elevated C/DHEA-S ratios decreases, while the proportion with low values increases. This may reflect, on the one hand, a reduction in stress burden and, on the other, an exhaustion of adaptive reserves.

Conflict of interest. The authors declare no conflict of interest.

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ГОРМОНАЛЬНИЙ ДИСБАЛАНС ЯК ПРОЯВ СТРЕСУ ПРИ ФОРМУВАННІ ОЛІГОМЕНОРЕЇ У ДІВЧАТ-ПІДЛІТКІВ

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Резюме.

Стрес на даний час є найбільш значущим фактором, відповідальним за порушення репродуктивної функції. який став однією з найважливіших проблем здоров'я в суспільстві у XI столітті. Стрес є одним з елементів виникнення олігоменореї (ОМ), особливо зараз, коли в Україні йде повномасштабна війна.

Метою дослідження стало з'ясування особливостей вмісту стероїдних гормонів, у тому числі гормонів стресу, у дівчат-підлітків з олігоменореєю.

Матеріали і методи. Під наглядом знаходилося 193 дівчинки 12-18 років з ОМ, які були розподілені на групи у залежності від тривалості ОМ. Гормональне обстеження включало визначення в крові рівнів естрадіолу (E_2), тестостерону (Т), кортизолу (К), 17-гідроксипрогестерону (17-ОН), дегідроепіандростерону сульфату (ДГЕА-С), сексстероїдзв'язуючого глобуліну (ССЗГ). Розраховувалися індекси К/ДГЕА-С, вільного Т.

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На всі медичні заходи було отримано письмову поінформовану згоду від кожного зареєстрованого учасника або їх батьків/опікунів. Протокол дослідження схвалено комітетом з біоетики та деонтології ДУ «Інститут охорони здоров'я дітей та підлітків НАМН України» (протокол № 7 від 25.11.2024 р.).

Статистичну обробку результатів проводили за допомогою комп'ютерної програми «Statgraphics plus». Результати було проаналізовано за допомогою однофакторного дисперсійного аналізу. Різниця в показниках вважалась достовірною при $\rho<0,05$. Дані представлені у вигляді середнього ±SD (стандартне відхилення) та розрахунку частот. Значимість різниці між групами оцінювалася за допомогою критеріїв Фішера, Wilcoxon-Mann-Whitney, χ^2.

Робота виконана згідно плану НДР: «Вивчити механізми формування коморбідної патології у дівчат-підлітків з порушеннями менструальної функції (первинною олігоменореєю і аномальними матковими кровотечами)» (№ ДР 0121U114425).

Результати. З'ясувалося, що на початку формування ОМ майже у кожної п'ятої дівчинки реєструвалися знижені рівні E_2. При подальшому існуванні ОМ (на 2 і 3 році) питома вага підлітків з низькими цифрами E_2 зменшувалася, а кількість дівчат з високими значеннями E_2 зростала. Вважається, що E_2 окрім впливу на становлення репродуктивного потенціалу, пов'язаний також зі змінами настрою, особливо при його підвищеному рівні. Аналогічна тенденція простежувалася і відносно К. Рівень ДГЕА-С, навпаки, зі збільшенням тривалості захворювання зростав. На початку виникнення порушень за типом ОМ характерним є низькі рівні E_2, К, ДГЕА-С, підвищені значення співвідношення К/ДГЕА-С, що може свідчити про зниження адаптаційних ресурсів організму дівчинки. З подовженням тривалості ОМ зростає питома вага дівчат з високою концентрацією вільного Т, 17-ОН, ДГЕА-С, індексу Т/E_2, що характерно для формування СПКЯ. Знижується відсоток підлітків з підвищеними значеннями співвідношення К/ДГЕА-С і зростає з низькими. Виявлено тісні позитивні кореляційні зв'язки К і Т ($r=0,31$; $P<0,001$), а також між ДГЕА-С і К ($r=0,46$; $P<0,000$) і вільним Т і ДГЕА-С ($r=0,44$; $P<0,0005$).

Висновки. Отримані дані дозволяють стверджувати, що формування ОМ пов'язано з дискоординацією діяльності адреналових і гонадних взаємовідносин, відповідальних не тільки за встановлення певних ланцюгів регуляції менструальної функції, але й асоційованих з реалізацією стресових подій і проявами дезадаптації.

Ключові слова: олігоменорея, дівчата-підлітки, стероїдні гормони. стрес.

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