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### АЁЛ СПОРТЧИЛАРНИНГ ГОРМОНАЛ ҲОЛАТИГА ТАЪСИР ЭТУВЧИ ОМИЛЛАР

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### ФАКТОРЫ, ВЛИЯЮЩИЕ НА ГОРМОНАЛЬНОЕ СОСТОЯНИЕ СПОРТСМЕНОК

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**Резюме.** Тадқиқот мақсади: Турли спорт турлари билан шугулланувчи ва турли стажга эга бўлган спортчи аёлларнинг гормонал ҳолатини баҳолаш ҳамда жисмоний юкларнинг репродуктив ва стресс гормонлари даражасига таъсирини аниқлаш. Материаллар ва усуллар: Эстетик, чидамлик, куч ва жамоавий спорт турлари билан шугулланувчи 240 нафар (15-40 ёш) спортчи аёл иштирокида кузатув когорта тадқиқоти ўтказилди. Иштирокчилар спорт тури ва машғулот стажига кўра (<5 йил, 5-10 йил, >10 йил) гуруҳларга ажратилди. Фолликуляр фазанинг эрта босқичида (ҳайз циклининг 3-5-кунлари) FSG, LG, эстрадиол, тестостерон ва кортизол даражалари таҳлил этилди. Статистик аҳамиятлик  $p < 0,05$  да белгиланди. Натижалар: Гуруҳлар ўртасида гормонлар даражасида статистик жиҳатдан аҳамиятли фарқлар аниқланди ( $p < 0,05$ ). FSG, LG, эстрадиол ва тестостероннинг энг паст даражалари эстетик спорт турлари билан шугулланувчи спортчиларда, тестостерон ва эстрадиолнинг энг юқори кўрсаткичлари эса куч спорт турлари вакиллари орасида қайд этилди. Кортизол даражаси эстетик спорт тури вакилларида энг юқори ва куч спорт турлари билан шугулланувчи спортчиларда энг паст бўлиб, бу юкларга мослашнинг турли механизмларини кўрсатиши мумкин. Хулоса: Турли спорт турлари спортчи аёлларнинг гормонал мувозанатига сезиларли таъсир кўрсатади. Эстетик спорт турлари юқори физиологик стресс ва репродуктив гормонлар даражасининг пасайиши билан боғлиқ бўлса, куч машғулот тестостерон ва эстрадиол миқдорининг ортishiга олиб келади. Кортизол даражаси эстетик спорт тури вакилларида энг юқори ва куч спорт турлари билан шугулланувчи спортчиларда энг паст бўлиб, бу юкларга мослашнинг турли механизмларини кўрсатиши мумкин. Хулоса. Турли спорт турлари спортчи аёлларнинг гормонал мувозанатига сезиларли таъсир кўрсатади.

**Калит сўзлар:** спортчи аёллар, гормонал мувозанат, спорт физиологияси, эндокрин мослашув.

**Abstract.** Objective: This study aimed to assess the hormonal status of female athletes across different sports disciplines and training durations, evaluating the impact of various physical loads on reproductive and stress hormone levels. Methods: An observational cohort study was conducted, including 240 female athletes (aged 15–40 years) from aesthetic, endurance, strength, and team sports. Participants were grouped based on sports discipline and training experience (<5 years, 5–10 years, >10 years). Blood samples were collected in the early follicular phase (days 3–5), and hormone levels (FSH, LH, estradiol, testosterone, cortisol) were analyzed. Statistical significance was set at  $p < 0.05$ . Results: Statistically significant differences ( $p < 0.05$ ) were observed in hormone levels among the groups. Aesthetic sports athletes had the lowest FSH, LH, estradiol, and testosterone levels, along with the highest cortisol levels, suggesting increased physiological stress. Strength athletes exhibited the highest testosterone and estradiol levels, indicating an adaptive response to high-intensity training. Endurance and team sports athletes showed intermediate hormone levels. Conclusion: The study confirmed that different sports disciplines significantly affect the hormonal status of female athletes. Aesthetic sports were associated with higher physiological stress and lower reproductive hormone levels, while strength sports promoted higher testosterone and estradiol concentrations.

**Keywords:** Female athletes, Hormonal balance, Sports physiology, Endocrine adaptation.

**Introduction.** Sports activity has a significant impact on the hormonal balance of the body, particularly in women engaged in professional sports. Various types of physical exercise can affect the endocrine system in different ways, influencing the levels of reproductive hormones and stress markers. This is especially relevant for female athletes exposed to high physical and psycho-emotional

stress, which may lead to alterations in the functioning of the hypothalamic-pituitary-ovarian axis [1,2,6]. At present, the study of hormonal status in female athletes across different sports disciplines is gaining relevance due to the increasing number of women in professional sports and the need to develop recommendations for their physical training and recovery [3,4,5].

Existing scientific data suggest that physical activity can have both beneficial and adverse effects on the reproductive health of female athletes. For example, intense training combined with low body fat levels can lead to a reduction in estradiol and other hormone levels, increasing the risk of menstrual irregularities and reduced fertility. Different types of sports impose specific physical demands, which may result in varying hormonal responses [2,7,8,9]. However, there is currently insufficient data to conduct a comprehensive comparison of the hormonal profiles of athletes from different disciplines.

**Objective of the Study.** To determine the characteristics of the hormonal status of female athletes depending on the type of sport and the duration of training, assessing the degree of influence of various physical loads on the levels of reproductive and stress hormones.

**Materials and Methods.** The study was designed as an observational cohort study and included both cross-sectional and longitudinal analyses.

The study was conducted at the Republican Specialized Scientific and Practical Center of Sports Medicine. A total of 240 female athletes aged 15–40 years, who train at least three times per week and participate in official competitions, were included in the study.

Inclusion criteria:

Engagement in sports at a professional or high amateur level.

Absence of chronic diseases that could affect reproductive health.

Stable training regimen.

Exclusion criteria:

Diagnosed endocrine and gynecological disorders (e.g., polycystic ovary syndrome, endometriosis).

Use of hormonal therapy.

History of severe injuries or surgical interventions affecting hormonal status.

All participants were categorized based on their sports discipline and training experience. By sports discipline, they were divided into four groups:

Aesthetic sports (gymnastics, figure skating, rhythmic gymnastics, dance).

Endurance sports (long-distance running, swimming, cycling, triathlon).

Strength sports (weightlifting, powerlifting, CrossFit).

Team sports (basketball, volleyball, football, handball).

By training experience, participants were classified into three subgroups:

< 5 years of experience (n = 80).

5–10 years of experience (n = 80).

> 10 years of experience (n = 80).

**Laboratory Analysis.** Blood samples were collected in the morning (between 7:00 and 9:00 AM) on days 3–5 of the menstrual cycle under fasting conditions. The following hormone levels were assessed: Follicle-stimulating hormone (FSH), Luteinizing hormone (LH), Estradiol (E2), Testosterone (total and free), Cortisol (morning level and circadian rhythm).

**Statistical Analysis.** Data analysis was performed using SPSS 26.0 and R 4.2. Descriptive statistics included mean values (M) and standard deviation (SD). Differences were considered statistically significant at  $p < 0.05$ .

**Ethical Considerations.** The study was approved by the Local Ethics Committee, and all participants provided informed consent. All procedures complied with bioethical standards and were conducted in strict accordance with the principles of voluntary participation.

**Results.** Analysis of FSH and LH levels revealed statistically significant differences among the groups of female athletes ( $p < 0.05$ ). The lowest FSH and LH levels were observed in athletes from aesthetic sports, whereas the highest values were recorded in strength sports athletes. Endurance and team sports occupied an intermediate position, with no significant differences between these two groups (Table 1).

The lowest estradiol levels were observed in athletes from aesthetic sports, while the highest values were recorded in strength sports. The differences among all groups were statistically significant ( $p < 0.05$ ). Athletes in team and endurance sports had intermediate estradiol levels, which were also significantly higher than those in aesthetic sports.

Testosterone and cortisol concentrations also varied among the groups. Strength athletes had the highest testosterone levels, which were significantly higher than in all other groups ( $p < 0.05$ ), while the lowest values were recorded in aesthetic sports athletes.

Endurance and team sports athletes showed intermediate testosterone levels. Regarding cortisol, a physiological stress marker, the highest levels were found in aesthetic sports athletes, whereas strength athletes had the lowest cortisol levels ( $p < 0.05$ ). This suggests that aesthetic sports may be associated with higher chronic stress levels.

**Table 1.** Hormonal status of female athletes by sport type

	Sport Type (n=60)	FSH (mIU/mL)	LH (mIU/mL)	Estradiol (pg/mL)	Testosterone (nmol/L)
Aesthetic (n=60)	5,8±1,3	4,9±1,1	32,1±4,5	1,2±0,3	680±105
Endurance (n=60)	6,2±1,5	5,3±1,2	35,4±5,0	1,4±0,4	640±98
Strength (n=60)	6,9±1,4	6,0±1,3	41,3±4,7	2,3±0,5	560±87
Team (n=60)	6,5±1,3	5,7±1,2	38,6±5,2	1,7±0,4	590±92
	<i>p</i>	<i>P</i>	<i>p</i>	<i>p</i>	<i>p</i>
Aesthetic / Endurance	<0,05	<0,05	<0,05	<0,05	<0,05
Aesthetic / Strength	<0,05	<0,05	<0,05	<0,05	<0,05
Strength / Endurance	<0,05	<0,05	<0,05	<0,05	<0,05
Aesthetic / Team	<0,05	<0,05	<0,05	<0,05	<0,05
Strength / Team	0,071	0,053	<0,05	<0,05	0,920
Endurance / Team	0,135	0,103	<0,05	<0,05	<0,05

**Discussion.** The results confirm that the type of physical activity significantly influences the hormonal status of female athletes. The most pronounced differences were found in FSH and LH levels, which were lowest in aesthetic sports athletes and highest in strength sports athletes. This may be related to training characteristics: high-intensity exercise combined with strict body weight control in aesthetic sports may lead to reduced gonadotropin secretion, potentially increasing the risk of menstrual dysfunction. Significant differences were also observed in estradiol levels, which were lowest in aesthetic sports athletes and highest in strength sports athletes. Low estradiol levels in gymnasts and figure skaters may indicate an energy deficit, which is common in these sports. Conversely, the higher estradiol levels in strength athletes may be due to increased androgen secretion and peripheral aromatization into estrogens, a known physiological adaptation to strength training. Testosterone analysis revealed that the highest levels were observed in strength sports athletes, whereas the lowest levels were found in aesthetic sports athletes. This highlights the role of testosterone in muscle mass development and strength performance, which is crucial for anaerobic-demanding sports. At the same time, higher cortisol levels in aesthetic sports athletes compared to other groups suggest that chronic stress may be caused by both intense physical training and strict body weight and appearance requirements. These findings underscore the importance of an individualized approach to training and recovery strategies for female athletes. Optimizing nutrition, monitoring training loads, and regularly assessing hormonal status can help reduce the risk of endocrine dysfunction and support reproductive health.

**Conclusion.** This study confirmed that specific physical demands in different sports significantly impact the hormonal balance of female athletes. Lower FSH, LH, and estradiol levels in aesthetic sports athletes may indicate a risk of hypoestrogenism and menstrual disturbances, whereas higher testosterone and estradiol levels in strength athletes reflect physiological adaptations to intense training. These findings highlight the necessity for hormonal monitoring and sport-specific training approaches to maintain optimal endocrine and reproductive health in female athletes.

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#### ФАКТОРЫ, ВЛИЯЮЩИЕ НА ГОРМОНАЛЬНОЕ СОСТОЯНИЕ СПОРТСМЕНОК

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**Резюме.** Цель исследования. Оценить гормональный статус спортсменок различных спортивных дисциплин и стажа занятий, выявить степень влияния физических нагрузок на уровень репродуктивных и стрессовых гормонов. Материалы и методы. Проведено обсервационное когортное исследование с участием 240 спортсменок (15–40 лет), занимающихся эстетическими, выносливостными, силовыми и командными видами спорта. Участницы были разделены по спортивной дисциплине и стажу занятий (<5 лет, 5–10 лет, >10 лет). Анализировались уровни ФСГ, ЛГ, эстрадиола, тестостерона и кортизола в раннюю фолликулярную фазу (3–5 день цикла). Статистическая значимость установлена при  $p < 0,05$ . Результаты. Выявлены статистически значимые различия ( $p < 0,05$ ) в уровнях гормонов между группами. Минимальные уровни ФСГ, ЛГ, эстрадиола и тестостерона обнаружены у спортсменок эстетических видов спорта, тогда как максимальные показатели тестостерона и эстрадиола зарегистрированы у спортсменок силовых дисциплин. Уровень кортизола был наиболее высоким у представительниц эстетических дисциплин и наиболее низким у силовых спортсменок, что может свидетельствовать о различных механизмах адаптации к нагрузкам. Заключение. Различные виды спорта оказывают значимое влияние на гормональный баланс спортсменок. Эстетические виды спорта связаны с более высоким физиологическим стрессом и снижением уровней репродуктивных гормонов, тогда как силовые дисциплины способствуют повышению тестостерона и эстрадиола.

**Ключевые слова:** женщины-спортсменки, гормональный баланс, физиология спорта, эндокринная адаптация.