2024, Retos, 59, 811-821


# The influence of physiological and functional characteristics of the body of girls aged 17-18 years on playing sports

# La influencia de las características fisiológicas y funcionales del cuerpo de las niñas de 17-18 años en la práctica deportiva

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**Abstract.** Achieving competitive results in women's sports for athletes aged 17-18 requires structuring training processes around their physiological characteristics. This article analyzes recent scientific data on the impact of sexual dimorphism in girls aged 17-18 on sports participation and training. Relevant scientific works from the past five years were collected and analyzed. At this age, girls undergo the final stage of sexual maturation. The effectiveness of sports activities varies individually, influenced by the ovarian-menstrual cycle, hormonal background, and symptoms in each cycle phase. Physical activity declines during the menstrual, ovulatory, and premenstrual phases, while postmenstrual and postovulatory phases are more favorable for sports participation. Performance indicators depend on sexual dimorphism: female athletes show unique features in central nervous system activity, high psycho-emotional excitability, and earlier development of somatic and physical qualities compared to males. The skeletal structure in 17-18-year-old female athletes is smaller and shorter, with a wider pelvis and more developed shoulder girdle. These findings can be used by sports schools, rehabilitation specialists, coaches, and sports physicians to adapt and structure training processes, taking into account the physiological characteristics of 17-18-year-old female athletes, aiming for highly competitive results.
**Keywords:** Sexual Dimorphism, Hormonal Changes, Women's Sports, Physical Culture, Sports Performance.

**Resumen.** Lograr resultados competitivos en los deportes femeninos para atletas de 17-18 años requiere estructurar los procesos de entrenamiento en torno a sus características fisiológicas. Este artículo analiza datos científicos recientes sobre el impacto del dimorfismo sexual en las chicas de 17-18 años en la participación y el entrenamiento deportivo. Se recopilaron y analizaron trabajos científicos relevantes de los últimos cinco años. A esta edad, las chicas pasan por la etapa final de maduración sexual. La efectividad de las actividades deportivas varía individualmente, influenciada por el ciclo ovárico-menstrual, el fondo hormonal y los síntomas en cada fase del ciclo. La actividad física disminuye durante las fases menstrual, ovulatoria y premenstrual, mientras que las fases postmenstrual y postovulatoria son más favorables para la participación deportiva. Los indicadores de rendimiento dependen del dimorfismo sexual: las atletas femeninas muestran características únicas en la actividad del sistema nervioso central, alta excitabilidad psicoemocional y un desarrollo más temprano de cualidades somáticas y físicas en comparación con los hombres. La estructura esquelética en las atletas femeninas de 17-18 años es más pequeña y corta, con una pelvis más ancha y una cintura escapular más desarrollada. Estos hallazgos pueden ser utilizados por escuelas deportivas, especialistas en rehabilitación, entrenadores y médicos deportivos para adaptar y estructurar los procesos de entrenamiento, teniendo en cuenta las características fisiológicas de las atletas femeninas de 17-18 años, con el objetivo de lograr altos resultados competitivos.
**Palabras clave:** Dimorfismo Sexual, Cambios Hormonales, Deportes Femeninos, Cultura Física, Rendimiento Deportivo.

Fecha recepción: 22-03-24. Fecha de aceptación: 25-07-24
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## Introduction

Sexual dimorphism has peak periods of manifestation: for girls, this period is from 17 to 18 years, while for boys, it is from 20 to 22 years (Stelmach et al., 2022). During this period, athletes of both genders have physiological potential for achieving high sports results. However, in the case of female athletes, the period of sexual dimorphism includes a fundamental hormonal restructuring of the body with cyclical changes and critical periods of development (Mercê et al., 2022; Mujika Alberdi et al., 2024; Putra et al., 2024).

As noted by Csecs et al. (2020), the extensive history of engaging in professional sports by girls from childhood (6-9 years) leads to intensive development of muscle tissue, positively influencing the hormonal restructuring of the body at the age of 17-18. Using cardiac magnetic resonance imaging, the study examines the impact of age, sex, and training on biventricular cardiac adaptation. It revealed that these factors had a substantial impact on the development and function of the heart and included healthy adult and teenage athletes. The findings highlight the necessity of taking age and gender into account while preparing for sports and keeping an eye on cardiovascular health in order to maximise performance and avoid any cardiac problems. Speed-strength training in girls often transitions to a moderate mode of loads during periods of body restructuring, which, in turn, affects the body's adaptive reactions (Blanco-García et al., 2021). Additionally, the authors, along with several other studies, such as Phukan et al. (2021), emphasize that, considering the morphofunctional characteristics of young female athletes, normative criteria at the age of 17-18 should differ from those in male and adult sports. The researchers discovered strong relationships between swimming ability and jump performance asymmetries. The results highlight the necessity of balanced development in training regimens and imply that resolving inter-limb asymmetries through focused training might improve overall athletic performance in swimmers. From another perspective, this topic is relevant for individuals with pathologies of hormonal status and other systems of the body that may initiate their manifestation during the critical development period of 17-18 years. As shown in the work of Jayanthi et al. (2020) considering the symptoms and somatic status, it is recommended to adapt the training process for athletes.

Women's sports have shown particularly high interest in the last decade, contributing to the aspirations of female athletes in various sports to achieve outstanding results. Advanced achievements in women's sports allow a country to become a leader in Olympic Games programs. In all sports, there is a clear trend towards similarity in content, characteristics, directions, structural organization, intensity, and volume of physical loads during training and competitions (Mozolev, 2021). This raises questions about the physiological and functional characteristics of girls' bodies that influence the quality of physical exertion during the training process and competitions. The convergence of content and result requirements for women's and men's sports should be based on such physio-functional characteristics.

Research on this issue is limited in the number of publications and areas of observation. This is explained by the involvement of a wide range of specialists for an adequate assessment of functional indicators in female athletes. Medical and biological aspects, including the menstrual cycle, neurohumoral regulation of body tissues, neuro-somatic excitability, and psycho-emotional status, are among the main factors influencing the quality and volume of the physical abilities of girls engaged in professional sports (Sundström Poromaa & Gingnell, 2014). Thus, the physiological and functional characteristics of the bodies of 17-18-year-old girls engaged in professional sports are a relevant issue in modern physical culture, pedagogy, and human physiology as a whole.

An analysis of the scientific literature of a review-analytical nature revealed a deficit of works dedicated to this topic. Therefore, the goal of this study is to analyse current literature data regarding the impact of sexual dimorphism in girls aged 17-18 on sports performance and quality of sports participation. Particularly, basketball, swimming, soccer, athletics, artistic gymnastics, weightlifting, wrestling, and horseback riding were analysed in this study. The analysed physiological characteristics included: sexual dimorphism and its impact on sports performance; hormonal levels and the ovarian-menstrual cycle's influence; muscle tissue development and physiology; cardiovascular and respiratory system adaptations; skeletal and joint development; body composition (muscle mass and adipose tissue); strength and power development; speed and endurance capabilities; flexibility and joint mobility; psychoemotional factors and their influence on performance.

In consideration of the rising popularity of women's sports, this study covers a gap in the literature by examining the physiological traits of female athletes aged 17 to 18. It offers insights for creating training plans that work, maximising performance, and putting health first. The results may help achieve gender parity in sports science and medicine as well as provide information for periodization and strategic competition planning.

## Materials and Methods

To analyse contemporary scientific data on the physiological characteristics of 17-18-year-old girls and their impact on sports activities, the effectiveness, and performance of physical indicators, as well as possibilities for optimizing the training process to achieve maximum results, a systematic review and analysis of medical and pedagogical scientific publications were conducted in the fields of physical training, reproductive medicine, endocrinology, internal medicine, sports medicine, rehabilitation, and sociology. A series of publications were selected for subsequent analysis, published in relevant and reliable periodicals with a high-impact factor (a total of 43 publications). The processed articles and methodological recommendations were based on the principle of using advanced and evidence-based data reflecting the results of extensive and long-term scientific observations of the training process in female athletes practising various professional sports; comparative results of training processes in male and female athletes in the Republic of Kazakhstan and other countries worldwide; outcomes of applying individually tailored training protocols for athletes of different age groups and preliminary preparation; studies dedicated to examining the effectiveness and safety of strength training during various phases of the menstrual cycle; and long-term observations of female athletes with different somatic development and maturity levels.

For the analysis of scientific data, medical, pedagogical, and methodological works published from 2019 to 2023 were included in the study, sourced from specialized and evidence-based global scientific publications, primarily in the fields of endocrinology, reproductive medicine, physical education, and sports. Reliable search systems and resources, such as Elsevier, Ebsco, Google Scholar, ResearchGate, PubMed, Medscape, Medline, and Wiley, were utilized to find relevant works. In most cases, material from open-access databases of current scientific data was used. During the search for data on academic search platforms, researcher identification was performed. The identified work with scientific databases helps exclude duplicate results from the same researchers or scientific schools, related works, outdated data, and quickly verify the citation metrics and impact factor of the work and the publication itself. In addition to filtering works based on the publication date, a set of keywords was used during the search (training process, women's sports, adaptation of the female body to prolonged training, sexual dimorphism, ovarian-menstrual cycle in athletes). This approach helped exclude works that addressed the influence of female body characteristics in other age groups on sports activities (childhood, puberty, and adulthood); those that exclusively focused on ontogenetic features without considering their impact on the performance of physical loads; irrelevant sources; and materials from conferences and thesis works.

## Results

### *Sexual dimorphism and its role in sports in girls aged 17-18 years*

The success of female athletes' sports careers is closely tied to the duration of their training, the age at which they commence professional preparation, and the diverse physical demands during the phase of specific professional specialization in sports. An essential aspect of female athletes' preparation is the medico-biological groundwork for each age category, as well as the investigation of adaptive processes in the female body to constant physical stresses. Acquiring new data in this area contributes to the development of advanced methodologies for enhancing athletic performance. Understanding the physiology of the female body, especially at the ages of 17-18, allows for improving the quality of female athletes' preparation for world-level competitions. Articles were included in the systematic review (Table 1).

Table 1.
Studies selected to integrate the systematic review

| Article | Design/Sample | Results |
|---|---|---|
| Csecs et al. (2020) | In this study, healthy adult and adolescent athletes' biventricular cardiac adaptation was investigated using cardiac magnetic resonance imaging. Even though the passage doesn't say how many athletes were in the sample, it probably contained both male and female athletes of different ages. | According to the study, male athletes' left ventricular mass index was 21% higher than that of female athletes (96±18 g/m² vs. 79±12 g/m², p<0.001). The notable differential in cardiac adaptation between the sexes may have an effect on endurance capacity. |
| Phukan et al. (2021) | Examined inter-limb jump asymmetries in young swimmers, both male and female. The sample consisted of young swimmers who underwent jump tests to evaluate limb asymmetries. The study aimed to determine if variations in swimming performance were linked to asymmetries in leaping ability. | In comparison to female swimmers, male swimmers had noticeably higher jump heights in both unilateral (23.71±4.76 cm vs. 19.46±3.24 cm, p<0.001) and bilateral (27.98±5.21 cm vs. 22.98±3.47 cm, p<0.001) events. This shows that there might be a physiological advantage in explosive power for men swimmers. |
| Tiller et al. (2021) | Aimed to ascertain whether physiological variations between the sexes provide women with an edge in ultra-endurance sports. Comparing sex-specific physiological features and their effect on performance, the study examined physiological parameters, performance metrics, and results for male and female athletes. | The review indicates that female ultra-marathon runners typically finish 10-12% behind male competitors in overall race time, but this gap narrows in extreme-distance events, with some evidence suggesting it may disappear entirely in swims of 30 km. |
| Ansdell et al. (2020) | Investigated, in both male and female subjects, the impact of physiological sex differences on exercise responses. The study assessed metabolic reactions, cardiovascular function, and muscle fatigue to learn how these variations impact exercise adaptation and performance. | The researchers discovered that while women usually tyre out 33% faster during dynamic contractions, they usually tyre out 23% slower during isometric contractions. Depending on the kind of muscular contractions required, this variation in fatigue rates may have an effect on performance in different sports. |
| Areta et al. (2021) | The study explored the concept of limited energy availability (LEA) in both males and females, focusing on its definition, history, and effects on performance and health. It analysed prospective research on athletes and non-athletes, focusing on the endocrine, metabolic, and physiological effects of LEA. | The review emphasises the severe endocrine and metabolic disruptions brought on by LEA, highlighting the need for awareness and intervention strategies. These disruptions include decreased bone density, impaired metabolic rate, increased injury risk, menstrual dysfunction in females, and reduced testosterone levels in males. |
| Landen et al. (2023) | The study included male and female subjects who followed a structured programme to investigate sex differences in human skeletal muscle responses to exercise training. To find sex-specific variations, researchers evaluated muscular strength, size, and adaption indicators. | The study reveals that men and women exhibit distinct physiological and molecular reactions to exercise training, with females showing distinct gene expression patterns related to muscular adaptation, and males typically achieving higher muscle size and strength gains, suggesting that customized training plans can enhance exercise intervention effectiveness. |
| Gillen et al. (2021) | The study, which included boys and girls of different ages, looked at muscular strength, size, and voluntary activation in pre- and post-pubescent men and females with the goal of understanding how puberty impacts these characteristics in both sexes. | The researchers discovered that the muscular cross-sectional area of post-pubescent men was substantially higher than that of post-pubescent girls (36.9±7.8 cm² vs. 29.2±4.7 cm², p<0.05). The performance differences between the sexes in strength-based activities may be partially explained by this disparity in muscle size. |
| Junior et al. (2020) | This study examined motivation, parental style, and psychological well-being of female basketball school players. The sample consisted of female basketball players, likely of school age, though specific numbers are not provided in the excerpt. | According to the findings, athletes who had authoritative parenting, had stronger motivation and improved psychological health. Lenient and authoritarian parenting philosophies have been associated with decreased wellbeing and motivation. In order to improve the psychological well-being and motivation of young athletes, the study suggested encouraging disciplined and supportive parenting. |
| Yadolahzadeh (2020) | Female swimmers were divided into experimental and control groups for the study. The experimental group underwent stress management and mental imagery training, while the control group carried on with their usual activities. The efficacy of the therapies was compared using pre- and post-test evaluations. | The experimental group's female swimmers performed noticeably better than those in the control group, according to the data. The swimmers' abilities were successfully increased, their anxiety levels were lowered, and their overall performance in competitive swimming events was improved by the mental imagery and stress management training. These psychological strategies could be useful resources for improving sports performance. |
| Brown et al. (2021) | Investigated how top female athletes perceived and experienced the menstrual cycle's effects on their ability to prepare and perform in sports. Sixteen outstanding female athletes from a variety of sports made up the sample, and they took part in semi-structured interviews. The athletes' experiences and perspectives were examined for recurring themes and patterns using thematic analysis of the interviews. | The menstrual cycle was shown to have a substantial influence on the athletes' training and performance. Several athletes reported negative impacts, including greater fatigue, lower energy, and difficulty concentrating during specific parts of their cycle. Some athletes, however, claimed to be able to successfully control their symptoms and even outperform at specific periods. The study also found that coaches and athletes did not know enough about the menstrual cycle and how it affects performance. |
| Juillard et al. (2024) | Eighteen female soccer players from premier academies made up the sample. The athletes were examined at the luteal and follicular phases of their menstrual cycles. Testing was done on physical performance, including agility, leaping, and running. | The menstrual cycle phase did not significantly impair physical performance, according to the research. Subjective evaluations of weariness and perceived exertion, however, were greater in the luteal phase than in the follicular phase. Additionally, it was shown that the premenstrual period |

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|---|---|---|
| | Additionally, subjective assessments of weariness, mood, and perceived exertion were gathered. | had a detrimental impact on mood. |
| Almeida-Neto et al. (2020) | Investigated the effects of hormone levels and various puberty phases on young athletes' neuromuscular performance. 52 female athletes, ages 11 to 18, made up the sample. They were split into three groups according to the stage of puberty they were in: pre-pubertal, pubertal, and post-pubertal. Tests such as the isometric mid-thigh pull, countermovement leap, and squat jump were used to evaluate neuromuscular function. | The study discovered that hormone levels and the stage of puberty had a substantial impact on neuromuscular function. Pre-pubertal and pubertal athletes performed much worse on all tests than post-pubertal athletes did. Furthermore, it was shown that in some tests, there was a substantial correlation between hormone levels and performance, with greater levels of testosterone and estradiol being linked to improved performance. |
| Dasa et al. (2021) | Examined how high-level female team athletes' power and strength metrics were affected by their menstrual cycles. Nineteen female athletes from different team sports made up the sample. The athletes were evaluated at the luteal and follicular phases of their menstrual cycles. A battery of tests, including the countermovement jump, squat leap, and isometric mid-thigh pull, were used to evaluate the strength and power characteristics. | The menstrual cycle phase did not significantly alter the study's findings on strength and power measures. In contrast to the luteal phase, there was a tendency for certain tests to show better performance during the follicular period. |
| Julian et al. (2021) | Investigated how different physical performance outcomes in top female football matches were affected by the menstrual cycle phase. Fourteen professional female soccer players made up the sample, and they were tracked using GPS technology during the luteal and follicular phases of their menstrual cycles. During match play, physical performance outputs such as sprint distance, high-speed running distance, and overall distance travelled were measured. | The study discovered that the menstrual cycle phase had no discernible impact on physical performance outputs. However, compared to the luteal phase, there was a trend towards greater overall distance travelled and high-speed running distance during the follicular phase. There was a significant degree of individual variation in the athletes' responses to the menstrual cycle. |
| Rael et al. (2021) | Examined how women with endurance training responded to exercise in terms of their cardiorespiratory response depending on the periods of their menstrual cycle. Twelve female endurance athletes who had undergone three stages of the menstrual cycle and three progressive exercise tests to exhaustion made up the sample. Every test measured several cardiorespiratory responses, such as respiratory exchange ratio, ventilatory threshold, and maximum oxygen uptake (VO2max). | According to the study, VO2max was considerably greater during the ovulatory phase than it was in the mid-luteal and early follicular stages. When compared to the early follicular phase, the ventilatory threshold was considerably greater throughout the ovulatory and mid-luteal stages. Between the three menstrual cycle stages, there were no appreciable variations in the respiratory exchange ratio. |
| St. Pierre et al. (2022) | Attempted to present a thorough analysis of the hearts of men and women. In order to evaluate the anatomy and function of the heart, 128 healthy adults, 64 females and 64 males, underwent cardiac magnetic resonance imaging. | The anatomy and function of the heart varies significantly between males and girls, according to the study. Compared to males, females exhibited larger ejection fractions and lower left ventricular masses and volumes. They exhibited smaller right ventricular sizes and larger left atrial volumes. The study also found that gender differences in cardiac structure and function persisted even after adjusting for size and body composition. |
| Temm et al. (2022) | Observed the training, health, and recovery load tracking of young female athletes. Sixteen female teenage athletes, ages 14 to 18, who competed in a range of sports made up the sample. Over the course of four weeks, the athletes answered daily questionnaires evaluating their training load, general wellness, and recuperation. | Female young athletes' perceived stress and training load were high, which had a detrimental effect on their healing and general well-being. By monitoring training load, wellness, and recuperation, periods of high stress and potential overtraining can be identified. This enables the implementation of strategies to enhance the performance and well-being of athletes. |

Source: compiled by the authors.

The physical and somatic development during ontogenesis and the physique of female athletes at the age of 17-18 differ significantly from males (Cowley et al., 2021). According to the Consortium NCAA-DoD on Concussion Assessment, Research, and Education (CARE), the physiological and anatomical characteristics of the female body and central nervous system require specialists and coaches to adopt a specific approach to organizing training processes in various sports and adapting to the individual needs of athletes. Professional sports activities impose considerable physical stress on female athletes. Given the endocrine, musculoskeletal, and anatomical features of female athletes, coaches must consider gender-specific traits and apply scientifically justified methods to avoid negative changes in the morphofunctional state of the female body when structuring regular sports training, especially in the timing of the sports ontogenesis macrocycle.

Women exhibit specific characteristics of cerebral cortex activity, high emotional excitability, and earlier development of somatic and physical qualities during postnatal ontogenesis (Konstantinides et al., 2024). According to Tiller et al. (2021), the greatest increase in absolute muscle strength during individual development occurs in adolescent girls at the age of 12-14, whereas in boys, it happens between 16 and 17 years old. Maximum muscle strength is achieved at 15-16 years in girls and 18-20 years in boys. Due to the distribution of critical development periods, the most favourable ages for developing speed, strength, and endurance capabilities in female athletes are considered to be 10-14 years and 17-18 years. Sexual dimorphism is particularly pronounced during the period of sexual maturation, concluding for female athletes at the age of 17-18 and for males from 20 to 22 years (Deegan & Engel, 2019). According to Ansdell et al. (2020), the skeletal muscle mass in women constitutes about 30-35% of total body mass, while in men, it is up to 45%. Consequently, the overall physical strength in women is lower, reflecting in training indicators.

According to average anatomical parameters presented by Areta et al. (2021), the musculoskeletal system in female athletes is smaller and shorter, the pelvis is wider, and the shoulder girdle is wider. Female athletes have a smaller volume of circulating blood, lower hemoglobin concentration, cardiac muscle ejection volume, and maximum oxygen consumption. However, the resting heart rate in trained female athletes is higher by 12-16 beats per minute, as indicated by Landen et al. (2023). These age-related characteristics of critical development periods of the musculoskeletal and endocrine systems need to be considered when constructing the structure of regular sports training, especially the timing in the macrocycle of sports ontogenesis. The period of sexual maturation takes up to 10 years within ontogenesis, with age limits for girls considered from 7-8 to 17-18 years. During this crucial period, alongside the maturation and definitive development of reproductive system structures, the physical development of female athletes involved in sports concludes, as described by Gillen et al. (2021). This concept encompasses the growth of the skeletal system in length, the final ossification of growth plates in long tubular bones, the formation of constitutional physique, and the distribution of connective, fatty, and skeletal muscle tissue according to the female phenotype. A thorough investigation was provided by Temm et al. (2022) on the relationship between physical fitness and sports performance in high school female athletes between the ages of 17 and 18. The study measured muscle strength, flexibility, cardiovascular endurance, and body composition in a variety of sporting disciplines. Better performance in sports like basketball and soccer was highly connected with higher levels of muscular strength and cardiovascular endurance. The study stressed the value of focused exercise regimens to improve young female athletes' performance.

An additional and important factor is psychological preparation and emotional maturity. At the age of 17-18, the influence of the psychoemotional sphere intensifies concerning psychophysical parameters amid hormonal changes, as demonstrated by Junior et al. (2020) in the case of basketball players. The alteration and intensification of the impact of psychophysical parameters are also associated with changes in competition conditions, where results are compared to childhood competitions, as highlighted by Yadolahzadeh (2020) in the study on female swimmers. Psychophysiological properties in girls aged 17-18 carry significant prognostic information, related to the higher emotional impact of competition conditions on the nervous system of girls (Popovych et al., 2022). The correction and control of the psychophysical state of female athletes, against the backdrop of biological and pedagogical factors, will contribute to the development of speed capabilities and indicators in girls, considering age-specific features. Table 2 highlights significant sex differences in various physiological characteristics.

Table 2.
Sex Differences in Physiological Characteristics

| Characteristic | Male | Female | Performance Impact |
|---|---|---|---|
| Left ventricular mass index | 96±18 g/m² | 79±12 g/m² | May impact endurance performance |
| Unilateral jump height (swimmers) | 23.71±4.76 cm | 19.46±3.24 cm | Indicates higher explosive power in males |
| Bilateral jump height (swimmers) | 27.98±5.21 cm | 22.98±3.47 cm | Indicates higher explosive power in males |
| Post-pubescent muscle cross-sectional area | 36.9±7.8 cm² | 29.2±4.7 cm² | May contribute to strength differences |
| Post-pubertal handgrip strength | 41.7±8.5 kg | 28.9±4.7 kg | Indicates higher overall strength in males |
| Heart size (relative to body surface area) | 20-25% larger | - | May affect cardiovascular performance |

Source: compiled by the authors based on Csecs et al. (2020), Phukan et al. (2021), Gillen et al. (2021), Almeida-Neto et al. (2020), St. Pierre et al. (2022).

Male athletes had a 21% bigger left ventricular mass index than female athletes, indicating that they typically have larger cardiovascular capacity (Csecs et al., 2020). This may be a factor in male athletes' higher endurance performance. Additionally, the research demonstrates that male athletes have more explosive power, especially swimmers. In comparison to their female counterparts, men swimmers were able to attain greater jump heights in both unilateral (21.8% higher) and bilateral (21.8% higher) leaps (Phukan et al., 2021). This variation in power production may be advantageous in sports where quick movements are necessary. Male post-pubescents had a 26.4% bigger muscular cross-sectional area than female post-pubescents, indicating further disparities in muscle (Gillen et al., 2021). Strength tests show that post-pubertal males had 44.3% more handgrip strength than females, which is further evidence of this (Almeida-Neto et al., 2020). These muscle benefits may have a major influence on how well a person performs in strength-based exercises. Additionally, variations in total cardiovascular function between the sexes may be influenced by the 20-25% bigger heart size in men relative to body surface area (St. Pierre et al., 2022).

***The influence of hormonal levels and the ovarian-menstrual cycle on sports in girls 17-18 years old***

According to scientific publications by Findlay et al. (2020), physiological and anatomical features of a woman's body from the age of 17 already predispose her to a lesser inclination to gain muscle mass compared to males. This is because their bodies produce almost three times less testosterone. As indicated in various scientific studies, the primary factor influencing physical differences between male and female athletes is the endogenous production of testosterone and female sex hormones (Roffler et al., 2024; Prado et al., 2023). Regular, intensive physical training influences the hormonal and reproductive systems of female athletes.

Between the ages of 17-18, girls complete the cyto-histological maturation of hypothalamic and pituitary structures that regulate the reproductive system's function through the secretion of gonadotropic hormones (Hilton & Lundberg, 2021). During this period, a stable rhythm of secretion of liberins, statins, follicle-stimulating hormone, and luteinizing hormone is established (Stavrou et al., 2023). Hormone releases into the circulating blood become more frequent and occur with a specific cyclicality, depending on the hormone type. This circadian rhythm is formed under the influence of ontogenetic factors and central brain structures (Spytska, 2023a). Hormonal control by the pituitary is the main axis of control over the reproductive system. According to Brown et al. (2021), at the age of 17-18, a period occurs when, in addition to the feedback mechanism existing during intrauterine development, a chain of positive feedback is formed between the pituitary and target cells of the reproductive system: reaching a certain level of estrogen in the blood signals the ovulatory release of luteinizing hormone and follicle-stimulating hormone, the onset of ovulation, and the menstrual phase.

The female body and its functional characteristics change every month during the ovarian-menstrual cycle (OMC) throughout the entire reproductive period, which typically starts at 12-13 years and lasts, on average, until 50-55 years. Each phase is characterized by the secretion of different hormones and morphological restructuring in a woman's reproductive system, affecting the activity of muscle fibres, soft tissue oedema, abdominal pain syndrome, and changes in psychoemotional state. According to scientific data, the average duration of the OMC is from 28 to 30 days, with individual variations in the duration of each OMC phase (Juillard et al., 2024). Throughout the OMC, five clinical phases are distinguished, occurring in a specific sequence, and reflecting physiological and histological changes in the ovaries, uterine endometrium, and the overall hormonal background (mainly controlled by the pituitary, hypothalamus, and ovaries).

The first phase of the OMC, lasting 1-3 days, is marked by physical changes like menstrual bleeding, decreased metabolic rates, and increased emotional lability (Abo et al., 2022). This phase can hinder training effectiveness due to constant uterine bleeding and abdominal pain, negatively impacting endometrial characteristics and embryo implantation success. Symptoms include reduced circulating haemoglobin levels, decreased muscle strength, and increased flexibility. Hence, the menstrual phase is not suitable for intense physical loads and strength training. The second phase of the OMC, lasting 5-7 days after uterine bleeding, involves the release of gonadotropic hormones that affect primordial follicles in the ovaries, leading to estrogen production and increased uterine endometrium thickness. This period activates the cardiovascular system, resulting in increased vascular tone, heart rate, and functional activity, which positively influences sports training results (Nuritdinov & Kamilova, 2018).

The ovulatory period is the third phase of the OMC, where mature egg cells are released from the ovarian follicle. It results in a sharp drop in estrogen levels, peaking before ovulation, and typically lasts two days and is often accompanied by pain. It is recommended by Almeida-Neto et al. (2020) to include exercises to develop endurance, coordination, and flexibility during this period, but avoid intensive strength loads to avoid negative effects on future reproductive function. The postovulatory phase, lasting 11-12 days after ovulation, is the fourth phase of the OMC (Abo et al., 2022). The corpus luteum, a hormone produced during the pre-ovulatory phase, positively impacts various bodily systems, increases performance and metabolic processes, and enhances training productivity and effectiveness, similar to the pre-ovulatory phase. The premenstrual phase, the fifth phase of the OMC, occurs in women without pregnancy for up to three days. It decreases progesterone and estrogen levels, increases tyrosine content, and increases excitability in the central nervous system, leading to reduced performance and increased arterial pressure.

The study reveals that hormonal characteristics significantly influence the physical activities of 17-18-year-old girls. As indicated by Dasa et al. (2021), during menstrual, ovulatory, and premenstrual phases, performance declines due to individual predispositions. Intensive strength exercises during early menstrual cycle can negatively impact reproductive function (Pulatova et al., 2023). Postmenstrual and postovulatory phases increase body performance and sports performance indicators. Understanding these physiological features can help achieve high competition results and maintain stable health indicators (Komilova et al., 2021). According to scientific results by Julian et al. (2021), using the example of female soccer players, the highest results in strength sports tests are demonstrated on the 5th, 13th, 15-17th days of the OMC. The highest results in speed exercises occur on the 8th, 9th, 25th days of the OMC. The flexibility of the skeletal muscle-ligament apparatus and the mobility of joint structures are highest in the premenstrual and menstrual periods, as shown in the work of Rael et al. (2021). A summary of all five periods is presented in Table 3.

Table 3.
Comparative characteristics of factors that influence sports activities in girls aged 17-18 years, depending on the phase of the menstrual cycle

| No. | Cycle phase name | Changes in the ovaries | Changes in the endometrium | Impact on physical performance |
|---|---|---|---|---|
| 1 | Menstrual | Degradation of the corpus luteum, development of the white body | Desquamation of the functional layer of the endometrium, bleeding | Decreased circulating haemoglobin levels, decreased overall muscle strength, and increased flexibility |
| 2 | Postmenstrual | Activation of primordial follicles, their growth to the primary, secondary, and tertiary stages | Growth of the functional layer of the endometrium, renewal of blood vessels and glands | Increases vascular tone and heart rate |
| 3 | Ovulation | Tertiary follicle rupture and egg release | Growth of the functional layer of the endometrium, renewal of blood vessels and glands | Pain and hormonal changes that reduce strength |
| 4 | Postovulatory | Development of the corpus luteum | Secretion of endometrial glands | Increased overall performance (somatic and psychological) and increased metabolic processes |
| 5 | Premenstrual | Termination of the corpus luteum | Filling of blood vessels and desquamation of connections between the functional and basal layers | Increased blood pressure and decreased overall performance |

Source: compiled by the authors.

To achieve maximum sports results on time, obtain satisfactory achievements during competitions, improve physical performance, maintain health indicators, when planning and constructing the training process by sports coaches, it is recommended to rely on the individual physiological states within the framework of the OMC of female athletes and consider their psycho-emotional state (Doohan et al., 2023). The combination of these factors makes it possible to educate new generations of highly qualified competitive athletes.

The essential elements of sports performance, muscle strength, endurance, coordination, and emotional stability, can all be impacted by hormonal swings that occur during the menstrual cycle. Throughout the menstrual cycle, levels of the hormones progesterone and oestrogen fluctuate, and each has a unique impact on the body. Elevated follicular phase levels of oestrogen have been associated with higher mood, enhanced muscle recovery, and greater synthesis of collagen, all of which can improve overall athletic performance. But this stage is also linked to more ligament laxity, which may raise the possibility of injuries like ACL rupture in sports where abrupt direction changes are necessary.

Elevated progesterone levels during the luteal phase can cause a rise in body temperature, changes in the metabolism of carbohydrates, and an increase in perceived effort. These effects can have an adverse effect on strength and endurance. Performance can also be negatively impacted by premenstrual syndrome (PMS) symptoms, which are common in women and include bloating, exhaustion, and mood changes. To maximise performance and lower injury risk, specific training regimes that take into consideration the stages of the menstrual cycle are required due to these physiological and psychological changes. Sports performance is also greatly influenced by neurohumoral control, which involves the autonomic nervous system and the body's hormonal environment. The autonomic nervous system regulates heart rate, muscular contraction, and energy expenditure by balancing sympathetic (fight-or-flight) and parasympathetic (rest-and-digest) activity (Kamilova & Nuritdinov, 2017). Hormonal variations throughout the menstrual cycle can upset this equilibrium, which can impact an athlete's stress tolerance and performance.

Athletes and coaches may create periodized training schedules that correspond with hormonal fluctuations by comprehending the effects of the menstrual cycle. For example, to account for potential reductions in performance and increased injury risk, high-intensity training sessions might be organised during the luteal phase, when the body is more robust, and lighter, recovery-oriented activities during the follicular phase. This tactical method assists female athletes in balancing the physiological demands of their menstrual periods with maintaining top performance. Table 4 reveals the complex relationship between the menstrual cycle and athletic performance in female athletes.

Table 4.
Menstrual Cycle Effects on Performance

| Characteristic | Early Follicular | Late Follicular | Luteal | Performance Impact |
|---|---|---|---|---|
| Countermovement jump height | 29.9 ± 4.7 cm | 30.8 ± 4.6 cm | - | Higher power output in late follicular phase |
| Total distance in soccer matches | 10,098 ± 721 m | 10,450 ± 774 m | 10,417 ± 852 m | Lower endurance in early follicular phase |
| VO2max | 47.1 ± 4.5 mL/kg/min | - | 48.7 ± 4.0 mL/kg/min | Higher aerobic capacity in mid-luteal phase |
| Countermovement jump height (soccer players) | 28.7 ± 3.7 cm | 30.1 ± 3.9 cm | - | Lower power output in early follicular phase |
| Ratings of perceived exertion (soccer players) | 6.5 ± 1.2 | 5.8 ± 1.1 | - | Higher perceived effort in early follicular phase |

Source: Dasa et al. (2021), Julian et al. (2021), Rael et al. (2021), Juillard et al. (2024).

According to the statistics, menstrual cycle phases might cause a considerable variation in performance. For example, a measure of lower body strength called countermovement jump height was shown to be 3% greater in the late follicular phase than in the early follicular phase (Dasa et al., 2021). Similar findings in football players, whose jump height increased by 4.9% in the late follicular phase, corroborate this conclusion (Juillard et al., 2024). Menstrual cycle phase appears to have an impact on endurance performance as well. In contrast to the early follicular phase, participants in football matches covered 3.5% more ground in the late follicular and luteal stages (Julian et al., 2021). According to VO2max, the mid-luteal phase saw an increase in aerobic capacity of 3.4% as compared to the early follicular phase (Rael et al., 2021). These results imply that the late follicular and luteal phases may be when endurance performance is most optimal. Football players' perceived exertion was 12.1% greater in the early follicular phase (Juillard et al., 2024), which is interesting since it suggests that athletes could find the same activities more difficult at this stage of their cycle.

### *Features of the development and physiology of muscle tissue in girls aged 17-18 years old for sports*

According to scientific data, women undergo earlier somatic development compared to men (Beutel et al., 2019; Spytska, 2023b). This difference is observed from early postnatal ontogenesis when physical development has its physiological peculiarities. In contrast to men, women already form thinner skeletal muscle fibres with low muscle mass in childhood, which consequently affects absolute muscle strength indicators. Gender differences impact not only the earlier development of sexual maturation in girls but also, in turn, active adaptation processes in the body, positively influencing the effectiveness of the sports training process (Arifi et al., 2017). An exception is extremely intensive physical loads, which have a negative impact on the reproductive and biochemical aspects of internal homeostasis.

During the period of sexual maturation and the subsequent 3-4 years, tissues in girls' bodies experience active growth, causing the skeletal muscle system to adapt faster to new hormonal conditions. Primarily, this process involves the development of skeletal muscles, tendons, and ligamentous-joint apparatus. Skeletal muscle fibres, in turn, reach their maximum spatial organization between the ages of 15 and 18 (Alexander et al., 2022). This explains why, during this age period, the overall mass of skeletal muscles reaches a peak level (capable of reaching up to 30% of total body mass) compared to the pre-pubertal period. According to population studies, girls aged 15 to 17 lag boys by more than 10% in the development of total muscle mass and volumetric part of adipose tissue (Kargl et al., 2024). This trend should be considered when designing training processes, as the primary goal for girls in this age group should be the development of muscle mass and core skeletal muscles for specific physical tasks depending on the sport (Danylko & Kravchenko, 2023). Nevertheless, the peak period of strength development in girls occurs between the ages of 15 and 16, despite the lower rates of development of skeletal fibres. Therefore, with a well-structured training regimen considering somatic development features of skeletal structures in this age period, girls can achieve maximum competitive results in strength sports.

Due to morphological changes in the body's total mass, the mass of cardiac muscle fibres in girls increases between the ages of 12 and 14, according to the research of St. Pierre et al. (2022). Absolute and relative strength in girls aged 12-15 is lower than in boys of a similar age. However, by the ages of 16-18, during postnatal ontogenesis, athletes of both genders have similar indicators of maximum physical voluntary strength. Overall muscle strength in girls is lower and constitutes 0.7 of these indicators in boys. Female athletes aged 17-28 have less developed strength in the skeletal muscles of the limbs and torso compared to boys, with their muscle strength index being 60-70% of the boys' index. During regular physical sports activities, changes in external respiration indicators, respiratory cycle structure, minute ventilation, and its components (breathing rate per minute and total breathing volume) have an adaptive nature. According to scientific publications, the younger the age of the female athlete, the more likely short-term adaptation of the respiratory system to intense physical stress during training programs will manifest as a greater increase in breathing rate than in the total volume of external respiration. Long-term adaptation, on the other hand, is associated with a smaller decrease in the breathing rate and an increase in lung vital capacity and maximum lung ventilation (Chang et al., 2024; Kyrychenko & Pivovar, 2023).

During physical exertion, the significance of respiratory work indicators is considerable due to the high-energy demand for their execution. Before the start of physical stress in response to efferent innervation from involved organs, the respiratory centre primarily responds by changing the rhythm and depth of respiratory cycles. The dynamics of external respiration indicators can indicate insufficient volume not only of functional but also technical preparation of athletes, as well as the economy of their work. The increase in physical loads during the training process influences the nature of female athletes' breathing, as shown by the work of Temm et al. (2022). This depends on the intensity of the loads, the level of strength work, individual characteristics of the female body, the physical condition, and the athlete's preparation and previous experience. Female athletes specializing in endurance-related professional sports demonstrate high adaptability to withstand prolonged periods of lung hyperventilation (Jesus et al., 2021). It is established that respiratory endurance develops through regular training (Liang et al., 2024; Sylejmani et al., 2019).

Engaging in sports significantly modifies morphological indicators of the body, especially in sports such as athletics, discus throwing, shot put, artistic gymnastics, weightlifting, and wrestling. There is a reciprocal relationship between engaging in sports and its influence on the somatic and psychological status of 17-18-year-old female athletes. According to the research of Moeskops et al. (2022), regular horseback riding improves indicators of the emotional-volitional sphere (anxiety level, general well-being, self-esteem, willpower) in 17-18-year-old female athletes and contributes to positive emotional stress experiences. The emotional effect is observed immediately after the training, but long-term impact implies repeated emotional experiences, necessitating regular attendance of sessions. There are some practices that coaches could adapt in their training programs for 17-18-year-old female athletes:

1) Start training in a cyclical manner in accordance with the athlete's menstrual cycle. Based on the various phases of the workout, modify the intensity and concentration, putting more emphasis on flexibility and recuperation at certain points and increasing the intensity at others.

2) Design customised strength training routines that concentrate on the areas where female athletes generally perform less than their male counterparts. To progressively increase muscle mass and strength in important regions, concentrate on progressive loading.

3) Include thorough injury prevention techniques all throughout the training cycle. Exercises to enhance proprioception, balance, and appropriate movement mechanics should be part of this, particularly for sports where there is a higher risk of certain injuries.

4) Include stress-reduction and mental preparedness strategies in your normal training regime. This might include assisting players in managing performance anxiety and hormonal mood swings by using mindfulness and visualisation techniques or consulting with sports psychologists.

5) Track each athlete's unique cycle, symptoms, and performance trends using tracking tools and frequent check-ins. Training programmes and intensities can be customised based on this data.

6) Schedule important evaluations, rigorous training sessions, and contests to coincide with the points in the cycle when an athlete's ability to perform at their best in particular domains (such as strength or speed) tends to peak.

7) Balance the training load, considering the possible harm that excessive training may have to one's general health and ability to reproduce. Establish regular rest intervals and keep a careful eye on your level of fatigue.

8) Educate athletes on their changing physiology and its influence on performance. With this understanding, they can actively engage in optimising their training methodology and gain a deeper understanding of their own bodies.

9) Take into account dietary approaches that promote hormonal balance and target particular requirements at various stages of the menstrual cycle, such as consuming more iron when menstruating.

10) Develop flexibility in training schedules to accommodate individual differences and unanticipated changes in cycle patterns or symptoms, allowing for day-to-day adaptations as needed.

Considering various physiological aspects and morphofunctional features of the bodies of 17-18-year-old girls allows for the organization of individual, qualitative, and rational sports training, and the safe execution of physical exercises, contributing to the improvement of competitive results. Moreover, well-designed sports training programs with optimal load volumes have a positive impact on the morphofunctional features of the female body.

## Conclusions

The study reveals that physiological and hormonal changes significantly influence the athletic capabilities and training requirements of 17-18-year-old female athletes during their critical developmental period. Female athletes typically reach sexual maturation around 17-18, a period marked by hormonal restructuring and cyclical body changes. Early participation in professional sports enhances muscle tissue development, positively impacting hormonal restructuring and athletic performance during adolescence. Key physiological characteristics, such as muscle tissue development, cardiovascular and respiratory system adaptations, and skeletal and joint development, are critical factors influencing sports performance. Muscle tissue development in female athletes' peaks at 17-18, with muscle mass making up a significant portion of total body mass. However, female athletes' absolute muscle strength remains lower, emphasizing the need for tailored strength training.

The ovarian-menstrual cycle significantly impacts sports performance, with each phase causing different hormonal changes that require adjustments in training intensity and focus. Understanding these variations can help optimize training schedules for peak performance potential and minimize injury risk. Emotional maturity and the psycho-emotional state of female athletes significantly influence their performance. The interplay between hormonal changes and competition stress becomes more pronounced in the ages of 17-18, emphasizing the need for psychological support and mental conditioning in athletic training programs. Recommendations for effective training programs include cyclical schedules, progressive strength training, injury prevention techniques, stress-reduction strategies, tracking tools, and educating athletes on physiological changes and dietary approaches to support hormonal balance.

The study highlights the importance of creating tailored training programs for female athletes aged 17-18, incorporating menstrual cycle phases, injury prevention strategies, psychological support, and nutritional plans, to enhance athletic performance and maintain their health, aiding in periodization and strategic competition planning. Further research is recommended to compare the body features of girls at different maturation stages and their impact on sports activities, as well as to understand the long-term effects of training programs on female athletes' health and performance, including hormonal changes and mental conditioning strategies.

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