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AYOL SPORTCHILARNING MORFOFUNKSIONAL KO'RSATKICHLARINI TAHLIL QILISH: ADABIYOTLAR SHARHI

Annotatsiya. Ushbu maqolada Qoraqalpog'iston Respublikasida yashovchi ayol sportchilarning morfofunktsional xususiyatlari bo'yicha tadqiqotlar tahlil qilingan. Ayollarning sport faoliyatiga ta'sir etuvchi mashg'ulotlarga yo'naltirilgan sport turlari, yengil atletika, kurash, basketbol, volleybol, gandbol va taekvondo kabi sport turlariga qaratilgan. Sportga xos fiziologik va antropometrik profillarni aniqlash, morfofunktsional xususiyatlarni va gormonal ta'sirni baholash, hayz davrining jismoniy faoliyatga ta'sirini taqqoslash va moslashtirilgan mashg'ulot metodologiyasini tahlil qilishga qaratilgan. Gormonal va antropometrik ko'rsatkichlarga asoslangan hududiy va tegishli adabiyotlarning tizimli tahlili o'tkazildi. Aniqlangan umumiy ma'lumotlar sport va rivojlanishga bog'liq antropometrik ko'rsatkichlarni ochib beradi. Adabiyotlarda elita darajasidagi sportchilariga xos tana tuzilishi va somatotiplar, hayz sikli ta'siri haqida aralash dalillar, ba'zi sport turlarida kuch - charchoqning fazasiga bog'liqligi, boshqalarda esa barqarorlik, sportga xos fiziologik moslashuvlar maqsadli mashg'ulot protokollarini qo'llab-quvvatlaydi va ayollarning morfofunktsional ko'rsatkichlariga moslashtirilgan davriy ta'lim va oziqlanish strategiyalarining samaradorligi ochib beriladi. Ushbu ma'lumotlar ayol sportchilar organizmining rivojlanishini optimallashtirish uchun gormonal holat va jismoniy rivojlanishni birlashtiruvchi individuallashtirilgan, intizomga xos yondashuvlar zarurligini ta'kidlaydi. Tahlil qilingan ma'lumotlar Qoraqalpog'istonning turli sport turlarida ayol sportchilarga moslashtirilgan dalillarga asoslangan mashg'ulotlar va iste'dodlarni aniqlash strategiyalarini taqdim etadi.

Kalit so'zlar: Ayollar sporti, gormonal ta'sir, jismoniy rivojlanish, sport turlari, barqarorlik, hayz davri, kuch, chidamlilik.

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АНАЛИЗ МОРФОФУНКЦИОНАЛЬНЫХ ПОКАЗАТЕЛЕЙ СПОРТСМЕНОВ: ОБЗОР ЛИТЕРАТУРЫ

Аннотация. В данной статье анализируются исследования морфофункциональных особенностей спортсменов, проживающих в республике Каракалпакстан. Виды спорта, ориентированные на занятия, влияющие на спортивную активность женщин, сосредоточены на таких видах

спорта, как легкая атлетика, борьба, баскетбол, волейбол, гандбол и тхэквондо. Он направлен на выявление физиологических и антропометрических профилей, специфичных для спорта, оценку морфофункциональных характеристик и гормонального воздействия, сравнение влияния менструального цикла на физическую активность и анализ адаптированной методики тренировок. Проведен систематический анализ территориальной и соответствующей литературы на основе гормональных и антропометрических показателей. Выявленные общие данные раскрывают антропометрические показатели, связанные со спортом и развитием. В литературе представлены смешанные данные о структуре тела и соматотипах, характерных для спортсменов элитного уровня, влиянии менструального цикла, зависимости силы от фазы усталости в одних видах спорта и стабильности в других, физиологические адаптации, специфичные для спорта, поддерживают целевые протоколы тренировок и раскрывают эффективность периодических стратегий тренировок и питания, адаптированных к морфофункциональным характеристикам женщин. Эти данные подчеркивают необходимость индивидуальных, специфичных для дисциплины подходов, сочетающих гормональный статус и физическое развитие, для оптимизации развития организма спортсменок. Проанализированные данные предоставляют научно обоснованные стратегии обучения и выявления талантов, адаптированные для женщин-спортсменок в различных видах спорта Каракалпакстана. Эти данные подчеркивают необходимость индивидуальных, специфичных для дисциплины подходов, сочетающих гормональный статус и физическое развитие.

Ключевые слова: женский спорт, гормональное воздействие, физическое развитие, спорт, стабильность, менструальный цикл, сила, выносливость.

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ANALYSIS OF MORPHOFUNCTIONAL INDICATORS OF FEMALE ATHLETES: A LITERATURE REVIEW

Annotation: This article analyzes research on the morphofunctional characteristics of female athletes living in the Republic of Karakalpakstan. The review focuses on sports disciplines that shape women's athletic performance, including athletics, wrestling, basketball, volleyball, handball, and taekwondo. The study aims to identify sport-specific physiological and anthropometric profiles, evaluate morphofunctional traits and hormonal influences, compare the effects of the menstrual cycle on physical performance, and assess adapted training methodologies. A systematic analysis of regional and relevant literature was conducted based on hormonal and anthropometric indicators. The findings reveal general patterns related to anthropometric measures influenced by sport type and athlete development. The literature highlights body composition and somatotype profiles typical of elite female

athletes, mixed evidence regarding the impact of the menstrual cycle on performance, phase-dependent fluctuations in strength and fatigue in certain sports, stability in others, and sport-specific physiological adaptations that support targeted training protocols. The review also demonstrates the effectiveness of periodized training and nutrition strategies tailored to female athletes' morphofunctional characteristics. Overall, the evidence underscores the importance of individualized, discipline-specific approaches that integrate hormonal status and physical development to optimize the athletic progression of women. The analyzed materials provide evidence-based recommendations for designing adapted training systems and talent identification strategies for female athletes across various sports in Karakalpakstan.

Keywords: women's sports, hormonal influence, physical development, sports, stability, menstrual cycle, strength, endurance.

Introduction

Research examining the morphofunctional characteristics of female athletes living in the Republic of Karakalpakstan has become an important area of study due to the increasing participation of women in various sports disciplines and the physiological demands associated with these activities [1, 2]. Over the past decades, research has shifted from a general evaluation of female athlete physiology to emphasizing differences in body composition, hormonal influences, and sport-specific adaptations [28]. Considerable evidence shows that factors such as maturation status and menstrual cycle phases significantly affect physical performance and recovery, which highlights the importance of optimizing training programs and injury-prevention strategies tailored to female athletes [20, 27]. For example, adolescent female volleyball players demonstrate maturation-dependent kinanthropometric variations that influence physical preparation outcomes [28]. Additionally, hormonal fluctuations during the menstrual cycle modulate strength and endurance parameters in team sports [3, 16].

Despite the growing interest in this field, a specific gap remains in comprehensively characterizing the morphofunctional profiles of female athletes across different sports in the Republic of Karakalpakstan. Sociocultural and environmental factors in the region may directly or indirectly influence these characteristics [1, 27].

The existing literature reveals a knowledge gap related to integrated analyses of anthropometric, physiological, and hormonal indicators in sports such as athletics, wrestling, basketball, volleyball, handball, and taekwondo [10, 17]. Debates persist regarding the extent to which menstrual cycle phases influence anaerobic capacity and strength performance: while some studies report minimal or insignificant effects [8, 21], others demonstrate phase-dependent variations in muscle strength and fatigue [7].

The fundamental structures of biological maturity, hormonal status, and sport-specific morphofunctional characteristics in female athletes are closely interconnected with the development of their athletic performance [14, 20, 27]. Biological maturation also influences anthropometric indicators such as muscle mass and body composition, which in turn affect physical preparedness and performance metrics [28]. Hormonal fluctuations—particularly those occurring during the menstrual cycle—modulate neuromuscular function and recovery, necessitating their consideration in training design [3].

Purpose

The purpose of this article is to examine research on the morphofunctional characteristics of female athletes in the Republic of Karakalpakstan and to analyze existing knowledge on the physical, physiological, and hormonal factors that influence women's athletic performance. By consolidating sources related to anthropometric traits, hormonal influences such as menstrual cycle phases, and sport-specific physiological demands, the study aims to inform targeted training methodologies and talent identification strategies. Based on the reviewed literature, the article seeks to contribute to the development of programs that optimize the physical development and performance of female athletes across various sports in Karakalpakstan.

Literature Selection Methodology

Focusing on sports such as athletics, wrestling, basketball, volleyball, handball, and taekwondo in the Republic of Karakalpakstan, we compiled the most relevant studies on the morphofunctional characteristics of female athletes. The selection

process considered physiological adaptations, training methodologies, the impact of hormonal fluctuations on body composition, the influence of menstrual cycle phases on athletic performance and training adaptation, and the relationship between physical working capacity, training methodology, and recovery strategies. In total, 210 candidate documents were identified (145 from search queries and 65 from citation chaining), from which 204 articles were found to be relevant to the research question. Among these, 50 articles were deemed highly pertinent, and over 30 studies conducted within the past five years were selected for detailed analysis and data extraction.

Results

Physical and respiratory performance patterns in female athletes vary across volleyball, basketball, handball, and athletics, and cannot be directly compared. Volleyball and basketball players demonstrate higher respiratory function, indicating that training programs must incorporate sport-specific respiratory demands. Limb breadth and respiratory capacity correspond to the functional requirements of each sport [28]. Maturation status influences body mass and height, muscle and fat mass, growth patterns, and physical preparedness in adolescent volleyball players; however, a direct association with hormonal phases has not been established. Physical fitness test outcomes differ according to age and biological maturity, with both age and maturation serving as strong predictors of strength and power performance. Bone and muscle indicators significantly determine physical test results [23]. Shoulder strength varies between volleyball and handball athletes. Handball players exhibit greater internal rotation strength due to the upper-body demands of the sport, whereas volleyball players show strength differences linked to sport-specific spiking and hitting requirements [26]. In volleyball, physiological adaptations to sprint-interval training show that longer rest intervals improve anaerobic performance. The structure of work-to-rest intervals strongly influences strength and sprint outcomes [15]. Olympic-style training in handball enhances jumping, throwing, and sprinting ability, and yields effective results when integrated into targeted strength-training programs [4]. Functional performance in handball, governed by energy-supply mechanisms,

depends on balanced training that optimizes both anaerobic and aerobic capacities, ensuring efficient energy-system functioning [16]. Menstrual-cycle phases affect maximal strength in handball players, with strength values fluctuating across phases but showing no significant influence on agility. Periodized strength training throughout the cycle is recommended, as strength performance is linked to hormonal variations during menstrual phases [7]. Cycle phases also influence fatigue and susceptibility to muscle damage in handball players. Neuromuscular and biochemical responses vary by phase: the follicular phase appears most favorable for high-intensity training due to optimal fatigue-recovery profiles and associated hormonal patterns [6]. Plyometric training improves jumping performance in handball athletes; both self-administered loading and structured plyometric protocols contribute effectively to enhanced jump outcomes [17].

Training load in elite basketball players affects both recovery and overall performance. Hormonal markers remain observable but stable, while periodized training enhances strength, power, and endurance. Proper management of training load is essential for performance, as recovery–stress status is closely related to training phases [24]. Among athletic girls, handgrip strength remains stable across menstrual cycle phases. Hormonal fluctuations influence grip strength only in non-athletes; athletes demonstrate consistent strength-power outcomes, whereas non-athlete subjects show greater variability. Thus, hormonal effects are less pronounced in trained groups but more significant in untrained individuals [8]. In amateur volleyball players of developmental age, anthropometric indicators are not influenced by menstrual cycle phases. Flexibility and strength remain stable throughout the cycle, and anaerobic capacity is not determined by menstrual phases. No significant effect of menstruation on performance is observed [22]. Across sports groups, menstrual characteristics are similarly high but irregular. No significant differences are found in cycle regularity or symptoms, and menstrual features appear strong but not sport-dependent [1]. Sex-specific physiological characteristics of women in sports—including hormonal and biomechanical aspects—have been outlined. Training protocols adapted to female-specific physiological traits, including energy-system

usage and recovery exercises, are essential for designing sport-appropriate training programs [2]. Female athletes differ from males in cardiac and physiological parameters. Hormonal cycles influence performance and cardiac adaptation. Women typically show lower endurance capacity and muscle mass than men; pregnancy-related screening and training considerations have been discussed, and sex-specific cardiac adaptations in women are less frequently identified [27].

Seventeen- to eighteen-year-old female athletes exhibit sexual dimorphism in skeletal structure, along with noted features of central nervous system (CNS) activity and psycho-emotional excitability. Training adapted to physiological characteristics enhances competitive success, while morphological traits associated with performance vary according to menstrual-cycle phases [18]. Menstrual status fluctuates among elite Turkish national-team athletes; psychological symptoms related to menstruation affect performance, and psychological support is recommended. The influence of menstruation is primarily psychological rather than physical [21]. Athletes and non-athletes differ in menarche age and performance patterns. Menstrual cycle phases do not affect performance in most analyzed sports, and the menstrual phase is not a limiting factor. Athletes exhibit later menarche compared to non-athletes [19]. Training programs adapted for sexual dimorphism—including physical, technical, and tactical preparation—enhance performance in female wrestlers. Innovative training concepts tailored to female physiological and morphological traits improve athlete performance, as sexual dimorphism influences training design [25].

Critical Analysis and Synthesis

The reviewed literature on the morphofunctional characteristics of female athletes in the Republic of Karakalpakstan and their related contexts reveals a multifaceted understanding of anthropometric, physiological, and hormonal influences across various sports. One of the most prominent themes is the impact of menstrual cycle phases on performance, with mixed findings regarding fluctuations in strength and energy. Collectively, the studies highlight sport-specific physiological profiles and training adaptations; however, methodological heterogeneity and small

sample sizes often limit the generalizability of conclusions. Furthermore, while some studies integrate hormonal assessments with performance indicators, others rely solely on self-reported data, which affects the robustness of the findings. Overall, the literature emphasizes the importance of individualized and discipline-specific approaches, while simultaneously underscoring existing gaps that necessitate comprehensive, longitudinal, and well-controlled research.

Table 1

Analysis of strengths and weaknesses in areas of research studying the morphofunctional characteristics of female athletes

Aspect	Strengths	Weaknesses
Profiling based on anthropometric and morphological indicators	Several studies provide detailed anthropometric and somatotype analyses across sports such as volleyball, wrestling, taekwondo, and combat sports, highlighting sport-specific body composition patterns and morphological optimization that support talent identification and development (e.g., differences in muscle mass among volleyball players, somatic characteristics in wrestling, and somatotype trends in taekwondo) [17]. These findings contribute to understanding the physical prerequisites for performance among female athletes in both regional and international contexts.	Despite detailed measurements, many studies rely on small sample sizes or focus on narrow age groups, which reduces external validity. For example, somatotype studies in taekwondo include limited female samples, and although morphological comparisons in karate are adequate, elite-level athletes are underrepresented [10, 17]. Furthermore, cross-sectional designs restrict the ability to understand developmental changes or training effects over time.
Hormonal influences and the impact of the menstrual cycle	Studies that incorporate biochemical analyses to examine hormonal phases provide valuable insights into the effects of the menstrual cycle on strength, energy, and recovery. Several investigations demonstrate phase-dependent changes in muscle strength and neuromuscular fatigue, highlighting the follicular phase as particularly favorable for high-intensity training [3, 7, 18]. Research on handgrip strength and anaerobic performance further contributes to relevant findings related to training periodization [24].	Contradictory findings are common, as several studies report no significant menstrual-phase differences across various sports, including volleyball, handball, and basketball—typically relying on small samples or cycle-phase classification without hormonal verification [3, 16, 21]. Heterogeneity in menstrual-cycle definitions and testing protocols further complicates comparisons. Moreover, many studies do not control for contraceptive use or symptom burden, both of which may confound the results [11, 20].

Aspect	Strengths	Weaknesses
Sport-specific physiological and performance adaptations	The literature clearly identifies sport-specific physiological and performance characteristics—such as greater shoulder strength in handball and volleyball, enhanced anaerobic fitness in combat sports, and sprint-interval adaptations in volleyball—which collectively support the need for discipline-specific training regimes [23, 26]. Interventional studies further demonstrate the effectiveness of targeted training protocols (e.g., elastic-band training, Olympic-movement training) in improving key performance indicators among female handball and other team-sport athletes [9, 15].	Many intervention studies involve small sample sizes and short durations, which may limit the ability to capture long-term adaptations or translate findings to competitive performance. Additionally, some studies lack control groups or randomization—procedures in which participants are assigned to groups at random—thereby weakening the strength of the conclusions [6, 19]. The focus on youth or amateur athletes in several studies further restricts the applicability of the findings to elite populations.
Integrating nutrition and recovery considerations	Some studies examine nutrition and recovery—stress states in female athletes, acknowledging their influence on morphofunctional characteristics and performance—particularly in volleyball and basketball players—and thereby supporting the need for holistic athlete management [13]. Incorporating assessments of symptom burden and sleep quality in relation to menstrual cycle phases further contributes to understanding recovery dynamics [11].	Nutritional studies often reveal inadequate dietary habits among athletes; however, interventions and long-term monitoring are limited, which restricts the development of practical recommendations [13]. Assessments of recovery and stress are constrained by small cohorts and short observation periods, reducing generalizability. The complex interactions between nutrition, hormonal status, and performance remain insufficiently explored.
Recognizing sex-specific physiological differences	The sources and empirical studies acknowledge the fundamental physiological differences between female and male athletes, including cardiovascular, hormonal, and muscular characteristics, which justify the development of tailored training and recovery protocols for female athletes [2, 12, 14]. This recognition supports the advancement of gender-sensitive sport science and coaching practices.	Despite acknowledging sex-based differences, many studies do not include male comparison groups or fail to appropriately adapt training recommendations. The complexity of female-specific physiological responses—including the influence of the hormonal cycle—is often oversimplified or inconsistently addressed throughout the research.

Conclusion

The literature on the morphofunctional characteristics of female athletes in Karakalpakstan highlights key themes related to anthropometric and physiological

profiles, menstrual cycle phases, hormonal influences, and sport-specific training adaptations across various disciplines. The primary focus centers on the interaction between biological maturity, body composition, and physical preparedness, with many studies demonstrating variability depending on sport type and competitive level. The reviewed sources collectively show that menstrual cycle phases influence strength, energy levels, and recovery, underscoring the complexity of hormonal effects in women's athletic performance. Moreover, training methodologies tailored to the physiological needs of female athletes are essential for optimizing physical work capacity and recovery across different sports.

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