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THE ROLE AND EFFECTIVENESS OF MODERN FITNESS TECHNOLOGIES IN IMPROVING THE SPECIAL PHYSICAL TRAINING OF FEMALE MILITARY PERSONNEL

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Abstract

The article analyzes the scientific-pedagogical and physiological foundations of modern fitness training in enhancing the professional-physical readiness of women serving in the armed forces system. Taking into account the anatomical and physiological characteristics of the female body, the expediency of introducing fitness trends that develop functional training, strength, and endurance into the military training process is scientifically substantiated.

Keywords: Female military personnel, physical training, fitness training, functional training, professional skills, aerobic endurance, biomechanics.

Introduction

Today, the rapid changes in the global security architecture, the characteristics of modern armed conflicts, and the intellectualization of the military sphere necessitate expanding the participation of women in the ranks of the armed forces and increasing the scope of their service. In parallel with ensuring gender equality in the armies of leading world countries, the successful service of female military personnel in various units (including special-task structures) has radically changed the requirements for their professional training. The combat readiness of female military personnel, their activity in performing tasks in complex

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conditions, and their professional stability directly depend on their high level of special physical training.

However, looking at current practical military-applied training practices, we see that the traditional physical education system often relies on universal and standardized approaches. In many cases, norms and loads are set without adequately taking into account gender and functional specifics. Meanwhile, the anatomical-physiological, biomechanical, hormonal, and metabolic characteristics of the female body differ significantly from those of men. The structure of the musculoskeletal system, ligament elasticity, location of the center of gravity, as well as the reactivity of the cardiovascular and respiratory systems to physical loads require a specific approach [1].

To fill this exact scientific-methodological gap and sharply increase training effectiveness, introducing modern fitness technologies and scientifically grounded innovative methods is becoming a very pressing issue. Modern fitness trends, including functional training, Core muscle development, and a complex of intensive aerobic and anaerobic exercises, serve to safely and effectively unlock the biological capabilities of the female body. This research work is aimed at revealing the theoretical and practical foundations of applying such targeted fitness technologies in improving the special physical training of female military personnel.

The issue of physical training for female military personnel is becoming increasingly urgent in the modern military education system. The widespread involvement of women in combat and combat support positions necessitates a revision of the requirements placed on their physical training. Studies show that women and men respond similarly to the same training programs—meaning that gender differences in training effectiveness are insignificant. However, the morphofunctional characteristics of the female body, particularly relatively low muscle mass, limited aerobic capabilities, and a high risk of injury, require a special approach [2].

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The traditional physical education system is often based on standards adapted to male physiology. Modern fitness technologies create new opportunities in solving this problem: managing individual load in real time, tracking fatigue and recovery status, and adapting training programs to the characteristics of the female body. The purpose of this study is to analyze the role and effectiveness of modern fitness technologies in the special physical training of female military personnel and to develop practical recommendations.

Performing military service takes place in extremely harsh and changing conditions, requiring military personnel to endure high levels of strength, speed, endurance, spatial orientation, and extreme psychophysical loads. A deep analysis of the individual-typological, anatomical-physiological, and biomechanical characteristics of their body is of critical importance in organizing the special physical training of female military personnel on a scientific basis. According to modern sports science and kinematics data, the response of women's and men's bodies to physical loads differs in several key aspects:

Anatomical-physiological and hormonal characteristics: In the female body, a slightly higher physiological proportion of adipose tissue and relatively low muscle mass (relative to total body weight) affect power generation and basal metabolic rate. Also, cyclic fluctuations of estrogen and progesterone hormones directly affect muscle contraction strength, ligament elasticity, and energy metabolism. This necessitates applying a cyclical approach when drafting training plans [3].

Biomexchanical factors and the center of gravity: The center of gravity in the female body structure is located lower (in the pelvic region) compared to men, which gives them a certain advantage in maintaining static balance, but requires redistribution of body angles and vectors during dynamic movements, such as lifting heavy loads, overcoming obstacles, or changing direction quickly (agility).

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Therefore, special fitness exercises developing balance and coordination optimize their movement trajectory.

Musculoskeletal system and injury prevention: Anatomical weaknesses in women's knee joints (specifically, the anterior cruciate ligament — ACL) and the lumbar region, as well as high joint flexibility (hypermobility), increase the risk of injury during heavy physical loads and landings after jumps. Scientifically grounded fitness approaches must aim to minimize these risks by strengthening the muscle corset (Core) and stabilizer muscles.

Assessment of aerobic and anaerobic capabilities: The dimensions of the cardiovascular system in women (heart volume and stroke volume) are relatively smaller, which affects oxygen-carrying capacity. However, through correctly chosen interval and functional fitness training, it is possible to significantly increase their oxygen consumption capacity ($VO_2\max$) and overall aerobic endurance, and elevate the body's fatigue-resistance capacity during long-term marches [4].

NATO studies note that women have on average 30 percent lower aerobic capacity compared to men, and a similar trend is observed in anaerobic indicators. Taking body composition into account, this gap shrinks to 20 percent, but remains significant. Due to lower muscle mass and lower efficiency in utilizing energy substrates, women experience peripheral fatigue faster during physical exercise. At the same time, an important conclusion is that there is no significant difference between women and men in terms of trainability. A study by Kraemer et al. shows that in terms of percentage improvement relative to the pre-training baseline, both sexes achieve similar results. This means that a properly organized training program can significantly increase women's physical performance [6].

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1.Main Directions of Fitness Training and Their Military-Applied Significance. Enriching and integrating standard, uniform physical exercises with modern fitness trends in the military-applied training process significantly expands the functional capabilities of military personnel. In particular, taking into account the physical and psychophysiological characteristics of female military personnel, applying the following main fitness directions yields high effectiveness:

Functional Training: This direction includes multi-joint exercises modeling movements performed in daily and real combat conditions (lifting heavy loads, overcoming various obstacles, rapid bending, jumping, and sharply changing direction). Unlike isolated exercises, functional training engages multiple muscle groups and joints simultaneously. This develops female military personnel's spatial coordination, agility, and skills in making quick decisions and moving in extreme situations [7].

Developing Aerobic and Anaerobic Endurance (High-Intensity Interval Training — HIIT and Cyclic Loads): Performing combat missions often requires prolonged physical exertion (e.g., long-distance marching with full combat equipment) as well as short-term, high-intensity movements (attacking, rapid concealment). Therefore, interval cardio workouts and aerobic loads increase the body's oxygen consumption capacity (VO_2max), improve cardiovascular system adaptability, and delay fatigue symptoms.

Stabilizing and Strengthening Core Muscles: The "Core" system, which includes the deep muscles around the abdomen, back, pelvic floor, and spine, is considered the center of body stability. Carrying heavy body armor, weapons, and special gear requires strong core muscles for female military personnel. Purposefully developing these muscle groups reduces excess pressure on the

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spine, maintains posture, and most importantly, prevents injuries in the lower back region when lifting heavy loads [8].

Mobility, Flexibility, and Active Recovery (Mobility & Flexibility): Tension arises in muscles and ligaments after any intense workout. Mobility training, including stretching, myofascial release (MFR), and yoga elements, restores joint mobility, helps faster breakdown of lactic acid in muscles, and significantly speeds up physical recovery.

2. Practical Recommendations for Improving Physical Training. To raise the special physical training of female military personnel to modern requirements and ensure the stable maintenance of their combat readiness in military units, special training centers, and field conditions, it is appropriate to introduce the following practical recommendations step-by-step:

Creating an individualized load system based on pedagogical and biological cycles: When planning training, along with age indicators and baseline physical fitness levels, a cyclical approach should be applied that takes into account their hormonal and biological rhythms (physiological cycle specifics). This approach prevents overtraining, expands the body's adaptive capabilities, and optimizes recovery.

Widespread introduction of digital monitoring and biometric control tools: To increase the safety and effectiveness of the training process, it is required to use modern heart rate monitors, smart fitness bracelets, and digital sensors evaluating heart rate variability (HRV). These systems enable specialists to monitor the functional state of each military servicewoman in real time, assess the cardiovascular system's reaction to physical loads, and adjust training intensity individually and on time.

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Including injury prevention and proprioceptive (balance) training in the mandatory curriculum: Based on the anatomical features of the female body, to prevent occupational injuries that may occur in the knee joints, lower back, and spine, it is necessary to permanently include balance boards, special stabilization platforms, and preventive exercise complexes aimed at strengthening core muscles into training programs.

Shaping psycho-emotional stability and active recovery culture: During periods of high stress, emotional tension, and tasks performed in extreme conditions, to maintain psychofunctional stability, it is appropriate to establish the practice of using deep diaphragmatic breathing gymnastics, myofascial release (MFR), stretching, and neuromuscular relaxation rehabilitation methods during the post-training recovery period. Integrating fitness exercises into the daily training program of female military personnel on a scientific basis sharply increases their professional performance. This not only ensures their physical endurance and combat readiness, but also serves as an important methodological foundation for health preservation, injury prevention, and psychological stability strengthening during service.

3.Integrating Modern Digital Ecosystems and Artificial Intelligence Solutions. Elevating the management process of special physical training for female military personnel to a qualitatively new stage requires deep integration of modern information technologies, Big Data analysis, and artificial intelligence (AI) algorithms into the educational process. In this direction, applying the following innovative approaches is extremely important:

Creating AI-based personalized load models: Implementing digital platforms that analyze each female military servicewoman's physiological indicators, body mass index, muscle-to-fat tissue ratio, and fatigue levels from previous workouts.

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AI algorithms automatically generate the optimal load volume, rest time, and exercise sequence for each individual.

Using Virtual and Augmented Reality (VR/AR) technologies: Developing military personnel's spatial orientation, quick decision-making speed, and stress-tolerance skills through simulators by modeling severe psychophysical loads and obstacle courses in field conditions in a safe environment [8].

Forming a unified digital monitoring base: Creating a single cloud ecosystem ensuring data exchange between physical training departments and medical services in military units. This ecosystem allows real-time tracking of each servicewoman's dynamic physical growth, risk of injury levels, and recovery indicators.

Instructors must undergo special training to effectively utilize modern fitness technologies. They must learn not only to manage technologies, but also to analyze obtained data and adjust training programs accordingly. Knowledge regarding female physiology is also necessary. Modern fitness technologies play an important role in improving the special physical training of female military personnel. Wearable devices, smart fitness equipment, AI-based systems, and digital monitoring tools provide an individualized approach taking into account the characteristics of the female body. International experience, particularly NATO research and innovative programs in Russian military education, shows that properly organized training can significantly increase women's physical performance. Women and men respond similarly to training, but the morphofunctional characteristics of the female body require special programs.

In the context of Uzbekistan, it is appropriate to introduce these technologies step-by-step, utilize existing infrastructure, and focus on personnel training. Future research should aim to study the anthropometric and physiological indicators of

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Uzbek female military personnel and develop national programs based on this foundation.

In conclusion, ensuring the combat readiness and professional stability of women serving in the modern armed forces system requires a fundamental improvement in their special physical training. Unlike traditional universal approaches, introducing targeted fitness technologies that deeply consider the anatomical-physiological, biomechanical, and hormonal characteristics of the female body (functional training, core stabilization, interval aerobic/anaerobic loads, and proprioceptive exercises) yields high effectiveness. Implementing the proposed scientific-methodological recommendations and digital monitoring systems into practice not only sharply increases the physical capabilities and endurance of female military personnel, but also serves as a robust scientific-practical foundation for preventing occupational injuries, strengthening psycho-emotional stability, and guaranteed assurance of their service efficiency.

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