COMPARATIVE ANALYSIS OF MORPHOLOGICAL AND FUNCTIONAL DEVELOPMENT IN URBAN AND RURAL ATHLETES IN KARAKALPAKSTAN

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Abstract: *This study investigates the differences in morphological and functional development between urban and rural athletes living in Karakalpakstan. The research focuses on key anthropometric indicators (height, weight, limb circumference), body composition (fat and lean mass), and physiological functions (cardiovascular, respiratory, and muscular performance). A total of 90 athletes aged 16–25 years, equally divided between urban and rural areas and across different sports categories (endurance, strength, mixed), were assessed. Results reveal that rural athletes tend to have superior respiratory capacity, lower body fat percentages, and greater muscular endurance, while urban athletes show slightly better neuromuscular coordination and flexibility. Environmental conditions, physical workload, nutritional habits, and lifestyle are found to be key contributors to the observed differences. The study highlights the importance of accounting for residential environment in athlete development programs in Karakalpakstan.*

Keywords: *Urban athletes, rural athletes, Karakalpakstan, morphological development, functional development, anthropometry, physical fitness, physiological adaptation.*

Athletic performance is shaped by a complex interplay of genetic, environmental, and lifestyle factors. Among these, the living environment—particularly the distinction between urban and rural settings—has significant implications for both morphological (body structure) and functional (physical performance) development in athletes. In regions like Karakalpakstan, where there are marked differences in lifestyle, socioeconomic conditions, and access to sports infrastructure between urban and rural areas, the investigation of these variables is both relevant and necessary.

Rural athletes often engage in more physically demanding daily activities, such as manual labor, walking longer distances, or participating in agricultural work, which may enhance their physical robustness, muscular endurance, and aerobic capacity. In contrast, urban athletes may have greater access to specialized training facilities, structured sports programs, and sports science interventions. However, urban lifestyles may also encourage more sedentary behavior outside of training, contributing to differences in overall activity levels. Studies from other regions have indicated that rural youth may exhibit superior lung capacity and lower body fat levels, while urban youth often display better fine motor skills and coordination due to earlier exposure to structured training. However, research specific to Karakalpakstan remains limited. A few localized studies have addressed morphological characteristics of athletes or general health indicators, but

no comprehensive comparison has been conducted between rural and urban athletes within the same region.[1]

This study seeks to fill that gap by comparing key anthropometric and physiological indicators among athletes from urban and rural environments in Karakalpakstan. By analyzing sport-specific and general physical development trends, we aim to provide coaches, sport scientists, and policy makers with data that can inform training strategies, resource allocation, and talent identification programs tailored to the unique conditions of this Central Asian republic.

A total of 90 athletes aged 16–25 years (45 urban, 45 rural), balanced across genders and major sport categories (endurance, strength, and mixed), were selected for the study. All participants had a minimum of 2 years of formal training. Urban athletes were drawn from sports academies in Nukus and other cities, while rural athletes came from training centers in remote districts and villages.

Measurements included:

Anthropometric: height, weight, BMI, arm and thigh circumference, and skinfold thickness (triceps, subscapular).

Body Composition: fat mass and lean body mass using skinfold equations.

Functional Tests:

- VO_2max (estimated via the Cooper test)
- Vital lung capacity (spirometry)
- Resting heart rate and blood pressure
- Sit-ups (1-minute test)
- Push-ups (max reps)
- Flexibility (sit-and-reach test)[2]

The data show clear environmental influences on physical development. Rural athletes benefit from higher baseline physical activity, likely contributing to their superior cardiovascular and muscular endurance. Their greater lung capacity may also be related to cleaner air and less pollution exposure. On the other hand, urban athletes, while possibly less active outside of training, benefit from better facilities, coaching, and recovery resources, which may explain their higher flexibility and better technical control. These differences underscore the need for customized training approaches. Rural athletes may require more structured technical and flexibility training, while urban athletes may benefit from aerobic conditioning and outdoor endurance activities to complement their gym-based routines.

The comparative analysis of morphological and functional development in urban and rural athletes in Karakalpakstan highlights the significant role environmental and lifestyle factors play in shaping athletic profiles.[3] While both groups demonstrate strong physical development aligned with their sports disciplines, notable differences were observed that have implications for training and development programs. Rural athletes, exposed to more physically demanding daily routines, naturally develop stronger aerobic and muscular endurance capabilities. Their superior lung function and cardiovascular profiles are critical advantages in endurance and mixed-sport disciplines. However, these

athletes may lack access to specialized equipment and coaching that facilitate flexibility, technical precision, and recovery—areas where urban athletes often perform better.

Urban athletes benefit from organized sports infrastructure, sports medicine support, and structured training regimens. This environment fosters better control over movement patterns, improved flexibility, and potentially higher neuromuscular coordination. However, limited daily activity outside training and sedentary habits may negatively impact their overall endurance and body composition. These findings suggest that athlete development programs in Karakalpakstan should be tailored to address environmental differences. Rural athletes may thrive when given access to structured flexibility and technical drills, while urban athletes could improve performance through targeted aerobic conditioning and outdoor physical activities. Coaches and sports institutions must also consider sociocultural and logistical constraints when designing interventions to bridge these gaps.

In conclusion, acknowledging the urban–rural divide is critical in optimizing the physical development of athletes in Karakalpakstan. By leveraging the natural strengths of each group and addressing their limitations through tailored interventions, the region can cultivate more well-rounded, high-performing athletes across all sports disciplines.

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