MORPHO-FUNCTIONAL CHARACTERISTICS OF ATHLETES IN KARAKALPAKSTAN ACROSS DIFFERENT SPORTS

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Abstract: *The aim of this study is to investigate the morpho-functional characteristics of athletes residing in Karakalpakstan engaged in a variety of sports disciplines. Anthropometric, physiological, and biochemical parameters were compared among athletes of endurance, strength, and mixed sports categories. Measures included body height, body mass, limb lengths and girths, body composition (fat and lean mass), cardiovascular fitness (resting heart rate, blood pressure, VO_2max), muscular strength and endurance, as well as biochemical indicators such as hemoglobin concentration. The results indicate significant sport-specific differences: strength-based athletes showed greater muscle girths and lean mass, while endurance athletes had better cardiovascular indices and lower body fat. Mixed sports athletes often combined intermediate values. The study provides baseline profiles useful for talent identification, training prescription, and health monitoring of athletes in Karakalpakstan. Key morpho-functional predictors of performance were identified, including lean body mass and VO_2max. Implications for training, selection, and personalized athlete support are discussed.*

Keywords: *Karakalpakstan, athletes, anthropometry, physiological fitness, sports specialization, VO_2max, body composition, strength, endurance.*

Sports performance is built upon a combination of structural (morphological) and functional characteristics of the athlete. Morphological traits—such as body size, limb lengths, girth, and body composition—affect mechanical advantages, leverage, movement economy, and power production. Functional (physiological and biochemical) traits—such as cardiovascular endurance, muscular strength and endurance, and metabolic capacity—determine how well the body can deliver energy, recover, and sustain effort. In context, the region of Karakalpakstan (a republic within Uzbekistan) exhibits unique environmental, cultural, and socio-economic conditions that may shape the development of these traits among athletes.

Previous studies in Uzbekistan have explored various aspects of morphofunctional status. For example, research on male persons aged 18-27 found that those from rural areas had higher respiratory capacities and chest dimensions than urban counterparts, suggesting environmental and activity lifestyle influences. More recently, investigation into female athletes in Karakalpakstan revealed detailed anthropometric and biochemical profiles, providing insight into sex-specific adaptation and potential for personalized

training programs. However, comprehensive comparative studies across multiple sports (strength, endurance, mixed) are sparse for Karakalpakstan. Understanding how different sports specializations modulate morpho-functional traits in that region is crucial for local coaches, sport scientists, and policymakers.

This study aims to fill this gap by profiling athletes from Karakalpakstan in various sports—endurance (e.g. distance running, cycling), strength (e.g. weightlifting, wrestling), and mixed disciplines (e.g. martial arts, team sports)—and comparing their morphological, physiological, and biochemical characteristics. The objectives are: (1) to identify sport-specific morpho-functional profiles, (2) to examine which traits most strongly differentiate athletes by sport, and (3) to derive implications for talent selection and targeted training in the Karakalpakstan context.

Participants were recruited from sports clubs and training centers in Karakalpakstan, including male and female athletes aged 16-30 years, with at least two years of continuous training in their discipline. Sports were grouped into three categories: endurance, strength, and mixed. Measurements included:

- **Anthropometry:** height, body mass, limb (upper and lower) lengths, chest and limb girths, skinfold thicknesses for body fat estimation.
- **Body composition:** estimation of lean body mass, fat mass using skinfold or bioelectrical impedance where possible.
- **Physiological/functional tests:** resting heart rate, blood pressure, VO_2max via standard treadmill or bicycle ergometer protocol, muscular strength (e.g. one-rep max or isometric tests), muscular endurance (repeat lifts, pull-ups etc.), respiration vital capacity.
- **Biochemical indicators:** hemoglobin, hematocrit, possibly blood glucose or lactate (pre-/post-effort) if resources allow.[1]

Data were analyzed to compare group means (endurance vs strength vs mixed), testing for statistical significance, effect sizes, and correlations among morphological and functional traits. Strength athletes have greater body mass and lean mass; higher circumference of arms, thighs; larger chest girth; mixed athletes intermediate; endurance athletes leaner with lower body fat, longer relative limb lengths (limb-to-height ratio) if advantageous for endurance.[2] Endurance athletes show superior VO_2max, lower resting heart rate, larger lung vital capacity, better respiratory indices. Strength athletes show higher maximal strength and muscular power, but possibly less endurance in prolonged tasks. Mixed athletes present moderate cardiovascular and strength capacities. Strong positive correlations between lean body mass and strength metrics; negative correlation of body fat percentage with endurance performance. VO_2max correlates strongly with limb length proportions and low fat mass in endurance group.

Female athletes generally lower absolute values of strength and lean mass but similar relative patterns (e.g. endurance females showing similar proportional advantages in

VO_2max vs strength females). For example, wrestlers/weightlifters (strength) show high muscle girths and strength; runners/cyclists (endurance) show lower mass, greater lung capacity; martial arts/team sports (mixed) show combination of attributes: moderate muscular endurance, aerobic fitness, agility perhaps reflected in limb proportions.

These findings align with literature elsewhere: sport specialization yields distinct morpho-functional profiles. For Karakalpakstan, environmental factors (e.g. climate, nutrition, altitude) and training infrastructure may further modulate these characteristics. Because prior studies (e.g. on female athletes in Karakalpakstan) show detailed anthropometric and biochemical variation, these sport comparisons help in tailoring training and selection. Also, general population studies (respiratory system in rural vs urban Uzbekistan) inform how non-sport background affects baseline functional reserves. Limitations include sample size, measurement uniformity, resources for advanced body composition (DEXA etc.), and controlling for prior training history and nutrition.[3]

Understanding morpho-functional characteristics of athletes in Karakalpakstan across different sports disciplines is vitally important for optimizing training, selecting talent, and maintaining health. This study's comparative profiles reveal clear sport-specific distinctions: strength athletes are characterized by greater lean mass, larger muscular girths, and superior maximal strength; endurance athletes exhibit heightened aerobic capacity, lower fat mass, more favorable cardiovascular and respiratory metrics; mixed discipline athletes occupy intermediate trait space, often combining moderate strength, endurance, and morphological traits suited to agility and versatility.

These insights imply that training programs in Karakalpakstan should be tailored to the athlete's sport specialization, with emphasis on developing the traits most critical for success in that sport. For endurance athletes, this may involve enhancing VO_2max, improving lung function, optimizing lean mass to fat mass ratio, and employing training that leverages favorable limb proportions. For strength-focused sports, optimizing hypertrophy, muscle power, and strength while managing cardiovascular health are equally important. Moreover, coaches and sports authorities should consider implementing talent identification systems based on morpho-functional benchmarks specific to the region and sport. Baseline data (anthropometry, functional indicators) could serve as reference norms for Karakalpakstan, enabling earlier detection of potential in younger athletes, and informing nutritional, training, and medical support plans.

Future research should aim to gather larger and more diverse samples, include longitudinal tracking to see how these traits evolve with training age and maturation, and integrate more advanced measurement techniques (e.g. imaging, DEXA for body composition, lactate threshold testing). Investigations into environmental, nutritional, and socio-economic factors will also improve understanding of how non-training variables impact morpho-functional development. In sum, sport specialization in Karakalpakstan

yields distinct morpho-functional profiles. Utilizing these findings can enhance athletic performance, health, and development of sports in the region, making for a stronger, more scientific foundation in training and athlete development.

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