

**EFFECTIVENESS OF IMPROVING SHOT PUT TECHNIQUE  
BASED ON BIOMECHANICAL ANALYSIS****Akhror Islamovich Djabbarov***Tashkent State University of Economics**Tashkent, Uzbekistan***ABOUT ARTICLE**

**Key words:** biomechanics, shot put, technique analysis, kinematics, dynamics, sports pedagogy, movement parameters, improvement, efficiency, track and field athletics.

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**Abstract:** This article examines biomechanical analysis methods in shot put athletics and their importance in technique improvement. The article analyzes the theoretical and methodological foundations of modern biomechanics, the parameters of kinematics and dynamics of movement in shot put, as well as ways to assess and improve athletes' technique. The main focus is on force application phases, velocity parameters, optimal angle indicators, and energy expenditure efficiency. The obtained results show that biomechanical analysis tools enable objective assessment of athletes' technique and provide scientific foundation for the training process.

**Introduction.** As a result of modern scientific and technological progress in sports, alongside athletes' physical preparation, the need to scientifically improve movement technique is increasing. Shot put, as a discipline in athletics, is a complex motor activity that requires the harmonious demonstration of strength and speed qualities [1]. The technique of shot put is based on the effective transfer of force through the athlete's body, the correct organization of movement phases, and ensuring optimal biomechanical parameters. Therefore, scientific analysis of these processes is considered one of the urgent issues today [2]. Biomechanical analysis methods make it possible to objectively assess athletes' movement structure, identify technical errors, and optimize training processes. In world practice, athletes' technique is studied with millimeter and millisecond precision using video analysis systems,

force platforms, electromyography, and other innovative technologies [3]. At the same time, the application of biomechanical analysis methods in the Uzbek athletics system is still limited, which indicates the need to deepen theoretical and practical research in this area [4].

**Literature Review.** Biomechanics is a field of science that studies human motor activity in sports based on the laws of mechanics, with its main branches being kinematics and dynamics [5]. Kinematics examines the spatial and temporal characteristics of movement—speed, acceleration, distance, angular parameters—while dynamics analyzes force effects and energy exchange processes. The main goal of biomechanical analysis in shot put is to understand the mechanisms of the athlete's movements, develop optimal technique, and eliminate errors. Modern biomechanical research shows that performance in shot put depends not on the maximum force applied by the athlete, but on the efficiency with which this force is converted into shot velocity [6]. Therefore, studying force-velocity relationships and determining their optimal combination is central to technical improvement.

The biomechanical structure of shot put technique consists of several key phases, each with its own functions and parameters. In the initial stance and preparation phase, the athlete must ensure optimal body position, maintain balance, and create conditions for the next phases [7]. The glide/rotation phase is the most crucial part of the shot put technique, during which the athlete sequentially engages body segments from the lower body upward, transferring energy toward the shot. Biomechanically, this process is based on the principle of the kinetic chain—each body segment passes impulse and energy to the next. In the final release phase, the shot reaches maximum velocity through maximal force application by the arm and shoulder. Maintaining balance and not crossing the boundary line are also essential technical requirements. The duration of each phase, direction of force application, and changes in velocity directly affect performance [8].

In modern sports practice, various tools and technologies are used for biomechanical analysis. Video analysis systems record the athlete's movements from multiple angles at high speed for frame-by-frame analysis. This allows accurate measurement of movement trajectories, speed profiles, and joint angles. Force platforms are used to determine ground reaction force vectors, changes in impulse, and the center of force application. Electromyography records muscle activity via electrical signals, revealing which muscle groups work, when they activate, and with what intensity. This integrated approach provides a comprehensive and objective assessment of movement technique [9]. Among the key criteria for determining optimal shot put technique is the release angle; theoretically, the ideal angle is

around 42 degrees, but in practice the athlete's individual characteristics and release height must be considered [10].

**Methodology.** This study employed theoretical analysis and generalization methods, examining Uzbek, Russian, and international sources relevant to the topic. Literature review was conducted in two main directions: first, studying the theoretical–methodological foundations of biomechanics; and second, analyzing the practical aspects and improvement methods of shot put technique. Priority was given to peer-reviewed journal articles, dissertations, textbooks, and training manuals with confirmed scientific credibility. A content analysis method was used to extract and systematize data from each source related to biomechanical parameters, technique phases, measurement methods, and principles of technical improvement.

**Results.** Summarizing the results of the literature review, several important conclusions and recommendations were formulated regarding improving shot put technique based on biomechanical analysis. First, modern biomechanical tools enable millimeter- and millisecond-accurate assessment of athletes' movement technique, helping coaches and athletes identify errors and develop effective improvement strategies. The literature shows that world champions and Olympic medalists share common technical features: they achieve optimal force application angles, efficiently engage all body segments in sequential order to maximize velocity, and perform movements with minimal energy loss. However, since each athlete has unique anthropometric characteristics, muscle strength distribution, and coordination abilities, the necessity for individualized biomechanical analysis became evident.

The analysis also revealed the most common technical errors in shot put: improper sequencing of body segments, failure to maintain optimal angles during the glide/rotation phase, incorrect control of arm speed during the final push, loss of balance, and unnecessary extra movements. Biomechanical analysis is highly effective for identifying such errors, showing exactly in which phase and how the error occurs. For example, video analysis reveals angles of shoulder and arm movement, force platforms show force vector direction and magnitude, and electromyography identifies weak or improperly working muscle groups, enabling the development of specialized strength exercises. Thus, biomechanical analysis not only detects problems but also helps determine how to eliminate them.

The literature review identified several key directions for improving shot put technique. First, alongside enhancing special strength preparation, it is necessary to improve the biomechanical efficiency of converting strength into speed. This requires plyometric exercises, speed-strength training, and phase-specific technical drills. Second, athletes should be educated

in biomechanical theory to develop conscious self-control of their movements. Understanding the mechanical basis of their actions helps athletes better follow coaching instructions and independently correct technical errors. Third, a biomechanical monitoring system should be regularly integrated into training—measuring technical parameters and tracking their dynamics. Fourth, video analysis, force measurement technologies, and other biomechanical tools should be widely introduced into Uzbek sports institutions, as achieving modern high-level results without such technology is difficult.

The findings also show that biomechanical analysis is important not only for elite athletes but also for beginners and intermediate-level athletes. Considering biomechanical principles early helps prevent serious technical errors later and reduces the need for retraining. Therefore, coaches working with young athletes must understand biomechanics and apply simple biomechanical assessment methods. The literature also indicates that individualized training programs based on biomechanical data, taking into account each athlete's strengths and weaknesses, significantly increase effectiveness. Moving away from standardized approaches toward personalized programs ensures a scientifically grounded method for technical improvement.

**Discussion.** Improving shot put technique based on biomechanical analysis is one of the most effective directions in modern sports pedagogy. The literature review shows that objectively assessing athletes' technique, measuring biomechanical parameters, and considering individual characteristics enables the creation of scientifically grounded strategies for improving performance. Key biomechanical parameters—release angle and velocity, sequential activation of body segments, force application direction, and balance—are the main determinants of technical efficiency. Modern biomechanical tools—video analysis systems, force platforms, electromyography—allow precise measurement and analysis of these parameters. According to the results, integrating biomechanical monitoring into training, educating athletes in biomechanics, and applying individualized approaches are essential principles for technical improvement.

The following recommendations were developed for Uzbek sports practice. First, national athletics centers and sports schools should be equipped with modern biomechanical analysis tools, including high-speed cameras, force platforms, and specialized analysis software. Second, coaching development programs should include courses on biomechanics fundamentals and analysis methods. Third, multidisciplinary teams of biomechanics specialists, coaches, and medical staff should be formed to conduct comprehensive monitoring of athletes. Fourth, pedagogical work with athletes should include lessons aimed at increasing

biomechanical literacy—understanding the mechanical basis of their movements. Fifth, training programs should be individualized based on biomechanical analysis results, and a system of continuous monitoring of technical performance should be implemented. Implementation of these measures will significantly improve technical preparation in Uzbek athletics, particularly in shot put, and contribute to developing athletes capable of competing at the international level.

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