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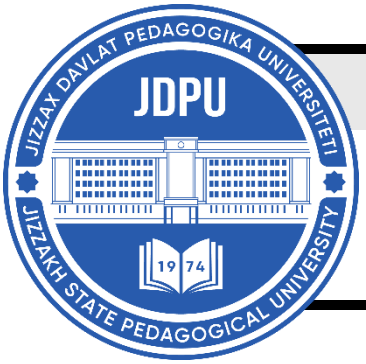
MENTAL ENLIGHTENMENT SCIENTIFIC – METHODOLOGICAL JOURNAL



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BIOMECHANICAL ANALYSIS OF THE TECHNICAL PREPARATION OF DISCUS THROW ATHLETES AND INNOVATIVE METHODS FOR ITS IMPROVEMENT

Zebo Khusanovna Yusupova
Associate Professor
Uzbekistan State University of Physical Education and Sports
Chirchik, Uzbekistan

ABOUT ARTICLE

Key words: metal disk, technical preparation, angular velocity disk, medium speed, flight distance, biomechanical correction, kinematic characteristics and metal disk.

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Abstract: This study aims to enhance the technical training of discus throwers using biomechanical analysis methods and innovative technologies. In a scientific laboratory, the athlete's movement was recorded in 3D space using high-precision OptiTrack cameras and specialized Motive software for their control. Kinematic indicators (joint angles, angular velocity, center of gravity trajectory, and impulse transfer) were determined, and a model of individualized training loads was developed. During the pedagogical experiment, the application of this model resulted in significant improvements in throwing distance, stability during the rotation phase, and energy transfer efficiency ($p<0.05$). Integration of this methodology into the long-term training system ensures steady performance improvement, reduced injury risk, and adaptation to elite athletes' training standards. The research findings are expected to have practical significance in targeted preparation for the Los Angeles 2028 Olympic Games.

Introduction. Today, the field of physical education and sports is considered one of the priority areas of national development. In New Uzbekistan, large-scale reforms are being implemented aimed at nurturing a healthy and physically well-developed generation,

preparing young athletes for worthy participation in international competitions, and enhancing sports performance on a scientific basis. In President Shavkat Mirziyoyev's "Development Strategy of New Uzbekistan" and the "Concept for the Development of Physical Education and Sports for 2023–2030", particular emphasis is placed on strengthening scientific approaches in sport, introducing modern innovative technologies, and evaluating athletes' preparedness based on digital analytical systems.

Discus throw is one of the technically complex and skill-intensive disciplines of athletics, where the primary factors determining sports performance include the athlete's movement technique, biomechanical coordination, and the efficiency of force impulse transmission. Therefore, improving the training of discus throw athletes not only through traditional methods, but also through scientific analysis and innovative techniques, is considered an effective approach that aligns with international standards.

At present, biomechanical analysis is widely used as an important scientific direction that enables detailed study of athletes' movements, identification of technical errors, and their correction based on individualized models. Using contemporary video analysis software (such as Dartfish, Kinovea, Coach's Eye), sensor platforms, and 3D motion modeling systems, spatial parameters of movement, joint angles, rotational velocity, and the efficiency of force impulse transmission can be accurately assessed. This facilitates the refinement of technical skills, stable improvement of performance, and reduction of injury risk.

A number of regulatory documents adopted in Uzbekistan also support the implementation of scientific research in this direction. The "Development Strategy of New Uzbekistan", the "Concept for the Development of Physical Education and Sports", the decree "On Improving the System for Training Olympic and Paralympic Reserves", as well as the "Law on Youth Policy", define objectives related to preparing athletes based on scientific and innovative principles, improving sport performance, and achieving high results on international stages.

At the same time, this scientific direction also serves to ensure high-level preparation of Uzbekistan's athletes for the XXXIV Summer Olympic Games to be held in 2028 in Los Angeles, USA. In the process of forming Olympic reserves, a scientifically grounded training system, individualized models based on biomechanical analysis, and digital monitoring will make it possible to improve each athlete's technique and increase performance by 5–10 percent. The main factors determining results in discus throwing include technical competence, the harmony of movement phases, the parameters of rotational throwing mechanics, and injury prevention. In modern sports, success is defined by increasing competition, early specialization

in youth sports, and the rational use of scientific and technological achievements. Under such conditions, biomechanical analysis and innovative methods allow for the individualization of technical preparation, the rapid identification of errors and unnecessary movements, and the reconstruction of efficient movement patterns for swift correction.

Therefore, improving the technical preparation of discus throwers through biomechanical analysis and innovative methods has significant scientific and practical importance not only for the development of national sports science, but also for preparing young athletes who will represent our country in international competitions. Based on the results of this research, it is possible to develop new-generation training programs for sports schools and universities, assess sports technique using automated analytical methods, and create individualized performance models, thereby advancing the field of athletics in our country to a new stage.

Purpose of the Research:

The purpose of this study is to develop a methodology aimed at improving the performance indicators of discus throwers through biomechanical correction within the framework of long-term sports training, and to determine its effectiveness through pedagogical experimentation.

Research Tasks:

To develop biomechanical indicators, a set of physical exercises, and a training program directed at developing the special strength preparation of discus throwers and improving their technical movement patterns.

Research Results and Discussion:

In this research, the planning of annual training loads was optimized based on the athletes' level of integrated preparedness. In addition, particular attention was given to the development of technical preparedness during the annual training cycle. Therefore, the effective implementation of the developed methodology in training sessions requires coordinated cooperation between the coach and the athlete, which in turn enables the achievement of high-level sports results.

These training activities were carried out in a scientific laboratory equipped with OptiTrack high-precision cameras, markers, and sensor-based monitoring systems, along with specialized Motive software that records the athlete's movement in three-dimensional space, as well as at the throwing field of the Uzbekistan State University of Physical Education and Sports.

The scientific research conducted is not limited solely to the application of the “Sports Biomechanics” academic course, but also provides the opportunity to be utilized directly in the athlete’s training process. To ensure convenience and clarity during pedagogical analysis, the entire movement sequence—from the moment the athlete takes the discus in hand, enters the throwing circle, releases the discus, and completes the final stabilization phase—was divided into several specific phases, each of which was examined in detail.

Specifically:

A) The First Phase of Movement in Discus Throwing

The initial phase of the discus throw begins with the “wind-up” position, which prepares the athlete to execute the throw. In this phase, the athlete stands in a stable double-leg support position, holding the discus in the right hand while rotating the shoulder girdle to the right toward an optimal final point. The right and left arms must be positioned along the projection line of the shoulder axis. During this movement, the left arm continues its motion toward the right, crossing the projection line of the shoulders.

The biomechanics of the lower limbs in this phase are as follows: the legs are slightly flexed at the knees, and the left foot is positioned such that its inner edge is oriented outward, prepared to initiate rotational movement.

B) The Entry Phase (Transition Into Rotation)

The second phase, known as the entry phase, represents the initiation of rotation. This phase is executed by rotating the inner edge of the left foot outward, thereby creating optimal conditions for performing the sweeping motion with the right leg, and simultaneously maximizing the separation between the right and left femurs. During this phase, the arms extend beyond the projection of the shoulder axis and should remain parallel to the plane of rotation. Before the sweeping motion begins, the left arm must remain parallel to the left thigh.

The sweeping motion of the right leg, combined with pelvic rotation, creates conditions for the discus to accelerate with maximum amplitude as it moves leftward away from the athlete’s center.

C) The Rotation Phase in Discus Throwing (See Figure 1.)

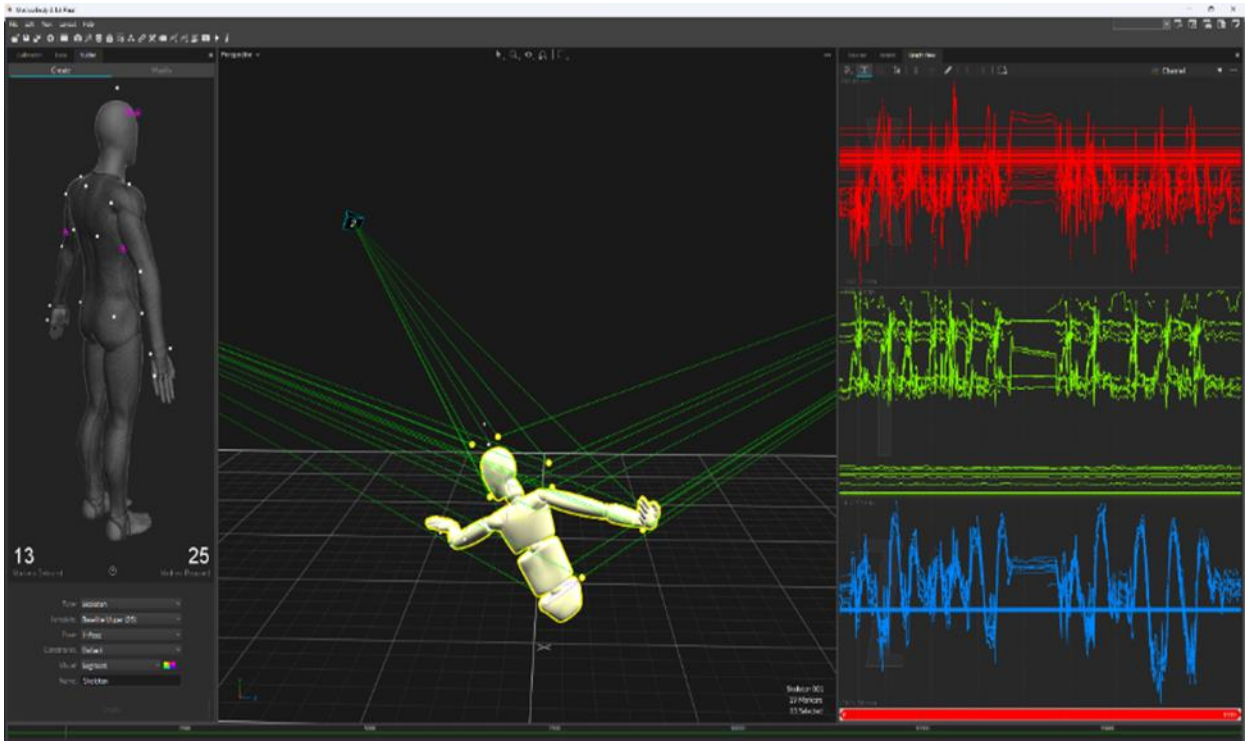


Figure 1. Transition from the First Phase to the Second Support Phase in the Rotational Discus Throw

The sweeping motion is performed with the right thigh, enabling the athlete to achieve maximum rotation of the pelvis until the body turns with the back facing the throwing direction. During this movement, the left foot actively pushes off the surface, and the leg is placed onto the opposite side of the throwing circle along the shortest trajectory.

At this moment, the right leg and the right side of the pelvis make active contact with the circle surface, initiating rotational movement of the pelvis toward the throwing direction.

D) The Final Acceleration (Force Application) Phase in Discus Throwing

When the left foot is planted inside the circle, the discus is positioned behind the athlete, at approximately the level below the lumbar region of the vertebral column. From this position, rotation of the right side of the body toward the left is used to transmit force into the discus, directing the implement toward the throwing sector through the firmly stabilized left leg. (See Figure 2.)

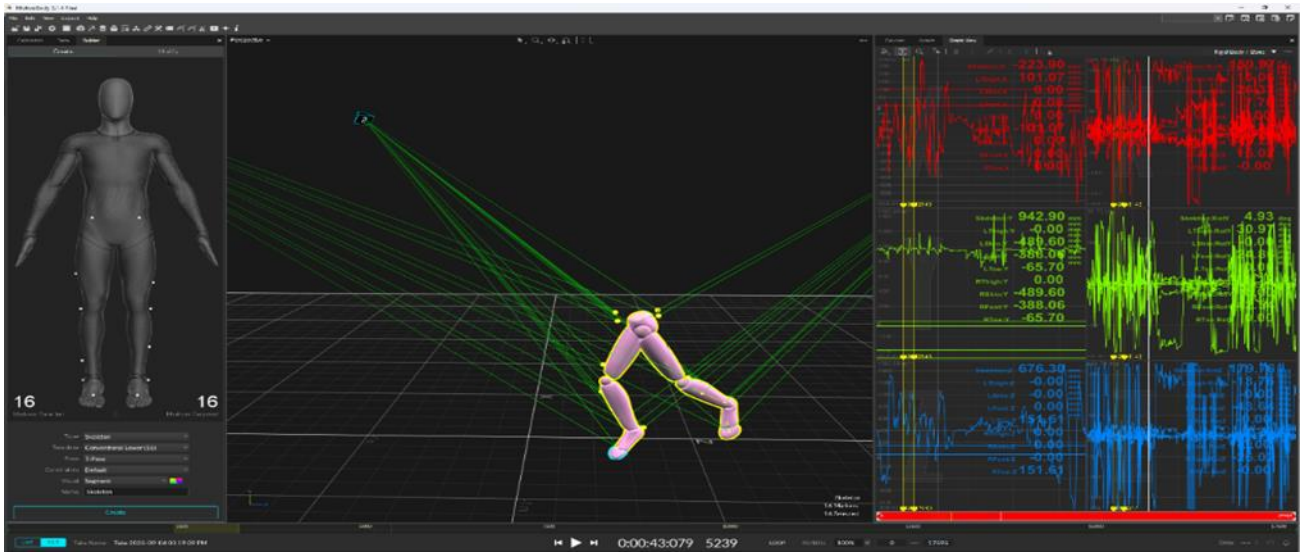


Figure 2. The fifth phase – the final acceleration phase – the phase of energy transfer to the implement through the legs.

E) Deceleration phase of the discus throw.

After releasing the discus, the athlete must either jump in place or reposition the feet to remain within the circle. Through active rotation of the left heel and the placement of the right foot in its position, the left arm moves along the shoulder line during the final extension of the wing. This prevents the discus from moving with maximum amplitude toward the left side. (Figure 3)

(Figure 3)

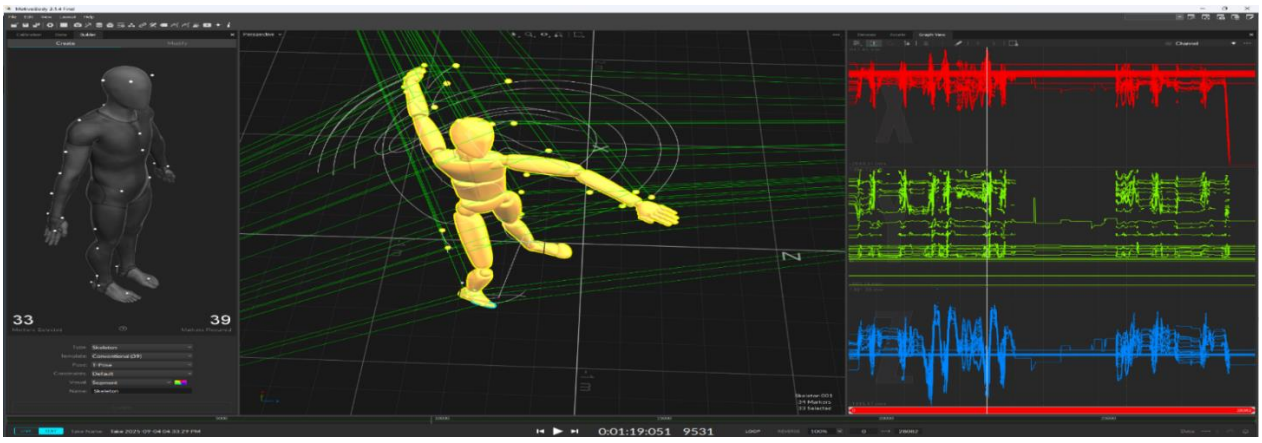
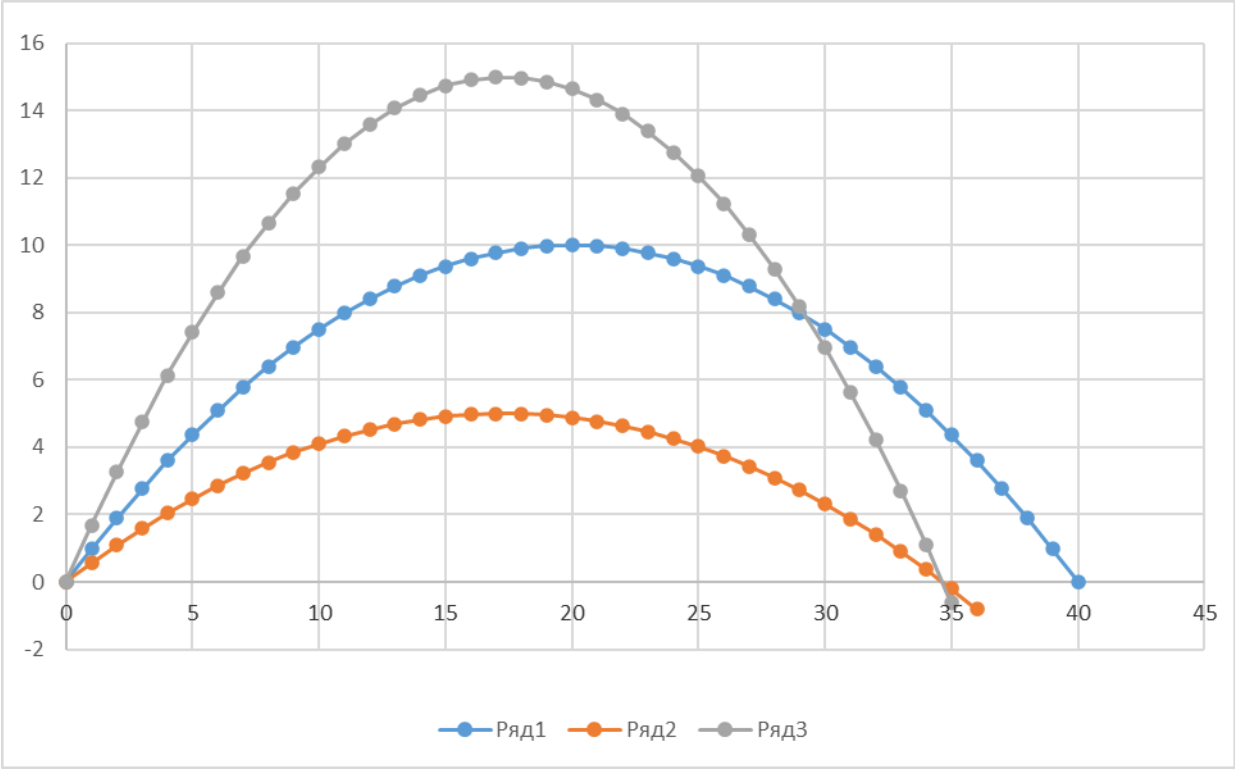


Figure 3. Sixth phase – the deceleration phase.

The purpose of the deceleration phase in the discus throw is to maintain a stable position while simultaneously reducing the athlete's body velocity in order to avoid exiting the throwing circle. This is achieved through a step from the supporting left foot to the right foot and continuation of body rotation around the vertical axis. In the final stage of the throw, the rotational angular velocity of the thrower can reach up to 10 rad/s, which corresponds approximately to 1.6 rotations per second.

In determining the initial velocity of the implement, it was observed that both the magnitude of the angular velocity and the radius of rotation—that is, the distance from the rotation axis to the center of gravitational force—play a crucial role in the throw. During the discus throw, the distance of flight is influenced by the length of the athlete's arm, the distance of the discus from its rotation axis, and the position of the center of mass relative to the discus itself.

At a given angular velocity, the larger the radius of rotation, the higher the initial velocity of the implement, which in turn results in a greater throwing distance. The outcomes of the research are presented in the following tables. The subsequent graph shows the calculated optimal values of the throwing results for the experimental group (EG) and control group (CG) at the beginning of the pedagogical experiment.



Thus, in general, the performance in the discus throw is influenced by the following factors:

1. The initial velocity of the implement (V_0);
2. The release angle of the implement (α);
3. Environmental conditions (air resistance, wind strength, and direction);
4. The height of the implement above the ground during flight (h_0);
5. The aerodynamic properties of the implement;
6. The attack angle of the implement (β).

Each of the above factors determines the efficiency and overall performance of the throw in a given situation. At the same time, the significance of each parameter varies. In practice, the most critical factors are the scale (size), center of mass, rotational velocity, release angle, and initial velocity.

Based on the conducted analysis, identified errors and deficiencies were corrected through the implementation of various targeted training directions and the use of specialized exercise complexes. The analysis of these factors is primarily essential for a precise and comprehensive evaluation of all movements performed by the discus thrower.

The individually designed training loads, optimized within this study, largely depend on the athlete's current physical preparedness and their readiness level at a given moment. Therefore, applying this developed methodology in the training process encourages coaches and athletes to work in coordinated synergy, facilitating higher technical proficiency and improved performance outcomes.

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