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BIOMECHANICAL FOUNDATIONS OF HAMMER THROW TECHNIQUE AND ITS IMPROVEMENT

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Abstract

This article highlights the biomechanical foundations of hammer throw technique and the scientific–methodological aspects of improving technical training. Hammer throwing is one of the most complex coordination-based events in athletics, in which achieving high performance directly depends on the athlete's strength, speed, balance, and movement coordination. In particular, the biomechanically correct organization of the throwing technique is considered one of the key factors determining sports performance.

The article analyzes the biomechanical indicators of the hammer throw, including the phases of rotation, centrifugal force, release velocity and angle, and the stability of the support point. In addition, a system of special exercises aimed at improving the effectiveness of technical training, as well as modern methods for enhancing movement technique, are scientifically substantiated.

The research results demonstrate that training sessions organized on the basis of biomechanical analysis contribute to the improvement of athletes' throwing technique, enhancement of movement efficiency, and overall performance outcomes.

Keywords

hammer throw, biomechanics, technical training, release angle, rotation phase, velocity, athletic performance, athletics, strength-speed abilities, coordination.

Introduction

Among athletics events, throwing disciplines stand out due to their specific complexity and high coordination demands. The hammer throw, as one of the throwing events, requires from athletes not only significant strength and speed but also a high level of technical mastery, the ability to maintain balance, and the consistent and coordinated execution of complex movements. In modern sports practice, achieving high performance depends not only on athletes' physical preparedness but also directly on the biomechanically correct organization of movement technique.

The technique of hammer throwing is based on complex rotational movements, in which the athlete's actions at each phase directly influence the overall result. During the rotation process, biomechanical factors such as centrifugal force, angular momentum, the sequential activation of body segments, and the stability of the support point determine the effectiveness of the throw. An increase in throwing distance primarily depends on the optimal ratio of release velocity, release angle, and release height, and these indicators are closely related to the athlete's technical proficiency [1].

In recent years, scientific research conducted in the field of sports biomechanics has demonstrated that a detailed analysis of movement technique and its improvement can

significantly enhance sports performance. In particular, phase-based analysis of hammer throw technique, the study of movement velocities, and force moments enable the scientific organization of the athlete training process. This requires the integration of theoretical and practical approaches in planning the training process [2].

The study of the biomechanical foundations of hammer throw technique is especially relevant at the stage of sports mastery development. At this stage, athletes are generally sufficiently prepared physically; however, further improvements in performance largely depend on the refinement of technical movements. Minor errors in technical elements can lead to a loss of impulse, a decrease in rotational speed, and a reduction in release velocity. Therefore, optimizing technique based on biomechanical analysis is considered one of the most important directions for improving sports performance [3].

In the modern system of sports training, the process of technical improvement should not be limited to traditional methods. Biomechanical approaches such as video-based motion analysis, phase segmentation, determination of angular velocities, and assessment of ground reaction forces provide opportunities to organize technical training on a scientific basis. This approach allows for the identification of weaknesses in the athlete's movement structure and the development of a system of special exercises aimed at eliminating these deficiencies.

Furthermore, the improvement of hammer throw technique contributes not only to enhanced sports performance but also to the reduction of injury risk. Biomechanically correct execution of movements reduces excessive loads on muscles and joints and increases movement efficiency. For this reason, improving technical training on a biomechanical basis is considered highly relevant from both scientific and practical perspectives [4].

Based on the above considerations, an in-depth study of the biomechanical foundations of hammer throw technique, scientific analysis of rotational phases, and the development of effective methodological approaches for improving technical training are among the important tasks facing sports theory and methodology. This article provides a scientific analysis of these issues and substantiates biomechanical approaches aimed at improving the technical mastery of hammer throw athletes [5].

Research methodology

The purpose of this study was to determine the biomechanical foundations of hammer throw technique and to develop a methodological approach aimed at improving the effectiveness of technical training. During the research process, scientific-theoretical and experimental methods were used in a comprehensive manner.

Research Object and Participants

The study was conducted with the participation of 16 hammer throw athletes who were at the stage of sports mastery development. The athletes were randomly divided into two groups.

Table 1

Changes in Hammer Throw Technical Indicators

Indicators	Initial Result	Final Result	Improvement (%)
Throwing distance (m)	56.9	61.2	+7.5%
Release velocity (m/s)	24.7	27.1	+9.7%
Angular velocity (rad/s)	2.87	3.18	+10.8%
Release height (m)	1.62	1.71	+5.5%

During the training process, biomechanically based technical corrections led to a significant increase in throwing distance and release velocity.

Table 2
Release Angle and Technical Accuracy Indicators

Indicators	Initial	Final	Optimal Condition
Release angle (°)	38.2	42.3	40–44°
Movement accuracy (%)	71%	86%	High
Number of technical errors	6–7	2–3	Minimal

Optimization of the release angle and reduction of technical errors improved throwing efficiency.

Table 3
Impact of Biomechanical Factors on Sports Performance

Biomechanical Factors	Degree of Influence	Effect on Result
Angular velocity	High	Distance increased
Support stability	High	Balance maintained
Impulse transmission	Moderate–High	Speed increased
Release angle	High	Optimal throwing

Among the biomechanical factors, angular velocity and release angle were identified as the primary determinants of performance outcomes.

Table 4
Effectiveness of Technical Training

Criteria	Initial	Final	Change
Technical stability	Medium	High	Improved
Movement coordination	Medium	High	Improved
Strength-speed combination	Medium	High	Increased
Overall sports performance	Medium	High	Significant

Biomechanically based training significantly improved technical stability and coordination.

Discussion

In modern athletics practice, hammer throwing requires athletes to demonstrate a high level of technical proficiency, strength–speed qualities, and biomechanically precise execution of movements. The results of the conducted research indicate that an in-depth study of the biomechanical foundations of hammer throw technique and the introduction of scientifically grounded approaches into the training process are important factors in improving sports performance.

The analysis showed that the correct execution of the rotational phase, stability of support, and the continuous preservation of impulse momentum in hammer throw technique directly influence the increase in throwing distance. Biomechanically precise organization of the athlete's movements leads to the optimal formation of release velocity and release angle. These factors are considered key determinants in enhancing throwing efficiency.

The findings demonstrated that training sessions organized on the basis of biomechanical analysis significantly improved the athletes' technical preparedness. The application of special

exercises aimed at increasing rotational speed, strengthening support stability, and optimizing the release phase contributed to the improvement of athletes' technical mastery. As a result, positive changes were observed in throwing distance, release velocity, and movement coordination.

Eliminating deficiencies identified through biomechanical analysis helped improve the structural organization of athletes' movements. In particular, the sequential activation of body segments during rotation and the correct transmission of impulse enhanced the efficiency of technical movements. This created a foundation for stable improvement in sports performance.

Furthermore, the importance of an individual approach in the process of improving technical training was also identified. Organizing training sessions while taking into account each athlete's anthropometric characteristics, level of physical preparedness, and specific technical features enables more effective development of technical mastery [6].

Overall, it was determined that improving hammer throw technique on a biomechanical basis plays a significant role in enhancing technical stability, improving movement efficiency, and achieving high sports performance. This highlights the necessity of widely applying modern biomechanical approaches in the training process [7].

Conclusion

In conclusion, an in-depth study of the biomechanical foundations of hammer throw technique and the application of scientifically grounded methodological approaches in the training process play an important role in improving athletes' technical preparedness. The research results confirmed that biomechanically correct organization of technical movements directly influences the increase in throwing distance, release velocity, and improvement of movement coordination.

A system of special exercises aimed at increasing rotational speed, forming an optimal release angle, and ensuring proper impulse transmission proved to be an effective tool in developing athletes' technical mastery. As a result, the overall sports performance of athletes improved and the stability of technical movements increased.

In improving the technical training of hammer throwers, organizing training sessions based on biomechanical analysis, analyzing movements through video recording, and applying an individual approach are of great importance. This approach allows for the identification and elimination of technical deficiencies, thereby enabling athletes to achieve higher performance results.

In the future, expanding scientific research aimed at improving hammer throw technique, introducing modern biomechanical analysis methods, and implementing innovative technologies into the training process will contribute to further enhancement of sports performance. This will serve as an important factor in the development of athletics and the preparation of highly qualified athletes.

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