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EFFECTIVENESS OF MODERN PEDAGOGICAL METHODS IN TEACHING HAMMER THROW TECHNIQUE BASED ON BIOMECHANICAL ANALYSIS

Saidova Sarvinoz Iskandar kizi
Asia international university of
department of physical culture
Email: saidovasarvinoz@oxu.uz

Abstract: This study examines the effectiveness of modern pedagogical methods in teaching hammer throw technique to university students based on biomechanical analysis. A total of 30 students aged 18–22 participated in the study and were divided into control and experimental groups. The experimental group was trained using an improved methodology incorporating step-by-step instruction, video analysis, and individualized feedback. Biomechanical analysis was applied to evaluate movement efficiency and technical accuracy. The results showed a significant improvement in technique execution (15–20%), throwing distance (18–22%), and physical qualities such as strength and coordination. The findings were statistically significant ($p < 0.05$), confirming the effectiveness of integrating biomechanical principles into teaching methodology.

Keywords: hammer throw, biomechanics, teaching methodology, athletics, physical education, technique improvement.

Introduction

Physical education plays a key role in developing students' physical abilities and overall health. Athletics disciplines, particularly hammer throw, require a complex combination of strength, coordination, and technical precision. The effectiveness of teaching methodologies significantly influences the level of skill acquisition.

Traditional teaching approaches often rely on repetitive practice and general instruction, which may not be sufficient for mastering complex motor skills. Modern pedagogical methods emphasize individualized learning, visual feedback, and scientifically grounded training principles.

Biomechanical analysis provides a deeper understanding of movement phases, force application, and coordination patterns. Integrating biomechanical principles into the teaching process can significantly enhance technique learning and performance outcomes.

The novelty of this study lies in the integration of biomechanical analysis with modern pedagogical approaches, including step-by-step instruction, video feedback, and individualized correction.

2. Methods

2.1 Participants

The study involved 30 university students aged 18–22. Participants were randomly divided into two groups:

1. Control group (n=15)
2. Experimental group (n=15)

All participants had similar baseline levels of physical fitness and technical skills.

2.2 Research Design

The experiment was conducted over an 8-week period during regular physical education classes.

Initial and final testing included:

1. technique accuracy
2. throwing distance
3. strength
4. coordination

2.3 Methods Used

1. Pedagogical observation
2. Pedagogical experiment
3. Testing methods
4. Comparative analysis
5. Biomechanical analysis

2.4 Experimental Methodology

The experimental group was trained using an improved methodology that included:

1. Step-by-step learning of movement phases
2. Video analysis for visual feedback
3. Individualized correction of technical errors
4. Biomechanical explanation of movements (force, angle, rotation)

a. The control group followed traditional teaching methods.

3. Results

The results showed significant improvement in the experimental group:

1. Technique accuracy increased by **15–20%**
2. Throwing distance increased by **18–22%**
3. Coordination improved by **15–18%**
4. Strength indicators increased by **15–20%**

Biomechanical analysis revealed improved:

1. movement coordination
2. force application efficiency
3. body positioning during release phase

Statistical analysis confirmed that differences between groups were significant (**$p < 0.05$**).

4. Discussion

The findings of the present study provide substantial evidence that the integration of biomechanical analysis into teaching methodology significantly enhances the technical performance of students in hammer throw. This improvement can be explained by the optimization of movement structure and the more efficient coordination of biomechanical variables involved in the execution of the technique.

The application of step-by-step instruction proved to be particularly effective in facilitating motor learning. By dividing the hammer throw technique into distinct phases—preparation, rotation, power position, release, and follow-through—students were able to focus on mastering each component sequentially. This approach reduces cognitive overload and allows for the gradual development of complex motor patterns, which is consistent with contemporary theories of skill acquisition and staged learning processes.

Moreover, the use of video analysis significantly enhanced students' visual perception and self-regulation abilities. Visual feedback enables learners to compare their own performance with model techniques, thereby improving error detection and correction mechanisms. From a motor learning perspective, this aligns with the principles of augmented feedback and observational learning, which are known to accelerate skill acquisition and improve movement accuracy.

Individualized feedback further contributed to the effectiveness of the teaching process by addressing specific technical deficiencies of each student. Unlike traditional approaches that rely on generalized instruction, personalized correction allows for targeted interventions, leading to more efficient neuromuscular adaptation and faster improvement in performance. This individualized approach also positively influences motivation and engagement, which are critical factors in learning complex athletic skills.

From a biomechanical standpoint, the improvement in performance can be attributed to a better understanding and application of key mechanical principles. Factors such as optimal release angle, efficient force generation, angular velocity, and coordination of rotational movements play a decisive role in achieving maximal throwing distance. The enhanced synchronization between lower and upper body segments observed in the experimental group indicates improved kinetic chain efficiency, which is essential for effective force transfer.

The results of this study are consistent with previous research conducted by Vladimir N. Platonov (2020), Tudor O. Bompa (2018), and Vladimir M. Zatsiorsky (2019), who emphasize the importance of integrating scientific principles and modern pedagogical technologies into sports training. Their studies highlight that the application of biomechanical analysis and individualized training methods leads to significant improvements in both technical execution and physical performance.

In addition, the integration of pedagogical innovation with biomechanical analysis creates a more effective and scientifically grounded learning environment. Such an approach not only improves immediate performance outcomes but also contributes to the development of long-term motor skills, movement efficiency, and injury prevention. It ensures that students acquire not only practical skills but also a deeper conceptual understanding of movement mechanics.

Overall, the findings confirm that combining modern teaching methodologies with biomechanical analysis represents a highly effective strategy for optimizing the educational and training process in athletics. This integrated approach should be considered a key component in the modernization of physical education systems and coaching practices.

5. Conclusion

The findings of this study provide strong empirical evidence that the integration of modern pedagogical methods with biomechanical analysis significantly enhances the effectiveness of teaching hammer throw technique to university students. The application of scientifically grounded instructional strategies not only improves technical execution but also contributes to the development of key physical qualities and motor coordination.

The results demonstrate that a structured and phase-based approach to teaching facilitates a deeper understanding of movement mechanics. By dividing the hammer throw technique into sequential phases and ensuring gradual mastery, students are able to reduce technical errors and achieve more consistent performance outcomes. This confirms the importance of systematic instruction in complex motor skill acquisition.

Furthermore, the incorporation of biomechanical analysis plays a crucial role in optimizing technique learning. Understanding biomechanical principles such as force generation, rotational dynamics, and optimal release angle enables students to perform movements more efficiently and with greater precision. This scientific approach enhances not only performance but also cognitive awareness of movement patterns.

The use of individualized instruction significantly increases learning efficiency by addressing the specific needs and limitations of each student. Personalized feedback allows for targeted correction of technical errors, thereby accelerating the learning process and improving overall skill acquisition. In contrast to traditional methods, which often rely on generalized instruction, individualized approaches ensure a more effective and student-centered training process.

In addition, modern pedagogical tools such as video analysis provide immediate visual feedback, which enhances self-assessment and motor learning. This contributes to higher levels of motivation, engagement, and active participation among students, ultimately leading to improved training outcomes.

Based on the obtained results, it can be concluded that modern, scientifically based teaching methodologies are more effective than traditional approaches in developing both technical and physical aspects of athletic performance. The integration of biomechanical analysis into the educational process creates a more efficient and evidence-based training environment.

Therefore, it is strongly recommended that higher education institutions incorporate these innovative methodologies into physical education curricula, particularly in athletics disciplines that require high technical precision, such as hammer throw.

Future research should aim to expand the sample size, include athletes with different levels of expertise, and investigate the long-term effects of biomechanical-based training methods on performance, injury prevention, and motor skill retention. Additionally, further studies may explore the application of this methodology to other throwing events in athletics.

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