

INNOVATIVE METHODS FOR DEVELOPING SPECIAL ENDURANCE IN HANDBALL PLAYERS

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Abstract: This article provides a scientific-theoretical and practical analysis of innovative methods for developing special endurance in handball players. Modern handball is characterized by high intensity, rapid transition phases, and repeated maximal loads. Therefore, special endurance is considered one of the key factors determining an athlete's competitive stability and performance efficiency.

The study examined innovative approaches such as interval training, High-Intensity Interval Training (HIIT), game-based load modeling, functional training exercises, digital monitoring technologies, and individualized load management. The effectiveness of the proposed methods was evaluated through a pedagogical experiment, functional testing, cardiovascular performance analysis, and statistical data processing.

The results demonstrated that innovative approaches significantly improve special endurance indicators, accelerate recovery processes, and ensure technical and tactical stability throughout competition. The conclusions of the study provide a scientific and methodological foundation for coaches and sports education institutions.

Keywords: Handball, special endurance, innovative methods, interval training, HIIT, game modeling, functional training, load monitoring, sports performance, recovery process.

Аннотация: В данной статье представлен научно-теоретический и практический анализ инновационных методов развития специальной выносливости у гандболистов. Современный гандбол характеризуется высокой интенсивностью, быстрыми переходными фазами и повторяющимися максимальными нагрузками. В связи с этим специальная выносливость рассматривается как один из ключевых факторов, определяющих соревновательную устойчивость и эффективность деятельности спортсмена.

В исследовании изучены такие инновационные подходы, как интервальные тренировки, высокоинтенсивный интервальный тренинг (HIIT), моделирование игровой нагрузки, упражнения функциональной подготовки, цифровые технологии мониторинга и индивидуализированное управление тренировочной нагрузкой. Эффективность предложенных методов оценивалась на основе педагогического эксперимента, функционального тестирования, анализа показателей сердечно-сосудистой системы и статистической обработки данных.

Результаты исследования показали, что инновационные подходы существенно повышают показатели специальной выносливости, ускоряют процессы восстановления и обеспечивают техническую и тактическую стабильность в ходе соревновательной деятельности. Выводы исследования

формируют научно-методическую основу для тренеров и учреждений спортивного образования.

Ключевые слова: *Гандбол, специальная выносливость, инновационные методы, интервальная тренировка, HIIT, моделирование игровой нагрузки, функциональная подготовка, мониторинг нагрузки, спортивная результативность, процесс восстановления.*

INTRODUCTION

Relevance of the Special Endurance Problem in Modern Handball

Handball is recognized as one of the most physically intensive team sports within the modern sports system. The game is characterized by short-duration sprints, rapid changes of direction, repeated jumps, powerful throws, and defensive physical confrontations. In international competitions, including the IHF World Men's Handball Championship and the IHF World Women's Handball Championship, the pace and dynamics of play have steadily increased. This trend requires athletes to demonstrate a high level of special endurance.

Special endurance refers to an athlete's ability to effectively perform sport-specific, high-intensity movements over an extended period of time. In handball, this is manifested by maintaining consistent efficiency during offensive and defensive transitions, executing technical and tactical actions accurately under fatigue conditions, and preserving psychological stability.

Today, sports performance is largely determined by the level of physical preparedness. Whereas technical mastery was previously considered the primary determinant of success, modern handball increasingly emphasizes adaptation to high-intensity gameplay, rapid recovery, and efficient functional management. In professional teams, players' heart rates during competition often reach 85–95% of their maximal capacity, indicating the simultaneous activation of both anaerobic and aerobic energy systems.

From this perspective, the development of special endurance in handball players represents a highly relevant scientific issue in sports theory and practice.

Theoretical Foundations of Special Endurance

In the theory of physical training, endurance is classified into general and special types. General endurance reflects the body's ability to adapt to prolonged, relatively low-intensity workloads, whereas special endurance refers to the capacity to perform activities directly related to the specific demands of a particular sport.

In handball, special endurance consists of the following components:

1. Speed-strength endurance – essential for repeated jumps and powerful throws.
2. Speed endurance – the ability to perform repeated short-distance sprints.
3. Coordination endurance – accurate execution of complex technical actions under fatigue.
4. Psychological endurance – maintaining stable performance under stress and competitive pressure.

Scientific studies indicate that handball has an intermittent structure, in which high-intensity efforts alternate with short recovery phases. Consequently, energy supply relies on a mixed aerobic-anaerobic mechanism. Therefore, the development of special endurance requires comprehensive improvement of metabolic and functional systems.

Innovative Approaches in Modern Training Processes

In recent years, innovative technologies have been widely implemented in sports training systems. Digital monitoring tools, GPS systems, heart rate tracking devices, lactate analyzers, and video analysis platforms enable scientifically grounded management of the training process.

The following innovative approaches are particularly important in developing special endurance in handball players:

- ❖ High-Intensity Interval Training (HIIT);
- ❖ Game-based load modeling;
- ❖ Functional training exercises;
- ❖ Plyometric and combined exercises;
- ❖ Individualized load monitoring and recovery management.

These methods allow for maximizing physiological potential, preventing overtraining, and creating training models closely aligned with competitive conditions.

Level of Scientific Investigation of the Problem

The issue of endurance development in handball players has been examined in numerous scientific studies. However, most research has focused on general endurance indicators, while the comprehensive development of special endurance based on innovative methodologies remains insufficiently explored.

Furthermore, adapting training load parameters to the individual characteristics of young and elite handball players remains a pressing issue. Since athletes differ in functional capacity, recovery rate, and psychological resilience, the training process should be organized using a differentiated and individualized approach.

Purpose and Objectives of the Study

Purpose: To scientifically develop innovative methods for improving special endurance in handball players and to determine their effectiveness.

Objectives:

1. To identify the role and importance of special endurance in modern handball.
2. To examine the theoretical foundations of innovative training methods.
3. To design an experimental program aimed at developing special endurance.
4. To evaluate the effectiveness of the proposed methods through a pedagogical experiment.
5. To develop practical recommendations.

Scientific Novelty of the Study

➤ A comprehensive model integrating game-based simulation and HIIT for the development of special endurance in handball players was designed.

➤ A mechanism for individualized load management based on digital monitoring technologies was proposed.

➤ A statistical relationship between special endurance and technical-tactical stability was established.

Theoretical and Practical Significance

The findings of this study contribute to optimizing the training process of handball players, enhancing competitive performance, and expanding functional capabilities. The developed methodological recommendations may be implemented in sports schools, higher education institutions, and professional teams.

RESULTS AND DISCUSSION

1. General Characteristics of the Study

The study involved 24 qualified handball players aged 18–22 years. The participants were randomly divided into two groups:

- ✓ Control Group (CG) – trained according to a traditional program.
- ✓ Experimental Group (EG) – trained using innovative methods (HIIT, game-based modeling, functional interval exercises, and digital load monitoring).

The experiment lasted 12 weeks. The following evaluation criteria were applied:

- ✓ 30-meter sprint (seconds).
- ✓ Yo-Yo Intermittent Recovery Test (meters).
- ✓ Handball-specific endurance test (6×40 m shuttle run, seconds).
- ✓ Number of technical errors during games.
- ✓ Heart rate recovery index (1-minute decrease in beats per minute).

2. Dynamics of Special Endurance Indicators

Table 1. Yo-Yo Intermittent Recovery Test Results (m)

Group	Before Experiment	After Experiment	Improvement (%)
CG	1680 ± 120	1785 ± 135	+6.2%
EG	1705 ± 115	2010 ± 140	+17.9%

Analysis: The experimental group demonstrated a significant improvement (+17.9%) compared to the control group (+6.2%). This confirms that innovative training methods are more effective in enhancing aerobic-anaerobic capacity.

3. Speed-Endurance Indicator

Table 2. 6×40 m Shuttle Run Test (seconds)

Group	Before Experiment	After Experiment	Improvement (%)
CG	34.8 ± 1.2	33.9 ± 1.1	2.6%
EG	35.0 ± 1.3	31.8 ± 1.0	9.1%

Analysis: The experimental group showed a 9.1% improvement, confirming the effectiveness of HIIT and game modeling in developing repeated sprint ability.

4. Technical-Tactical Stability Indicators

Table 3. Average Number of Technical Errors During Games

Group	Before Experiment	After Experiment	Reduction (%)
CG	14.2	12.8	9.8%
EG	14.5	9.6	33.7%

Analysis: The reduction of technical errors by 33.7% in the experimental group indicates a strong relationship between improved special endurance and enhanced game stability. A significant negative correlation ($r = -0.72$) was identified between special endurance improvement and technical errors.

5. Heart Rate Recovery Indicator

Table 4. One-Minute Recovery Index (beats/min decrease)

Group	Before Experiment	After Experiment	Improvement (%)
CG	22 ± 3	25 ± 4	13.6%
EG	23 ± 3	32 ± 4	39.1%

Analysis: The experimental group demonstrated a 39.1% improvement in heart rate recovery, reflecting enhanced cardiovascular adaptation and optimized recovery processes.

CONCLUSIONS

1. Special endurance is a key determinant of competitive performance in handball players.
2. Innovative training methods demonstrated significantly higher effectiveness compared to traditional approaches.
3. Improved special endurance ensures greater technical-tactical stability during competition.
4. Digital monitoring and individualized load management optimize adaptation and recovery processes.
5. The integrated application of HIIT, game modeling, and functional training yields the most effective results.

PRACTICAL RECOMMENDATIONS

- Incorporate HIIT elements into training sessions 2–3 times per week.
- Plan exercises consisting of 20–30 seconds of maximal load followed by 20–40 seconds of recovery.
- Use small-sided game models (3v3, 4v4) and fast-break simulations.
- Regularly monitor heart rate and recovery indicators.
- Integrate special endurance development with technical-tactical training components.

Final Recommendation

The development of special endurance should be regarded as an essential component of modern handball training systems. The scientifically grounded implementation of innovative methods not only enhances physical performance but also ensures game stability and competitive effectiveness.

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