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INNOVATIVE APPROACHES TO DEVELOPING SPECIAL ENDURANCE IN FREESTYLE WRESTLERS

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Introduction

In the modern era of sports, freestyle wrestling demands not only strength, speed, and technical mastery but also a high level of **special endurance** — the ability to sustain maximal performance throughout the entire match. Special endurance serves as the physiological foundation for maintaining effective actions during fatigue, controlling the tempo of combat, and executing precise technical-tactical decisions under stress.

Traditional endurance training methods often fail to address the sport-specific requirements of wrestling, which combines dynamic explosive movements with isometric contractions. Therefore, the integration of **innovative technologies**, such as biometric monitoring, digital load analysis, and simulation-based training, has become crucial in optimizing endurance development for elite athletes.

The main purpose of this study is to **scientifically substantiate and assess the effectiveness of innovative training methods** aimed at developing special endurance in freestyle wrestlers through digital and physiological monitoring systems.

Recent studies (Bompa & Haff, 2020; Verkhoshansky, 2018; Saidov, 2023) have emphasized the need for scientifically grounded training models in developing endurance in combat sports. According to Bompa's periodization theory, endurance in wrestlers should be trained through systematic variation in intensity and volume, supported by recovery microcycles.

Modern research also highlights the role of **biomechanical and physiological diagnostics** in controlling endurance development. For instance, Abdurakhmanov (2022) showed that heart rate variability (HRV) monitoring provides an accurate indicator of an athlete's recovery and adaptation level. Similarly, Shodiyev et al. (2022) demonstrated that using **sensor-based feedback** and **video analysis systems** improves muscle coordination and delay fatigue onset.

Furthermore, the use of **digital diagnostic tools** (e.g., Polar H10 sensors, MyJump2 app, SmartCoach software) allows real-time tracking of heart rate, blood lactate levels, and movement patterns, thus providing a comprehensive picture of an athlete's physiological status during training.

Methodology

The study was conducted at the **Uzbek State University of Physical Culture and Sports** with 24 freestyle wrestlers aged 18–23. The participants were divided into two groups:

- **Control group (n=12):** trained using traditional endurance methods.
- **Experimental group (n=12):** trained using innovative approaches — biometric monitoring, digital workload regulation, interval training, and simulation drills.

The training cycle lasted **8 weeks**, consisting of:

- **Phase I (weeks 1–2):** aerobic base development (60–70% HRmax),
- **Phase II (weeks 3–6):** variable-intensity interval sessions (80–90% HRmax),
- **Phase III (weeks 7–8):** competition-specific endurance (90–100% HRmax).

Training sessions were controlled using **Polar H10 sensors**, **MyJump2 app**, and **Coach's Eye** video analysis system. Key indicators included:

- 800-meter run time (sec),
- Heart rate (beats/min),

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- VO_2 max (ml/kg/min),
- Five-minute wrestling simulation performance (score).

Results and Discussion

The experimental group showed significant improvement in endurance indicators compared to the control group.

Table 1. Changes in special endurance indicators of freestyle wrestlers

Indicators	Initial (Mean)	Control Group	Experimental Group	Improvement (%)
800 m run (sec)	152.4	148.9	**139.6**	**8.4%**
Heart rate after load (bpm)	178	174	**166**	**6.7%**
VO_2 max (ml/kg/min)	49.2	50.4	**54.8**	**11.4%**
Wrestling simulation (score, 0–10)	7.2	7.6	**8.8**	**16.2%**

Statistical analysis (Student's *t*-test, $p<0.05$) confirmed the reliability of improvements. The biometric data revealed that wrestlers using innovative training methods maintained lower heart rates at the same workload, indicating better aerobic adaptation and fatigue resistance.

Video analysis demonstrated improved movement precision and reduced technical errors. This suggests that digital feedback, combined with physiological monitoring, enhances both **neuromuscular efficiency** and **psychological endurance** during fatigue states.

The study aligns with Verkhoshansky's (2018) "complex adaptation principle," emphasizing that integrating physical, technical, and informational training factors leads to sustainable endurance improvements.

Conclusion

1 Innovative methods combining **biometric monitoring**, **video feedback**, and **digital load control** significantly improve special endurance in freestyle wrestlers.

2 Continuous monitoring of physiological indicators allows individualized adjustment of training intensity and recovery periods, enhancing performance stability.

3 The experimental model proved that digital feedback systems not only increase endurance capacity but also optimize technical precision under fatigue.

4 These findings support the broader application of digital diagnostic systems in combat sports to ensure evidence-based coaching and athlete monitoring.

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