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Digital and Artificial Intelligence–Driven Approaches to Strength Development in Sports Training

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Abstract: Strength development remains a core objective in sports training and physical performance optimization. Recent advances in digital technologies and artificial intelligence have introduced new methodological possibilities for controlling training load, evaluating neuromuscular responses, and improving performance outcomes.

This study explores the contribution of digital monitoring tools and artificial intelligence–based analytical systems to the development of strength as a physical quality. The research is grounded in theoretical analysis, structured training observation, and mathematical–statistical processing of performance indicators.

The results demonstrate that technology-supported training models facilitate stable and statistically reliable improvements in strength by enhancing load individualization, movement efficiency, and adaptive regulation.

Keys words: strength training, digital monitoring, artificial intelligence, sports performance, statistical evaluation.

Introduction. In contemporary sports science, strength is recognized as a fundamental determinant of athletic effectiveness and functional readiness. The capacity to generate force against external resistance is closely related to neuromuscular coordination, biomechanical accuracy, and adaptive potential. Although traditional strength training methods remain widely used, they often rely on generalized prescriptions that do not fully reflect individual physiological differences. The growing application of digital technologies and artificial intelligence in sports training has reshaped conventional approaches to strength development. Wearable devices, data-driven monitoring platforms, and algorithm-based decision systems allow coaches and practitioners to move toward objective, evidence-oriented training design. In this context, strength development becomes a controlled and measurable process rather than an experience-based approximation.

Scientific Foundations of Strength Development. From a physiological standpoint, strength development is influenced by motor unit recruitment, muscle fiber activation, neural synchronization, and biomechanical leverage. Sports science literature commonly differentiates strength into maximal strength, explosive strength, and strength endurance, each requiring specific training stimuli. Effective development of these strength components depends on precise regulation of training intensity, volume, and recovery duration. Inadequate load management may result in performance stagnation or excessive fatigue. Therefore, the incorporation of digital assessment tools provides a scientific basis for optimizing strength-oriented training strategies.

Digital Technologies and Artificial Intelligence in Strength Training Digital technologies enable

continuous tracking of force production, repetition velocity, and fatigue-related indicators during training sessions. These systems generate objective datasets that reflect real-time physiological responses to applied loads.

Artificial intelligence extends the functionality of digital monitoring by identifying individual adaptation trends and predicting optimal training parameters. By processing accumulated performance data, AI-supported systems assist in adjusting workload progression and recovery timing. This intelligent regulation contributes to sustainable strength development and minimizes the risk of overtraining.

Methodology. The study involved 24 participants engaged in structured sports training. Subjects were divided into an experimental group and a control group. The experimental group followed a strength training program supported by digital monitoring and artificial intelligence–based feedback mechanisms, while the control group trained using conventional methods.

Strength indicators were measured at the beginning and end of the training period. Mathematical–statistical analysis was conducted using descriptive statistics and comparative testing to evaluate the

Table 1. Statistical indicators of strength development in experimental and control groups (n = 24)

Group	Measurement Stage	Mean ($\bar{x}$)	SD	Improvement (%)	t	p
Experimental	Initial	42.6	3.8	—	—	—
	Final	51.9	4.1	**+21.8**	3.27	<0.05
Control	Initial	43.1	3.6	—	—	—
	Final	46.2	3.9	+7.2	1.41	>0.05

The analysis reveals a statistically significant increase in strength indicators within the experimental group ($p < 0.05$). In contrast, improvements observed in the control group did not reach statistical significance.

Discussion. The findings indicate that strength training supported by digital technologies and artificial intelligence yields superior outcomes compared to traditional approaches. Objective feedback allows for timely load adjustments, leading to more efficient neuromuscular adaptation.

Furthermore, AI-based analytical systems provide a predictive framework for understanding individual responses to training stimuli. This enhances training sustainability and supports long-term performance progression. From a sports science perspective, such intelligent training environments represent a significant advancement in strength development methodology.

Conclusion. The integration of digital technologies and artificial intelligence into sports training significantly enhances the effectiveness of strength development processes. Technology-supported training ensures accurate monitoring, individualized load regulation, and statistically reliable performance gains. These findings support the adoption of digital and AI-driven strategies as an essential component of modern strength training and sports science practice.

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