Functional state of the neuromuscular system in young athletes depending on the specifics of sports activities

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ANNOTATION.

The functional preparedness of the neuromuscular and autonomic nervous systems plays a crucial role in athletic performance during adolescence, since this developmental stage is characterized by intensive maturation of the mechanisms responsible for movement control, coordination, and muscular energy supply [1]. Regular training stimuli enhance reflex responsiveness, accelerate neuromuscular conduction, and promote an optimal interaction between the sympathetic and parasympathetic branches of the autonomic nervous system, which underlies effective physiological adaptation to physical exercise.

Keywords: *coordination-speed and endurance mechanisms, neuromuscular transmission, neuromuscular transmission, neuromuscular transmission.*

Introduction

The functional readiness of the neuromuscular and autonomic nervous systems is a key factor in athletic performance during adolescence, as it is during this period that the mechanisms regulating movement, coordination, and energy supply of muscle activity intensively develop [1]. Systematic training loads contribute to the improvement of reflex activity, an increase in the speed of neuromuscular transmission, and the formation of an optimal balance between the sympathetic and parasympathetic divisions of the autonomic nervous system, which is considered the basis for the body's adaptation to physical activity [2]. Moreover, various sports induce specific adaptive responses of the neuromuscular system. Thus, cyclic and game sports are characterized by the predominance of coordination-speed and endurance mechanisms, while strength and martial arts disciplines develop pronounced reactions of short-term activation, increased

muscle strength, and resistance to static-dynamic loads [3]. The vegetative support of the training process is characterized by varying degrees of stress on regulatory mechanisms, which requires regular functional monitoring to prevent overstrain and failure of adaptation in young athletes [4].

Objective:

To evaluate the functional parameters of the neuromuscular system and autonomic regulation in adolescent football players and martial artists.

Materials and methods.

The study included 115 athletes aged 12–14. Clinical and functional methods were used: assessment of unconditioned reflexes, coordination tests (Romberg , finger-nose), tapping test, ortho- and clino-orthostatic tests, and dermographism analysis. Statistical significance was determined at $p < 0.05$.

Results.

Football players demonstrated higher neuromuscular function scores compared to martial artists, as evidenced by both absolute values and relative percentage differences. Thus, the football players' plantar reflex score was ≈4.0% higher (4.63 vs. 4.45 points), knee reflex score was ≈5.2% higher (4.63 vs. 4.40 points), Achilles reflex score was ≈5.6% higher (4.54 vs. 4.30 points), and biceps reflex score was ≈5.6% higher (4.52 vs. 4.28 points), with statistically significant differences for most scores ($p<0.05$). The football players also demonstrated higher motor coordination scores: the simple Romberg test results exceeded those of the martial artists by approximately 4.6%, the complex test by 5.4%, and the finger-nose test by approximately 5.7%, indicating more stable mechanisms of postural control and movement precision. The hand movement frequency according to the tapping test in the football players was 63.63 movements per minute, which is approximately 6.9% higher than that of the martial artists (59.50 movements; $p=0.008$), reflecting a higher rate of neuromuscular transmission and dynamic performance. Autonomic regulation in representatives of both sports groups was within the age norm: the differences in heart rate in the orthostatic and

clinoorthostatic tests did not exceed 3–8% and were not statistically significant ($p>0.05$). At the same time, the analysis of dermatographism showed that in football players, the predominance of parasympathetic tone was observed in 44.2% of those examined, while in martial artists this type of reaction was detected in 38.0%, which indicates a more pronounced functional adaptation of the cardiovascular and autonomic nervous systems to long-term dynamic loads in young football players.

Conclusion.

Football players exhibit greater neuromuscular and coordination adaptation to prolonged dynamic loads, while the functional characteristics of martial artists reflect a focus on short-term explosive activity. These findings support the need for individualized medical and training monitoring in adolescent sports.

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