

ANALYSIS OF THE INFLUENCE OF THE STRUCTURE OF RHYTHMIC DISTANCE BETWEEN BARRIERS ON THE RESULTS OF ATHLETES IN COMPETITIONS

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Abstract

In this article, the influence of the rhythm of the distance between obstacles on the results in barrier running competitions was investigated. It analyzes the main factors related to the rhythmic structure of running, in particular, the optimal step length and frequency, which help athletes reduce time and energy expenditure in the process of overcoming obstacles. Also, based on scientific data and practical observations, analytical conclusions were developed that reveal the influence of rhythmic changes in distances between obstacles on technical movements, speed indicators, and the overall effectiveness of runners.

Keywords: Rhythmic structure, distance, running technique, athletic performance, individual characteristics, training programs.

Introduction

The formation of a rhythmic structure in hurdling is an important component of training young track and field athletes. This sport requires not only a high level of physical fitness but also complex coordination abilities. The rhythmic structure is crucial for the effective execution of running technique, directly influencing the process of successfully clearing hurdles and the speed dynamics between them.

Literature Review

The problem of technical training for young athletes at the stage of initial sports specialization is one of the pressing issues in the athletic training system [2].

The effectiveness of the athletic training process is, first and foremost, closely linked to the formation of rational technical movements and, in particular, to mastering the rhythmic structure of athletic exercises. Therefore, building a rational technique correctly at this stage ensures that the athlete will achieve high results in the future during the optimal age period for their sport [1].

According to many researchers, the formation and improvement of the rhythm of movement is a key focus of the educational process in physical education and sports [3]. It is therefore natural for athletes, coaches, and scientists to be interested in studying, documenting, and further developing rhythmic structure. In light of these aspects, the problem of forming a rational technique in hurdling at the initial stage of sports specialization deserves special attention. As noted in scientific literature, a rational rhythm in hurdling is one of the leading factors that determine high athletic performance, serving as the main criterion for the correctness and effectiveness of the technique [4].

An analysis of scientific and methodological sources on the technical training of young hurdlers, along with pedagogical observations and practical experience, has revealed the following contradictions:

- a) although sports training theory requires a more thorough scientific basis for the technical training system, in practice, insufficient attention is paid to the model rhythmic characteristics of hurdling during the training of young athletes;
- b) although there is a need to develop a rational technique in young athletes, a scientifically-based pedagogical technology aimed at developing a model rhythmic structure for hurdling has not been developed for the initial stage of sports specialization.

From this perspective, the effectiveness of training young hurdlers will yield high results only when a specially designed pedagogical technology is applied. Such a technology must, first and foremost, entail: identifying the model characteristics of the running technique typical of elite athletes, incorporating them into the training process of young athletes, and purposefully orienting training sessions toward the acquisition of advanced athletic mastery.

Research Methodology

The research process was based on the dialectical theory of cognition. This approach involves studying phenomena holistically and multifacetedly, in conjunction with their internal developmental processes. Therefore, the analysis

of facts and phenomena prioritized the principles of a historical and logical approach, the unity of theory and practice, interconnectedness and interaction, scientific reliability, and objectivity.

Within the scope of this research, a pedagogical technology aimed at forming a model rhythmic structure for hurdling was developed and experimentally tested. This technology incorporates a number of components: a target model based on the rhythmic structure of the hurdling block; the stages of the technology and their respective tasks; programmatic, content-based, and didactic support for the implementation of these stages; the periodization of training within the annual cycle; and computer diagnostics to assess the formation of the rhythmic structure. The technology was developed based on the cultivation of psychomotor abilities and the stages of interiorization, exteriorization, and stabilization. Concurrently, a set of pedagogical requirements was established to ensure its effective implementation. These include expanding the scope of theoretical training, considering initial data on the athletes' physical development and motor preparedness, fostering a motivational sphere, and ensuring the optimal development of the runners' speed and speed-strength abilities.

Additionally, the fundamental principles for the technology of forming the rhythmic structure of hurdling in young track and field athletes have been developed. These consist of the following: accessibility, individualization, systematicity, the organic unity of training and competitive activity, and the interconnectedness of general and special preparation. These principles make a significant scientific contribution to the theory of motor skill formation.

Based on the results of the experiment, the formation of a model rhythmic structure, characteristic of skilled athletes, was established as the primary goal and priority in the training process for young hurdlers. For this purpose, a diagnostic management complex was developed. This complex provides the capability to obtain real-time data on the rhythmic structure, observe the dynamics of changes, conduct comparative analysis, and, based on this, correct technical movements.

Analysis and Results

The effectiveness of forming the core rhythmic characteristics of hurdling during the technical training of young track and field athletes is ensured by applying a pedagogical technology developed at the initial stage of sports specialization.

This technology consists of a system of interconnected stages, their programmatic and content-based support, pedagogical requirements for the implementation of these stages, and computer-based diagnostic tools that allow for the assessment of the rhythmic structure's level of formation.

The rhythmic characteristics of the hurdling model are formed in young athletes through the phased implementation of pedagogical technology. In the first stage, the psychomotor abilities necessary for the intensive development of the motor skill's rhythmic structure are formed. In subsequent stages, these abilities are enhanced by the consolidation of the rhythmic structure and its adaptation to model parameters.

The successful formation of the rhythmic structure of hurdling in young athletes during the initial stage of sports specialization is ensured by adhering to the following requirements while implementing the pedagogical technology: expanding the scope of theoretical preparation, considering initial and current data on the trainees' physical development and motor readiness, fostering high motivation in athletes, prioritizing the use of a holistic training method in the educational process, and introducing a comprehensive pedagogical monitoring system.

The results of the experiment show that in the third stage of the technology, the indicators of the rhythmic structure of hurdling for the experimental group participants significantly improved and approached the model parameters, which confirms the effectiveness of the developed approach.

Table 1 Results of the experimental and control groups in hurdling by stages and their comparative analysis

Steps	Model	Experimental group (n = 25)			Control group (n = 25)		
		<i>avg</i> ± <i>SD</i> , s	Difference	<i>V</i> , %	<i>avg</i> ± <i>SD</i> , s	<i>avg</i> ± <i>SD</i> , s	<i>avg</i> ± <i>SD</i> , s
Hurdles	0.525	0.516 ±0.03	0.009	3.30	0.591 ±0.05	0.591 ±0.05	0.591 ±0.05
1st	0.195	0.187 ±0.02	1.46; p>0.05	9.10	0.185 ±0.02	0.185 ±0.02	0.185 ±0.02
2nd	0.300	0.304 ±0.02	0.008	5.12	0.333 ±0.03	0.333 ±0.03	0.333 ±0.03
3rd	0.245	0.247 ±0.01	1.35; p>0.05	6.44	0.325 ±0.02	0.325 ±0.02	0.325 ±0.02

In the conventional notation, $V, \%$ was taken as the coefficient of variation relative to the model parameters. The coefficients of variation for the duration of the running step over the block of hurdles for athletes in the experimental group showed significantly lower values ($p < 0.05$) across three repeated attempts. This confirms the stability of the formed motor skill, specifically the rhythmic structure of the hurdle block.

During the study, a comparative analysis of the degree of formation of the rhythmic structure at various stages of the technology and in the final test showed that the coefficient of variation of running steps in the experimental group gradually improved, approaching the model parameters as closely as possible ($p < 0.05$). Positive trends were also observed in the control group; however, their changes were insignificant and not statistically reliable ($p > 0.05$). As a result, the degree of correspondence between the rhythmic structure and the model indicators in the control group remained at the previous level of deviation.

A comparative analysis of the results from the 50-meter hurdles and the 50-meter sprint showed that the experimental group's performance in the hurdles was significantly better ($p < 0.05$). At the same time, no significant differences were found between the groups' results in the sprint (on a flat track) ($p > 0.05$). Importantly, the time difference between the 50-meter runs with and without hurdles for the experimental group was 1.05 seconds, corresponding to the optimal criterion for technical efficiency, whereas in the control group this difference reached 2.08 seconds.

According to the results of the expert assessment, the hurdle clearance technique (attack, clearance, and landing elements) was recorded at nearly the same level for the athletes in both groups (Table 1). Based on this, it is assumed that the superior result of the experimental group was achieved mainly by establishing an optimal rhythmic structure for their running and hurdle clearance. High expert evaluations of the rhythm between hurdles and the hurdle clearance process itself also support this conclusion ($p < 0.05$).

An analysis of the correlation between the 50-meter hurdle results of young athletes and certain elements of the rhythmic structure of the hurdle block showed a negative correlation ($r = -0.508$) between the distance from the takeoff point to the hurdle and the duration of the third step in the inter-hurdle interval. This indicates that an increase in the third step's duration leads to a shorter attack

length, resulting in a more vertical jump over the hurdle and a decrease in overall running speed.

As a result of the targeted development of the model rhythmic structure of the hurdle block in the experimental group, a rational rhythm for clearing the hurdle (based on the ratio of attack and landing lengths) was successfully formed. Their indicators were recorded at a ratio of 60.5% to 39.5%, a result that closely approximates the model parameters. In contrast, this ratio was disrupted in the control group, recorded at 57.2% to 42.8%. This situation, as noted above, is associated with the excessive lengthening of the third inter-hurdle step and an increased flight phase over the hurdle, which disrupts the rhythmic structure of the entire block.

The reliability and scientific validity of the research results were ensured by several factors: strict adherence to the research logic, a set of initial theoretical and methodological principles, the use of objective research methods appropriate for the stated tasks, the organization of pedagogical experiments based on metrological requirements, mathematical-statistical processing of the results using modern computing technology, and a detailed scientific interpretation of the data obtained.

Thus, the research results confirm that the stated goal was achieved and the defined tasks were consistently resolved. The data obtained substantiate the high effectiveness of the developed pedagogical technology for forming the rhythmic structure of hurdling in young athletes.

Conclusion and Recommendations

An analysis of scientific and methodological literature on teaching young athletes the hurdling technique reveals that specific methodological approaches for forming the main rhythmic characteristics of this type of running in the initial stages of sports training have not been sufficiently developed. Therefore, to effectively solve this problem, it became necessary to develop a scientifically-based pedagogical technology aimed at forming a rational rhythmic structure for hurdling, based on the competitive activity model of skilled athletes.

The proposed technology includes the following components: the targeted development of model rhythmic characteristics for hurdling; sequential training stages and their programmatic and content-based support; a system of pedagogical requirements; and an instrumental diagnostics complex.

During the study, four stages for implementing the technology in the process of forming the model rhythmic structure were identified:

Development of psychomotor skills - forming the foundational psychomotor capabilities necessary for mastering hurdling technique.

Interiorization - the assimilation of an externally provided rhythmic structure into the athlete's consciousness and its adoption as an internal model of movement.

Exteriorization - the transfer of the formed internal model into practical motor activity, i.e., adapting the running rhythm to the technical execution.

Stabilization - the relative reinforcement of the model rhythmic structure under increasingly complex conditions.

During the experiment, the effectiveness of forming the hurdling rhythm in young athletes was monitored using instrumental diagnostic tools. This complex, consisting of seismic sensors, a signal amplifier, and a personal computer, allowed for the determination of running step duration and the recording of results in digital or graphical form. This made it possible to assess the conformity of an individual's rhythmic structure to the model parameters and, when necessary, to make adjustments to technical elements or the rhythm.

The results of the pedagogical experiment confirmed the effectiveness of the developed technology. The athletes in the experimental group were able to establish optimal ratios for the duration of running steps between hurdles at a significantly higher level compared to the control group ($p < 0.05$). Additionally, a significant advantage was achieved in the 50-meter hurdles results ($p < 0.01$) and technical indicators ($p > 0.05$). This clearly demonstrates the importance of the developed pedagogical technology in improving athletic performance.

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