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Original Article

Theoretical and methodological foundations for improving technical skills of highly skilled athletes in track and field competitions

ANDRII KOLOT[1], SERHII SOVENKO[2], OLEKSANDR REZANOV[3]
[1,2,3]National University of Ukraine on Physical Education and Sport, Kiev, UKRAINE

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Abstract:
At the current stage of athletic development, technical training within long-term improvement system must incorporate clearly defined model characteristics of technical actions and physical fitness. Identifying biomechanical indicators and criteria of technical skills in highly qualified athletes enables the adjustment the training process by considering individual features of competitive performance. This approach facilitates the creation of effective technical training models. ***Objective:*** The objective is to improve the technical mastery of elite track and field athletes by establishing clear requirements for their technical fitness level and identifying the key components of technical skill. ***Material and methods:*** The data from more than 60 literature sources concerning the structural components of technical skills and the content of technical training of highly qualified track and field athletes at different stages of long-term training have been systematized. An expert survey of 36 coaches who have experience in working with highly qualified athletes was carried out; the documents of the training process planning as well as the diaries of athletes (n=244) were analyzed, and the optimal criteria of technical skill assessment were determined. Video recording and biomechanical analysis of the competitive exercise performance by long jumpers (n=15) and race walkers (n=36) at the stage of specialized basic training, as well as by long jumpers (n=8) and race walkers (n=31) at the stage of maximum realization of individual capabilities were carried out. ***Results.*** The basic provisions of improving the technical skills of highly qualified athletes in track and field competitive events are presented. The main structural components and criteria characterizing the technical mastery of athletes at the modern stage are highlighted. The basic biomechanical indices of the technique of motor actions and the level of special physical fitness of athletes at each stage of long-term improvement are established. The dynamics of the competitive practice volume and requirements for the selection of training means of technical orientation are determined. The analysis of scientific and methodical literature resulted in supplementing the data on biomechanical criteria of evaluating the technical skills of highly qualified track and field athletes. ***Conclusions.*** The effectiveness of training methods for highly qualified athletes is determined by the transformation of the technical potential accumulated at the previous stages of long-term training into the final competitive result. This can be achieved by determining a proper ratio of means and methods of different orientations, where the use of exercises aimed at improving the high level of technical fitness of track and field athletes will be the key one. Technical mastery as an integral criterion of the athlete's highest level of fitness allows to achieve maximum results in conditions of tough competition due to perfect mastery of the most rational motor structures of sports exercises.
Keywords: technical skills, technical training, highly skilled athlete, training means, sports result, technique of motor actions, criteria of technical skills.

Introduction

The steadily on the rise competition in the world sports arena imposes strict requirements for the long-term training of high-class track and field athletes, necessitates the search for and introduction of effective means and methods of improving technical skills, allowing to achieve high results (Akhmetov et al., 2016; Bauersfeld & Schroter, 2015; Schnabel et al., 1994; Volker, 2003).

Achievement of modern peaks of sportsmanship is largely due to the mastering of perfect movement techniques. Nowadays it becomes obvious that a high level of technical fitness of an athlete not only provides maximum utilization of his motor potential in conditions of tough competition, but also creates opportunities for intensification of the training process, improvement of its qualitative level. Modern trends in the development of athletics require the athlete's perfect mastery of rational technique, as well as the ability to independently find the correct tactical and technical solutions to motor tasks in the conditions of psychological tension of competition.

When an athlete reaches the pinnacle of sports excellence, the coach and athlete face a difficult task. To continue to use the previous variants of training planning, only increasing the load volume and intensity or to search for new forms of training process organization and design. It is obvious that the training of average and high-skilled athletes differs significantly both in the competitive activity intensity and the nature of preparation

Corresponding Author: ANDRII KOLOT, E-mail: ankoll69@ukr.net

for it, as well as its tasks, content, and organization. At the same time, the general principles of training design that were formed many years ago no longer meet the requirements of today. Therefore, the search for new principles and forms of organizing the training of high-class athletes is justified, necessary, and represents an important task for scientists and coaches (Anderson et al., 2009; Bal et al., 2012; Martin, 1991; Schnabel, 1994).

In recent years, the requirements for the reliability of sports techniques and technical skills of athletes have increased dramatically. Hence, the tendency to perform a complete competitive exercise or reproduce a competitive mode of muscle work in training is becoming more and more evident. This technique, used at certain stages of the preparatory period with a gradual increase in the power of effort or running speed, provides, above all, effective preparation of the athlete for competitive activity. At the same time, it increases the effectiveness of special physical training (because there is nothing more "special" in its arsenal than a competitive exercise performed at the maximum or submaximal level of effort) and also contributes to the intensification of the training process as a whole (Czerwinski et al., 2015; De Vries & Housh, 1994; Deng et al., 2023).

In this regard, the need for the most rigid requirements for technical training should be also pointed out. In highly qualified athletes the stages of perfection and achievement of reliability of technical skills should be singled out and clearly defined in time. The first stage should have a target goal of relative (for a given level of special physical fitness) completion of the process of mastering the technique. The second stage is to achieve a high level of its reliability in competitive conditions. The realization of these requirements is an important reserve and a prerequisite for the use of those methodological principles of increasing the effectiveness of training (Bondarchuk, 2007; Grosso, 2006; Horlov et al., 2019; Kutek, 2015).

For this reason, the problem of increasing the level of technical fitness becomes one of the most urgent issues of track and field. Meanwhile, there is a contradiction between the existing system of technical training and the potential capabilities of athletes. Despite the emerging progress, until recently in the practice of training athletes, control over technical skill and proper planning of the training process has not been given due attention, which negatively affects the performance of Ukrainian athletes, as evidenced by the final protocols of many international competitions in athletics.

That said, the analysis of special scientific and methodical literature on the issues of technical skill and technical training of highly skilled athletes shows insufficient elaboration on the mentioned subject. Unfortunately, the works of many authors are mainly of a journalistic nature and do not contain substantiated recommendations regarding the determination of the level of technical skill of athletes and the identification of reserves for its improvement (Bobrovnik, 2005; Chojnicki, et al., 2021; Gavaa et al., 2015; Laputin, 1997).

Due to these circumstances, the development of scientifically substantiated and experimentally verified criteria for assessing the level of technical skill of track and field athletes is of topical importance. These criteria are designed to become an important reference point in the construction of sports training and serve as a tool for the coach's activity in terms of ensuring the compliance of athletes' abilities with the planned achievements (Bayraktar, 2023; Bompa, 1999; Kolot, 2016; Robertson et al., 2014).

Determination of biomechanical indices and criteria of technical mastery of highly qualified athletes will allow to make corrections in training process taking into account individual features of competitive exercise performance and on this basis to develop models of technical fitness.

The objective of the study is to improve the technical skills of highly qualified athletes in athletics competitive events based on determining the requirements for the level of their technical fitness and identifying the main components of technical skills.

Tasks:

1. To study the main components of technical skill of highly qualified athletes.
2. To determine biomechanical indices and criteria characterizing the level of technical mastery of athletes.

Material & methods

Participants

The study involved 36 athletics coaches with experience in working with highly qualified athletes and 244 athletes of different ages and fitness levels. Long jumpers being at the stage of specialized basic training at the age of 16 - 17 years (n=15) and that of maximum realization of individual capabilities at the age of 20 and more years (n=8) also participated in the study. Athletes specializing in race walking were also at the stage of specialized basic training and the stage of maximum realization of individual capabilities, and were aged 16 - 19 years (n=36) and 20 and more years (n=31), respectively.

Procedure

The study was conducted from 2014 to 2024. From 2014 to 2021, an analytical review of scientific and methodological literature was carried out to study the problem of improving the technical skills of highly qualified track and field athletes. The data concerning the volume of competitive practice and means of technical training at different stages of long-term training were summarized. It is revealed that such data at different stages of long-term improvement are insufficient.

At this stage of the research, the practical activity of the leading Ukrainian athletics coaches was analyzed: an expert survey of coaches who have experience in working with highly qualified athletes was carried

out; the documents of planning the training process and athletes' diaries (n=244) were analyzed; the optimal criteria for assessing technical skills were determined.

The biomechanical analysis of the technique of competitive exercise execution was carried out based on the data obtained in the course of our video recording of the Ukrainian championships in track and field and race walking in 2021 and 2024 in different age groups among men. In race walking, the video was filmed at distances of 10 and 20 kilometers.

Since the length of competitive distances differed among athletes of different age groups, video recording and further biomechanical analysis were carried out in the following sections: 20 km distance - 5, 10, 14, and 18 km; 10 km distance - 2, 5, and 8 km.

Athletes were tested a week before the championships of Ukraine. When selecting control exercises for athletes, the informativeness and reliability of the tests, compliance with the competitive exercise in terms of individual kinematic parameters and muscle work mode, simplicity and mastery of the exercises by athletes. In addition, the testing procedure should be simple in terms of organization and conduct, fit into the schedule of complex control, and not take much time. Control exercises were selected in accordance with traditional methodological recommendations (Grosso, 2006; Martin et al., 1991; Track and field, 2023).

Methods

To analyze the video images, the "Lumax" hardware-software complex was used (Ostrovskyi, 2003). Registration of athletes' body positions during the competitive exercise was carried out with Sony HDR-PJ50E video cameras at a speed of 50 fps^{-1}.

All metrological requirements were taken into account during the research, which provided the correct placement of cameras and minimized systematic and random errors (Kolot, 2007; Sovenko, 2025). A human body model consisting of 20 points was used to digitize the movements of the athletes' biolinks and their application had a clear sequence (Laputin, 1997).

Data on age and anthropometric characteristics of athletes (body length and weight) were obtained from the official website of the Athletics Federation of Ukraine, as well as during the survey at competitions.

Statistical analysis

Descriptive statistics indices were determined according to the level of results, kinematic characteristics of the technique, age, and anthropometric data: arithmetic mean ($\bar{x}$), standard deviation (S), and coefficient of variation (V). Licensed MS Excel software was used for the analysis.

Spearman and Pearson correlation coefficients were used to determine the presence or absence of interrelation between the studied biomechanical indices of long jump technique and race walking and their influence on the achievement of sports results, depending on the conformity of the data to the law of normal distribution. The conformity of the obtained data to the law of normal distribution was assessed using the Shapiro-Wilk conformity criterion at a significance level of p=0.05.

Statistical processing of the results by correlation analysis methods was performed using Statistica 14.0.0.15 software from StatSoft developers (TIBCO Software, USA).

Results of the study

Statistical analysis showed that 28 (78 %) of 36 coaches do not have objective criteria for assessing the level of technical skills of athletes. The majority of specialists (32 - 89 %) mistakenly understand sports technique as only the geometry of sports movements or their kinematics (visually observed external manifestation) in the best case, whereas the invisible biodynamic picture of movements is ignored.

The analysis of athletes' diaries demonstrated that in 198 cases (81 %) the means of technical training neither corresponded to the biomechanical structure of the competitive exercise nor contributed to the realization of the accumulated motor potential in competitions. 207 athletes (85 %) use in the training process non-specific means of strength training, which have lost their training effect.

Technical mastery is understood as the perfection of the motor component itself, the rationality of technical structures, and the degree of mastery of them. This notion includes not only the structural and technical perfection of the motor action, but also all the components and mechanisms that participate in the control and regulation of technical actions and provide a high final effect. Taking into account the requirements of the extreme mode of sports actions, "technical mastery should be understood as perfect mastery of the most rational motor structures of sports exercises when set to the maximum - in conditions of tough competition" (Chojnicki et al., 2021; Diachkov, 1984).

The goal of sports improvement, which determines the content, methods, and planning of training effects (inducing a long series of necessary adaptive changes in the athlete's body), is to bring the athlete's fitness to a level that could ensure the achievement of the desired sports result (Bompa & Haff, 2009; Sosanski & Zaporozanow, 1993). When preparing a program of training influences and designing a model of the upcoming training process, it is necessary to proceed from the differences between the initial and final level of sportsmanship, which is defined as a "model of the future" (Diachkov, 1984; Laputin, 1997).

The determination of quantitative characteristics of optimal interaction of different aspects of the model of the future for both the final goal and individual intermediate stages is of exceptional importance for increasing the effectiveness of the training process and the steady growth of sportsmanship. It is especially important to

take into account the interrelationships between the physical and technical aspects of athletics training.

Proper training process organization should provide an inevitable increase of not only the physical fitness of the athlete, but also to a greater extent technical mastery, as well as the degree of its usage in sports actions. Otherwise, there will be contradictions, expressed in the fact that motor skills, mastered and consolidated at a certain level of motor qualities, will later serve as a "brake" for the full use of increased functional capabilities (Diachkov, 1984; Laputin, 1997; Track and field, 2023).

In practice, there are two main variants of technical skill improvement: the first, when the athlete's technique in its basis corresponds to the modern rational structure of movements and individual features of his physical fitness; the second, more common variant, when the athlete's motion technique does not fully correspond to his functional capabilities and contains a number of more or less serious deviations from the modern technical model (Diachkov, 1984). In this regard, in each case, it is necessary to approach the process of improving motor skills differently.

In the first case, it is associated with the further development of correct movements along the line of quantitative characteristics: increasing the motion speed and amplitude, force impulses, clarification of the key elements of coordination and their subordination relations in the rhythm of an integral motor act and on this basis - the formation of the appropriate motor attitude (Diachkov, 1984).

In the second case, improvement in movement technique is associated with a more or less serious restructuring of motor skill, replacement of inefficient elements of movement structure with more efficient ones, which is based on the reconstruction of the functional structure of the nervous processes controlling movements and on the replacement of some links of this structure with new ones (Chojnicki et al., 2021; Diachkov, 1984).

Thus, the main task of the second, dissected, form of conjugated improvement of technical and physical training is the problem of selecting special exercises adequate to technical training. In such exercises, the development of physical qualities (taking into account the key one) should be carried out in accordance with those structural and functional conditions in which they should be manifested in a complete sports exercise. Due to a clear conjugate improvement of motor function, not only the necessary morphological and functional rearrangements, which determine the specifics of motor qualities development, but also the formation of special mechanisms of inter-muscular coordination, corresponding to the requirements of the modeled part of the motor act, should be carried out (Bondarchuk, 2007; De Vries & Housh, 1994; Verkhoshasnky, 2012)

In essence, the process of selecting such exercises has all the features of structural and functional modeling of the main phases of an integral motor action with the highest possible degree of similarity of spatial, strength, and temporal characteristics.

Work experience and special studies have shown that the main reason for deficiencies in movement technique is that coaches (as well as athletes) do not have objective criteria for assessing the level of technical mastery, control over its improvement. For them the model of perfect technical mastery is often not clear, they do not possess the entire information complex, which determines the possibilities of effectively managing the specific motor activity of an athlete (Bobrovnik, 2005; Diachkov, 1984; Laputin, 1997). Technical mastery should be formed in the environment and the mode closest to the competitive one provided frequent performances in the most important competitions. In the process of competitions, the formation of motor skills should be completed and the whole complex of qualities and skills that characterize experience and sportsmanship should be developed (Diachkov, 1984).

Technical mastery of athletes is an integral concept of the theory and methods of sports training, which is based on such fundamental concepts as sports technique and technical training. It is the result of the development of effective techniques of a particular type of athletics and the successful implementation of the pedagogical process of technical training. The high quality of technique and technical training process, as a rule, leads to the acquisition of such a high level of technical skill by athletes, which provides them with a sufficiently high probability of achieving record results (Bompa & Haff, 2009; Track and field, 2023). The result obtained in competitions is an integral indicator of athletes' skills, it seems to integrate many multidirectional factors of training (Fig. 1).

In recent years, a great positive experience has been accumulated in sports practice in improving the technical skills of track and field athletes [6, 9, 25]. However, the dynamics of growth require finding new, more effective ways to improve the level of special technical fitness, including the development of special physical qualities.

Discussion

Fig. 1 shows that the sports result of an athlete depends on his technical mastery, the components of which are the technique of motor actions, the main types of athlete’s fitness, and competitive activity.

At the present stage, the high level of sports results and almost ultimate values of training loads necessitate qualitative changes in the improvement of athletes' training. One of the directions on this path is to achieve a more complete realization of the athlete's motor potential. In this regard, the constant improvement of technical skills in the process of technical preparation is of great importance in sports training.

It follows that technical mastery can be understood as a certain level of technical and physical fitness, characterized by the degree of mastering by the athlete of a system of motor actions, corresponding to the

peculiarities of this type of athletics and defined by the rules of competitions and allowing to more fully realize his motor potential, ensuring the achievement of maximum results during the competitive activity.

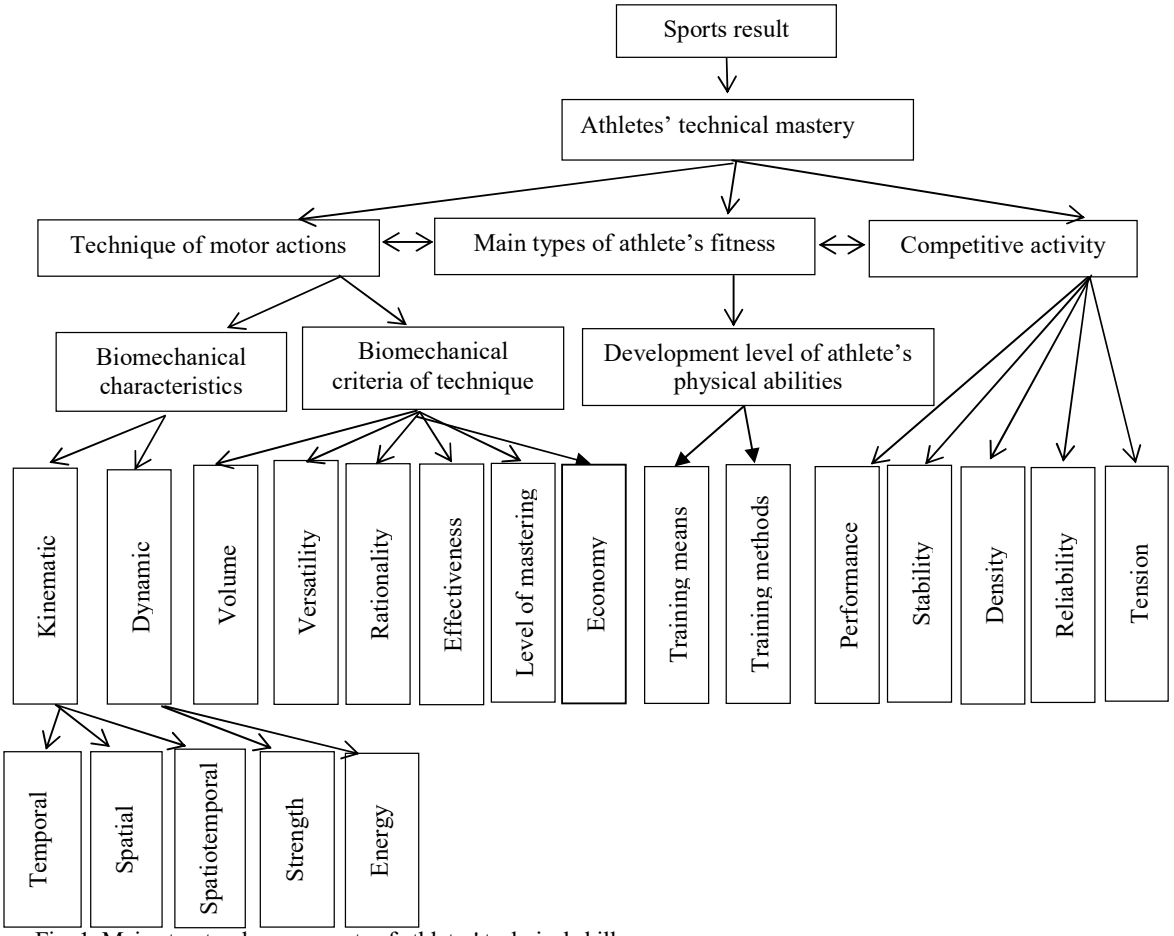

Fig. 1. Main structural components of athletes' technical skill

Thus, for instance, to show the level of technical mastery corresponding to the first category or master of sports in long jump competitions, the athlete during the competitive activity must demonstrate certain characteristics of the technique of motor actions and the level of physical fitness (Table 1) (Hollings et al., 2014; Horlov et al., 2019; Kolot, 2005; Kolot, 2007).

Table 2 presents the biomechanical characteristics of the technique and level of special physical fitness of athletes who specialize in race walking to achieve in competitions the result of the first category and master of sports (Sovenko, 2022; Sovenko, 2023; Sovenko, 2025).

For the holistic characterization of motor action sports technique, it is of great importance to understand the structural basis of the movement system, which is defined as a regular, relatively stable order of combining individual moments, sides, and complex features of the movement system within an integral motor action (Laputin, 1997). It is not about the movements themselves that form a system, but about the necessary interrelationships between them, their expedient organization in space and time, and the interaction of forces that ensure the final result of the action.

When studying and analyzing sports techniques, kinematic and dynamic structures of the movement system are distinguished (Bobrovnik, 2005; Diachkov, 1984; Laputin, 1997). In reality, they do not exist in isolation from each other, but considering them not only jointly, but also selectively is not devoid of cognitive and practical sense. In order to investigate the structure, a number of features describing movements and their connections, the so-called biomechanical characteristics of movement technique, are taken into account.

The kinematic structure is the regularities of interrelation and interconditionalities of movements in space and time. Accordingly, spatial (reveals the form and connections of movements in space), temporal (shows how the system of movements is organized in time), and spatiotemporal (represents the character of movements) structures are distinguished, each of which has its own special, private meaning, and only together they condition the external picture of movements as a whole (Laputin, 1997; Track and field, 2023).

Table 1. Characteristics of long jump technique and special physical fitness of athletes to achieve a certain result in competitions

Characteristics of long jump technique and special physical fitness of athletes		Stage* of long-term training (age, years), number of trials					
		SBT (16–17), (First category, n=15)			MRIC (20 or more) (MS, n=8)		
		$\bar{x}$	S	V	$\bar{x}$	S	V
Result, m		6,91	0,06	0,9	7,60	0,06	0,8
The minimum knee flexion angle of the support leg in the phase of take-off, degr.		148,83	9,04	6,1	134,47	5,37	4,0
The angular velocity of the hip joint extension of the support leg during take-off, rad·s^{-1}		6,37	0,52	8,2	7,26	0,05	0,7
The average horizontal velocity of swinging leg CM in the phase of take-off, m·s^{-1}		11,09	0,65	5,9	12,65	0,24	1,9
The angle of departure, deg.		15,77	0,79	5,0	22,39	0,61	2,7
The run-up speedy, m·s^{-1}		9,30	0,06	0,6	10,30	0,09	0,9
The GCM departure velocity, m·s^{-1}		8,73	0,03	0,3	9,79	0,08	0,8
The duration of the take-off phase, s		0,16	0,02	12,5	0,10	0,01	10
The average power of take-off, kW		3,39	0,23	6,8	5,01	0,21	4,2
10 running step long jump, m		6,12	0,24	3,9	7,10	0,18	2,5
5th jump from 6 running steps, m		20,88	0,56	2,7	22,42	0,67	3,0
Standing jump, m		2,88	0,24	8,3	3,18	0,21	6,6
Standing 10th jump, m		29,08	1,31	4,5	34,36	1,42	4,1
30 m time hops on take-off (t) and swinging (s) leg, s	p	4,86	0,14	2,9	4,28	0,24	5,6
	m	4,92	0,16	3,2	4,39	0,32	7,3
60 m time step jumps, s		7,38	0,42	5,7	7,02	0,38	5,4
30 m run from crouch start, s		3,82	0,18	4,7	3,62	0,12	3,3
30 m run from standing start, s		3,01	0,11	3,6	2,84	0,09	3,2
150 m run, s		16,84	0,28	1,7	16,56	0,24	1,4

Notes. Stages*: MRIC – maximum realization of individual capacities, SBT – specialized basic training, $\bar{x}$ – arithmetic mean, S – standard deviation, V – coefficient of variation

The rational interposition of links of the locomotor apparatus, providing the best performance of the action, and the optimum trajectory of movements is determined by spatial characteristics, that is, the spatial pattern of motor action technique is identified.

Temporal characteristics allow establishment of duration, sequence, rhythm, and tempo of movements. It is important to keep in mind such signs of movements as timeliness of their beginning, change and completion and consistency in time with each other (manifested in synchrony or regular sequence of moments and phases of various movements).

Spatial and temporal parameters of movements can be separated only in abstraction, but in real manifestations they are inseparable. Their ratio is expressed in the values of velocity and acceleration. In this regard, the technique is characterized by an expedient combination and regulation of movement speeds in the process of motor actions.

Dynamic structure is the regularities of interacting internal and external forces involved in the execution of movements. Dynamic structure is studied according to dynamic characteristics (inertial, strength, and energy), thereby investigating the causes of a particular movement pattern. The optimal dynamic structure should contribute to the efficient use of forces that ensure the achievement of the goal, while simultaneously reducing the disruptive forces, which provides for the justified transfer of the amount of motion from one link of the locomotor apparatus to another, the creation of counteraction to oppositely directed forces, and a consistent increase in effort in the decisive phase of the motor action (Laputin, 1997; Track and field, 2023; Verkhoshasnky, 2012).

In the process of technical training, skills ensuring efficient use of the athlete's functional potential are formed. The formation of motor skills occurs by searching for the optimal variant of movement with the leading role of consciousness. In this case, specialized perceptions are formed, the athlete develops the ability to analyze and think creatively, and simple movements are combined into more complex motor actions. Multiple repetitions of motor actions lead to the automation of the main elements of their coordination structure, and the skill turns into the one that allows to free the consciousness from control over the details of movements and switch it to the selection and application of the most appropriate means of solving the motor task in specific conditions (Verkhoshasnky, 2012).

Table 2. Biomechanical characteristics of technique and special physical fitness of athletes specialized in race walking to achieve the result of the first category and master of sports (men) at the stages of long-term training

Indicator	Stage* of long-term training (age, years), number of trials					
	SBT (16–19), 10 km (First category, n=36)			MRIC (20 or more) 20 km (MS , n=31))		
	$\bar{x}$	S	V	$\bar{x}$	S	V
Result	0:46:42	0:02:41	5,8	1:24:53	0:02:55	3,4
Average speed over the distance, $m \cdot s^{-1}$	3,58	0,20	5,7	3,93	0,14	3,5
Stride length, m	1,12	0,05	4,5	1,19	0,03	2,6
Stride frequency, $stride \cdot s^{-1}$	3,20	0,15	4,7	3,32	0,08	2,6
Flight time, s	0,035	0,011	30,5	0,033	0,006	19,6
The knee joint angle at the moment of foot placing on the support, deg.	179,02	1,05	0,6	178,85	0,76	0,4
The knee joint angle at the moment of vertical, deg.	182,32	1,67	0,9	181,96	2,42	1,3
Speed of the GCM displacement at the moment of foot placing on the support, $m \cdot s^{-1}$	3,62	0,26	7,3	4,03	0,52	12,9
Speed of the GCM displacement at the moment of foot leaving the support, $m \cdot s^{-1}$	3,77	0,21	5,5	4,07	0,14	3,5
Angle of foot placement on the support, deg.	72,31	2,86	4,0	72,01	1,44	2,0
Take-off angle, deg.	58,28	3,44	5,9	59,71	1,75	2,9
Resulting support reaction force in the single support phase, N	1462	86	5,9	1592	152	9,5
Take-off power in single support phase, W	4014	153	3,8	4345	457	10,5
5000 m run, min.	15,22	1,38	12,7	14,26	1,16	11,8
Standing 10th jump, m	24,48	1,86	11,7	28,63	1,46	12,4

Note. Stages*: MRIC – maximum realization of individual capacities, SBT – specialized basic training, $\bar{x}$ – arithmetic mean, S – standard deviation, V – coefficient of variation

Intensification of technical training of highly qualified athletes requires from specialists a high level of organization and pedagogical control, which should be carried out more carefully and at all stages of technical training - from acquaintance with new types of technique, training of its basic elements, and up to perfection of technical skill. Such control can be effective only if its structure includes such biomechanical criteria as volume, versatility, rationality of technical fitness, efficiency of technique mastery, proficiency, and economy as objective indicators determining the level of technical mastery (Bobrovnik, 2005; Bondarchuk, 2007; Track and field, 2023).

The volume of technical fitness includes the technical actions that an athlete performs. It is defined by the total number of mastered technical actions, while the competition volume - by the number of technical actions that the athlete can perform or perform directly in competitive conditions. Usually, even in athletes of the highest qualification, the competitive volume of technical actions is much less than the total (Horlov et al., 2019; Track and field, 2023; Verkhoshasnky, 2012).

For instance, the competitive volume of a long jumper's technical fitness is characterized by the athlete's ability to perform a running broad jump. For this purpose, he has to master a large arsenal of special lead-up and imitation exercises to improve his technical skills in the jump. The total volume of his technical fitness should cover the skills of mastering the techniques of various athletics events (running, jumping, throwing), as well as other sports events (to carry out a full-fledged general and specific physical preparation) (Bobrovnik, 2005; Bondarchuk, 2007).

The versatility of technical fitness is determined by the degree of diversity of technical actions that the athlete possesses or uses in competitions, hence the general and competitive versatility is distinguished (Laputin, 1997). Rationality of technique is not a characteristic of the athlete. It characterizes the way of solving a specific motor task in this or that athletics event and determines the possibility of achieving a high result in case of using such a rational way of constructing technical actions.

The criteria of rationality of one or another way of solving a motor task in different athletics events are different. They can be: the rationality of a certain geometry of movements; minimization of duration (time) of

action; achievement of maximum speed and acceleration of movements, maximum (or minimum) indicators of developed efforts (strength dynamic characteristics of starting or final actions); minimization of energy expenditure in the implementation of technical actions or, on the contrary, creation of conditions for maximum manifestation of the energy potential of technical actions in maximum short time, etc.

The efficiency of sports technique shows how close the characteristics of technical skill of a particular athlete are to the most rational variant of technique or the way of solving a motor task in a given athletics event. In essence, it is a characteristic of not the technique variant itself, but the quality of its mastery.

A distinction should be made between absolute, comparative, and realization efficiency. Absolute efficiency characterizes the degree of closeness of the technique variant performed by the athlete to its rational model. Comparative efficiency of the technique is usually determined in practice by the way it is mastered by athletes of low and high qualifications. Realization efficiency shows how and to what extent the athlete used his motor capabilities and what result he achieved in competitions (Bobrovnik, 2005; Kolot, 2016; Track and field, 2023).

The degree of mastery of technique in pedagogical control should be determined in order to more objectively assess the quality of the training process. One may judge whether an athlete has mastered this or that rational model of technique well or poorly, sufficiently or insufficiently, by the following: whether his results at competitions are stable, whether the characteristics of movements are stable when performed under changing conditions (e.g., fatigue), whether his motor skills are preserved during breaks in the training process, whether he performs individual elements of given technical actions in an automated manner (Laputin, 1997; Track and field, 2023). The economy of technique characterizes the athlete's ability to perform motor actions and achieve the desired result with minimum energy expenditure or, on the contrary, to be able to use all his energy potential, if necessary.

The level of technical skill of an athlete is determined by accounting for the following indicators:

1) arsenal of technical actions used by the athlete in competitions;

2) efficiency and adequacy of the applied sports technique in terms of:

- economy of technical actions, taking into account modern trends in sports movement technique;
- the degree of motor potential utilization (there are several variants of a discrepancy between the technical and physical fitness of athletes. In some cases, the technique of movements does not allow to fully realize the physical capabilities of the athlete, in other cases, on the contrary, the insufficient level of physical fitness of the athlete limits the improvement of technique);
- correspondence of technique to individual features of the athlete (morphofunctional, psychophysiological, etc.).

Despite a certain variability of individual structural elements of technique, there are objective biomechanical limits to the requirements that ensure successful performance of certain technical actions;

3) sports technique resistance to the action of a number of confounding factors:

- mental state change (prestart fever, emotional lift, previous failures, etc.);
- variability of motor skill structural components within certain limits, providing fulfilment of planned actions, indicates the level of sports technique stability;
- fatigue, which can take movements beyond their optimal variability and lead to the loss of their efficiency. The study of technique stability under the influence of fatigue can go in different ways - the study of the quantity and quality of performed technical actions and their efficiency, as well as by studying changes in the nature of movement in its individual structural elements (dynamic and kinematic characteristics);
- changes in external conditions (climatic conditions, sports facilities, equipment, lighting, noise, etc.).

When choosing special training means to improve the elements of the technique of athletics competitive exercises, it is necessary to be guided by the principle of dynamic correspondence, when training effects are selected with account for the peculiarities of the dynamic mechanism of a complex motor action of a person, i.e., taking into account the character of the athlete's movements and the way of his improvement. The realization of this important methodological principle is possible on the basis of certain criteria of conformity (Verkhoshasnky, 2012):

1) the criterion of conformity according to amplitude and direction of movement. Based on this criterion, special exercises should be selected taking into account the spatial, temporal, and dynamic characteristics of the movement. This criterion realization implies the choice of a very specific initial position and posture of the athlete;

2) the criterion of conformity according to the accentuated part of the working amplitude envisages manifesting the required effort at a certain joint angle;

3) the criterion of conformity according to the magnitude of strength and speed of maximum effort development. Since, for instance, the long jump belongs to the speed-strength athletics events, the main importance in performing the competitive exercise is the athlete's demonstration of explosive power. When selecting training means, it should be taken into account that the training stimulus should not only be as high as the conditions of the exercise, but also exceed it;

4) the criterion of conformity according to muscle work mode. The long jump requires high coherence of movements, precise technical coordination of each phase of the movement.

The level of special physical fitness of the athlete should be determined with account for the presence of a high level of development of physical qualities and assessment of this level from the standpoint of its sufficiency to ensure the reliability of performance when mastering more advanced techniques of athletics event.

The assessment of physical fitness level is carried out in two aspects:

a) determination of the so-called motor potential of the athlete;

b) identification of the degree of this potential usage in the structure of motor skill (Bondarchuk, 2007; Sosanski & Zaporozanow, 1993; Track and field, 2023).

An athlete's physical fitness analysis should be sufficiently multifaceted, but with a mandatory focus on the "key" physical qualities for a given event of athletics. In this group of "key" qualities it is advisable to single out those that are the most conservative, and not easily trainable.

Forecasting of physical fitness individual indicators should be specified in accordance with athletics event specifics, accentuating depending on these specifics:

a) ultimate capabilities and the level of utilization of strength, speed, and power qualities;

b) the level of special endurance development.

Depending on the athlete's motor activity peculiarities, pedagogical tests should be also used to determine the level of development of general (nonspecific) endurance, flexibility (joint mobility), coordination capabilities, orientation ability, and other prognostically significant indicators.

The most important requirement of modern sports training, aimed at improving the technical skills of track and field athletes, is the need for an objective connection of its components (load, means, methods, etc.) with the main indicators of competitive activity. In order to make the process of sportsmanship development rational, it is necessary to plan correctly the correlation between the structure of indicators of competitive activity and that of track and field athlete's fitness, as the latter provides the possibility of achieving the required characteristics of competitive activity. In this case, the coach should clearly define the correspondence of:

- the main components of competitive activity that ensure its effectiveness. For instance, concerning cyclic events of athletics: the effectiveness of the start, the level of starting and distance speed, and the speed of finishing;
- the main aspects of a track and field athlete's fitness (physical, technical, tactical, psychological);
- special physical qualities determining the efficiency of fulfillment of the main parameters of competitive activity in the chosen event of athletics;
- the main functional characteristics determining the level of development of special physical qualities;
- private indicators assessing the level of the main functional characteristics. For instance, with regard to MOC (the main criterion of the aerobic energy system power), the determination of such indicators as heart volume, cardiac output, maximal lung ventilation, aerobic enzyme activity, and percentage of red muscle fibers.

The effectiveness of the various components of competitive activity is easily determined in all cyclic and speed-strength athletics events. For instance, in the structure of competitive activity of a short-distance runner, four components should be evaluated:

1) reaction time to the starting signal, determined from the moment of the shot to the beginning of the first movement;

2) starting stride time, which can be estimated according to the time of covering a 30 m segment from the start;

3) absolute running speed, which is determined by the time of running at a maximum speed over a 30 m segment from standing start (run-up);

4) running speed at the finishing segment (20 m), which is determined by the level of speed decrease at the end of the distance on a 80 to 100 m segment (Track and field, 2023).

Each of the recorded indicators influences the level of performance and technical mastery in sprinting. The characteristics obtained in this way allow us to accurately determine the strengths and weaknesses of competitive activity, compare them with the models of the strongest runners and rationally influence by specific means in the conditions of the training process.

Attention should be also paid to some characteristics of the competitive activity, in other words, competitive fitness of a track and field athlete, such as performance, stability, density, reliability, and tension.

Competitive activity performance characterizes the athlete's ability to achieve the set goals and show maximum or close to them results throughout the competition season.

It has been established that an athlete demonstrates high competitive activity performance if he/she shows sports results exceeding the level of his/her maximum result or close to it (in the range of 2% of his/her best sports result in the current year) (Bondarchuk, 2007; Verkhoshasnky, 2012).

Competitive activity performance can be significantly influenced by:

- environmental conditions (peculiarities of venues, their geographical location, climatic conditions, time zone, time of day, air temperature, atmospheric pressure);
- the state of the material and technical base;
- the nature of pre-competition warm-up and rest;
- the presence of sports competition.

Constant use of all the above-mentioned factors, which a track and field athlete will have to face in the

conditions of competition, allows to carry out more rational preparation for competitive activity and to show the planned sports results. Competitive activity stability is the ability (in the absence of disturbances in the training process) to show results within 2% of the maximum personal achievement for a certain period of time.

When assessing the stability of sports results, three zones are distinguished relative to the maximum achievement: high level within 2 %, average level from 2 % to 3.5 %, low level of stability, if the result is shown from 3.5 % and more (Bondarchuk, 2007; Verkhoshasnky, 2012).

Competitive activity density is the ability to demonstrate high results depending on different time periods (days, weeks, months). Competitive activity reliability represents the athlete's ability to show the necessary efforts and use the rational technique of motor actions regardless of changing conditions of competitive struggle and disruptive factors, such as changes in weather conditions, temperature, and atmospheric air pressure, the surface of competition venues; behavior of spectators; rank of competitions; presence of competition, etc. Competitive activity tension is characterized by the level of mental and physical tension of the athlete during the competition (Chojnicki et al., 2021).

Mental tension, representing the emotional background of the competition, causes the emergence of a specific physiological background, manifested in shifts in the activity of functional systems of the body.

Mental tension of competitive activity depends on the rank and significance of the competition, the level of responsibility of the athlete, the presence of competition, the mental impact of opponents, etc.

Physiological tension of competitive activity depends on the fitness level of opponents and the athlete, the intensity and duration of competitive struggle, the distribution of efforts during the performance of competitive exercise, the number and level of involvement of functional systems that provide competitive activity, the level of effort and energy supply mechanism during competitive struggle, etc.

Such a diverse nature of the structure of the organization and content of competitive activity sets the main task before coaches - reasonable use of these or those developed scientific and methodological concepts in their work to obtain a high level of technical mastery of athletes - stable preparation of highly qualified track and field athletes. At the same time, one should not but note the fact that in the process of improving the technical skills of track and field athletes at the present stage significant changes occur concerning, in particular, the most rational selection of specific training means and loads; more effective combination of training programs, which are based on different mechanisms of energy supply, focused on the competitive specifics and planned result; a significant increase in the role of specific means of training; an enhanced portion of non-traditional means of training, and, above all, simulator complexes; expansion of the competitive practice, balance of training and competitive loads, the introduction of special restorative nutrition to stimulate work capacity.

The results of the study confirm the need to find ways to improve sports performance related to the improvement of the technical skills of athletes (Laputin, 1997; Martin, 1991; Schnabel et al., 1991). In the course of the study, it was established that when assessing the technical mastery of highly qualified track and field athletes it is necessary to take into account not only biomechanical characteristics but also biomechanical criteria of motor action technique, as well as the level of athletes' fitness and competitive performance.

Conclusions

1. Technical mastery as a systemic property of motor function of a person engaged in this or that type of athletics has a multidimensional hierarchical structure. Its level cannot be assessed by one of the listed indicators. That is why it is necessary to approach the problems of its improvement from complex system positions, which in the future will allow to significantly improve the quality of athletes' preparation for the major international competitions.

2. In order to significantly increase the effectiveness of athletes' preparation for major competitions, it is necessary to solve all the problems arising in the improvement of their technical skills, at least.

3. In track and field, it is not so much the amount of load volumes that is of crucial importance, but their skillful use: determining the effective content of the training load, rational distribution of load volumes at different stages of training, selection of effective means and methods and their place in the annual training plan.

4. The effectiveness of training methods for highly skilled athletes is determined by the transformation of the technical potential accumulated at previous stages of training in the final competitive result. This can be achieved by determining a proper ratio of means and methods of different orientations, with the use of exercises aimed at improving the high level of technical fitness of track and field athletes as a key one.

5. Rational training process design implies a strict focus on the formation of the optimal structure of competitive activity, providing effective conduct of competitive struggle, and achievement of the chosen model of competitive activity. This is possible only in the presence of ideas about the factors determining effective competitive activity, and the relationship between the structure of competitive activity and fitness.

6. Technical mastery as an integral criterion of the highest fitness level of an athlete allows due to perfect mastery of the most rational motor structures of sports exercises, to achieve maximum results in conditions of tough sports competition.

7. The primary direction for further technical mastery improvement of highly skilled track and field athletes is the search for the most effective means corresponding to the biomechanical structure of the main competitive exercise and methods of their application.

Conflict of interest

The author(s) declared no conflict of interest concerning this work, authorship, and/or publications of this paper.

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