

# Rationalization of running techniques based on coordinated movements of all link of the flying leg

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## Abstract

**Objective of the study** was to formulate and practically justify the concept of running technique, taking into account the interaction of coordinated movements of all parts of the fly leg when performing a running step.

**Methods and structure of the study.** The pedagogical experiment was carried out during the summer training camp with highly qualified athletes in athletics (age  $23,5 \pm 0,7$  years), who were divided into 8 people into two comparison groups: experimental and control. In the course of the work, the basic principles of the concept of running technique were formulated and two sets of exercises were developed that have an effective impact on the running step technique in the running disciplines of multi-athletes.

**Results and conclusions.** According to the provisions of the concept of running technique, taking into account the interaction of coordinated movements of all parts of the swing leg when performing a running step and the developed sets of exercises, the results of the pedagogical experiment recorded positive dynamics: when running 100 m, the results improved by 10,7%; at a distance of 200 m – by 10,5%; times at distances of 600 and 400 m became higher by more than 10%. As a result of the work, it was established that the lack of the vertical component of the ground reaction force impulse is an external factor limiting running speed; when running along a distance, the resulting direction of take-off is close to vertical; forward acceleration of all links of the swing leg throughout the entire period of support allows you to increase the moment of force of moving the free leg forward.

**Keywords:** *coordinated movements, swing leg, running step, running technique concept, vertical component, repulsion.*

**Introduction.** All-around includes numerous and multidirectional types of loads, differing in the structure of movement, the nature of the loads, and energy supply. A multi-athlete must have all the physical qualities that are inherent in a sprinter, jumper, thrower and middle athlete. The variety of types of exercises also determines the requirements for the athletes physical fitness. Along with a high level of development of speed and speed-strength qualities, technical readiness is also important for a multi-athlete.

In our country, the concept of biomechanics of sports running based on the reaction of the support of two clearly defined pushes: front and back has become widespread. Experts propose to reduce the braking influence of the front push, if possible, to give a shock-absorbing character to the force process in the first phase of the support period, to absorb the energy of the body's downward movement with inferior

muscle work in the depreciation phase, to soften the placement of the foot on the track, to place the foot closer to the projection of the general center of body mass (OCMT), reduce the duration of the depreciation phase, do not rush to push off when landing, go through the middle part of the support period by inertia with some rest. However, many authors have a negative attitude towards the use of the concept of «advanced push» in the description of the biomechanics of running and try not to mention it, and the first phase of the support period began to be called the «depreciation phase», the semantic content of which aims to reduce the energy of the force interaction of the runner with the track in this phase .

Increasing the important role of the «back push» has become the main feature of the concept of sports running biomechanics that has emerged in our country, in which the ability to concentrate the greatest push-off



forces in the final moments of the support period, the ability to more energetically perform the «back push» (with a soft shock-absorbing placement of the foot on the track) is considered the most important element of running technique. The main idea of this concept is the leading role of the «back push» for the forward movement of the runner's body. This biomechanical concept is conventionally called posterior push, since the «back push» and the energetic final straightening of the supporting leg are given the leading importance for moving the body forward.

Adjusting the training process involves a targeted change in methodological approaches and resource functionality under the influence of external and internal factors that determine the direction, nature and depth of the impact of training technologies [1, p. 32]. In this regard, it is necessary to analyze the technical characteristics of athletes and correct the technique of running locomotion based on specialized means related to the biomechanics of running.

**Objective of the study** was to practically substantiate the concept of running technique, taking into account the interaction of coordinated movements of all parts of the swing leg when performing a running step.

**Methods and structure of the study.** In the course of the work, a meta-analysis of a vast amount of information in the field of research on running techniques at different distances was used in order to justify the need to study axioms in the training of multi-athletes.

The pedagogical experiment was carried out during the summer training camp with highly qualified athletes in athletics (age  $23,5 \pm 0,7$  years), who were divided into 8 people into two comparison groups: experimental and control (EG, CG). The pedagogical research included: pedagogical observation, testing of physical fitness, as well as testing of running at different distances. At the first stage, we analyzed the level of physical and technical preparedness of each athlete.

The second stage of the study consisted of conducting the experiment itself. The training process in the experimental group was carried out according to the methodology we developed, based on special exercises using simulators: a foot activator and a shoe system. Athletes in the control group trained according to the generally accepted method.

Testing of physical fitness and speed abilities in distance running among all-around athletes before and after the experiment was carried out using tests based on the correlation between all-around types: 30 m - under the run-up of athletes in the long jump, high jump and pole vault; 100 m – under the 100 m

sprint/110 m hurdles; 600+400 m – under 400 m run/1500 m run. Test measurements were carried out using the OMEGA Chronos-Timer electronic equipment.

The third stage of the study consisted of statistical processing of the experiment results using Student's t-test and interpretation of the research results.

Results of the study and discussion. Analysis of studies on this issue revealed:

- exaggeration in the posterior push concept of the role of the final straightening of the supporting leg to move the body forward;
- underestimation of the energetic acceleration of the foot and lower leg of the free leg forward during the support period;
- insignificance of vertical repulsion from the beginning of the support period [2].

In the course of their work, the authors formulated the main provisions of an alternative concept (Figure 1).

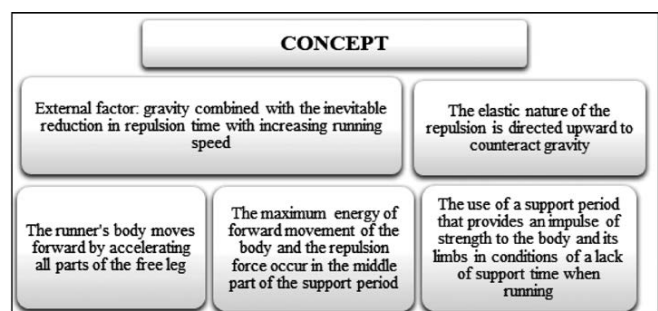


Figure 1. The concept of improving running technique

The basis of the new concept is the quality of the repulsion, which is determined by its elasticity to counteract gravity, and not by the power of the final repulsion. Elastic take-off does not provide for the accentuated energy of the «back push», while the landing becomes elastic rather than shock-absorbing. Fundamental to the new concept is the verticality of repulsion, and the forward movement is based on the swing movements of all links of the free leg. When performing a good acceleration of all links of the free leg forward, naturally, in the unsupported period, there is a forward movement forward due to the inertia of the shin in front of the leg, unless the runner specifically slows it down. This is the most important provision of the new biomechanical concept.

Comparing the new biomechanical concept with the «wheel» mechanism of moving the body forward, it is worth noting that the main provisions of the latter are also used in the concept proposed by the authors. However, the new concept reveals the features of the

external factor, the verticality of the direction of repulsion at a steady speed when running, the essence of elastic repulsion. When running along a distance, the resulting direction of take-off is close to vertical. In this case, there is a balance of impulses of external forces, and the impulse of the support reaction force does not have a braking component

To implement our concept and improve the results in the running disciplines of multi-athletes, two sets of exercises were developed and experimentally tested, which have an effective effect on the running step technique (Figure 2).

<b>COMPLEXES</b>	
<p>Set of exercises 1 focuses on moving the swing leg forward:</p> <ol style="list-style-type: none"> <li>1) jumps with forward movement;</li> <li>2) running on straight legs;</li> <li>3) multi-jumps with maximum forward movement, constantly reducing the number of multi-jumps on a set segment of the distance;</li> <li>4) running along a distance using a "foot activator";</li> <li>5) running in a simulator with a block load system "X-trend Run Rocket".</li> </ol>	<p>Set of exercises 2 is aimed at training elastic repulsion:</p> <ol style="list-style-type: none"> <li>1) jumping up on one/two legs;</li> <li>2) jumping from an elevation and rebounding upward;</li> <li>3) multi-jumps up;</li> <li>4) bounces on two legs;</li> <li>5) jumping in separate steps with changing legs.</li> </ol>

Figure 2. Options for special exercise sets

To confirm the effectiveness of the proposed sets of special exercises for rationalizing running technique based on coordinated movements of all parts of the swing leg and improving results, athletes were tested before and after the experiment.

Analysis of intergroup differences in test results demonstrated that the level of physical fitness of young men in the EG and in the CG at the initial stage of the study was almost at the same level.

When repeated testing, the athletes results after the experiment, with the exception of the 30 m run, significantly improved ( $p < 0,05$ ). Thanks to the use of special exercises, positive dynamics were recorded in the EG: when running 100 m, the results improved by 10,7%; at a distance of 200 m – by 10,5%; times at distances of 600 and 400 m became higher by more than 10%. Therefore, we can conclude with high certainty that performing jumps with a sharply short elastic nature of repulsions is more economical than with a soft one. This is explained by the fact that with a sharply short landing, the kinetic energy of the falling body is better (more fully) converted into the energy of elastic tension of the muscles and ligaments of the legs, as a result of which in the phase of straightening the legs, the athlete spends less of his own energy resources. Thanks to the use of the swing movement, the recovered energy and power of the extensor muscles of the

pushing leg during the push-off process, exercises using simulators - a foot activator and a simulator with a block system, the increase in physical fitness and improvement of results in all-around running events has been practically confirmed.

**Conclusions.** The obtained results of the pedagogical experiment prove the effectiveness of the proposed concept for improving the running technique of multi-athletes over a distance. As a result of the work it was established:

- the lack of the vertical component of the ground reaction force impulse is an external factor limiting running speed;
- when running along a distance, the resulting direction of take-off is close to vertical. In this case, there is a balance of impulses of external forces, and the impulse of the support reaction force does not have a braking component;
- forward acceleration of all links of the swing leg throughout the entire period of support allows you to increase the moment of force of moving the free leg forward, determines the active "rowing" movement of the supporting leg back in the middle part of the support period and promotes the movement of the body forward;
- to reduce energy consumption to maintain running speed, the repulsion energy in the final phase should be as little as possible than the repulsion energy in the initial phase, which improves the elasticity of repulsion;
- an experimental method for teaching running technique has been developed, which includes a well-founded theory of running biomechanics, new methodological techniques for teaching the elasticity of repulsion and moving the body forward, special exercises aimed at elastic repulsion and acceleration of all parts of the fly leg and a method for monitoring running technique over a distance using the method of expert assessment.

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