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PHYSIOLOGICAL AND ANATOMICAL CHARACTERISTICS OF SHORT-DISTANCE SPRINTERS

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Annotation

This article provides a scientific analysis of the physiological and anatomical characteristics of short-distance runners and the main factors influencing their athletic performance. The study examines the structure of muscle fibers, the development of speed and speed–strength abilities, the role of neuromuscular mechanisms, and the relationship between stride length and stride frequency. In addition, the functioning of muscles in isometric, concentric, and eccentric contraction modes during sprinting, the coordination of muscle groups during the support phase, and the principles for selecting specialized speed–strength exercises in the training process are substantiated. The materials presented in the article have practical significance for developing effective training programs for short-distance runners.

Keywords

short-distance running, sprinter, muscle fibers, speed, speed–strength training, isometric contraction, muscle contraction, stride length, stride frequency, neuromuscular mechanism

Short-distance running events are classified according to the length of the distance: competitions start from 60 m (which is run only indoors) and extend up to 400 m. The requirements for physical fitness in short-distance running vary depending on the length of the distance, but the most fundamental quality for all distances is **speed**. In sprinters, speed is the result of rapid and powerful contractions of the muscles that ensure efficient and relatively elastic movements required for running at high velocity. The speed at which skeletal muscles contract largely depends on the properties of muscle fibers.

Elite sprinters possess a higher percentage of fast muscle fibers compared to long-distance runners. In contrast, the muscles of long-distance runners contain a greater proportion of slow (oxidative) fibers. From this originates the saying *"Sprinters are born, not made."* However, this statement is only partially true. Skills acquired during training help transform muscle contractions into rapid running movements. These abilities must be trained and developed. Through training, other qualities-such as strength, coordination, and special endurance-can also be improved, which contributes to success in short-distance running. Moreover, training can influence the activity of different muscle fiber types, increasing their potential contraction speed. Finally, the assumption that muscle fiber types are completely unchangeable is not always confirmed by research.

Both neurological and metabolic components within the muscles can determine success in sprinting. The anatomical and morphological characteristics of sprinters, as well as the relationship between stride length and stride frequency, have been studied. These indicators depend on the athlete's height, leg length, and running speed, while stride length is also related to the extension strength of the thigh muscles. One of the most important findings of these studies is that in less highly skilled sprinters, performance can be improved mainly by increasing stride length through strength training. In general, it is easier for women than for men to increase stride frequency. Among highly qualified sprinters, the difference between the maximum achievable stride frequency and their developed frequency is very small.

The optimal time to begin training aimed at increasing stride length is the period following the onset of sexual maturity (approximately 15–17 years for boys and 13–15 years for girls).

Athletes of different heights, body weights, and leg lengths can still achieve high results in short-distance running.

The anthropometric characteristics of sprinters are genetically inherited from their parents. The properties of the nervous system that express coordination abilities during maximal speed movements change very little during the sports training process. In many children, effective sprint acceleration is maintained over 150–160 m, while in some adolescents this distance may be only 80–90 m. According to their ability to perform mechanical work, muscle fibers are divided into slow (red) and fast (white) fibers. The study of muscle fiber structure is conducted through muscle biopsy samples, which are performed under laboratory conditions using special equipment. This diagnostic method is not widely used in sports selection practice.

The basis of muscular work in running is the cross-coordination of movements. Let us consider muscle function during certain phases of running.

Evaluating the external appearance of an athlete’s movements-assessing the complete visible form of movement or, in mechanical terms, studying movement kinematics-does not always provide complete information. Movement is the result of the contractile activity of the main motor apparatus of the human body-the skeletal muscles. Therefore, when analyzing sprinting technique, it is first necessary to understand the internal structure of movement.

Although the complex anatomical and physiological structures of the human locomotor system have been sufficiently modeled and described in modern times, accurately defining the characteristics of running remains difficult. This difficulty arises because not only each of the approximately 50 muscles of the legs, but also many muscles of the trunk and arms, influence the overall nature of movement. In addition, muscle fiber structure varies among individuals, and when morphological features (such as body segment dimensions) are also considered, it becomes evident how difficult it is to qualitatively describe the primary movement effects of a short-distance sprinter.

Therefore, rather than discussing an ideal movement model for a sprinter, it is more appropriate to speak about the laws governing muscle contraction and the interaction of muscle groups during the execution of maximal-speed movements by the athlete. It is well known that during running, muscular effort leads to a decrease in the joint angle covered by the muscle, causing it to shorten. In movements of different character, muscles must either absorb impact when the foot contacts the ground or decelerate the limbs moving at high speed. As a result, the tensed muscle lengthens under the influence of external forces; this mode is called **eccentric contraction**.

Such use of muscles during rapid movements requires that the joints be “encircled” and stabilized. In this type of work, the antagonist muscles surrounding the joint from opposite sides are activated simultaneously, balancing their forces, “locking” the system, and controlling joint stability. This type of muscular tension is called **isometric contraction**. Thus, during the execution of a movement, a muscle may either be relaxed or be in one of three contraction states. Therefore, when studying the internal mechanism of movement, it is necessary to know the characteristics of tension in specific muscle groups, the number of motor units simultaneously active within a muscle (which determines contraction force), as well as the duration of their activation.

Regular work under extreme conditions leads to a significant increase in the maximal strength potential of the calf muscles. For this reason, short-distance sprinters-judging by the stiffness and strength of their lowerleg musclesare considered far superior to athletes engaged in many other sports.

Information regarding the sequential functioning of muscle groups and their modes of activity during the support phase of the running stride provides an opportunity for a selective and targeted approach in choosing special speed–strength exercises used in sprinter training. As is well known from sports training theory, the selection of special training means is based on the principle of dynamic correspondence between training exercises and competitive movements.

In practice, to develop the speed–strength capabilities of the calf muscles, various exercises are commonly used, such as vertical jumps, jump-ups, toe raises with additional weights, and similar drills. Multiple-jump exercises, which occupy a significant place in speed–strength training for runners, also differ in their movement parameters from those of sprint running. This is because foot contact with the ground is performed with a flat foot, and during the amortization phase, the main load falls on the muscles and ligaments surrounding the knee joint.

Thus, the analysis of the most suitable exercises for short-distance sprinters should focus on the following: **running on one leg with forefoot (ball-of-the-foot) ground contact**, in which **multiple hopping and jumping exercises** help ensure muscular strength and stability.

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