# MUSCLE STRENGTH AND SPEED-POWER PHYSIOLOGICAL BASIS OF THEIR QUALITIES

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**Abstract:**
This article provides a brief overview of the physiological basis of muscle strength and speed power qualities.

**Key words:** muscle, strength, quality, speed, sport, exercise, load, static,movement.
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The higher the speed of movement, the smaller the force and vice versa. Different sports correspond to different points on the strength-speed curve. External load exercises that are close to or equal to the muscle's maximum isometric strength are considered strength exercises. For example, gymnastic exercises such as "stand on hands", "crest", "front balance" on the hips, weightlifting exercises performed with barbells close to the maximum or maximum weight are among them.

When the external resistance decreases, the speed of movement increases, and the displayed muscle strength decreases. During its performance, the relatively large force and speed of muscle contractions, to the external load equal to 40-70% of the maximum isometric force, i.e. to the type of high-power exercises, speed-strength exercises (short-distance running, jumps ) is included.

High speed is achieved in movements moving from one place to another with a small mass (less than 40% of the maximum isometric force), in which the muscle force displayed is relatively small. Such exercises (for example, throwing a small ball standing still, movements of arms and legs without load) are suitable for speed.

In conditions of isometric contraction, muscles exhibit maximum static force.

Maximum static and maximum voluntary static muscle strength. An isometrically contracting muscle exhibits the maximum tension possible for it. At the same time, the following three conditions must be met:

1) activation of all movement units (muscle fibers) of this muscle;
2) full tetanus mode in all its movement units;
3) muscle contraction at rest.

In this case, the isometric contraction of the muscle corresponds to its maximum static strength.

The maximum force produced by a muscle depends on the number of muscle fibers that make up the length of the muscle and their thickness. The number and thickness of the fibers determine the total thickness of the muscle, or, in other words, the surface of the muscle cross-section (anatomical cross-section). Maximum muscle strength, its ratio to the anatomical cross-section is called the relative strength of the muscle. This force is measured in newtons or kilograms per cm2 (P/cm2 or kg/cm2).

Muscle strength is measured when it voluntarily exerts force and strives to maximally contract the required muscles. Therefore, when we talk about a person's muscle strength, we are talking about his maximum voluntary strength (in pedagogical practice, the equivalent concept is "absolute muscle strength"). This strength is divided into two:

muscular (peripheral) and coordinating (central - nervous) depends on the factor.

The muscle (peripheral) factors that determine the maximum voluntary strength include: 1) the conditions of mechanical impact on the muscle pulling force - the shoulder of the muscle force lever and the angle of impact of this force on the bone levers; 2) muscle length, — muscle tension depends on its length; 3) the cross-section (thickness) of the activating muscles - the greater the sum of the cross-sections of the contracting voluntary muscles, the greater the resulting muscle force under the same conditions; 4) muscle composition - that is, the ratio of muscle fibers in fast and slow contracting muscles.

Coordinating (central nervous) factors, muscle apparatus

a unit of central nervous coordination mechanisms of control - includes intramuscular coordination mechanisms and muscle coordination mechanisms.

Coordinating mechanisms within the muscle indicate the frequency of the number of impulses of muscle motoneurons and the dependence of their impulses per unit of time. With the help of these mechanisms, the central nervous system controls the maximum voluntary force of the muscle, that is, the force of the voluntary contraction of the muscle determines how close it is to the maximum force. Even the indicator of maximum voluntary strength of any muscle group of one joint depends on the strength of contraction of many muscles. The perfection of muscle coordination is manifested in the adequate selection of "necessary" muscle-synergists and in limiting the "unnecessary" activity of muscle-synergists in other joints, and in the strengthening of the activity of muscle-antagonists that ensure the fixation of neighboring joints. . Thus, controlling muscles when required to exhibit MI is a complex task for the central nervous system. Based on this, it is understandable why the maximum voluntary force of muscles under normal conditions is less than their maximum force. The difference between the strength of the muscle and its maximum voluntary strength is called the strength deficit.

The more perfect the central control of the muscle apparatus, the smaller the strength deficit of the muscle group. The size of the power deficit depends on three factors: 1) the psychological and emotional state of the person being studied (given instructions); 2) to the required number of simultaneously activated muscle groups;

3) depends on the level of perfection of their voluntary management.

The first factor is that a person can show such strength in certain emotional states that this strength is much greater than his maximum capabilities under normal conditions. Such emotional (stress) situations include, in particular, the state of the athlete during the competition. In experimental conditions, a significant increase in the indicators of maximum voluntary strength (that is, a decrease in the strength deficit) was found in cases where a strong emotional reaction occurs in the athlete being studied, during his strong motivation, for example, when an unexpected sharp sound is heard (when a shot is fired). . In this case, the positive effect (increase in maximal voluntary strength, reduction in strength deficit) is stronger in those who do not exercise and weaker in those who do a lot of good exercise (or not at all). This shows that the central control of the muscular system in athletes is at a high level of perfection.

The second factor.When measured under the same conditions, the greater the number of simultaneously contracting muscle groups, the greater the strength deficit. For example, when measuring the MIC of only the muscles that actuate the thumb, the strength deficit in different participants is 5-15% of the MIC of these muscles. It is known that the strength deficit increased by 20% when the MIC of the muscle that activates the thumb and flexes its phalanx is determined. During the maximum voluntary contraction of the large group of calf muscles, the strength deficit is equal to 30%.The third factor. The role of this factor has been proven in various experiments.

For example, isometric exercise performed in a specific arm position has been shown to significantly increase maximal voluntary strength measured in that position. If the measurements were taken in other positions of the hand, then the increase in the maximum voluntary strength was not so great or did not increase at all. If the increase in the maximum voluntary strength depends only on the increase in the cross-section of the exercising muscle (peripheral factor), it would be found in the measurements in any position of the arm. Based on this, the increase in the maximum voluntary strength in this case depends on the more perfect central control of the muscle apparatus in this exercise state, compared to before the exercise.

The role of the coordinating factor is also seen when studying the relative voluntary strength index, and it is determined by dividing the maximum voluntary strength index by the size of the muscle cross-section. For example, after 100 days of training using isometric exercises, the maximum voluntary strength of the exercising arm increased by 92%, and their cross-sectional area increased by 23%. Correspondingly, relative voluntary strength increased from 6.3 to 10 kg/cm2 on average. Based on this, systematic exercises can help improve voluntary muscle control. The maximum voluntary strength of the arm muscles that did not perform the exercise also increased slightly due to the last factor, because the cross-sectional area of these arm muscles did not change. This suggests that a more perfect central control of muscles can be demonstrated over symmetrical muscle groups (the phenomenon of "carry-over" of the training effect).

It is known that fast-moving parts of muscles have the highest threshold ("less excitable"). Their contribution to the overall strength of the muscles is especially large, because each of them contains a lot of muscle fibers. Fast-moving muscle fibers are thicker, have more myofibrils, and because of this, their force of contraction is greater than slow-moving units. This explains why the maximum voluntary strength depends on the composition of the muscles: the more fast-twitch muscle fibers they contain, the higher their maximum voluntary strength.

When the athlete is faced with the task of developing a large muscle strength during a competitive exercise, he should use exercises that require the manifestation of a large muscle strength during the training process (not less than 70% of the maximum voluntary strength). In this case, the execution of voluntary exercises with the muscles is perfected and, in particular, the internal muscle coordinating mechanism is adapted, which ensures that the largest possible number of fast-twitch fibers are recruited, including the major muscles, including those of the higher system.

The relationship between voluntary muscle strength and endurance.

There is a complex relationship between voluntary muscle strength and endurance ("local" endurance). Maximum voluntary strength and static endurance of a single muscle group are related: the greater the maximum voluntary strength of this muscle group, the longer it can hold the selected tension ("absolute local endurance").

In experiments, a different relationship between voluntary strength and endurance is determined when different subjects develop the same relative muscle tension, for example, 60% of their maximum voluntary strength. In this case, the stronger the tested person is, the greater the muscle tension should be in terms of absolute magnitude. In these cases, the average threshold time of the work ("relative local endurance") is often the same in people with different maximum will power.



Maximal voluntary strength and dynamic endurance performance showed a direct relationship between non-athletes and different athletes. For example, both men and women have the strongest leg muscles in disco balls, but their dynamic endurance indicators are the lowest. Mid- and long-distance runners do not differ in leg muscle strength from non-athletes, but dynamic local endurance is greater in athletes. At the same time, high dynamic endurance was not determined in their hand muscles. All this indicates a high specificity of training: the necessary functional properties of the muscles, which are considered the main ones during the athlete's training, increase more. More exercises aimed at developing muscle strength, perfecting the mechanisms that help to improve these qualities, have less effect on muscular endurance, and vice versa.

Muscle hypertrophy. Since the strength of the muscle depends on its cross-section, its increase occurs along with the increase in the strength of this muscle. Due to physical exercise, the increase in the cross-section of the muscle is called working hypertrophy of the muscle (Greek: "trophos" - nutrition).

Active muscle hypertrophy occurs due to thickening (increase in size) of existing muscle fibers. During a significant thickening of muscle fibers, their transverse mechanical breakdown can occur and "extra" fibers with common ligaments can be formed. In the process of strength training, the number of transversely mechanically broken fibers increases.

Separation of working hypertrophy of muscle fibers into two types

possible — sarcoplasmic and myofibrillar. Sarcoplasmic working hypertrophy is a thickening of muscle fibers, often due to an increase in the size of the sarcoplasm, that is, their non-contracting part. This type of working hypertrophy occurs due to an increase in the amount of non-contractile (in particular, mitochondrial) proteins and metabolic reserves of muscle fibers: glycogen, non-nitrogenous substances, creatine phosphate, myoglobin, etc. A significant increase in the number of capillaries as a result of exercise can lead to some thickening of the muscle.

Slow and fast-oxidizing fibers are probably more prone to sarcoplasmic hypertrophy. This type of working hypertrophy has little effect on the increase of muscle strength, but it greatly increases the ability to work for a long time, that is, it increases their endurance.

Myofibrillar working hypertrophy increases the number of myofibrils and

it is related to the increase in size, i.e. muscle fibers, personal contractile apparatus. In this case, the density of myofibrils in muscle fibers increases. Such active hypertrophy of muscle fibers leads to a significant increase in the maximum strength of the muscle.

The absolute strength of the muscle also increases significantly, while during the first type of active hypertrophy, it either does not change at all or decreases slightly. Muscle fibers are probably more prone to myofibrillar hypertrophy.

In these cases, hypertrophy of muscle fibers is a combination of the two named types, each of which predominates. The dominant development of one or another type of working hypertrophy is determined by the nature of muscle training.

Performance of long-term dynamic exercises with a relatively small force load that develops endurance, mainly causes the first type of worker hypertrophy. Exercises performed with high muscle tension (more than 70% of the MIC of the muscle groups being exercised), on the contrary, contribute to the development of hypertrophy of the first type.

The basis of working hypertrophy is the rapid synthesis and rapid breakdown of muscle proteins. In hypertrophied muscles, the concentration of DNA and RNA, respectively, is higher than in normal muscles. The amount of creatine increases in the structure of the contracting muscle, increases the strong synthesis of actin and myosin, and thus helps to develop the active hypertrophy of muscle fibers.



Androgens (male sex hormones) play an important role in controlling the size of muscle mass, especially in the development of muscle hypertrophy. They are produced by the cortex of the genital (ovaries) and adrenal glands, and in women - only by the cortex of the adrenal glands. So, compared to women, men have more androgens in their bodies.

Like other types of exercise, strength training does not change the ratio of the two main types of fast and slow muscle fibers.

At the same time, it has the property of changing the ratio of the two types of fast fibers by increasing the percentage of fast glycolytic fibers and, accordingly, reducing the percentage of fast oxidizing glycolytic fibers. In this case, as a result of strength training, the degree of hypertrophy of fast-twitch muscle fibers is greater than that of slow-twitch fibers, while endurance training primarily leads to hypertrophy of slow-twitch fibers. This difference shows that the degree of muscle fiber hypertrophy depends on the amount of its use during training and the nature of hypertrophy.

Strength training involves maximal or near-maximal muscle contractions involving both fast-twitch and slow-twitch muscle fibers. However, to increase the working hypertrophy of fast fibers, a small number of returns is enough, which shows that they are more prone to developing working hypertrophy (compared to slow fibers). The large percentage of fast-twitch fibers in muscles serves as an important basis for a significant increase in muscle strength during improper strength training. Therefore, a person with a lot of fast-twitch fibers in his muscles has a much higher potential for developing strength and power.

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