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Muscle Biodynamics and Statistical Analysis

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Annotation: The modern system of athletes' training is a complex multifactorial process that gradually ensures that athletes achieve the highest results. Undoubtedly, one of the most important factors in achieving sports results at the international level is not only the modern way of playing sports, but also the innate predisposition of the athlete. One of the important characteristics affecting the level of athletic performance is the composition of skeletal muscle fibers. One of the main functions of muscles is the conversion of chemical energy into mechanical work or force. When a muscle is excited, its mechanical state changes, and this change is called muscle contraction.

Keywords: statistics, energy, mechanical work, biomechanical indicators, strength, speed and strength, elasticity, concentric, eccentric, fixation, endurance.

A living organism is a complex, constantly changing, developing whole system, which is in constant contact with the external environment and forms a continuous whole with it. Most of the human body is made up of free muscles (up to 40% in adults), and individual muscles located in a certain order are expressed in appearance and perform certain movements. Muscle tissue is characterized by the ability of its elements to contract.

In a calm state, muscle tissue has the following properties: viscosity, relaxation, viscosity, elasticity, tension.

In the human locomotor apparatus, there are long, wide and short muscles. Long muscles are located in the trunk and legs and set in motion long kinematic chains.

Wide muscles supply blood to the hollow parts of the body, move the shoulder, arms and legs.

Short muscles are found in bones that have a segmental character (intervertebral, intercostal muscles).

Muscles vary in their location and fibers. Parallel-fibered muscles are the most common.

The types of muscles depend on their function of movement.

Muscles have a certain tensile strength and depend on mechanical, anatomical, and physiological conditions.

Mechanical conditions include the forces that affect muscle contraction.

Anatomical conditions include its structure and location.

Physiological conditions include the excitability, fatigue, and changes of the muscle.

The strength of the work done depends on the cross-section of the muscle performing this work. Muscles have bone spurs, that is, levers, which increase the strength of the work and help it.

If the first group of muscles contracts, the second group of muscles also contracts, such muscles are called synergistic muscles. If the first group of muscles contracts, the second group of muscles relax, such muscles are called antagonist muscles.

Various statistical methods are used to assess the work activity of muscles and their efficiency. In this article, the characteristics of muscle performance are analyzed using statistical methods.

1. Muscle mass percentage

Studies show that human muscles make up 30-40% of body mass. This figure depends on age, gender and physical activity.

The main function of muscles is to convert chemical energy into mechanical work or force. The main biomechanical indicators that characterize muscle activity are: a) the force recorded at its end (this force is called muscle tension or tensile strength) and b) the rate of change in length.

When a muscle is excited, its mechanical state changes; these changes are called contraction. This is manifested by changes in the tension and length of the muscle, as well as its other mechanical properties (elasticity, stiffness, etc.).

The mechanical properties of muscles are complex and depend on the mechanical properties of the elements that make up the muscle (muscle fibers, connective tissue, etc.) and the state of the muscle (excitation, fatigue, etc.).

Age group	Average muscle mass (%)	Gender difference
18-25 age	38-42 %	Higher in men
26-40 age	35-40 %	Slightly lower in women
41-60 age	30-35 %	Decreases muscle mass
60+	25-30 %	Continues to decrease with age

This data confirms that muscle mass decreases with age and is relatively higher in men.

2. Speed and strength of muscle contraction

The quality of muscle performance depends on the following factors:

Type of muscle fibers (fast and slow-twitch fibers)

Level of excitability

Biomechanical factors that determine the strength and speed of muscle contraction

As is known, a muscle can work in several modes:

* overcoming (concentric) - the length of the muscle decreases;

* inferior increases; (eccentric) - length

* isometric - the length of the muscle does not change.

There are a number of factors that affect the manifestation of the strength and speed of muscle contraction in overcoming and contraction modes.

These factors include:

* muscle length;

* mode of muscle work;

* the value of the external force.

Duration and severity of work

Studies show that while the maximum force and speed of muscle contraction depend on individual factors, there is a general statistical relationship.

Muscle type	Maximum force (N)	Maximum contraction speed (cm/s)	Work endurance (s)
Fast-twitch fibers	500-80 ON	6-8 cm/s	10-30 s
Slow-twitch fibers	300-60 ON	2-4 cm/s	60+ s

As you can see from this table, fast-twitch fibers are stronger and move faster, but have less endurance. Slow-twitch fibers can work for a longer period of time, but at a slower speed.

3. Muscle performance and biomechanical analysis

Muscle work is studied in dynamic and static conditions.

From the point of view of biomechanics, there are three qualitative differences in static muscle work:

1. Muscle holding work

2. Muscle strengthening work

3. Muscle fixing (fixation) work

The dynamic mode of muscle work causes the movement of the body's joints, while the distance between the muscle attachment points changes. There are two types of dynamic muscle work:

1. Overcoming muscle work.

2. Less muscle work.

To determine the efficiency of work, the following parameters are analyzed:

Force production (N)

Energy consumption (kJ)

Resistance resistance (kg)

For example, the maximum force production ability of muscles changes as follows:

Muscle group	Maximum load capacity (kg)	Average operating power (W)
Thigh muscles	600 kg	500 W
Calf muscles	400 kg	300 W
Wrist muscles	150 kg	100 W

The thigh muscles have the greatest load-bearing capacity, which is due to their size and location.

4. Muscular strength and endurance in athletes

Strength is the ability of a person's muscles to exert force.

The quality of strength can manifest itself as follows:

1. Real strength is static strength. It is manifested in the static form of muscles and in slow movements, for example, when holding a weight.

2. Fast-strength quality, that is, the combination of the force and speed of muscle contraction.

The ability to resist fatigue is called endurance.

The following types of endurance are distinguished:

1. General endurance is the body's ability to resist general fatigue.

2. Special endurance is the body's ability to resist fatigue in certain types of sports activities. In turn, special endurance can be divided into:

- ✓ strength endurance
- ✓ fast endurance
- ✓ statistical endurance
- ✓ coordinated endurance

Athletes have higher muscle strength and endurance than ordinary people. According to research results, the indicators of muscle strength and endurance in different sports are as follows:

Sport type	Average maximum force (N)	Endurance (s)
Weightlifting	900-1200 N	20-30 s
Sprinter runners	700-900 N	15-25 s
Marathon runners	400-600 N	120+ s

Weightlifters are stronger but have less endurance. Marathon runners can run longer but have relatively less muscle strength

5. Muscle fatigue process and recovery statistics

During muscle work, fatigue goes through two stages:

1) the compensated fatigue stage - in which, despite increasing difficulties, the athlete maintains the intensity of performance

2) the decompensated fatigue stage - in which, despite all efforts, the athlete cannot maintain the required intensity of the task.

The endurance of an athlete depends largely on the physiological characteristics of his muscular system, which, in turn, are determined by the specific structural and biochemical properties of

muscle fibers. The increase in endurance as a result of training is associated not only with an increase in the ability of the oxygen transport system to deliver O2 to the working muscles. There are also significant changes in skeletal muscles, which lead to an increase in the capabilities of the whole body.

Muscle fatigue depends on the duration of work, its severity and individual physiological characteristics. The recovery time of tired muscles has the following statistical data:

Faoliyat turi	CHarchash vaqti (min)	To'liq tiklanish vaqti (min)
Og'ir yuk bilan mashq	5-10 min	30+60 min
O'rta og'irlikdagi mashq	15-20 min	20-4010-20 min
Engil jismoniy xarakat	30+ min	10-20 min

This data shows that the heavier the load, the faster the muscles fatigue and the longer it takes to recover.

Summary:

Statistical analysis plays an important role in assessing muscle performance and understanding the processes associated with them. Studies show that:

Muscles make up 30-40% of body mass.

Fast-twitch fibers are stronger but less durable.

Maximal muscle strength is highest in the thigh muscles.

Muscle strength among athletes depends on the type of sport.

Muscle fatigue depends on the level of load, and recovery time varies accordingly.

These statistical results serve as an important basis for analyzing the dynamics of muscle movement and optimizing physical training.

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