The smallest functional neuromuscular structure of mammals is the motor unit, which consists of motoneuron and muscle fibers innervated only by this neuron. The research presented in the application will refer to changes in the contractile properties of the motor units of the three basic physiological types (S – slow-twitch, FR – fast-twitch resistant and FF – fast-twitch fatigable) under the influence of temperature (reduced and raised in relation to the body's physiological temperature) in the medial gastrocnemius and soleus muscles of the rat. The project aims to determine the relationship between temperature and the characteristics of contractions of the three types of motor units, including the time parameters of twitch contraction and relaxation, the contraction force, relationship between the force and the frequency of stimulation, and resistance to fatigue. The project propose the first studies concerning sensitivity of motor unit force to changes in the muscle temparature (earlier literature data refer to muscle contraction or isolated muscle fibers) and the innovative comparison of the influence of the temperature on contractions of fast and slow motor units within one muscle. It can be assumed that the analysis of experiments focused on the force-frequency of stimulation analysis will allow indirect understanding of the neuronal mechanisms of muscle force regulation in conditions of muscle temperature changes (hypothermia and overheating). The research hypotheses assume that the observed changes in the characteristics of the contraction of motor units of various types have different intensity under conditions of changed temperature (hypothermia and hyperthermia), and the changes relate to a significant extent to the mechanisms of control of contraction force and resistance to fatigue. These studies deepen the knowledge about the influence of physical factors on the physiological processes of the contracting muscle.

The experiments will be carried out in vivo on the medial gastrocnemius muscle, containing all three types of motor units (slow- and fast-twitch) and soleus muscle, containing mainly slow-twitch (S) motor units in Wistar rats. The functional isolation of individual motor units will be achieved by isolating the thin axonal bundles from the dorsal roots of the spinal nerves until the "all or nothing" response will be achieved during a threshold stimulation with rectangular electrical impulses. The examined motor units will be stimulated by standardized stimulus sequences that will evoke single twitches, the unfused tetanus contractions with different degree of fusion, the fused tetanus contractions and the fatigue test, and on a basis of measurement results these units will be classified into the main physiological types. All basic characteristics of motor unit contraction and fatigue index will be measured. The motor unit action potentials will be recorded and their properties at three studied temperature levels will be compared. Additionally, the dependence of motor unit twitch force on the muscle passive force at the three temperature levels will be also studied. The temperature will be controlled by an automatic system regulating the temperature level of paraffin oil in the pool in which the muscle will be immersed.

The need to broaden knowledge about muscle physiology and the influence of temperature on the basic properties of contraction and fatigue resistance of various types of motor units and the ability to regulate the contraction force is the main reason for undertaking the presented research topic. The results of the experiments can significantly deepen the basic knowledge in the field of kinesiology, biomechanics and muscle physiology as well as working conditions. In addition, the studied changes have a significant impact on the performance of any movements in environments with specific thermal conditions, e.g. during winter mountain trips, sailing cruises, swimming in open water areas or even work done outside in different seasons, or in the conditions of hyperthermia sometimes encountered in sports or work in industry. The results obtained may contribute to a significant increase in knowledge in the field of rehabilitation and physical therapy and may enable the development of innovative therapy techniques using low and high temperatures.