

# The Use of Training Devices in the Strength Training of Disabled Athletes

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**Abstract:** *Since the mid-twentieth century, the problems of physical rehabilitation of disabled people with different nosologies are highly relevant due to various reasons. Initially, this was connected with the processes of the integration of disabled people into educational and cultural spaces; then the developing educational technologies, including those in the field of physical culture and sports, served as the ground for the rehabilitation of disabled people with various nosologies. The first Summer Paralympic Games, held in 1960, marked the massive involvement of disabled people in sports, actualizing the development of training technologies for these categories of athletes. General physical training of disabled athletes, including strength training, serves not only the tasks of performing at competitions and achieving sports results but also the tasks of strengthening the body of a disabled person, including him or her in the society. For disabled people who have various nosologies, especially lesions of the musculoskeletal system, various training devices are an important means of rehabilitation and physical training. The article examines the features of the general physical training of disabled people, engaged in sports (for example, people with lesions of the musculoskeletal system, engaged in powerlifting) and the use of training devices in this kind of performance.*

**Index Terms:** *disabled people with lesions of the musculoskeletal system, general physical training, training devices, athletes.*

## I. INTRODUCTION

Over the past 20 years, Russia has gained extensive scientific and methodological experience in the physical rehabilitation and social integration of disabled people of different nosological groups, and a large number of rehabilitation programs have been developed and implemented [1-8]. But despite this, the problems of physical rehabilitation remain important and relevant. The main position of the concept of adaptive physical rehabilitation (AFR) in the opinion of the creator of the new constructions of sports training devices for restoring the strength of

disabled people, the doctor of pedagogical sciences V. S. Dmitriev goes as follows: "Any pathology or disorder, regardless of the initial state of a person, leads to temporary or sustained disorders of motor, coordination and other functional qualities. Improving the organization (level and modes) of individual motor activity is a determining factor in the physical rehabilitation and socialization of people with limited functional opportunities, including disabled people" [9]. One of the available forms of physical activity of disabled people is lessons in gyms, organized for this category of people.

## II. METHODS

To substantiate the use of training devices in the strength training of disabled athletes, the following main methods of research were used: theoretical analysis of literary sources, pedagogical observations of the training process of disabled athletes with lesions of the musculoskeletal system engaged in adaptive powerlifting.

## III. RESULTS AND DISCUSSION

The basis for further improvement of technical means and methods of adaptive physical culture is the achievements of a number of basic sciences and applied medical disciplines. The modern ideas about the organization of the human motor action, the functional and structural relationships in the musculoskeletal system, motor-visceral interconnections, biological nature and social mediation of human motor activity in health and pathology are taken as the basis [10, 11]. Training on sports devices or training gymnastics is known in the European countries as medical training therapy – the use of training equipment with a therapeutic and recreational purpose. A training device is technical equipment or an appliance, intended for the education and improvement of motor, professional and applied skills and abilities, as well as for medical rehabilitation [12].

The foundations of mechanotherapy were laid during the development of the first mechanotherapy appliances for the medical rehabilitation of patients with motor disorders of the musculoskeletal system. The principle of action of mechanotherapeutic devices is based on the biomechanical features of movement in the joints: the block system, the pendulum system, and the lever system.

The systematic use of technical devices in rehabilitation practice began in the mid-nineteenth century, when Gustav Zander, the professor of anatomy at Uppsala University (Sweden), created a new gymnastics system and called it a machine system.

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## The Use of Training Devices in the Strength Training of Disabled Athletes

In 1857, Zander opened the first institute, in which there were 27 apparatuses for machine gymnastics [12]. The purpose of these devices was to ensure and increase the opportunity of movement in the joints in the conditions of pathology: paralytic disorders, contractures, deformities, and post-traumatic conditions. In other words, mechanical devices contributed to the implementation of passive movements in the complete absence or limitation of the active ones. It seems obvious that the "technical support" was provided not only to a patient but also to the medical staff, since it included the functions of fixation (restraint of a limb) and the manipulation of an assistant during the procedure and the course of treatment as a whole. Along with the fulfillment of the conditions of light or passive movement, the mechanical devices made it possible to technically improve the system of strength training, not only in medical but also in sports and recreational practice [13].

The Russian specialists in the field of rehabilitation treatment attributed its monotony and possible distortion of the normal (physiological) motor pattern to the significant shortcomings of mechanotherapy. The achievements of the scientific and technological progress to a large extent influenced the level of constructive solutions and the rehabilitation opportunities of modern training equipment. From simple mechanical devices, it was transformed into complex technical devices, which had software in some cases.

The existing training devices vary considerably in terms of the freedom of allowable movement. In this regard, three types of training devices can be conventionally distinguished [14-16].

**Training devices of narrowly local action** have an imperative construction that defines a completely specific type of the training effect, as a rule, for one muscular group of synergists and with a movement of a link that has only one degree of freedom. Many simulators are the same, designed, for example, to work only with flexors of a shoulder, forearm, etc.

**Training devices of local action** prescribe movements of one specific coordination, but unlike the devices of the previous type, they act not on one, but on several muscle groups and several joints. The movements corresponding to this are generally characterized by several degrees of freedom. They are, for example, all training devices that set movements such as pulling up with hands, leg extensions, squats with overcoming resistance, etc. The training devices of this class can have a greater number of degrees of freedom than the devices of narrowly local action, due to which the exercises vary within certain limits, deviating from the basic method of performance according to some characteristics: the direction of thrust, the width of the grip, etc. This allows achieving a more complete training effect.

**Multifunctional training devices** are the devices of the "combined" type, which allow training different muscle groups, applying training effects in various working positions for this purpose. For each of these positions (standing with the thrust below, above, etc., lying on the stomach, back, sideways with the thrust using hands, arms, legs, etc.) there are most characteristic basic exercises, which in turn can vary. Training devices also differ in the ways of burdening. On this basis, two characteristic classes of training devices

are distinguished.

**Training devices with artificial weights** are made, given that external load is applied, transmitted through the system of blocks to the working link of the exerciser. The main advantage of such a constructive solution is not so much in service as in the ability to easily and flexibly vary the degree of weights.

**Training devices with natural weights** are designed to use the mass of the body involved (or its links). Usually, it is a different kind of support, lodgements, making it possible to accept and fix the working position. Changing the difficulty of the exercises in this case is possible only by means of the techniques associated with the methods of work, changes in working posture, as well as through the use of traditional weights – adjusting dumbbells, barbells, etc.

The kinematics of movements on training devices with a different number of degrees of freedom are fundamentally different. In this regard, there are two categories of training devices:

**Imperative training devices** have strict "geometry" of movements and work in accordance with a specific pattern for the purpose of analytical distinguishing of the motor function. In particular, it includes training devices of narrowly local action.

**Training devices with free "geometry"** make it possible to vary the kinematics of the working movement more or less widely, performing thrusts during one exercise or the series of exercises in different directions in relation to the axes of the joints. They are, first of all, all training devices that transmit the load from the blocks through a free cable, due to which it becomes possible to change both the working positions, the positions in relation to the apparatus, and the direction of thrust within one working position. This is a very important feature of the training device that makes it possible not only to perform various exercises but also to "correctly" change the load on the muscular system within the same exercise, if required, turning on or off various muscular synergies, mixed modes, muscle bundles, etc.

Special medical training devices "Steens" have become widespread. Their design provides for the requirements for performing procedures of therapeutic gymnastics and, in particular, physical exercises for patients with diseases of the musculoskeletal system: orthostatic unloading of the spine and joints of the limbs; load dosage according to the strength and amplitude of the impact; the variety and adequacy of starting points; exercises with "negative weight" in light conditions; the possibility of localized effects on muscle groups and joints; the implementation of various types of muscle contractions (concentric, eccentric and isometric) [11]. As noted by the analyzed authors, the use of exercises with weights, performed on a training device, is quite an effective, but little-studied direction at present in the physical rehabilitation of disabled people.

It has been scientifically proven that the strength training with the use of free weights and training devices is the most effective means of physical activity of disabled people who have disorders of the musculoskeletal system of various etiologies [1-6, 17].

Strength training makes it possible to consciously, selectively and directly influence the muscular system, forcing the whole body to function more actively, including the process of respiration, the work of the cardiovascular system, metabolism, etc. Strength exercises have significant impact on the entire musculoskeletal system, namely: on the growth of tubular bones in length, the bones are able to change their genetically predetermined thickness and strength; ligaments become stronger and more extensible; the strength and mobility of the joints increases; mobility of the chest increases (VC), the tone of the muscles of the back improves, resulting in a correct posture [18].

The main tool for the development of muscle power is strength exercises. All strength exercises can be divided into 6 groups: exercises to overcome the weight of one's own body (link), performed without weights and objects; exercises with a partner (in pairs, triples); exercises on gymnastic equipment (parallel bars, crossbars); exercises with auxiliary means and devices of a specific design (shock absorbers, expanders, rubber bands, balls, sticks, etc.); exercises with free weights (barbell, dumbbells, weights); exercises on the training and special devices.

The most accessible exercises for all nosological groups are exercises performed on training devices. With the help of sports devices, it is possible to effectively form motor skills and abilities, to develop and improve the qualities and abilities of an athlete, which are required not only for competitive activities but also in daily routine.

Based on the use of training devices, one can significantly develop coordination abilities and noticeably smooth out the asymmetry of movements. Training devices are especially popular among disabled people with a diagnosis of infantile cerebral palsy (CP). The effectiveness of the use of the training devices for the conjugate development of strength and abilities to accurately perform movements in students was proven by Khezhev [19].

The effectiveness of the use of the training devices for the treatment of patients with various diseases of the musculoskeletal system was scientifically proven by the well-known Russian Doctor of Medical Sciences, Professor Sergei Bubnovskii. Bubnovskii elaborated a unique author's method of treating the most common diseases of the joints and spine, which was confirmed by his long-term practice. As a remedy, Sergei Mikhailovich did not use painkillers, but various training devices [14, 15].

In the research conducted by Melikhov on the basis of the Russian State Humanitarian Boarding Institute in Moscow among 30 disabled students with lesions of the musculoskeletal system at the age of 18 to 21 years of the Yelets State Ivan Bunin University and the physical culture and sports club of the disabled people "Lider" of the Municipal Department of Social Protection "Center for Social Services and Rehabilitation of Elderly and Disabled Citizens" in Yelets, the effectiveness of a complex method of strength training was proved, which consisted of exercises to develop flexibility and muscle relaxation; exercises with free weights (exercises with a barbell and dumbbells, exercises with weights), exercises with a medical ball. As a result of this research, positive dynamics in all morphofunctional and psycho-emotional indicators was scientifically proven. The greatest changes in the direction of improvement were

observed in the indicators of stiffness (involuntary muscle tension) and involuntary eye movements, the tremor decreased (trembling of the arms, legs, face), in the process of training on the training systems, as the strength training increased, the correction of posture and vicious positions was observed in the students. The exercises on training devices and with medical balls also allowed developing differentiated finger activity, correcting fine motor skills and the manipulative function of the hands. Strength training also influenced psychoemotional and volitional qualities, improved attention and memory [6].

Training sessions with the use of training devices among disabled people of various nosological groups have been held for a long time. They are a universal means of developing power abilities for everyone. Pedagogical observations show that teaching strength exercises at the initial stages of training should begin with training devices, and not with exercises with free weights. Regardless of the type of the lesion, the training conducted 3 times a week has the most productive effect. The duration of lessons depends on many factors: age, gender, the type and degree of lesion, the capabilities of an athlete, practical experience, etc. Nevertheless, as a rule, the first lessons last no more than an hour. Athletes with infantile cerebral palsy and visually impaired athletes require more time to prepare and perform exercises. At the beginning of the lessons, regardless of the nosological group, everyone is engaged in a warm-up exercise consisting of general developmental exercises. At the first lessons, individually for each beginner, training devices available for performance are selected. In special cases when it is necessary, adaptations to them are used. These can include bandages, harnesses, metal brackets, chains, etc. Depending on the level of training, the weights are selected. The weights are chosen so that an athlete himself or herself, without help, could perform the exercise 10 times. The position of the body in the training device is sometimes fixed by belts when it is impossible to maintain the necessary starting position on his or her own.

For the hearing-impaired athletes, at the initial stages of the preparation, experienced athletes or a coach himself or herself demonstrate guidelines for the correct execution of an exercise, or the subtleties of the technique can be noted in writing. Videos are well suited for such purposes. In working with visually impaired athletes, a beginner should be constantly supported by a coach. Much attention is paid to safety. An athlete should constantly receive information about the location of the apparatus and the weight established on it. For the whole time of training, especially at the first lessons, it is simply necessary to accompany a student. In this regard, it is difficult to train a group of such beginners simultaneously.

Based on many years of observation and practical work with athletes with lesions of the musculoskeletal system, the authors elaborated a universal set of exercises consisting of exercises performed with the use of training devices and exercises with overcoming own body weight, which are performed without weights and objects, that are suitable for the initial preparation for beginners of all nosological groups (Table 1).

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The number of approaches during exercise increases gradually, but there are not more than four of them. The complex is selected in such a way that there is no load on the lumbar spine. Athletes with spinal cord injury can use it in training. These exercises develop all the abdominal muscles

(straight, oblique, transverse). For more comfortable performance of some exercises, a wooden stand under the knees, about 15 cm high, can be used.

**Table 1.** A set of exercises on training devices for people with lesions of the musculoskeletal system

| No. | Exercise  | Number of repetitions | Methodical instructions  |
|-----|---|-----------------------|--|
| 1   | lifting the body on an inclined board   | 6-8 times             | Legs are fixed (the angle is selected individually); athletes with limb amputation do not make this exercise.  |
| 2   | "compression in the training device"  | 12-15 times           | The exercise is performed from the starting position while knee standing, in the hands there is the handle of the upper block of the training device with a grip from above; while leaning forward, simultaneously sit on the heels, pull the handle beyond the head, exhale squeezing the abdominal muscles; after that – inhale. |
| 3   | bending body over gymnastic apparatus   | 8-10 times            | The exercise is performed with the fixing of the legs, an athlete's body is supported on the apparatus at the level of the hip joints; athletes with limb amputation make this exercise on a bench 6-8 times.  |
| 4   | raising legs from hanging position with elbow support   | 5-6 times             |  |
| 5   | thrust of the upper block of the training device, in a sitting position, behind the head (shoulder-width grip, wide grip) | 8-10 times            |  |
| 6   | thrust of the lower block of the training device, in a sitting position, to the belt (close grip, wide grip)              | 8-10 times            |  |
| 7   | converging hands, sitting on the "Butterfly" training device  | 8-10 times            |  |
| 8   | leg pressing of a platform of the training device   | 8 times               | Except athletes with limb amputation   |
| 9   | bending the legs, lying on the training device  | 6-8 times             |  |
| 10  | leg extensions sitting on the training device   | 6-8 times             |  |
| 11  | rising on toes standing or sitting with the support on a rack of the training device                                      | 15-20 times           | Except athletes with limb amputation   |
| 12  | hanging on a crossbar or a gymnastic wall   |                       |  |

To achieve the best effect of training, especially for disabled people between the strength exercises, it is recommended to hang on a crossbar and make stretching exercises. According to Zuev, an experienced specialist in the field of treating and restoring people's health "when straining, as well as during special stretching exercises, there is a change of short-term muscle tension and relaxation, which allows a person to fully relax and regain an active working state in a short time" [20]. Other experts in the field of strength exercises also note the significance of the return of the vertebral discs to their initial state. Own training and coaching experience with healthy athletes and disabled athletes confirm the importance of hanging after making strength exercises.

Physical rehabilitation of disabled people is currently a relevant and fruitfully developing research topic. It is used not only to adapt and socialize disabled people, but also to prepare them for performances at competitions in various sports, including adaptive powerlifting. Strength exercises for people with lesions of the musculoskeletal system play a special role related to the functional capabilities of the body and the psycho-emotional state. Training devices for various purposes are successfully used both in physical rehabilitation and in preparing athletes for competitions. Training devices play a special role in the initial stages of training of disabled people, when they are introduced to physical activity.

### IV. CONCLUSION

As a result of the study, the following generalizations can

The elaborated set of exercises and recommendations for its implementation were approbated in working with athletes, involved in adaptive powerlifting and showed their high efficiency throughout the work of this group of athletes.

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