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# STUMILATION OF RUNNERS' SPECIAL WORKING CAPACITY WHILE PERFORMING 110 METRES HURDLING AT TRAINING SESSION DURING THE FATIGUE GROWTH PERIOD

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## Abstract

Contemporary sport is characterized by usage of a wide range of means for stimulation of working capacity (training and extra-training ones), being applied in special regimens as means for stimulation of organism during different types of fatigue which sportsmen face. Practicing eccentric exercises for this purpose provokes a number of discussions between coaches and sports doctors. The article represents resistance exercises being applied for stimulation of athletes' working capacity, the methodology of using eccentric exercises, and practical recommendations for sportsmen and coaches. The new opportunities for stimulation of runners' special working capacity while performing 110 metres hurdling are demonstrated. Specific strength exercises are developed to be performed during eccentric regimen of muscle work and be applied within a training session aimed to boost runners' special working capacity while performing 110 metres hurdling.

*Aim is* to develop and experimentally verify the efficiency of exercise series aimed to stimulate runners' special working capacity while performing 110 metres hurdling at training session during the fatigue growth period.

*Methods.* The following methods were used in research: special scientific and methodical literature analysis, pedagogical experiment, mathematical statistics methods. The age bracket of the individuals tested: 20–24, the number of individuals tested – 7.

*Results.* In response to applying strength exercises performed in eccentric regimen of muscle work, the results of completing six fractions of distance with six hurdles have improved by 2,3 %, 1,3 %, 0,8 %, 1,5 %, 0,8 %, and 1,6 %, respectively. The average individual time of completing the distance with six hurdles improved by 0,1–0,2 sec.

*Conclusions.* The new opportunities for stimulation of runners' special working capacity while performing 110 metres hurdling are demonstrated. Specific series of strength exercises are developed to be performed during eccentric regimen of muscular resistance. The developed series of exercises have been applied within a training session aimed to boost runners' special working capacity while performing 110 metres hurdling. The necessity of further analysis of opportunities to apply strength exercises performed in eccentric regimen of work within pre-start preparation of sportsmen has been established.

**Keywords:** stimulation of working capacity, athletics, hurdling, eccentric exercises.

## Introduction

It is well-known that rising of sportsmen's fitness is connected with reasonable balance of load and rest where fatigue plays a crucial role in forming adaptive effects. In theory and practice of sports training wide opportunities of managing the processes of recovery due to depth of influence, duration and intensity of load as well as types and specificity of performing exercises are given [13].

The issue of differentiation of means for recovery depending on the degree of fatigue including stimulation of recovering specific qualities of an organism providing the ability to react on training and competitive loads fast, adequately and fully is observed [10]. Due to that, the experts' particular attention is drawn to developments letting keep (or recover) the level of sportsmen's capacity while performing a competitive exercise [3, 12, 14, 15]. This means stimulation of physiological mechanisms providing control of the achieved level of capacity under development of fatigue. It is shown that appliance of stimulative effects under fatigue cumulation boosts the effect of training load, and programs higher training effects [1, 17, 18].

The existing approaches are oriented towards searching the variations of training loads taking place under compensated fatigue. The complexity of using such approach consists in specificity of fatigue development, and, as a result, neurohumoral factors of its compensation during performing load influencing it [2]. The latter ones, as we know, have original structure, and demand strict control of specificity of reactive qualities of organism as well as sportsmen's capacities related to them in each kind of sport (competitive event) [10].

One of the effective approaches towards actualization of the factors boosting working capacity mentioned above is stimulation of neurodynamic processes in sportsmen's organisms early in the course of fatigue development [7, 8]. That impacts the maintenance of the period of working capacity stability, and drives the mechanisms of fatigue compensation. One of the variations of fatigue compensations is applying extra-training means as additional to the training ones, which depending on their aim of appliance influence the nature of adaptive processes within working or rest period [9, 17]. As one of the variations of training impacts aimed to stimulate working capacity in theory and practice of sports strength exercises performed in eccentric regimen of muscle work are observed.

During eccentric contractions activation of cerebral cortex is higher by amplitude and comprises a bigger area, equally electromyographic (EMG) activity is lower than in the course of analogical level of effort with concentric contraction. EMG activity shows the number of motor units of muscles being involved in the contraction. The higher EMG activity is the more muscle fibers contract. As EMG activity during eccentric contraction is lower than during analogical contraction in concentric regimen, consequently, mechanic load towards particular motor units (muscle fibers) is higher. As most authors put it, improvement of contractive functions is observed mostly in «rapid» muscle fibers, which is peculiar to the work of sportsmen sprinters. A subset of the most rapid muscle fibers activates only in course of eccentric contractions of high intensity. Great activity of cerebral cortex is resulting from peculiarity of muscle activation. In course of eccentric contractions muscle fibers contract in response to afferent irritation, namely, the muscle «adapts» to unstable working conditions. Thus, nervous system is enforced to learn more quickly [5, 12]. It specifies new opportunities of development and intended use of exercise regimens that may be used as additional (to training and competitive) means for stimulation of working capacity.

*The goal of research* is to develop and experimentally verify the efficiency of exercise series aimed to stimulate runners' special working capacity while performing 110 metres hurdling at training session during the fatigue growth period.

## Methods

Experimental part of research was conducted during special preparatory period under natural conditions of sports training at the base stadium (Kyiv). Structure and content of training process did not change except for the experimental part of warm-up on the second experiment day before completing the fractions of distance with hurdles. The experiment lasted for two days. 7 male sportsmen (21–24 years old) took part in the experiment: 4 sportsmen of the first category, two sub-master sportsmen, and one master of sport of Ukraine.

The testing included completing of training distance (6 fractions with hurdles of 106,7 cm height and 9,14 m distance between them) with maximal intensity. Recording of time needed for covering the fractions of test distance was carried out six times using crouch start upon command and after «leaving» each hurdle (at the track touch). The sportsmen's personal feelings were an important aspect of the assessment as well as the efficiency of locomotor technique realization of the runners.

In the control and experimental parts the sportsmen performed four races along the distance. The interval between covering the fractions amounted to 5 minutes. The recovery period between the control and experimental measures amounted to 22–24 hours. Within the experimental part of the research, the invited massage therapists of the National athletics team of Ukraine performed eccentric exercises with each participant of the experiment prior to the first race before covering the distance with hurdles. In 12–15 minutes of rest the sportsmen covered the distance with hurdles 6 times, as the day before.

The results of the research were processed using mathematical statistics methods of processing the received data.

**Results and discussion**

Empirical and practical basis of applying extra-training resistance impacts by sportsmen have been known for long, and today resistance exercises during speed and strength kinds of athletics are very often applied while warm-up and pre-start activity. We have developed the methodology of applying eccentric exercises. Taking into account the known effects of such means of stimulation of special working capacity, the exercises showing efficiency in cyclic kinds of sports have been arranged. The exercises aimed to create mobilization effects during pre-start preparation of runners to 110 hurdles have been selected. The approach to their usage was based on technologies of extra-training means use being additional to the training ones, boost their effects and provide the highest state of sportsmen's readiness to the start.

The exercises presented in the series consider tempo rhythmic structure of special locomotions of 110 meters hurdles runners as well as intensity and composition of the main muscle groups' work.

The exercises are performed with a trained physiotherapist, a doctor, a kinesiotherapist, a trainer or a skilled assistant. You need to pay a few minutes to teach a sportsman initial positions, technique of muscle pre-strain, duration of efforts, and feeling of efforts' «depth».

*Cautions:* the angle of knee joint flexion should be not less than 90°, you should avoid strain, while efforts perform an accented breathing out, do not perform exercises when tired [6, 12].

Prior to doing a series of exercises, a sportsman stays in the initial position (I.P.) standing by the support, both hands help to keep the body (at the stadium it is a hurdle for 110 m or barrier for 3 000 m race). The torso angle is around 60° with respect to the ground surface where an athlete is standing, the shoulders, pelvis, and feet remain on the same line. 1–2 seconds before performing each move a sportsman prior tenses their muscles that will be involved in motion. Exercises are performed in the regimen of sportsman's muscular resistance, an assistant performs a move, the athlete resists, the muscles work in the eccentric regimen. Absence of muscle relaxation during motion is an important technical demand for a sportsman.

Exercise 1.

I.P.: standing on the right foot a sportsman lifts his leg with the knee bent towards the left shoulder. The thigh is parallel to the ground surface. The partner grabs the sportsman's thigh with their left hand, and supports the left foot. Dealing with the athlete's resistance the partner puts the thigh down in the direction down-back while the sportsmen's anterior femoral muscles remain in eccentric muscle strain. 2–3 reps are performed with effort up to 60 % from peak force (PF) for anterior femoral muscles.

Exercise 2.

I.P. is like in exercise 1. The sportsman lifts their left heel to the left thigh bending their knee, and thighs remain at the same level. The partner supports the sportsman's knee with their left hand and holds their left heel with their right hand (bending angle up to 90 °), after that the partner puts it down, going on with posterior femoral muscles resistance in eccentric regimen. 2–3 reps are performed as in the previous exercise with equivalent efforts.

Exercise 3.

I.P. is the same. The sportsman moves their left leg aside, bends their knee, the heel is by the thigh. The partner supports the leg in horizontal position and puts it down with a force pushing the knee exteriorly. The abductor muscles are involved. *The first muscle group* consists of all muscles lying anterior to the frontal plane crossing the body

center: the tensor fasciae latae, the anterior fibers of the gluteus medius, and the main bulk of the gluteus minimus muscle. These muscles provide abducting – bending – internal rotation, contracting independently from other muscles or together with the weaker ones. *The second muscle group* consists of posterior fibers of the gluteus minimus and gluteus medius muscles (the fibers lying posterior to the frontal plane), and the abducens fibers of the gluteus maximus muscle. They provide abducting –extension – external rotation, contracting independently from other muscles or together with the weaker ones. To get «clear» abduction without any additional moves these two muscle groups have to work as a balanced couple of synergists-antagonists [6].

Exercise 4.

I.P. is the same. The sportsman lifts their left heel towards the left thigh bending the knee; the thighs should remain at the same level. The partner is in the half-squat position by the sportsman's left leg. Standing up from the half-squat and supporting the sportsman's knee with their left hand; the right hand is on the sportsman's left heel, the partner moves the thigh aside putting impact on the muscle group and stretching them in eccentric effort. The muscles being involved: adductor longus muscle of the thigh (function – adducting and bending of the leg); adductor brevis muscle of the thigh (function – adducting and bending of the leg); adductor magnus muscle of the thigh (function – adducting, bending, unbending of the leg).

After that repeat the exercises 1–4 for the right leg in the equal sequence.

Exercise 5.

I.P. The sportsman stands with their back to the hurdle. The partner is in the half-squat position by the sportsman's left leg. The partner supports the sportsman's left heel with their right hand, and the athlete's leg half-bent in thigh with their left hand. Standing up from the half-squat the partner stretches the sportsman's posterior femoral group of muscles (the leg is half-bent).

Exercise 6.

I.P. is the same, perform exercise 5 for the right leg.

Exercise 7.

I.P. of the sportsman in supine position, legs straight. The partner is standing on the sportsman's left, and supports their left ankle joint with their right hand, puts their left palm on the sportsman' left foot sole closer to the toes, and performs foot dorsiflexion stretching the strained posterior tibial muscle group (surface and deeper layers).

Exercise 8.

I.P. is the same, perform exercise 7 for the right leg.

These two exercises (7 and 8) are important for pushing during onward motion at a quick pace (here the transverse joint position is important). It is preferable to be done by means of subtalar joint fixation. This can be learnt by sportsmen from the next exercise, proved by long-term practical experience, and boosts sprinter's muscle coordination capacity while distributing efforts along plantaris muscles (the accent is put on the big toe flexor). The effort regimen of gastrocnemius muscles changes to concentric. It is needed to demonstrate explosive efforts for gastrocnemius and plantaris muscles 2–3 times.

Exercise 9.

I.P. is the same. Passive, slow stretching of the sportsman's left leg posterior tibial muscles is performed by the partner, then rapid tibial muscle contraction is performed upon the partner's command (or the trainer is standing by).

Exercise 10.

I.P. is the same. Perform the tasks of exercise 9 for the right leg.

As a result of the conducted experiment it was revealed that using eccentric strength exercises within the structure of training session of athletes-sprinters allowed maintaining the resistance period of special working capacity during the fatigue generation. As a result of applying a series of stimulation impacts, a steady tendency to improve the time needed to complete the fractions of hurdle distance during the period of compensation of fatigue development (speed growth). This is evident from group statistical characteristics of change of the sportsmen's working capacity when completing the third fraction of distance in the experimental part of the research (table 1).

*Table 1*

**Statistical characteristics of the results of control and experimental coverings of the distance with six hurdles (n = 7)**

| Statistics | Time needed for covering the distance, s | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | I* | II** | I | II | I | II | I | II | I | II | I | II |
| $\bar{x}$ | 2,56 | 2,50 | 3,71 | 3,66 | 4,87 | 4,83 | 5,99 | 5,90 | 7,16 | 7,10 | 8,33 | 8,20 |
| median | 2,60 | 2,50 | 3,70 | 3,60 | 4,80 | 4,70 | 5,90 | 5,90 | 7,10 | 7,10 | 8,30 | 8,20 |
| SD | 0,13 | 0,12 | 0,12 | 0,08 | 0,18 | 0,20 | 0,28 | 0,25 | 0,30 | 0,22 | 0,27 | 0,24 |
| min | 2,40 | 2,40 | 3,60 | 3,60 | 4,70 | 4,70 | 5,70 | 5,70 | 6,90 | 6,90 | 8,00 | 7,90 |
| max | 2,70 | 2,70 | 3,90 | 3,80 | 5,20 | 5,20 | 6,50 | 6,40 | 7,70 | 7,50 | 8,80 | 8,60 |
| 25% | 2,40 | 2,40 | 3,60 | 3,60 | 4,70 | 4,70 | 5,80 | 5,70 | 6,90 | 6,90 | 8,10 | 8,00 |
| 75% | 2,70 | 2,60 | 3,80 | 3,70 | 5,00 | 5,00 | 6,20 | 6,00 | 7,40 | 7,20 | 8,50 | 8,40 |

Notes: * - I control measurements; ** - II experimental measurements

During the third run on the first day of the experiment a steady tendency to decrease the speed of completing the distance was indicated (the initial stage of fatigue development period), an important role was dedicated to personal feelings of the sportsmen, and the tasks to control the motion techniques in the following runs were put. During this period, the stimulation of neurodynamic reactions of organism allows supporting the level of the sportsmen's working capacity, and activation of fatigue compensation mechanisms [16].

The presence of an evocative tendency for improving the sports result is confirmed by personal data indicating the differences (increasing or decreasing) of the time needed to complete the fractions of distance by each sportsman. This data is presented in the table 2.

*Table 2*

**Individual differences in time needed for covering the distance of the third control and experimental fractions of distance with six hurdles**

| Sportsman | Differences in time needed for overcoming the hurdle in control and experimental tests, s | | | | | |
|---|---|---|---|---|---|---|
| | hurdle 1 | hurdle 2 | hurdle 3 | hurdle 4 | hurdle 5 | hurdle 6 |
| 1 | -0,1* | -0,2 | -0,2 | -0,1 | 0 | -0,1 |
| 2 | -0,1 | 0 | 0,1 | -0,2 | 0 | -0,1 |
| 3 | 0 | 0 | 0 | -0,1 | 0 | -0,1 |
| 4 | -0,1 | 0 | 0 | 0 | 0 | -0,1 |
| 5 | -0,1 | 0 | -0,1 | 0 | -0,2 | -0,2 |
| 6 | -0,1 | -0,1 | 0 | -0,2 | -0,3 | -0,1 |
| 7 | 0 | -0,1 | 0 | -0,1 | -0,2 | -0,2 |

Note. * - the minus sign means time decrease (improvement of the result)

It is specified that all sportsmen have improved the time of completing the last fraction of distance: three sportsmen have completed the hurdles 5 and 6 faster whilst the overall improvement of the time needed to cover the distance, and two other sportsmen have completed the hurdles 4, 5, and 6 faster whilst the overall improvement of the time needed to cover the distance. This indicates increase of working capacity under compensation of fatigue. It is known that demonstration of high working capacity under fatigue growth and under its compensation while working is a motive for boosting sportsmen's special functional capacities [11].

There are reasons to suppose that the effects achieved are based on realization of functional reserves of organism, they boost the depth and level of loading impact on organism, and, thereby, is an additional motive to develop highly specialized training effects.

The given data forms the reasons for pilot testing of such kind of actions under competitive activity of the runners of 110 meters hurdles. Boosting the neurogenic mechanisms of stimulating functional provision of special working capacity is one of the tasks of warm-up functional realization. Optimization of the warm-up structure, substitution of low-efficient or inefficient exercises whilst maintaining the general content and focus of warm-up can have numerous mobilization effects, and be the factor of improving the results.

## Conclusions

The new opportunities for stimulation of runners' special working capacity while performing 110 metres hurdling are demonstrated. Specific series of strength exercises are developed to be performed during eccentric regimen of muscular resistance and applied within a training session aimed to boost runners' specialized training to perform 110 metres hurdling.

In response to applying strength exercises performed in eccentric regimen of muscle work, the results of completing six fractions of distance with six hurdles have improved by 2,3 %, 1,3 %, 0,8 %, 1,5 %, 0,8 %, and 1,6 %, respectively. The average individual time of completing the distance with six hurdles improved by 0,1–0,2 sec.

Accordingly, we have given the reasons to continue research in this area; the necessity of further analysis of opportunities to apply strength exercises performed in eccentric regimen of work within pre-start preparation of sportsmen has been established.

## Conflict of interests

The authors claim no conflict of interests.

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