

Summary

Title: Effect of post-activation potentiation of the lower and upper limbs muscles on freestyle swimming performance.

Introduction: During sport competition, often hundredths of a second are decisive for victory or defeat, so a properly conducted warm-up immediately before the performance can have a huge impact on the final success. Increasingly popular among swimming coaches is the use of strength exercises during warm-up, both before training and competition, especially in sprint events. The concept that provides the basis for such an action is the phenomenon of post-activation potentiation (PAP), i.e. a short-term increase in the efficiency of the bone-joint-muscular apparatus after performing high-intensity exercise.

Background: The aim of the study is to assess the impact of post-activation potentiation of the muscles of the upper and lower extremities on the effectiveness of the swimming start and the variability of the swimming technique among national level competitors.

Methods: 16 swimmers (male) from the AZS AWF Katowice sport section participated on the study (age $20,2 \pm 1,28$ years, body weight $83,5 \pm 9,26$ kg, body height $185,8 \pm 6,86$ cm, body fat content $9,9 \pm 3,56$ %), who had at least 2nd Polish sports class (FINA = 732 points). All participants gave their written consent to participate in the study. The research was approved by the University Bioethics Committee for Research at the Jerzy Kukuczka Academy of Physical Education in Katowice. Each time, applying the randomization principle, the swimmers were divided into two groups: experimental and control. The athletes from the experimental group, in addition to the standard warm-up on land and in water, also performed physical exercise aimed at activating selected muscle groups, taking into account: 1) upper limbs (pulling the lift lines on Keiser Functional Trainer while lying facing the front on an oblique bench, 2) lower limbs (squat in the forward position on the Keiser Squat trainer, 3) both upper and lower limbs. The subject performed 3 series of 6 repetition at one minute intervals with a load of 70% 1RM, and then, after an optimal, individual rest break, they performed a 50-meter front crawl test, during with the time and kinematic parameters of the swimming technique and starting jump were recorded.

Results: The conducted studies showed that after the application of stimulation of the upper limb muscles, compared to the control group, the T50 time significantly decreased by 1,08% ($25,67$ s vs. $25,39$ s; $p < 0,001$), the stroke rate SR2 increased by 1,74% ($53,24$ cycles/min. vs. $54,17$ cycles/min.; $p < 0,05$) and T15 time was shortened by 1,26% ($6,74$ s vs. $6,65$ s; $p < 0,05$). After applying the activation exercise for lower limbs a significant decrease in TT time was

found by 0,82% (7,77 s vs. 7,71 s; $p < 0,05$) compared to the group performing the traditional warm-up in water. The results of the study showed that the exercise that stimulated muscles of the lower and upper limbs significantly increased the stroke rate SR1 and SR2 respectively by 1,98% and 3,34% (55,88 cycles/min. vs. 56,99 cycles/min.; $p < 0,05$ and 52,54 cycles/min. vs. 54,29 cycles/min.; $p < 0,001$), shortening the SL1 and SL2 stroke length respectively by 2,1% and 2,75% (1,97 m vs. 1,93 m; $p < 0,05$ and 1,95 m vs. 1,90 m; $p < 0,001$), shortening the TT time by 0,89% (7,83 s vs. 7,76 s; $p < 0,05$) and decrease of BT time by 2,28% (0,82 s vs. 0,80 s; $p < 0,05$).

Conclusion: The results of the research suggest that it is possible to benefit from the use of post-activation potentiation of the upper and lower limbs muscles to improve swimming times in sprint competition. The effect obtained as a result of PAP, however, depends on the specific stimulation of the muscle or muscle group responsible for the performance of given movement act. An activation exercise in the form of split squat may not be an appropriate form of muscle stimulation during swimming start from the starting block without the back plate, but it may shorten the times on the turning zone. The stimulation of the upper extremities used in the research did not significantly increase the swimming velocity but only increased the dynamics of the arm propulsion movements, which indicates the need to look for a more specific muscle stimulation exercise that will fully reflect the muscle activation during the propulsion phase in the front crawl.

Keywords: post-activation potentiation, PAP, swimming, swimming start, front crawl