

## Summary

**Title:** The effects of a 6-week core exercises on swimming performance of national level swimmers

Strength and muscular power are significant determinants of success in swimming sport. The appropriate level of muscle strength and power leads to the maximization of the ability to generate by swimmers the driving force in the water, and thus to the improvement of swimming efficiency. Therefore an essential part of swimmers training is specialized training on land. One of the elements that should be included in dry-land training are stabilization exercises. Strong core muscles are responsible for maintaining a streamlined body position and balance in the water which minimize resistance, an appropriate high and stable body position allows to optimize the power generating by upper and lower limbs. Core muscles are also involved in the swimming start and the swimmer's turns.

Some publications show that exercises strengthening the core muscles have a positive effect on the performance of athletes but some scientists have found no correlation between training performed on land and swimming efficiency. There is little research on the influence of stabilization training on swimming efficiency. In addition, publicly available researches have many gaps and the conclusions are ambiguous. Swimming race consists of three main elements: the start, turns and swimming at distance. Race components are characterized by a difficult technique and are significantly different from each other. Thus, the effect of additional training may have a different effect on the individual elements of a race.

The aim of this study was to assess the impact of a 6-week core exercises on swimming performance of national level swimmers. In addition to the sport result, the study also included the individual elements of the swimming race (swimming start, turns and technical of swimming).

Fourteen male national level swimmers participated in the research. The competitors were randomly assigned to 1 of 2 groups before the data collection process: an experimental (EG,  $n = 7$ ) and a control (CG,  $n = 7$ ) group. Both groups of swimmers took part in the same swimming training program (volume and intensity), while swimmers from the EG additionally performed strengthening of the stabilizing muscles training which took place 3 times a week for 6 weeks. The task of the swimmers was an individual front crawl swim of 50 m and 200 m, during which the kinematic parameters of the start jump, turn and swimming

techniques were recorded using a video camera system. All video files were analyzed via the Kinovea software (v. 0.8.26, Kinovea, Paris, France), which allowed time-motion analysis of the registered elements.

In the EG was noted a statistically significant improvement in Time in the air with take-off on both distance (50 m:  $\Delta = -0,09$  (-8,45%),  $p = 0,002$ ; 200 m:  $\Delta = -0,07$  (-6,35%),  $p = 0,006$ ). In the CG change was not significant (50 m:  $\Delta = 0$  (-0,39%);  $p = 0,732$ ; 200 m:  $\Delta = 0$  (-0,39%),  $p = 0,732$ ). Statistically significant improvement in Reaction time was observed in the EG (50 m:  $\Delta = -0,08$  (-10,07%),  $p = 0,003$ ; 200 m:  $\Delta = -0,05$  (-6,9%),  $p = 0,004$ ) while in the CG was not registered change (50 m:  $\Delta = 0$  (0,26%);  $p = 0,873$ ; 200 m:  $\Delta = 0$  (0,26%),  $p = 0,873$ ). In the EG was noted significant increase in velocity 5 m after the turn (50 m:  $\Delta = 3,22$  (27,4%),  $p = 0,001$ ). For the distance of 200 m, a statistically significant increase in speed was noted in 3 turns (1:  $\Delta = 1,083$  (9%),  $p=0,008$ ; 3:  $\Delta = 1,462$  (12,9%),  $p<0,001$ ; 4:  $\Delta = 1,294$  (11,5%),  $p=0,002$ ). In the CG was not found significant change of speed after turn. In both the Experimental and Control groups, at the distance of 50 and 200 m, no significant changes were found in stroke rate, stroke length, and stroke index. At the distance of 200 m, there was a statistically significant increase in swimming speed in the last two segments of the race (7: 0,06 (4,9%),  $p<0,001$ ; 8: 0,063 (5,1%),  $p<0,001$ ). The observed changes led to an improvement in the swimming performance for a distance of 50 m (EG: -0,28 (-1,1%),  $p=0,004$ ; CG: -0,14 (-0,5%),  $p=0,426$ ) and 200 m (GE: -1,02 (-0,8%),  $p=0,027$ ; CG: -0,02 (-0,0%),  $p=0,967$ ).

The results of the research show that the implementation of core stability training seems to be a valuable addition to the standard training of swimmers.