

Original Article

The impact of sprinting means on the improvement of aerobic work capacity in 12-14 year-old swimmers

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Abstract

This research started from the premise that the ultra-short race-pace training (USRPT) improves performance and positively influences the superior aerobic work capacity.

The need to know the superior aerobic work capacity of the 12-14 year-old swimmers gives the coach a better understanding of the specific training on the work areas for this research.

This research studied 30 athletes divided in two groups of 15 swimmers each, from the clubs CSM Bacău and Sport Club Bacău.

The tests have revealed a significantly higher progress for the experimental group (USRPT), of 01:25 minutes, compared to the control group (interval training), where the progress was of 00:26 minutes. The relative progress is higher in the experimental group (7.49%) than the control one (2.17%), which leads to the conclusion that the ultra-short race-pace training (USRPT) is more effective in increasing the superior aerobic work capacity in junior swimmers. After analyzing the correlation between the work's internal and external parameters needed to reach VO₂max, it can be concluded that the athletes have performed correctly, specific to the superior aerobiosis area in both training methods.

Keywords: ultra-short race-pace training, sprinting means, aerobic work capacity

Introduction

Repeat sprint training consist of short series of maximum power sprints of 3-7 seconds, with short breaks, of under 60 seconds. Studies have determined that repeat training with longer breaks are a more effective strategy to improve the maximal power compared to the training with short breaks.

Kenny, W.L., Wilmore, J.H., Costill, D.L. (2015) have analyzed the effect of interval training on various types of people (from the point of view of the training level). In people with a sedentary lifestyle, the training affects both the cardiovascular system and the ability of the muscles to oxidize enzymes. In contrast, in the case of trained people, an increase in the exercise intensity close to VO₂max is necessary to get the improvement of the VO₂max and the performances. Interval training is a method of sports training composed of multiple cycles that contain a high pace work interval and a passive or active recovery interval. The exercise interval is performed near the maximal aerobic power, between 30 seconds and 3 minutes. The method allows the athletes to train more intensely over a longer period of time, contrary to a continuous series at a constant speed, and to improve their cardiovascular endurance in regard to the lactic aerobic and anaerobic work (Cregg et al., 2013).

The ultra-short race-pace training (USRPT) is an integrated system of scientific athletic events. A complete explanation of its characteristics was provided by Rushall (2014a,b). Some coaches have experimented with this method of alternating short term work with short term rest multiple times in a row (e.g. Martinez et al., 2013). Nevertheless, the traditional, dogmatic training model was taught by most swimming coaches.

Because the most important determining factor for success is the technique, and the techniques are specific to swimming speed, it is important to be as many training sessions as possible at a speed that is the most appropriate for each race. The race speed is very high and is close or over HR_{max} and/or VO₂max, because speed is the race pace. The way to accomplish the highest amount of work in a training session is to perform short action, short break repetitions, so that the lactate deposits would not increase, and the glycogen ones would not decrease. Thus, the short action, short break training is the path to experiment the highest possible relevant training volume (Rushall, 2013).

Unfortunately, this message seems to be lost to many people involved in swimming. The USRPT benefits compared to the traditional training are extensive and impressive. Also, the USRPT gives the option to practice activities (e.g. the race strategy content) that rarely are possible in traditional training. If the ultra-short race-pace training has critics, that is because of its format, the critics showing a lack of knowledge,

understanding and interpretation of the literature that the USRPT is based on and on which the traditional training methods should be based.

McGinnis (2015) describes the USRPT as follows: USRPT is a technical-orientated system that uses a certain training format to maximize the opportunities to learn the relevant racing techniques. Its second priority is to make good teachers out of coaches so that they could help the swimmers change their relevant techniques. Thirdly, psychology determines the result of races. Lastly, conditioning is limited to the inherited abilities and can be accomplished the fastest and most effectively through the ultra-short race-pace training.

The very young swimmers do not have to participate in tough traditional training programs that are very demanding, nor do they need to exaggerate with the USRPT. Two growth periods must be implemented. The first is the skill development stage, applicable to both boys and girls, aged between 7 and 10. The start, end, and duration of the stage varies considerably in this age group, but most children come out of this stage before the age of 10. As a consequence, accentuating strongly the technical skills of the children and instructing them using the USRPT is a good investment in their development. Also, one can observe them start to love swimming, a love that can last a lifetime.

The second growth period includes and goes beyond the start of puberty. There is a suppression of the work capacity factors (e.g. VO₂max) during the growth over a short period of time and during the gender changes associated with puberty (Astrand, 1978; Rushall, 2010). There is also considerable variation among the individuals during the time of the suppression. The coach and parents need to support the swimmers at this stage more than they need to demand them to maintain the performance improvement rate that they had up to this point.

Relatively new information support this research, such as that the phosphagen system must be stimulated regardless of the swimming distance, and that the stimulation of the enzyme system involved in the neuro-cerebral, neuromuscular and neuro-mental coordination improves the performance both in an endurance and in a sprint event by improving the motor skills (Ehrsson, 2001).

Material and Methods

This research started from the premise that the ultra-short race-pace training (USRPT) improves performance and positively influences the superior aerobic work capacity.

The research objectives were:

- to improve the swimming speed endurance on work areas;
- to determine the metabolic cost after a ultra-short race-pace training session.
- to present the advantages of the ultra-short race-pace training.

Research Hypothesis. For a comparison between the classic interval training method and the USRPT method in junior swimmers, the following hypothesis was elaborated: the ultra-short race-pace training (USRPT) is effective in increasing the superior aerobic work capacity in junior swimmers.

The subjects of the research. The research studied 30 athletes divided in two groups of 15 swimmers each, from the clubs CSM Bacău and Sport Club Bacău.

The first group, which used the interval training, was considered the control group, while the second group, which used the USRPT, was considered the experimental group.

The training programs were applied for 12 weeks, between August 31 and November 13, 2018. The evaluation of the groups took place on November 14 and 15, 2018, at the Bacau Olympic Pool.

The research methods were:

- the study of the professional literature;
- the directed observation method;
- anthropometric measurements;
- the measurement of the lactic acid blood concentration;
- the measurement of the physiological parameters: heart rate;
- biomechanical measurements: stroke rate;
- the graphical representation method;
- the statistical-mathematical method.

Both groups had 12 weeks of training, 6 sessions per week, from Monday to Saturday (August 31 - November 13, 2018).

The control group (classic interval training) had 3 days per week (Monday, Wednesday, Friday). The experimental group's water training sessions took 1h30 each day, from 8:00 to 9:30, 6 times per week, from Monday to Friday. The training sessions had a total volume of 1500-2500 meters per day, meaning about 12 km per week.

What follows is an example of an ultra-short race-pace training session:

Warm-up:

- 400m freestyle, 60% intensity;
- 200m medley, 60% intensity;
- 8 *(12.5m sprint + 12.5m break);

Work

- 30*15m freestyle start at 20 seconds, 100% intensity (race pace);
- 16*50m backstroke sliding, start at one minute at 60% intensity;
- 16*50m butterfly, start at one minute, 100% intensity (race pace);

Cool-down:

- 20 minutes free play.

Results

Table 1. Comparison between the time averages recorded by the control group during the initial and final tests

Test	Average	Diff. between Averages	Median	Minimum	Maximum	Variab. coeff.	Wilcoxon Test		Effect increase
							Z	P	
Initial	19:57	0:26	19:34	16:20	25:32	11%	—	0.01	0.46
Final	20:23		20:12	17:01	25:35	10.7 %	2.500	2	

As one can see in table 1, the average time recorded after the training period has increased in the final test by 0:26 minutes, which represents a progress from 19:57 minutes during the initial test to 20:23 minutes during the final test. The increase is statistically significant, according to the Wilcoxon test, for a significance threshold of $p = 0.012 < 0.05$ and $z = -2.500$. The effect increase index (0.46) shows a medium to high difference between the two tests.

It was noticed also a drop in the average resting heart rate, during the final test, by 3.40 b/min, which is a progress of 3.3%, the average heart rate varying from 103b/min during the initial test, to 99.60 b/min during the final test. The drop is statistically significant, according to the Wilcoxon test, for a significance threshold of $p = 0.036 < 0.05$ and $z = -2.098$. The effect increase index (0.38) shows a medium to high difference between the two tests.

The average values of the maximum heart rate varies from 199.67b/min during the initial test to 198.73b/min during the final test. The maximum heart rate has dropped in average after the training by 0.93b/min, representing a progress of 0.5%. The drop is statistically insignificant, according to the Wilcoxon test, for a significance threshold of $p = 0.475 < 0.05$ and $z = -0.714$. The effect increase index (0.13) shows a small difference between the two tests.

The basal lactic acid has increased by 0.73mMol/l in average, representing a progress of 21.8%, from 3.36mMol/l initially to 4.09 mMol/l finally. The increase is statistically insignificant, according to the Wilcoxon test, for a significance threshold of $p = 0.345 < 0.05$ and $z = -0.943$. Although the differences are insignificant, the effect increase index (0.17) shows a small to medium difference between the two tests.

The average value of the lactic acid has decreased by 0.35 mMol/l, representing a progress of 3.5%, the averages being 9.91mMol/l initially and 9.57 mMol/l in the final test. The drop is statistically insignificant, according to the Wilcoxon test, for a significance threshold of $p = 0.496 < 0.05$ and $z = -0.682$. The differences are insignificant, the effect increase index (0.12) shows a small difference between the two tests.

For the stroke index, the average value has decreased by 0.34, or 0.8%, the averages being 40.46 during the initial test and 40.12 during the final test. The drop is statistically insignificant, according to the Wilcoxon test, for a significance threshold of $p = 0.156 < 0.05$ and $z = -1.420$. Although the differences are insignificant, the effect increase index (0.26) shows a small to medium difference between the two tests.

Figure 1 presents the average time values recorded by the control group during the two tests.

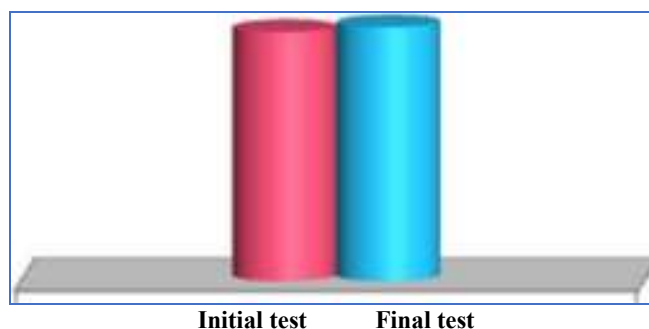


Figure. 1. The average time recorded by the control group during the two tests

Table 2. Comparison between the time averages recorded by the experimental group during the initial and final tests

Test	Average	Diff. between averages	Median	Minimum	Maximum	Variab. coeff.	Wilcoxon Test Z	P	Effect increase
Initial	18:55	1:25	19.34	10.56	26.53	18.7 %	2.726	0.006	0.50
Final	20:20		20.02	15.56	25.36	12.8 %			

As one can see in table 2, the average time has increased in the final test by 1:25 minutes (7.3%), from 18:55 minutes during the initial test to 20:20 minutes during the final test. The increase is statistically significant, according to the Wilcoxon test, for $p = 0.006 < 0.05$ and $z = -2.726$. The effect increase index (0.50) shows a medium to high difference between the two tests.

The average value of the resting heart rate has decreased by -2.20 b/min, representing 2.2%, from 102.20b/min initially to 100.00b/min during the final test. The drop is statistically insignificant, according to the Wilcoxon test, for $p = 0.219 < 0.05$ and $z = -1.231$. Although the differences are insignificant, the effect increase index (0.22) shows a small to medium difference between the two tests.

Regarding the maximum heart rate, the average value has dropped by 3.47 b/min. This represents a drop of 1.7%, from 200.13b/min during the initial test to 196.67b/min during the final test. The drop is statistically significant, according to the Wilcoxon test, for $p = 0.002 < 0.05$ and $z = -3.072$. The effect increase index (0.56) shows a high to very high difference between the two tests.

The average value of the basal lactic acid has dropped by -0.30mMol/l. This represents a drop of 8.6%, from 3.43b/min during the initial test to 3.13b/min during the final test. The drop is statistically insignificant, according to the Wilcoxon test, for $p = 0.826 < 0.05$ and $z = -0.220$. The differences are insignificant. The effect increase index (0.04) shows a very small difference between the two tests.

The average value of the lactic acid has increased by 0.30mMol/l. This represents an increase of 3.0%, from 9.86b/min during the initial test to 10.15b/min during the final test. The increase is statistically insignificant, according to the Wilcoxon test, for $p = 0.496 < 0.05$ and $z = -0.682$. Although the differences are insignificant, the effect increase index (0.12) shows a small to medium difference between the two tests.

The average value of the stroke index has increased by 0.59, representing 1.5%, from 39.99 initially to 40.58 during the final test. The increase is statistically insignificant, according to the Wilcoxon test, for $p = 0.078 < 0.05$ and $z = -1.761$. Although the differences are insignificant, the effect increase index (0.32) shows a medium difference between the two tests.

The figure below (Fig. 2) presents the average time recorded by the experimental group during the two tests.

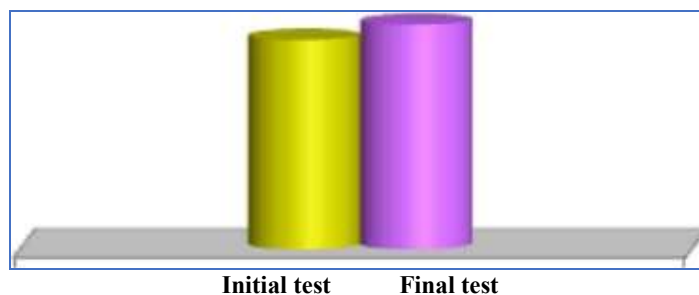


Figure 2. The average time recorded by the experimental group during the two tests

Discussions

What follows is a short analysis of the progress of each group, before and after the training.

The resting heart rate recorded by the first group during the initial test was of 103b/min., and during the final test, of 99.60b/min. One can observe a drop in the heart rate by 3.40b/min., which represents a relative progress of 3.3%. The resting heart rate recorded by the second group during the initial test was of 102.20b/min., and during the final test, of 100b/min. One can observe a drop in the heart rate by 2.20b/min., which represents a relative progress of 2.15%. The maximum heart rate recorded by the first group during the initial test was of 199.67b/min., and during the final test, of 198.73b/min. One can observe a drop in the heart rate by 0.93b/min.,

which represents a relative progress of 0.5%. The maximum heart rate recorded by the second group during the initial test was of 200.13b/min., and during the final test, of 196.67b/min. One can observe a drop in the heart rate by 3.47b/min., which represents a relative progress of 1.70%. The lactacidemia in the first group during the initial test was of 9.91mMol/l, and during the final test, of 9.57mMol/l. One can observe an increase of the lactacidemia by 0.35mMol/l, which represents a 3.5% modification. The lactacidemia in the second group during the initial test was of 9.86mMol/l, and during the final test, of 10.15mMol/l. One can observe an increase of the lactacidemia by 0.30mMol/l, which represents a 3% modification. The stroke index recorded by the control group during the initial test was of 40.46 strokes/min., and during the final test, of 40.12 strokes/min. One can observe a decrease of the stroke index by 0.34 strokes/min., which represents a 0.80% modification. The stroke index recorded by the experimental group during the initial test was of 39.99 strokes/min., and during the final test, of 40.58 strokes/min. One can observe an increase of the stroke index by 0.59 strokes/min., which represents a 1.50% modification.

Conclusions

The work in children athletes respects the same training principles as in the case of adults. Out of the external parameters of effort, the training-break ratio is modified in the children's favor. The biomechanical measurements in the specific work as well as in various levels of intensity allow comparisons between the training methods. The lactacidemia recorded values of 9.57mMol/l in the control group and 10.15mMol/l in the experimental group. Even if the difference is not statistically significant, according to the Mann-Whitney test, these values are high in relation to the subjects' age. The drop of the maximum heart rate in one of the athletes during the endurance training can be due to the adaptation of the cardiac output through the increase of the end-systolic volume. Very important is the education of the sense of pace, without which the athletes cannot achieve the intensity variations demanded by the work areas. The tests have revealed a significantly higher progress for the experimental group (USRPT), of 01:25 minutes, compared to the control group (interval training), where the progress was of 00:26 minutes. The relative progress is higher in the experimental group (7.49%) than the control one (2.17%), which leads to the conclusion that the ultra-short race-pace training (USRPT) is more effective in increasing the superior aerobic work capacity in junior swimmers, thus confirming the initial hypothesis.

In an ultra-short race-pace training session, swimmers are responsible with the timing of every repetition, with the analysis of their progress, with the development of strategies to complete more repetitions than before over the same distance, with the need to be disciplined. All these elements appear in a race and are vital for top performances. As a consequence, the ultra-short race-pace training programs develop the athletes' management skills and abilities to cope with the stress of a competition. This changes the role of the coach, from being a traffic and time manager to a stroke teacher. The ultra-short race-pace training (USRPT) should be focused on the swimming strokes on various speeds and races, and should condition those speeds. When swimmers take responsibility for following the rules, the coach can complement this by being a good stroke teacher.

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