Change of critical speed in swimmers aged 10–11 years old

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Abstract
The purpose of this research was to study the effect of aerobic and anaerobic training in critical swimming speed during the second training cycle after five months of training in swimmers aged 10 to 11 years. The method of critical speed is used as an alternative method because it is simple, inexpensive and non-intrusive. Many distance combinations are used to determine critical speed of swimming. The research involved 16 active pre-pubertal swimmers. Seven of them (n = 7) were boys, age: 10.9 ± 0.9 years, and 9 of them (n = 9) were girls, age: 11.0 ± 0.7 years. Their basic technique was freestyle swimming and all of them were swimmers of short and middle distance. The mathematical model calculates the value of critical speed distances, 50m, 100m, 200m and 400m. Subjects underwent a series of tests carried out on three different periods. The results showed that there is no statistical significant difference between the two genders and the three different measurements (Sig .651 and Sig .259 respectively). In individual level, boys and girls had a statistical significant improvement in critical speed over the different measurements (Sig .000 and Sig .000 respectively). From the findings of this research it appears that critical speed obtained with mathematical determination, can be used as an alternative to determine the appropriate speed for endurance training in children and young swimmers. The results of the research can lead to the following conclusion: The critical speed varies from period to period studying individually boys and girls.

Introduction
Critical speed has occupied researchers in order to find its true meaning and the perfect way to introduce in the coaching process (Toubekis & Tokmakidis 2013). A big part of training in swimming is executed with different energetic systems maximum speed, which aims to improve endurance in swimming. It is important for the coach to know the speed limits that should used to improve the particular endurance of swimmers without possible causing unwanted burden during a training cycle. Critical speed is a valuable tool for each trainer, easy and cheap as procedure and can help to develop a detailed of different intensities used in training program. Furthermore, critical speed must change with change with training.
Various methods for measuring aerobic and anaerobic capacity of swimmers have been applied (Bonen et al. 1980) as well as for determining appropriate loads (Costill et al. 1985). In swimming distances of 15 to 100m (Thanopoulos et al. 2008), 50 to 400 meters (Wakayoshi et al. 1992) are usually used and in some cases of elite swimmers testing procedures distances from 50 to 1500 meters (Fernandes & Villas-Boas 1999; Dekerle et al. 1999). Many combinations are used to determine the critical speed of swimmers (Martin & Whyte 2000). The duration of used distance must differ at least 5 minutes while for the calculation 2 to 4 attempts are required (Hill 1993; Bosquet et al. 2002). Choosing one of these, coaches can check the changes in the ability of their swimmers as a result of the adjustments of their body adaptation in the process of training (Smith et al. 2002).

A research of Wakayoshi et al. (1992; 1992a) was to create a simple test which could assess the endurance capacity of swimmers. This method includes swimming at maximum intensity, with the determination of the linear regression equation between different distance and the time required to cover it. The calculation of critical velocity become the subject of many investigations (Dekerle et al. 1999; Dekerle et al. 2002) both for its low cost and secondly because it is a reliable indicator of aerobic capacity.

Investigations in swimming have shown that the activation of energy systems in efforts of maximum intensity differs from children compared to adult swimmers (Takahashi, Bone, Spry, Trappe & Troup 1992) because children exhibit different oxygen consumption (Fawkner & Armstrong 2003). In swimming athletes start maximum intensity trainings from quite an early age (Denadai et al. 2000). Also, children and young swimmers have not stable characteristics of their technique compared to adult swimmers. It is therefore necessary to study the critical speed in children under this restriction.

The aim of this research was to study the effect of aerobic and anaerobic training in critical speed during the second training cycle after five months of training in swimmers aged 10 to 11 years old.

Methods

Sample

The research involved 16 active pre-pubertal swimmers. Seven of them (n = 7) were male: age—10.9 ± 0.9 years; body height—151 ± 7 cm and weight—36.40 ± 7.4 kg and nine (n = 9) were girls, age—11.0 ± 0.7 years, with body height—152 ± 7 cm and weight—42.0 ± 9.0 kg. Their basic technique was freestyle swimming and all of them were swimmers of short and middle distance. All of them had competitive experience for at least two years. The study was approved by the ethical committee of the University.

Procedures

All swimmers participated in two hours daily training at least five days a week. Training involved during the first period 90% aerobic and 10% anaerobic training and they were completing 3 km. During the second period, the training was 3.5 km with 80% aerobic and 20% anaerobic and third period they were swimming 2.5 km with 75% aerobic and 25% anaerobic training. In anaerobic training the pace was similar to competition with 50m sprints and split distances before competition.

Swimmers were informed about the purpose of the research and the measurement procedures and they gave with their parents their written consent. Afterwards we proceeded with the conduction of measurements. All participants executed a warm up of 800 meters with the guidance of their coach.

From all athletes we measured body height and body weight in the afternoon between 17:00 to 19:00 before training in the gym. Considering that critical speed is calculated reliably from distances that can be completed over a period of 2-10 minutes, distances were adjusted so as to cover this range of time. The measurements were completed randomly in 4 different sessions. Swimmers were instructed to swim with maximum intensity freestyle swimming.
Critical velocity was calculated from performance time in the distances of 50m, 100m, 200m and 400m swimming (Wakayoshi et al. 1993) executed with maximum intensity and time required to cover each swimming distance (Figure 1). In order to complete the procedures, swimmers swam the above distances in three different periods. The first measurement was performed on the second phase of basic preparation period of the summer cycle, the second measurement on preparation season and the third on pre-competition period. The third measurement was performed 10 to 15 days before the main competition. Each measurement was carried out in three sessions. The athletes swam with the maximum speed the distances of 50m and 100m on the first session. On the second session they swam 200m and on the last session 400m. Each distance was measured starting from the water, taking into account swimming regulations and always with the same conditions. All measurements were performed in an open swimming pool of 50 meters with a water temperature of 26°C ± 1°C. Their aim was to improve aerobic capacity and achieving the best performance during the national championships in July. The performance of each distance was recorded with electronic watch Seiko Water Resistant 10Bar S140.

**Method of mathematical determination of critical speed**

The mathematical model calculates the value of critical speed of the distances 50m, 100m, 200m and 400m. The calculation of critical speed (V critique) includes the following: the time required for the swimmer to swim the distances (50m, 100m, 200m, 400m) on a linear function of the link distance-time (Figure 1) (MacLaren & Coulson 1999; Martin & Whyte 2000; Dopsaj et al. 2000; Thanopoulos et al. 2008). The constant \( a \) is the value of \( y \) for \( x = 0 \) and is called the equation stable, while the constant \( b \) determines the slope of the line and is called regression coefficient.

![Linear relationship of swimming distance versus time](image)

Note: The slope of the line expresses the critical swimming velocity (example of one swimmer).

**Statistics**

The results were first submitted to a descriptive analysis to calculate basic statistical parameters (means, standard deviations). Also for the identification of the difference between genders we used the two way analysis of variance ANOVA. For the individual study of girls and boys we used one way analysis ANOVA for repeated measurements.

**Table 1** The CV calculated from four swimming distances in male and female swimmers

<table>
<thead>
<tr>
<th></th>
<th>CV (50,100,200,400)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>January</td>
</tr>
<tr>
<td></td>
<td>MIN</td>
</tr>
<tr>
<td>Boys</td>
<td>0,9067</td>
</tr>
<tr>
<td>Girls</td>
<td>0,9290</td>
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</table>
Table 2. Anova Results

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>CV</th>
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</thead>
<tbody>
<tr>
<td>Two way Anova</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>.207</td>
<td>.651</td>
</tr>
<tr>
<td>Phases (monthly measurements)</td>
<td>1.395</td>
<td>.259</td>
</tr>
<tr>
<td>One way Anovas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>25.817</td>
<td>.000*</td>
</tr>
<tr>
<td>Girls</td>
<td>43.647</td>
<td>.000*</td>
</tr>
</tbody>
</table>

*Statistical significance between different measurements for separately boys and girls p>0.05

Results

We measured 16 swimmers in the distances of 50, 100, 200 and 400 meters. The averages and standard deviations of the critical speed for boys and girls in each different measurement are presented in Table 1.

The analysis of variance showed that there were no statistically significant differences between the three measurements on the critical speed for the whole sample (Sig. .259).

Also, there were no statistically significant differences in the critical speed between the two genders (Sig. .651).

Studying the sample to an individual level, significant difference was found between the measurements of critical speed of girls (Sig .000) and boys (Sig .000), which showed that the critical speed improved from the first to the last measurement.

Conclusion

This investigation examined the effect of training after five months on critical speed of swimmers aged 10-11 years.

The aerobic and anaerobic swimming training positively affected the performance of these swimmers. The performance improvement in the distances of 50m, 100m, 200m, and 400m. was able to alter the value of their critical speed. The results of this research support the view that in early stages of training periods, a slight and steady increase in the value of critical speed is observed while there is also important improvement in later stages of training (Peak Performance Subscribe 2005).

In conclusion, five months of training for swimmers aged 10-11 years, had a positive effect on the critical speed as tested in this sample of boys and girls separately.

The critical speed could be studied in a larger sample of swimmers. It is proposed to carry out investigations with larger sample of swimmers to draw clearer conclusions on these results. Also, further studies are worth examining combinations of distances to calculate the critical speed and other age groups of swimmers regardless of their level of performance.

From the findings of this research it appears that the critical speed can be used as an alternative tool for the determination of the appropriate speed for endurance training in children but does not differ in relation to gender.

References


