Prescribing Aerobic pace training to the National Swim Team of Faroe Islands.

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Abstract— Swimming is a popular competitive sport, high influenced by the endurance. The aim of the present research was to determine values as critical swimming velocity (VCrit) and the correlation among to the rate of perceived exertion (RPE) and Heart rate at anaerobic threshold (HRAnT); in elite national swimmers of Faroe Islands. There were 17 (11 female, 6 male) volunteer participants (age 17.25 ± 1.01 years; height 169 ± 10.20cm; body mass 61.33 ± 9.90kg). The results of the correlation analysis showed significant correlations between VCrit and HRAnT ($r = 0.79$, $p<0.01$); between VCrit and RPE ($r = 0.73$, $p < 0.01$); In addition, the HRAnT was correlated to HRmax ($r = 0.52$, $p < 0.05$). We conclude: estimation of VCrit its and easy, reliable and simple way to prescribe the onset of anaerobic training.

Index Terms.— Swimming-velocity, periodization, endurance, aerobic-conditioning, fatigue, work, stres.

1 Introduction

In the competitive sports, most of coaches and athletes, from beginners to elite level of competition, frequently organize their training program in a periodical plan to maximize performance through the correct balance of stress/recovery relationships. [1]

The Sport training programs are designed to maximize competitive performance. A usual program of traditional periodization starts on a basic period by high volume of aerobic training and gradually altering the preparation by reducing the total amount of volume at time to increasing the intensity of the exercise into a period called competitive. [1-2]

Although the most effective periodization is yet to be determined; multiple studies show how determinant is the influence of aerobic training on competitive performance for all range of distance and official events. [2]

At the international highest level of competition; swimming races being decided by only fractions of a second and every little detail of preparation and training, would represent the desired success.

In an official tournament, swimmers often compete in a preliminary, before being selected to take position at the final event; in some cases more than two events per day. This might demand swimmers to swim multiple events within short periods of recovery.

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Endurance training and aerobic threshold is a constant concern of coaches and swimmers. It has been suggested that excessive lactate accumulation is associated with sport performance fall and can be explained by increasing H+ because lactic acid accumulation, act as force depressing factor. [3-4]

Attempting to improve the understanding of human work capacity; Monod, and Scherrer, (1965) [5] introduced the concept of Critical power, understood as the slope between work and fatigue.

In swimming the concept of critical power it´s well referred as swimming critical velocity (VCrit). A variety of terms were used to refer the VCrit, including concepts as: anaerobic threshold (AnThT), lactate threshold (LT), Onset of Blood Lactate Accumulation (OBLA), maximal lactate steady state (MLSS), and ventilatory threshold (VT). [3-4-5]

The understanding of those concepts have in common the intention to delay the fatigue and there effects. Different protocols and tests have being designed to study VCrit, in accordance to the slope of linear d-t. [4-5]

The influence of the energetic cost in swimming suggested the uninterrupted swimming of 30 minutes, test well refereed in swimming as T30, with the intention to simplifies the test determination of Vcrit and therefore recommended to include in the model tests distances that enable VO2max to be reached (average 7 minutes). Competitive distances ranging from 200 to 1500m can be advised in swimming to determine VCrit. [3-4-5]

Attending this suggestion; and with the intention to make the determination of VCrit easy and rapid for coaches, the suggestion of Wakayoshi et al. [6] and Dekerle et al. [7] to base this determination on only two performances 200 and 400m; however the same authors suggest to include estimations as 50, 100, 200 and 300 in depends of the level, characteristics, experience and specialization of the swimmer. Although the most effective

way, to estimate VCrit is yet to be determined; even less, how to estimate the aerobic training zones trough noninvasive easy field evaluations for to designate optimal training to enhance endurance.

The primary purpose of this research was to determine critical swimming velocity (VCrit) to a group of a representative national swimming team of Faroe Islands during the competitive period and previously to the main seasonal international competition. The secondary purpose was to study the correlations among the VCrit with to the rate of perceived exertion (RPE) and Heart rate at anaerobic threshold (HRAnT), the complementary purpose was to defining conceptualizations related to lactate behavior and endurance training.

MATERIALS AND METHOD:

Participants

The participants were recruited by national competitive program with at least 8 years of experience training for a competition; In this study, there were 17 volunteer (11 female, 6 male) participants (17.25 ± 1.01 years; height 169 ± 10.20cm; body mass 61.33 ± 9.90kg), subjects did not report any characteristics that would impede their participation in swimming training. Each participant and his parents were informed about the purpose of the study before start the investigation and signed an informed consent document approved by Faroese Swimming Association (SSF) ethics research committee. All procedures were in accordance with the Declaration of Helsinki.

Testing protocols

All participants of the study; performed a familiarization with the various test and assessment tools, 2 days before the first test and beginning of the research.

Procedure

We analyzed the following parameter before and immediately after the diagnosis test:

Rating of perceived exertion (RPE), scale 6–20 [8]

Heart rate at anaerobic threshold (HRAnT), record of the heart rate marker was taken in a tactile way by researcher assistants. For comparison to Heart rate max (HRmax) [9]

HRmax was assumed as: 205.8 – (0.685 x age) [9]

VCrit diagnosis test

Before the tests all swimmers performed a warmup that consisted of 900m swim followed by rest period of 5 to 7 minutes before the test.

The VCrit test consisted in a:

a) Maximal 100m front crawl (t1), performed in an official indoor 50m swimming pool, starting inside the pool.

b) Active recovery consistent in 1000m low intensity freely swimming on a maximum time of 20 minutes.

c) Maximal 300m front crawl (t2), starting inside the pool. Data times were recorded with a manual stopwatch (Geounaute Trt´l 900, China).

VCrit was assumed as: t2 - t1 / 2 = Velocity per 100m. [6-7]

Statistical Analysis

Data were analyzed using SPSS 24.0 (SPSS Inc., Chicago, IL). The probability level of statistical significance was set at $p \leq 0.05$ and descriptive statistics were expressed as means ± SE. Intra-class Correlation Coefficient (ICC) estimates and their 95% confident intervals were calculated based on a single rating (k = 1), absolute-agreement, 2-way mixed-eff ects model.[10] Based on the 95% confident interval of the ICC estimate, values less than 0.5, between 0.5 and 0.75, between 0.75 and 0.9, and greater than 0.90 are indicative of poor, moderate, good, and excellent reliability, respectively.[11] A will Hopkins Typical Error of Measurement, with Pearson's correlation were implemented to determine the agreement between measurements.[12] To assess the size and direction of the linear relationship between VCrit, HRAnT, and RPE, a bivariate Pearson's product-moment correlation coefficient (r) was calculated.

Results

The results of the correlation analysis (Table 1) showed significant correlations between VCrit and HRAnT ($r = 0.79$, $p<0.01$). There was also a significant correlation between VCrit and RPE ($r = 0.73$, $p < 0.01$). In addition, the HRAnT was correlated to HRmax ($r = 0.52$, $p < 0.05$).

Table 1. Summary of assessments.

Parameter	Mean ± SD	*r*
Age (years)	16.75 ± 1.13	
VCrit (s)	75.24 ± 4.43	
HRAnT (bpm)	150.00 ± 14.13	0.79 with VCrit †
RPE (a.u.)	15.14 ± 1.42	0.73 with VCrit †
HRmax (bpm)	193.88 ± 0.72	0.52 with HRAnT *

Data are expressed as mean and standard deviation. VCrit=critical swimming velocity; HRAnT=Heart rate at anaerobic threshold; RPE=Rating of perceived exertion; a.u.=arbitrary units; HRmax=Heart rate max; *P<0.05, † P<0.01 significance level.

Discussion

The primary purpose of this research was to determine critical swimming velocity (VCrit) to a group of a representative national swimming team of Faroe Islands at the competitive period and previously to the main seasonal international competition.

The concept of VCrit has an origin in studies of Monod and Scherrer [5] more than five decades ago. These authors express that, the threshold of local fatigue is the slope relationship located on the cross line between local work and the time to

exhaustion.

However in the competitive swimming most of the events least less than three minutes; Sharp,[13] considers that two reasons support the inclusion of aerobic training in swimming: one is that it´s contributes to improve the recovery and the second is, endurance training improves the lactate tolerance and clearance.

Attending this recommends; several distances between 50 to 2000 meters, was tested to estimate VCrit. More recently Dekerle, et al. (2002) [7] did valid the two distances of 200 and 400meters as reliable and coinciding with previous studies. [6]. The results of the present study suggest that the mathematical estimation to easy designates VCrit thought the distances of 100 and 300 meters front crawling; are valid and reliable too.

Furthermore, an important finding it's about that coincidently; the final estimation of VCrit was found at the 83.8% of the comparison to the first Maximal 100m front crawl (t1), performed with starting inside the pool. Moreover, the final estimation to the HRAnT corresponds to the 77.7% of the HRmax.

Thus, the results of these two findings suggest that: at the competitive period, the anaerobic threshold would be estimated at the proximity of the 80% of Maximal 100m front crawl, performed with starting inside the pool.

The secondary purpose of this research was to study the correlations among the VCrit with to the rate of perceived exertion (RPE) and Heart rate at anaerobic threshold (HRAnT). The results (Table 1), exhibit good reliability among the final estimation of VCrit with the data obtained to the HRAnT and also with RPE.

This results support the estimations proposed by Borg (1970) [8] when estimates de correspondence to the arbitrary units (6-20) to the heart rate. In the present research the estimated HRAnT appears at the average of 150 bpm. Very coincident to the 15 unit of the aforementioned 6-20 scale of perceived exertion.

The moderate reliability among HRAnT with HRmax, it´s the lower correlation found at this research. We attribute that to the fact of HRmax is estimation low accurately and in most of the cases studied with a populations whose differs to an elite athletes [9] and moreover at the competitive period after a several weeks of training and participation in a competition. [1-2] However, the simple estimation to designs and differentiate aerobic to anaerobic training; appears very useful to a coaches and athletes without expensive monitor and devises. [14-15]

The complementary purpose of this research was to defining conceptualizations related to lactate behavior and endurance training. As was aforementioned, different terms were used to refer the VCrit some of these concepts as: anaerobic threshold (AnThT), lactate threshold (LT), Onset of Blood Lactate Accumulation (OBLA), maximal lactate steady state (MLSS), and ventilatory threshold (VT). [4-5-6-7]

Monod, and Scherrer, (1965) [5] conceptualize the VCrit as "the swimming velocity that would train thought extended periods of time, without experience excessive fatigue"

With the understanding of this concept; its opportune declares that; the concept of VCrit appears more related to the estimated maximal lactate steady state (MLSS) what will find at the proximity of 3mM/l; moreover, the onset of blood lactic accumulation (OBLA) appears estimated at the closer of 4 mM/l. [2-14-15]

To this understanding the definitions of Onset of Blood Lactate Accumulation (OBLA) are coincident to anaerobic threshold (AnThT), lactate threshold (LT) and second ventilatory threshold (2VT) and are the onset of intensive aerobic work (below) and the beginning the anaerobic work (above and limited to the maximal oxygen uptake). [2-14-15]

The maximal lactate steady state (MLSS) would represent the division among the moderate aerobic work (below) and the intensive aerobic work (above and limited to the anaerobic work). And is equivalent to the aerobic threshold (AThT). [2-14-15]

The low intensity training zone (LIT) is understood as aerobic zone in where is conceptualized the regenerative and lipolysis aerobic work. [2]

A limitation of this study was the lack of access to Lactate samples. Future researches will consider this study as base to keep defining the training and work zones.

CONCLUSION

With these results is concluded:
Distances of 100 and 300m are reliable to determine VCrit and also would be estimated at the proximity of 80% of Maximal 100m front crawl with starting inside the pool. VCrit doesn't correspond to the concept of prolonged swimming without exhaustion but VCrit its and easy, reliable and simple way to prescribe the onset of anaerobic training.

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