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CONTROLLING THE SWIMMING ENDURANCE TRAINING THROUGH THE LACTAT.PAS SOFTWARE

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Abstract

One of the fundamental problems of contemporary training is the monitoring of training in all aspects, in particular high-level performance. The importance of comprehensive assessment of athletes and of the preparation process increases with their level of performance[8].

Therefore, accomplishing the model of the effort areas correspondence, in relation with the power and capacity particularities of the energetic systems and the LACTAT.PAS software allowed us to:

- Correlate different classifications of types of effort in swimming, making accessible the selection of training methods and means based on an unitary vision;
- Realizing reference time predictions, based on the linear extrapolation and standard correction.

Aim

Approaching this theme started from observing that less and less senior swimmers are participating in the "Senior National Championships" finals, their place being taken by more and more junior swimmers.

Along with the multitude of reasons that can explain this phenomenon, we can also found the abandonment of performance work, caused by biological weariness, after the senior level.

This research aims to create a computer program that will allow a controlled management of the specific swimming speeds during the endurance training.

Research organization, development and results

In order to ease the process of calculating the reference swimming time for the different levels of physiological impact and in order to benefit in time from the testing information, after the initial study, which comprised[1,2]:

- Creating the model of the effort areas correspondences, in relation with the power and capacity particularities of the energetic systems;
- Establishing the structure of the 2-Speed 2x400 m freestyle test, of evaluating the aerobic capacity based on determining the lactic acid level in the blood;
- Creating the method of calculating the reference time by linear extrapolation and standard correction, the LACTAT.PAS software was build, in Turbo Pascal.

This program was successfully applied for controlled monitoring and managing of the training process in the Piteşti sportive clubs swimmers.

The creation of the program comprised the following stages:

Stage 1. *Establishing the protocol for the 2-Speed 2x400m freestyle test, of evaluating the aerobic capacity based on determining the lactic acid level in the blood*

The first test that allowed the simple evaluation of the aerobic metabolism was the 2-Speed test, by Mader A., Heck H., Hollmann W1, which consists in two swim repetitions on the same distance, in the same style, but with different speeds. The first repetition will be done at a submaximal speed, while the other will be exhaustive. Before each repetition, the swimmer shall be given a period of complete rest, of 5 minutes, while between the two repetitions must be a break of at least 15 minutes, preferably an active rest. We will try to determine the maximal concentration of lactic acid in the blood, after each effort.

The 2-Speed 2 x 400 m freestyle test we used has the following structure:

Methodical step	Method or activity	Situation
1	Determining the lactic acid	Base conditions
2	Warm-up	Effort training
3	Timing	400 m swimming – submaximal intensity
4	Determining the lactic acid	Maximum level
5	25 min. swimming/5min. passive break	Cool-down
6	Timing	400 m swimming – maximal intensity
7	Determining the lactic acid	Maximum level

***Table 1** – the structure of the 2-Speed 2x400 m freestyle test, of evaluating the aerobic capacity*

After these 7 methodical steps, we calculated the following indicators that lead to understanding the evolution of metabolic adaptations:

a. The base level of the blood lactic acid, which must remain within normal limits

b. The swimming speed at 4 mmol/l or V4, which indicates, by its increase, an improvement of aerobic performances.

c. Determining the maximum level of lactic acid after the tests. A decreased level, correlated with a higher swimming speed, indicate an improvement of the aerobic parameters.

Stage 2. Creating the model of the effort areas correspondences, in relation with the power and capacity particularities of the energetic systems

By synthesizing and correlating the data in the specialized literature, we elaborated a model of the effort areas correspondences, presented in the following table.

Characteristics of the energetic system	Effort areas 1*	2*	3*	4*	Characteristics of the effort	Effort intensity	Cardiac frequency (p/min)	Lactic acid (mmol/l)
Aerobic capacity CAE	R1	O_2 stable	N1	A1	inferior aerobe Regeneration aerobe	50%	120-140 140-150	0 - 2
			N2	A2	Average aerobe aerobic threshold	55-70%	150-160	2 - 3,5
Aerobic power PAE	R2	O_2 relative	N3	B1	anaerobic threshold MaxLaSS aerobic-anaerobic	70-80%	160-170	3,5 – 5,5
	R3	O_2-LA2	N4	B2	aerobic-anaerobic VO2max	80-85%	170-180	5,5 - 12
Lactacidicid anaerobe capacity CANLa	S1	O_2-LA1	N5	C1	Lactate tolerance Lactate production	85-95%	180-190	<18
		LA-O_2						
Lactacidic anaerobe power PANLa	S2	Lactate	N6	C2	lactate peak	95-110%	180-220	12 - 18
Alactacidic anaerobe capacity CANALa Alactacidic anaerobe power PANALa	S3	Anaerobic alactacidic	N7	C3	Maximum speed	100-110%	-	-

Table 2 - The model of the effort areas correspondence, in relation with the power and capacity particularities of the energetic systems; adapted and completed according to: 1* - Maglischo E.W. (1993), 2* - Tocitu D. (2000), 3* - Pedroletti M. (1997), 4* - Colorado Spring Swimming Team

Stage 3. *Creating the method of calculating the reference time by linear extrapolation and standard correction*

The swimming speed values corresponding to the fixed levels of the blood lactic acid are used for prescribing the intensity of the training, for the different effort areas. These speed values represent important marks for coaches and are verified and adjusted by sets of standard repetitions.

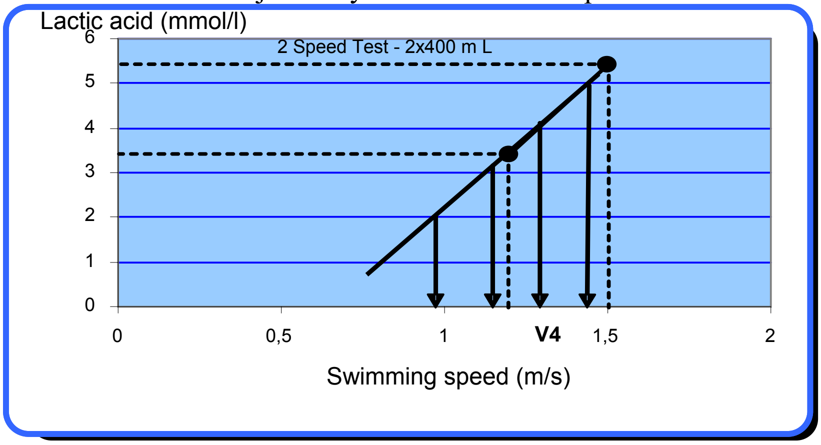

Figure 1 – Calculating the swimming speed for the blood lactate's fixed levels of 2, 3, 4 and 5 mmol/l

The swimming speed at 4 mmol/l or $V4_{400}$, determined by the lactic acid "2-Speed de 2 x 400 m freestyle" test, indicates, by its increase, an improvement of the aerobic performances.

This swimming speed was initially determined by using the Microsoft Office Excel program this way: the graphical representation of the lactic acid – swimming speed line and the calculation with this software's equations of the intersecting point between this line segment or its extension and the line corresponding to the lactic acid level of 4 mmol/l. and then the swimming speed at 4 mmol/l, which can be found in the chart at the uniting point between the perpendicular from the intersection point to the axis that represents the swimming speed. In a similar manner we determined the swimming speed values corresponding to the fixed blood lactic acid levels of 2.3 and 5 mmol/l.

Following, we calculate the reference times by applying the correction factors of the swimming speed, for the distance repetitions and varied resting periods, according to Madsen O. şi Lohberg M.[2] (1987). These factors are based on the training speed values determined through specific tests of the blood lactic acid, after 400 m repetitions.

Gender	Break	400 m	200 m	100 m	50 m
Female	10 sec	100%	101.5%	103%	110%
	30 sec	100.5%	102.5%	106.5%	114%
Male	10 sec	99.5%	101.5%	103%	108%
	30 sec	100.5%	102.5%	108%	115%

Table 3 – The correction factors for different distances and rest periods, according to Madsen O. and Lohberg M. (1987)

By using the LACTAT:PAS program which includes all of the previously described operations, we are provided with a chart (table 4) that comprises predictions of reference times for different levels of physiological impact, addressed to the aerobic capacity and power. The time values are for constructing the repetition sessions for the swimming distances of 50m, 100m, 200m and 400m.

Characteristics of the energetic system	Effort areas				Lactic Acid (mmol/l)	Effort intensity	Break (sec.)	Swimming distance (m)			
								400 (min)	200 (min)	100 (min)	50 (min)
CAE	**R1**	**O_2 stable**	**N1**	**A1**	**2**	**50%**	**10 s**	5.07.25	2.36.68	1.22.54	0.43.95
							30s	5.04.19	2.35.15	1.18.72	0.41.27
			N2	**A2**	**3**	**55-70%**	**10 s**	5.00.01	2.32.99	1.20.60	0.42.91
							30s	4.57.02	2.31.50	1.16.87	0.40.30
PAE	**R2**	**O_2 relative**	**N3**	**B1**	**4**	**70-80%**	**10 s**	4.53.10	2.29.47	1.18.74	0.41.92
							30s	4.50.19	2.28.01	1.15.10	0.39.37
	R3	**O_2-LA2**	**N4**	**B2**	**5**	**80-85%**	**10 s**	4.46.51	2.26.11	1.16.97	0.40.98
							30s	4.43.66	2.24.68	1.13.41	0.38.49

Table 4 – Reference time predictions – endurance training – M.A. case study

Conclusions

The creation of the computer program for calculating the reference swimming speed for the different levels of metabolic impact, and the model of the effort areas correspondences, in relation with the power and capacity particularities of the energetic systems allow the selection of an optimal speed for each endurance effort area, in agreement with the training stage.

The information given by the case studies, made for swimmers with different specializations, can constitute reference data for the swimmers who are specialized in these events. Nevertheless, this cannot be more than informative values, because the biological reaction to the training stimuli is individualized.

The use of the LACTAT.PAS program allows us to obtain useful information regarding:

- The efficiency of the training;
- The quality and structure of the current training stage;
- The prognosis of the potential to achieve top sportive performance;
- The necessary conclusions for a future training, especially regarding the aims of the training, effort intensity and the succession of the training methods that will be used.

CONTROLUL ANTRENAMENTULUI DE REZISTENŢĂ ÎN ÎNOT PRIN INTERMEDIUL PROGRAMULUI LACTAT.PAS

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Cuvinte cheie: Înot, control, rezistenţă, software.

Rezumat

Una dintre problemele fundamentale ale antrenamentului contemporan o reprezintă monitorizarea procesului de antrenament, sub toate aspectele, în special la nivelul înaltei performanţe. Importanţa evaluării complexe a sportivilor şi a procesului de pregătire creşte împreună cu nivelului de performanţă al acestora[8].

De aceea realizarea modelului corespondenţei zonelor de efort în concordanţă cu particularităţile de putere şi de capacitate ale sistemelor energetice şi a programului de calcul LACTAT.PAS ne-a permis:

- corelarea diferitelor clasificări ale tipurilor de efort în înot, făcând accesibilă selectarea metodelor şi mijloacelor de pregătire pe baza unei viziuni unitare;
- realizarea de previziuni de timpi de referinţă, pe baza extrapolării liniare şi a corecţiei standard.

Ipoteza cercetării

Abordarea temei acestei lucrări a fost provocată de constatarea că tot mai puţini înotători seniori participă la finalele "Campionatelor Naţionale de Seniori", în locul lor apărând din ce în ce mai mulţi înotători juniori. Alături de multitudinea de motive care pot explica acest fenomen se regăseşte şi abandonul activităţii de performanţă cauzat de uzura biologică, după trecerea la nivelul seniorilor.

Cercetarea de faţă are ca scop realizarea unui program de calcul care să permită conducerea controlată a vitezelor de înot specifice antrenamentului de rezistenţă în înot.

Organization, development of research and results

Pentru uşurarea procesului de calcul a timpilor de înot de referinşă pentru diferitele niveluri de impact fiziologic şi pentru a beneficia în timp util de informaţiile testărilor, după studiul iniţial care a cuprins[1,2]:

- realizarea modelului corespondenţei zonelor de efort în concordanţă cu particularităţile de putere şi de capacitate ale sistemelor energetice;
- stabilirea structurii testului 2-Speed 2x400 m liber, de evaluare a capacităţii aerobe pe baza determinării nivelului acidului lactic sanguin;
- realizarea metodei calculării timpilor de referinţă prin extrapolare liniară şi corecţie standard, a fost realizat programul de calcul LACTAT.PAS, în Turbo Pascal.

Acest program a fost aplicat cu succes în monitorizarea şi conducerea controlată a procesului de antrenament al înotătorilor componenţi ai cluburilor sportive din Piteşti.

Realizarea programului a cuprins următoarele etape: