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Does higher effectiveness means better mood? Training effectiveness and mood alternations in the national finswimming team – An interdisciplinary study

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Abstract

Background:The aim of the following paper was the attempt to: 1) assess the influence of 12-day anaerobic threshold (AT) training on finswimmers' endurance and speed, 2) assess the relationship between mood and 12-day AT training. The authors focused on individual differences in psychophysiological indices connected with a training camp, with inclusion of results of the whole group of athletes. Material and methods:The study was conducted on the national team: 7 athletes (17–28 years) and was performed before and after 12 days of a training camp. The Profile of Mood States (POMS) and AT training were used in the study. Two measurements of mood and lactate tests were performed before and after 12 days of the training camp. Results:Individual maximal speed (t(6)= -5.303; p=.002; d=- 2.00) and fatigue (measured by the POMS questionnaire) (t(6)= -3.163; p = .019; d =-1.20) increased due to participation in the training camp in the whole group of athletes. Individual analysis revealed discrepancies in mood alternations.Conclusions:Only 12 days' training camp based on AT training resulted in increased maximal speed in every finswimmer, which may by substantial information in planning a training program. Additionally, mood analysis is a useful indicator and its application supports the training process.

Keywords

endurance training, anaerobic thresholds, lactate test, swimming, mood state

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Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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INTRODUCTION

In order to perform the optimal and precise evaluation of the effectiveness of training and training loads, researchers use the interdependence among biochemical, genetic and psychological factors as indicators to support and diagnose the state of sport training [1–7]. Although some coaches and researchers are skeptical about anaerobic threshold training and promote their own concepts [8–10], the most effective intensity in increasing aerobic endurance is threshold intensity [11–15]. It is an intensity that does not exceed the lactate threshold (anaerobic). This threshold is determined by the intensity during which a sudden increase in the lactate level in the body can be observed in laboratory conditions. In other words, it is the point at which anaerobic metabolism begins to play a greater role in oxygen delivery, and aerobic processes are no longer able to dissociate lactic acid and thereby fight with the increased lactate level in muscles [16–17].

In the training literature, in order to increase the effectiveness of endurance training, adaptive change takes a long time. Sindiani, Eliakim, Segev & Meckel [18] compared the effect of 6 weeks of an increasing-distance interval-training program and a decreasing-distance interval-training program (ITG and DTG), matched for the total distance, on aerobic and anaerobic physiological indices in a group of forty physical education students. Both training programs caused significant positive effects on aerobic and anaerobic fitness; however, the DTG showed significant superiority over the ITG in improving aerobic and anaerobic performance capabilities.

Park, Shin & Lim [19] discovered that the 6-week intermittent hypoxic training regime composed of high-intensity aerobic continuous exercise and anaerobic interval exercise can be considered an effective altitude/hypoxic training method in improving exercise economy and aerobic exercise performance in moderately trained swimmers.

Effectiveness in endurance is part of coaches, physiologists or biomechanics' task. Sport psychologists, on the other hand, try to find a relationship between mental condition (like mood alternation) and the performance. Researchers stressed that negative mood is an evolutionary signal of danger or problematic situations [20].

In previous studies authors have dealt with the analysis concerning swimming in the context of the analysis of physiological indicators including lactate concentration, or with analysis of mood [21–23]. Hooper et al. [21] attempted to identify useful variables in monitoring recovery during tapering. Changes in physiological variables, tethered swimming force, mood states, and self-ratings of well-being were measured from before to after 2 weeks of tapering for national championships. Physiological measurements included: resting heart rate (HR); blood pressure (BP); blood lactate concentration; red, white and differential blood cell counts; plasma cortisol, free testosterone, and catecholamine concentrations. Measurements taken after 100 m maximal and 200 m standardized submaximal swims included HR, BP, and blood lactate concentration. Step-down regression analysis showed that changes in plasma norepinephrine concentration, HR after maximal effort swimming, and confusion as measured by the POMS predicted the changes in the swimming time with tapering. Myers et al. [22] monitored physical and psychological variables as well as competition performance of 10 elite swimmers before and during a

21-day taper in preparation for the Canadian National Championships or the World Championships. Mood and recovery were assessed using the Brunel Mood Scale, and the heart rate was assessed with a 2x200 m submaximal swim test. Resting HR was measured using the Rusko test. Results showed that all abovementioned parameters changed significantly throughout the taper period and were related to improved performance.

O'Connor et al. [23] examined the POMS scores and resting salivary cortisol levels (SCLs) during changes in training volume (TVO). Swimmers showed significant alterations in 6 POMS subscales, i.e. tension, depression, anger, vigor, fatigue, and global mood (GM). Salivary cortisol levels were significantly correlated with depression during overtraining but not at baseline or taper.

Many other studies have analyzed the POMS in swimming without taking physiological markers into account. Raglin & Morgan [24] used a scale developed using items from the POMS to identify athletes being at a risk of training-induced distress. Similarly, Hooper et al. [25] used the POMS as an indication of staleness (including poorer performance and fatigue), and recovery.

Most of the abovementioned research concerned only quantitative studies without the analysis of individual results. Additionally, studies on AT training typically have not included data on psychological changes from the athletes' perspective. Therefore, the abovementioned studies led authors to conduct interdisciplinary research concerning the effectiveness of 12 days' AT training and mood alternation. The authors would like to focus on individual differences in psychophysiological indices connected with a training camp, with the inclusion of results of the whole group of athletes. This paper is a unique study in which the whole finswimming national team from Poland took part.

Finswimming is an underwater sport consisting of techniques involving swimming with the use of fins either on the water's surface or underwater.

The aim of the following paper was the attempt to:

1. assess the influence of the 12-day anaerobic threshold (AT) training on endurance, and speed of the finswimmers as the whole group but also of each individual athlete;
2. assess the relationship between mood and 12- day AT training.

MATERIAL AND METHODS

PARTICIPANTS

The study involved 7 finswimmers aged 17 to 28 (3 women and 4 men; M = 20.14, SD = 4.30) of the finswimming national team with 8–18 years' training experience.

MEASURES

POMS. The Profile of Mood States (POMS) [26] is a questionnaire consisting of the following scales: anger, confusion, depression, fatigue, tension, vigor and friendliness. The questionnaire, in the Polish adaptation by Dudek and Koniarek [27] (1987), contains 65 adjectives defining a person's different states and moods. The test assesses the degree of intensity of a state during a particular period, on a scale from 0 (not at all) to 4 (definitely yes). Five scales describe the negative aspects of mood, while the other two (vigor and friendliness) describe positive mood states (In the original version, there were 6 scales, excluding friendliness.). Authors of the questionnaire and authors of the Polish version evaluate the level of its accuracy and reliability as satisfactory. Internal consistency coefficients for the analyzed scales ranged from 0.84 to 0.95.

AT (Anaerobic Threshold) Training. The idea is that AT training is based on achieving an anaerobic threshold in lactate testing. Among many methods of determining anaerobic transformation, the authors chose the method of Cheng, Kuipers, Snyder, Keizer, Jeukendrup, & Hesselink [28]. The main idea of this method is to determine the point on the exponential curve for metabolic dependence between lactate and exercise load (in our study this is the relationship between lactate and swimming speed). This method consists of calculating the point that yields the maximal distance from a curve representing ventilatory and metabolic variables as a function of oxygen uptake (VO_2) to the line formed by the two end points of the curve (Dmax method). The athletes perform the main training tasks with a threshold speed.

The interpretation of the lactate curve is as follows: the curve shift to the left or right part of the curve, i.e. the earlier or later lactate level in the blood at the AT level indicates a change in endurance. Raising or lowering the highest point of the curve reflects an improvement or deterioration in the athlete's speed. Changes in the ratio of endurance and the maximum lactate (M) change the shape of the graph and reflect the athlete’s strength. The image desired by coaches and competitors is to improve all three components: endurance, strength and speed, which is expressed by positive changes in the height and shape of the curve.

Lactate profiling protocol. The incremental 8 × 200 m step test was used to provide objective information about the aerobic or endurance fitness of the swimmer. All testing was conducted in a 25-m pool. The lactate tests (8 × 200 m) were carried out before and after the camp (on the first and the last day) in order to determine the swimming speed at the AT level (anaerobic threshold) and the measured maximum speed of the swimmers achieved in a maximum intensity effort.

Procedures

All procedures were performed in accordance with the ethical standards of the Helsinki Declaration, and the participants signed an informed consent form. The study was approved by the Bioethical Committee at the Regional Medical Chamber.

The study was performed before and after 12 days of training camp. In order to determine the individual swimming speed for the AT (Anaerobic Threshold) training, the 8 × 200 m lactate test was performed. The results of the first test were used to determine the individual swimming speed in the AT. The results of the second lactate test were used to assess the effects of training (i.e. lactate concentration and swimming speed at the tested intensity levels).

Individualized target times, based on the personal best time for each swimmer, were calculated before each test. The final swim was set to be the swimmer’s maximal effort. The times taken for each 100 m split and for the total 200 m were recorded manually. After completion of each 200 m, a 25 mL capillary blood sample was taken from either the swimmer's earlobe or fingertip and analyzed for lactate concentration using the Lactate Scout portable lactate analyzer (Boehringer, Mannheim, Germany). The lactate threshold and lactate tolerance levels were assessed graphically on a plot of swimming velocity (swimming pace, m/s over the distance of 200 m) versus lactate concentration. The maximum speed of each athlete at the maximum lactate level from the first and second measurement were used in statistical analyses in this study.

The POMS questionnaire was filled in twice – on the first and the last day of the training camp. Furthermore, an interview was conducted with each swimmer, which excluded the influence of other strong factors affecting the mood.

The training program. The training camp was a microcycle lasting for 12 days and comprising three training units each day at the following times: 7:00–9:30 swimming; 11:00–13:00 walking and/or running, with every other day stretching; and 15:00–17:00 swimming. During this microcycle, each of the competitors performed 30 training units, equating in total to 65 hours of training. Each of the subjects swam on average 7 km per day.

STATISTICAL ANALYSES

The statistical analyses were performed using the SPSS 21 software packages. T-tests with bootstrap estimation in 1000 simulation for dependent samples were used to examine differences before and after the camp.

RESULTS

When the changes due to participation in the training camp were taken into account, two variables increased in the whole group: speed ($t(6)$ =-5.303; p =.002; d = -2.00) and fatigue (from Profile of Mood States) ($t(6)$ =-3.163; p = .019; d = -1.20), which was confirmed by bootstrap estimation. The average change in fatigue was M =-7.43 and the 95% confidence interval of this difference ranged between LB = 3.03 and UB = 11.61 points. Similarly, results of speed changed by an average of M = -.043, when 95% confidence interval of this difference ranged between LB = -.057 to UB = -.028 m/s.

Individual speeds and lactate levels from the first and second measurements are presented in Table 1, and profiles of mood changes from both measurements are shown in Table 2.

Table 1. Results in the lactate test before and after the camp

Swimmer	1st measurement		2nd measurement	
	V[m/s]	LA[mmol/l]	V [m/s]	LA[mmol/l]
1	1.31	2.2	1.3	2.7
	1.36	2.7	1.38	2.8
	1.53	4.2	1.55	3.3
	1.64	6.3	1.64	5.6
	1.87	13.1	1.9	12.8
2	1.23	2.7	1.23	1.1
	1.35	4.1	1.33	1.1
	1.48	4.8	1.45	2.7
	1.56	7.6	1.54	4.8
	1.63	10.8	1.64	9.1
3	1.26	5.4	1.27	3.0
	1.41	7.2	1.37	3.1
	1.49	8.1	1.44	6.4
	1.52	9.4	1.41	5.7
	1.55	10.2	1.61	11.6
4	1.27	3.1	1.34	3.1
	1.47	4.8	1.49	3.0
	1.61	7.0	1.64	6.1
	1.71	9.3	1.72	13.5
	1.77	13.0	1.83	12.6
5	1.25	1.1	1.38	2.1
	1.35	2.1	1.5	2.1
	1.52	4.1	1.6	4.2
	1.6	6.6	1.65	6.8
	1.67	10.6	1.71	10.9
6	1.32	3.5	1.36	3.1
	1.46	4.5	1.48	4.3
	1.55	7.2	1.6	7.1
	1.64	10.4	1.65	9.4
	1.69	12.5	1.72	10.5
7	1.35	4.8	1.25	1.6
	1.44	5.6	1.37	2.3
	1.54	6.5	1.49	3.5
	1.67	11.1	1.71	8.8
	1.68	11.9	1.75	12.2

V – swimming speed [m/s]; LA – lactate level [mmol/L]

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Table 2. Results achieved by athletes in Profile of Mood States in the first and second measurement

	Anger		Confusion		Depression		Fatigue		Tension		Vigour		Friendliness	
Measurement / Swimmer	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1	4	4	4	3	0	0	1	0	1	4	24	25	18	20
2	14	20	13	11	19	32	12	22	17	20	16	11	19	12
3	15	6	7	3	24	10	6	18	15	8	15	15	17	15
4	9	20	10	18	9	30	9	26	10	14	22	5	16	13
5	14	15	5	8	18	18	12	14	14	12	19	19	15	23
6	16	12	8	9	5	10	12	16	10	9	23	20	16	16
7	0	2	2	3	3	3	2	10	6	5	24	24	24	20

To illustrate the results better, the authors decided to present graphs with a lactate curve and a profile of mood states of two selected swimmers with different profiles of mood states (Figures 1–4).

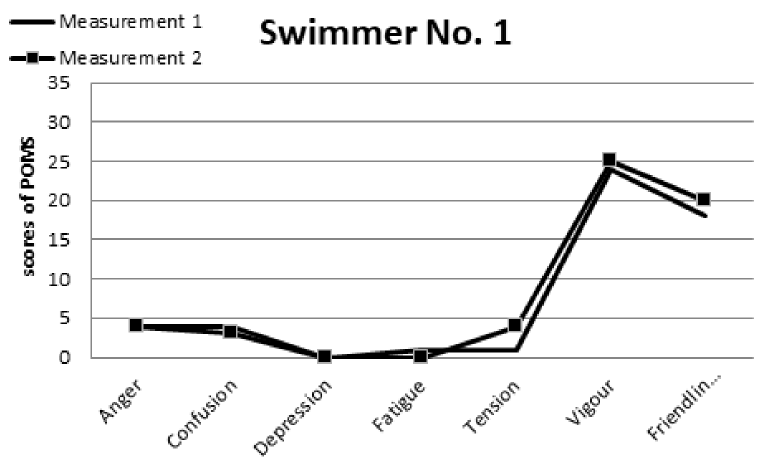

Fig. 1. The dimensions of the profile of mood in the 1st and the 2nd measurement of swimmer No. 1

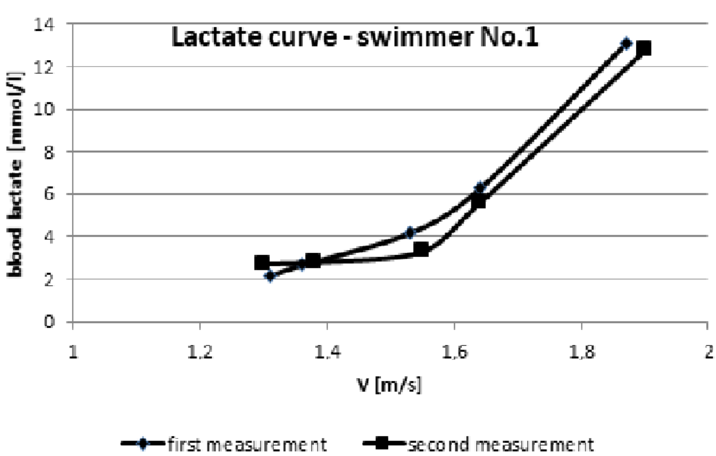

Fig. 2. The lactate curve of swimmer No. 1

Athlete No. 1 is characterized by a desirable profile of mood in sport, because his negative characteristics are low, whereas the positive features received high rates both in the first and the second measurements. Training camp affected his mood to a small but positive degree. The athlete has improved speed and endurance, which is indicated by the shift of the lactate curve from the second measurement to the right.

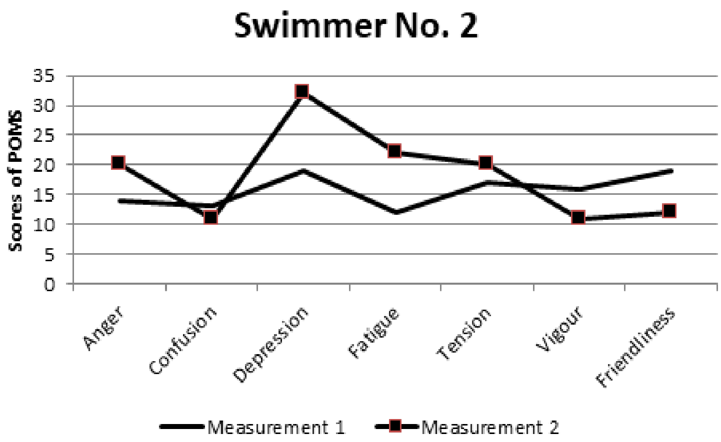

Fig. 3. The dimensions of the profile of mood in the 1st and the 2nd measurement of swimmer No. 2

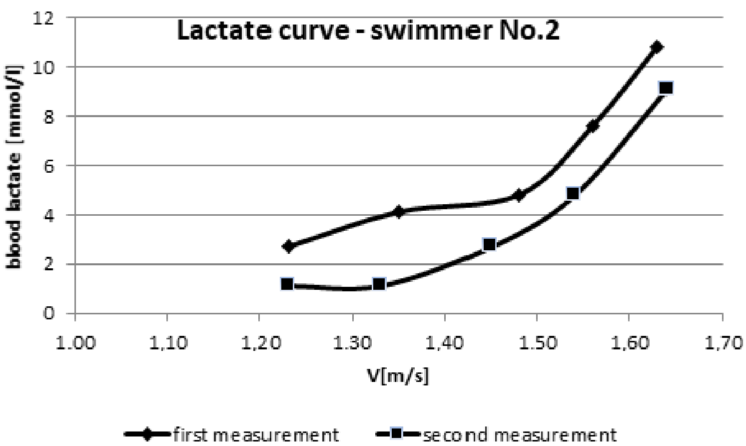

Fig. 4. The lactate curve of swimmer No. 2

In the second measurement, athlete No. 2 achieved lower scores in positive POMS scales, i.e. vigor and friendliness, while achieving higher results in the scales of anger, depression, fatigue and tension. This athlete seems to be tired after the training camp. However, she experienced a speed increase of 0.01 m/s and a decreased lactate level as indicated by the lactate curve shift to the right in the second measurement compared to the first one.

Athlete No. 3 received higher scores in the fatigue scale in the second study, but lower scores in anger, confusion, depression, tension and friendliness. The score in the vigor scale remained unchanged. The training camp seemed to affect his mood positively, but she showed signs of tiredness. It may also have been indicated by an increasing lactate level. However, she improved her maximal speed in the 2nd measurement.

In the second measurement, athlete No. 4 showed a lower score in the positive mood scales of vigor and friendliness, while obtaining higher results in the negative ones of anger, confusion, depression, fatigue and tension. His assessment indicated that he seemed to be very tired after the training camp. Despite this, he improved his speed and reduced the lactate level.

In the second study, athlete No. 5 received higher scores in the scales of anger, confusion, fatigue, and friendliness, and lower scores in tension. The vigor and depression scales remained unchanged. Differences in the mood change were small. The most visibly observed difference was in increased friendliness. This swimmer seemed to have adapted to the conditions of the training camp, and she increased maximal speed. However, the increased lactate level may indicate light fatigue.

Athlete No. 6 gained lower results in anger, tension and vigor in the second measurement, while gaining higher results in confusion, depression and fatigue. His scale of friendliness remained unchanged. He manifested signs of light fatigue after the training camp. However, he increased his speed and endurance.

Athlete No. 7 received higher scores in anger, confusion, fatigue in the second measurement, and lower scores in tension and friendliness. Vigor and depression remained unchanged. However, the changes were small, and a greater difference was observed only in the fatigue scale. He improved his maximal speed by 0.07 seconds, which was the best result amongst all the swimmers, and also experienced increased lactate level. This athlete seemed to be the most tired of the whole group or become wearied by the monotony of training.

DISCUSSION

The aim of the study was the attempt to assess the influence of the 12-day anaerobic threshold (AT) training on the finswimmers' endurance and speed and to assess the relationship between mood and 12-day AT training. All athletes improved their individual maximal speed, which may indicate an effective training plan during the training camp as well as adaptive changes taking place in the swimmers' bodies. Only two weeks of training at the AT level improved endurance and, at the same time, improved the speed of swimming. In previous studies changes occurred after 6 weeks' programs [18-19]. The achieved results may support swimming coaches in planning training programs.

A higher level of fatigue measured by POMS seems to be a normal effect of a 12-day-long camp with intensive training. The depressed mood could itself be due to the monotony of training during the camp. The question is whether or not applying the individualization of training and adjusting the body's recovery time to the indicators of mood would magnify the effects of improving the speed? It is also recommended to monitor the mood alternations after returning to a normal training routine.

Finswimmer No. 1 represents the tip of the iceberg, i.e. those athletes who are the best adapted in terms of mood, corresponding with those capable of the greatest achievements [29]. According to Morgan, who propagated the POMS test [29], leading athletes presented lower scores on the negative mood scale, and higher ones in vigor than athletes in a normative, i.e. standard, group. Moreover, they were characterized by a generally healthier profile of mood than less experienced and less titled athletes or a normative population. The sport elite comprises the so-called ‘tip of the iceberg’, which using the analogy of an iceberg suggests all the negative sentiments in the normative population are below the surface, while those with vigor level are placed well above the normal and are above the surface.

Greater negative changes in the mood were observed among some athletes, i.e. lower scores in the positive POMS scales, i.e. vigor and friendliness, while achieving higher results in the scales of anger, depression, fatigue and tension. These athletes seemed to be tired after the training camp. However, despite mood alternation, speed and endurance improved. In these cases, mood monitoring seems to be a very useful technique. In the future these athletes could present the first signs of staleness if the intensity of trainings and surroundings remain similar.

Modern, multi-process training requires coaches to employ scientific precision based on preparing motor skills, fitness, technical, tactical and psychological indicators, the health status, as well as the nature of an athlete’s training loads. The control of the training process is carried out by analyzing the implementation of training and post-training effects. Analysis of modern swimming training increasingly relies on physiological studies, revealing adaptive changes in an athlete’s body under the influence of training stimuli. However, a lack of analysis of the psychological aspects, which have a substantial impact on the athlete's functioning and their health, led to authors to plan the present study. Authors believe that the use of mood analysis protocol could be appropriate as an indicator supporting the training process.

The practical application of these results could be as follows. In cases when an athlete manifests the first signs of depression, it would be useful to involve a sports psychologist’s intervention. One of the techniques used in mental training is to teach self-awareness of one's emotions, mood and emotional arousal [30-31]. It is very important for coaches to reinforce the observation ability of their athletes in order to recognize the first signs of overtraining, which may occur in the long term despite the athlete’s still improving physiological and biochemical parameters.

Hooper, MacKinnon, & Hanrahan [25] asked 19 elite athletes to complete the POMS three times during a 6-month training season (early-, mid-, and late-season), during the tapering period prior to and then shortly after major competitions. Their aim was to investigate whether those athletes who were stale showed different values from those who were intensely-trained but not stale. Stale swimmers showed higher scores on several POMS measures. The conclusion was that stale athletes may not always demonstrate different mood scores from non-stale athletes, but that the total mood disturbance score (TMD) as evaluated by the POMS may be used to indicate those athletes predisposed to the condition long before symptoms of poor performance and prolonged fatigue are observed. O'Connor et al. [23] reached a similar conclusion, observing higher scores in the POMS in global mood and depression in stale swimmers.

Subjective measurement of the mood is a limitation of this study. However, if the atmosphere in the team is proper, the coach will discover any discrepancies between the presented and the declared mood. The POMS is solidly grounded in the field by Morgan's early work, but many have been critical of its improper use by coaches in monitoring staleness and overtraining. This case report provides some evidence for its efficacy that mirrors what others have found in previous studies. The authors do not overstate its use but provide some evidence for its efficacy in monitoring mood states of athletes engaged in rigorous and sometimes boring training regimens (in this case a difficult lactate producing 12-day swimming program). Endurance sports are often associated with high levels of mood breakdown in the participating athletes. It is obvious that mood changes are caused by various factors; nevertheless, the analyzed research group was subjected to intensive training influencing their mood, which was the main focus of the authors of this paper.

In future research, apart from subjective measure of mood, it is recommended to add another physiological marker of the first signs of staleness, i.e. the morning heart rate level.

CONCLUSIONS

All finswimmers increased their maximal speed after the only 12 days' camp bases on AT training, which may be substantial information for coaches planning a training process. Additionally, mood analysis is a useful indicator, and its application supports the training process.

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