Endurance Test Sets for Individualization Training Swimmers*

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Abstract

Successful training in swimming is impossible without precise and correct control of a swimmers' training process. The coach must have as much information as possible about the athlete's fitness to obtain a comprehensive picture of the course of training and to optimally plan future activities. The results of performing a specific exercise depend on the state of function which is most vital for ensuring performance under certain conditions. The key precondition logically underpinning the informative nature of the tests is that the results of the test. Thus exercises which provoke immediate maximum deviations from training effects can provide the most objective pedagogical evaluation of various endurance components. The use of specially designed swimming test sets allows swimmers to learn the necessary control of their training process, helps determine strengths and weaknesses of their preparation and prepares them to accept operative corrections. The aim of the work is to optimize the management of swimmers' training processes on the basis of special testing results. In order to determine their areas of need, two of Latvia's best swimmers were tested with 6 specifics endurance test sets. Once determined, the swimmers' were given different swimming sets to develop their areas of weakness. For all swimmers we have developed 6 areas of sets to either sustain or improve a swimmer's endurance (endurance of anaerobic and aerobic ability). Intensity for each set differs depending on whether the athlete is improving or sustaining these areas. Intensity within the sets for improvement of the areas ranges between 83-98% of maximum speed and to sustain the areas 80-96% of maximum speed depending on individual swimmer results from the test sets.

Keywords: Sport swimming, endurance, testing, training planning

1. Introduction

Effective control of an athlete's training is only possible if the coach knows what is happening to the athlete's organism at each stage of training (Counsilman 1977, Shirkovec 2002, Maglischo 2003,Vasilie, 2014, Talanian 2015, Dalamitros 2016,).

Successful swimming training is impossible without accurate and appropriate monitoring of the swimmer. The process of planning and organizing training is largely driven by analyzing changes in the swimmer's capabilities during various periods and stages of training and ascertaining her strengths and weaknesses. The couch must have as much information as possible about the athlete's fitness to obtain a comprehensive picture of the course of training and to optimally plan future activities. The results of performing a specific exercise depend on the state of function which is most vital for ensuring performance under certain conditions (Sokolovas 2002, Maglischo, 2003, Anderson et al, 2008 , Ford et al, 2011., Williams 2011).

The key precondition logically underpinning the informative nature of the tests is that the results of the test (Petrovich, 1989, Petrovich et al,1990 Oliveira et al, 2012). Thus exercises which provoke immediate maximum deviations from training effects can provide the most objective pedagogical evaluation of various endurance components. The results of the exercises are mutually comparable, therefore testing under the auspices of this program provides objective information about the proportional development of specific characteristics during various stages of training.

The aim of the work is to optimize the management of swimmers' training processes on the basis of special testing results.

2. Methods and Organization

The study involved two Latvian athletes, both breaststroke swimmers. One of them, P., was National champion 50 and 100 m swimmer, 18 years old; while the other, V., was National champion in 200m breaststroke, 19 years old. In order to compare the overall endurance fitness and just the training of these athletes and encourage improved results, a set of tests was employed over three (3) sessions to determine and evaluate the swimmers' special endurance development level. Interval exercises with maximum swimming speed (Petrovich, 1998, Shirkovec, 2002) can be used for the pedagogical control of the various special endurance criteria.

A-2 25 m, rest interval 80 s – anaerobic alactic power;
B-16 25 m, rest interval 80 s – anaerobic alactic capacity;
C-4 50 m, rest interval 45 s – anaerobic lactate power;
D-4 50 m, rest interval 10 s – anaerobic lactate capacity;
E-8 50 m, rest interval 10 s – aerobic power;
F-16 50 m, rest interval 10 s – aerobic capacity.

In order to evaluate the developmental balance of special endurance components, the following special coefficients were used:

K1=A/B – describes anaerobic alactic capacity compared with alactic power; K2=B/C – describes lactic capacity compared with alactic capacity;
K3=C/D – describes lactic capacity compared with lactic power;
K4=D/E – describes aerobic power compared with lactic capacity;
K5=E/F – describes aerobic capacity compared with aerobic capacity;
K6, K7, K8, K9 (K6=A/C; K7=A/D; K8=A/E; K9=A/F) – describes all components compared with alactic power (maximum speed);
K10=D/F – describes aerobic capacity compared with lactic capacity.

In order to comprehensively assess their special endurance development level, the athletes' individual coefficients were compared with model indicators. If an individual coefficient describing a particular characteristic is significantly lower than the relevant model coefficient, the given characteristic has a development reserve and close attention must be paid to this characteristic in the immediate future. If the coefficient is greater than the model coefficient, it can be considered that the given characteristic is overly developed, possibly at the expense of some other characteristic.

Indicators were measured after each test. Time was measured in seconds after each test using a SEIKO hand chronometer.

Pulse rates were taken by the swimmers themselves. The pulse rate was measured on the carotid artery, 3 times after workout at interval: 0-10 s (P1), 30-40 s (P2) and 60-70 s (P3). Together with sporting results, these indicators are often the most objective criteria used by trainers working with swimmers. The size of the P1 indicator reveals the reaction to load of the cardiovascular system. P2 and P3 indicators describe recovery of heartrate frequency.

Lactate indicators were determined using a lactate express diagnosis device in the third minute after completion of the C, D, E, F tests and the first minute after test A.

The key aspect of this study was to identify the attitudes of the school administrators in regards to how they view the children with disabilities and their inclusion in the general schools. In addition, study framed to find out to what extent the demographic variables (i.e., gender, age, years of teaching and administrative experiences, training in special education, personal experience with individuals with disabilities, school type, job position, students' enrolment and the level of disabilities) affect school administrators' attitudes toward inclusion. Therefore, the significant findings from this study will provide educational implications to the educators; include school administrators, teachers, special education supervisors and researchers as a part of the professional development in the field of educational leadership and administration, management and supervision. Moreover, the findings of this study will add to the existing literature related to the school administrators' attitudes toward the inclusive education practices as reviewed in the series of legislative laws on the importance of including children with special education needs in the general education schools.

3. Results

In order to determine and evaluate the swimmers' special endurance development level, we used the aforementioned set of tests. The test results are shown in table 1.

Table 1. Athlete's results of the special endurance test (time, heart rate and lactate) at the beginning of swimming season.

Swimmer		Alactic power Test A	Alactic capacity Test B	Anaerobic power Test C	Anaerobic capacity Test D	Aerobic power Test E	Aerobic capacity Test F
V.	Time, s*	30.1	29.75	33.8	36.29	36.65	37.4
	Heart rate, 10 s**	25-24-18	26-24-18	29-26-21	29-26-21	30-24-22	30-25-20
	Heart rate's per 10s sum	67	68	76	76	76	75
	La, mmol/l	4,7	6.6	12,5	8.5	8.6	9.5
P.	Time, s*	31.28	31.75	37.65	39.48	41.35	43.22
	Heart rate's per 10s sum	29-26-20	30-26-25	33-28-25	32-27-24	33-27-24	32-28-25
	P-sum	74	81	86	83	84	85
	La, mmol/l	7.2	7.5	11.4	9.1	8.5	10.6

* - average test time on 50 m;

**- number of heart rate in 10 seconds immediately after the swim, after 30 seconds, after 60 seconds.

After summarizing the test results we obtained the following individual coefficients (see table 2).

Table 2. Athletes 'special endurance individual coefficients in comparison with model indicators

Coefficients	Normality range	Swimmer V.		Swimmer P.	
K_1 A/B	0.97-0.99	1.01	Higher	0.99	Normal
K_2 B/C	0.89-0.92	0.88	Lower	0.83	Lower
K_3 C/D	0.95-0.97	0.93	Lower	0.95	Normal
K_4 D/E	0.97-0.99	0.99	Normal	0.95	Lower
K_5 E/F	0.97-0.99	0.97	Normal	0.95	Lower
K_6 A/C	0.87-0.90	0.89	Normal	0.83	Lower
K_7 A/D	0.84-0.87	0.84	Normal	0.79	Lower
K_8 A/E	0.81-0.83	0.82	Normal	0.75	Lower
K_9 A/F	0.79-0.82	0.8	Normal	0.72	Lower
K_{10} D/F	0.93-0.96	0.97	Higher	0.91	Lower

Swimmer V., whose specialty is 200m breaststroke, scored within the normal range for six coefficients covering aerobic power, capacity development and anaerobic capacity levels. Anaerobic alactic and lactic power are in development reserve. Pulse and lactic indicators recorded after the tests align with accepted bodily reactions and loads.

Swimmer P. had only two coefficients within normal range. These are alactic power and lactic capacity. All other endurance components– anaerobic power and capacity, aerobic power and capacity – are poorly developed. Furthermore, pulse reaction to test loads is inadequate, pulse indicators are higher than the accepted norm, and recovery takes longer. This may be regarded as an inadequate endurance level or due to individual cardiovascular system peculiarities. Furthermore, lactic indicators after tests align with accepted bodily reactions and loads. The test result explain why swimmer P. is only successful in sprint distances.

Comparing the test results for both swimmers, we conclude that the overall endurance component development level is satisfactory for swimmer V. and unsatisfactory for swimmer P.

On the basis of both swimmers' test results, individual training programs were created to achieve improvement in the proportional development of special endurance components. The tasks were performed over a single season from 6 September 2012 to 2 July 2012. Sports training theory and the criteria of athletic swimming were used to select and systematize efficient interval training series in order to realize the reserve of the weaker components of special endurance (see table 3). The column "intensity" presents the results for the respective distances as a percentage in accordance with the length to be swum for the given exercise. Intensity can be calculated using this formula:

A=R/I 100, where:

A – Training session time, 50m;

R – Exiting result (average time 50m) in concrete test

I – required training set's intensity, in percentage from every specifics test.

Table 3. Basic swimming sets for general development of special endurance

Energy supply mechanisms/ Load capacity	Exercises	Intensity, %
Anaerobic alactic power	2×25 m, i*-15 s	90-92
	2×25 m, i-80 s and more	95-97
Anaerobic alactic capacity	8-16×25 m, i-15 s	88-90
	8-16×25 m, i-80 s and more	93-95
	16×100 m, i-30s	81-84
	8-16×100 m, i-80 s and more	87-89
Anaerobic lactic power	2×50 m, i-20 s	88-90
	2×50 m, i-40 s	90-92
	4×50 m, i-45 s	88-90
Anaerobic lactic capacity	4×100 m, i-20 s	86-87
Aerobic power	2×50 m, i-80 s and more	89-92
	2×200 m, i-60 s	88-90
	4×200 m, i-60 s	85-87
	2×200 m, i-80 s and more	93-95
	4×200 m, i-90 s and more	90-93
Aerobic capacity	10 and more times 50m,100m or 200 m	AnTh** mode, 2000 m and longer distances

*i – rest interval;
** - anaerobic threshold.

For example, analysis revealed that swimmer P. had weak aerobic capacity and power. We proposed the following exercises to realize the aerobic capacity reserve:

1) swimming (2000 m and more) with average result 1min.50 sec in100 m, once per week in September and October;

2) 20*50 m, breaststroke, rest interval-15 s with result 45-47 s three times per week, throughout the training cycle;

3) 8 200 m in anaerobic threshold mode with result 3.05-3.10 once per fortnight from December to March; with

result 3.00-2.59 from March to July; Rest interval 30-40sek.

4) 8-10*100, rest interval-30 s with result 1.24-1.25 from March to July.

An analogous method was used to calculate the training swimming sets results for both swimmers by performing

exercises to develop the individual components of endurance. Taking account of the rather high pulse indictors for swimmer P., we increased the rest intervals when swimming 100 and 200 m. For example, when swimming 16 100 m, during rest intervali-30s swimmer's heart rate was 25 per 10 s,,or 150 per one min .So rest interval was prolonged till heart rate became 20 per 10 s,or 120 per minute.

Comparing repeated test results for both athletes after six months, we concluded that the special exercises helped to improve the lactic capacity and power (K2, K3) indicators for both athletes. Swimmer V. was also able to record an increase in anaerobic capacity (K1, K2). Over six months swimmer P. also achieved improved aerobic capacity indicators. Overall swimmer V. had 9 out of 10 coefficients in the normal range, while swimmer P. only had three. Continuing training by individual training parameters, after the start of the repeated testing season (ten months later), two swimmers' results are presented (see tables 4 and 5).

Table 4. Swimmer's V. tests of the special endurance results (time, heart rate and lactate) at the beginning and at the end of the swimming season.

Load capacity	Alactic power Test A		Alactic capacity Test B		Anaerobic power Test C		Anaerobic capacity Test D		Aerobic power Test E		Aerobic capacity Test F	
Time, s*	30.1	**29.0**	29.75	**29.1**	33.8	**32.7**	36.29	**35.5**	36.65	**35.8**	37.4	**36.9**
Heart rate per 10 s, sum	67	**69**	68	**70**	76	**75**	76	**75**	76	**74**	75	**74**
La, mmol/l	4.7	**4.5**	6.6	**7.0**	12,5	**13.4**	8.5	**8.6**	8.6	**7.8**	9.5	**8.8**

*results at start of season – standard font, end of season - bold.

Results in all tests improved, with no change in pulse indicators. Lactate indicators fell in tests E and F (aerobic power and capacity indicators). The improvement of results with lower pulse indicators indicate increased work economy.

Table 5. Swimmer's P. tests of the special endurance results (time, heart rate and lactate) at the beginning and at the end of the swimming season.

Load capacity	Alactic power Test A		Alactic capacity Test B		Anaerobic power Test C		Anaerobic capacity Test D		Aerobic power Test E		Aerobic capacity Test F	
Time, s*	31.28	**31.1**	31.75	**31.4**	37.65	**35.0**	39.48	**38.11**	41.35	**39.1**	43.22	**40.4**
Heart rate per 10 s, sum	74	**73**	81	**79**	86	**85**	83	**80**	84	**82**	85	**83**
La, mmol/l	7.2	**7.0**	7.5	**7.6**	11.4	**10.5**	9.1	**8.1**	8.5	**8**	10.6	**8.8**

* Results at the beginning of swimming season – standard font, end of season - bold.

Swimmer P. saw an improvement for all test results, as well as a reduction in lactic quantity. Pulse indicators remained high, indicating individual reaction to training loads. Throughout the season the athlete's rest intervals were increased in order to ensure recovery in accordance with the load. Regarding improvement of overall results, we could not achieve proportional development improvement for all special endurance components (see table 6). While the athletes saw improvement in the aerobic endurance components, in comparison with alactic power (maximum speed) two of them remained in development reserve. During the season the four lagging endurance components were raised within normal bounds. There were no changes in the aerobic capacity coefficient or the relationship between maximum speed and anaerobic lactic power and capacity.

Table 6. Comparison of athletes' individual P. coefficients with model indicators

Coefficients	Normal range	First test		Repeated test	
K_1 A/B	0.97-0.99	0.99	Normal	0.99	Normal
K_2 B/C	0.89-0.92	0.83	Lower	0.89	Normal
K_3 C/D	0.95-0.97	0.95	Normal	0.91	Lower
K_4 D/E	0.97-0.99	0.95	Lower	0.97	Normal
K_5 E/F	0.97-0.99	0.95	Lower	0.95	Lower
K_6 A/C	0.87-0.90	0.83	Lower	0.88	Normal
K_7 A/D	0.84-0.87	0.79	Lower	0.81	Lower
K_8 A/E	0.81-0.83	0.75	Lower	0.79	Lower
K_9 A/F	0.79-0.82	0.72	Lower	0.79	Normal
K_{10} D/F	0.93-0.96	0.91	Lower	0.94	Normal

4. Conclusions

In reading the above results, equally increasing proportionate (7%) results across the test sets (percentage of time) assists in determining strengths and weaknesses in the associated tests. The following are conclusions based upon the above results.

1. Using the proposed test system makes it possible to determine and evaluate swimmers' special endurance development level, and on this basis to establish the various components of fitness.
2. The proposed exercises make it possible to implement reserves for improving the weakest components of special endurance, as well as improving the balance of special endurance component development for each athlete individually.
3. The time required to improve the weakest components of endurance depends on the swimmers' individual characteristics.

Discussion: Testing over three sessions allowed recovery of the athletes giving more accurate test results and deeper knowledge and insight into their overall fitness. Upon repeating these tests, athletes and coaches should be aiming to reduce pulse rate and lactate measurements.

To use these test sets beneficially for each swimmer, individualization of each athletes work out is essential. To stay within the correct load, coaches must use an individual swimmer's test results to find the correct pace the athlete should working at. With deviation from that pace, the swimmer will enter an alternate load working a different system. For swimmers not meeting required times, rest periods should be increased to increase the load capacity and allow athletes to achieve the desired (individualized swimming time) outcomes.

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