ADAPTATION OF NAVAL PENTATHLON ATHLETES TO PHYSICAL TRAINING

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Abstract: *Rationally planned training leads to adaptation and progress, and irrational planning leads to disruption of the course of adaptation reactions and overwork. For a rational periodization it is very important to identify training concepts based on detailed analysis of fatigue development mechanisms. Proper planning and execution of training will result in an increase in effort capacity. Adaptation, viewed from a biological point of view, is a complex defense mechanism against the demands caused by environmental changes. This requires an adequate response of the organism to environmental conditions in order to survive under the new conditions. For sports training, adaptation refers to the set of transformations that the athlete's body undergoes in training, in order to develop a superior state of bio-psycho-motor balance, materialized in the easy execution of a task.*

Research objectives:

- ✓ *Initial evaluation of subjects;*
- ✓ *Development of the training program;*
- ✓ *Evaluation of the level of adaptation to physical effort obtained from specific naval pentathlon training;*
- ✓ *Development of a training planning model, allowing the improvement of physical effort capacity by means specific to the naval pentathlon.*

Methods:

The research carried out started from the premise that the appropriate use of training means specific to the naval pentathlon can lead to an improvement of the effort capacity of military students, which fully satisfies their performance needs in fulfilling combat missions arising from the graduate's model. At a preliminary stage of the research, by applying general physical training tests, we obtained an initial assessment of the research subjects. These data were a benchmark in developing the training program and setting effort parameters. The training plan thus designed contains training sessions specific to naval pentathlon trials, adapted to the normal conditions of the naval academy training process.

Results:

The comparative analysis of the results, based on mathematical-statistical and graphical methods, reveals significant increases in performance recorded in the final testing stage. The dynamics of the

results demonstrates a significant evolution of the results of the experimental group carried out during the training program, carried out according to the designed model. This confirms to us the effectiveness of applying the training program. The statistical results confirm a very good evolution of the results for the general motor tests and for the Ruffier test.

Conclusions:

Regular exercise is a particularly important stimulus for adaptation. Sports training, by its specific means, aims to increase the level of performance. In order to achieve this objective, it is necessary to apply a well-defined programme in great detail. Effective training requires constant variability in programming. In addition, in order to maximize the positive transfer of training, the means used in the training lesson should be as close as possible to the characteristics of the effort. Because of this, there is a permanent conflict in training programming, between diversity and specificity. This conflict can only be successfully managed through professional intervention on the part of the coach and involvement of the athlete according to training requirements.

Key Words: naval pentathlon, training, adaptation, effort capacity.

1. INTRODUCTION

In order to define adaptation, it is necessary to make known the term homeostasis. The term homeostasis originates from the Greek homoios (like) and stasis (state), together signifying a state similar to itself. Homeostasis is "*the tendency to maintain normal internal stability in an organism through coordinated responses of organ systems that automatically compensate for environmental changes"* (https://www.yourdictionary.com/homeostasis). The stimulating role of training is to destabilize the body's homeostasis to adapt to a higher state.

Adaptation occurs in response to a "stressor", claims physiologist Hans Selye (1950), who researched this phenomenon . The stress factor will produce adaptive effects only if the intensity and duration with which it acts do not exceed the energetic possibilities of accommodation of the body. If the effort is very strong or long-lasting, exhaustion will set in. Training leads to changes in the athlete's body in many forms, the most important of which is an increase in working capacity. From a biological point of view, training performed in a consistent form serves as an adaptive stimulus. The applications of the principles of adaptation to sports training, argues V. Issurin (2008), aim to increase the effort capacity of the athlete, being conditioned by three general

factors: magnitude of the stimulus (effort parameters: volume, intensity, complexity), specificity and accommodation.

Regular exercise is a particularly important stimulus for adaptation. Sports training, by its specific means, aims to increase the level of performance. In order to achieve this objective, it is necessary to apply a well-defined programme in great detail.

The author V. M. Zatsiorski (1995) argues in his book on strength development that a corresponding adaptation to the specifics of training is achieved only when the effort demand is at a higher level than normal or the athlete is not accustomed to exercise (V.M. Zatsiorski, W.J. KraemerScience and Practice of Strength Training, 1995).

Short-term adaptation it manifests itself during and after performing various exercises, the reactions of athletes are different depending on their level of training. Immediate adaptation reactions are carried out over three phases:

- In the first phase, stimulation of various organs and systems that ensure the conduct of activity occurs: sharply increases heart rate, pulmonary ventilation, oxygen consumption, accumulation of lactic acid in the blood, etc.
- The second phase is characterized by carrying out functional activity at a constant level, also called a "stable state".
- The third phase is specific to disturbance of balance (stable state) due to the discordance between the body's needs and the ability of organs and systems to cope with these needs. The body's reactions to this adaptation are determined by the intensity of the stimulus, the level of training, the athlete's ability to adapt and the ability to recover.

Long-term adaptation it is determined by judiciously performed training, over a long period of time, which produce a hyperfunction of organs and systems. It occurs only if pregnancy stimuli have optimal intensities and durations and are applied systematically. This adaptation is based on multiple transformations in the structure of organs, an increase in the level of functionality of different body systems, a functional harmonization between these systems and organs and an increase in efficiency down to the cellular level. Long-term adaptation is materialized by repeated achievements of short-term adaptation and is achieved in three stages:

- systematic mobilization of the body's functional resources by conducting the training process;
- systematic, planned increase in effort, which causes intensive structural and functional transformations in organs and tissues;
- achieving stable adaptation for a long time, through a close correlation between regulatory and execution organs (VN Platonov, 2015).

Systematic training will perfect neural connections, which will lead to automation in the process of directing and controlling movements. Thus, a dynamic stereotype is formed that will also have influence on functions at the vegetative level. All this will form a unitary system with action to effectively regulate muscle activity.

The adaptation of the central system, represented by the automation of movements, will manifest itself in increased efficiency and economy of the effector system. Long-term adaptation is characterized by the increase of functional reserves made by organs and tissues that in the adaptation process have undergone structural transformations that have increased and streamlined their functioning capacity. The repeated use of excitants leading to mobilization of the system gradually causes the development of long-lasting adaptation.

The efficiency of a system that has reached a long-lasting level of adaptation lies both in a harmony of operation of all its subsystems and in an economy recorded at the cellular level. However, the high degree of adaptation to physical effort can decrease the body's resistance to other aggressive factors in the environment. For example, decreasing the amount of fatty tissue makes it difficult to defend the body against cold, or it can lead to hormonal disorders that delay sexual maturation. Dysregulation of cellular and endocrine immunity can lead to a predisposition to illness of some athletes in periods of intense training.

At the opposite pole, maladaptation appears as a malfunction at the level of the central link, which manifests itself in an inadequate coordination of movements executed with insufficient intensity and duration. In case of maladjustment, there is also a lack of coordination between agonist and antagonist muscles and a lack of coordination between the respiratory, circulatory and muscular systems.

Metabolic adaptation. Metabolism is all changes that take place in the human body, by which food substances introduced into the body are chemically transformed, maintained or destroyed, and by which the resulting energy is made available to cells.

Training produces a series of transformations that can be considered adaptations of metabolism. A complex training program will cover most of the possible adaptations required for the sport practiced. For example, strength training combined with cardio will increase the amount of myoglobin, the compound that stores oxygen in muscles. It will also increase the ability of muscles to store glycogen, which is made available to cells during exercise. Aerobic training increases the body's ability to use fatty acids as an energy source, which is especially important in long-term endurance efforts.

In metabolic adaptation for effort, we can talk about a whole system of providing energy to muscle activity:

- alactacid system that can provide energy in the absence of oxygen, from macroergic sources (ATP, CP). However, the restoration of the system's capacity also occurs aerobically by using ATP at the mitochondrial level;
- the lactacid system (anaerobic glycolysis), which provides cells with energy from glucytic sources in the absence of oxygen;
- the aerobic energy supply system, which is inferior in power and speed of initiation of energy supply to the first two, but is much superior to them in capacity and economy. Aerobic energy can have different sources: glycogen, fatty acids, proteins.

In the study of the phenomenon of adaptation can not miss terms closely related to it, namely: overload, overtraining, overcompensation, maladaptation and readaptation.

Overload is considered to be of prime importance in adapting to effort and must be carefully evaluated and programmed, argues V. Issurin (2008).

Overtraining is a state, manifested by exhaustion and wear of functional systems, caused by the body's inability to defend itself against excessive, repeated, irrationally planned training efforts.

Dysfunctional states can occur in the heart muscle, skeletal muscle or hormonal system. All this can cause a decrease in functional capacity, disturbance of recovery

processes and the development of pathological processes. For example, planning an excessive volume of aerobic-anaerobic training exercises, characteristic of effort in naval pentathlon swimming trials, can quickly cause the phenomenon of overtraining.

Overcompensation as a phenomenon is based on the interaction between stress and recovery. The cycle of overcompensation starts from the physical strain that serves as a stimulus for future reactions. A single load causes fatigue and acute reduction of working capacity, corresponding to the first phase of this cycle. The second phase is characterized by a pronounced recovery process, consisting in increasing above the initial level of working capacity. It will continue to grow, exceeding the initial level and achieving a climate corresponding to the overcompensation phase. In the next phase, the working capacity will return to the preload level. The cycle of overcompensation is the most comprehensive mechanism of improving physical condition, having the role of clarifying the training process in the sense of a beneficial interaction between stress, fatigue and recovery (VN Platonov, 2015).

Disadaptation represents the return of the athlete's body to the initial functional level, due to interruption of training or change in effort parameters. It is clear from the studies carried out that there is no equivalent relationship between adaptation and maladaptation periods. For example, an adaptation of the body to an aerobic effort obtained after a judiciously organized training for five years can be lost within three months of stopping training (Wilmore, Costill, 2009)

Rehabilitation is the process of returning the body to the level of capabilities before maladaptation. Limiting factors of adaptation. Adaptation is closely linked to functional reserves and the ability to capitalize on functional reserves is directly dependent on motivation (Platonov, 2015). Motivation can be the engine of mobilizing functional resources that may seem insufficient analyzing the real possibilities of the individual. However, careful control of the effects of excessive mobilisation of functional resources is necessary. Such responses to periodic requests of a workout can lead to changes inconsistent with the intended purpose.

Physical training. General physical training will aim to obtain an increase in the body's effort capacity and develop motor capacity, improve health, all at a level that

ensures the premises of specific training imposed by the motor diversity of pentathlon samples.

Physical training "*ensures the energy background of performance, stimulating the growth of functional and morphological indices and, consequently, of motor qualities, thus increasing the general effort capacity of the organis, which will allow highlighting the technical-tactical baggage"* (N. Alexe, 1993) specific to naval pentathlon tests. The physical training component has a significant share in the naval pentathlon. Its duration depends on the needs of the five events and the planning of competitions. Most specialists divide the period of physical training into three stages: general physical training, specific physical training and the stage of *perfecting specific motor qualities* (T.O.Bompa, 2014) .

Varied training for pentathlon, due to the need for preparation for each test, can ensure a good evolution in terms of physical training development and helps avoid monotony of training, but at the same time the evolution of athletes in training specific motor skills can be slower due to the low frequency in training for each of the tests. Physical training involves solving two objectives: increasing the physiological potential of the athlete and developing motor qualities specific to the sport practiced (T.O Bompa, G. Haff, 2009).

Table 1. Sequential approach to physical training during one year of training (After T.O.Bompa & Haff, 2009)

Phases of preparation	Preparatory phase		Competition phase
Development phases	1	2	3
Duration (weeks)	≥3	≥6	≥4
	- General physical training	- Specific physical training - Development of specific motor qualities	- Maximizing specific motor qualities - Maintaining the physiological basis

Among the exercises recommended to achieve the goals of general physical training, those of a general nature are selected, in athletics, swimming, sports games, water sports. The specific physical training exercises must be correlated with the learning and consolidation of the motor skills specific to the tests, in order to optimize and improve the executions and adapt them to the requirements of the competition.

Specific physical training must have a solid foundation, represented by general physical training . The primary objective of specific physical training will be to develop the physiological capacity of the athlete in accordance with the requirements of the naval pentathlon trials.

In order to achieve competition-appropriate performances, the physiological demands to which athletes will be subjected in naval pentathlon training must relate correctly to the physiological and technical characteristics of each of the five events.

Making adaptation more efficient by energetically directing effort.

Characterizing effort according to the energy principle involves monitoring the reactions that take place in the body to generate energy and the imbalances produced by these reactions at metabolic level. The measurement of these imbalances produced by effort can be achieved in sports training by careful analysis of two important parameters: heart rate and lactic acid concentration. Both parameters are easy to monitor during exercise due to the evolution of specialized medical equipment.

Analysis of lactic acid levels in the blood brings information that helps to frame the effort performed by the athlete on intensity levels, based on energy-generating reactions.

The accuracy of energetic monitoring of training effort is brought by the correlation between heart rate and lactic acid concentration level. Thus, in a workout carried out at an intensity of 75-80%, the following situations can be encountered that determine the orientation of effort (D. Tocitu, 2000):

- ✓ high heart rate (180 b/min) and low lactic acid level (6.5 mmol/l). In this situation, training should be oriented towards the development of cardiorespiratory capacity through aerobic and aerobic-anaerobic training;
- ✓ low heart rate (160 b/min) and high lactate corresponding to VO2max. (10mmol/l), is the situation corresponding to optimal cardiovascular training but poor training of muscular endurance. For optimization, training will have to be directed to the mixed training area, namely aerobic-anaerobic, through which the metabolic stress of the body will also be monitored; the situation may also indicate the performance of effort against the background of a lack of muscle recovery (lactate concentration is 5 mmol / l in the basal state);

- ✓ high values of both parameters indicate poor training of the athlete;
- ✓ low values of both parameters are an ideal situation for optimal preparation.

Andrei Vorontsov (1990) systematizes effort in eight distinct areas and uses heart rate, percentage of engagement of maximum oxygen consumption, pH in muscles and lactic acid value in blood as variables to differentiate areas.

Table 2. Sistematizarea zonelor de efort de Vorontsov A. (1990)

Zonele Metabolice	Frecvența cardiacă	%VO_2max	pH	Acid lactic (mmol/l)
Aerobic-1	120-140	50-60%	7.42-7.40	0.9-2.0
Aerobic-2	140-160	60-70%	7.40-7.38	2.0-4.0
Aerobic-Anaerobic	160-170	70-90%	7.37-7.33	4.0-8.0
Anaerobic-Aerobic	170-180	90-100%	7.32-7.28	8.0-10.0
Glycolysis-A	185-190 (200)	75-85%	7.27-7.20	9.0-13.0
glycolysis -B	190-210	60-70%	7.20-7.14	12.0-16.0
Glycolysis -C	210-230+	50-60%	7.14-6.95	14.0-20.0
Alactic creatine phosphate	insignificant	insignificant	insignificant	insignificant

2. RESEARCH SUMMARY

2.1. The purpose of the research was to analyze the degree of adaptation of military students to effort using training means specific to naval pentathlon.

2.2. *Research hypothesis*

We assumed that the introduction in the curriculum and the practice by students of naval pentathlon disciplines, as themes within physical education, will facilitate, through the diversity of means and the degree of effort, the optimal increase of physical performance and implicitly a better adaptation to effort of students.

2.3. Research objectives

- ✓ Highlighting the efficiency of training means specific to naval pentathlon;
- ✓ Testing functional capabilities as a means of determining the degree of adaptation to effort of subjects subjected to research

2*.4. Organization and conduct of research*

The evaluation of the effectiveness of naval pentathlon means shall be carried out over a period of three months starting in March. The training plan was divided into two periods. The first period, of four weeks, focused on anatomical training and adaptation

to effort. The second period, of eight weeks, had a specific effort content and aimed in parallel to develop basic skills for approaching exercises specific to naval pentathlon disciplines. The results obtained by the experimental group of the research were compared with the results obtained by the students members of the teams from other military applied sports, which formed the control group. For the training of the control group, various means of general physical training and exercise specific to the sports trials in which they were to participate in competitions were used.

3. RESULTS

Initial testing. Heart rate values in the initial morphological test (Table 3) averaged 82.667 for the experimental group (M1) and 80.8 for the control group (M2). The coefficient of variability corresponding to the two groups indicates a homogeneous population. The difference between the two means is insignificant at $p>0.05$. The mean weight measured in the test is slightly higher in favour of the test group, but not statistically significant, and the coefficient of variability for both groups indicates a population of values with mean homogeneity. The height averages of the subjects are at a small difference, not statistically significant, with a variability coefficient indicating for both groups homogeneous population of values.

The ratio between weight and height, assessed by the Body Mass Index, falls within the values corresponding to a normal weight: M1 ± DS1 - Exp. = 24,153 ± 1,06 and M2 ± DS2 - Ctrl. = 24,107 ± 1,22. The difference between the means of the two groups is statistically insignificant at the materiality threshold $p>0.05$, and the variability coefficient indicates homogeneous value population for both groups of subjects. During the general motor testing, the values recorded by the subjects in the 800m flat, 100m flat run and 500m rowing at the rowing ferry were statistically analyzed.

The average performances recorded for the component subjects of the two groups of research are slightly higher in favor of the experimental group, but the difference is statistically insignificant for all four tests. According to the variability index, the population of values is homogeneous.

Final testing. In Table No. 4, the results obtained in the final test for the test and control groups are presented. According to the results presented in the table, there are significant differences in the performance averages of the two groups in favor of the experiment group, for general motor tests. For morphofunctional testing, comparative analysis of the results of the two groups indicates statistically insignificant differences for measuring heart rate, weight and body mass index.. The significant difference between height averages is due to a slight increase in this parameter, during preparation, in the case of seven of the subjects in the experimental group under research. This difference was calculated at t=1.884, corresponding to materiality p<0.05. The general motor tests were similar to those in the initial test. Recorded statistical parameters indicate statistically significant differences between the experimental and control group in all three applied tests, which confirms a significant efficiency of the training program based on means specific to the naval pentathlon.

Table 3. Main statistical indicators of the research - initial testing

Item No.	Parameters compared	Average		Criteria „Cv"		"t"	"p"
		Experiment group	Control group	Experiment group	Control group		
MORPHOFUNCTIONAL TESTS							
1	F.C.	82,667±5,69	80,8±7,083	6,883	8,766	0,796	>0,05
2	Weight	77,56±8,171	73,413±8,128	10,535	11,072	1,394	>0,05
3	Height	1,789±0,071	1,743±0,094	3,969	5,393	1,512	>0,05
4	B.M.I.	24,153±1,06	24,107±1,22	4,389	5,061	0,11	>0,05
5	Test Ruffier	8,907±1,41	8,713±1,283	15,83	14,725	0,394	>0,05
TESTE ALE MOTRICITĂȚII GENERALE							
1	800m plat	152,333±4,03	152,6±3,979	2,646	2,607	0,183	>0,05
2	100m plat	13,067±0,782	12,809±0,748	5,985	5,84	0,923	>0,05
3	Rowing 500m	111,333±5,407	108,4±10,034	4,857	9,256	0,997	>0,05

Table 4. Main statistical indicators of research - final testing

No crt	Parameters compared	Average		Criteria „Cv"		"t"	"p"
		Experiment group	Control group	Experiment group	Control group		
MORPHOFUNCTIONAL TESTS							
1	F.C.	81±4,598	79,867±6,058	5,677	7,585	0,577	>0,05
2	Weight	77,567±6,605	73,413±8,128	8,515	11,072	1,536	>0,05
3	Height	1,801±0,057	1,75±0,088	3,165	5,024	1,884	<0.05
4	B.M.I.	23,853±0,695	23,787±0,751	2,914	3,157	0,724	>0,05
5	Test Ruffier	7,2±0,941	7,713±0,746	13,069	9,67	1,655	>0,05
GENERAL MOTOR TESTS							
1	800m plat	147,267±4,267	150,667±3,436	2,897	2,281	2,404	<0,025
2	100m plat	12,493±0,608	12,867±0,425	4,867	3,303	1,953	<0,05
3	Rowing 500m	98,467±4,688	107,867±9.97	4,761	9,243	3,304	<0,005

Dynamics of results. The analysis of the dynamics of results (table no.5) aimed to highlight from a statistical point of view the progress obtained by the experimental group following the application of the training program designed within the research work. The statistical indicators analysed were the mean values of the two tests and the specific difference, the coefficient of variability (CV), the index of the independent 't' test, the materiality threshold corresponding to its value (p) and the magnitude of increase (M.Cr.), expressed as a percentage. The analysis of statistical data for the most important indicator of the level of adaptation to effort, represented by the Ruffier test, shows a magnitude of increase of -19.165% and a large intervention effect, with a value of -1.2111, which demonstrates the efficiency of the applied training programs. The results obtained are also apparent from the graphical analysis of the averages obtained in the initial and final tests (Figures 1 and 2).

Table 5. Dynamics of results – experiment group

No crt	Parameters compared	Average		Criteria „Cv"		"t"	"p"
		T.I.	T.F.	T.I.	T.F.		
MORPHOFUNCTIONAL TESTS							
1	F.C.	82,667±5,69	81±4,598	6,883	5,677	3,19	<0,005
2	Weight	77,56±8,171	77,567±6,605	10,535	8,515	0,012	>0,05
3	Height	1,789±0,071	1,801±0,057	3,969	3,165	2,965	<0,01
4	B.M.I.	24,153±1,06	23,853±0,695	4,389	2,914	2,097	<0,05
5	Test Ruffier	8,907 ±1,41	7,2±0,941	15,83	13,069	10,94	<0,0005

GENERAL MOTOR TESTS							
1	800m plat	152,333±4,03	147,267±4,267	2,646	2,897	4,962	<0,0005
2	100m plat	13,067±0,782	12,493±0,608	5,985	4,867	6,246	<0,0005
3	Rowing 500m	111,333±5,407	98,8±4,443	4,857	4,443	6,463	<0,0005

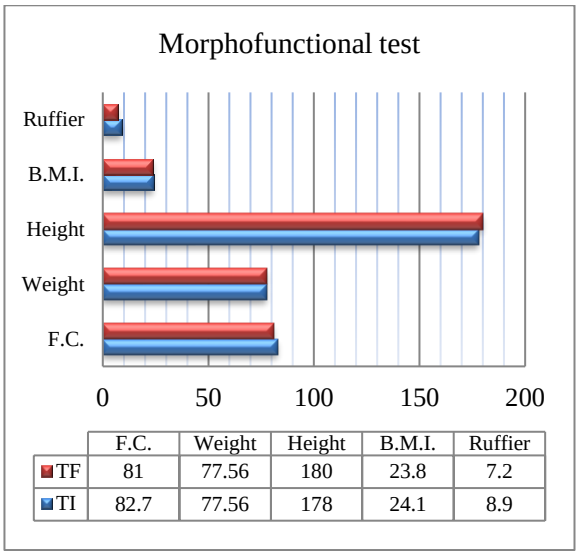

Figure 1. Dynamics of morphological test results

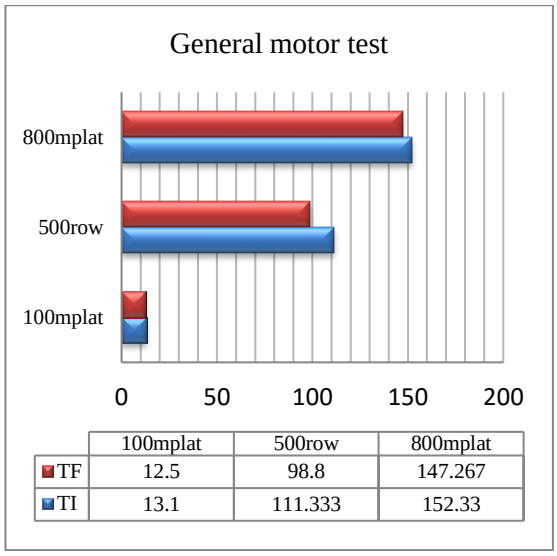

Figure 2. Dynamics of motor test results

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