VASIL LEVSKI NATIONAL SPORTS ACADEMY
Faculty of Sports
Department of Sports Theory

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CONTROL OF SPECIFIC PERFORMANCE IN KAYAK COMPETITORS IN THE 1000 m DISCIPLINE

ABSTRACT

Sofia, 2021

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DISSERTATION WORK
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The dissertation contains 151 standard typewritten pages. It is illustrated with 38 tables, 13 figures and 2 appendices. The bibliography includes 72 literature sources, of which 27 in Cyrillic and 45 in Latin.

The paper was discussed and scheduled for public defense by the Department of Sports Theory at the National Sports Academy "Vasil Levski". The scientific college of the department was expanded by order of the Rector of NSA "Vasil Levski" № 1398 from 29.10.2021 with five habilitated lecturers.

The defense of the dissertation will take place on 02.02.2022 from 14:00 in NSA "Vasil Levski".

INTRODUCTION

The sport of canoeing was created in the middle of the 19th century in London. Since then, it has undergone major technological changes to allow for optimal comfort, speed and performance. Canoe-kayak sprint is one of the endurance sports, but it requires great strength and effective technique over the distance covered. The goal of sprint canoeing is to achieve the highest possible speed for a given racing distance (Csaba Szanto, 2014).

Research on kayaking is mainly focused on the analysis of physiological responses in various tests, to determine the biomechanics of kayaking, to anthropometrically study the somatotype of rowers and to assess overload damage (C. López López y J. Ribas Serna, 2011).

The speed of a kayak boat is determined by a number of factors and can be divided into two major groups - equipment and physiology of the athlete.

The change in the development of the appearance of the kayak boat has undergone serious changes from the early Olympic models, which were made of wood and fabric to the latest models made of light and precise materials - carbon, kevoir and wood. The physiological factors needed to increase the speed of a kayak include the ability to generate high average power, the ability to generate large average forces, effective technical skills, and a large metabolic capacity. It is assumed that a change of 0.3-0.6% in execution time or a 1-2% increase in power output from one season to the next is needed to improve the prospects for medals in kayaking (Don McKenzie, MD, PhD, Bo Berglund, MD, 2019).

Traditionally, research in canoeing has focused primarily on physiological tests of athletes to determine levels of physical fitness and then develops training programs to optimize the physiological condition of the athlete. Earlier studies analyzed only VO_{2max} to monitor and assess physiological capacity in elite kayakers. Nevertheless, the measurement of maximum oxygen consumption in rowers is not the only possible factor determining performance and the anaerobic aspects should not be neglected (Daniel López-Plaza, Fernando Alacid, José María Muyor, Pedro Ángel López-Miñarro, 2017).

Fry and Morton (1991), using a battery of anthropometric and physiological tests, identify the most important attributes for elite kayakers, sprinters. Anthropometric variables such as muscle mass, height, body fat and limb length have been identified as factors contributing to optimal results (Daniel López-Plaza, Fernando Alacid, José María Muyor, Pedro Ángel López-Miñarro, 2017). The relationship between anthropometry and productivity has been confirmed by other studies (van Someren, K.A. and Oliver, J.E, 2001). Ken A. van Someren and Glyn Howatson (2008), provide evidence on which to prescribe training and are stable criteria for selecting appropriate anthropometric and physiological variables for longitudinal observation of kayakers of different genders and ages. However, further research is needed to confirm whether such determinants of performance can be used to predict and to the same extent in a more homogeneous group of kayakers.

The accelerated development of world sports requires special attention to meet the modern requirements for realization on the international field. That is why special attention is needed to the science for the development of sports results and in particular to the control of training, control of the load - "dose - effect", control of physical training, control of technical training. Tracking the listed subsections will give clear information about the condition of the athlete and his preparation in the various stages of training (Dasheva D., 2015).

Therefore, the present study is aimed at studying the relationship between anthropometric and functional indicators with the specific performance in the discipline of kayak 1000 m. Exploring this relationship would help to improve control in the training process and achieve higher results in competitions.

FIRST CHAPTER

1. Characteristics of the sport discipline kayak 1000 m.

1.1. Biomechanical characteristics.

The sprint discipline canoe-kayak is a technical, isokinetic, dynamic sport involving symmetrical (kayak) or asymmetrical (canoe) rhythmic movements. Canoeing is defined as a cyclic endurance sport. The interaction of the components water, meteorological features, boat, paddle and paddler makes the technique very complex and difficult to repeat perfectly every time.

The rowing technique is based on hydrodynamic effects, the laws of physics (mechanics and kinetics) and biomechanics.

The rowing cycle has a complex character, as all units of the whole biomechanical system take part here (carcass, arms, shoulders, paddle and blades, seats, etc.)

This cycle in canoe-kayak sport has a phase character. For greater convenience, it is divided into 2 phases:

- water work (reference phase);
- air work (supportless phase or preparation); (Markov, G., 1983).

The phase structure of movements is one of the most generalized structures, which determines their integrity and purposefulness. The motor composition and the phase distinction depend on the interrelated manifestation of their biomechanical and semantic content. The biomechanical side is manifested in the realization of the laws of biology and mechanics. The semantic content determines the interrelation of the phases in the overall motor action and their orientation to achieve the goals of the movement. (Nikanorov, A., 1989).

The water work phase is the result of the rower's effort applied by rowing in the water.

The air work is the movement of the boat by inertia and preparation of the position of the paddle and the paddler for the next water work.

The rowing cycle in the canoe-kayak, as in other types of rowing, is continuous as each movement is repeated many times and serves the next.

The work effort developed by a kayaker is pulling and pushing.

During 25-30% of the time of the kayak rowing cycle both blades are in the air and the rower rests. Studies show that as the speed of the boat increases, the power of the towing hand and the pushing force increase.

A well-prepared kayaker makes rarer paddles and increases their power, i.e. reduces the time to apply force. (Markov, G., 1983)

According to the difference in water work, there are three styles:

- with abrupt engagement in the water;
- with smooth gearing in the water;
- with smooth gearing and acceleration at the end of the water work;

1.2. **Kinematics of the kayak discipline.**

For the purposes of the analysis, the segments for pulling the paddle (wrist, elbow, shoulder) are defined as those of the lower arm (closest to the water), while the segments of pushing are those of the upper arm.

The interaction of forces arising during shoveling can be divided into the following phases:

- gripping phase - the strength of the blade is the greatest;
- gravity phase - the main phase of the raking, here the most advantageous angles of attack 45° are realized and the maximum force of the paddle is registered;
- repulsion phase - it is the next in efficiency;
- extraction phase - the submerged part of the blade decreases and the effort decreases;

From what has been said so far, the following biomechanical positions of the raking are formed:

The impulse effect of the raking ensures the interaction of the hydrodynamic lifting force and the force of the frontal resistance;

The high impulse effect in the middle phase of the shoveling is realized thanks to the optimal or close to them conditions of force impact of the shovel with the water;

In the final stages, although the blade moves forward, a support force is also created; (Issurin, W., 1989).

1.3. Hydrodynamics of canoeing.

In canoeing, the boat is propelled through the water by paddles (with one or two blades), carrying rowers of different sizes and weights. Freedom of movement is influenced by the resistance, momentum and stability of the boat in the water.

The canoes and kayaks are half submerged in the water. The movement of the boat is limited by a force called hydrodynamic resistance or frontal resistance. The boat and paddles are mostly above the water, where there is aerodynamic drag. Both slow the boat. The water resistance is about 93% and the air resistance is about 7%. The water resistance is formed by the frontal resistance of the boat 2%; friction in the hull of the boat 80%; wave formation 18% (Csaba Szanto, 2014).

- Aerodynamic drag
- Friction resistance
- Resistance to wave formation.

2. Anthropometric indicators.

2.1. Height and physique.

The physique of world-class kayakers and canoeists varies considerably. There were world champions 170 cm tall, while some reached 200 cm in height. Some world champions have a capacity to lift 160 kg from bench press, while others reach only 80 kg.

2.2. Age

Age is an indicator of physical and mental maturity of the individual. Many international sports competitions are classified by age. The definition of youth or adolescents by age in groups is not the same due to the physical and mental activity on which each particular sport is based.

2.3. Body mass and body composition.

Body weight is an important anthropometric characteristic, but it is not an adequate indicator of an individual's muscle mass, so focusing only on this measurement should be avoided.

3. Physiological characteristics of the discipline kayak 1000 m.

The physical characteristics of this discipline determine a time of about 4 minutes to overcome the distance with high frequency and strength of the movements. The relatively short duration of the exercise implies the involvement of the maximum number of motor units in performing the rowing movements. The realization of these movements has its physiological prerequisites in several directions, on which we will dwell briefly.

3.1. Energy supply of muscles during physical work.

The 1000 m kayak discipline uses anaerobic and aerobic-anaerobic energy supply. For contraction, muscles use the energy produced by the cleavage of the molecule of adenosine triphosphate (ATP) to adenosine diphosphate (ADP) and phosphate (F). This energy serves to slide the actin relative to the myosin filaments in the myofibril.

3.2. Types of muscle fibers and their physiological properties.

According to the contractile and metabolic characteristics, muscle fibers are divided into slowly contracting and rapidly contracting. According to the number and order of actin and myosin fibers, muscles are divided into smooth, transversely striated and cardiac muscles.

3.3. Oxygen consumption during muscle work according to its intensity and duration.

From what has been described, it is clear that the largest energy source in the body - fat - cannot be used anaerobically. On the other hand, 1g of glucose through aerobic glycolysis produces 19 times more energy than anaerobic. Therefore, the more oxygen is delivered to the muscles, the more efficiently produced energy will be obtained.

3.4. Physiological indicators of the cardiovascular system determining the performance in the discipline of kayak 1000 m.

Metabolic needs under load with increasing intensity to the maximum can increase by 15 to 20 times. Therefore, the blood flow to the working muscles must increase in proportion to these needs.

3.5. Psychological characteristics of the discipline kayak 1000 m.

It is known that the sports-competitive result depends directly on a number of factors, most often summarized as physical, technical, tactical and mental. (Yancheva T., 2006).

4. Characteristics of the specific motor activity in kayakers 1000 m.

4.1. Canoeing in calm waters is one of the most popular water sports in the world. It is particularly prevalent on the European continent.

5. Control of the training process in sports.

5.1. Control is a process in which information is collected and the actual condition of a competitor and his comparison with the planned (with the model) is assessed. The subject of control are the main factors of sports achievement - motor skills - strength, endurance, speed, agility, flexibility and motor skills and habits. (Daniela Dasheva, 2015).

2. WORKING HYPOTHESIS

The literature review and our systematic observations on the training process raise the question of how the anthropometric and functional indicators of athletes practicing the discipline of kayak 1000 m. affect their specific performance. We assume that height, ATM (active body mass) and stretch will be of the greatest importance for the achievements. From the functional indicators we assume that the greatest influence on the specific performance in the studied discipline will have W_{max} / kg (relative maximum power), VO_{2max} / kg (relative maximum oxygen consumption), HR_{max}, W_{LTD} (power at the lactate threshold determined by the D_{max} method) , W_{LT4} and some of the others, but with a smaller relative share, such as:% W_{maxLTD} (percentage of maximum power at lactate threshold determined by D_{max} method), HR_{LTD} (heart rate at lactate threshold determined by D_{max} method),% HR_{maxLTD} (percentage of HR_{max} at the lactate threshold determined by the D_{max} method), La_{pic} (peak lactate value in the last step), La_{LTD} (lactate value at the lactate threshold determined by the D_{max} method),% La_{picLTD} (percentage of peak lactate at the lactate threshold determined by the D_{max} method).

CHAPTER TWO

PURPOSE, TASKS AND METHODOLOGY OF THE DISSERTATION WORK.

1. The aim of the research is to establish the influence of the morpho-anthropometric features and functional indicators on the sports result of the competitors in the discipline kayak 1000 m.

2. Tasks of the research:

1) To characterize the anthropometric indicators of the studied athletes;
2) To establish the specific working capacity and functional condition of the competitors - kayak 1000 m, through a specialized spiroerogmetric test to failure;
3) To determine the relationship between the studied anthropometric and functional indicators with the sports result (time) at a distance of 1000 m;
4) To establish the relationship between the indicated anthropometric and functional indicators of the studied athletes and the results of the tests for specific performance.
5) To derive regression models of the sports achievement rom the experience.
6) To make a comparative analysis of the anthropometric indicators and the specific working capacity between the Bulgarian national team and other national teams.
7) To determine the indicators that can improve the control of the training process.

3. The object of the study is the specific working capacity in the discipline of kayak 1000 m.
4. The subject of the research are the anthropometric and functional characteristics, and the tests for specific working capacity of the athletes practicing the kayak discipline 1000 m.
5. The subject of the study are 17 rowers, men, average age 19 years, practicing the discipline of kayak 1000 m, in teams with a national level from the Republic of Bulgaria, conducting a regular training process, in good health. The research was carried out during the preparatory phase and immediately before the stage of early competitions of the annual training program.

The subjects who took part in this dissertation are part of the national team, selected by 8 sports clubs - Sports for you and me, Vanto Vidin-Bdin 77, Danube-Georgi Demirev, Asenovets, CSKA, NSA, Levski and Trakia. The cubes are located in the cities of Sofia, Vidin, Ruse, Asenovgrad and Plovdiv. The sports experience of the athletes is in the range of 3-7 years and they are in the process of year-round centralized training in the cities: Kardzhali, Pirdop, Sofia and Plovdiv.

6. Experimental approach to the problem:

6.1. The first stage covers the period 23-25.10.2020 - participation in a control information test (water comb test) to assess the specific physical performance and aerobic and anaerobic capacity of the participants.

6.2. Second stage, covering the period 01-15.02.2021 - Check of the general physical training, through specific strength tests (exercises for overcoming a certain weight-bars and exercises for overcoming one's own weight) and its influence on the sports result at 1000 m.

6.3. The third stage covers the period 15-28.02.2021. - taking part in functional tests: tests to check the current physiological condition of the competitors.

6.4. The fourth stage covers the period 19-20.03.2021. - conducting rowing tests to check the specific working capacity, through tests to determine the aerobic capacity of the subjects, which has a direct impact on the sports result at 1000 m.

7. Mathematical and statistical methods:

The sporting achievement in a canoe-kayak competition is complexly determined and depends on a complex of permanent and variable factors. Permanent factors are the type of boat, the number of crew and the racing distance. The variable factors are obviously the individual characteristics of the athlete - gender, age, personal qualities, incl. functional and technical readiness, moral and volitional qualities, as well as the external conditions for the competition, the condition of the water track, meteorological and climatic conditions. While permanent factors can with certain reservations be considered as constant, which create equal preconditions for the participants, the variable factors are not only highly variable but also difficult to accurately measure and quantify.

From what has been said so far, it is clear that the construction of a mathematical model is impossible due to the large number of factors influencing the disputed result.

As mentioned in this dissertation, the research was conducted in competitive conditions, equal for all kayakers. (Iliev, Il., Dimitrova. A., 1989).

To process the data obtained from the subjects we used the following statistical methods: variation, correlation and regression analysis. We also identified:

7.1. Determination of the second lactate threshold (LT2) by the D_{max} method.

LT2 is defined as the maximum perpendicular distance in a straight line between the first and last measured lactate concentration to the third-order polynomial curve, which represents the kinetics of blood lactate during loading of increasing intensity. The method is prone to variability due to the dependence of the marker on the location of the first and last point of the lactate curve. To eliminate the influence of the location of the first data point, a line is created between the point preceding the first increase in lactate by 0.4 mmol / L and the last reporting point (Bishop D, Jenkins DG, Mackinnon LT., 1998).

7.2. Determination of fan threshold (VT) from the ventilator parameters recorded during the spiroergometric measurement according to the methodology of Iliev I. (1982), adopted in the research center "Dianabad" at the Directorate "COORDINATION AND CONTROL OF SPORTS TRAINING".

Introduction of the results obtained in the separate directions of the methodology in the EXCEL spreadsheet of Microsoft Office 10 and their preparation for statistical analysis through the statistical program SPSS. Variation, correlation and regression analysis with a guaranteed probability of 95% was used.

7.3. Toolkit.

The following apparatus and equipment was used for the study: Boats, paddlers, anemometer, chronometer, caliper, stadiometer, electronic scales, heart rate monitors, heart rate sensors, gas sample measuring mask, gas analyzer, blood pressure monitor pressure, device for measuring lactate samples, comb ergometer, GPS watches, sneakers and comfortable equipment, pull-up lever, couches for the back of the head and face, mat for abdominal presses.

The technical means for measurement were provided entirely by the laboratory for functional research at the DIRECTORATE "COORDINATION AND CONTROL OF SPORTS TRAINING" at the Ministry of Sports - Dianabad. Weight-height meter, medical scale for measuring stretch, caliper, automatic device for measuring blood pressure, kayak simulator Dansprint connected to a computer measuring speed, power, pace and strength of the paddles, gas analyzer COSMED Quark CPET, lactate analyzer.

CHAPTER THREE

RESULTS AND ANALYSIS

1. Quantitative values of morphological, anthropometric and functional indicators for kayakers in a single boat at a distance of 1000 m.

A variational analysis of the data obtained on the mean values, standard deviations, coefficients of variation and the type of distribution of the individual samples was performed. In the table 12 are presented:

Min - minimum value of the sample

Max - maximum value of the sample

X - arithmetic mean of the sample

STDEV - the standard deviation

STERR - standard error of the mean

% V - coefficient of variation

Table 12 Results of the variation analysis.

Indicator	**Min**	**Max**	**X**	**STDEV**	STERR	**%V**
Height (cm)	174.0	189.0	180.38	4.82	1.177	2.67
Weight (kg)	72.8	93.5	82.14	5.82	1.407	7.08
% TM	9.7	13.8	11.22	3.27	0.330	11.31
% MM	47.2	52.0	49.53	1.43	0.325	2.88
MM (kg)	36.25	47.4	40.9	3.09	0.75	7.56
ATM (kg)	64.7	81.8	72.91	5.03	1.204	6.89
Stretch (cm)	174	198	186.41	7.9	1.934	4.23
t1000	216.2	253.5	229.64	10.35	2.512	4.50
Wmax	190	253	218	16.71	4.054	7.66
Wmax / kg	2.35	3.02	2.66	.187	0.044	7.03
VO2max	3900	5500	4594	364.8	88.48	7.94
VO2max / kg	41.7	64.56	56.17	5.41	1.307	9.63
VO2max / MM (kg)	82.27	129.6	112.93	11.3	2.741	10
HRmax	180	210	196.35	8.14	1.974	4.14
WLTD	153	215	174.29	15.85	3.846	9.09
WLT4	137	222	170.5	20.34	4.933	11.93
% WmaxLTD	70.46	84.09	79.20	3.78	0.918	4.77
HRLTD	177	202	187.24	6.52	1.582	3.48
% HRmaxLTD	92.0	98.33	95.39	1.75	0.426	1.83
Lapic	6.9	16.4	10.62	2.47	0.6	23.25
LaLTD	3.6	5.2	4.23	.503	0.122	11.89
% LapicLTD	26.2	66.66	41.64	9.88	2.397	23.72
HR at VT2	176	203	187	7.39	1.795	3.95
VT2-VT1	17	42	29.5	6.24	1.512	21.15
L. leg kg	100	145	124	12.89	3.128	10.39
L. leg / ATM	1.46	1.96	1.7025	.13	0.033	7.63
Dialing	26	63	37.41	9.28	2.253	24.81
Abdominal Press	75	88	78.05	3.89	0.945	4.98
2000 m Average	470.00	561	514.28	22.40	5.435	4.35

The coefficient of variation makes it possible to compare the differences between characteristics expressed in different units of measurement or in relation to different averages. Calculated by the formula:% V = (STDEV / X) .100. In addition to comparing the scatter for the values of different variables, the coefficient of variation is also used to estimate the degree of scattering (sample uniformity): %. Between 10 and 30% of the sample is approximately homogeneous. When it is over 30%, the scattering of the trait is large (the sample is very heterogeneous).

If we look at the results of the variation analysis presented in table 12 it is noteworthy that the coefficient of variation has very low values for the growth of the participants in the study, which may be due to the selection process in the team and the training process, and shows the homogeneity of the sample. These reasons probably lead to a lower coefficient of variation for% MM, the percentage of HR_{max} at which LT is detected by the D_{max} method and HR_{LTD}. Slightly higher scattering was observed at HR_{max}, t1000 and% W_{maxLTD}, but the homogeneity of the sample was very high. This shows relatively similar indicators in all subjects and their close achievements at 1000 m. Approximate homogeneity was observed for La_{pic} and% La_{picLTD} due to greater scattering in peak lactate values. Although blood sampling for lactate concentration testing is technologically advanced and lactate analyzers are becoming more accurate, there is an error of up to 27% in the reported results (Saunders, P. U., 2004).

To determine what statistical methods we will use in the analysis, we checked the normality of the distribution of raw data. We chose the Shapiro-Wilk test (1965), which in most cases is considered one of the most powerful. It represents the relationship between two indicators of variation of the normal distribution, based on a random sample of n number of observations. The samples can be between 3 and 5000 observations. In our data it shows a normal distribution of all examined samples with significance level $p > 0.05$, as can be seen in table 13.

Table 13. Shapiro-Wilk test for normal distribution at $\alpha = 0.05$

Indicator	**Warranty probability - p**
Height (cm)	0.191
Weight (kg)	0.669
% TM	0.099
% MM	0.782
MM (kg)	0.79
ATM (kg)	0.769
Stretch (cm)	0.098
t1000	0.059
Wmax	0.037
Wmax / kg	0.589
VO2max	0.53
VO2max / kg	0.065
VO2max / MM (kg)	0.041
HRmax	0.870
WLTD	0.214
WLT4	0.459
% WmaxLTD	0.270
HRLTD	0.743
% HRmaxLTD	0.5
% LapicLTD	0.604
HR at VT2	0.773
VT2 - VT1	0.481
L. leg kg	0.315
L. leg / ATM	0.918
Dialing (pcs)	0.057
Abdominal press (pcs)	0.002
2000 m Average	0.904

If the guarantee probability $| p |$ is greater than $\alpha = 0.05$, the distribution is assumed to be normal or close to normal. This gives us a reason, in the analysis of the observed phenomena, to use parametric statistical methods, except for the results of abdominal presses, VO_{2max} relative to muscle mass and W_{max}.

If we use the sigma method for creating standards and the five-point scale of Shevko (V. Gigova, 2009) we will get the following verbal estimates of the time to overcome the distance of 1000 m:

High rating - under 208.94 s

Above average - below 219.29 s

Average rating - 229.64 s

Below average score - over 239.99 s

Low score - over 250.34 s

According to this scale, only 2 of the participants in the experiment have an above-average score on time to cover the distance and none a high score. These are the participants with the initials H.R. and K.C. Two with initials A.T. and T.A. are low grade. The others have an average grade. If we look at the table 8 we will see that H.R. and K.C. have VO_{2max} / kg over 60 ml / kg / min, and participants A.T. and T.A. have a value close to VO_{2max} / kg. Other participants with lower VO_{2max} / kg had a better time to overcome 1000 m than A.T. and T.A. Therefore, VO_{2max} / kg is not a major factor in sporting achievement in this kayak distance. If we compare W_{max} / kg, however, we will see higher values for H.R. and K.C. compared to those of A.T. and T.A. When comparing% MM between these two opposite pairs we will see that it is similar. Therefore, it can be expected that Wmax / kg is one of the factors influencing the time to cover the distance of 1000 m.

From the results of table 9 highlights the differences between H.R. and K.C. to A.T. and T.A. only for the indicators W_{LTD} and W_{LT4}, which for H.R. and K.C. are higher. In other words, the power detected at the lactate threshold by the two described methods is higher for H.R. and K.C. to A.T. and T.A ..

If we use the "rule of the three sigmas" in the analysis of the average times of the test "3 x 2000 m rowing" we will get the following distribution:

High rating - under 469.48 s

Above average - below 491.88 s

Average rating - 514.28 s

Below the average score - over 536.68 s

Low score - over 559.08 s

In this specific test, two of the participants had a time above the average score and, as in the distance of 1000 m, none with a high score. These are the same participants from the already considered time scale at 1000 m, namely H.R. and K.Ch .. One of the participants, A.T. is low. table From the results in table 8 shows that

H.R. and K.C. have a higher VO_{2max} / kg and W_{max} / kg than AT. The indicators from table 9 W_{LTD} and W_{LT4} for H.R. and K.C. are higher than those for AT. 10 results for L.leg (kg) are obviously higher for H.R. and K.C. of those of AT.

The findings made on the basis of the five-point scale of Shevko will be subjected to correlation and regression analysis in order to determine the statistical significance of the observations.

Conclusions from the analyzes of quantitative values of morphological, anthropometric and functional indicators: 17 athletes from the national canoe-kayak team, participating in the single kayak 1000 m discipline, took part in the study to check the quantitative indicators of the athletes. After the variation analysis we found the following indicators: regarding the growth of the athletes, we managed to prove that the height of the athletes does not matter on their sports results. Confirmation of the statement we have is from the research done by Csaba Szanto, presented in Table 1 above in this study. He studied athletes from the world's elite who have similar height to the subjects in the dissertation.

In addition to height, we analyzed other indicators of stretch, body weight, body fat and time to overcome a distance of 1000 m. After the comparisons of these quantitative indicators, it was found that our competitors have similar results to those of the world's elite, with the exception of the time to overcome the distance of 1000 m. As we said earlier, our athletes cover the distance in 229.64 s, and the elite athletes cover it in 213 s, The obvious difference of 16.4 s., Are due to other factors that we will try to find through further research in order to improve the sports results of Bulgarian athletes and get closer to those of the elite.

Another quantitative indicator that we found from the current variation analysis is VO_{2max} / kg in the subjects, compared to VO_{2max} /kg of the Italian national team. We found that our competitors had 56.17 ml/kg / min, while the Italians VO_{2max}/kg was 61.4 ml / kg / min, this difference of 5.23 ml/kg / min, although significant, this difference does not affect the result of 1000 m, because as we said earlier, the average distance time for the group of national athletes is 229.64 s, and during the first 120 s the energy supply is entirely at the expense of anaerobic mechanisms, which subsequently go into mixed mode and after its completion are activated aerobic mechanisms. From this it is clear that VO_{2max} / kg does not affect the result at 1000 m, because the activation of oxygen consumption is in the last phase of the distance.

According to the analysis of the lactate threshold, we found a similarity with the studies of other authors, which we applied for comparison to the present study. It has been found that in order to improve sports results, it is necessary to emphasize endurance training, because they are aimed at the lactate, which interacts with the maximum oxygen consumption. The longer the elbow stays below 4 mmol/L, the longer the athlete can maintain the given racing speed.

2. **Relationship between the sporting achievement of a single-seater kayak 1000 m and significant anthropometric and functional indicators in the competitors participating in the present research.**

We investigated the relationship between the time achieved for overcoming a distance of 1000 m kayak during competitions and the indicators recorded in the functional studies of athletes in the DIRECTORATE "COORDINATION AND CONTROL OF SPORTS TRAINING" at the Ministry of Sports - Diana. We used correlation analysis to study this relationship. We traced the relationship between a group of independent variables and the dependent variable | t1000 |. It is used to build a linear mathematical model, with the help of which predictions can be made about the state of | y | at different values for | x |. A coefficient of determination r2 ($-1 \leq r2 \leq 1$) is used to determine the strength of the relationship between two variables. The larger its value in absolute value up to 1, the stronger the dependence between | x | and | y |. When r2> 0, the presence of a correlation dependence means that with increasing | x | the dependent variable | y | also growing. When r <0 with increasing |

x | the variable | y | decreases.

Coefficient of determination, shows what percentage of the scattering of the dependent variable is explained by the action of the independent variable. For example, if r2 = 0.942, then 94.2% of | y | depends on | x |.

The following tables show the coefficients of determination: Pearson r2 | between the observed indicators and their significance. α - indicates the level of significance. Due to the large number of indicators, the correlation matrix is presented in several tables - from table 15 to table 20

Table 15. Correlation matrix 1

1		Height cm	Weight kg	%TM	%MM	% ATM	Разтег cm	t1000	2000 m Average	Wmax	Wmax/kg
Height cm	r^2	1	0.508	0.074	-0.325	0.548	0.855	-0.337	-0.374	0.684	0.21
	α		.037	.779	.203	.023	.000	.185	.140	.002	.419
Weight kg	r^2	.508	1	.247	.002	.977	.317	-.084	-.005	.580	-.384
	α	.037		.339	.995	.000	.215	.748	.986	.015	.128
% TM	r^2	-.074	.247	1	-.036	.034	-.339	.301	.343	.036	-.202
	α	.779	.339		.890	.897	.184	.240	.177	.890	.436
% MM	r^2	-.325	.002	-.036	1	.007	-.341	.128	.008	-.201	-.239
	α	.203	.995	.890		.979	.181	.625	.975	.438	.356
% ATM	r^2	.548	.977	.034	.007	1	.411	-.149	-.076	.589	-.353
	α	.023	.000	.897	.979		.101	.568	.771	.013	.165
Stretch cm	r^2	.855	.317	-.339	-.341	.411	1	-.319	-.441	.544	.257
	α	.000	.215	.184	.181	.101		.212	.077	.024	.320
t1000	r^2	-.337	-.084	.301	.128	-.149	-.319	1	.772	-.584	-.585
	α	.185	.748	.240	.625	.568	.212		.000	.014	.014
2000 m Average	r^2	-.374	-.005	.343	.008	-.076	-.441	.772	1	-.605	-.694
	α	.140	.986	.177	.975	.771	.077	.000		.010	.002
Wmax/kg	r^2	.684	.580	.036	-.201	.589	.544	-.584	-.605	1	.527
	α	.002	.015	.890	.438	.013	.024	.014	.010		.030
Wmax / kg	r^2	.210	-.384	-.202	-.239	-.353	.257	-.585	-.694	.527	1
	α	.419	.128	.436	.356	.165	.320	.014	.002	.030	

On the table 15 shows correlations between anthropometric and morphological indicators, which are not new and will not be discussed in this dissertation. Findings that are confirmatory in nature will only be noted. For example, there is a large correlation between | Growth | and | Stretch |, which has been known for a long time. These findings are simply part of the overall correlation matrix. A significant correlation between W_{max} and body weight and height, as well as with ATM, is also expected. Our interest is focused on the correlation between the time for overcoming a distance of 1000 m (t1000) and some of the anthropometric and morphological indicators from table 15. As can be seen, there is a moderate correlation of t1000 to | Growth |, which, however, is not statistically significant because α is greater than 0.05. This once again confirms the fact that elite canoe-kayakers may be shorter (Csaba Szanto, 2014). For the | Stretch | indicator r2 and α are even less statistically significant. The correlation matrix clearly shows the significant correlation of W_{max} and W_{max} / kg to the distance of 1000 m during the race and to the specific test "3 x 2000 m rowing". This confirms the opinion of the authors mentioned in the literature review that height and extension do not have this significance for the kayak discipline 1000 m, compared to the maximum and relative power obtained in laboratory tests with an ergometer comb. The relationship between the time for overcoming 1000 m - kayak (in water racing) and W_{max} / kg defines this criterion as important for the management and control of the training process. Interesting is the large correlation between the average time "3 x 2000 m rowing" time to overcome 1000 m., Which has a very high statistical significance. This correlation shows the relative consistency in the performance of the participants in the study, as the test "3 x 2000 m rowing" is conducted in March, and the best time to overcome the distance of 1000 m is during the competition period. It is logical to predict the achievements in the competition period according to the performance in the specific test "3 x 2000 m rowing".

Table 16. Correlation matrix 2

2		VO2max kg	VO2max	HRmax	W_{LTD}	W_{LT4}	$\%W_{maxLTD}$	HR_{LTD}	$\%HR_{maxLTD}$
Height cm	r^2	-0.051	0.454	0.1	0.637	0.56	0.124	0.006	-0.229
	α	.846	.067	.701	.006	.019	.634	.981	.377
Weight kg	r^2	-.647	.088	.118	.437	.455	-.041	.068	-.151
	α	.005	.736	.651	.080	.066	.876	.795	.564
%TM	r^2	-.367	-.267	.256	-.157	-.228	-.390	.205	-.200
	α	.147	.301	.321	.546	.379	.122	.431	.441
%MM	r^2	-.053	-.072	-.313	-.297	-.241	-.385	-.267	.200
	α	.839	.783	.221	.248	.352	.127	.300	.443
% ATM	r^2	-.584	.153	.067	.487	.521	.045	.023	-.119
	α	.014	.558	.797	.047	.032	.864	.930	.649
Stretch cm	r^2	.034	.385	.267	.552	.481	.173	.135	-.358
	α	.896	.127	.299	.022	.051	.507	.605	.159
t1000	r^2	-.236	-.378	-.076	-.504	-.572	-.053	-.089	.006
	α	.362	.135	.772	.039	.016	.840	.734	.983
2000m	r^2	-.405	-.512	.009	-.629	-.604	-.256	-.120	-.236
Medium	α	.107	.036	.973	.007	.010	.321	.645	.362
Wmax	r^2	-.018	.511	.112	.841	.798	.114	.101	-.076
	α	.946	.036	.668	.000	.000	.664	.700	.772
Wmax/kg	r^2	.624	.444	.033	.485	.415	.162	.080	.072
	α	.007	.075	.899	.049	.097	.533	.761	.785

On the table 16 shows that there is a significant correlation of | t1000 | compared to W_{LTD} (lactate threshold power determined by the D_{max} method), and compared to W_{LT4} (lactate threshold power fixed at 4 mmol/L), it is even higher. The relationship with both indicators is negative, i.e. increasing them reduces the time to cover the distance. α is below 0.05, therefore the correlation is statistically significant. Although the lactate threshold determined by the D_{max} method is more reliable, many trainers continue to use a fixed lactate concentration of 4 mmol / L as the lactate threshold (Svedahl, K., and MacIntosh, B.R., 2003).

The reliability of lactate threshold determinants varies from sport to sport. For the 1000 m kayak discipline, our results show that W_{LT4} is a more sensitive indicator.

A significant correlation between the maximum oxygen consumption (VO_{2max}) in relation to body weight and ATM is a completely expected result, taking into account the specifics of the kayak discipline, 1000 m and the functional changes that are caused by a regular training process. However, these observations have already been well described by other authors before us. Interestingly, there is a significant correlation between W_{LTD} on the one hand in terms of height and stretch of participants on the other. The relationship between height and extension as anthropometric indicators is also expected and described before us.

Table 17. Correlation matrix 3

3		LT_{pic}	La_{LTD}	$\%LT_{picLTD}$	HR VT2	VT2-VT1	MM/kg	VO_{2max}/MM(kg)
Height cm	r^2	0.014	-0.056	0.065	0.122	-0.179	0.35	0.032
	α	.959	.830	.803	.641	.492	.168	.904
Weight kg	r^2	-.057	-.175	.011	.192	-.076	.935	-.618
	α	.827	.503	.968	.461	.773	.000	.008
% TM	r^2	-.091	.279	.200	.216	-.257	.223	-.335
	α	.728	.278	.441	.404	.320	.389	.189
% MM	r^2	.054	.165	-.045	-.351	-.291	.356	-.315
	α	.838	.527	.863	.167	.257	.161	.218
% ATM	r^2	-.044	-.242	-.028	.150	-.018	.914	-.561
	α	.865	.349	.916	.565	.945	.000	.019
Stretch cm	r^2	-.010	-.016	.089	.224	-.041	.167	.118
	α	.968	.951	.734	.388	.875	.521	.651
t1000	r^2	-.126	.378	.317	-.235	.059	-.035	-.260
	α	.630	.135	.215	.363	.821	.893	.313
2000 m Average	r^2	.156	.177	-.082	-.099	.189	.001	-.388
	α	.551	.497	.754	.706	.468	.997	.123
Wmax	r^2	.007	-.237	-.137	.217	-.264	.473	.035
	α	.978	.360	.601	.402	.306	.055	.895
Wmax/kg	r^2	.075	-.069	-.165	.079	-.207	-.439	.658
	α	.776	.791	.526	.763	.424	.078	.004

In order to determine the significance of the maximum oxygen consumption in the kayak discipline 1000 m, we related VO_{2max} to muscle mass in kg. This indicator reflects the oxygen consumption only of the muscle tissue active during rowing and will reflect the aerobic energy supply. From table 17 shows the significant correlation between W_{max} / kg and VO_{2max} / MM (kg), which is probably due to maximum oxygen uptake by working muscles at the end of the test. However, this absorption depends on the ratio between the different types of muscle fibers, which is individual for each of the participants.

Table 18 Correlation matrix 4.

4		Height cm	Weight kg	%TM	%MM	% ATM	Stretch cm	t1000	2000 m Average	Wmax	Wmax/kg
VO2max_kg	r^2	-.051	-.647	-.367	-.053	-.584	.034	-.236	-.405	-.018	.624
	α	.846	.005	.147	.839	.014	.896	.362	.107	.946	.007
VO2max	r^2	.454	.088	-.267	-.072	.153	.385	-.378	-.512	.511	.444
	α	.067	.736	.301	.783	.558	.127	.135	.036	.036	.075
HRmax	r^2	.100	.118	.256	-.313	.067	.267	-.076	.009	.112	.033
	α	.701	.651	.321	.221	.797	.299	.772	.973	.668	.899
W_{LTD}	r^2	.637	.437	-.157	-.297	.487	.552	-.504	-.629	.841	.485
	α	.006	.080	.546	.248	.047	.022	.039	.007	.000	.049
W_{LT4}	r^2	.560	.455	-.228	-.241	.521	.481	-.572	-.604	.798	.415
	α	.019	.066	.379	.352	.032	.051	.016	.010	.000	.097
$\%W_{maxLTD}$	r^2	.124	-.041	-.390	-.385	.045	.173	-.053	-.256	.114	.162
	α	.634	.876	.122	.127	.864	.507	.840	.321	.664	.533
HR_{LTD}	r^2	.006	.068	.205	-.267	.023	.135	-.089	-.120	.101	.080
	α	.981	.795	.431	.300	.930	.605	.734	.645	.700	.761
$\%HR_{maxLTD}$	r^2	-.229	-.151	-.200	.200	-.119	-.358	.006	-.236	-.076	.072
	α	.377	.564	.441	.443	.649	.159	.983	.362	.772	.785

Table 18 shows a significant correlation between | W_{max} / kg | and | VO_{2max}/kg | with significant statistical reliability (α lower than 0.05), which is also an expected result and shows that there are no major random errors in the study in terms of methodology and procedure. We described a significant correlation between W_{LTD}, W_{LT4} and t1000, but did not find one between% W_{maxLTD} and t1000. The reason for the observed discrepancy is probably due to the fact that not every participant reaches its actual maximum power (W_{max}). When conducting the experiment, each of them works differently for a long time in the last stage of the load before reaching failure. I.e. at the same power, the subjects work for different lengths of time, which probably leads to some inaccuracy in the determination of W_{max}. These are methodological features of step tests. It would be good to do additional research on the relationship between% W_{maxLTD} and t1000.

The significant correlation between the time for overcoming 1000 m and the average time from the test "3 x 2000 m rowing" on the one hand and W_{LTD} and W_{LT4} on the other is impressive. While for t1000 the correlation is higher with W_{LT4}, for "3 x 2000 m rowing" it is higher for W_{LTD}. This is probably due to the different duration of the two loads, which causes a different degree of activation of the aerobic energy supply and a different degree of lactate production. MLSS causes a blood lactate concentration of about 4 mmol / L. In addition, MLSS has high variability among athletes (2 to 8 mmol/L in capillary blood) and this variability is not related to performance (Veronique L. Billat, 2003).

The significant correlation between VO_{2max} and the average time of the test "3 x 2000 m rowing" and the lack of such a relationship with the time to overcome 1000 m once again confirms the conclusion based on the literature review that the kayak discipline 1000 m VO_{2max} is of great importance, but it is not a major factor in sports performance.

Table 19. Correlation matrix 5. Visualizes the relationship between anthropometric and

physiological indicators and the described physical tests.

5		$VO_{2max}kg$	VO_{2max}	HR_{max}	W_{LTD}	W_{LT4}	$\%W_{maxLTD}$	HR_{LTD}	$\%HR_{maxLTD}$
VO2max_kg	r^2	1	.699	-.316	.254	.221	.458	-.175	.395
	α		.002	.216	.326	.394	.065	.503	.117
VO2max	r^2	.699	1	-.320	.730	.708	.542	-.203	.343
	α	.002		.210	.001	.001	.025	.435	.178
HRmax	r^2	-.316	-.320	1	-.050	-.100	-.278	.900	-.569
	α	.216	.210		.848	.703	.280	.000	.017
W_{LTD}	r^2	.254	.730	-.050	1	.959	.595	.037	.175
	α	.326	.001	.848		.000	.012	.889	.501
W_{LT4}	r^2	.221	.708	-.100	.959	1	.601	-.038	.149
	α	.394	.001	.703	.000		.011	.884	.569
$\%W_{maxLTD}$	r^2	.458	.542	-.278	.595	.601	1	-.094	.456
	α	.065	.025	.280	.012	.011		.718	.066
HR_{LTD}	r^2	-.175	-.203	.900	.037	-.038	-.094	1	-.153
	α	.503	.435	.000	.889	.884	.718		.557
$\%HR_{maxLTD}$	r^2	.395	.343	-.569	.175	.149	.456	-.153	1
	α	.117	.178	.017	.501	.569	.066	.557	

From the results shown in table 19 it is obvious that% W_{maxLTD} (percentage of maximum power at the lactate threshold) is positively related to W_{LTD} (power at the lactate threshold determined by the D_{max} method) with sufficient statistical significance. The correlation is significant. I.e. as W_{LTD} increases, so does% W_{maxLTD}. It is known that the higher the threshold, the higher the aerobic endurance (Laurent Bosquet, 2002). Probably the higher the% W_{maxLTD}, the greater the endurance of the athlete.

The relationship between HR_{max} and% HR_{maxLTD} shows a significant correlation, and the correlation between HR_{max} and HR_{LTD} is large. HR_{max} connects them because there is no correlation between% HR_{maxLTD} and HR_{LTD}. As HR_{max} increases, so does the HR at the lactate threshold determined by the D_{max} method. The observed correlations are probably due to the linear relationship between heart rate and exercise intensity (Stefanov L., 2017).

Lawton (2011), reviewed rowing strength tests and training and identified strength tests that are reliable and valid correlates (predictors) of rowing ergometer performance. They created strength, power and muscular endurance exercises for weight training, which are strong determinants of success in measuring specific performance, used to assess elite rowers using rowing ergometers. (Lawton et al., 2011). Here they raise the question of the validity of the performance of a comb ergometer. We analyze strength capabilities in a gym and specific water tests, which is an advantage of our study.

The systematic meta-analysis of Dirk Thiele (2020), showed that strength training is an effective means of improving the maximum strength of the lower limbs and the specific performance of rowers. However, the effects induced by strength training are not modulated by either the type of strength training or the level of the rowers (Dirk Thiele, 2020). The results of our study confirm the importance of relative muscle strength for the specific performance in the discipline of kayak 1000 m and show that further and more detailed research is needed in this direction.

Table 20. Correlation matrix 6.- Relationship between specific tests and tests for general physical

training.

6		t_1000	W_{max}	VO_{2max}	W_{LTD}	W_{LT4}	Face lay	pull ups	Abdominal press no Face lay	2000 m Average
t_1000	r^2	1	-.584*	-.378	-.504*	-.572*	-.104	-.167	.207	.772**
	α		.014	.135	.039	.016	.693	.521	.426	.000
W_{max}	r^2	-.584*	1	.511*	.841**	.798**	.623**	-.147	-.226	-.605*
	α	.014		.036	.000	.000	.008	.575	.382	.010
VO_{2max}	r^2	-.378	.511*	1	.730**	.708**	.331	.084	-.066	-.512*
	α	.135	.036		.001	.001	.195	.749	.802	.036
W_{LTD}	r^2	-.504*	.841**	.730**	1	.959**	.513*	.014	-.318	-.629**
	α	.039	.000	.001		.000	.035	.959	.214	.007
W_{LT4}	r^2	-.572*	.798**	.708**	.959**	1	.468	-.036	-.491*	-.604*
	α	.016	.000	.001	.000		.058	.892	.045	.010
Face lay	r^2	-.104	.623**	.331	.513*	.468	1	.014	-.347	-.423
	α	.693	.008	.195	.035	.058		.959	.172	.091
pull ups	r^2	-.167	-.147	.084	.014	-.036	.014	1	.127	-.379
	α	.521	.575	.749	.959	.892	.959		.627	.134
Abdominal press no Face lay no	r^2	.207	-.226	-.066	-.318	-.491*	-.347	.127	1	.216
	α	.426	.382	.802	.214	.045	.172	.627		.406
2000 m Average	r^2	.772**	-.605*	-.512*	-.629**	-.604*	-.423	-.379	.216	1
	α	.000	.010	.036	.007	.010	.091	.134	.406	

On the table 20 we find a large correlation between the weight lifted in the supine position and W_{max}, which is absolutely logical and we will not discuss it. Two other significant correlations that we found were those between the power obtained at the lactate threshold by the D_{max} method with the weight lifted at the frontal leg and the average time from the specific test 3 x 2000 m. The statistical significance of these two correlations is α = 0.035 and α = 0.007, respectively. This cross-link confirms the importance of W_{LTD} and W_{max} / kg for specific performance and proves the point of using the weight lifted in the supine position as a specific test for the kayak discipline, but more research is needed to link it to athletic performance. The other correlations have already been discussed in the previous tables.

Conclusions from the analyzes of the relationship between the sporting achievement of a single kayak 1000 m and significant anthropometric and functional indicators: After the correlation analyzes, we confirmed our statement that the height and extension do not interact with the sports result, or in other words, the kayakers do not have to be tall.

Unlike height and extension, which do not affect the sports result, W_{max}/kg affects the control of the training process and the sports result.

The statistical significance between the average time of the test "3 x 2000 m rowing" and t1000 m, proves that if the work process in the preparatory period is focused on training for the development of endurance and speed endurance, it will permanently improve the sports result at the distance of 1000 m.

The relationship between the time to cover the distance of 1000 m with the lactate once again proves that the result that the athlete shows during the competition and training is directly influenced by the pH level in the muscles and blood. We explained this dependence in the variation analysis, and thanks to the correlation dependence we confirm the statement that endurance training will contribute to keeping lactate values at a low level for as long as possible is the stage of the competition.

Regarding the interaction between VO_{2max}, in relation to body weight and ATM, we believe that it is logical, because the changes that occur during the training - competition processes thanks to the energy supply are normal. The stages of activation of the occurring processes (anaerobic, mixed and aerobic energy supply, influence the dynamics of the power capabilities of the kayakers.) Are also the appearance of the achieved results.

The correlation between relative maximum power and relative oxygen consumption is normal and clear. This relationship will explain it with the constant and correct training activities of the kyakaras, participants in the test. The power developed by each athlete is different, because the test in a laboratory environment was conducted to failure, but with good training, their results are quite similar and thanks to the uniformity of the training program, this significant correlation can be seen.

The interaction between the test of "3 by 2000 m" and t1000 m is proved by both the variation analysis and the correlation analysis. The sequence of the training stages in the annual cycle shows that the test of "3 by 2000 m" (conducted in the stage of early competitions) affects the sports result of a single kayak 1000 m (conducted in the competition period). The interconnection is logical and with proper implementation of the annual program there is a gradual but steady improvement in the time to overcome the distance.

The significant correlation between the endurance test from the Face lay and Wmax is logical, because as the strength endurance increases, so does the power to perform an action. With the increase of the strength, the sports result improves both in the dry trainings and tests, as well as in the tests in real water conditions.

3. Models for optimizing the control of competitors in single kayak 1000 m.

Table 28 W_{LTD} versus t1000

Model	r^2	α	Constant	b1
Linear	.254	.039	287.052	-.329
Logarithmic	.257	.038	536.009	-59.407
Exponential	.259	.037	293.840	.999
Degree	.262	.036	858.205	-.256

The result t1000
Factor W_{LTD}

A statistically significant correlation from our study was found between W_{LTD} versus t1000. From table 28. it can be seen that α is below 0.05, therefore all four models adequately describe the data reflecting the relationship between W_{LTD} and t1000. However, if we compare the coefficients of certainty r2 we will see that the power model with 26.2% is the most adequate.

$\hat{y} = ax^b$ where:

x - independent variable, factor

y - the dependent variable, result

a - this coefficient is in the column "Constant"

b - is in column “b1”

W_{LTD} occupies values between 153 and 215

b = -0.256

a = 858.205

If we substitute in the formula we will get the following results for each W_{LTD} presented in table 29.

Table 29. Seconds required to cover 1000 m for each W_{LTD}. Difference (s) reflects the difference in seconds for every 1 Watt of W_{LTD}.

W_{LTD} (W)	**t1000 (s)**	**The difference (s)**	**W_{LTD} (W)**	**t1000 (s)**	**The difference (s)**
153	236.76		185	225.53	-0.31
154	236.37	-0.39	186	225.21	-0.31
155	235.98	-0.39	187	224.91	-0.31
156	235.59	-0.39	188	224.60	-0.31
157	235.20	-0.39	189	224.29	-0.30
158	234.82	-0.38	190	223.99	-0.30
159	234.44	-0.38	191	223.69	-0.30
160	234.06	-0.38	192	223.39	-0.30
161	233.69	-0.37	193	223.09	-0.30
162	233.32	-0.37	194	222.80	-0.29
163	232.95	-0.37	195	222.51	-0.29
164	232.59	-0.36	196	222.22	-0.29
165	232.23	-0.36	197	221.93	-0.29
166	231.87	-0.36	198	221.64	-0.29
167	231.51	-0.36	199	221.35	-0.29
168	231.16	-0.35	200	221.07	-0.28
169	230.81	-0.35	201	220.79	-0.28
170	230.46	-0.35	202	220.51	-0.28
171	230.11	-0.35	203	220.23	-0.28
172	229.77	-0.34	204	219.95	-0.28
173	229.43	-0.34	205	219.68	-0.28
174	229.09	-0.34	206	219.40	-0.27
175	228.76	-0.34	207	219.13	-0.27
176	228.42	-0.33	208	218.86	-0.27
177	228.09	-0.33	209	218.59	-0.27
178	227.76	-0.33	210	218.32	-0.27
179	227.44	-0.33	211	218.06	-0.27
180	227.11	-0.32	212	217.80	-0.26
181	226.79	-0.32	213	217.53	-0.26
182	226.47	-0.32	214	217.27	-0.26
183	226.15	-0.32	215	217.01	-0.26
184	225.84	-0.32			

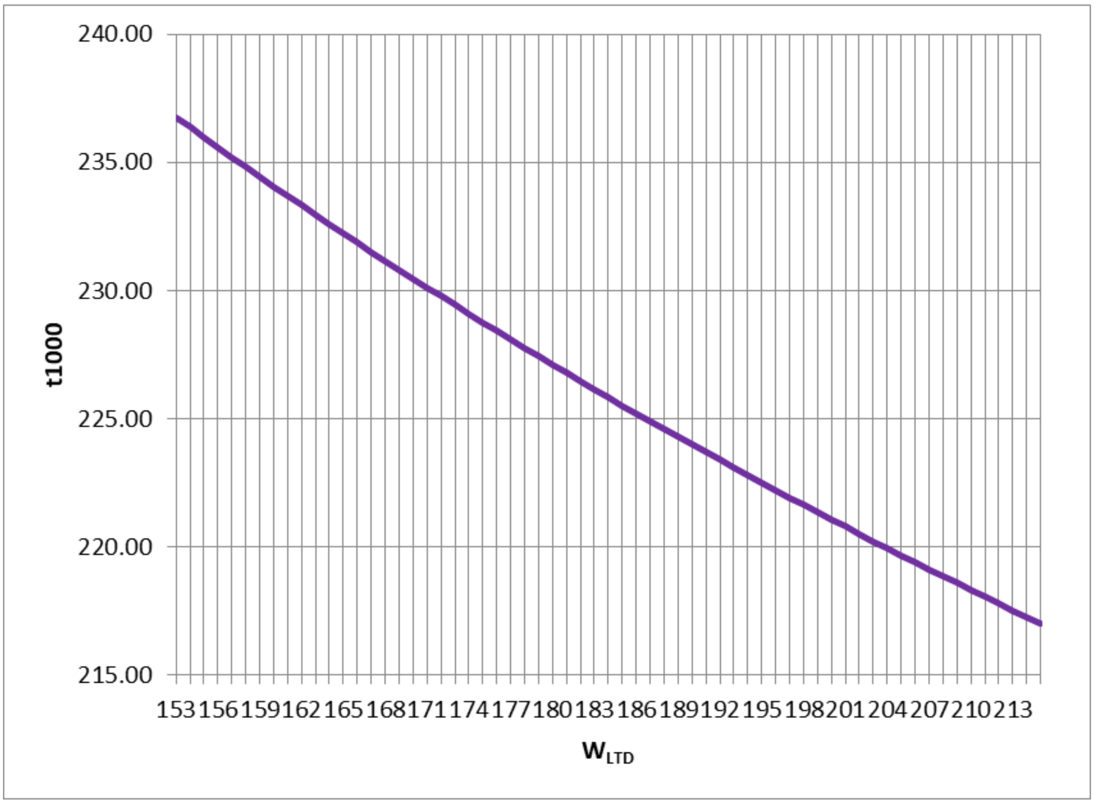

Figure 13. Depicts the relationship between W_{LTD} and t1000.

In FIG. 13 graphically shows the relationship between W_{LTD} and t1000. From table. 28 it can be seen that according to the mathematical model with increasing the power at the lactate threshold by 1 W the time for passing the distance decreases by between 0.39 s to 0.26 s. This systemic slight decrease in performance with increasing W_{LTD} (0.39 s to 0.26 s) is probably due to an increase in pH in the muscles and in the blood. Under these conditions, the rate-determining enzymes of glycolysis reduce their effectiveness (Stefanov L., 2017).

For coaches and athletes, this means that if, as a result of the training process, the power achieved at the lactate threshold determined by the D_{max} method is increased by 10 W, the time to overcome the distance of 1000 m. will shorten by between 3.9 to 2.6 seconds. Such a test is performed in the laboratories for functional diagnostics by loading with increasing intensity of a comb ergometer, to failure.

Table 30 W_{LT4} versus t1000.

Model	r^2	α	Constant	b1
Linear	.327	.016	279.311	-.291
Logarithmic	.344	.013	497.284	-52.147
Exponential	.347	.013	721.667	-.223
Degree	.331	.016	283.911	-.001
The result	t1000			
Factor	W_{LT4}			

A statistically significant correlation from our study was also found between W_{LT4} versus t1000. From table. 30 shows that α is below 0.05, therefore all four models adequately describe the data reflecting the relationship between W_{LT4} and t1000. However, if we compare the coefficients of certainty r^2 we will see that the power model with 34.7% is the most adequate.

ŷ = axb where:

x - independent variable, factor

y - the dependent variable, result

a - this coefficient is in the column "Constant"

b - is in column “b1”

W_{LTD} takes values between 137 and 222

b = -.223

a = 721,667

If we substitute in the formula we will get the following results for each W_{LT4} presented in table 31

W_{LT4} (W)	**t1000 (s)**	**Difference (s)**	**W_{LTD} (W)**	**t1000 (s)**	**Difference (s)**	**W_{LTD} (W)**	**t1000 (s)**	**Difference (s)**
137	240.91		172	228.99	-0.30	207	219.72	-0.24
138	240.52	-0.39	173	228.69	-0.30	208	219.49	-0.24
139	240.13	-0.39	174	228.40	-0.29	209	219.25	-0.23
140	239.75	-0.38	175	228.11	-0.29	210	219.02	-0.23
141	239.37	-0.38	176	227.82	-0.29	211	218.79	-0.23
142	238.99	-0.38	177	227.53	-0.29	212	218.56	-0.23
143	238.61	-0.37	178	227.24	-0.29	213	218.33	-0.23
144	238.24	-0.37	179	226.96	-0.28	214	218.10	-0.23
145	237.88	-0.37	180	226.68	-0.28	215	217.87	-0.23
146	237.51	-0.36	181	226.40	-0.28	216	217.65	-0.23
147	237.15	-0.36	182	226.12	-0.28	217	217.42	-0.22
148	236.79	-0.36	183	225.84	-0.28	218	217.20	-0.22
149	236.44	-0.36	184	225.57	-0.27	219	216.98	-0.22
150	236.09	-0.35	185	225.30	-0.27	220	216.76	-0.22
151	235.74	-0.35	186	225.03	-0.27	221	216.54	-0.22
152	235.39	-0.35	187	224.76	-0.27	222	216.32	-0.22
153	235.04	-0.34	188	224.49	-0.27			
154	234.70	-0.34	189	224.23	-0.27			
155	234.37	-0.34	190	223.96	-0.26			
156	234.03	-0.34	191	223.70	-0.26			
157	233.70	-0.33	192	223.44	-0.26			
158	233.37	-0.33	193	223.18	-0.26			
159	233.04	-0.33	194	222.92	-0.26			
160	232.71	-0.33	195	222.67	-0.26			
161	232.39	-0.32	196	222.41	-0.25			
162	232.07	-0.32	197	222.16	-0.25			
163	231.75	-0.32	198	221.91	-0.25			
164	231.43	-0.32	199	221.66	-0.25			
165	231.12	-0.31	200	221.42	-0.25			
166	230.81	-0.31	201	221.17	-0.25			
167	230.50	-0.31	202	220.92	-0.24			
168	230.19	-0.31	203	220.68	-0.24			
169	229.89	-0.30	204	220.44	-0.24			
170	229.59	-0.30	205	220.20	-0.24			
171	229.29	-0.30	206	219.96	-0.24			

From table 31 it can be seen that according to the mathematical model with increasing the power at the lactate threshold by 1 W the time of passing the distance decreases by between 0.39 s to 0.22 s. We found a similar change in the model describing the relationship between W_{LT4} and t1000.

In FIG. 14 graphically shows the relationship between W_{LT4} and t1000.

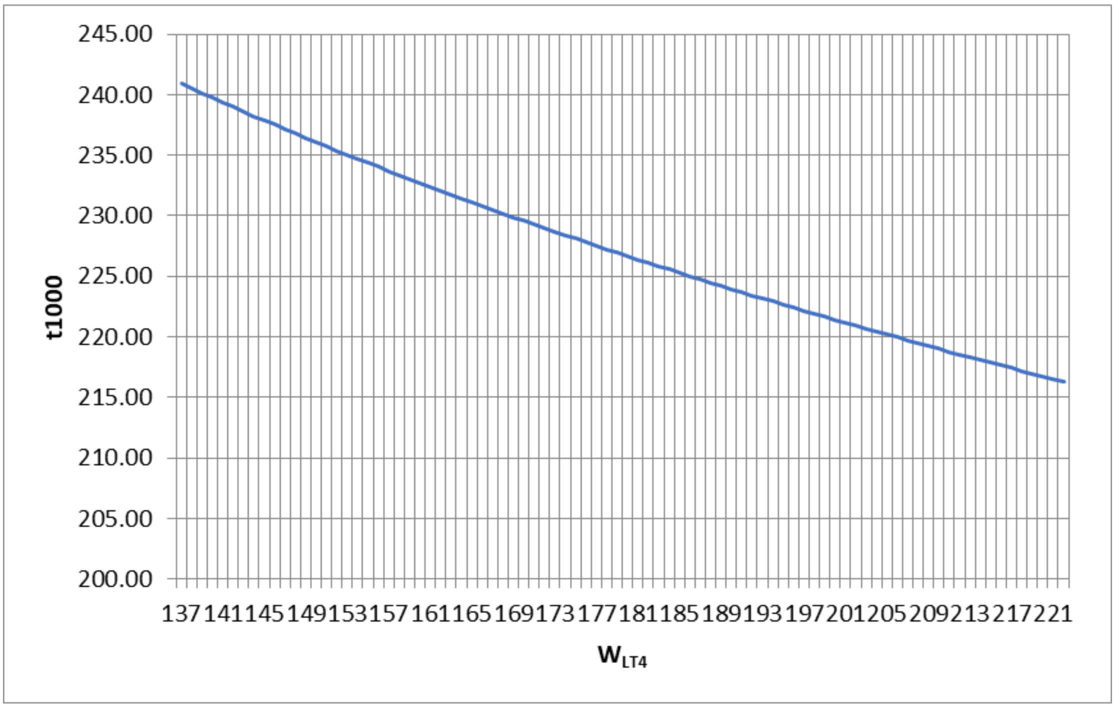

Figure 14 Depicts the relationship between W_{LT4} and t1000.

Table 32. Wmax / kg versus t1000.

Model	r^2	α	Constant	b1
Linear	.345	.013	316.247	-32.508
Logarithmic	.337	.015	313.256	-85.533
Exponential	.356	.011	334.052	.868
Degree	.348	.013	329.741	-.371

The result t1000

Factor W_{max}/kg

As we found in the correlation analysis (Table 15 and Table 16), there is a moderate correlation between W_{max} / kg and t1000. From table 32 shows that α is below 0.05, therefore all four models adequately describe the data reflecting W_{max} / kg relative to t1000. However, if we compare the coefficients of certainty r^2 we will see that the most adequate is the exponential model with 35.6%. However, we focused on the power model because, according to the correlation analysis, the relationship is negative, and in addition, the other factor (W_{LTD}), which showed a moderate correlation, is also described by the power model. From table 33 shows that all models adequately describe the relationship.

ŷ = axb where:

x - independent variable, factor

y - the dependent variable, result

a - this coefficient is in the column "Constant"

b - is in column “b1”

W_{max} / kg is in the range of 2.35 to 3.02 W / kg

b = -.371

a = 329,741

Table 33. Seconds required to cover 1000m for each Wmax / kg. Difference (s) reflects the difference in seconds for each 0.05 Watt / kg of Wmax / kg.

W_{max}/kg	**t1000(s)**	**difference (s)**
2.35	240.16	
2.4	238.29	-1.87
2.45	236.48	-1.82
2.5	234.71	-1.77
2.55	232.99	-1.72
2.6	231.32	-1.67
2.65	229.69	-1.63
2.7	228.11	-1.59
2.75	226.56	-1.55
2.8	225.05	-1.51
2.85	223.58	-1.47
2.9	222.14	-1.44
2.95	220.73	-1.40
3	219.36	-1.37
3.02	218.82	-0.54

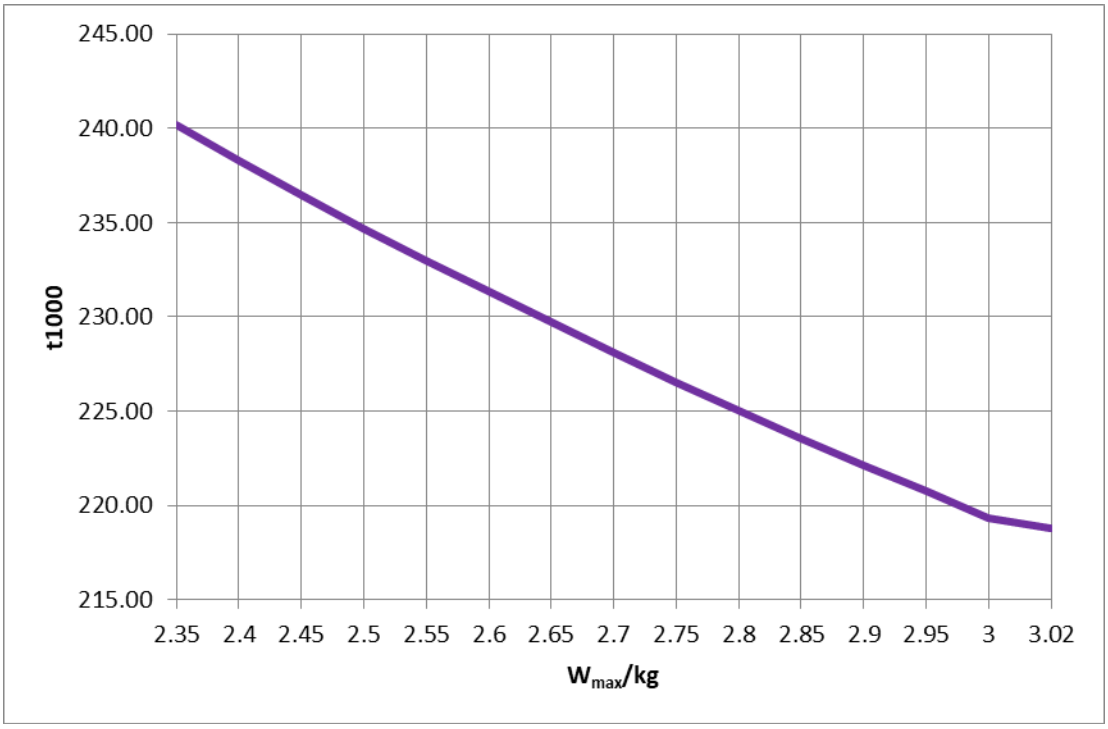

Figure 15. Depicts the relationship between Wmax / kg and t1000.

In FIG. 15 graphically shows the relationship between W_{max} / kg and t1000. From table. 33 shows that according to the mathematical model with increasing W_{max} / kg by 0.05 W the time for overcoming the distance of 1000 m decreases by between 1.87 s to 1.37 s.

Table 37 2000 m Average compared to t1000.

Model	r^2	α	Constant	b1
Linear	.596	.000	46.063	.357
Logarithmic	.589	.000	-909.619	182.519
Exponential	.597	.000	1.724	.784
Degree	.603	.000	104.387	.002

The result t1000
Factor 2000m Average

A statistically significant correlation from our study was found between the time in seconds for the average of the test 3 x 2000 m rowing compared to the time in seconds for overcoming the distance of 1000 m. From table 37 shows that α is below 0.05, therefore all four models adequately describe the data reflecting the relationship between 2000 m Average and t1000. However, if we compare the coefficients of certainty r2 and compare the coefficient b, we will see that the power model with almost 60% is the most adequate.

ŷ = a.xb where:

x - independent variable, factor

y - the dependent variable, result

a - this coefficient is in the column "Constant"

b - is in column “b1”

The indicator is 2000m Average occupies values between 470 s and 561 s

b = .784

a = 1,724

If we substitute in the formula we will get the following results for every 10 seconds of the indicator | 2000 m Average | presented in table 38 These results show how long a competitor would achieve in a 1000 m kayak competition depending on the time achieved in the specific test "3 x 2000 m rowing". Every 10 s in the test "3 x 2000 m rowing" a time delay for t1000 s can be expected with between 3.44 s and 3.57 s.

Table 38 Relationship between times in seconds for | 2000 m Average | and | t1000 |.

2000 m (s)	t1000 (s)	Difference (s)
470	214.52	
480	218.09	3.57
490	221.64	3.55
500	225.18	3.54
510	228.70	3.52
520	232.21	3.51
530	235.71	3.49
540	239.19	3.48
550	242.65	3.47
560	246.10	3.45
570	249.54	3.44

This dependence is presented graphically in fig. 16

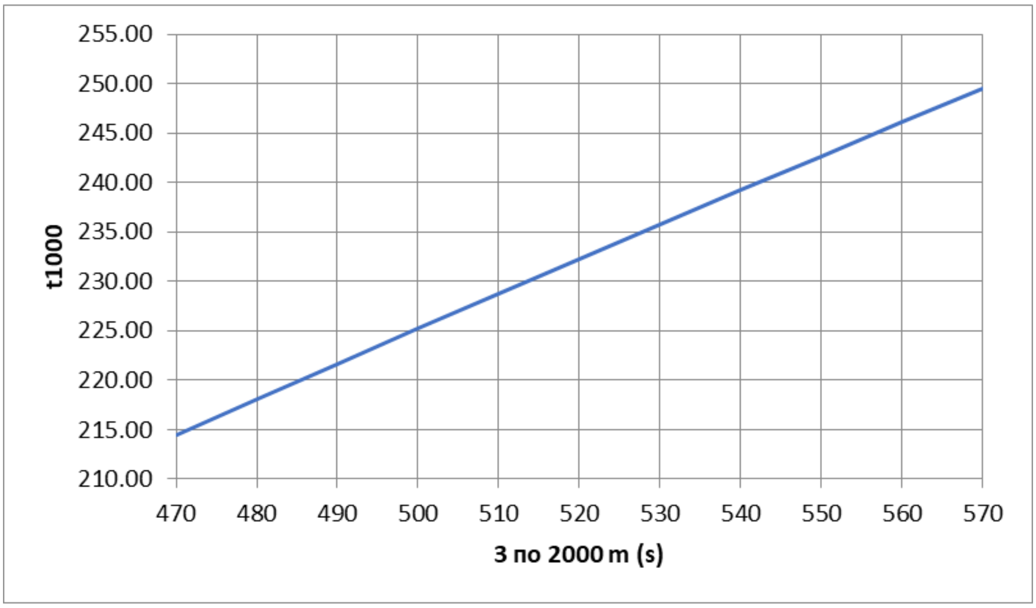

Figure 16. Graphically depicts the relationship between the test "3 x 2000 m rowing" and the result of 1000 m rowing.

It should not be forgotten that the prediction of performance through various physiological and physical indicators, using preliminary tests, so far do not have an unambiguous answer and reproducibility for all sports. That is why in the present study we refer the results only to the discipline kayak - 1000 m.

Conclusions from the analyzes of the models for optimizing the control of the competitors in kayak single 1000 m:

In the conclusions we will touch only on the most significant relationships presented in the regression analysis.

With an increase in power at the lactate threshold by 1 W, the distance to travel the distance decreases by between 0.39 s to 0.26 s. This is because the pH in the muscles and blood increases, which does not allow the speed to be maintained during the racing distance.

The same relationship was observed for W_{LT4} and t1000. With an increase in power at the lactate threshold by 1 W, the travel time of the distance decreases by between 0.39 s to 0.22 s. The reason for the increase in time is again the presence of a higher ph.

With an increase in W_{max} / kg by 0.05 W, the distance to cover the distance of 1000 m decreases by between 1.87 s to 1.37 s. As the average power increases, there is a decrease in the result in seconds during the distance of 1000 m. This is because the forces acting (energy supply) change during the distance and it is difficult for the competitors to maintain the same speed from end to end, provided that they perform a test at maximum speed.

The regression dependence between the average time of the test "3 x 2000 m" is the following result. Passing every 10 s in the test "3 x 2000 m rowing" can be expected to delay time for t1000 with between 3.44 s and 3.57 s., This is because with the activation of aerobic mechanisms in the body there is a decrease in the speed of athlete.

Summary:

In high sportsmanship, the physical, technical, tactical, moral and volitional, mental and intellectual qualities do not manifest in isolation, but represent a complex, in which some depend on the degree of formation of others. This makes it difficult both to measure them separately and to manage them. All these factors affect the sports result and influence the analyzes presented in this paper.

The analysis of the performed researches on the morpho-anthropometric features, functional indicators, and their influence on the sports result of the competitors in the discipline kayak 1000 m. allows to make some generalizing conclusions and the corresponding recommendations for the theory and practice concerning this sports discipline.

If we summarize the considered results we will find that none of the anthropometric indicators has a statistically significant correlation with the time to overcome the distance of 1000 m in the discipline of kayak. We found such a statistically significant correlation only for the functional indicators W_{max} / kg, W_{max}, W_{LTD}, W_{LT4}. We found a large correlation and α <0.001 between the average time achieved in the test "3 x 2000 m rowing" and the time achieved in the kayak 1000 m. All four functional indicators have a negative correlation coefficient, i.e. increasing them reduces the time to cover the distance. The results of the correlation analysis showed that the use of W_{LT4} is more sensitive to the prediction of sports results in the kayak discipline 1000 m compared to W_{LTD}.

Monitoring of the three indicators giving information about the relationship between the maximum oxygen consumption and the travel time of the distance of 1000 m, namely VO_{2max}, VO_{2max} / kg and VO_{2max} / MM (kg), did not show a statistically significant correlation. This end result was expected from us in view of the literature analysis of the sources we used.

We looked for an adequate mathematical model describing the relationship between the described factors influencing the travel time of the distance of 1000 m, with the exception of Wmax, which has no normal distribution. The degree model turned out to be the most adequate for all selected indicators. In conclusion, we derived the following dependences in the regression analysis.

According to our stepwise mathematical model with an increase in power at the lactate threshold (W_{LTD}) by 1 Watt, the travel time from 1000 m decreases by between 0.39 s to 0.26 s. We found a similar relationship in the model describing the relationship between W_{LT4} and t1000, where with an increase in power at the lactate threshold (W_{LT4}) by 1 Watt, the travel time from 1000 m decreases by between 0.39 s to 0.22 s.

The same step mathematical model showed that with an increase in W_{max} / kg by 0.05 Watt, the time to overcome the distance of 1000 m decreases by between 1.87 s to 1.37s.

Following the results of the regression analysis for the specific test we conducted, we found that for every 10 s in the test "3 x 2000 m rowing" we can expect a delay in overcoming 1000 kayaks during a race with between 3.44 s and 3.57 s.

From the above it is clear that very specific training goals can be set to improve the specific performance. Through these models we know what specific improvement in W_{LTD}, W_{LT4} or W_{max} / kg and the test "3 x 2000 m rowing" we must pursue in the training process to achieve a shortening of the time to overcome the distance in seconds.

The homogeneity of the samples from the studied anthropometric and functional indicators shows the correct conduct of the study. The small scattering of the indicators of the individual athletes shows the correct selection in the team and an adequate training process.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. There is a significant correlation between W_{LTD}, W_{LT4} and W_{max} / kg, and the results of the "3 x 2000 m rowing" test versus the time to cover the distance of 1000 m in the kayak discipline.

2. The insignificant correlation of 0-.236 between VO_{2max} / kg and t1000 proves that VO_{2max} / kg is not a decisive factor for the specific performance due to the peculiarities of the energy supply in the kayak discipline 1000 m.

3. As HR_{max} increases, so does the HR at the lactate threshold determined by the D_{max} method.

4. The significant correlation between | Growth | is confirmed and | Stretching | adopted in practice.

5. The significant correlation between maximal oxygen consumption (VO_{2max}) in relation to body weight and active body mass (ATM) is confirmed.

6. The significant correlation between | W_{max} / kg | is confirmed and | VO_{2max} / kg | with great statistical reliability.

7. The comparison of the time to overcome the distance of 1000 m between our participants, which is 229.64 s, and competitors from the Italian national canoe / kayak team with a time of 229.4 s. Despite the seemingly close result of our and Italian athletes to that of the world elites, namely the ones from year 2013. This difference of 16.4 s. is so large that some competitors would find it difficult to participate in the final races of a given championship.

8. Despite the relatively similar results in the time for overcoming the distance of 1000 m of the Italian and Bulgarian national teams, the difference in VO_{2max} / kg

for our participants is 56.17 ml / kg / min, and VO_{2max} is 61.4 ml / kg / min. in the Italian, shows a visible difference in the training of Italian kayakers, but nevertheless we support the data from the analysis that VO_{2max} does not have a decisive influence on performance in the kayak discipline 1000 m.

9. There is a large correlation between the time to overcome 1000 m during a competition and the sports-specific test "3 x 2000 m".

RECOMMENDATIONS

1. We recommend the use of W_{LTD} or W_{LT4}, W_{max} / kg, and the results of the specific performance test "3 x 2000 m rowing".

2. We recommend the use of mathematical models describing the relationship between the factors W_{LTD}, W_{LT4}, W_{max} / kg and the test "3 x 2000 m rowing" relative to the time to overcome the distance of 1000 m, as control markers of specific performance in the training process.

3. We recommend additional studies on the relationship between% W_{maxLTD} and the time to overcome 1000 m.

4. We recommend a study of a larger sample of competitors in the discipline of kayak 1000 m to create a regulatory framework for predicting the time to overcome 1000 m during the competition and the sports-specific test "3 x 2000 m rowing".

CONTRIBUTIONS

1. We derived mathematical models describing the relationship between the factors W_{max} / kg, W_{LTD}, W_{LT4} and the specific test "3 x 2000 m rowing" in relation to the time to overcome the distance of 1000 m.

2. We determined which anthropometric and functional indicators, and which specific tests can be used for forecasting and control of the specific working capacity in the discipline of kayak 1000 m.

3. As a result of our study, we made conclusions of a confirmatory nature.

LIST OF ABBREVIATIONS

ATM – active body mass

t1000 – cover time distance of 1000 m. As a result of the competitions, the time is in the format / minutes: seconds: hundreds /, but we turned it into seconds due to the requirements of the statistical programs for the variables to be in digital format.

W_{max} – maximum power

W_{max}/kg – relative maximum power.

VO_{2max} – absolute maximum oxygen consumption

VO_{2max}/kg – relative maximum oxygen consumption.

VO_{2max}/MM(kg) – absolute maximum oxygen consumption relative to muscle mass in kg.

HR_{max} – maximum heart rate

W_{LTD} – power at the lactate threshold determined by the D_{max} method.

W_{LT4} – power at the lactate threshold fixed at 4 mmol / L.

%W_{maxLTD} – percentage of the maximum power at the lactate threshold determined by the D_{max} method.

HR_{LTD} – heart rate at the lactate threshold determined by the D_{max} method.

%HR_{maxLTD} – percentage of HRmax at the lactate threshold determined by the D_{max} method.

La_{pic} – peak lactate value in the last stage.

La_{LTD} – lactate value at the lactate threshold determined by the D_{max} method.

%La_{picLTD} – percentage of peak lactate at the lactate threshold determined by the D_{max} method.

HR при VT2 – heart rate at the second ventilator threshold (VT2).

VT2 – VT1 – effective pulse zone.

Face lie – face lying maximum value in kg.

Face lie/ ATM – Lying down referred to ATM.

Pull ups - number.

Abdominal Press – number.

2000 m Average - average value from the specific test „3 x 2000 m rowing. The format / minutes: seconds: hundreds / we converted to seconds for the same reason as for the indicator t1000.

%MM - The percentage of muscle mass.

VO_{2max} - maximum oxygen consumption.

VO_{2max}/kg – relative maximum oxygen consumption.

FFM - Fat free mass (body weight without fat).

LBM - lean body mass (lean body mass).

BMI- (Body Mass Index) body mass index.

ATF - adenosine triphosphate.

ADF - adenosine diphosphate.

F – phosphate.

КF - cratin phosphate.

E – energy.

VO_2 - oxygen consumption.

FOG - (fast-oxidative-glicolytic) fast oxidative glycolytic fibers.

FG - (fast-glicolytic) fast glycolytic fibers.

ST – (slow twitch) slowly shrinking.

VO_{2peak} - peak oxygen consumption.

АНС - the autonomic nervous system.

УО - Impact volume.

BPM - beats per minute.

HR_{max} - maximum heart rate.

VNS – vegetative nerve system.

CO – cardiac output.

VC - vital capacity.

Ve - pulmonary ventilation.

RR - respiratory rate.

TV - tidal volume.

V_E/VO_2 - ventilatory oxygen equivalent.

LA - lactate.

EC - European championship.

WC - World Cup.

WC - World Cup.

OG - Olympic games.

К1 - Single kayak.

C1 - canoe single.

AT - anaerobic threshold.

MLSS – maximum lactate steady state.

D_{max} – maximum distance – D.

AT4 – anaerobic threshold at a lactate concentration of 4 mmol / L.

LT_D – lactate threshold determined by the D_{max} method.

LT2 - second lactate threshold.

LT_{MOD} – modified method for determination of LT.

$VO_{2\ max}$ – maximum oxygen consumption.

OBLA – initiation of accumulation of blood lactate.

WRMLSS - MLSS workload.

WR_{max} - the maximum workload.

ml/kg/min- milliliters per kilogram of body weight per minute.

HR- heart rate.

EL- electrocardiogram.

ATM - active body mass.

Min – minimum value of the sample.

Max – minimum value of the sample.

X – arithmetic mean of the sample.

STDEV – the standard deviation.

%V – coefficient of variation.

Sig – α (statistical significance)

STERR – standard error of the mean

AUTHOR'S REFERENCE

List of publications:

- **Stoycheva K. (2021) "SPECIALIZED TRAINING LOADS IN CANOE-KAYAK FOR BOYS AND GIRLS", Magazine "Sport and Science", Sofia issue 3;**