PROGRAMMING METHODOLOGY AND CONTROL OF AEROBIC TRAINING BY RUNNING

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Abstract
The aim of this paper is to present a training methodology which can be a powerful incentive for cardiovascular and metabolic adaptation via individually programmed aerobic training by running directly through oxygen uptake. The experiment was conducted on a top judo female contestant during 24 weeks of training. The distribution of training loads was in the range between a anaerobic threshold and the maximal oxygen uptake. The change models were made by using the least squares fitting method. In 24 weeks, the female judoka improved the results of the maximal oxygen uptake (VO_2max) by 26%, the relative maximal oxygen uptake (VO_2rel) by 26%, the velocity at maximal oxygen uptake (VO_2max) by 26% and the Cooper running test (K) by 24%. She started with 59% of her genetic capacity of maximal oxygen uptake (VO_2max), 58% of maximal relative oxygen uptake (VO_2rel), and after 24 weeks of training she reached 84% of the maximal oxygen uptake (VO_2max) and 85% of the relative maximal oxygen uptake (VO_2rel). The applied type of training required an additional three months to reach capacity values. At the beginning of treatment, the anaerobic threshold was 71% of the relative maximal oxygen uptake (VO_2rel) and at the end of the treatment it was 86%. In order to achieve these results, the judoka had to expend 8963.9 liters of oxygen ($\sum VO_2$) during six months (24 weeks) of training and run a distance (∑ DT) of 445525.3 m and expend 44819.5 kilocalories (∑ kcal).

Key words: *training, methodology, programming, oxygen uptake, judo.*

Introduction

Two training models were used for programming aerobic running - continuous and discontinuous (intervals).A continuous training model improves the capillary and oxidative muscle capacity while the interval training model improves the capacity of the heart muscle, the key determinant of maximal oxygen uptake. However, interval methods are preferred. The most commonly used interval methods are the Hoff-Helgerud method (Helgerud, Engen, Wisloff, Hoff, 2001), and the Billat method (Billat, 2001). In the Hoff-Helgerud method, running is controlled via the heart rate and ranges between 90% and 95% of the maximal value. The Bilatt method is slightly different and uses velocity (vVO_2max) to achieve maximal oxygen uptake (VO_2max). The output sizes in both types of training are the distances run. In both cases, individualization of training is possible. In the first case, control is achieved via the pulse and in the second by way of running speed. The question is whether a continuous method can achieve cardiovascular and metabolic adaptation as can the interval training method and whether individual training programming is possible. We are assuming that this is possible when the work intensity is programmed so that it is found between the anaerobic threshold and the maximal oxygen uptake (Astrand, Rodahl, Dahl, Strømme, 2003, Kenney, Wilmore, Kostill, 2015, Klisuras 2013, Wilmore & Costil 2008). Secondly, individualization of aerobic training is possible because programming is based directly on oxygen uptake (Milošević & Milošević, 2010, 2013a, b). For this type of programming, a maximal and relative oxygen uptake is used, as well as the velocity at maximal oxygen uptake, the anaerobic threshold, the capacity values of oxygen uptake and the speed of the uptake (Milošević & Milošević, 2010, 2013 a,b; Milošević, Nemec, Jourkesh, Nemec, Milošević, David, 2016; Bouchard, Sarzynski, Rice, Kraus, Church, Sung, Rao, Rankin, 2011; Tucker & Collins, 2012). For this purpose, the hardware software system (VAC Bioengineering, Belgrade) was used. It conducted programming and control of training, as well as creating an analysis of the results of the judoka achieved in 24 weeks of training. Therefore, it can be said that the aim of this paper is to present a training methodology that we believe to be a powerful incentive for cardiovascular and metabolic adaptation by individually programmed aerobic training in running, directly through oxygen uptake. By individualizing the training, we managed to avoid the average values obtained in practice and scientific research work being used as reference values for programming the training of top athletes and their cardiovascular and metabolic adaptation.

Materials and methods

Participants
The experimental data used for aerobic training by running were obtained for the female judoka (age = 27), height (BH = 170 cm), and weight (BW = 99 kg), a champion of world and European competitions. The participant was a member of the Serbian National team in a full multi-year training process, and she gave her informed consent to the procedures of the study. The conditions of the study were approved by the university's ethics committee.

Programming methodology and control of aerobic training by running

For programming and control of training for development (aerobic potential) we used the training technology supported by the specially designed hardware and software system (VACBioengineering, Belgrade) (Table 1 and 2). Programming of the training effect was based on monthly quantified training goals, potential, training effects, changes and training in accordance with the current state of the judoka (Milošević & Milošević, 2010, 2013 a,b). The training was conducted 24 weeks, on Monday, Tuesday, Wednesday, Friday and Saturday mornings, with breaks on Thursdays and Sundays. The running in one training session lasted 20 minutes. Each time, training was programmed for 4 weeks or a month.

Table 1. Aerobic training, Week 1.

TRAINING WEEK 01					
+DAY	DATE (mmddyy)	DISTANCE (m)	TIME (min)	OXYGEN (liter)	ENERGY (kcal)
MONDAY	01.02.16	3335	20	64.94	324.7
TUESDAY	02.02.16	2747	20	53.48	267.4
WEDNESDAY	03.02.16	3139	20	61.12	305.6
THURSDAY	04.02.16	PAUSE			
FRIDAY	05.02.16	3296	20	64.94	324.7
SATURDAY	06.02.16	2946	20	57.30	286.5
SUNDAY	07.02.16	PAUSE			
	SUM	15463	100	301.78	1508.9

For the purposes of programming and controlling the effects of training and changes, the parameters of age, as well as body height and body weight were used, and Cooper's12 minute test results. The various aerobic parameters were calculated from these data (Milošević & Milošević, 2010, 2013 a,b).

Table 2. Aerobic training, Week 24.

TRAINING WEEK 24					
+DAY	DATE (mmddyy)	DISTANCE (m)	TIME (min)	OXYGEN (liter)	ENERGY (kcal)
MONDAY	25.07.16	4042	20	83.68	418.4
TUESDAY	26.07.16	3789	20	78.45	392.3
WEDNESDAY	27.07.16	5052	20	104.6	523.0
THURSDAY	28.07.16	PAUSE			
FRIDAY	29.07.16	3789	20	78.45	392.3
SATURDAY	30.07.16	4042	20	83.68	418.4
SUNDAY	31.07.16	PAUSE			
	SUM	20714	100	428.86	2144.4

The relative maximal oxygen uptake was calculated according to the following formula: $VO_2rel = 3.134304 \cdot 10^{-7} \cdot K^2 + 0.02077344 \cdot K - 9.03125$, where VO_2rel is the relative maximal relative oxygen uptake in milliliters per kilo of body weight in one minute ($ml \cdot kg^{-1} \cdot min^{-1}$) and K is the value of Cooper's 12 minute running test in meters (m).

The maximal oxygen uptake was calculated according to this formula: $VO_2max = [(3.134304 \cdot 10^{-7} \cdot K^2 + 0.02077344 \cdot K - 9.03125) \cdot BH] \cdot 1000^{-1}$, where VO_2max is the maximal oxygen uptake in minutes ($L \cdot min^{-1}$), K isthe value of Cooper's 12 minute running test in meters (m) and BW is the body weight in kilograms (kg).

The velocity of running at maximal oxygen uptake was calculated according to the following formula: $vVO_2max = 0.0014 \cdot K + 0.1786$, where vVO_2max is the velocity of running at VO_2max in meters in a second (ms^{-1}), and K isthe value of Cooper's 12 minute running test in meters (m).

The value of the genetic capacity of the relative oxygen uptake was calculated according to the following formula: $VO_2rel_{(GK)} = VO_2rel_{(I)} + 105 \cdot e^{[(-.02803419 - .00040123 \cdot AGE) \cdot VO2rel\,(I) + 0.0000003134304 \cdot AGE]}$, where $VO_2rel_{(GK)}$ is the genetic value of the relative maximal oxygen uptake in milliliters per kilogram of weight in one minute ($ml \cdot kg^{-1} \cdot min^{-1}$), and $VO_2rel_{(I)}$ ist he initial value of the relative maximal oxygen uptake in milliliters per kilogram of body weight in one minute ($ml \cdot kg^{-1} \cdot min^{-1}$), AGE – years of age.

The value of the genetic capacity of Cooper's 12 minute running test was calculated according to the following formula: $K_{(GK)} = \{VO_2rel_{(I)} + 105 \cdot e^{[(-.02803419 - .00040123 \cdot AGE) \cdot VO2rel\,(I) + 0.0000003134304 \cdot AGE]} + 9.1976\} \cdot 0.027^{-1}$, where $K_{(GK)}$ is the genetic value of the distance traveled for 12 minutes in Cooper's test in meters (m), and $VO_2rel_{(I)}$ is the initial value of the relative maximal oxygen uptake in milliliters per kilogram of body weight in one minute ($ml \cdot kg^{-1} \cdot min^{-1}$), AGE – years of age.

The value of the genetic capacity of the maximal oxygen uptake was carried out according to the following formula: $VO_2max_{(GK)} = \{VO_2rel_{(I)} + 105 \cdot e^{[(-.02803419 - .00040123 \cdot AGE) \cdot VO2rel\,(I) + 0.0000003134304 \cdot AGE]} \cdot BH\} \cdot 1000^{-1}$, where $VO_2max_{(GK)}$ is the maximal oxygen uptake in liters per minute ($L \cdot min^{-1}$), $VO_2rel_{(I)}$ -initial value of relative maximal oxygen uptake in milliliters per kilogram of body weight in one minute ($ml \cdot kg^{-1} \cdot min^{-1}$), AGE – years of age and BW is body weight in kilograms (kg).

The anaerobic threshold was specifically determined. Among other things, it was used to determine the range of monthly load distribution (Klisuras 2013). The speed and uptake of oxygen at the aerobic threshold was always at the lower load limit, which was changed from month to month in accordance with the measured values. The upper load limit has always been measured by maximal oxygen uptake and the velocity of the uptake. This kind of load is appropriate for judo as it belongs to anaerobic aerobic sports (Astrand, et al., 2003; Kenney, et al., 2015; Klisuras 2013; Wilmore & Costil 2008). Subsequently, the oxygen uptake of the judoka in a month of training (one of the training goals) is determined in conjunction with the training effects, changes and capacities according to the following formula (Milošević & Milošević 2010, 2013a,b): VO_2 = 117 6.683 + 78.885 (Month)+ 2.277 (Month)^2, where VO2 is the totaloxygen uptake in liters per minute (L . min^{-1}), and Month is the number of training months.

After the oxygen uptake in a month is determined, then, in accordance with the other set goals, the expected effects and changes, the oxygen for the individual training in the week is distributed (Table 1 and 2).

Every month during the first week, there was one peak (95% VO_2max), two peaks during the second week (96% VO_2max), and three peaks in the third week (98% VO_2max) and in the fourth week one peak once again (100% VO_2max) (Milošević & Milošević, 2010, 2013 a,b).

Oxygen uptake during the other days ranged every week from 71% to 92% VO_2max (Milošević & Milošević, 2010, 2013 a, b).

Every training session took 20 minutes. After the oxygen uptake for each day of the week was determined, the running speed of each training session was established (Table 1 and 2). Speed should enable the oxygen uptake established for a particular training day (Milošević & Milošević, 2010, 2013a,b).

By multiplying the speed by 20 minutes, the running distance for each training was obtained, and by multiplying the oxygen uptake by 5, the energy expenditure was obtained (Table 1 and 2).

After a month, the programmed training failed to render the planned effects and the procedure of testing and programming the training was repeated (Milošević & Milošević, 2010, 2013 a,b).

Data analysis

The paper defines the rules (functions) of changes in maximal oxygen uptake (VO_2max), the relative maximal oxygen uptake (VO_2rel), the velocity at maximal oxygen uptake (vVO_2max), the amount of energy expended (kcal) and the distance run in the Cooper test (K) over time expressed in months. The functions were established by using the least squares fitting method.

They are described in the form of a polynomial: $Y = a_0 + a_1 X + a_2 X^2 + \ldots\ldots + a_n X^n$, where VO_2max is the maximal oxygen uptake in L . min^{-1}, VO_2rel is the relative maximal oxygen uptake inml . kg^{-1}. min^{-1}, vVO_2max is the velocity at VO_2max in ms^{-1}, kcal is the amount of energy expended in kilocalories, K is the distance traveled in Cooper's test in meters (m); X is the time in months; and $a_0, a_1, a_2, \ldots\ldots a_n$ are polynomial coefficients.

Results

All the results achieved by the female judoka in six months are shown in tables 3 to 6.

Table 3. Aerobic initial and transitive indicators.

$K_{(I)}$	$K_{(T)}$	VO_2 $max_{(I)}$	VO_2 $max_{(T)}$	VO_2 $rel_{(I)}$	VO_2 $rel_{(T)}$	vVO_2 $max_{(I)}$	vVO_2 $max_{(T)}$
2200	2882	3.82	5.23	38.98	53.34	3.29	4.42

$K_{(I)}$ i$K_{(T)}$ - initial and transitive value of Cooper's 12 minute test, VO_2max $_{(I)}$ andVO_2max $_{(T)}$ –initial and transitive value of maximal oxygen uptake, VO_2rel $_{(I)}$ andVO_2rel $_{(T)}$ – initial and transitive value of relative maximal oxygen uptake, vVO_2max $_{(I)}$ and vVO_2max $_{(T)}$ – initial and transitive value of running speed at VO_2max.

Table 4. The total distance traveled, the oxygen uptake and the genetic capacities.

∑ DT	∑ VO_2	$K_{(GK)}$	VO_2max $_{(GK)}$	VO_2rel $_{(GK)}$	vVO_2max $_{(GK)}$
445525.3	8963.9	3410	6.43	67.01	5.09

∑ DT – the total distance traveled at 24 weeks in meters (m), ∑ VO_2 – total consumed VO_2 in running for 24 weeks in liters per minute (L . min^{-1}), $K_{(GK)}$ – the value of genetic capacity of Cooper's 12 minute test in meters (m), VO_2max $_{(GK)}$ – the value of the genetic capacity of the maximal oxygen uptake in liters per minute (L . min^{-1}), VO_2rel $_{(GK)}$ – the value of the genetic capacity of the relative maximal oxygen uptake in milliliters per kilogram of body weight per minute (ml.kg^{-1}.min^{-1}), vVO_2max $_{(GK)}$ – value of genetic velocity capacity at maximal oxygen uptake in meters (m).

Table 5. The total calorie intake and initial and transitive anaerobic threshold.

∑ kcal	%VO_2 $max_{AT(I)}$	VO_2 $rel_{AT(I)}$	vVO_2 $max_{AT(I)}$	%VO_2 $max_{AT(T)}$	VO_2 $rel_{AT(T)}$	vVO_2 $max_{AT(T)}$
44819.5	71	27.68	2.24	86	45.87	3.8

∑ kcal – the total energy expended in24 weeks of training, %$VO_2max_{AT\ (I)}$, %$VO_2max_{AT(T)}$ – initial and transitive relative value of the anaerobic threshold in percentage (%),$VO_2rel_{AT(I)}$, $VO_2rel_{AT\ (T)}$ – initial and transitive value of anaerobic threshold in milliliters per kilogram of body weight in minutes (ml.kg^{-1}.min^{-1}) , v$VO_2max_{AT\ (I)}$, v$VO_2max_{AT(T)}$ – initial and transitive value of running speed at an anaerobic threshold in meters (m).

Table 6. Change models.

Models	a_0	a_1	a_2
VO_2max (L . min^{-1})	3.697	0.168	0.014
VO_2rel (ml.kg^{-1}.min^{-1})	37.766	1.685	0.151
vVO2max (m.s^{-1})	3.211	0.109	0.009
Kcal	5883.415	394.425	11.385
K (m)	2134.00	91.143	5.143

VO_2max – change model of maximal oxygen uptake in time, VO_2rel –change model of relative maximal oxygen uptake in time, vVO2max – change model of running speed at VO_2max in time, kcal –change model in energy expenditure in time, K (m) – change model of running distance in Cooper's test.

Discussion

The results show that in six months (24 weeks), the judoka had improved maximal oxygen uptake (VO_2max) by 26%, the relative maximal oxygen uptake (VO_2rel) by 26%, the velocity at maximal oxygen uptake (vVO2max) by 26% and Cooper's test (K) by 29% (Milošević & Milošević, 2010, 2013 a,b). When treatment started, she was at59% of her genetic capacity in maximal oxygen uptake (VO_2max),at 58% of relative maximal oxygen uptake (VO_2rel) while after the 24th week of training there was 84% maximal oxygen uptake (VO_2max)that is, 85% relative maximal oxygen uptake (VO_2rel) (Milošević & Milošević, 2010, 2013 a,b). At the beginning of treatment, the anaerobic threshold was at 71% of the relative maximal oxygen uptake (VO_2rel) and at the end of training it was at 86% of relative maximal oxygen uptake (VO_2rel). Thus, at the beginning of the treatment, the anaerobic threshold (VO_2rel_{AT}) was 27.68 ml . kg^{-1}. min^{-1} at running speed (vVO_2max_{AT}) at 2.24 $ms^{-1}$and at the end of treatment (VO_2rel_{AT}) 45.87ml. kg^{-1}at running speed (vVO_2max_{AT})) at3.8 ms^{-1} (Milošević & Milošević, 2010, 2013 a,b). In order to achieve these results, the judoka had six months (24 weeks) of training, an uptake of 8963.9 liters of oxygen (ΣVO_2), running a distance (Σ DT) of 445525.3 m and expending 44819.5 kilocalories (Σ kcal) (Helgerud, Engen, Wisloff, Hoff, 2001; Milošević & Milošević, 2010, 2013 a,b).The least aerobic strength with which she ran in the 6-month period was 2.67 liters per minute ($L . min^{-1}$), that is, 13.37 kcal and the largest aerobic strength was 5.23 liters per minute ($L . min^{-1}$), that is, 26.15 kcal. She was projected (genetic capacity) for a maximal oxygen uptake ($VO_2max_{(GK)}$) at 6.43 L. min^{-1}, that is, a relative maximal oxygen uptake ($VO_2rel_{(GK)}$) of 67.01 $ml.kg^{-1}.min^{-1}$. She achieved the maximal oxygen uptake at a genetically projected speed ($vVO_2max_{(GK)}$) of 5.09 m. s^{-1} (Milošević & Milošević, 2010, 2013 a,b; Milošević, et al., 2016; Bouchard, et al, 2011; Tucker & Collins, 2012). The change models have a high level of description of the observed phenomena significant for a level no higher than 0.003 and they function as the quantification of training aims in time. The change model of the maximal oxygen uptake (VO_2max) had the strength of R^2 = 0.988 significant for level 0.001. The change model of maximal relative oxygen uptake (VO_2rel) had the strength R^2 = 0.998 significant for level 0.001. The change model of velocity at maximal oxygen uptake (vVO2max) has the strength of R^2 = 0.989 significant for the level 0.002. The change model for energy expenditure (kcal) had the strength of R^2 = 0.987 significant for level 0.003.

The change model of Cooper's running test (K) had the strength R^2 = 0.988 for the level of 0.003. Considering that after 24 weeks of training the contestant arrived at 84% maximal oxygen uptake (VO_2max), that is, a85% relative maximal oxygen uptake (VO_2rel), with the applied type of training she can achieve capacity valuesin an additional three months(Milošević & Milošević, 2010, 2013 a,b; Milošević, et al., 2016; Bouchard, et al., 2011; Tucker & Collins, 2012). The speed at which she achieved a maximal oxygen uptake (vVO_2max $_{(GK)}$)is at the level of 86% of the genetically programmed, which means that along with appropriate training she can improve by another 13% (Milošević & Milošević, 2010, 2013 a,b; Milošević, et al., 2016; Bouchard, et al., 2011; Tucker & Collins, 2012). The results attained point to the fact that this kind of training is a powerful stimulus for increasing cardiorespiratory adaptations, oxidation capacity of the skeletal muscles, the biogenesis of the mitochondria and other physiological adaptations (Astrand, et al., 2003; Kenney, et al., 2015; Klisuras 2013; Wilmore& Costil 2008). The weekly distribution of loads contributes to such a response of the organism (Milošević & Milošević, 2010, 2013 a,b).

During one week, 35% of the total training time had the intensity of 95% to 100% VO_2max, 35% per cent of the total training time had the intensity from 80% to 92% VO_2max, and 30% had the intensity of 70% to 75% VO_2max (Milošević & Milošević, 2010, 2013 a,b). Training with these sort of loads always lasted 20 minutes. Programming training thus always gives an exceptionally high progress along with relatively low energy expenditure. This paper presents the methodology which enables the assessment of the development dynamics of aerobic parameters, the quantification of training aims and the selection of individuals based on their assessed capacity rather than their current state. The methodology also secures individual programming of training and control of training effects and changes by using modern hardware and software (Milošević & Milošević, 2010, 2013 a,b; Milošević, et al., 2016). The proposed methodology can be used in any sport of an aerobic anaerobic character for creating top sportsmen and women.

Conclusion

The results obtained show that individual programming and control of aerobic training directly via oxygen uptake is possible. During 24 weeks of training, the judoka improved her results in maximal oxygen uptake (VO_2max) by 26%, the relative maximal oxygen uptake (VO_2rel) by 26%, the velocity at maximal oxygen uptake (vVO_2max) by 26% and Cooper's test results (K) by 24%. She started with 59% of her genetic capacity of maximal oxygen uptake (VO_2max), 58% ofrelative maximum oxygen uptake (VO_2rel) while after 24 weeks of training she attained 84% of maximal oxygen uptake (VO_2max) that is, 85% relative maximal oxygen uptake (VO_2rel). With the applied training type, an additional three months are necessary for achieving capacity values.

At the beginning of the treatment, the anaerobic threshold was at 71% of the relative maximal oxygen uptake (VO_2rel) and at the end of treatment it wasat 86%. In order to achieve these results, the judoka had six months (24 weeks) of training, an uptake of 8963.9 liters of oxygen ($\sum VO_2$), running a distance (Σ DT) of 445525.3 m and expending44819.5 kilocalories (Σ kcal).

Furthermore, the results showed that a cardiovascular and metabolic adaptation by continued training is possible.

References

Astrand, P.O., Rodahl, K., Dahl, H.A., & Strømme, S.B. (2003). *Textbook of work physiology*. *Physiological bases of exercise*. Champaign, Ill.: Human Kinetics.

Billat, V. (2001). Interval training for performance: a scientific and empirical practice. *Sports medicine, 31* (1), 13-31.

Bouchard, C., Sarzynski, M.A., Rice, T.K., Kraus, W.E., Church, T.S., Sung, Y.J., Rao, D.C., & Rankinen, I. (2011). Genomic predictors of the maximal O_2 uptake response to standardized exercise training programs. *J Appl Physiol, 110*(5), 1160-1170.

Helgerud, J., Engen, L.C., Wisloff, U., & Hoff, J. (2001). Aerobic endurance training improves soccer performance. *Medicine and science in sports and exercise, 33*(11), 1925-1931.

Kenney, W.L., Wilmore, J.H., & Kostill, D.L. (2015). *Physiology of sport and exercise*. Champaign IL: Human Kinetics.

Klisuras, V. (2013). *Fundamentals of sports psychology*. Belgrade: Institute for Sports.

Milošević, B.M., & Milošević, M.M. (2010). *Physical preparation of elite athletes: standardization of management processes.* Belgrade: APP.

Milošević, B.M., Milošević, M.M. (2013a). Model for assessing the physical status, as well as prediction and programming of training and sports performance of a soccer player. *Journal of Physical Education and Sport, 13*(4), 479-488.

Milošević, B.M., Milošević, M.M. (2013b). *Special Physical Education: scientific basis*. Belgrade, Serbia: CEDIP.

Milošević, B.M., Nemec, J.V., Jourkesh, M., Nemec, M.P., Milošević, M.M., David. G.B. (2016). Determination of capacity and rules of the variability of maximum force using nonlinear mathematical models: a case study. *Central European Journal of Sport Sciences and Medicine, 16*(4), 91–101.

Tucker, R., & Collins, M. (2012). What makes champions? A review of the relative contribution of genes and training to sporting success. *British Journal of Sports Medicine*, *46*(8), 555–561.

Wilmore, J.H., Costill, D.L. (2008). *Physiology of sport and exercise*. Champaign, Il: Human Kinetics.

PROGRAMSKA METODOLOGIJA I NADZOR AEROBNOG TRENINGA UZ TRČANJE

Sažetak

Cilj ovog rada je predstavljanje metodologije osposobljavanja koja može biti snažan poticaj za kardiovaskularnu i metaboličku prilagodbu putem individualno programiranog aerobnog treninga izravnim pokretanjem unosa kisika. Eksperiment je proveden na vrhunskoj judo natjecateljici tijekom 24 tjedna treninga. Raspodjela opterećenja treninga bila je u rasponu između anaerobnog praga i maksimalnog unosa kisika. Modeli za promjenu napravljeni su pomoću metode najmanjih kvadrata. U 24 tjedna judoka žena poboljšala je rezultate maksimalnog unosa kisika (VO2max) za 26%, relativni maksimalni unos kisika (VO2rel) za 26%, brzinu pri maksimalnom unosu kisika (VO2max) za 26%, a Cooper Test (K) za 24%. Započela je s 59% genetskog kapaciteta maksimalnog unosa kisika (VO2max), 58% maksimalnog relativnog unosa kisika (VO2rel), a nakon 24 tjedna treninga dosegla je 84% maksimalnog unosa kisika (VO2max) i 85% relativnog maksimalnog unos kisika (VO2rel). Primijenjena vrsta osposobljavanja zahtijeva dodatna tri mjeseca za postizanje vrijednosti kapaciteta. Na početku tretmana anaerobni prag bio je 71% relativnog maksimalnog unosa kisika (VO2rel) i na kraju tretmana bio je 86%. Da bi se postigli ti rezultati, judoka je tijekom šestomjesečnog (24 tjedna) treninga morala potrošiti 8963,9 litara kisika (ΣVO2) i prijeći udaljenost (Σ DT) od 445525,3 m, te potrošiti 44819,5 kilocalorija (Σ kcal).

Ključne riječi*: obuka, metodologija, programiranje, unos kisika, judo.*

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