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The influence of an original training programme on the general physical fitness of *ju-jitsu* trainees

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Abstract:

Aim. *Ju-Jitsu* is a discipline which has a high level requirements when it comes to trainees' motor skills preparation. Great changeability of actions in the course of fight makes it necessary to develop the strength of shoulders, legs, back, stomach and forearms. The aim of this study was to determine the scope of influence on selected somatic features and the level of physical fitness of ju-jitsu trainees taking part in a modified circular training that is an original programme as well. The conducted research allowed to formulate the following research questions:

1. Has the experimental training programme influenced the level of the participants' selected somatic characteristics?
2. Does the experimental training programme influence the level of strength, speed and stamina skills in the group of ju-jitsu trainees?

Method. In the study ju-jitsu trainees (N = 30) characterized by similar somatic parameters have been included. In the course of participant verification the following assumption was made: participants have to be males who have been training actively for at least three, but not longer than five years. Experimental training programme based on the circuit method were used. STATISTICA PL software was used to compile the results.

Results. The original training programme has exerted positive influence on the participants' level of selected somatic characteristics and has contributed to the improvement of the level of strength, speed and stamina skills of ju-jitsu trainees.

Conclusion. The proposed training programme may be implemented as strength training in ju-jitsu training in the preparatory period.

Introduction

The fundamental objective of a sports training is obtaining a maximal sporting achievement. To obtain an optimal effect of work with a sportsperson it is essential to develop a perfect level of technique which is based on psycho-physical possibilities related to special fitness, which in turn, are based on motor basis. According to Sozański [1999: 147] "an appropriate level of physical fitness as a component of a motoric technique is essential to make an effective movement". Tactics, on the other hand, is identified mainly with psychical predispositions, intellect and thinking processes in the course of a fight. It seems, however, that in this case fitness potential matters significantly as well, influencing versatility, precision and effectiveness of tactical actions.

When it comes to trainees' motor skills preparation *Ju-Jitsu* is a discipline which has a high

Table 1. Experimental research programme – methodological assumptions

Experimental training programme based on the circuit method **Eksperymentalny program treningowy oparty na metodzie obwodowej**
The number of circuits
The number of exercises per circuit
The number of repetitions and cycle duration
% of maximum weight
The pace of exercise
Duration of brakes between cycles

level requirements [Sterkowicz, Ambroży 1992; Sterkowicz 1998: 39-43; Cynarski 2012]. In sporting competition on a mat punches and kicks as well as throwing, strangling and grasping techniques are used. A ju-jitsu competitor should be ready for offensive and defensive actions. The possibility to win with particular opponents is conditioned by the level of physical preparation, which is visible during attacks and counter-attacks during the fight.

High changeability of a situation in the course of a competition requires as many muscular fibers as possible to be engaged in training [Ambroży 2008: 15-19]. Effort made in the course of fight lasts 3 minutes. Many times such confrontation takes place in tournaments where subsequent fights are organized after only a short break. That is why the circuit method, which enables to develop not only strength and speed, but also stamina, is used in training programmes [Ambroży 2007]. Its structure is similar to the system of tournament fights. Great changeability of actions in the course of fight makes it necessary to develop the strength of shoulders, legs, back, stomach and forearms. It needs to be noted as well that defensive and counter-attacking techniques are used when competitors find themselves in a unstable position. This should be taken into account when a training programme is prepared so that functional strength training engages groups of muscles that are used in allowed techniques and develop the so-called postural muscles.

The aim of this paper was to determine the scope of influence on selected somatic features and the level of physical fitness of ju-jitsu trainees taking part in a modified circular training that is an original programme as well.

On the basis of a subjective expert evaluation of trainers and competitors qualified for the research, an attempt was made to verify if the proposed experimental training programme can be implemented effectively into the cycle of regular motor skills preparation of a ju-jitsu training.

The conducted research allowed to formulate the following research questions:

1. Has the experimental training programme influenced the level of the participants' selected somatic characteristics?
2. Does the experimental training programme influence the level of strength, speed and stamina skills in the group of ju-jitsu trainees?

Material and research method

Ju-jitsu trainees characterized by similar somatic parameters have been included in the study. In the course of participant verification the following assumption was made: participants have to be males who have been training actively for at least three, but not longer than five years. The adopted condition results from high intensity of the proposed training form, requiring the participants to be adapted to effort. In addition, a criterion specifying time frames of participation in a specialist training has been used, which enabled to single out people with a similar level of training and technical advancement. 30 participants between the age of 21 and 28 have been selected by means of a purposeful selection. Prior to the experiment they participated in a standard ju-jitsu training [Ambroży 2008: 103-110]. Strength training consisted mainly in general and special exercises with own body weight resistance.

On the basis of different variants of a circular training [Scholisch 1986; Ambroży 2007] and governed by the guidelines of a functional training[1] for trainees, we have developed a training programme which aims to develop strength, stamina and special speed skills characteristic of the selected sport discipline. Table 1 presents the methodological assumptions of the experimental research programme.

The concept of the experimental training programme was based on the rule of "small

[1] Functional training – it is a type of training in which fundamental movement patterns underpinning human motor skills are essential for a healthy development of a trainee.

strength circuits" [Ambroży 2007] in which there is an additional assumption, that is doing suitably grouped exercises: strength, functional and targeted ones.

Each training unit is divided into three small circuits:

— the circuit of strength training (with the use of barbells, dumb-bells and weights),
— the circuit of exercises developing functional fitness (plyometric and coordination exercises),
— the circuit of targeted exercises (exercises engaging those parts of muscles which are most often used in sporting competitions).
— Doing particular exercises was time limited – 30 seconds, except for the circuit of strength training which the aim was to make 15 repetitions which were also time limited, but in this case the limit was 45 seconds. The training starts with shaping exercises (5-10 minutes). Each training unit finishes with stretching exercises (10-15 minutes).

Suitable statistical methods were used (one factor analysis of variance *Anova* and *post hoc Shaffe* test) and no significant differences in the group of participants were found. The experiment lasted for 8 weeks (4 training units a week).

After the assumed time period passed, the group was tested for effectiveness. All participants were informed about the assumptions of the experiments and took part in it of their own will. The participants could have any medical contraindications against making physical effort. The scope of research obtained a positive opinion (No./77/KBL/OIL/2010) of the Bioethics Committee at the Regional Medical Chamber in Cracow.

The participants of the study were subjected to specialist training before and after the project. This enabled to evaluate the scale of the impact training had on participants' organism. Anthropometric measurements were conducted in the week preceding and following the eight week training cycle. Whereas circuits were measured with a tape with accuracy to 0,1 cm, body weight was measured with electronic scales (Tanita BC-582W) with accuracy to 0,1 kg.

Taking the interdependency of high influence of a diet on the results obtained in tests, the participants were advised not to follow a special diet. Another assumption of the experiment was giving up all possible forms of supplements. The interview method by Charzewska was used to evaluate diet. Each participant was given a notebook where they were supposed to keep record of all consumed products, foods and drinks. Participants provided information on portion sizes without weighing them and describing them by means of home measurements – based on an album containing photos of products and dishes that was given to them. This procedure of recording was performed for three days: 2 working days and 1 day off [Szponar *et al.* 2008].

The analysis of diets has not indicated that any use of special diet or supplements or diet supplements supporting physical effort in training groups. The supervision over diet and supplementation enabled to exclude a factor which could have a significant influence on research results.

In the course of the project (before and after the training cycle) motor skills were evaluated. Selection of a particular test was verified by training specificity of *Ju-Jitsu*. The following control samples were selected by means of using Eurofit physical fitness tests [Grabowski, Szopa 1991; Starosta, Tracewski 2012] and International Test of Physical Fitness: static balance - *flamingo balance*, frequency of hand movement - *plate tapping,* the dynamic strength of stomach muscles – *sit ups* – the transition from lying on one's back to sitting in 30 seconds, pull-ups on a bar, gripping force – measurement of static force, doing bench press – with weight equaling to the mass of the person doing the exercises (the number of repeats), classic squat with a barbell with weight equaling the mass of the person doing the exercises (the number of repeats), explosive strength (standing long jump), shuttle run 10x5 m, Cooper Test: constant run for 12 minutes, seated forward bend.

STATISTICA PL software was used to compile the results. In order to determine statistical significance of differences between pre- and posttest measurements in the evaluated group of ju-jitsu contestants, a t-test for related groups was used.

Results

As table 2 shows, the results of the experiments indicate statistically significant influence of the experimental training on anthropometric characteristics. In case of all measurements the result of the post-test was statistically higher than the pre-test measurement, where $p<0,001$. The results were as follows: the perimeter of the chest – exhalation – pretest results (mean=100,8±2,9 cm), post-test results (mean=102,3±3,0cm), (mean difference: 1,5 cm), the perimeter of the chest – inhalation – pretest results (mean=103,6±2,7 cm), post-test results (mean=105,4±3,0 cm), (mean difference: 1,83 cm), arm circumference at rest – pre-test results (mean 33,2±2,0 cm), post-test results (mean=33,8±1,8 cm), (mean difference: 0,66 cm), circumference of bent arm – pretest results (mean=35,7±1,8

Table 2. The comparison of post- and pre-test measurements on ju-jitsu trainees with respect to anthropometric characteristics (circumferences of selected body parts) – student t-test for dependent samples.

	Pre-test		Post-test		Student t-test (df=28)		
	mean	sd	mean	sd	Differences between measurements		t
	[cm]		[cm]		mean [cm]	sd [cm]	
the perimeter of the chest – exhalation	**100,8**	**2,9**	**102,3***	**3,0**	**1,5**	**0,9**	**8,764**
the perimeter of the chest – inhalation	**103,6**	**2,7**	**105,4***	**3,0**	**1,8**	**1,0**	**10,186**
arm circumference at rest	**33,2**	**2,0**	**33,8***	**1,8**	**0,7**	**0,6**	**5,747**
circumference of bent arm	**35,7**	**1,8**	**36, 8***	**1,8**	**1,1**	**0,4**	**13,157**
thigh circumference at rest	**58,1**	**2,9**	**59,0***	**2,6**	**0,9**	**0,7**	**6,250**
circumference of tense thigh	**60,3**	**2,9**	**61,7***	**2,7**	**1,5**	**1,0**	**7,917**
forearm circumference	**30,5**	**1,6**	**31,1***	**1,6**	**0,6**	**0,5**	**6,322**

*p<0,001

Table 3. The comparison of post- and pre-test measurements on ju-jitsu trainees with respect to anthropometric characteristics (body mass, muscle mass) – student t-test for dependent samples.

	Pre-test		Post-test		Student t-test (df=28)		
	mean	sd	mean	sd	Differences between measurements		t
	[kg]		[kg]		śr. [kg]	sd [kg]	
Body mass	**78,4**	**4,8**	**77,9**	**4,6***	**0,5**	**1,1**	**2,377**
Muscle mass	**65,1**	**4,9**	**65,8**	**4,9****	**0,7**	**0,4**	**9,232**

*p<0,05; **p<0,001

cm), post-test results (mean=58,1±2,9 cm), post-test results (mean=36,8±1,8 cm)(mean difference: 1,1 cm), thigh circumference at rest – pre-test results (mean=58,1±2,9 cm), post-test result (mean=59,0±2,6cm), (mean difference: 0,9 cm), circumference of tense thigh – pre-test results (mean=60,3±2m9 cm), post-test results (mean=61,7±2,7 cm), (mean difference: 1,5 cm), forearm circumference – pretest results (mean=30,5±1,6 cm), post-test results (mean=31,1±1,6cm), (mean difference: 0,6 cm).

Statistical analysis using student t-test (table 3) has shown that there are statistically significant differences in average results of pre- and post-test measurements of the following variables: body mass – pre-test results (mean=78,4±4,8 kg) was statistically significantly higher (p<0,05), (mean difference: 0,5 kg) than post-test results (mean=77,9±4,6 kg) and muscle mass – post-test measurement (mean=65,1±4,9 kg) was statistically significantly higher (p<0,001) than pre-test measurements (mean-65,8±4,9 kg).

Data presented in table 4 are indicative of clear changes in physical fitness before and after using the original training programme. Based on the conducted statistical analysis using the parametric student t-test, the following statistically significant differences between pre- and post-test measurements of ju-jitsu trainees have been found. The results of Cooper test (endurance run) after the experiment was finished (post-test, mean=2963,6±124,7 m) were significantly statistically higher (p<0,001) than the results obtained before the experimental training (pre-test, mean=2856,4±112,2 m), (mean difference: 107,2 m). In case of pull-up on bars (arm and shoulder girdle strength) the post-test result (mean=16,5±4,0 cycles) was statistically significantly higher than the pre-test result (mean=13,3±3,1 cycles), (mean difference: 3,1 pull-ups). When it comes to the result of the test determining stomach muscle strength (the transition from lying to sitting), the post-test results (mean=27,4±3,7 cycles) were statistically significantly higher (p<0,001) than the results obtained in the pre-test (mean 24,1±3,7 cycles), (mean difference: 3,3 cycles).

On the basis of the conducted statistical analysis, statistically important differences between post- and pre-test measurements were observed: standing long jump (maximal anaerobic strength) – the post-test measurement (mean=239,7±8,3 cm) was significantly higher (p<0,001) than the pre-test measurement (mean=234,7±83, cm), (mean difference: 4,9 cm), doing bench presses (the weight of the barbell equaling body mass) – the result of the post-test measurement (mean=14,7±4,3 cycles) was significantly higher (p<0,001) than the pre-

Table 4. The comparison of physical fitness in the pre- and post-test of the study group of ju-jitsu trainees – student t-test for dependent samples.

	Pre-test		Post-test		Student t-test (df=28)		
	mean	sd	mean	sd	Differences between measurements		t
					mean	sd	
Cooper test [m]	**2856,4**	**112,2**	**2963,6***	**124,7**	**107,2**	**48,7**	**11,852**
Pull-ups on a bar [a cycle]	**13,3**	**3,1**	**16,5***	**4,0**	**3,1**	**2,0**	**8,626**
Transitions from lying to sitting [a cycle]	**24,1**	**3,7**	**27,4***	**3,7**	**3,3**	**2,17**	**8,131**
Standing long jump [cm]	**234,7**	**9,8**	**239,7***	**8,3**	**4,9**	**3,3**	**8,087**
Compressing a dynamometer [N]	**58,6**	**8,4**	**59,3***	**7,3**	**0,7**	**1,7**	**2,222**
Doing bench presses [a cycle]	**11,9**	**4,3**	**14,7***	**4,3**	**2,8**	**1,1**	**13,403**
classic squat with a barbell [a cycle]	**21,8**	**9,2**	**28,5***	**9,1**	**6,7**	**3,1**	**11,665**
Shuttle run [m]	**12,5**	**1,1**	**12,3***	**1,0**	**0,2**	**0,2**	**6,544**
Plate tapping [cycle]	**13,9**	**1,6**	**13,4***	**1,4**	**0,5**	**0,3**	**8,037**
Seated forward bend [cm]	**17,5**	**7,4**	**20,2***	**6,7**	**2,7**	**2,3**	**6,254**
Balance test [s]	**4,2**	**1,5**	**4,1***	**1,5**	**0,1**	**0,8**	**0,722**

*p<0,001

test measurement (mean=11,9±4,3 cycles), (mean difference: 2,8 cycles), classic squat with a barbell (the mass of the barbell equaling body mass) – the result of the post-test measurement (mean=28,5±9,1 cycles) was significantly lower (p<0,001) than the results of the pre-test measurements (mean 21,8±9,2 cycles), (mean difference: 6,7 cycles), shuttle run – the average result of the pre-test result (mean=12,5±1,1 cycles) was significantly higher (p<0,001) than the post-test result (mean=12,3±1,0 cycles), (mean difference= 0,2 cycle), plate tapping (the measurement of hand movement speed) – the pre-test result (mean=13,9±1,6 cycles) was significantly higher (p<0,001) than the post-test result (mean=13,4±1,4 cycles), (mean difference: 0,5 cycles); (table 4). The statistical analysis using a student t-test (table 4) showed that there are statistically significant differences between the post- and pre-test regarding the flexibility test (forward bends). The obtained results of the forward bend test after following the experiment were significantly statistically higher (p<0,001) than the results obtained before the experiment (mean=17,5±7,4 cm), (mean difference: 2,7 cm). On the basis of the conducted statistical analysis using a parametric student t-test for dependent variables (table 4), no statistically significant differences between post- and pre-test measurements of balance and finger flexor strength variables were found.

Results summary and discussion

An increase in the level of examined anthropometric features (circumference of the chest, arm, forearm and thigh) has been observed in the group of *Ju-Jitsu* trainees, which is the result of the growth of muscle mass. The strength trainings which so far have been carried out in *Ju-Jitsu* have not significantly affected the growth of muscle mass and focused mainly on increasing dynamic power and force [Sterkowicz, Ambroży 1992; Ambroży 2008]. The growth of muscle mass resulting from strength training took place only in case of a change of the weight category. What is more, at the end of the original training programme a greater number of repeated exercises has been observed in the following tests: barbell presses, squats with a barbell, compressing a dynamometer and stomach muscles strength. This is indicative of a comprehensive increase in strength skills in the examined group of trainees. The research into muscle strength of *Judo* trainees, a discipline which is a component of techniques used in *Ju-Jitsu,* has shown that years of training develop stronger muscle groups responsible for specialist movements – using techniques in the course of a fight [Sterkowicz *et al.* 2011]. Preparations of ju-jitsu trainees requires harder work of arms, shoulders girdle and back arms which has also been shown by the results of strength training *pretest* conducted before the experiment. Appropriate physical preparation could be a solid base for the development of strength training [Duez *et al.* 2010].

The results of the influence of the original training on trainees have indicated a parallel development of lower limbs endurance and power. It seems that introducing complex exercises with free-weights and plyometric exercises into the training programme effectively improves functional motor skills of trainees [Yetter, Moir 2008; Chely

et al.. 2009; Cormie *et al.*. 2010; Ebben *et al.* 2011]. The research by Cronin, Hansen [2005] on rugby players has shown that the essence of locomotive speed development is using plyometric exercises in the programme of physical preparation. Rahimi, Behpur [2005] recommend to join strength training with plyometric exercises to achieve optimum improvement of speed and strength of lower limbs. By comparing various kinds of strength training, the authors have shown that the group using static and explosive strength training has achieved optimum results in anaerobic strength improvement. Compilations of this kind of exercises have been used in experimental training of small circles after which the development of the participants' speed skills has been clearly stated. Bell *et al.* [2002] quote a different reference. On the basis of results of own research they concluded that despite using an appropriate form of strength training, that is a selection of exercises, rate of implementation, the circuit method, anaerobic strength improvement is not always observed. The results of motor skills test following the original training have not corroborated those findings.

In parallel with the development of locomotive speed, an improvement in the speed of muscle work of the upper part of the body. Following the period of experimental training an improvement in the speed of upper limb movement has been observed in the group of ju-jitsu trainees. This result may be related to the selection of some exercises in the small circuit set of exercises. Dynamic changes of the body position and arm bent with the use of two dimensions of movement can be qualified as plyometric exercises which are characterized by work stretching muscle fibers (eccentric work) and a dynamic contraction phase (concentric work) [Chmielewski *et al.* 2006]. Employing different exercises of an explosive character of movement with time may predispose trainees to improve the speed and dynamics of lower limbs [Garcia-Massó *et al.* 2011].

The employed original programme of the circuit training has not been the reason of a fall in flexibility in trainees which is confirmed by the results of seated forward bending. Andrejić [2012], who investigated the influence of a six week training programme on young basketball players in which strength training and plyometric exercises were used, states that the level of flexibility has not regressed. On the basis on the carried out test, a vertical bend, the author confirms that in case of some participants the scope of bend increased by 3 cm. Faigenbaum *et al.* [2007] notice that classic resistance training may reduce the level of flexibility. The authors recommend to combine strength training with static stretching or with dynamic plyometric exercises which, on the basis of their own research, can result in an increase in the level of flexibility even by 28% as short as after a six week training cycle. These recommendation is confirmed by Lyakh [2003]who recommends to combine strength training with relaxation exercises to increase the level of flexibility. Using strength training and flexibility exercises in a comprehensive way not only fosters muscle strength, stretch-ability and flexibility improvement, which are responsible for movement, but also improve the permanence of muscular and ligamentous apparatus [Adams *et al.* 2001; Permsirivanich *et al.* 2006]. Referring the abovementioned insights to the effectiveness of the employed small circuit training to develop flexibility, it can be noticed that they have been implemented in the course of training units. In addition it needs to be mentioned that after each training the trainees did static stretching exercises which could also influence progress in selected motor skill test.

As a result of the conducted training the results of the balance test have also been improved. Two circuits – the targeted and performance ones – included exercises perfecting balance, such as coordination ladder exercises, single leg *plyo box* jumps, *bosu ball* arms bends. Using equivalent exercises in the training programmed should not only have a positive influence on balance development, but also on functional muscle strength [Heitkamp *et al.* 2001]. This observation is confirmed by better results in the balance test obtained after the experimental circuit training.

Effects, even of suitably selected strength exercises, depend on the rate at which they are performed [Munn *et al.* 2005]. When they examined the influence of squats with a barbell, Morissey *et al.* [1998] showed that exercises done at a faster rate in the course of the experiment brought better results in final tests. This observation has been confirmed by the result of the experimental circuit training in which clear improvement of generated strength in trainees has been observed. Lamas *et al.* [2012], who examined the influence on strength training and training targeted at developing power, conclude that in both cases increase in the strength of lower limbs has been observed (participants performed vertical jump). They also observed that in the study group the training targeted to increase strength gave better results than the strength training. Referring the abovementioned results to the original programme of small circuits and its results, it can be noted that the methodological structure of the training assumed doing exercises at a moderate pace, where additionally in one of the circuits exercises developing explosive strength were included which could serve as a basis for the obtained final results.

Summing up, the conducted project consisting of carrying out a special strength training in accordance with an original programme has indicated positive changes to both somatic characteristic and examined motor skills.

Conclusion

1. The experimental training programme has exerted positive influence on the participants' level of selected somatic characteristics.
2. The original training programme contributed to the improvement of the level of strength, speed and stamina skills of ju-jitsu trainees.
3. The proposed training programme may be implemented as strength training in ju-jitsu training in the preparatory period.

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Wpływ autorskiego programu treningowego na sprawność fizyczną zawodników trenujących *ju-jitsu*

Słowa kluczowe: ju-jitsu, sprawność fizyczna, trening siłowy, sporty walki

Abstrakt

Ju-jitsu jest dyscypliną, która stawia bardzo wysokie wymagania, w zakresie przygotowania motorycznego zawodników. Duża zmienność działań podczas prowadzonej walki powoduje konieczność wypracowania siły ramion, nóg, grzbietu, brzucha oraz przedramion. Celem pracy było określenie zakresu oddziaływania na wybrane cechy somatyczne oraz poziom sprawności fizycznej zawodników ju-jitsu zmodyfikowanego treningu obwodowego według programu autorskiego. Badaniami objęto zawodników o podobnych parametrach somatycznych. Podczas weryfikacji uczestników postawiono założenie, że muszą być to mężczyźni z minimum trzyletnim, ale nie więcej niż pięcioletnim, stażem aktywnego trenowania. Autorski program treningowy wpłynął na poprawę poziomu wybranych cech somatycznych oraz zdolności siłowych, szybkościowych i wytrzymałościowych zawodników uprawiających ju-jitsu. Proponowany program treningowy może być implementowany jako trening siłowy w treningu ju-jitsu, w okresie przygotowawczym.