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EFFECTS OF 8-WEEKS LONG MUSCULAR ENDURANCE TRAINING WITH BODY WEIGHT IN CASE OF RECREATIONAL ATHLETES

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Original scientific paper
UDC: 796.015.52

Abstract
The aim of this study is to determine effects of 8-weeks long muscle endurance training with the weight of body in case of recreational athletes. Study included 10 males (age 26.4 ± 1.2; 181.38 ± 5.64 cm and 84.49 ± 11.29 kg). Three muscular endurance trainings per week were performed during the program. Modified types of conventional body exercises, which include basic models of movements for the whole body are included in the program. Training load was dosed by position of the body, speed of exercise performance, number of series of a certain exercise (3-5 x 3-5), number of repetitions (10-25) and length of passive recovery between series of exercises (30-90 sec). The following variables were used: maximal number of pull-ups in 60", maximal number of squats in 60", maximal number of push-ups in 60", maximal number of rotational forward bends of the body in 30"; body extension hang ; left arm hang under the angle of 90°; right leg hang under 90° and pull-ups hang. Results of the T-test for dependent samples were statistically significant differences between two measurements ($p<0.01$). Muscular endurance of recreational athletes can be significantly improved by continuous and programmed exercises using the whole body as basic loading. Coaches need to consider implementation of training of strength with your own body, due to its useful effects.

Key words: **conventional exercises, basic models of movements, training loading, static and dynamic strength**

Introduction

Apart from development of quality training equipment, exercises with your own body, traditionally give more possibilities for achievement of desired result. Exercises with your own body often include conventional type of training for development of muscular endurance, which provides strength performance during dynamic or static conditions of muscular work, without reducing work abilities of an athlete. It can be manifested by isometric and isotonic muscular contractions (Jelešković, Alić, Čović i Jelešković, 2018). During warm-up and cooling down phase, exercises with your own body can be useful as well. Žaljaskov (2004), states that training of strength endurance can be very important at the beginning of conditional preparation, when it's necessary to establish the fundaments of strength. Muscular endurance is not closely related to muscular strength, except if it is performed on bigger extern resistance (Sherkey & Gaskill, 2008). Still, according to contemporary trends of recreational sport it is important to gain healthy, harmonic and universal development of human body. The new trends of health improvement are included by a great number of people in recreational work-outs and sports (Čaušević, Ormanović, Doder & Čović, 2017). Therefore, it is important to determine which exercises, methods and loading levels at certain time, can lead to positive effects. With apply of body weight training, it is possible to achieve certain effects of training both with top-level athletes (Lipecki & Rutowicz, 2015), younger women (Colakoglu, 2008), untrained older individuals (Yamauchi, Nakayama, & Ishii, 2009), and younger athletes (Gardasevic, Bjelica, Vasiljevic and Milasinovic, 2017). During the age of 15, there is an increase in biological growth and muscle development, also increase of muscle section, which certainly can contribute to positive results (Gardasević, Bjelica & Vasiljević, 2016). The aim of this study was to determine effects of 8-weeks long muscle endurance training with the weight of body in the case of recreational athletes.

Methods

Participants

Ten healthy men aged 23-30 participated in this research (*Table 1*). Subjects belong to category of recreational athletes and had doctor's approval for participation in the program. Procedure of intentional sample selection is used in this research. According to Helsinki provision, all participants signed the consent willingly for participation in this study, with an open option to leave anytime.

Table 1 Basic features of subjects (n=10)

Age (yrs.)	26.4 ± 1.2
Height (cm)	181.38 ± 5.64
Weight (kg)	84.49 ± 11.29

Sample of variable

Initial and final testing is conducted in the morning. The following testing procedures were implemented:

1. Maximal number of push-ups in 60"
2. Maximal number of pull-ups in 60"
3. Maximal number of squats in 60"
4. Maximal number of rotational forward bends of body in 30"
5. Body extension hang (till release)
6. Left arm hangs under the ankle of 90° (till release)
7. Right leg hangs under 90° (till release)
8. Right leg hangs under 90°and pull-ups hang (till release)

Training program

Training program lasted 8 weeks. with frequency of 3 trainings a week (24 trainings in total). One training lasted 60 minutes. basic warm-up 10-15 minutes; main part of the training 30-40 minutes and the cooling 5-10 minutes. Three types of conventional exercises with only body weight (push-up. squad and pull-up) were used in this program. Exercises for development of muscular endurance are selected in relation to basic model of movements. where each standard exercise was done in three modified forms (*Table 2*). Subjects were previously trained to perform programmed exercises. biomechanically.

Table 2 Basic information about exercises

Basic model of movement	Standard exercise	Modification of exercise
Body push	Push-up	Incline; normal; decline.
Body pull	Horizontal pull-up	Narrow grip; wide grip; narrow pushdown.
Lowering and lifting your body	Squat	Posture on two legs; posture on one leg; one leg lunge.

Training loading apart from personal weight is dosed by speed of the exercise. position of the body. number of series of certain exercise. number of repetitions. and duration of passive recovery between series of exercises (Table 3). Training load increased with each of the following training sessions. Speed of the exercises varied from slow to medium. Biomechanically correct realization of the exercise was with special emphasis on the correct position of the spine. and was controlled by coach.

Table 3 Load of individual training

Exercises	Series	Repetitions	Pause
3-5	3-5	10-25	30"-90"

Statistical analysis

Basic descriptive parameters (IBM SPSS) were calculated for all variables. Univariant *t*-test for dependent samples was used for determination of statistically significant differences between two measurements ($p < 0.05$).

Results

Better results of mean values are noticed in all variables after final measurement (table 4). Percentage increase in all variables was between 18.62% and 31.2%. Results of standard deviations are lower in the final measurement in case of six variables. The lower variability of the results in the final measurement indicates the results approximation in their relation. The results have a normal distribution which allows the use of parametric statistical procedures. The t-test results for dependent samples indicate statistically significant differences between the two measurements ($p < 0.01$) (*Table 5*).

Discussion

All subjects had equal level of loadings during 8-weeks training program. Apart from positive effects of the program there is also equalization of group of subjects with the same level of muscular endurance in relation to initial testing. It is interesting that there was no static exercise in this program. Still. with the dynamic strength body weight exercises it is possible to achieve positive effects on static muscular strength of legs. backs. arms and shoulders. The benefits of this exercises are their functionality. since basic models of movement (horizontal body push with arms. horizontal body pull with arms and vertical body lowering into squat and lifting) are implemented in them. Apart from activation of big muscle groups all types of conventional exercises included more joints. at the same time. Different variations of exercises were included in program. According to Vrcić. Kovačević & Abazović (2016). shifting exercises lead to positive effects. Also, basic movement can be lost if an athlete is focused only on one aspect of movement (Kuk. 2010). Increase of volume of work was em-

Table 4 Descriptive indicators of initial and final measurement

Variable	Initial measurement		Initial measurement		
	m ± sd	cv	m ± sd	cv	%
Maximal number of pull-ups (60")	31.30 ± 7.81	24.95	38.7 ± 6.44	16.64	23.64
Maximal number of pull-ups (60")	4.60 ± 2.87	62.39	6.60 ± 2.98	45.15	30.44
Maximal number of squats (60")	34.70 ± 8.45	24.35	41.1 ± 3.78	9.19	18.44
Maximal number of body flexion (30")	34.00 ± 10.2	30.00	40.5 ± 7.41	18.29	19.12
Body extension hang	30.66 ± 7.08	23.09	40.5 ± 8.88	21.92	32.1
Left leg hangs under 90°	33.92 ± 11.3	33.31	43.8 ± 8.42	19.22	29.13
Right leg hangs under 90°	38.38 ± 12.2	31.78	45.9 ± 9.05	19.71	19.56
Pull-up hand (sec)	94.00 ± 30.4	32.34	111.5 ± 29.5	26.45	18.62

Legend: m ± sd mean ± standard deviation; c.v. - coefficient variation; % - percentage increase

Table 5 Significance of the difference

	t
Maximal number of pull-ups in 60"	-5.784**
Maximal number of pull-ups in 60"	-4.567**
Maximal number of squats in 60"	-3.868**
Maximal number of rotational forward bends of body in 30"	-5.713**
Extension body hang	-7.773**
Left leg hangs under 90º	-5.437**
Right leg hangs under 90º	-4.805**
Pull-up hang	-6.431**

*Legend: * p <0.05; ** p <0.01.*

phasized in the first six weeks of program. Performance of training of muscular endurance under a large but not maximal number of repetitions. provide an athlete larger volume of work. Otherwise. the athlete is considerably more energetically exhausted. if the activities are performed at maximum number of repetitions (Bajramović. Likić. Manić. and Mekić 2015). During the training one can achieve maximal result in relatively short period. with optimal usage of energy if one respects the principles from easier to heavier. from simple to complicated and from known to unknown (Bjelica. 2010). After first six months the intensity of loading was increased. gradually. by increasing the speed of performance of exercises or work in more demanding position of the body in relation to the standard position. By applying exercises of different type, it is possible to avoid adaptation of muscles. It is known that different angle and position of the body during performances of exercises can highly activate muscle groups. Changing the push-up type can result to significant changes in neural activation of primary pectoralis major and back deltoid muscle (Allen. Dean. Jung & Petrella. 2013). Also. narrow pushdown activates muscles of the back side of forearm. triceps brachi more than wide pushdown (Evans. 2010). Higher lifted arms during performance of push-up in relation to the level of legs (*incline).* contributes lower intensity of loading. Higher lifted legs in relation to the level of arm position during performance of push-up (decline) leads to higher intensity of loading. Modified pull-up in form of reversed rowing primary activates large back muscle. other smaller muscles of upper back and muscles of extensors of hip in relation to other exercises of pulling with load. such as standard exercises of pulling (rowing) in forward body band with outer loading (Fenwick. Brown & McGill. 2009). After pushdowns in training. body pulls were done and vice versa.

It is known that opposite model of movement prevents injuries. Asymmetry of muscles can be cause of injury or chronically orthopedic problem. Therefore. a well created

program can include movements for each muscle group (Plisk. 2010). In case of muscle asymmetry. its removal should be obligatory part of training of strength (Kazazovic. Tabakovic. Talovic. Alic. Jeleškovic & Mrković. 2010.).
In multi-joint strength exercises there is an activation of muscles of stomach and back. In this way. one avoids unnecessary body motions and incorrect performance of exercise. When performing exercise push-up, the outer abdominal_oblique muscles maintain stabile position so that primary initiators *m. pectoralis major* and *m. deltoideus* can complete the push up task (Mori. 2004; Cresswell. Oddsson. & Thorstensson. 2006). Also. different exercises variations of squat and pull-up. give muscles of stomach and back the role of stabilizers. For this reason it is not surprising that positive changes in tests of evaluation of muscle endurance have occurred. Muscular endurance of recreational athletes can be significantly improved by continuous and programmed exercises using the whole body as the main loading.

Conclusion

It is evident that body weight as a loading can be efficient in improvement of muscular endurance of the whole body. Training of strength with body weight is economical way of training because it doesn't demand additional material conditions and it is adequate or applicable in different situations. For beginners it is important that the whole training with own body weight contains basic models of movements. Models of basic movements need to have important role during the selection of exercises for training. Therefore. muscles of torso are secondary activated during the basic models of movement, which makes these exercises optimal. Apart from certain advantages. training of strength with own body weight has its disadvantages. Outer loading is better for isolation exercises. Adjustments of loading in exercises with own body weight is more complicated in relation to exercises with outer loading because it is necessary to shift angles and positions in relation to the pad or the equipment.
Manipulating variations of exercises gives possibility of dosing training load. By modifying exercises of strength with your own body weight can make quality stimulus on muscles during trainings for top-level athletes. This can be a suggestion for future studies.

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Submitted: April 2, 2018
Accepted: April 28, 2018

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