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Improving body composition and strength in athletes through a 4-month combined martial arts and strength training program

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Abstract

Background and aim. Body composition is one of key components of health in both general and athletic populations. In martial arts great significance is attached to the development of mesomorphy and strength, which are crucial for performing offensive and defensive actions during fights. The study proposes to introduce progressive strength training programme - arranged primarily for beginners – in order to improve body composition of non-elite male martial arts competitors. The present study aims to evaluate the changes in body massiveness, body composition and strength in 31 martial arts practitioners from academic sports clubs after a combined martial arts and strength training programme.

Material and methods. The 16-week intervention was based on a targeted progressive resistance training protocol developed by Stefaniak [1995]. The anthropometric, physical and motoric measurements were performed twice at four months interval. This programme includes training three times weekly with increased number of repetitions (19-24), number of sets (1-3) and increased loads (5%).

Results. After the completion of the training program, significant increase for about 1.8 kg in body mass was observed. Body massiveness (BMI) increased from 23.2 ± 1.8 kg/m^2 to 23.9 ± 1.8 kg/m^2. The analysis using Sheldon's somatotypes revealed an increase of mesomorphy (from 5.5 to 5.7) and decrease of ectomorphy (from 2.5 to 2.4). The level of endomorphy became stable (2.1). The maximal circumferences of flexed arm, forearm, calf and thigh increased significantly of about 0.6-1.2 cm. The amount of fat mass remained unchanged, but the amount of fat free mass and muscle mass increased about 1.5 kg (MM from 43.7 ± 4.8 kg to 45.3 ± 5.5 kg). Back muscle strength increased of 10.0 kg. In left hand there was visible increase of grip strength, whereas right hand grip strength became stable.

Conclusions. The results of the present study indicate that even experienced but non-elite academic male martial artists could improve their body composition and muscle strength by completing the proposed strength training programme together with martial arts training. The effect of symmetrization in hand grip strength is beneficial for sport performance and everyday movements practice.

1. Introduction

Body composition is one of key components of health in both individuals and populations. Sometimes even experienced athletes face with problems with their weight and body composition. In martial arts such as judo, jiu-jitsu and karate the need of a weight management control programme is raised [1]. Sport training is connected with adaptation of body build and body composition, therefore constant diversify of training methods is needed to improve body build and sport performance.

Strength training, depending on the type of training protocol, brings about changes in muscle size and structure, muscle cross-sectional area, and also increases muscular strength by improving muscle function [2, 3]. Resistance training can also be targeted to improve body build and body composition [4 - 6]. Some authors indicate that in martial arts strength training can potentially improve male competitors' strength and agility [7] what is especially advantageous in experienced athletes adapted to previous judo training. Other studies focused on the biomechanical aspects of resistance training to find that this form of training provides a number of competitive advantages, such as for judo practitioners [8, 9]. Effects of training on muscle hypertrophy and adipose tissue reduction are the most visible during the initial period of training and differ according to male or female sex, age and fitness level [7, 10-12]. Several mechanisms explain the effects of resistance training including changes in muscle cross-

sectional area and muscle fiber type composition and increased voluntary muscle activation [3].

Martial arts such as judo, karate, and jiu-jitsu place a strong emphasis on spiritual and moral development and following the teachings of a master. However, the practice of these disciplines as sport has prioritized competitive results above all. Within the realm of combat sports, attributes such as tactical and mental training are as important as high levels of strength and flexibility [13] since many fighting techniques involve generating a great deal of force. During a bout, these vary from incapacitating or throwing an opponent on their back, sparring from the knees, or performing takedowns. The generated force also translates into impact strength. Such moves place large and dynamic loads on the muscles and joints of the shoulders, trunk, and hips [13 - 15]. This has led researchers to dichotomize martial artists into those who fight with a series of attacks and counterattacks (practitioners able to exert significant force) and those who wait to strike at the most opportune moment [16]. The tactical rationale for such fighting styles is strongly grounded in individual predispositions in which body build plays a deciding role.

As mentioned, the physical and motor effects of resistance training differ depending on the adopted protocol and need to be controlled for sex, age, physical fitness, and individual predispositions. In order to be useful for athletes and coaches, research is needed on specific training methods while also adopting valid yet accessible measurements of body build and motor performance. In light of the above, the aim of the present study was to examine changes in the body somatotype, size, body composition and strength profiles of non-elite martial artists after an adaptive resistance training intervention continuing for 16-week period of time.

2. Material and methods

The study involved 31 male judo, jiu-jitsu, and karate practitioners (aged 20–30 years) competing for university-level sports clubs. Participants must have met the following inclusion criteria: minimum 2 years training experience, university sports club member, and competing in the middleweight class in regional and national championships. They represent similar sports level (non-elite, degree above the rank of 3rd kyu and below the rank of 1st dan).

The recruited athletes at the time of the study were not at the competitive stage of their training cycle. They attended judo training sessions three times a week (4.5 +/- 0.5 hours per week). The sample was screened to verify that they were not suffering from any injury or disease that might affect participation in the study. Participants maintained their normal diet and refrained from consuming any additional vitamin and nutritional supplements during study's duration.

The 16-week intervention was based on a targeted progressive resistance training protocol developed by Stefaniak [17]. It involves training three times per week by progressively increasing the number of repetitions (from 19 to 24), then the number of sets (from 1 to 3), and then load (5%); after load is increased the entire protocol is then repeated. The programme was based on the following exercises: barbell squats, barbell lunges, stiff-legged barbell deadlifts, bent over rows, barbell bench presses, barbell pullovers, seated dumbbell shoulder presses, dumbbell shrugs, dumbbell lateral raises, underhand barbell curls, alternate dumbbell hammer curls, dumbbell side bends, standing cable crossovers, standing biceps cable curls, overhand cable pushdowns, mountain climbers, hanging knee raises, and crunches.

Pre- and post-intervention measures included body height; flexed and relaxed arm girths, maximum and minimum forearm, thigh, and calf girths; and skinfold thickness at the

arm, forearm, thigh, and calf sites using GPM anthropometric instruments (Siber Hegner, Switzerland). Body mass was measured using a standard electronic scale and body mass index (BMI) was calculated to determine body size. The above measures were also used to classify body type following Sheldon's typology as modified by Heath and Carter [18]. This determined the somatotype of the participants according to the level of endomorphy, mesomorphy, and ectomorphy. Body composition was assessed by bioelectrical impedance analysis (BIA 101 Anniversary Sport Edition, Akern, Italy). Strength was measured via handgrip and back strength with adjustable-grip hand and back dynamometers, respectively (Takei Scientific Instruments, Japan).

The technical error of measurement (TEM) was calculated to assess reliability. Basic descriptive statistics were calculated for each variable and Student's *t* test for repeated measures was used to compare pre- and post-intervention values. Levene's test was used to analyze the homogeneity of variance. Statistical significance was set at $p < 0.05$ for all tests. Differences between the pre- and post-intervention somatotype were examined using Somatotype Analysis of Variance (SANOVA) included in Somatotype Calculation and Analysis software (Sweat Technologies, Australia). Data were graphed using Excel 2003 (Microsoft, USA).

The study was approved by the Ethics Committee of the University School of Physical Education in Wroclaw, Poland and conducted in accordance to the Declaration of Helsinki. Informed consent was collected from all participants. This study was performed under the auspices of the Polish Ministry of Science and Higher Education Programme *The Development of Academic Sport*.

3. Results

After the 16-week resistance training intervention, mean body mass of martial arts competitors increased from 74.9 ± 6.9 kg to 76.7 ± 7.1 kg (t = −4.45, p = 0.0003). This result correspondingly increased BMI from 23.2 ± 1.8 kg/m^2 to 23.9 ± 1.8 kg/m^2 (t = −5.02, p = 0.0000).

Table 1. Body composition of male martial artists pre- and post- resistance training intervention

Body composition [kg]	Pre		Post		Student's *t* test	
	Mean	*SD*	*Mean*	*SD*	*t*	*p*
Fat-free mass	61.6	6.3	63.0	6.7	−2.66	0.0159
Fat mass	13.2	3.4	13.8	3.3	-1.72	0.1025
Muscle mass	43.7	4.8	45.3	5.5	−3.10	0.0061
Total body water	45.1	4.6	46.1	4.9	−2.68	0.0154
Intracellular water	26.4	2.9	27.3	3.6	−3.06	0.0068
Extracellular water	18.7	1.9	18.8	2.0	−0.19	0.8521

Among the components of body composition, a positive effect was observed in total body water which significantly increased by approximately 1 kg (Tab. 1). Intracellular water also significantly increased but no change was observed in extracellular water (Tab. 1). Post-intervention muscle mass and fat-free mass increased by approximately 1.5 kg. No change was observed in fat mass (Tab. 1).

Table 2. Girth measurements of male martial artists pre- and post-resistance training intervention

Girth [cm]	Pre		Post		Student's *t* test	
	Mean	*SD*	*Mean*	*SD*	*t*	*p*
Relaxed arm	31.5	1.9	32.1	2.0	−2.28	0.0350
Flexed arm	35.1	2.4	35.3	2.2	−1.17	0.2590
Maximum forearm	27.3	1.6	28.1	1.1	−3.61	0.0020
Thigh	55.6	3.0	56.7	3.3	−2.82	0.0114
Maximum calf	36.2	2.4	37.3	2.4	−5.39	0.0000

Girth measurements indicated a significant increase in right relaxed arm by 0.6 cm although no change was observed in flexed arm girth (Tab. 2). Maximum forearm girth increased by 0.8 cm with no change in minimum arm girth. Maximum calf girth also significantly increase by 1.0 cm with no change in minimum calf girth. Maximum thigh girth increase by 1.2 cm comparing to pre-intervention values (Tab. 2).

Analysis of skinfold thicknesses showed reduction in subcutaneous extremity fat by 1.7 mm what mainly resulted from forearm and calf skinfolds reduction (Tab. 3). No significant difference was observed for subcutaneous fat located on the trunk (Tab. 3).

Table 3. Skinfold thicknesses of male martial artists pre- and post-resistance training intervention

Skinfold thickness [mm]	Pre		Post		Student's *t* test	
	Mean	*SD*	*Mean*	*SD*	*t*	*p*
Subscapular	9.4	2.4	9.7	2.5	−1.37	0.1870
Biceps	3.2	1.1	2.8	0.5	1.80	0.0479
Triceps	4.9	2.0	4.7	1.4	0.74	0.4673
Forearm	3.3	0.6	2.9	0.7	2.16	0.0447
Suprailiac	7.8	3.2	7.4	2.7	0.96	0.3468
Calf	5.0	1.7	4.3	1.3	1.97	0.0449
Sum of extremity skinfolds	16.4	4.5	14.7	3.4	2.12	0.0482
Sum of trunk skinfolds	26.9	8.8	27.1	8.5	-0.26	0.7983

Somatotyping found a significant increase in mesomorphy, with pre- and post-intervention values of 5.5 ± 1.5 and 5.7 ± 1.5, respectively ($t = -3.09$, $p = 0.0043$). Mean ectomorphy slightly decreased from 2.5 ± 0.8 to 2.4 ± 0.8 ($t = 1.62$, $p = 0.1146$). No change was observed in the level of endomorphy, which remained at 2.1 ± 0.7 ($t = 0.87$, $p = 0.3913$).

Back strength significantly increased after the training intervention by 10.0 kG ($t = -2.3$, $p = 0.0308$), from 124.4 ± 30.0 kG to 134.4 ± 16.0 kG. Pre- and post-intervention right handgrip strength was 47.3 ± 9.3 kG and 47.9 ± 8.8 kG, respectively ($t = -0.45$, $p = 0.6617$).

Left handgrip strength increased visibly from 43.3 ± 9.2 kG to 47.0 ± 9.6 kG ($t = -4.80$, $p = 0.0002$) and reached the values observed in right hand.

Discussion

The results of the present study indicate that experienced but non-elite academic male martial artist could improve their performance in back muscle strength, left handgrip strength and their body composition by completion their training with a 16-week strength training programme according to adaptive method described by Stefaniak [17].

The adopted training protocol resulted in a significant increase in musculature, expressed by a significantly larger component of mesomorphy and approximately 1.5 kg increase in muscle mass. This increase in musculature was also reflected in higher BMI values, an increases in arm girth for about 0.6 cm, maximum forearm girth for about 0.8 cm, maximum thigh girth and maximum calf girth, both for about 1.1 cm. Franchini et al. [19] showed that muscle girths and upper body strength were significantly larger in elite martial artists with longer training experience, allowing the statement that such criteria are valid in the selection of athletes in martial arts. After the training programme male athletes experienced also an increase in percentage content of total body water, especially intracellular water for about 1 kg.

Body fat is particularly important in martial arts not only due to how weight classes are determined but also the large role it plays in determining fighting effectiveness [20]. Previous studies have found that body fat percentage can serve as a valid predictor of vertical jump performance and lower extremity power in both male and female martial artists [21]. Other researchers have postulated that high body fat percentage correlates negatively with performance in activities that involve entire body locomotion [20]. The results of the present study suggest that the adopted 16-week resistance training programme reduces subcutaneous

fat on extremities (via arm, forearm and calf skinfold thicknesses). This program did not affect changes in fat located on the trunk, as evidenced by the lack of significant differences between pre- and post-measures of subscapular and suprailiac skinfolds and body fat percentage by bioelectrical impedance analysis. A similar finding was reported by Cloutier et al. [22], in which fat mass did not change after 8 weeks of resistance training. In turn, Baker et al. [23] showed a slight decrease in skinfold thicknesses after resistance training, although this difference was larger in the case of exercise performed with one set compared with three sets. This suggests the existence of a mechanism that impedes fat reduction when a large training volume is performed. It is also possible that the level of adiposity achieved by martial artists is optimal for their discipline and any further reduction of fat is limited by the metabolic rate of practitioners.

The examined male competitors reached a 10 kg increase in back muscle strength, and a 4 kg increase in left hand grip strength. The strength of right hand become stable. The observed effect of symmetrization in hand grip strength is beneficial for sport performance and everyday movements practice in this group of athletes [24]. Strength is an important component of fighting ability in martial arts, with greater levels of strength correlative with competitive success [25]. The results show that a 16-week regime of this protocol improved upper body muscle strength via increased back strength and handgrip strength by approximately 9 kG and 2 kG, respectively. Cloutier et al. [22] observed an increase in strength after only 8 weeks of resistance training. The influence of various resistance training protocols has been investigated by many researchers [23], who also confirmed increased skeletal muscle strength following resistance training.

Conclusions

- A 16-week intensive resistance training program based on Stefaniak's protocol induced significant increases in upper body strength as well as musculature.
- The observed effect of symmetrization in hand grip strength is beneficial for sport performance and everyday movements practice in this group of athletes
- Changes in adiposity proved to be minor and were mainly concentrated to the extremities. Combined with the findings of other studies, this suggests that the adiposity level achieved by martial artists with several years of experience is optimal for their discipline and any further reduction of fat is limited by the metabolic rate of practitioners.
- These somatic and motor effects reached by the male athletes created better physical conditions for sports practice and better general physical health of athletes.

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