ORIGINAL ARTICLE
SCIENCE OF MARTIAL ARTS

Programmed training effects on body composition indicators of female karate athletes from 12 to 14 years of age

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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Source of support: Departmental sources

Received: 30 December 2014; **Accepted:** 05 November 2015; **Published online:** 22 December 2015

ICID: 11000

Abstract

Background & Study Aim: Karate is sport who has high demands for energy consumption due to constant dynamic movements in training and fights. Transformation process in sport is ability to change body physiology using training methods. The aim of this research are the effects of a three month programmed training on body composition indicators in female karate athletes from 12 to 14 years of age.

Material & Methods: Twenty-two female karate athletes from 12 to 14 years of age have been submitted to a three month programmed training. Measuring the body composition indicators was conducted by Tanita BC420SMA – bioelectric impedance analysis (BIA), scale specifically used for the analysis of seven indicators relevant for karate sport, differentiated by weight classes. For determining the programmed training effects, paired sample T-test was used at the level of statistical significance of $p<0.05$.

Results: Three month programmed training resulted in changes regarding weight ($p = 0.020$), FM% ($p = 0.012$), FMkg ($p = 0.01$) and BMI ($p = 0.002$), and statistically significant increase in variables TBW% ($p = 0.007$). Concerning the variables FFM, MMSS and TBWkg, there were no statistically significant changes noted.

Conclusions: The results of this research have indicated that under the influence of programmed training in karate, positive transformations can be expected within the indicators of body composition in girls between 12 and 14 years of age. Transformation is most certainly a result of natural growth and development occurring in girls, but likewise a combination of programmed training and adequate nutrition.

Key words: martial arts • microcycle • morphology • subcutaneous adipose tissue • transformation

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Kata – originally were teaching and training methods by which successful combat techniques were preserved and passed on. Practicing kata allowed a company of persons to engage in a struggle using a systematic approach, rather than as individuals in a disorderly manner [26].

Bunkai – literally meaning "analysis" or "disassembly", is a term used in Japanese martial arts referring to process of analysing kata and extracting fighting techniques from the movements of a "form" (*kata*). The extracted fighting techniques are called *Oyo* [27]. Some *kata* have another layer of application that is taught using an *Oyo Bunkai*, an "application of the kata in ways other than the standard bunkai" [28].

Microcycle – shortest training cycle is characterising by the dynamic of loads occurring in 5 to 9 days (usually a week).

Morphology – in sports related researches presents overall structure of body, including subcutaneous adipose tissue (total amount of fat tissue beneath the skin).

Transformation – is process of structure changing using various training tools.

INTRODUCTION

Traditionally, karate represents a combination of martial art and budo life philosophy [1]. Karate' s structure demonstrates dominating wide stances, low centre of gravity, explosive movement and explosive hand and foot techniques for which performance purposes a kinetic chain including the entire body is engaged. Biomechanical analysis of karate indicates that efficient performance of karate techniques depends on physical capacity and the ability of sustaining mental focus [2]. This demonstrates karate's contribution to the development of bodily functions, motor abilities as well as control over mental abilities [3]. Individual kicks in karate depend on strength; however, their repetition leads to energy expenditure, which for its most part of 78 percent occurs during aerobic training and 16 percent during anaerobic processes [4]. Considering that aerobic processes can reduce the level of adipose tissue, one can conclude that the increased energy during karate training can cause changes in basic body composition indicators.

Male and female, especially during puberty significantly differ in height and body composition. From an evolutionary aspect, a greater amount of adipose tissue in female correlates to a greater energy demand for the purposes of a successful reproduction [5]. Girls distinctive features in puberty are exhibited through changes, an increase in body weight and amount of adipose tissue [6], while for boys those changes are reflected in an increase of fat-free mass (FFM). The authors claim that the basic difference, which leads to the increase of the adipose tissue for girls reaching puberty, is the steroid hormones. Boys demonstrate an increase in testosterone level, which in return affects the growth of muscle tissue, whereas girls' estrogen diverts energy, needs into adipose tissue which in return bears negative effects when demonstrating motor abilities, since it represents inactive body mass. Therefore, during the period of rapid growth, boys exponentially improve their movement structure, become faster and exhibit a much greater strength values along with an improved dynamic balance.

Research papers concerned with body composition and somatotypes of female karate athletes are scarce [7]. Female karate athletes are classified as endomorph somatotypes both in practical and literary terms. The total percentage of fat, as well as the amount of subcutaneous adipose tissue negatively affects the strength and speed expression [8], which is essential for the successful performance of karate kicks [9]. Females in comparison to males have higher percentage value of adipose tissue due to their morphological and hormonal characteristics. Data concerning the percentage of subcutaneous adipose tissue in adults range from 12.6% [10] in regards to Poland male karate athletes, to 10.9 % [11] for American male karate athletes, while for Japanese male athletes the percentage of adipose tissue amounts to 12.8% [12]. BMI can be lower in girls, but the fat-free mass is relevant for the motor task performance. The amount of water in the body plays a significant role. Positive correlations of water in the body have been generated by exhibiting strength, dynamic balance and speed, along with the notion that water in the body contributes to a more efficient method of energy production. The significance of water in the body serves as an aid to immunological function.

The aim of this research are the effects of a three month programmed training on body composition indicators in female karate athletes from 12 to 14 years of age.

MATERIAL AND METHODS

Participants

Twenty-two female karate athletes from the local karate club aged 12 to 14 participated in this research. At the initial assessment, the mean height was found to be 160.4 ±10.1, and mean age 13.6 ±2.1, and for the final assessment, the mean height was 161.4±10.3 along with mean age 13.8 ±2.3 with no significant difference.

All of the procedures and measurements were completed in Institute of sport, respecting rules and regulations provided by Ethic Committee.

Procedures

Subjects have been personally informed regarding the testing protocol. Body height was determined for each subject with the help of Holton Anthropometer, under the same conditions for the initial and final testing stage. Body composition was determined with Tanita BC420SMA scale (Tanita Corp, Tokyo, Japan) which has been medically approved and is considered reliable for this use. It operates on the principle of bioelectrical impedance (BIA) applying the leg-to-leg system [13, 14], and is available in commercial sale. The scale determines body composition based on electrical impedance [15] and it is accurate in measuring up to the ±0.1 kg. Testing was

conducted in the morning after a whole night fast (at least 6 hours). Each subject was characterized as an athlete on the scale indicators. Subjects wore body suits, without any jewelry or metal. Both stages of testing, initial and final were completed at room temperature of 22°C.

Body composition indicators

Indicators determined by Tanita scale for the purposes of body composition analysis are following: weight (kg), fat mass in % (FM%), fat mass kg (FMkg), fat free mass (FFM), muscle mass (MMSS), total body water in kg (TBWkg), total body water in % (TBW%), body mass index (BMI).

Training program

Training program was conducted in the period of twelve (12) weeks covering in total thirty six (36) training units. Three training units were performed within each weekly microcycle. The training content was divided into three (3) parts. Each microcycle was conducted for the purposes of developing specific motor ability (coordination, strength, flexibility, power and speed – SAQ training method). The first part of the training introduced warming up activities focusing on the development of flexibility. The second part of the training contained a series of exercises for the above listed motor abilities, while the third part of the training was used for the development of technical and tactical elements in karate performed by practicing karate techniques and *katas* for the brown belt.

In total the programme covers 10 techniques and 7 special techniques (specials) – Tables 1 and 2). Each technique was processed through the course of 1 microcycle, and the specials through the course of 4-5 training units. During the training, the exercises for the karate elements were distributed according to: current technique *(kihon* for the qualification), *kata* for the qualification and technique demonstrations (sparing, sport fight, *bunkai* – *kata* demonstration). All subjects attended training sessions with over 93 ±2.1%. Training units lasted for 88 ±3.1 min. in average.

Statistical analysis

Data have been calculated using arithmetic mean (Mean), and standard deviation (SD). The effects of the programmed training were analysed using software package SPSS 22.0 (IBM Corp.) and T-test was used for the paired samples at the level of statistical significance of minimum 0.05%.

RESULTS

T-test results have indicated the statistically significant difference ($p<0.05$ and $p<0.01$) between the initial and final assessment, along with the occurrence of weight loss ($p = 0.020$), FM% ($p = 0.012$), FMkg ($p = 0.010$) and BMI ($p = 0.002$), and a statistically significant increase in the variable TBW% ($p = 0.007$). In the case of FFM, MMSS and TBWkg variables, there were no statistically significant changes detected (Table 3).

Table 1. Female karate athletes' training programme designed for motor abilities

Main purpose (methods) of training	Training	Weeks of training											
		1	2	3	4	5	6	7	8	9	10	11	12
Flexibility		+	+	+	+	+	+	+	+	+	+	+	+
Coordination	T1		+	+	+	+	+	+	+	+	+	+	+
	T2		+	+	+	+	+	+	+	+	+	+	+
	T3			+		+		+		+		+	
Strength	T1		+	+	+	+	+	+	+	+	+	+	+
	T2		+	+	+	+	+	+	+	+	+	+	+
Power	T3		+	+	+	+	+	+	+	+	+	+	+
SAQ	T1		+	+	+	+	+	+	+	+	+	+	+
	T2		+	+	+	+	+	+	+	+	+	+	+

T1 – First training of the week, T2 - Second training of the week, T3 - Third training of the week

Table 2. Training programme designed for karate techniques and specials

Special techniques (exercises)	Weeks of training											
	1	2	3	4	5	6	7	8	9	10	11	12
Oi zuki jodan - gyaku zuki chudan	+										+	+
Jako ude uke + mavashi geri - uraken - gyaku zuki		+									+	+
Shuto uke (kokutsu) + mae geri – empi – gyaku zuki			+								+	+
Ushiro mawashi - gyaku haito				+							+	+
Kizami zuki + oi zuki – uraken – gyaku zuki					+						+	+
Ashi mae geri + mae geri – uraken						+					+	+
Awase zuki + mae geri – hasami zuki jodan							+				+	+
Mae geri – mawashi geri – mawashi zuki								+			+	+
Mawashi geri – yoko geri kekomi – yoko empi fudo – dachi)									+		+	+
Mae tobi geri										+	+	+
Kizama zuki	+	+									+	+
Kizama zuki jako zuki, ashi mawashi geri		+	+								+	+
Mawashi geri				+	+						+	+
Cleaning through the front foot					+	+					+	+
Uramawashi geri							+	+			+	+
Jako zuki uramawashi								+	+		+	+
Transition oi zuki									+	+	+	+
Enpi	+	+	+	+	+	+	+	+	+	+	+	+

DISCUSSION

The results indicated that the aim has been achieved and the necessity of their correlation with the research which has previously addressed the same issue. Lack of data regarding the effects of karate training, especially for young female athletes enables obtaining a relevant and complete picture, as well as the possibility of their comparison. Most of research is connected with the male karate athletes for different senior categories. The first relevant fact is the lack of statistically significant changes in body height for the course of three month training period. This result suggests that the biological development has not by far affected the height. The issue regarding the karate training indicated that energy expenditure is of a lesser amount during training than in the fight [4].

Most authors have proved connection between the energy expenditure and body composition. Sport specific characteristic is that it requires a lot of energy loss [16], therefore athletes have a lower level of the subcutaneous adipose tissue. Most of researchers have concluded that high level of physical activity has positive effects on reducing subcutaneous adipose tissue [6].

According to Gloc et al. [17] who conducted a research based on a sample of 9 female karate athletes in the age 22.8 ±4.9 and control group (n = 10 subjects in the age 24.5 ±3.39) the effects of a four month karate programme did not indicate any statistically relevant differences in the change of the body composition. Assessment was conducted during the

Table 3. T-test results for paired samples between the initial and final assessment (Initial and Final) of body composition indicators for female karate athletes (n = 22).

Indicators	Initial	Final	Differences	t	p
	Mean (SD)	Mean (SD)			
Weight (kg)	55.9 ±14.4	55.2 ±13.8	**0.7**	2.515	**.020***
FM%	24.9 ±6.5	23.9 ±6.1	**1.00**	2.749	**.012***
FMkg	14.7 ±7.3	13.8 ±6.7	**0.9**	2.831	**.010****
FFM	41.2 ±7.9	41.4 ±8.0	0.2	1.257	.223
MMSS	39.1 ±7.5	39.3 ±7.6	0.2	1.282	.214
TBWkg	30.1 ±5.7	29.8 ±6.1	0.3	.728	.475
TBW%	54.9 ±4.7	55.7 ±4.5	**0.8**	3.011	**.007****
BMI	21.4 ±3.8	20.9 ±3.5	**0.5**	3.438	**.002****

*p<0.05 **p<0.01

preparation stage and at the beginning of the competition session. Differences determined at the initial assessments were reflected at the final assessment, therefore one may state that the karate programme has affected, on a relatively smaller scale, the changes in the body composition. Of course high competition level should be taken into consideration along with the years of training experience regarding female karate athletes in group, therefore it is quite evident that lesser changes will be detected in the case of body composition variables. The most significant difference was detected in the total body water percentage TBW%. The results of this research have likewise determined statistically significant changes and an increase in the percentage of water present in the body of subjects after a three month karate programme.

Amusa and Onyewadume [18] have conducted a research of body composition and somatotypes of male karate athletes. The sample consisted of 10 males aged 26.4 ±3.0 and 7 females aged 22.4 ±3.7 in which they compared body composition with each competition level. Contestants at an international level had lower values in the percentage of adipose tissue but a higher level of fat free mass in relations to the contestants of lower level. Likewise, they have determined that males have lower values in the percentage of adipose tissue but a higher value of fat free tissue in relation to females. This attests to the values of high intensity training process in karate and how it affects body composition. This exercise regime in duration of 12 months led to energy release, which body conducted by burning fat accumulated supplies regarding the already mentioned high percentage of energy generated during aerobic process, so the reduction of the total percentage of adipose tissue and weight comes as no surprise.

Percentage of adipose tissue in relation to the total body mass may disturb dynamic balance and body stability, especially in the teenage population facing obesity [19,20]. Based on the research results, karate training can reduce percentage of adipose tissue as well as body mass assisting in maintaining dynamic balance so as not to result in falls and injuries due to obesity. Practicing martial arts contributes to the reduction of fat in children and youth [21]. Lower values of subcutaneous adipose tissue contribute to a higher explosive strength and speed exertion, determined by correlation between the subcutaneous adipose tissue and height of the jump [8]. Athletes have a bigger share of muscle tissue than non-athletes [22].

Most of training processes is based upon strength training, which induces increase in the muscle mass. Considering that the programme in some segments consisted of elements for developing muscle hypotrophy, the obtained results were as expected, i.e. no statistically significant increase in fat free mass (FFM) was determined. According to Imamura [23] the greatest differences between elite karate athletes and beginners is the amount of fat free body mass (lean mass) suggesting that a continuous training process in karate contributes to the increase in muscle fat free mass.

Contrary to this, there are a number of those who state that combat sports affect the level of fatness and that not every combat sport has same influence on

reducing fatness level [24]. However, there are those who believe that such differences do not exist [25].

Regarding the results obtained at the initial and final assessment and the lack of their statistically significant differences, the BMI results are significantly different and are lower at the final assessment, therefore we can state that one factor which contributed to that is for the most part, body mass reduction.

CONCLUSIONS

The results of this research have indicated that under the influence of programmed training in karate, positive transformations can be expected within the indicators of body composition in girls between 12 and 14 years of age. Transformation is most certainly a result of natural growth and development occurring in girls, but likewise a combination of programmed training and adequate nutrition. This can in future provide quality results in karate sport. The greatest changes which have occurred as a result of programmed training effects in karate are: weight loss, reduced percentage of fat supplies and increase in the total percentage of water in the body.

COMPETING INTERESTS

Authors have declared that no competing interest exists.

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Cite this article as: Kapo S, Rađo I, Kajmovic H et al. Programmed training effects on body composition indicators of female karate athletes from 12 to 14 years of age. Arch Budo Sci Martial Art Extreme Sport 2015; 11: 163-168