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Influence of Karate Training on Morphological Characteristics, Motor Abilities and Skills in Boys

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Abstract

The purpose of this study was to determine the effects of an experimental treatment on morphological characteristics as well as basic and specific motor abilities of young karate trainees. 12 morphological, 12 basic motor variables and 5 specific motor variables were applied on 82 boys aged 10-12 years. There were statistically significant differences in morphological characteristics at p<.001. The greatest effects were seen for skin folds, which were significantly lower after treatment. Significant differences were also found for most motor skills at p<.001 (for 9 variables; for one at p<.05). However, no differences were determined in foot tapping and balancing on one foot on a balance beam. The results showed that quite satisfactory effects were achieved, particularly in those abilities with no genetic limitations, which can be considered a significant contribution to sport science and theory of sport and sports training.

Key words: *boys; differences; influence; Olympic sport; physical education.*

Introduction

Karate has become a global phenomenon around the world since millions of families practice it in numerous countries on all five continents and as such, karate is deeply rooted in today's global society. Due to this popularity amongst the world's martial arts, karate will become a demonstration Olympic sport in Tokyo in 2021 for the first time. The World Karate Federation (WKF) includes 188 countries on five continents, with over 10 million members (Espinós, 2020). The same author states that it is estimated that more than 100 million individuals are involved in karate. It is known that the largest percentage of this number of athletes refers to children and youth**.** It

is therefore clear that karate can have a major impact on the prevention of inactivity and sedentary lifestyle as the biggest predictor of obesity.

Obesity has reached alarming levels in the world today, especially in children (World Health Organisation, 2019). If recent research is taken into account, it is obvious that the level of obesity is still increasing (Skinner et al., 2018; Venetsanou et al., 2019); therefore, the need for the prevention of childhood obesity is emphasised.

The world is increasingly considering the inclusion of children in designed sports programs of physical activity, which represents a vital contribution to reducing obesity (Kovač et al., 2013; Mead et al., 2017), with significant effects on the improvement of health aspects (World Health Organization, 2018).

Present scientific research shows that, with the increase of basic motor capacity and skills development (Doder et al., 2012, Emeljanovas et al., 2015), children have an innate ability to develop new motor skills even further.

In addition to the stated public health importance in practicing karate with children and youth, there is also a need to develop modern and efficient ways of planning and making a program at an early age as a basis for reaching top sports achievements in the senior period.

In order to achieve progress in today's modern karate sport, it is necessary to use the most modern approaches, concepts, forms, content and methods in working with the youngest participants in karate. Despite the above, it is almost unbelievable that only during the last decade more attention has been paid to the effects of continuous training encumbrance on the anthropological status of young karatekas.

However, in order to achieve the desired effects in training and competitive processes of young practitioners, it is necessary to initiate a timely and quality selection. This selection should be based on the planned goals and a 'desired state' in karate, as well as on appropriate diagnostics, planning, programming and monitoring the effects of the training process (Lapresa et al., 2011, Malacko & Doder, 2008, 2014).

For these very reasons, it is critical to understand not only the development of basic motor abilities but also pay attention to specific and situational skills primarily responsible for athletic performance (Hemba, 1991; Mori et al., 1997; Jozić, 2001; Mori et al., 2002; Katić et al., 2005; Mišigoj-Duraković & Matković, 2007; Doder et al., 2011; Sterkowicz & Franchini, 2009; Loturco et al., 2014). Furthermore, these skills require continuous measurement, development, control and correction if one aims to achieve the optimal results in the shortest possible time (Annesi et al., 2005; Doder et al., 2011).

The development of relevant anthropological abilities and characteristics in children (Viru et al., 1998; Malina et al., 2004; Pejčić & Malacko, 2004; Vidranski, 2006), which primarily depends on careful selection of training methodologies and programs, should not be achieved through meaningless, random exercise. This means that it is pointless to develop specific anthropological abilities and characteristics without consideration for specific needs and goals (Blažević et al., 2006; Burušić & Šerić, 2015).

The collection of data on the development of young athletes' anthropological abilities and technical-tactical movement structures over long periods of time and the ensuing mathematical-statistical data analyses present a solid foundation for their diagnostics (Malacko & Doder, 2008) and eventually practical applications of the resulting programmed training contents, as well as monitoring and analyses of their effects. As the effects of experimental treatment/training depend mostly on the methods of exercise and/or training, it is critical to know the measure and purpose of any exercise program and the right instruments for the evaluation of its effects.

With the desire to contribute to solving this problem, the Karate School program was designed and presented in this paper. It is intended for non-selected children of school age. The program is primarily focused on their multifaceted development and as such is the foundation for nurturing future top athletes. The acquisition of a significant amount of motor knowledge and greater number of skills in earlier stages of sports development enables successful specialization at a later age. It is equally important to influence some abilities during the sensitive phase of an athlete's development, since it is impossible to develop them later on. Research on children's training (Bompa, 1998) emphasizes that puberty should be the focus period for developing skills of coordination in children. This period is also considered the "gold standard" for development of a wide range of motor skills such as speed, strength, coordination and balance.

The program and training at this age must focus on the overall sports development, not just on performing a karate program. Proposed programs should include low-intensity exercises aimed at developing aerobic capacity, muscular endurance, strength, power, speed, agility, coordination and flexibility, with special emphasis on having fun.

The karate school program should above all be fun for children and offer varied opportunities, with an emphasis on adoption and improvement of proper movement structures, i.e. karate techniques. In order to achieve this direction, it is necessary to perform a sufficient number of repetitions of a karate technique.

When using such programs, it is important to use specific equipment, modify and follow simple sports rules and emphasize the importance of fair play guided primarily by the principle of safety in order to reduce the possibility of sports injuries (Hemba, 1991).

In other words, there is a possibility that a particular training program may compensate for or even jeopardize the predicted outcome, although its application seems appropriate for achieving a desired outcome (Mraković et al., 1992). Therefore, it is obvious that contents, methods and encumbrance cannot always be applied and assessed separately, but as interdependent parts of a complex process of planning, programming and applying the exercise (Jurak et al., 2011).

This research included careful planning and execution of exercise programs in order to create preconditions for adopting specific movement and situation structures on the one hand, and it provided for optimal development or transformation of relevant morphological characteristics, basic and specific complementary motor abilities and skills, on the other (Malacko & Doder, 2008).

The main purpose of this study was to assess the effects of a two-year experimental treatment, i.e. training program, on anthropological abilities and characteristics of young karate trainees. The secondary purpose was to make further recommendations based on these findings.

Methods

Experimental approach

The basic concept of this study was to evaluate the effects of an experimental treatment on the representative variables of morphological, basic and specific motor abilities and skills in 10-12-year-old male karate trainees. The univariate (ANOVA) and multivariate (MANOVA) analyses were applied for comparing the differences between the initial and final measurement.

Participants

The sample consisted of 82 boys recruited from 18 karate clubs from the territory of the Province of Vojvodina (Novi Sad, Bečej, Subotica, Sremski Karlovci, Inđija, Srbobran and Šid), aged 10-12 years. The participants regularly practiced karate and attended physical education at school and were both physically and mentally healthy. Parental consent forms were obtained for all participants since the parents were introduced to all the testing procedures. The study was performed in accordance with the Helsinki Declaration, and the experimental protocol was approved by the Ethics Committee of the Regional Institute of Sport and Sports Medicine (REC-96/2018) prior to the beginning of the study. Before the initial testing, all subjects were examined by a licensed physician. Only healthy children could participate in the study.

Procedures

The following predictor variables for the assessment of morphological characteristics were applied (Lohman et al., 1998): BOH – body height, LEL – leg length, ARL – arm length, SHS - shoulder span, PES - pelvic span, WRD - wrist diameter, MCG – mid-chest girth, LAG - lower-arm girth, BOM – body mass, UST – upper-arm skinfold thickness, AST – abdominal skinfold, SST – subscapular skinfold thickness. All measurements were done according to IBP standards

The following variables for the assessment of basic motor skills were used (Gredelj et al., 1975; Kurelić et al., 1975): AIA – agility in the air, HAT – hand tapping, FOT – foot tapping, HOB – hyper extentions on the bench, BOF – balancing on one foot on a balance beam, SHF – shoulder flexibility with a yardstick, 30S – 30-sec situps, PPB – pushups on parallel bars, HSL – half-squat with load, LSP – long-jump from a standing position, TSP – tripple-jump from a standing position, 20M – 20-m dash with a flying start. Metric characteristics of the basic motor variables have previously been validated.

The following variables for the assessment of specific motor skills were used: POZ – lunge punch – oi tsuki, PKZ – jab punch – kizami tsuki, PGZ – reverse punch – gyaku tsuki, KMG – front kick – mae geri, KMW – roundhouse kick – mawashi geri.

Metric characteristics of specific motor variables have previously been validated (Kuleš & Muratagić, 1993; Nakayama, 1996). The specific motor test was designed in such a way that a subject assumed a fighting stance 1m from the contact focus plate/board, which was connected to the computer timer with an audio signalizer placed 80cm above the ground. The subject's arms were in the middle fighthing position, while the front foot was about 1m away from the focus plate/board. Upon hearing an audio signal, the subject punched the focus plate/board with his/her hand, stepping and sliding forward. Three attempts were performed, and the best time was recorded with 1/100s accuracy.

Experimental treatment

The experimental treatment was run in various karate clubs over a two-year period, in two one-year microcycles. The boys underwent a typical training regimen consisting of 2 x 60 minutes sessions weekly, for 40 weeks in total over the two years. Additionally, they participated in regular physical education classes at school 2 x 45 min/week.

The program was based on the balance between motor skills and abilities and other aspects of overall children's development (Kukolj, 1999; Findak, 2003).

Table 1

Karate school curriculum

Training segments and units	No. of repetitions	
	Year 1	Year 2
1. Walking and running Low skip, high skip, running with heel-kicks, 30-m sprint, walking on all fours	25	30
2. Jumping Jumping over low hurdles up to 30cm, jumps over short skipping rope, long jump from standing position, jumps over 40cm hurdles and landing	15	20
3. Throwing and catching Ball-throwing and catching in various ways, bouncing balls in various ways, catching, throwing balls at a target	10	15
4. Climbing and crawling Climbing up and down the wall bars, crawling on chest and back in various ways, rope-climbing with hands and legs, moving on all fours on the rope lying on the ground, various games with rope	10	15
5. Lifting and carrying Lifting and carrying of a medicine ball in various ways, lifting objects up to 3kg to a given height	10	15
6. Rolling sideways and forward Side-rolls to the left/right, foward/backward rolls, handstands, and cartwheels	15	20

Training segments and units	No. of repetitions	
	Year 1	Year 2
7. Stances (Dachi)		
Heisoku dachi (feet-together stance), Musubi dachi (joining stance), Heiko dachi (parallel stance), Zenkutsu dachi (front stance), Kokutsu dachi (back stance), and Kiba dachi (horse stance)	25	30
8. Strikes and punches		
Oi tsuki (lunge punch), Gyaku tsuki (reverse punch), Kizami tsuki (jab punch), Shuto (sword-hand strike), Yoko empi (elbow strike), Tetsui (hammer-fist strike), and Nukite (spear-hand strike)	20	25
9. Blocks (Uke)		
Age uke (high block), Soto uke (inward middle-block), Uchi uke (outward middle-block), Gedan barai (lower block), Shuto uke (sword-hand block), and Morote uke (enforced block)	20	25
10. Leg kicks (Geri)		
Mae geri (front kick), Yoko geri (side kick), and Mawashi geri (roundhouse kick) and Ushiro geri (back kick)	15	20
11. Sweeps and throws		
Sweeps with front/back leg, falls forward/backward/on the side	10	15
12. Katas		
Heian shodan, Heian nidan, Heian sandan, Heian yondan and Heian godan.	15	20
Total	190	250

Testing procedures

All tests took place in the main gym of the Sports Center of the Faculty of Physical Education and Sport in Novi Sad, Serbia. The gym was spacious, bright, with temperatures between 18-22 degrees Celsius and the average humidity of 69%. All measurements were taken in the morning hours. The measuring instruments were standard, calibrated immediately prior to testing. All subjects wore a kimono. The following information was recorded for each subject: surname, name, date of birth, club name, city, years of experience, current belt, greatest competitive accomplishment, number of weekly practices, coach name, and specialty (kata or combat).

There were 187 boys aged 10-12 from all over the Serbian Province of Vojvodina. The experimental training regime was run in karate clubs by individuals with legal credentials for coaching karate. Practice sessions were held 2x60min weekly for 40 weeks over a period of two years. The program consisted of aerobic exercises, muscular endurance, force, power, explosiveness, agility, coordination, and flexibility, with a special focus on games. During this time, subjects also attended regular physical education classes at their schools, normally 2x45min a week. 82 boys from karate clubs from the provincial cities of Novi Sad, Becej, Subotica, Sremski Karlovci, Indjija, Srbobran and Sid completed the final testing.

Statistical analysis

The following central and dispersion parameters were calculated for each variable: M – arithmetic mean, Min – minimum score, Max – maximum score, R-range, SD – standard deviation, Sm- Standard error of the mean, Skew – asymmetry, Kurt – elongation, Max D – Kolmogorov-Smirnov test. For the determination of mean differences between initial and final measurements, both multivariate and univariate analysis of variance (Manova/Anova) were used. Multivariate analysis of group centroids (General Manova) was done with λ-Wilks' lambda test, F-test, and p-statistical significance ($p<.005$). Univariate statistics on the differences between means for all variables was performed with F-test and p-statistical significance ($p<.001$). All analyses were run by the IBM SPSS Statistics 19 software package.

Results

By reviewing the values of the results shown in Table 2, it can be seen that the results in the applied tests in initial measurement do not deviate significantly from the normal distribution of results. There are no maximum deviations of empirical results in relation to theoretical cumulative relative frequencies (Max D) and they do not exceed the critical value of KS_test (.13). Therefore, the distribution can be considered normal, except for the following variables: SST - shoulder blade fold (Max D = .22), AST - abdominal fold, (Max D = .20), PPB – parallel bar dips (Max D = .25), BOF – one leg balance on the balance ball, (Max D = .17) and HOB - hyperextensions on the bench (Max D = .17).

Table 2

Basic statistical parameters of the variables and their discrimination-Initial measurement

Variable	M	min	max	R	SD	Sm	Ku	Sk	Max D
Morphological variables									
BOH	149.88	120.90	182.40	61.50	13.16	1.45	-.43	.21	.07
LEL	86.05	71.70	104.30	32.60	7.72	.85	-.67	.16	.05
ARL	63.19	49.60	79.10	29.50	6.26	.69	-.33	.28	.09
SHS	31.98	25.10	41.50	16.40	3.17	.35	.08	.21	.06
PES	23.23	15.90	36.40	20.50	2.77	.30	5.39	1.23	.10
WRD	4.80	3.90	5.90	2.00	.46	.05	-.52	2.84	.12
MCG	70.35	56.50	91.50	35.00	7.96	.87	-.43	.38	.07
LAG	21.05	17.10	29.20	12.10	2.26	.25	1.10	.66	.07
BOM	39.68	20.00	72.00	52.00	11.05	1.22	-.07	.53	.10
UST	10.64	1.60	23.60	22.00	4.35	.48	.57	.89	.12
AST	10.83	2.40	40.00	37.60	8.53	.94	2.38	1.67	.20
SST	9.50	4.00	34.80	30.80	5.41	.59	6.58	2.35	.22
Basic motor variables									
AIA	15.30	11.80	20.00	8.20	1.79	.19	.49	.55	.10
HAT	41.37	24.00	55.00	31.00	6.70	.74	-.16	.09	.08
FOT	53.87	32.00	66.00	34.00	5.61	.61	1.80	-.55	.08

HOB	42.95	17.00	53.00	36.00	6.61	.73	2.57	1.17	.17
BOF	14.31	1.70	59.20	57.50	9.57	1.05	7.69	2.25	.17
SHF	5.99	2.30	8.60	6.30	1.19	.13	.78	-.58	.07
30S	23.12	15.00	34.00	19.00	3.31	.36	.90	-.08	.12
PPB	1.62	.00	8.00	8.00	2.14	.23	2.07	1.64	.25
HSL	4.69	4.00	11.40	11.00	2.05	2.26	1.08	.73	.11
LSP	161.13	105.00	240.00	135.00	25.61	2.82	-.01	.11	.06
TSP	502.20	313.00	700.00	387.00	71.15	7.85	.27	.32	.08
20M	3.83	3.10	4.80	1.70	.35	.03	-.15	.18	.10
Specific motor variables									
POZ	.87	.62	1.27	.65	.10	.11	1.96	.39	.12
PKZ	.82	.58	1.19	.61	.12	.12	.48	.62	.08
PGZ	.88	.64	1.18	.54	.12	.12	-.45	.23	.08
KMG	.84	.63	1.06	.50	.11	.11	-.49	-.19	.09
KMW	.84	.56	1.06	.50	.11	.11	-.18	-.19	.05

Critical value of the KS-test = .13; p = .01

M – arithmetic mean, Min – minimum score, Max – maximum score, R-range, SD – standard deviation, Sm- Standard error of the mean, Skew – asymmetry, Kurt – elongation, Max D – Kolmogorov-Smirnov test.

By reviewing the values of the results shown in Table 3, it can be seen that the results in the applied tests in the final measurement do not deviate significantly from the normal distribution. There are no maximum deviations of empirical results in relation to theoretical cumulative relative frequencies (Max D), and they do not exceed the critical value of KS-test (.13). Therefore the distribution can be considered normal, except for the following variables: AST - abdominal fold (Max D = .20), SST - shoulder blade fold (Max D = .15), PPB – parallel bar dips (Max D = .20) and BOF – one leg balance on the balance ball (Max D = .14).

Table 3

Basic statistical parameters of the variables and their discrimination-Final measurement

Variable	M	min	max	R	S	Sm	Ku	Sk	Max D
Morphological variables									
BOH	162.60	135.50	197.90	62.90	13.25	1.46	-.53	.00	.06
LEL	94.78	76.10	110.20	34.10	8.83	.97	-.66	-.29	.08
ARL	68.88	54.80	84.00	29.20	6.20	.68	-.44	-.16	.08
SHS	36.59	29.50	44.50	15.00	3.97	.43	-.84	.05	.06
PES	26.37	21.10	40.10	19.00	3.13	.34	3.22	.97	.06
WRD	5.35	4.30	6.40	2.10	.49	.05	-.59	-.18	.11
MCG	75.74	60.00	95.90	35.90	9.19	1.01	-1.03	.30	.10
LAG	22.86	17.90	31.80	13.90	2.70	.25	1.83	.83	.13
BOM	51.69	29.00	83.00	54.00	13.07	1.45	-.75	-.38	.08
UST	6.56	1.30	22.00	20.70	3.22	.35	5.87	1.82	.13
AST	6.44	1.00	29.60	28.60	4.89	.54	9.71	2.69	.20*
SST	6.99	1.10	21.20	20.10	3.65	.40	3.99	1.70	.15*

Variable	M	min	max	R	S	Sm	Ku	Sk	Max D
Morphological variables									
Basic motor variables									
AIA	13.49	9.40	19.30	9.90	1.82	.20	.23	-.00	.09
HAT	43.52	32.00	58.00	26.00	6.51	.71	-.75	.34	.12
FOT	54.87	42.00	76.00	34.00	6.35	.70	.61	.42	.07
HOB	46.58	22.00	68.00	46.00	8.14	.89	.90	-.32	.09
BOF	13.07	2.50	38.60	36.10	6.99	.77	2.18	1.15	.14*
SHF	6.69	2.00	9.90	7.90	1.35	.14	1.63	-.59	.12
30S	25.46	16.00	44.00	28.00	4.47	.49	2.86	.86	.12
PPB	3.31	.00	20.00	20.00	3.30	.36	7.76	2.26	.20*
HSL	10.97	1.90	32.00	30.10	5.28	.58	2.67	1.07	.11
LSP	192.09	110.00	290.00	180.00	29.03	3.20	1.22	.28	.11
TSP	562.08	299.00	860.00	561.00	83.46	9.21	2.49	.52	.11
20M	3.67	3.00	4.80	1.80	.34	.03	.20	.24	.12
Specific motor variables									
POZ	.82	.67	1.07	.40	.79	.08	.32	.49	.08
PKZ	.76	.54	1.04	.50	1.12	.12	-.30	.42	.12
PGZ	.80	.57	1.08	.51	1.09	.12	-.21	.36	.08
KMG	.79	.59	1.04	.45	.97	.10	-.08	.52	.11
KMW	.80	.56	1.04	.48	.97	.10	.42	.22	.11

Critical value of the KS-test = .13; p = .01

M – arithmetic mean, Min – minimum score, Max – maximum score, R-range, SD – standard deviation. Sm- Standard error of the mean, Skew – asymmetry, Kurt – elongation, Max D – Kolmogorov-Smirnov test.

BOH – body height, LEL – leg length, ARL – arm length, SHS - shoulder span, PES - pelvic span, WRD - wrist diameter, MCG – mid-chest girth, LAG - lower-arm girth, BOM – body mass, UST – upper-arm skinfold thickness, AST – abdominal skinfold, SST – subscapular skinfold thickness, AIA – agility in the air, HAT – hand tapping, FOT – foot tapping, HOB – hyper extentions on the bench, BOF – balancing on one foot on a balance beam, SHF – shoulder flexibility with a yardstick, 30S – 30-sec situps, PPB – pushups on parallel bars, HSL – half-squat with load, LSP – long-jump from a standing position, TSP – tripple-jump from a standing position, 20M – 20-m dash with a flying start, POZ – lunge punch, PKZ – jab punch, PGZ – reverse punch, KMG – front kick, KMW – roundhouse kick.

The data presented in Table 4 clearly show statistically significant differences in morphological, basic motor and specific motor skills for the final measurement as compared to the initial testing at p< 0.000, as shown by the multivariate analysis of variance (Manova).

The univariate procedures (ANOVA) for the morphological space revealed differences at p<.001 in all variables. In the basic motor space, there were significant differences at p<.005 in nine of the twelve variables, and at p<.05 in HAT (hand tapping). No differences were found in FOT (foot tapping) and BOF (balancing on one foot on a balance beam). Finally, the multivariate analysis of the specific motor variables' means before and after treatment showed significant differences at p<.000.

Table 4

Statistical parameters of univariate and multivariate analysis of variance (Anova/Manova)

Variables	ANOVA / MANOVA			
	Mi	Mf	F	p
	Morphological variables			
BOH – body height (mm)	1498.87	1626.09*	38.01	.00*
LEL – leg length (mm)	860.53	947.84*	45.38	.00*
ARL – arm length (mm)	631.93	688.80*	34.12	.00*
SHS - shoulder span (mm)	319.87	365.97*	67.39	.00*
PES - pelvic span (mm)	232.37	263.76*	46.15	.00*
WRD - wrist diameter (mm)	48.45	53.50*	32.76	.00*
MCG – mid-chest girth (mm)	703.52	757.47*	16.14	.00*
LAG - lower-arm girth (mm)	210.51	228.60*	21.54	.00*
BOM – body mass (kg)	39.86	51.06*	31.75	.00*
UST – upper-arm skinfold thickness (mm)	106.42*	65.63	46.46	.00*
AST – abdominal skinfold thickness (mm)	108.31*	64.42	16.32	.00*
SST – subscapular skinfold thickness (mm)	95.07*	69.92	12.13	.00*
	λ - Wilks' Lambda = .49 F = 13.29 p<.000*			
	Basic motor variables			
AIA – agility in the air (s)	153.01	134.92*	41.02	.00*
HAT – hand tapping (fr)	41.37	43.52*	4.32	.04*
FOT – foot tapping (fr)	53.87	54.87*	1.14	.29
HOB – hyperextentions on the bench (cm)	42.95	46.58*	9.84	.00*
BOF – balancing on one foot on a balance beam (s)	143.12	130.70*	.90	.34
SHF – shoulder flexibility with a yardstick (cm)	59.93*	66.96	12.41	.00*
30S – 30-sec situps (fr)	23.12	25.46*	14.50	.00*
PPB – pushups on parallel bars (fr)	1.62	3.31*	15.18	.00*
HSL – half-squat with load (s)	46.92	109.73*	100.72	.00*
LSP – long-jump from a standing position (cm)	161.13	192.09*	52.43	.00*
TSP – tripple-jump from a standing position (cm)	502.02	562.08*	24.59	.00*
20M – 20-m dash with a flying start (s)	38.35	36.79*	8.15	.01*
	λ - Wilks' Lambda =.51 F = 12.252 p <.000*			
	Specific motor variables			
POZ – lunge punch – oi tsuki (sec)	87.67	81.97*	15.89	.00*
PKZ – jab punch – kizami tsuki (sec)	82.58	76.32*	12.17	.00*
PGZ – reverse punch – gyaku tsuki (sec)	87.87	79.91*	20.19	.00*
KMG – front kick – mae geri (sec)	84.78	78.60*	13.94	.00*
KMW – roundhouse kick – mawashi geri (sec)	84.52	79.62*	9.54	.00*
	λ - Wilks' Lambda =.88 F = 4.42 p <.000*			

Legend: **Mi -** mean value of the initial measurements, **Mf -** mean value of the final measurements, **l -** Wilks' Lambda, **F -** test, **p -** significance level (*)

Discussion

In this study, it was expected that there would be statistically significant changes between the initial and final measurements in both multivariate and univariate morphological, basic and specific motor variables in young male karate trainees, after a two-year training program.

The results showed a statistically significant difference in morphological characteristics as a whole ($p<.000$), as well as for individual morphological variables ($p<.000$ for 11 variables, $p<.001$ for 1 variable) for the final vs. initial testing. Considering that most morphological variables in the longitudinal and transversal dimensions of the skeleton, and to some extent body voluminosity, are genetically defined, the most significant changes occurred in the variables of subcutaneous fat tissue. As expected, skinfolds at the final testing were significantly lower than at the initial testing, most likely due to the well-planned and executed treatment.

Planned and systematic implementation of karate training can significantly affect the reduction of subcutaneous adipose tissue (Malina & Katzmarzyk, 2006); it can have somewhat lesser impact on the circular dimensionality and almost negligible impact on the longitudinal dimensionality of the skeleton. Similar research by other authors yielded similar results and conclusions (Kurelić et al., 1975, Ivanić, 1996; Pejčić & Malacko, 2005; Gajević, 2009; Doder, 2010).

As for the basic motor dimension, statistically significant differences were observed post-treatment vs. pre-treatment ($p<.05$ for 10 of 12 variables), while there were no significant differences for FOT (Foot tapping; $p=.287$) and BOF (Balancing on one foot on a balance beam; $p=3.44$), probably due to an increased genotype for these variables.

The greatest changes that occurred as a result of the experimental treatment were found for variables of repetitive and static strength (30S – 30s sit-ups, PPB – push-ups on parallel bars, HSL – half-squat with load), and explosive strength (LSP – long-jump from a standing position, TSP – tripple-jump from a standing position, 20M – 20m dash with a flying start), due to a limited influence of the genotype for these anthropological dimensions on the one hand, and specific and situational karate structures applied in this experimental treatment, on the other.

The values obtained in strength assessment tests are expected at this age since major changes in boys begin to occur only after the age of 12, which was confirmed by the results of other studies (Doder et. al., 2012; Mišigoj-Duraković, 2018).

Since there are differences in the increment of the body mass index in time and body composition of karate practitioners, it is to be expected that these differences cause relationships in relative repetitive strength between initial and final measurement (Jozić, 2001; Vidranski et al., 2017).

The level of maximum achievement depended primarily on the genetic potential, activity of an individual and timely impact on motor skills. Motor skills do not develop at the same pace in middle school age (10-12 years) nor always reach the maximum at the same age (Kukolj, 1996).

The greatest improvement following the two-year training was found in the specific motor dimension. Performance time for all the tested specific/situational movement structures or technical elements was significantly shortened in the final measurement.

These results can be attributed mostly to perfecting and rationalising the performance of specific movement structures (Jovanović, 1991; Blažević et al., 2006; Čavala et al., 2014) expressed through the karate technique.

Experimental program with elements of karate was proven an effective tool that can affect the reduction of subcutaneous adipose tissue, volume and body weight and development of static, repetitive and explosive strength. Last but not least, it can be recommended for use in teaching physical and health education in primary schools.

Conclusions

The results of this research showed statistically significant differences in arithmetic means between the initial and final measurement at the level of p =.001 in karate boys (multivariate) across morphological, basic and specific motor variables under the influence of a two-year experimental treatment. When it comes to individual morphological variables (univariate), the largest transformations were obtained in the subcutaneous adipose tissue variable because the values significantly decreased in the final measurement, as expected. When it comes to basic motor variables, there were also multivariate and univariate statistically significant differences between the initial and final measurements at the level of p≤.001 (out of 10 variables, for 9 at the level of p≤.001 and for one at the level of p≤.05) in favour of the final measurement. However, no statistically significant changes were found for variables TAN (leg tapping; p = .287) and STG (one leg stand along the beam; p = .344). The greatest progress was achieved in specific motor abilities, because multivariate and univariate statistically significant differences were found between the initial and final measurement at the level of p≤.005, in favor of the final measurement, which was the primary goal. In the course of implementing specific moving structures in all the applied variables, the time of their execution has gradually shortened, therefore proving the applied program's efficiency.

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Utjecaj treninga karatea na morfološke karakteristike, motoričke sposobnosti i vještine kod dječaka

Sažetak

Cilj ovoga istraživanja bio je utvrditi utjecaj eksperimentalnoga programa vježbanja na morfološke karakteristike, bazične i specifične motoričke sposobnosti kod mladih polaznika treninga karatea. Na uzorku 82 dječaka, u dobi od 10 do 12 godina, primijenjeno je 12 morfoloških, 12 bazičnih i 5 specifičnih motoričkih testova. Utvrđeno je da postoje statistički značajne razlike ($p < 0,001$) u testovima za procjenu morfoloških karakteristika. Najveći učinci transformacijskoga procesa vježbanja uočavaju se na varijabli kožnih nabora koji su nakon kineziološkoga tretmana bili znatno niži. Uočene su i statistički značajne ($p < 0,001$) razlike kod 8 testova za procjenu motoričkih sposobnosti te za jednu varijablu na nivou značajnosti $p < 0,05$. Međutim, nije bilo statistički značajne razlike kod testa taping nogom i ravnoteža na jednoj nozi. Rezultati ukazuju kako su postignuti sasvim zadovoljavajući učinci, posebice kod onih sposobnosti koje nisu jako genetski determitirane, što se može smatrati značajnim doprinosom znanosti o sportu i teoriji sporta te sportskoga treninga karatea.

Ključne riječi*: dječaci; olimpijski sport; razlike; tjelesna i zdravstvena kultura; utjecaj.*

Uvod

Sportski karate postao je globalan fenomen širom svijeta koji uključuje milijune obitelji u brojnim zemljama na svih pet kontinenata i kao takav duboko se ukorijenio u globalno društvo. Zbog ovakve popularnosti među borilačkim sportovima u svijetu, od 2021. godine karate će po prvi put u Tokiju postat pokazni olimpijski sport. Svjetska karate federacija (WKF) broji 188 zemalja na pet kontinenata u okviru koje djeluje preko 10 milijuna članova (Espinós, 2020). Isti autor navodi da se procjenjuje kako je u bavljenje karateom uključeno više od 100 milijuna pojedinaca. Od ovoga broja sportaša poznato je kako se najveći postotak odnosi na udjel populacije djece i mladih**.** Stoga je jasno kako karate sport može imati veliki utjecaj na prevenciju neaktivnosti i sedetarnoga načina života kao najvećega prediktora pretilosti.

Danas je pretilost u svijetu, a posebice u djetinjstvu dosegla alarmantne razine (World Health Organization, 2019). Ako se uzmu u obzir posljednja istraživanja, uviđa

se kako je razina pretilosti još uvijek u porastu (Skinner, Ravanbakht, Skelton, Perrin i Armstrong, 2018; Venetsanou, Kambas, Gourgoulis i Yannakoulia, 2019) te se u njima naglašava na potrebu sprečavanja dječje pretilosti.

U svijetu se sve više razmišlja o uključivanju djece u osmišljene sportske programe tjelesne aktivnosti, što je vitalni doprinos za smanjenje pretilosti (Kovač, Strel, Jurak, Leskošek, Dremelj, Kovač, i Starc, 2013; Mead, Brown, Rees, Azevedo, Whittaker, Jones i Beardsmore, 2017), koji značajno utječe na poboljšanje zdravstvenih aspekata (World Health Organization, 2018).

Dosadašnja znanstvena istraživanja bitno ukazuju da se povećanjem razvoja bazičnih motoričkih sposobnosti i vještina (Doder, D., Babiak, Janjic i Doder, R., 2012, Emeljanovas, Mieziene i Putriute, 2015) djeci omogućuje značajna pretopstavka za daljnji uspješniji razvoj novih motoričkih znanja.

Pored navedne javnozdravstvene važnosti pri bavljenju karate sportom s djecom i mladeži postavlja se i potreba izrade suvremenih i efikasnih načina planiranja i programiranja u ranoj dobi kao podloga za ostvarenje i dosege vrhunskih sportskih dostignuća u seniorskoj dobi.

Kako bi se postigao napredak u današnjem modernom karate sportu potrebno je koristiti najsuvremenije pristupe, koncepte, oblike, sadržaje i metode u radu s najmlađim polaznicima karate sporta. Unatoč navedenom, gotovo je nevjerojatno da se tek tijekom posljednjega desetljeća nešto više obraća pozornost na učinke kontinuiranoga trenažnog opterećenja na antropološki status mladih karataša.

Međutim, da bi se postigli željeni efekti u trenažnom i natjecateljskom procesu kod mladih karataša, potrebno je izvršiti pravovremenu i kvalitetnu selekciju koja se temelji na planiranim ciljevima i „poželjnom stanju" u karate sportu, kao i odgovarajućoj dijagnostici, planiranju, programiranju te praćenju učinaka trenažnoga procesa (Lapresa, Ibanez, Arana, Garzón, i Amatria, 2011, Malacko i Doder, 2008, 2014).

Upravo iz tih razloga neophodno je razumjeti ne samo razvoj bazičnih motoričkih sposobnosti, nego jednako tako obratiti pažnju i na specifične i situacijske vještine prvenstveno odgovorne za učinkovitu motoričku efikasnost (Hemba, 1991; Mori i Ohtani, 1997; Jozić, 2001; Mori, Ohtani i Kuniyasu, 2002; Katić, Blažević, Krstulović i Mulić, 2005; Mišigoj-Duraković i Matković, 2007; Doder, D., Malacko, Stanković i Doder, R., 2009, Sterkowicz i Franchini, 2009; Doder, D., Malacko, Stanković i Doder, R., 2011; Loturco, Artioli, Kobal, Gil i Franchini, 2014). Jednako tako, navedene vještine i sposobnosti potrebno je kontinuirano mjeriti, razvijati, kontrolirati i ispravljati kako bi se u što kraćem vremenu optimizirali njihovi učinci (Annesi i Westcott, Faigenbaum i Unruh, 2005; Doder, i sur., 2011).

Razvoj značajnih antropološke sposobnosti i karakteristika u djece (Viru, A., Loko, Volver, Laaneots, Karelson i Viru, M. 1998; Malina, Bouchard i Bar-Or, 2004; Pejčić i Malacko, 2004; Vidranski, 2006), koje prije svega ovise o pažljivom odabiru metoda i programa treninga, ne bi se trebalo i vjerojatno se ni može postići neorganiziranim, nasumičnim vježbanjem. Navedno podrazumijeva da je besmisleno razvijati specifične

antropološke sposobnosti i karakteristike bez ikakvoga razmatranja specifičnih potreba i ciljeva treninga (Blažević, Katić i Popović, 2006; Burušić i Šerić, 2015).

Prikupljanje baza podataka o razvojnim karakteristikama antropoloških sposobnosti mladih sportaša te tehničko-taktičkih struktura gibanja praćenih tijekom dužega razdoblja, na temelju matematičko-statističkih analiza podataka predstavljaju čvrst temelj za njihovu dijagnostiku (Malacko i Doder, 2008) te kao takve mogu imati eventualnu praktičnu primjenu u programiranju sadržaja treninga, kao i praćenje i analizu njihovih učinaka. S obzirom da učinci eksperimentalnih tretmana/treninga uglavnom ovise o metodama vježbanja i/ili treninga, od ključne je važnosti znati količinu i svrhu bilo kojeg programa vježbanja te primijeniti određene testove za procjenu njihovih učinaka.

Sa željom da se doprinese rješavanju navedenoga problema osmišljen je program karate škole, koji je prezentiran u ovom radu, a koji je namijenjen neselekciranoj djeci školske dobi. Program je prvenstveno usmjeren na njihov višestrani razvoj i kao takav predstavlja temelj za stvaranje budućih vrhunskih sportaša. Usvajanjem većega broja motoričkih znanja i vještina u ranijim fazama sportskoga razvoja omugućuje se uspješna specijalizacija u kasnijoj dobi. Jednako tako važno je utjecati na pojedine sposobnosti u vrijeme senzibile faze njezina razvoja budući da je to kasnije nenadoknadivo. U istraživanjima vezanim za trening djece (Bompa, 1998) naglašeno je da je fokus razvoja koordinacijskih sposobnosti vezan za pubertetsku dob djece (7 – 12), također se ovaj period smatra „zlatnim standardom" za razvoj cijeloga spektra motoričkih sposobnosti kao što su brzina, snaga, koordinacija, ravnoteža.

Program i trening u ovoj dobi mora se usmjeriti na cjelokupan sportski razvoj, a ne samo na izvođenje karate programa. Predloženi programi trebali bi uključivati vježbe niskog inteziteta usmjerene na razvoj aerobnoga kapaciteta, mišićne izdržljivosti, sile, snage, brzine, agilnosti, koordinacije i fleksibilnsti s posebnim naglaskom na igru.

Program karate škole treba prije svega djeci biti zabavan i raznolik, s naglaskom na usvajanje i usavršavanje pravilnih struktura gibanja, odnosno karate tehnike. Kako bi se ostavarila ovakva usmjerenost, potrebno je kvalitetno izvesti dovoljan broj ponavljanja karate tehnike.

Važno je prilikom provedbe ovakvih programa koristiti specifičnu opremu, modificirati i upotrjebljavati jednostava sportska pravila te naglašavati važnost poštene igre vodeći se primarno načelom sigurnosti i smanjenja mogućnosti sportskih ozljeda (Hemba, 1991).

Drugim riječima, postoji mogućnost da određeni program treninga ponekad može izgledati prikladan za postizanje željenoga ishoda, ali njegova praktična primjena može eventualno nadoknaditi ili čak ugroziti ovaj predviđeni ishod (Mraković, Findak, Medved i Šturm, 1992). Stoga je očigledno da se sadržaji, metode i opterećenja ne mogu uvijek primijeniti i procijeniti odvojeno, već kao međusobno zavisni dijelovi složenoga procesa planiranja, programiranja i primjene procesa vježbanja (Jurak, Strel, Leskošek i Kovač, 2011.)

Ovo istraživanje uključivalo je pomno planiranje i izvedbu programa vježbanja kako bi se stvorile pretpostavke za usvajanje specifičnih struktura gibanja i struktura situacija (karate tehnike i taktike) s jedne strane te optimalnoga razvoja ili transformacije relevantnih morfoloških karakteristika, osnovnih i specifičnih motoičkih sposobnosti i vještina koje se međusobno nadopunjuju Malacko i Doder (2008).

Stoga je glavni cilj ovoga istraživanja bio procjeniti utjecaj dvogodišnjega eksperimentalnoga procesa, odnosno programa treninga, na antropološke sposobnosti i karakteristike mladih polaznika treninga karatea. Sekundarna svrha bila je, na temelju rezultata ovoga istraživanja, omogućiti izradu daljnjih preporuka za buduće programe treninga mladih karataša.

Metode

Eksperimentalni pristup problemu istraživanja

Osnovni dizajn ovoga istraživanja bio je procijeniti učinke eksperimentalnoga programa vježbanja/treninga na promatrane varijable morfoloških karakteristika, bazičnih i specifičnih motoričkih sposobnosti kod 10-godišnjih dječaka, polaznika treninga karatea. Za usporedbu razlika između početnoga i završnoga tetstiranja primijenjena je univarijarna (ANOVA) i multivarijarna (MANOVA) analiza.

Uzorak ispitanika

Uzorak se sastojao od 82 dječaka iz 18 karate klubova s područja Vojvodine (Novi Sad, Bečej, Subotica, Sremski Karlovci, Inđija, Srbobran i Šid), u dobi 10 – 12 godina, koji su redovito trenirali karate i pohađali redovite sate Tjelesne i zdravstvene kulture u svojoj školi te koji su bili fizički i psihički zdravi. Roditelji ispitanika upoznati su sa svim postupcima testiranja te su ispunili *Obrazac* s informiranim pristankom za sudjelovanje u istraživanju. Istraživanje je provedeno u skladu s Helsinškom deklaracijom, a eksperimentalni protokol prije početka istraživanja odobrilo je Etičko povjerenstvo Regionalnog zavoda za medicinu sporta (REC-96/2018). Prije početnoga istraživanja sve sudionike pregledao je ovlašteni liječnik te su na osnovi toga pregleda uključena samo zdrava djeca.

Postupak istraživanja

Za procjenu morfoloških karakteristika primijenjene su sljedeće prediktorske varijable Lohman, Roche i Martorell (1998): BOH – visina tijela, LEL – duljina nogu, ARL – dužina ruke, SHS – raspon ramena, PES – zdjelični raspon, WRD – promjer zapešća, MCG – opseg sredine prsnoga koša, LAG – opseg podlaktice, BOM – masa tijela, UST – nabor nadlaktice, AST – nabor trbuha, SST – nabor lopatice. Sva mjerenja izvršena su prema IBP standardima.

Za procjenu bazičnih motoričkih sposobnosti primijenjene su sljedeće varijable (Gredelj, Metikoš, Hošek i Momirović, 1975; Kurelić, Momirović, Stojanović, Radojević i Viskić-Štalec, 1975): AIA – okretnost u zraku, HAT – taping rukom, FOT – taping

nogom, HOB – hiperekstenzije na klupi, BOF – ravnoteža na jednoj nozi na balansnoj lopti, SHF – iskret u ramenom zglobu palicom (cm), 30S – podizanje trupa u 30 sekundi, PPB – potiskivanje na paralelnim ručama, HSL – polučučanj s teretom, LSP – skok u dalj iz stojećeg položaja, TSP – troskok u dalj iz stojećeg položaja, trčanje 20 m s letećim startom. Prethodno su potvrđene metrijske karakteristike testova za procjenu motoričkih sposobnosti.

Za procjenu specifičnih motoričkih sposobnosti primjenjene su sljedeće varijable: POZ – prednji dugi udarac rukom – oi tsuki, PKZ – kratki direktni udarac rukom – kizami tsuki, PGZ – suprotni udarac rukom – gyaku tsuki, KMG – prednji udarac nogom – mae geri, KMW – polukružni udarac nogom – mawashi geri.

Prethodno su potvrđene metrijske karakteristike testova za procjenu specifičnih motoričkih sposobnosti (Kuleš i Muratagić, 1993; Nakayama, 1996). Upotrijebljen je jedan specifični motorički test koji se izvodi tako da ispitanik zauzima borbeni stav 1 m od kontaktne ploče koja je spojena na brojčanik računala pomoću audiosignala koji je postavljen 80 cm iznad zemlje. Ruke ispitanika nalazile su se u srednjem borbenom položaju, dok je prednje stopalo udaljeno oko 1m od kontaktne ploče. Na odašiljanje zvučnoga signala, ispitanik rukom udara kontaktnu ploču, iskorači i klizi prema naprijed. Izvode se tri pokušaja, a bilježi se najbolje vrijeme s 1/100 točnosti.

Eksperimentalni postupak

Eksperimentalni postupak provodio se u različitim karate klubovima tijekom dvogodišnjega razdoblja, u dva jednogodišnja makrociklusa. Dječaci su sudjelovali u standardnom postupku treninga koji se sastojao od 2 x 60 minuta tjedno, ukupno 40 tjedana tijekom dvije godine. Osim toga, ispitanici su sudjelovali u redovitim satima Tjelesne i zdravstvene kulture u svojim školama 2 x 45 min/tjedno.

Program se temeljio na uravnoteženom odnosu između razvoja motoričkih sposobnosti i usvajanja motoričkih znanja uvažavajući ostale aspekte cjelokupnoga dječjeg razvoja (Kukolj, 1999, Findak, 2003).

Tablica 1.

Postupak testiranja

Svi testovi provedeni su u glavnoj teretani Sportskoga centra Fakulteta za fizički odgoj i sport u Novom Sadu u Srbiji. Teretana je bila prostrana, svijetla, s temperaturama između 18 i 22 Celzijeva stupnja i prosječnom vlagom od 69 %. Sva mjerenja izvršena su u jutarnjim satima. Mjerni instrumenti bili su standardni, kalibrirani neposredno prije ispitivanja. Svi ispitanici su nosili kimono. Za svakog ispitanika zabilježene su sljedeće informacije: prezime, ime, datum rođenja, ime kluba, grad, godine iskustva, trenutačno karate zvanje/pojas, najbolje natjecateljsko postignuće, broj sati treniranja u tjednu , ime trenera i specijalnost (kata ili kumite/borba). Sudjelovalo je 187 dječaka od 10 do 12 godina iz cijele Srpske pokrajine Vojvodine. Eksperimentalni postupak treniranja u karate klubovima provodili su licencirani treneri karatea. Treninzi su se

održavali 2 x 60 min tjedno u trajanju od 40 tjedana tijekom razdoblja od dvije godine. Program se sastojao od aerobnih vježbi, mišićne izdržljivosti, snage, eksplozivne snage, agilnosti, koordinacije i fleksibilnosti, s posebnim naglaskom na igre. Tijekom eksperimentalnoga postupka, ispitanici su također pohađali redovite sate Tjelesne i zdravstvene kulture u svojim školama, 2 x 45min tjedno. Na završnom testiranju sudjelovalo je ukupno 82 dječaka iz karate klubova iz pokrajinskih gradova Novi Sad, Bečej, Subotica, Sremski Karlovci, Inđija, Srbobran i Šid .

Statističke analize

Za svaku varijablu izračunati su sljedeći centralni i disperzivni parametri: M-aritmetička sredina, min-minimum, max-maksimum, R-raspon rezultata, S-standardna devijacija, Sm- Standardna greška aritmetičke sredine, (Skew), izduženost distribucije (Kurt) i Kolmogorov-Smirnovljev test normaliteta distribucije (Max D).

Za određivanje razlike između arimetičkih sredina početnih i završnih mjerenja korištena je multivarijantna i univarijantna analiza varijance (MANOVA / ANOVA). Multivarijantna analiza centroida grupa (General Manova) određena je lambda testom λ-Wilks, F-testom s p-statističkom značajnošću na razini $p < 0,005$. Univarijatna analiza razlika između aritmetičkih sredina za sve varijable izračunata je s F-testom na razini statističke značajnosti $p < 0,001$. Sve analize provedene su sa softverskim paketom IBM SPSS Statistics 19.

Rezultati

Uvidom u vrijednosti rezultata (Tablica 2) može se uočiti kako rezultati u primijenjenim testovima u inicijalnom mjerenju ne odstupaju značajno od normalne distribucije rezultata. Može se uočiti kako nema maksimalnih odstupanja empirijskih rezultata u odnosu na teorijske relativne kumulativne frekvencije (Max D) te ne prelaze kritičnu vrijednost KS_testa (.13), pa se distribucija može smatrati normalnom, osim kod varijabli: SST – nabor lopatice (Max D =. 22), AST – nabor trbuha, (Max D = .20), PPB – potiskivanje na paralelnim ručama (Max D = .25). BOF – ravnoteža na jednoj nozi na balansnoj lopti, (Max D = .17) i HOB – hiperekstenzije na klupi, (Max D = .17).

Tablica 2.

Uvidom u vrijednosti rezultata prikazanih u Tablicu 3, može se uočiti kako rezultati u primijenjenim testovima u finalnom mjerenju ne odstupaju značajno od normalne distribucije rezultata. Može se uočiti kako nema maksimalnih odstupanja empirijskih rezultata u odnosu na teorijske relativne kumulativne frekvencije (Max D) te ne prelaze kritičnu vrijednost KS-testa (.13), pa se distribucija može smatrati normalnom, osim kod varijabli: AST – nabor trbuha, (Max D = .20), SST – nabor lopatice. (Max D = .15), PPB – potiskivanje na paralelnim ručama (Max D = .20) i BOF – ravnoteža na jednoj nozi na balansnoj lopti, (Max D = .14).

Uvidom u Tablicu 3 može se uočiti kako na temelju primjenjene multivarijantne analize varijance (Manova) postoje statistički značajne razlike ($p < 0,000$) u varijablama

za procjenu morfoloških karakteristika, bazičnih i specifičnih motoričkih sposobnosti ukoliko se finalno mjerenje usporedi s početnim mjerenjem.

Tablica 3.

Univarijantna analiza varijance (ANOVA) primjenjena na varijablama za procjenu morfoloških karakteristika ukazuje kako u svim promatranim varijablama postoje statistički značajne razlike ($p < 0,001$). U varijablama za procjenu bazičnih motoričkih sposobnosti postoje statistički značajne razlike ($p < 0,005$) u devet od dvanaest varijabli, dok kod jedne varijable – HAT-u (taping rukom) postoje statistički značajne razlike na razini značajnosti $p < 0,05$. Nisu pronađene statistički značajne razlike u varijablama FOT (taping nogom) i BOF (ravnoteža na jednoj nozi na balansnoj lopti). Naposljetku, multivarijantna analiza varijance primijenjena na varijablama specifičnih motoričkih sposobnosti ukazuje da prije i nakon tretmana vježbanja postoje statistički značajne razlike ($p < 0,000$).

Tablica 4.

Rasprava

Ovim istraživanjem očekivano je da će se postići statistički značajne razlike u svim varijablama između početnih i završnih mjerenja kod varijabli za procjenu morfoloških karaktristika, bazičnih i specifičnih motoričkih sposobnosti primjenom multivarijantnih i univarijantnih analiza varijance nakon dvogodišnjega trenažnog procesa kod mladih, muških karate polaznika.

Rezultati ukazuju kako postoji statistički značajna razlika u varijablama za procjenu morfoloških karakteristika u cjelini ($p < 0,000$), kao i za pojedine morfološke varijable ($p < 0,000$ za 11 varijabli, $p < 0,005$ za 1 varijablu) uspoređujući finalno u odnosu na početno testiranje. S obzirom na to da je većina varijabli za procjenu morfoloških karakteristika u longitudinalnoj i poprečnoj dimenziji skeleta, a donekle i u voluminoznost tijela genetski determinirana, očekivane promjene ostvarile su se u varijablama koje procjenjuju potkožno masno tkivo.

Planiranim i sustavnim provođenjem treninga karatea može se značajno utjecati na redukciju potkožnoga masnog tkiva, (Malina i Katzmarzyk, 2006) nešto manje na cirkularnu dimenzionalnosti, a gotovo je zanemarujući utjecaj na longitudinalnu dimenzionalnost skeleta. Slična istraživanja proveli su i drugi autori, a rezultati i zaključci su slični (Kurelić i sur., 1975, Ivanić, 1996, Pejčić i Malacko, 2005, Gajević, 2009, Doder, 2010).

Što se tiče varijabli koje procjenuju bazične motoričke sposobnosti, uočene su statistički značajne razlike nakon provedenoga kineziološkog tretmana vježbanja ($p < 0,05$ za 10 od 12 varijabli), dok nije bilo značajnih razlika za varijablu FOT (taping nogom; $p = .287$) i BOF (ravnoteža na jednoj nozi; $p = 3.44$), vjerojatno zbog veće genetske determiniranosti kod navedenih varijabli.

Najveće promjene kao rezultat eksperimentalnoga tretmana vježbanja utvrđene su kod varijabli koje procjenjuju repetitivnu i statičku snagu (30S – podizanje trupa u 30 sekundi, PPB – potiskivanje na paralelnim ručama, HSL – polučučanj s teretom) i eksplozivnu snagu (LSP – skok u dalj iz stojećeg položaja, TSP – troskok u dalj iz stojećeg položaja, trčanje 20 m s letećim startom, zbog ograničenoga utjecaja genotipa na ove antropološke dimenzije s jedne strane te specifičnih struktura gibanja karate sporta primijenjenih u ovom eksperimentalnom programu treninga, s druge strane strane.

Dobivene vrijednosti u testovima za procjenu snage očekivane su u ovoj dobi s obzirom da se veće promjene počinju dešavati tek nakon 12. godine kod dječaka, što su potvrdili i rezultati drugih istraživanja (Hirtz, 1985, Doder i sur., 2012; Mišigoj-Duraković, 2018).

S obzirom da postoje određene razlike u vrijednostima prirasta indeksa tjelesne mase, a time i sastava tijela karataša, očekivano je da te razlike uzrokuju odnose u relativnoj repetitivnoj snazi između inicijalnoga i finalnoga mjerenja (Jozić, 2001, Vidranski, Tomac i Otković, 2017).

Razina maksimalnoga postignuća ovisila je prije svega, o genetskom potencijalu, aktivnosti pojedinca i od pravovremenoga utjecaja na motoričke sposobnosti. Motoričke se sposobnosti u ovom period (10. -12. godine) ne razvijaju istim tempom i ne dostižu uvijek isti maksimum u istoj dobi(Kukolj, 1996).

Kod varijabli za procjenu specifičnih motoričkih sposobnosti došlo je do najvećega poboljšanja nakon primijenjenoga dvogodišnjeg karate treninga. Vrijeme izvođenja specifičnih zadataka u svim testiranim specifičnim/ situacijskim strukturama gibanja ili tehničkim elementima karate sporta značajno je skraćeno ako se usporedi finalno s početnim mjerenjem.

Ovakvi rezultati ponajviše se mogu pripisati usavršavanju i racionalzaciji izvedbe specifičnih struktura gibanja (Jovanović, 1991; Blažević, Katić i Popović, 2006; Čavala, Jukić, Babin, Zagorac i Katić, 2014) izraženih kroz karate tehniku.

Eksperimentalni program s elementima karatea, pokazao se kao efikasno sredstvo, s kojima se može utjecati na smanjenje potkožnoga masnog tkiva, voluminoznosti i mase tijela, razvoja statičke, repetitivne i eksplozivne snage, pa se može preporučiti za primjenu u nastavi tjelesne i zdravstvene kulture u osnovnim školama.

Zaključak

Rezultati istraživanja pokazali su da je kod dječaka karataša u cijelom prostoru (multivarijantno) morfoloških, bazično motoričkih i specifično motoričkih varijabli pod utjecajem dvogodišnjega eksperimentalnoga tretmana došlo do statistički značajnih razlika u aritmetičkim sredinama između inicijalnoga i finalnoga mjerenja na nivou $p = .001$. U pojedinačnim morfološkim varijablama (univarijantno), najveće transformacije dobivene su u varijablama potkožnoga masnog tkiva jer su se vrijednosti u značajnoj mjeri smanjile u finalnom mjerenju, što je i očekivano. I u bazičnim motoričkim varijablama došlo je do multivarijantnih i univarijantnih statistički značajnih razlika

između inicijalnoga i finalnoga mjerenja na nivou p ≤ .001 (od 10 varijabli kod 9 varijabli na nivou p ≤. 001 i jednoj varijabli na nivou p ≤ .05) u prilog finalnom mjerenju, dok kod varijabli TAN – taping nogom (p = .287) i STG – stajanje na jednoj nozi uzduž grede (p=.344) nije došlo do statistički značajnijih transformacija. U prostoru specifičnih motoričkih sposobnosti postignut je najveći napredak u transformaciji ovih sposobnosti jer je došlo do multivarijantnih i univarijantnih statistički značajnih razlika između inicijalnoga i finalnoga mjerenja na nivou p ≤ .005 u prilog finalnom merenju, što je i bio primarni cilj. U svim primenjenim varijablama prilikom izvođenja specifičnih kretnih struktura vrijeme njihova izvođenja u znatnoj se mjeri skratilo, čime je postignuta željena efikasnost i efektivnost primijenjenoga programa.