ORIGINAL ARTICLE

The effect of 10 weeks of karate training on the weight body composition and FFF index of children at the early school age with normal weight and overweight

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

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Abstract

Background and Study Aim: One of the elements of obesity therapy is increased physical activity. The WHO, determined the level of physical activity necessary to maintain good health at 60 minutes a day for children and 30 minutes of intense physical activity 5 times a week for adults The aim of the study is the knowledge about the suitability of the fat-non-fat indicator (FFF) to monitor changes in body composition under the influence of 10 weeks of kyokushin karate training in younger school children.

Material and Methods: Seventy-seven children with normative body weight (N) and 76 with BMI above 85 percentile for age and sex (O – abnormal body weight) were qualified from 593 children examined for the research program. Body mass and body composition were determined in all subjects and on their basis the general and segment fat-free fat index (FFF) was calculated. Body composition was determined using Tanita's BC-418 MA 8-electrode body composition analyser. In individual groups, children were randomly selected to participate in NKKT (normative body weight kyokushin karate training) n = 30, OKKT (abnormal body weight kyokushin karate training) n = 29. The other children constituted the control group (48 girls; 46; boys). The subjects underwent a 10-week kyokushin karate training. After the training, comparative tests were carried out.

Results: Fat-free fat index was statistically significantly different between overweight children and normative body weight except for the upper limb in boys from the control group. After 10 weeks of training, a decrease in the FFF indicator in the training group and an increase in the control group were observed. Statistically significant changes were noted in the group of overweight boys kyokushin karate training.

Conclusions: Karate training is recommended for the group of younger children because it improves body posture and symmetry of fat distribution. The FFF index is a good tool for assessing the impact of training on changes in the level of the body composition components.

Keywords: bioelectrical impedance • correct posture • kyokushin karate • obesity therapy • physical activity • prevention

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Physical activity – *noun* exercise and general movement that a person carries out as part of their day [50].

Posture *noun* the position in which a body is arranged, or the way a person usually holds his or her body when standing [50].

Bioelectrical impedance analysis – *noun* an accurate method of measuring body fat using an electrical current. Abbreviation **BIA** [50].

Kata – *noun* a sequence of movements in some martial arts such as karate, used either for training or to demonstrate technique [50].

Technique – *noun* a way of performing an action [50].

Training session – *noun* a period of time during which an athlete trains, either alone, with a trainer or with their team [50].

Preventive – *adjective* used for describing an action taken to stop something happening, especially to stop a disease or infection from spreading [50].

Dan (dan'i) – a term used to denote one's technical level or grade [51].

INTRODUCTION

At present, one of the biggest health problems affecting quality of life and health is excessive body mass. In 1997 obesity was determining as a disease and therapeutic status was given [1]. One of the elements of obesity therapy is increased physical activity. The World Health Organization (WHO), determined the level of physical activity necessary to maintain good health at 60 minutes a day for children and 30 minutes of intense physical activity 5 times a week for adults [2]. Over the past years, the number of children and adolescents who have been found to be overweight and obese has increased dramatically. According to data from 2016, the problem of overweight or obesity concerns 340 million children and adolescents aged 5-18 years, while in children under 5 years of age this number is estimated at 38 million [3] Such a high percentage, especially of younger children with abnormal body weight, influenced the verification of indications regarding physical activity, increasing it in children under 5 years of age to 180 minutes of intense daily physical effort [4].

Excessive body weight is a risk factor for many diseases that appear throughout life [5-8]. Anomalies that occur in children have a good chance of maintaining and worsening in subsequent stages of life. Some scientists claim that the risk of complications and health problems associated with excessive body weight can be minimized if intervention and prevention begins before the age of 13 [9-11].

The choice of physical activity for children is not easy. It must agree not only on the parents' willingness, but also fulfil an educational role [12]. The introduction of physical activity in childhood on the task of primarily maintaining health well-being manifested in the normative body weight, correct posture, proper energy expenditure, the proper development of small and large motor skills. However, these are not the only tasks of physical education. A child playing sports acquires social skills – team work, competition, but also the qualities necessary in adult life – consistency in behaviour, pursuit of a goal, group communication, resistance to stress. One of the sports disciplines that affect not only the child's physical sphere but also the mental and social one is karate. This is one of the most popular martial arts having its roots in Japan [13]. The literature on the subject includes research on the impact of karate on physical fitness, biochemical changes or body composition [14, 15], but also on the relationship between training and the level of aggression, self-esteem or self-confidence [16-20]. Some authors focus on the adverse impact of karate on health, traumatism appearing in this sport [21, 22], but most authors emphasize the positive aspect of practicing karate from an early age not only in healthy children but also those in need of rehabilitation [23-26]. The beneficial aspects of practicing karate include, above all, improved body posture [24, 25], improved balance achieved thanks to the "kata" training form [23] or increased bone density [27]. Previous studies on the impact of karate on body weight were limited to determining the body profile of adult karate competitors [28], while there are no studies on the impact of training on body weight changes in terms of body composition components.

One of the most available methods of assessing body composition is bioelectrical impedance (BIA), which allows the separation of fat and non-fat components in the total body weight. thanks to the use of BIA, we can determine the fat-free fat index (FFF) necessary to assess changes in the internal structure of the body [29-31].

The aim of the study is the knowledge about the suitability of the fat-non-fat indicator (FFF) to monitor changes in body composition under the influence of 10 weeks of kyokushin karate training in younger school children.

MATERIAL AND METHODS

This was a prospective, randomized, non-blind study.

The research was approved by the Senate Commission for Ethics of Scientific Research at the University School of Physical Education in Wroclaw (decision of 07.06.2015). The parents of all respondents gave their written consent to the tests and participation in the program. The children had the right to refuse to take part in tests and activities. Refusal to participate in the classes was tantamount to resignation in the project. The study was conducted in accordance with the CONSORT (Consolidated Standards of Reporting Trials) statement (Consort flow diagram). The study was carried out in accordance with the tenets of the Declaration of Helsinki.

Participants

Five hundred ninety-three children (305 girls♀, 288 boys♂) from the Primary School in Lewin Brzeski and the Primary School No. 76 in Wroclaw, from classes 1-3 (between 7-9 years of age) were examined. By body weight, the subjects were divided into: group with normative body weight (N) (n = 77) BMI <85 percentile for age and sex and percentage body fat (FatP) below 20% for boys and 25% for girls, and group with abnormal body weight (O) (n = 76) – BMI >85 percentile and / or FatP >20% for boys and FatP >25% for girls.

In individual groups, children were randomly selected to participate in NKKT (normative body weight kyokushin karate training) n = 30, OKKT (abnormal body weight kyokushin karate training) n = 29. In both groups training karate there were both boys (NKKT♂ n = 16, OKKT♂ n = 16) and girls (NKKT♀ n = 14, OKKT♀ n = 13). Training classes for all groups were held simultaneously and lasted 10 weeks. The non-training group consisted of people with normative body weight (N) n = 47, N♀ n = 27, N♂ n = 20 and overweight (O) n = 47, O♀ n = 21, O♂ n = 26. Others subjects did not participate in additional physical activity classes except physical education classes at school.

Children who were not qualified for the study: in sports classes whose parents did not express their desire to participate in the project, the child's participation in classes was below 80%, or for health reasons. Health problems include: endocrine-related diseases (type I diabetes, growth hormone deficiencies, thyroid hormonal disorders etc.), cardiological and neurological diseases.

The average age of the examined children was 8.01 ±0.91 years (♀ 8.00 ±0.91; ♂ 8.02 ±0.92), average body height 130.68 ±7.60 cm (♀ 129.76 ±7.59; ♂ 131.65 ±7.49), average body weight 28.47 ±6.48 kg (♀ 27.75 ±6.01; ♂ 29.23 ±6.87); BMI 16.51 ±2.49 kg/m^2 (♀ 16.35 ±2.41; ♂ 16.68 ±2.57) while the average BMI centile 49.63 ±29.64 (♀ 49.07 ±30.37; ♂ 50.24 ±28.87). There were children in the examined group of the same age. Statistically higher were height and body weight in boys, compared to the group of girls (Table 1).

Study design

On the basis of the PAQ-C assessing physical activity, no differences were found in the physical activity undertaken in the studied children. Physical activity determined on the basis of PAQ-C did not exceed 5 hours a week. The questionnaire was given twice before and after the program. In the group of non-exercising children, there were no differences in the physical activity undertaken in the examined children.

The research project consisted of three stages. In the first stage, screening was conducted to select an experimental group. The height (SECA-213 height meter) and body composition were determined using the TANITA 8-electrode body composition analyser BC-418 MA, compatible with the GMON-TANITA PRO program. The bio-electrical impedance method (BIA) estimated fat components (percentage of fat tissue FatP, fat mass FatM) and lean body mass FFM) in 5 body segments (lower right limb RL, lower left limb LL, upper right RA), upper left limb LA, torso TR). The obtained FatM and FFM results were used to calculate the fat-free fat index FFF [29-31].

Determination of the BMI index and its centile on the basis of percentile grids was developed for the OLAF program [32]. After being selected as subjects for the experimental group, the children were divided according to the presence of oversized body mass. The group considered overweight included people with a BMI >85 percentile for age and sex (determination of percentile based on centile grids developed under the OLAF program – OLA) and children who were considered to be so-called "hidden overweight" whose percentage of total body fat exceeded 20% in boys 25% for girls [29, 32].

In stage II, a 10-week training program was conducted based on kyokushin karate guidelines. Classes were held twice a week for 60 minutes each in the gym. The training session consisted of warm-up (15 min), main part (30-35 min) and stretching and cooldown (10-15 min). During the warm-up, physical activation was carried out through general fitness exercises ("tag", races, short interval runs, and exercises in low positions such as "hare jumping", "jumping", walking on all fours). In the main part, the subjects learned karate techniques: basic punches, blocks, kicks, stances and elements of strength, speed and coordination training adapted to age. In the final part stretching and cooldown were introduced. Through out the whole training session proper exercise and body posture were monitored.

The heart rate of children was measured by Polar H10 heart rate monitors, training intensity was maintained at 80% HRmax for at least 50%

Table 1. Average and standard deviation (±) anthropometric values of girls divided into groups.

Variable	Karate training group		Control group	
	Normative body weight (NKKT)	Overweight (OKKT)	Normative body weight (N)	Overweight (O)
		Girls (♀)		
Number	n = 16	n = 13	n = 27	n = 21
Age [years]	7.58 ±0.22	7.49 ±0.56	7.78 ±0.87	8.16± 0.88
N vs O [p]	NS		NS	
Height [cm]	126.4± 4.6	128.2± 5.9	128.1 ±6.4	131.7 ±6.5
N vs O [p]	NS		NS	
Weight [kg]	25.05± 2.58	32.81± 4.04	25.94± 7.23	35.12 ±6.21
N vs O [p]	0.011**		0.000***	
BMI [kg/m^2]	15.64± 1.06	19.91 ±1.83	15.61± 2.9	20.10 ±1.97
N vs O [p]	0.001**		0.000***	
BMI for age percentile	45.63± 20.36	90.85± 5.81	28.15± 24.9	86.81± 18.0
N vs O [p]	0.002**		0.000***	
		Boys (♂)		
Number	n = 14	n = 16	n = 20	n = 26
Age [years]	7.72 ±0.24	7.67± 0.57	7.78 ±0.89	8.26 ±0.99
N vs O [p]	NS		NS	
Height [cm]	127.1± 6.0	133.7 ±3.7	133.1± 6.2	135.9± 8.4
N vs O [p]	NS		NS	
Weight [kg]	25.1± 3.9	37.1 ±7.3	29.8 ±7.0	37.5 ±9.1
N vs O [p]	**0.000*** **		**0.003** **	
BMI [kg/m^2]	15.4± 1.3	20.7± 3.5	16.7± 2.7	20.0 ±3.1
N vs O [p]	**0.000*** **		**0.003** **	
BMI for age percentile	36.2 ±24.1	88.6± 9.1	47.9± 30.5	87.9 ±11.5
N vs O [p]	**0.000*** **		**0.000*** **	

NS no statistically significant; **p<0.01; ***p<0.001

of the duration of the main part. The sessions were conducted by a karate kyokushin trainer with 1dan degree.

In the third stage of testing, measurements of height, mass and body composition were repeated in order to calculate the FFF index. The study was performed immediately after the end of the 10-week training program, at the same time in the training and control group.

Statistical analysis

The STATISTICA ver. 13 software was used to perform the statistical analysis. Descriptive statistics were used to describe the group – group size (n), average, standard deviation (±).

The normality of the distribution was examined by using the Shapiro-Wilk test. In the absence of normality of distribution, non-parametric statistics were used for the Kruskal-Wallis test and Spearman rank correlation. The level of statistical significance was assumed p<0.05.

RESULTS

In the studied group, the fat-free fat index was determined for individual body segments of the examined children. There were no statistically significant differences between the groups in the study prior to starting physical activity. In the group of girls with normative body weight, exercising and non-exercising karate, statistically significant differences were observed between the right and left lower limbs. In overweight girls who participated in karate training, the FFF index was statistically significantly lower on the right side in

both the lower and upper limbs. In the group of boys and girls who were overweight not participating in karate, there were no statistically significant differences between the right and left side of the body. The lowest values of the indicator were observed within the torso in all examined groups and the highest within the upper left limb. Statistically significant differences were observed in all FFF indices between normative body weight and overweight groups in both girls and boys, with the exception of the upper right limb index (RA FFF) in non-training boys (Table 2).

After training a statistically significant increase in body weight of about 0.9 kg was found in all subjects except the group of boys with normative body weight not participating in karate training. In the study, after the end of training program, statistically significant differences (p = 0.011) were observed between the FFF index for the lower right limb and the lower left limb in girls who participated in karate training. In the remaining segments, regardless of the groups, no statistically significant differences were observed between the right and left sides of the body.

Table 2. Fat-lean mass index (FFF) value before the start of the training cycle.

Variable	Karate training group		Control group	
	Normative body weight (NKKT)	Overweight (OKKT)	Normative body weight (N)	Overweight (O)
		Girls (♀)		
Number	n = 16	n = 13	n = 27	n = 21
FFF	0.276 ±0.036	0.388 ±0.075	0.268 ±0.071	0.378 ±0.064
N vs O p	0.000***		0.001***	
RL FFF	0.430 ±0.040^	0.550 ±0.093^	0.425 ±0.081^	0.544 ±0.073
N vs O p	0.000***		0.002**	
LL FFF	0.439 ±0.033^	0.574 ±0.109^	0.429 ±0.089^	0.557 ±0.070
N vs O p	0.000***		0.0005***	
RA FFF	0.499 ±0.075	0.610 ±0.133^	0.480 ±0.103	0.611 ±0.078
N vs O p	0.029*		0.009**	
LA FFF	0.513 ±0.084	0.668 ±0.116^	0.484 ±0.121	0.660 ±0.119
N vs O p	0.001		0.003**	
TR FFF	0.180 ±0.037	0.275 ±0.061	0.170 ±0.062	0.262 ±0.059
N vs O p	0.000***		0.001***	
		Boys (♂)		
Number	n = 14	n = 16	n = 20	n = 26
FFF	0.211 ±0.029	0.370 ±0.097	0.252 ±0.079	0.343 ±0.092
N vs O p	0.000***		0.006**	
RL FFF	0.356 ±0.037	0.558 ±0.132	0.406 ±0.097	0.513 ±0.118
N vs O p	0.000***		0.015*	
LL FFF	0.363 ±0.035	0.560 ±0.140	0.406 ±0.092	0.515 ±0.119
N vs O p	0.000***		0.015*	
RA FFF	0.405 ±0.109	0.543 ±0.119	0.438 ±0.091	0.510 ±0.127
N vs O p	0.038*		NS	
LA FFF	0.388 ±0.074	0.579 ±0.138	0.427 ±0.115	0.552 ±0.132
N vs O p	0.001***		0.010**	
TR FFF	0.125 ±0.035	0.245 ±0.067	0.158 ±0.066	0.229 ±0.073
N vs O p	0.000***		0.018*	

NS: no statistically significant; *p<0.05; **p<0.01; ***p<0.001; statistically significant difference between the right and left limb: ^p<0.05

After the training program, statistically significant differences were observed between the group with normative body weight and overweight in the case of the general index FFF (p = 0.04) and the left lower limb RL FFF (0.04), while the non-training girls FFF p = 0.04, RL FFF p = 0.01). In the boys group, the value of the FFF index after training statistically differed significantly between the groups with normative body weight and overweight in all segments (FFF p = 0.00; RL FFF p = 0.00; LL FFF p = 0.00; RA FFF p = 0.00; LA FFF p = 0.00, TR FFF p = 0.00). In the group of non-training boys, the differences were for the general FFF index (p = 0.03) and both lower limbs (RL FFF p = 0.04; LL FFF p = 0.01).

Comparing the FFF index values after the training period, a decrease in the index value of children participating in karate training was observed. In the case of overweight boys training, the changes are statistically significant in all segments except the upper left limb. In the case of a control group, the indicator value usually increases. In girls with normative body weight, the change is statistically significant for the overall index and for the torso. In the case of boys who were not training, the value of the index within the lower limbs decreased but it was a statistically insignificant change. The decrease in the FFF index indicates a decrease in the value of fat mass (Table 3).

DISCUSSION

One of the easiest and most appropriate ways to normalize a child's body weight is to encourage them to engage in physical activity [33, 34]. However, this is a difficult task because according to the research of Fijałkowska et al. [35] every 5th child of school age does not engage in any physical activity. This lack of physical activity is most often due to a lack of interest, an inability to participate in extracurricular activities, personal reluctance to participate, as well as children becoming discouraged because they may find some activities monotonous and not appropriate for their age and personal capabilities [36, 37]. For younger school aged children, their choice of physical activity, especially outside of school, depends on their parents and the prevailing norms [38, 39]. Depending on the child's sex, the most common types of juvenile physical activity are football, dance with elements of artistic gymnastics, and swimming [40, 41].

Research showed that karate training had a positive effect on the body weight and body composition of children. It was observed that the FFF index decreased in all children who participated in training (except for RA FFF in girls) regardless of BMI. A decrease in the FFF index is a desirable result of training. The FFF index based on fat and lean mass shows us the ratio of these components to each other. Relying on body weight assessment alone does not allow conclusions to be drawn regarding internal changes. However, the fat-free fat index used in this study demonstrates the impact of training on changes in body fat in the absence of changes in body weight. A significant statistical increase in body weight was observed in the studies which is not a positive development in groups of overweight children. However, despite the increase in body weight in the group of overweight children, karate training had positive effects. In these groups, the increase in body weight was caused by an increase in lean tissue, which can be interpreted as a positive difference between the FFF index which were measured before and after training. In addition, among the group of overweight boys who participate in training these changes are statistically significant. Similar results were obtained by Chwałczyńska et al. [30] who assessed changes in body composition in school-aged children. In their study, a reduction in the percentage of body fat was observed in overweight children after 6 weeks of training.

By only assessing body fat, you can underestimate the impact of training on body composition. Nassis et al. [42] in their research attempted to assess the effects of a 12-week overall training program composed of elements of basketball, volleyball and handball, by monitoring changes in BMI and body fat. They did not note any statistically significant differences, but a reduction in body fat was observed. If the index was used for these tests, one could estimate the effect of training on lean mass, and hence on muscle mass. Researchers assessing the impact of strength training on the prevention of obesity focused similarly on body fat [43]. Researchers observed a statistically significant decrease in body fat percentage, but did not investigate the effect of these exercises on lean mass.

The use of the general FFF index demonstrates the impact of physical activity on the development of muscle mass which is the main component of lean mass. In the presented studies not only the general index was used, but the segment index was also calculated, and the two were compared.

Table 3. Difference of FFF between first and second survey (within separate groups) together with the significance of changes ("–" means increased their fat mass; the index of the second measurement was higher).

Variable	Karate training group		Control group	
	Normative body weight (NKKT)	Overweight (OKKT)	Normative body weight (N)	Overweight (O)
		Girls (♀)		
Number	n = 16	n = 13	n = 27	n = 21
FFF	0.002 ±0.029	0.009 ±0.029	**–0.016 ±0.026***	–0.005 ±0.030
RL FFF	0.005 ±0.045	0.002 ±0.046	–0.006 ±0.031	–0.010 ±0.039
LL FFF	0.005 ±0.033	0.016 ±0.037	–0.012 ±0.033	–0.008 ±0.039
RA FFF	–0.002 ±0.065	–0.003 ±0.085	–0.026 ±0.069	0.022 ±0.054
LA FFF	0.001 ±0.066	0.030 ±0.069	–0.037 ±0.104	–0.019 ±0.081
TR FFF	0.001 ±0.033	0.011 ±0.030	**–0.016 ±0.028***	–0.003 ±0.031
		Boys (♂)		
Number	n = 14	n = 16	n = 20	n = 26
FFF	0.0046 ±0.0299	**0.0224 ±0.035***	–0.0066 ±0.0403	–0.0023 ±0.0447
RL FFF	0.0103 ±0.0390	**0.0243 ±0.045***	0.0082 ±0.0480	0.0121 ±0.0661
LL FFF	0.0085 ±0.0390	**0.0219 ±0.039***	0.0074 ±0.0471	0.0070 ±0.0591
RA FFF	0.0224 ±0.0540	**0.0236 ±0.049***	–0.0112 ±0.0803	–0.0182 ±0.1415
LA FFF	0.0187 ±0.0806	0.0309 ±0.071	–0.0265 ±0.0863	–0.0231 ±0.0932
TR FFF	0.0026 ±0.0305	**0.0207 ±0.037***	–0.0109 ±0.0382	–0.0087 ±0.0420

*p<0.05

The asymmetry of the structure was observed in the examined group especially in the upper limbs. The right side, dominant, contained less fat, and hence its RA FFF index was lower than in the case of the upper left limb. After the training cycle, the differences between the parties decreased, which proves the positive impact of karate training on body posture. Studies conducted by Filingeri et al [23] as well as Truszczynska et al. [25] showed similar results in terms of the positive impact of karate training on body posture. The authors emphasized that the use of techniques characteristic of "kata" training allows an individual to improve body posture and balance. Rutkowski et al. [37] assessing the physical fitness of children practicing karate, obtained results that showed an improvement in physical fitness, especially in equivalent tests, hand speed, and explosive strength. The evaluation of the FFF index confirmed the results of the performance tests, and complement them.

The authors, when describing the impact of short-term training under 6 months on body composition, very often did not observe statistically significant changes in terms of body weight, BMI or the percentage of body fat. This outcome may be the result of too low an intensity of physical effort [34, 44, 45]. Karate training is conducted in intervals. The study of individual techniques is interspersed with elements of speed, strength or coordination. They are enjoying the training form especially in the group of younger children. The study of karate techniques does involve expending some energy. Maintaining proper position and exercising requires strength, dexterity and coordination.

In the described research group, the was conducted as if the children were preparing for first level of karate exam. The children were required to learn the basic technics used in these martial arts. The training consisted of repetitions of the same movement, which influenced the intensity of the effort. Karate training intersperses aerobic forms which increase fat burning with anaerobic forms which increase the development of muscle mass.

The presented studies have shown that karate training has a positive effect on the fat-free fat index in children with normative and oversize body mass. This positive effect results from the fact that it can be used as an element of overweight and obesity prevention in school programs. The internal variability of the training unit in karate affects the variety of classes. Similar

conclusions were presented by Lau et al. [46] in his studies, in which standard physical education classes implemented at school were supplemented by 12-16 short, high-intensity running series. The authors claim that such a structure of classes was more attractive for children and allowed to shorten training. Lau et al. [47] created an outline of classes similar to the training unit used in karate, instead of learning kick techniques, the studying running and stretching techniques.

The study compared changes in the FFF index over 10 weeks. In the group of children who did not attend karate training, the overall index within the upper limbs and torso increased. This means that the children had increased their fat mass to a greater extent than the mass of lean tissue. Therefore, it can be concluded that the level of physical activity at schools is insufficient to maintain a healthy weight. Educational standards set the number of hours spent on physical activity during physical education lessons at 135 minutes a week. The WHO recommends 60 minutes a day for children between 5 and 18 years of age. In their research, Jodkowska and Korzycka [47] stated that the average amount of time spent in extracurricular physical activity classes in the age group of 8-year-olds is 3.44 hours per week. Even when supplemented with physical education lessons, the total time still does not meet the WHO minimum guidelines [2, 4, 47]. The problem of low participation in physical activity is not only a Polish problem. LeBlanc et al. [48] in a study of a group of 10-year-old children (n = 5800) from various countries stated that the development of children being overweight or obese among the subjects could be caused by a sedentary lifestyle. Participants in the study spent 8.6 hours per day sitting at school, doing homework, and sitting in front of computer and television screens.

The application of this new method, which is the calculation of the fat-free fat index, makes it possible to shorten the research period. Socha et al. [49] in their study of the influence of lateralization in judo techniques on body composition used not only the overall body composition but also measured the peripheral fat folds. The selection of these methods significantly extended the measurement time and required an experienced researcher. As in the case of Sheldon's typology, also in the case of anthropological measurements, especially fat folds used by researchers, these methods are very important, but they cannot be used by trainers, players without special training. The use of the FFF index requires only having a body composition analyser and this equipment is generally available and can be used by many researchers [29].

However, the most important element our research is to demonstrate the positive impact of karate training on the internal structure of the body and its symmetry. When compared to other studies in which children participated in additional general development classes and water gymnastics [34], the changes observed in the case of karate training lead to symmetrical distribution of lean and fat mass.

CONCLUSIONS

Karate training is recommended for the group of younger children because it improves body posture and symmetry of fat distribution

Karate training should be introduced as one of the forms of physical activity in physical education during early school years.

The FFF index is a good tool for assessing the impact of training on changes in the level of the body composition components.

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