



STRENGTH ABILITIES: ASSESSMENT AND SPECIFIC FEATURES OF THE DEVELOPMENT OF ELEMENTARY SCHOOL-AGED KARATE BOYS

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Abstract

The purpose of this study is to determine the age-specific features of the manifestation of differences in the strength fitness of younger grade boys who attend a karate class at the sports and health stage.

Materials and methods. The study participants were 57 children who were tested to determine their level of strength abilities. They were divided into four age groups: 7-year-old boys (n=14), 8-year-old boys (n=15), 9-year-old boys (n=15), and 10-year-old boys (n=13). The children and their parents were informed about all the features of the study and gave their consent to participate in the experiment. The children's technical level corresponded to the student grades of 10th or 9th Kyu (Orange Belt). The solution of the set tasks involved the use of the following research methods: review and analysis of scientific and methodical literature, pedagogical observation, timing of educational tasks, testing of strength abilities, pedagogical ascertaining experiment, methods of mathematical statistics.

Results. Statistically significant age-specific differences were observed between the groups of boys aged 7 and 8 in the results of the following tests: push-ups (p=0.0001), 30 second sit-ups (p=0.001), pull-ups and chin-ups (p=0.008), flexed-arm hang (p=0.003), left hand dynamometry (p=0.023), standing long jump (p=0.0001); between the groups of boys aged 8 and 9 in the results of the following tests: 30 second sit-ups (p=0.046), pull-ups and chin-ups (p=0.004), flexed-arm hang (p=0.002); between the groups of boys aged 9 and 10 in the results of the following tests: standing long jump (p=0.014).

Conclusions. It was established that the boys have differences in various structural elements that characterize strength indicators. And these differences are in line with the age indicators and technical level of the karatekas.

Keywords: boys, strength abilities, kyokushinkai karate, younger grade students.

Introduction

Childhood and early adolescence are considered to be critical periods for the development of the best possible physical literacy (Balyi, Way & Higgs, 2013; Lloyd, Cronin, Faigenbaum et al., 2016). Physical literacy is defined as people's ability, confidence and desire to be physically active throughout life and is considered the cornerstone of health and fitness (Whitehead, 2001; Farrey, Isard et al., 2015; Farrey, Isard, Chalipet et al., 2015).

There is growing recognition that a basic set of motor skills should be learned in childhood to ensure long-term participation in physical activity (Volkov, 2002; Platonov, 2015; Zwolski, Quatman-Yates & Paterno, 2017). Childhood is a sensitive period for learning and mastering basic motor skills. Motor skill mastery is positively related to health,

fitness, and academic performance (Boutios, Fiorilli, Buon-senso et al., 2021; Marchenko, Jagiello, Iermakov et al., 2021; Marchenko, Ivashchenko, Jagiello et al., 2022). Of particular concern is the lack of muscular fitness in children, which is considered a vital component of the health, well-being and success of young people who want to participate in sports and health activities (Runhaar, Collard, Singh et al., 2010; Cohen, Voss, Taylor et al., 2011; Smith, Eather, Morgan et al., 2014).

Strength abilities are one of the components that are the foundation for learning motor actions (Khudolii, Ivashchenko, Iermakov, Nosko & Marchenko, 2019; Minenko & Marchenko, 2021; Kim, Won & Shin, 2021). The acquisition of strength and motor competence is achieved not only through growing up, but also through constant interaction with a stimulating and supportive social and physical environment (Balushka, Khimenes, Okopnyi, Pityn, Sohor & Tkach, 2020; Marchenko & Satdyiev, 2021; Marchenko & Handymov, 2021).

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Training in a kyokushinkai karate class can produce improvement in children's physical condition (Chyu, 2010; Pinto-Escalona, Gobbi, Valenzuela et al., 2021; Driukov & Marchenko, 2021), their good neuromuscular coordination and balance (Marchenko & Bezpalko, 2020; Boutios, Fiorilli, Buonsenso et al., 2021; Marchenko & Verdys, 2021), harmony of their movements (Leong, Fu, Ng & Tsang, 2011; Pons van Dijk, Lenssen, Leffers, Kingma & Lodder, 2013), development of their motor skills (Ma & Qu, 2017; Marchenko & Satdyiev, 2021), and teaching them combat skills (Błaszczyszyn, Szczęsna, Pawlyta, Marszałek & Karczmit, 2019; Marchenko & Kovalenko, 2020; Litvin & Marchenko, 2021). Strength development is a prerequisite for learning, improving, stabilizing, and applying karate skills and related performance techniques (Saienko, 2012; Graham, Li, Bray & Cairney, 2018; Balushka, Khimenes, Okopnyi, Pityn, Sohor & Tkach, 2020).

Whereas the conditioning profile of adult karate athletes is widely documented in sports strength studies (Margari-topoulos, Theodorou, Methenitis, Zaras, Donti & Tsolakis, 2015; Pal, Joginder, Kalra & Sindhu, 2020; Kabadayı, Karadeniz, Yılmaz et al., 2022), virtually nothing has been published about young athletes at the sports and health stage, which includes school students aged between 6 and 15.

The analysis of literary sources showed the absence of objective data on the level and specific features of the development of strength abilities in school students aged 7 to 10 who take kyokushinkai karate classes at the sports and health stage. This does not allow to fully implement the selection of means and methods for the high-quality implementation of the educational and training process and the development of effective programs for physical training of children. The investigation of the age-specific patterns and regularities of the development of strength abilities is a problem of relevance as regards the training of young karatekas.

The purpose of this study was to determine the age-specific features of the manifestation of differences in the strength fitness of younger grade boys who attend a karate class at the sports and health stage.

Materials and methods

Study participants

The study participants were 57 children who were tested to determine their level of strength abilities. The study sample was divided into four age groups: 7-year-old boys ($n=14$), 8-year-old boys ($n=15$), 9-year-old boys ($n=15$), and 10-year-old boys ($n=13$). The children and their parents were informed about all the features of the study and gave their consent to participate in the experiment. The children's technical level corresponded to the student grades of 10th or 9th Kyu (Orange Belt). All the participants did regular practical training, which comprised 3 classes per week, each about 90 minutes long. The inclusion criteria were the absence of injuries in the last 2 months and the absence of intake of medication that could affect the correct performance of tests.

Ethical considerations. Ethical approval of the entire study was obtained from the Ethics Committee of H.S. Skovoroda Kharkiv National Pedagogical University. All the participants were given an information sheet detailing the study

conditions. The study procedure and possible risks were explained to all the participants and their parents by members of the research team. The participants were informed that they could withdraw from the study at any time and for whatever reason without explanation. Informed consent was obtained from all the participants and their parents. All procedures were performed in accordance with the Declaration of Helsinki.

Study organization

The solution of the set tasks involved the use of the following research methods: review and analysis of scientific and methodical literature, pedagogical observation, timing of educational tasks, testing of strength abilities, pedagogical ascertaining experiment, methods of mathematical statistics.

Strength fitness testing was conducted and evaluated using a battery of fitness tests that comprehensively characterize various manifestations of strength abilities. The tests were chosen depending on the subject matter and were included in the analysis according to the purpose of the study. The tasks performed during the examination of the children were assessed using quantitative indicators (Eurofit, 1993; Serhiienko, 2010; Đurić, Sember, Starc, Sorić, Kovač & Jurak, 2021).

Control exercises were carried out in the gym and on the sports field of the school. Before the examination, a set of exercises (10–15 minutes) was performed, which included running, jumping, general physical development exercises, and movement games. It was aimed at preparing the children to perform the test tasks.

Statistical analysis

The study used IBM SPSS 26 software application. The following parameters were calculated: arithmetic mean value (X), standard deviation, which characterizes the variability of the characteristic (S), independent samples t-test, Mann-Whitney U-test. The hypothesis of equality of variances for the compared groups was determined using Levene's test.

Results

The statistical analysis data are provided in Tables 1–6. In the age groups of 7 to 8 years, Levene's test indicates heterogeneity of variances in the tests 'Push-ups' and 'Flexed-arm hang' ($p<0.05$). In this case, the use of the independent samples t-test is unjustified. The same condition is observed in the 'Pull-ups and chin-ups' test in the samples of boys aged 8 to 9 years ($p<0.05$). This requires the use of other tests. We chose the non-parametric Mann-Whitney U-test (Tables 2, 3, and 5). In all other tests of the age groups of 7 to 8, 8 to 9, and 9 to 10 years, the level of significance according to Levene's test is greater than 0.05, therefore, the use of the independent samples t-test is justified.

The obtained levels of significance of the empirical t-tests demonstrate that there are statistically significant differences ($p<0.05$) between the groups of boys aged 7 and 8 years according to the results of the tests 'Pull-ups and chin-ups' ($p=0.008$), 'Standing long jump' ($p=0.001$), '30 second sit-ups' ($p=0.001$), and 'Left hand dynamometry' ($p=0.023$). No statistically significant differences are observed in the test 'Right hand dynamometry' ($p=0.089$).

Table 1. Analysis of the specific features of the manifestation of strength abilities in boys aged 7 to 8 years

Investigated indicators	Test for independent samples							
	Levene's test		t-test for equality of means				95% confidence interval for the difference	
	F	p	t	p	Δx	Δs	Lower	Upper
Push-ups, times	4.590	.041	-6.181	.000	-11.41	1.847	-15.203	-7.625
Pull-ups and chin-ups, times	1.874	.182	-2.873	.008	-1.595	.555	-2.734	-.456
Flexed-arm hang, s	9.528	.005	-3.832	.001	-7.096	1.852	-10.895	-3.297
Standing long jump, cm	0.108	.745	-5.910	.000	-31.09	5.260	-41.884	-20.297
30 second sit-ups, times	1.582	.219	-3.569	.001	-4.624	1.296	-7.282	-1.966
Right hand dynamometry, kg	3.486	.073	-1.762	.089	-1.743	.989	-3.773	.287
Left hand dynamometry, kg	2.870	.102	-2.404	.023	-2.167	.901	-4.016	-.317

Equal variances are assumed

Table 2. Analysis of the specific features of the manifestation of dynamic strength in the test 'Push-ups' in boys aged 7 to 8 years

Summary of the Mann-Whitney U-test for independent samples	
Total	29
Mann-Whitney U value	210.0
Wilcoxon W value	330.0
Test statistics	210.0
Standard error	22.834
Standardized test statistics	4.598
Asymptotic significance (2-tailed test)	0.000
Exact significance (2-tailed test)	0.000

Table 3. Analysis of the specific features of the manifestation of static strength in the test 'Flexed-arm hang' in boys aged 7 to 8 years

Summary of the Mann-Whitney U-test for independent samples	
Total	29
Mann-Whitney U value	173.000
Wilcoxon W value	293.000
Test statistics	173.000
Standard error	22.854
Standardized test statistics	2.975
Asymptotic significance (2-tailed test)	0.003
Exact significance (2-tailed test)	0.002

Table 4. Analysis of the specific features of the manifestation of strength abilities in boys aged 8 to 9 years

Investigated indicators	Test for independent samples							
	Levene's test		t-test for equality of means				95% confidence interval for the difference	
	F	p	t	p	Δx	Δs	Lower	Upper
Push-ups, times	0.276	0.604	-1.291	0.207	-3.0	2.325	-7.762	1.762
Pull-ups and chin-ups, times	4.626	0.040	-3.407	0.002	-2.667	0.783	-4.270	-1.063
Flexed-arm hang, s	0.048	0.828	-3.459	0.002	-8.203	2.372	-13.061	-3.345
Standing long jump, cm	2.397	0.133	-1.002	0.325	-4.667	4.656	-14.204	4.871
30 second sit-ups, times	0.063	0.804	-2.087	0.046	-2.533	1.214	-5.019	-0.047
Right hand dynamometry, kg	0.319	0.576	-1.739	0.093	-1.533	0.882	-3.340	0.273
Left hand dynamometry, kg	2.414	0.131	-1.390	0.176	-1.333	0.959	-3.299	0.632

Equal variances are assumed

Tables 2 and 3 show the null hypothesis testing analysis using the independent samples Mann-Whitney U-test. Since the asymptotic significance of the U-test is $p < 0.05$, the null hypothesis about the equal distribution of results in the tests 'Push-ups' ($p = 0.001$) and 'Flexed-arm hang' ($p = 0.003$) among the groups of boys aged 7 to 8 years on the basis of age is rejected. The differences between the values of the specified parameters in these samples are significant.

A positive dependence of the level of development of strength abilities on age was observed in young karatekas aged 7–8 years (Table 1). The 8-year-old boys demonstrate a higher level of strength fitness in general compared to the 7-year-old boys. Especially as regards the manifestation of strength endurance, dynamic and explosive strength. This

may be due to the fact that the first period of the boys' muscular system development begins from the age of 8, and not only the weight of the muscles increases, but also their physical and chemical properties change, and the innervation ratios are enriched. Muscle strength becomes greater. Age-related strength gains occur to some extent independent of physical loads.

The analysis of the specific features of the manifestation of strength abilities in boys aged 8 to 9 years (Table 4) showed that there is a statistically significant difference in the performance indicators of the tests 'Pull-ups and chin-ups' ($p = .004$), 'Flexed-arm hang' ($p = .002$), and '30 second sit-ups' ($p = .046$). No differences were found in the correlation of results between the samples in the tests 'Push-ups' ($p = .207$),

Table 5. Analysis of the specific features of the manifestation of dynamic strength in the test ‘Pull-ups and chin-ups’ in boys aged 8 to 9 years

Summary of the Mann-Whitney U-test for independent samples	
Total	30
Mann-Whitney U value	180.50
Wilcoxon W value	300.50
Test statistics	180.50
Standard error	23.858
Standardized test statistics	2.850
Asymptotic significance (2-tailed test)	0.004
Exact significance (2-tailed test)	0.004

‘Standing long jump’ ($p=.325$), ‘Right hand dynamometry’ ($p=.093$), and ‘Left hand dynamometry’ ($p=.176$).

A characteristic feature of the development of these age groups of school students is a higher level of strength development of the muscles of the torso compared to the muscles of the limbs. Due to the disparity between the work of the lower and upper parts of the body, it is advisable to recommend more exercises for the development of the upper part of the body: throwing, climbing a rope or gymnastic wall bars, crawling, game instruments with combat sport elements, exercises involving partners’ resistance, pulling, pushing, etc. It appears that training capacity in terms of relative strength gains is greater in child athletes than in adolescents. Therefore, specific means of development of strength, which are used in combat sports, can be particularly effective.

The boys aged 10 (Table 6) demonstrate a higher level of the manifestation of explosive muscular strength compared to the 9-year-old boys. A statistically significant difference between adjacent years is observed ($p=.014$). This can partly be explained by the beginning of the sensitive period of development of this ability at the age of 10–11. No statistically significant differences were found between the samples of 9–10-year-old boys based on the results of testing of all other types of manifestation of strength abilities ($p>0.05$). The age-specific characteristics of the boys of these groups do not affect the level of strength endurance and dynamic and static strength.

It is possible that the means of karate have a sufficient positive effect on the level of development of strength abilities, and therefore, 9-year-old children who have some train-

ing experience are little different from 10-year-old children in terms of strength indicators of various types. According to Marchenko and Ishchenko (2016), significant increases in strength indicators in elementary school-aged boys can be observed with rational organization of strength-oriented loads.

Discussion

It was assumed that the study of the age-specific features of the strength fitness of boys aged 7 to 10, who attend a kyokushinkai karate class at the sports and health stage, will allow physical education teachers, instructors and coaches to implement the education and training process in a quality manner, to prepare the musculoskeletal system of children to master the technical elements of karate, and to further promote the maximum realization of individual potential.

Opinions regularly appear in the literature that Fundamental Movement Skills (FMS: running, jumping, dribbling and catching a ball, etc.) are the basis of physical competence (Barnett, Stodden, Cohen et al., 2016; Edwards, Bryant, Keegan et al., 2017; Marchenko & Verdysch, 2021). School students’ FMS demonstrate a strong positive relationship with their level of physical activity (Barnett, Stodden, Cohen et al., 2016; Pullen, Oliver, Lloyd & Knight, 2020). However, the authors note a significant decrease in motor activity, which requires expanding the use of new means of physical education. Kyokushinkai karate has shown itself to be good in this respect.

The WHO (World Health Organization) guiding Global recommendations on physical activity state that young children should participate in activities that support the musculoskeletal tissue and improve movement control at least 3 times a week (Chaput, Willumsen, Bull et al., 2020). Our studies complement the findings of Marchenko & Kozar (2015), Pinto-Escalona, Gobbi, Valenzuela et al. (2021) about the need to involve children as much as possible in mass and sports events in out-of-class and out-of-school activities.

The obtained results match the data of Pochettia, Ponczoszniaka, Filártigaa et al. (2018), Marchenko & Satdyiev (2021), Marchenko & Handymov (2021) that regular strength training exercises can help increase motor activity, improve physical fitness and individual health only when they are part of a general physical education or sports program.

Table 6. Analysis of the specific features of the manifestation of strength abilities in boys aged 9 to 10 years

Investigated indicators	Test for independent samples							
	Levene’s test		t-test for equality of means				95% confidence interval for the difference	
	F	p	t	p	Δx	Δs	Lower	Upper
Push-ups, times	1.034	0.319	-0.549	0.588	-1.569	2.860	-7.447	4.309
Pull-ups and chin-ups, times	0.485	0.492	-0.417	0.680	-0.436	1.045	-2.583	1.712
Flexed-arm hang, s	0.001	0.981	-1.051	0.303	-2.479	2.360	-7.329	2.371
Standing long jump, cm	0.063	0.804	-2.639	0.014	-8.831	3.347	-15.710	-1.952
30 second sit-ups, times	1.060	0.313	-0.239	0.813	-0.354	1.483	-3.402	2.694
Right hand dynamometry, kg	0.569	0.457	-1.846	0.076	-1.944	1.053	-4.107	0.220
Left hand dynamometry, kg	0.002	0.967	-1.266	0.217	-1.462	1.154	-3.834	0.911

Equal variances are assumed

During the investigation of the patterns and regularities of the development of strength abilities, new information was obtained that the differences between 9–10-year-old boys in most indicators are somewhat leveled. The obtained mean values slightly exceed the average indicators proposed in the normative tables (Serhiienko, 2010) and the results we obtained in the previous studies (Khudolii & Marchenko, 2007; Marchenko, 2008; Marchenko & Satdyiev, 2021).

Conclusions

The analysis of scientific and pedagogical literature made it possible to investigate the structure of the motor ability 'strength' and to reveal the need for the development of strength abilities as an important component of motor fitness in kyokushinkai karate at the initial stage of classes for younger grade boys.

The importance of systematic monitoring of strength fitness in children has been revealed and confirmed, as it is one of the main characteristics of health and is considered the basis of an active lifestyle, especially during the period of their active development.

According to the study results, statistically significant age differences are observed between the groups of boys aged 7 to 8, 8 to 9, and 9 to 10 in the results of the tests characterizing different aspects of strength abilities.

Dynamic strength: push-ups – aged 7 and 8 ($p=.0001$); 30 second sit-ups – aged 7 and 8 ($p=.001$), aged 8 and 9 ($p=.046$); pull-ups and chin-ups – aged 7 and 8 ($p=.008$), aged 8 and 9 ($p=.004$).

Strength endurance: flexed-arm hang – aged 7 and 8 ($p=.003$), aged 8 and 9 ($p=.002$).

Static strength: left hand dynamometry – aged 7 and 8 ($p=.023$).

Explosive muscular strength: standing long jump – aged 7 and 8 ($p=.0001$), aged 9 and 10 ($p=.014$).

It was established that the boys have differences in various structural elements that characterize strength indicators. And these differences are in line with the age indicators and technical level of the karatekas.

Conflict of interest

All authors have read and approved the final version of the manuscript and declare no conflict of interest.

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СИЛОВІ ЗДІБНОСТІ: ОЦІНКА ТА ОСОБЛИВОСТІ РОЗВИТКУ ХЛОПЦІВ КАРАТИСТІВ МОЛОДШОГО ШКІЛЬНОГО ВІКУ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 7 с., 6 табл., 48 джерел.

Мета дослідження – визначити вікові особливості прояву відмінностей у силовій підготовленості хлопців молодших класів, які займаються в секції карате на спортивно-оздоровчому етапі.

Матеріали і методи. У дослідженні взяли участь 57 дітей, які пройшли тестування для визначення рівня розвитку силових здібностей. Вони були розподілені на чотири вікові групи: хлопці 7 років (n=14), 8 років (n=15), 9 років (n=15), 10 років (n=13). Діти та їхні батьки були інформовані про всі особливості дослідження і дали згоду на участь в експерименті. Технічний рівень дітей відповідав учнівським ступеням 10-9 Кю (помаранчевий колір поясу). Для вирішення поставлених завдань були використані методи дослідження: вивчення та аналіз науково-методичної літератури, педагогічне спостереження, хронометраж навчальних завдань, тестування силових здібностей педагогічний констатуючий експеримент, методи математичної статистики.

Результати. Статистично достовірні вікові розбіжності спостерігаються між групами хлопців 7-8 років за результатами тестів: згинання і розгинання рук у упорі лежачи (p=0,0001), піднімання в сід за 30с (p=0,001), згинання і розгинання рук у висі (p=0,008), вис на зігнутих руках (p=0,003), динамометрія лівої руки (p=0,023), стрибок у довжину з місця (p=0,0001); 8-9 років: піднімання в сід за 30 с (p=0,046), згинання і розгинання рук у висі (p=0,004), вис на зігнутих руках (p=0,002); 9-10 років: стрибок у довжину з місця (p=0,014).

Висновки. Встановлено, що між хлопцями існують відмінності за різними структурними ланками, що характеризують показники сили. І ці відмінності відповідають віковим показникам і технічному рівню каратистів.

Ключові слова: хлопці, силові здібності, кіокушинкай карате, школярі молодших класів.

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