CONTROL AND EVALUATION OF THE STRENGTH ABILITIES OF PRIMARY SCHOOL AGE KARATE BOYS

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Abstract
The purpose of this research is to provide a qualitative assessment of the development of strength abilities in 7 year old boys using the results of complex control.

Materials and methods. 32 boys of 7 years old took part in the research. The children and their parents were informed about all peculiarities of the research and gave consent to participate in the experiment. The following research methods were applied to solve the tasks: analysis of scientific and methodical literature, pedagogical testing, and mathematical statistics of research results processing.

Results. Pearson's correlation coefficient was calculated to estimate the closeness of interaction between parameters. The Spearman-Brown formula was used to determine the overall reliability (homogeneity) of the test. The test "Sit-ups in 30 s from the supine position" and the test "Throwing of a stuffed ball from a shoulder with a right hand" have the greatest number of numerous statistical interconnections ($r_{xy} = 0.701-0.851$) of high degree of significance ($p<0,001$) with other tests characterizing the structure of power fitness of the studied children. It is noteworthy that the test "Throwing a stuffed ball from a shoulder" is an exercise that involves different muscle groups of the trunk and upper and lower limbs. In its structure, it is similar to the technique of punching, so it is advisable to include it in the battery of tests to measure explosive power in martial arts. The 9-point scales of test evaluations were developed.

Conclusions. The tests we tested considering the specific qualities necessary for karate are logically and empirically informative and reliable. They can be recommended for the control of different relatively independent types of power abilities of 7 year old karate boys.

Keywords: strength training, reliability of tests, informativeness of tests, Kyokushinkai karate, boys.

Introduction
In recent decades, scientists have observed dynamic changes in the physical fitness of children and adults toward deterioration (Granacher, Lesinski, Büsch et al., 2016; Bull, Al-Ansari, Biddle et al., 2020; Driukov & Marchenko, 2021). The results of fitness tests indicate a tendency to decrease strength and physical performance in early childhood (Iermakov et al., 2020; Liqin Yin, Changfa Tang & Xia Tao, 2018; Khudolii, Ivashchenko, Iermakov et al., 2019).

Masanovic, Gardasevic, Marques et al. (2020) analyzed research studies that covered 1,746,023 children and adolescents from 14 countries (China, Finland, Sweden, Belgium, New Zealand, Denmark, Spain, Norway, Mozambique, Poland, the United States, Lithuania, Portugal, Canada) from 1969 to 2010. Most studies show a steady decline in strength and endurance, which is not surprising given the constant changes in the lifestyles of children and adolescents.

The tests used to determine static and dynamic muscle strength in the study by Rutkowski, Sobiech and Chwałczyńska (2019) showed significantly lower results compared with reference values from 16 years ago. Long-term changes in muscle fitness over 10 years have been reported in handgrip strength (-6%), squats (-27%), and bent arm hangs (-26%) in English children aged 10-11 years (Smith, Eather, Morgan et al., 2014).
From a health perspective, this decline is a cause for concern, as many studies have shown an inverse correlation between muscle fitness and obesity, cardiovascular disease, and metabolic risk factors in youth (Piek, Bayman & Barnett, 2016; Biernat, Krzepota & Sadowska, 2018; Gjonbalaj et al., 2022). The authors’ opinions coincide with the need to develop a comprehensive series of tests that are easy to use to assess motor skills (Masanovic, Gardasevic, Marques et al., 2020; Marchenko & Verdysly, 2021; Kruglov & Khudolii, 2022). This will definitely strengthen the data on longitudinal trends in the physical fitness of children and adolescents around the world.

Karate trainings can be a positive alternative to a sedentary lifestyle for children in terms of their leisure time. It is an active and comprehensive form of involving the body in movement (Marchenko, Ivashchenko, Jagiello et al., 2022). They do not require special equipment and can be widely implemented as part of physical education classes in schools and contribute to the development of motor skills and physical abilities (Rutkowski, Sobiech & Chwalczyńska, 2019; Marchenko, Khudolii, Ivashchenko et al., 2023; Marchenko, Ivashchenko, Jagiello et al., 2023).

The issues related to testing the strength abilities of 7 year old boys at the stage of initial training in Kyokushinkai karate need to be studied. Studying the qualitative assessment of the level of strength development, checking the tests for reliability and informativeness, and developing normative tables will make it possible to improve control over the effectiveness of the training process and competitive activity of young athletes.

The purpose of this research was to provide a qualitative assessment of the development of strength abilities in 7 year old boys according to the results of complex control.

Materials and methods

Participants

32 boys of 7 years old took part in the research. The children and their parents were informed about all peculiarities of the research and agreed to participate in the experiment.

Design of the study

The following research methods were used to solve the tasks: analysis of scientific and methodological literature, pedagogical testing, and methods of mathematical statistics for processing research results.

The testing program included well-known tests (Eurofit, 1993; Serhienko, 2015; Goncharenko, 2021). Tests were selected in such a way as to comprehensively characterize the structure of children's strength training.

Dynamic strength:
Test 1 – push-ups;
Test 2 – mixed hanging push-ups;
Test 3 – sit-ups in 30s from the supine position
Power endurance:
Test 4 – bent arm hang.
Static strength:
Test 5 – handgrips of a right hand;
Test 6 – handgrips of a left hand.

Explosive muscle strength:
Test – standing long jump;
Test 8 – Vertical jump;
Test 9 – throwing a stuffed ball (1kg) from a shoulder with a right hand
Test 10 – throwing a stuffed ball (1kg) from a shoulder with a left hand

Statistical analysis

Data were collected and systematized using EXCEL (Microsoft Excel 2016, Microsoft Corp., Redmond, WA, USA). Statistical analysis was performed using the statistical software package IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp. USA. The following parameters were calculated: the arithmetic mean of the value (X), the standard square deviation, which characterizes the variability of the trait (S). The hypothesis of normality of the data distribution was determined using the Kolmogorov-Smirnov test (Dn). To assess the closeness of the interaction between the parameters, Pearson's correlation coefficient (rxy) was calculated. The obtained values of the correlation coefficients were considered according to Hopkins (2002) as trivial (r < 0.1), small (0.1 ≤ r < 0.3), moderate (0.3 ≤ r < 0.5), large (0.5 ≤ r < 0.7), numerous (0.7 ≤ r < 0.9), almost perfect (r ≥ 0.9), and perfect (r = 1). The significance level was set at p < 0.05. The Spearman-Brown formula (rxx) was used to determine the overall reliability (homogeneity) of the test. We used a sigmoidal rating scale to obtain the evaluation standards.

Results

The results of the research are presented in Tables 1-4. The indicators of the studied children presented in table 1 characterize the level of their power abilities. The analysis of average statistical indicators of testing shows that, in general, all indicators of tests correspond to the law of normal distribution by the Kolmogorov-Smirnov criterion. Comparison of the obtained results with the tables "Normative standards."
estimations of physical fitness in primary school age pupils in Ukraine” (Serhiyenko, 2010) and normative tables presented in the curriculum “Kyokushinkai karate” for CYSS (Goncharenko, 2021) indicate that the power fitness of most studied children is at high, above average, and average levels. Many children could not perform the exercise “Hanging push-ups”, so it was decided to use a modified test “Mixed hanging push-ups on a rope”.

For an objective estimation of boys’ power fitness, analysis of the informativeness of tests was conducted. Table 2 presents characteristics of the interrelation of variables of general power fitness of boys aged 7 years in the form of results of Pearson correlation coefficients. The test “Sit-ups in 30 s from the supine position” and the test “Throwing of a stuffed ball from a shoulder with a right hand” have the greatest number of numerous statistical interconnections ($r_{xy} = 0.701-0.851$) of a high degree of significance ($p<0.001$) with other tests characterizing the structure of power fitness of the studied children. It is noteworthy that the test “Throwing a stuffed ball from a shoulder” is an exercise that involves different muscle groups of the trunk and upper and lower limbs. A statistically significant correlation ($p<0.001$) was found with very high correlation coefficients between the results of the test “Throwing a stuffed ball from the shoulder with a right hand” and the results obtained in the following exercises: “Mixed hanging push-ups on a rope”, $r_{xy} = 0.701$, “Bent arm hang”, $r_{xy} = 0.707$, “Sit-ups in 30 s from the supine position”, $r_{xy} = 0.851”, “Handgrips of a right hand”, $r_{xy} = 0.763”, “Throwing a stuffed ball from the shoulder with a left hand”, $r_{xy} = 0.840$. Also “Throwing a stuffed ball from the shoulder with a left hand” with the results in the tests “Sit-ups in 30 s from the supine position”, $r_{xy} = 0.740$.

At a high degree of significance ($p<0.001$) the results in the exercise “Sit-ups in 30 s from the supine position” are very closely interconnected with a large galaxy of tests: “Push-ups”, $r_{xy} = 0.753”, “Bent arm hang”, $r_{xy} = 0.792$, “Standing long jump”, $r_{xy} = 0.725$. The highest correlation coefficient obtained between “Sit-ups in 30 s from the supine position” and “Throwing a stuffed ball from a shoulder with a right hand” emphasizes active participation of muscles of an abdominal press during the performance of a push and consequently during the performance of strikes by hands. Strong abdominal muscles are able to transmit a greater force impulse from the leg push from the support to the arms and allow for greater rotational force during the execution of arm striking techniques.

If you perform this test without technical skills and rely only on the strength of your arm muscles, the result is not always desirable. Therefore, it should be borne in mind that throwing heavy objects from the shoulder is best performed with the simultaneous use of the legs (performed from the “kumite dachi” fighting stance with the legs semi-bent), torso muscles (helping to push the ball during its start), and arms (they do the lion’s share of the work), but without considering the previous two positions, the test’s effectiveness is reduced by 20-30%). It should be noted that the test “Throwing a stuffed ball from a shoulder” is similar in structure to the striking technique, so it is advisable to include it in the battery of tests when measuring high-speed power in martial arts.

Table 2. Correlation dependence between the test tasks

<table>
<thead>
<tr>
<th>No</th>
<th>Indicators</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>$r_{xy}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Push-ups, times</td>
<td>$r_{xy}$</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.973</td>
</tr>
<tr>
<td>2</td>
<td>Mixed hanging push-ups on a rope, times</td>
<td>$r_{xy}$</td>
<td>0.388*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.959</td>
</tr>
<tr>
<td>3</td>
<td>Bent arm hang, s</td>
<td>$r_{xy}$</td>
<td>0.849**</td>
<td>0.517**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.952</td>
</tr>
<tr>
<td>4</td>
<td>Standing long jump, cm</td>
<td>$r_{xy}$</td>
<td>0.461**</td>
<td>0.671**</td>
<td>0.517**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.978</td>
</tr>
<tr>
<td>5</td>
<td>Sit-ups in 30 s from the supine position, times</td>
<td>$r_{xy}$</td>
<td>0.753**</td>
<td>0.618**</td>
<td>0.792**</td>
<td>0.725**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.959</td>
</tr>
<tr>
<td>6</td>
<td>Handgrips of a right hand, kg</td>
<td>$r_{xy}$</td>
<td>0.518**</td>
<td>0.588**</td>
<td>0.617**</td>
<td>0.448*</td>
<td>0.687**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>0.970</td>
</tr>
<tr>
<td>7</td>
<td>Handgrips of a left hand, kg</td>
<td>$r_{xy}$</td>
<td>0.448*</td>
<td>0.547**</td>
<td>0.529**</td>
<td>0.484*</td>
<td>0.657**</td>
<td>0.794**</td>
<td>1</td>
<td></td>
<td></td>
<td>0.876</td>
</tr>
<tr>
<td>8</td>
<td>Vertical jump, cm</td>
<td>$r_{xy}$</td>
<td>0.394*</td>
<td>0.506**</td>
<td>0.489**</td>
<td>0.592**</td>
<td>0.637**</td>
<td>0.499**</td>
<td>0.442*</td>
<td>1</td>
<td></td>
<td>0.897</td>
</tr>
<tr>
<td>9</td>
<td>Throwing a stuffed ball from a shoulder with a right hand, cm</td>
<td>$r_{xy}$</td>
<td>0.676**</td>
<td>0.701**</td>
<td>0.707**</td>
<td>0.627**</td>
<td>0.851**</td>
<td>0.763**</td>
<td>0.663**</td>
<td>0.635**</td>
<td>1</td>
<td>0.996</td>
</tr>
<tr>
<td>10</td>
<td>Throwing a stuffed ball from a shoulder with a right hand, cm</td>
<td>$r_{xy}$</td>
<td>0.553**</td>
<td>0.568**</td>
<td>0.523**</td>
<td>0.526**</td>
<td>0.740**</td>
<td>0.579**</td>
<td>0.642**</td>
<td>0.446*</td>
<td>0.840**</td>
<td>1</td>
</tr>
</tbody>
</table>

*correlation is significant at the level of 0.05 (two-sided); **correlation is significant at the level of 0.01 (two-sided)
Table 3. Sigma limits deviations of a 9-point scale for evaluating test scores

<table>
<thead>
<tr>
<th>Qualitative assessment of motor abilities</th>
<th>Points</th>
<th>Sigma limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of abilities</td>
<td>1</td>
<td>less X – 1.76 S</td>
</tr>
<tr>
<td>Very poor abilities</td>
<td>2</td>
<td>from X – 1.26 S to X – 1.75 S</td>
</tr>
<tr>
<td>Low abilities</td>
<td>3</td>
<td>from X – 0.76 S to X – 1.25 S</td>
</tr>
<tr>
<td>Minor abilities</td>
<td>4</td>
<td>from X – 0.26 S to X – 0.75 S</td>
</tr>
<tr>
<td>Average abilities</td>
<td>5</td>
<td>from X + 0.25 S to X – 0.25 S</td>
</tr>
<tr>
<td>Capable</td>
<td>6</td>
<td>from X + 0.26 S to X + 0.75 S</td>
</tr>
<tr>
<td>Very capable</td>
<td>7</td>
<td>from X + 0.76 S to X + 1.25 S</td>
</tr>
<tr>
<td>Super capable</td>
<td>8</td>
<td>from X + 1.26 S to X + 1.75 S</td>
</tr>
<tr>
<td>Gifted</td>
<td>9</td>
<td>from X + 1.76 S and more</td>
</tr>
</tbody>
</table>

In the process of correlation analysis, a numerous statistical correlation of high significance was found between the tests “Bent arm hang” and “Push-ups”, $r_{xy} = 0.849$ at $p<0.001$ and in “Handgrips of a left and a right hand”; $r_{xy} = 0.794$, $p<0.001$.

The strong interaction of correlation coefficients calculated between the test results with a high degree of significance ($p<0.001$) made it possible to conclude that the tests are equivalent. Their joint use increases the reliability of assessments of the respective strength abilities. In practice, it may be useful to use only one equivalent test, which simplifies testing and only slightly reduces the informational content of the test battery.

The results of the test “Vertical jump” show an order of magnitude lower correlation with the whole range of other tests ($r_{xy} = 0.506$-$0.637$), characterizing different levels of the system of boys’ power fitness at the degree of significance ($0.01<p<0.001$).

After retesting, the reliability coefficient ($r_{xy}$) was calculated using the intraclass correlation coefficient between the two sets of results. This showed that the tests we selected have unequal but sufficient retest reliability ($r_{xy} = 0.786$-$0.996$). Excellent reliability was found in all tests except for “Vertical jump” ($r_{xy} = 0.897$) and “Handgrips of a left hand” ($r_{xy} = 0.786$). This may indicate that such element of power fitness as “speed and power” is probably not fully formed and not sufficiently stable in 7-year-old pupils. “Vertical jump” turned out to be technically difficult for children; its performance requires a sufficiently developed ability to coordinate movements. Handgrip reflects the functional state of the child's muscular and nervous systems and is an integral indicator of training and endurance. However, at the beginning of school, children use the leading hand more actively in their learning activities. Therefore, the results of the test “Handgrips of a left hand” showed lower retest reliability.

The mean square deviation served as the basis for determining confidence intervals according to the rule of three sigmas in the development of evaluation scales and indicative indicators for 9 levels (Table 3). According to Serhienko & Sharyi (2010), a 9-point scale for evaluating test scores is the most informative and differentiates the average results more than a 5-point scale.

**Discussion**

The study assumed that the effectiveness of the training process of 7-year-old karate boys within the framework of physical education classes at school depends on the qualitative assessment of the level of development of strength abilities.

The selection of scientifically based tests, checking their informativeness and reliability can solve the problem of decreasing strength and physical performance in children by obtaining accurate data on the state of their strength training. This will allow optimal planning and organization of the process of strength training.

Knowledge about the necessity of such important characteristics as informativeness and reliability for the

Table 4. Evaluation scale for control of coordination abilities of karate boys aged 7 years old

<table>
<thead>
<tr>
<th>Tests</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push-ups, times</td>
<td>&lt; 4</td>
</tr>
<tr>
<td>Mixed hanging push-ups on a rope, times</td>
<td>&lt; 2</td>
</tr>
<tr>
<td>Bent arm hang, s</td>
<td>&lt; 2.6</td>
</tr>
<tr>
<td>Standing long jump, cm</td>
<td>&lt; 105</td>
</tr>
<tr>
<td>Sit-ups in 30s from the supine position, times</td>
<td>&lt; 7.0</td>
</tr>
<tr>
<td>Handgrips of a right hand, kg</td>
<td>&lt; 6.8</td>
</tr>
<tr>
<td>Handgrips of a left hand, kg</td>
<td>&lt; 6.1</td>
</tr>
<tr>
<td>Vertical jump, cm</td>
<td>&lt; 12.6</td>
</tr>
<tr>
<td>Throwing a stuffed ball from a shoulder with a right hand, cm</td>
<td>&lt; 173</td>
</tr>
<tr>
<td>Throwing a stuffed ball from a shoulder with a left hand, cm</td>
<td>&lt; 113</td>
</tr>
</tbody>
</table>

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correct use of any tests has been confirmed (Anastasi & Urbina, 2007; Serhienko, 2010; Chaabène, Hachana, Franchini et al., 2012). These aspects were considered in the battery of tests. This improves the process of teaching physical exercise techniques, makes it possible to achieve the goal in the shortest possible time, significantly reduces injuries, and increases interest in training in sports (Marchenko & Kovalenko, 2020; Marchenko & Bezpalko, 2020; Marchenko & Satdyiev, 2021).

The results obtained complement the information of Marchenko & Ishchenko (2016), Rutkowski, Sobiech & Chwalczyńska (2019), and Hontarenko, Marchenko & Korol, 2022 about the very low level of results in the “Hanging push-ups” test. Our study identified children who could not perform the exercise; therefore, a modified test “Mixed hanging push-ups on a rope” was used. Knowledge about the importance of strength development and its different types in martial arts, means and methods of its determination, and special and effective development has been studied and supplemented (Chaabène, Tabben, Mkaouer et al., 2015; Liqin Yin, Changfa Tang & Xia Tao, 2018; Marchenko & Satdyiev, 2021).

The results of the study by Gąsior, Pawłowski, Jeleń (2020) demonstrate that in childhood, the handgrips test-retest has acceptable reliability. In this study, we found excellent reliability of the handgrips of a right hand and poor reliability of the handgrips of a left hand, which contradicts the data of the authors. This may be due to the more active use of the leading hand during training. According to Driukov & Marchenko (2021) and Mukhina & Marchenko (2021), this test is sufficiently informative for a comprehensive assessment of children’s prospects during the selection process for training in a karate sports section.

Kyokushinkai karate is a striking martial art that requires highly developed explosive power and speed. We agree with the opinion of Stamenković, Manić, Roklicer et al. (2022) that the use of the “Standing long jump” and “Medicine ball throw” tests are absolutely justified and logical to include in the battery of tests when measuring high-speed power in karate boys.

Conclusions

Based on the analysis of literary sources and experience of our own research, we can state that the choice of control exercises (tests) determines the depth of the studied material and, therefore, its evidence base. Checking and assessing the level of formation of important motor abilities in primary school students is quite complex, but one of the most important areas of activity for scientists and sports teachers. The choice of indicators of complex control depends on the purpose of testing, which determines the criteria for evaluating the relevant test indicators (informativeness, reliability, etc.).

The authors argue that regular strength training can increase physical activity and improve the physical fitness and individual health of schoolchildren. A high level of strength training is the basis for the effective implementation of high physical, technical, and tactical requirements in Kyokushinkai karate.

The tests we have tested, which considering the specific qualities required for karate, are logically and empirically informative and reliable. They can be recommended for controlling the different relatively independent types of strength abilities of 7-year-old karate boys.

Conflict of interest

The authors declare no conflict of interest.

References


КОНТРОЛЬ І ОЦІНКА СИЛОВИХ ЗДІБНОСТЕЙ ХЛОПЦІВ КАРАТИСТІВ МОЛОДШОГО ШКІЛЬНОГО ВІКУ

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

Реферат. Стаття: 7 с., 4 табл., 35 джерел.

Мета дослідження – надати якісну оцінку розвитку силових здібностей хлопців 7 років за результатами комплексного контролю.

Матеріали і методи. У дослідженні взяли участь 32 хлопця 7 років. Діти та їхні батьки були інформовані про всі особливості дослідження і дали згоду на участь в експерименті. Для вирішення поставлених завдань були застосовані такі методи дослідження: аналіз науково-методичної літератури, педагогічне тестування та методи математичної статистики обробки результатів дослідження.

Результати. Для оцінки тісноти взаємозв’язку між параметрами розраховувався коефіцієнт кореляції Пірсона. Для визначення загальної надійності (гомогенності) тесту використовувалась формула Спірмена-Брауна. Тест «Піднімання в сід за 30 c» і тест «Кидок набивного м’яча від плеча правою рукою» мають найбільшу кількість дуже великих статистичних взаємозв’язків (r = 0,701-0,851) високого ступеня значимості (р<0,001) з іншими тестами, які характеризують структуру силової підготовленості досліджуваних дітей. Звертає на себе увагу те, що тест «Кидок набивного м’яча від плеча» являє собою вправу, в якій задіяні різні м’язові групи тулуба, верхні та нижні кінцівки. За своєю структурою він подібний техніці ударів руками, тому його доцільно включати в батарею тестів під час вимірювання вибухової сили в єдиноборствах. Розроблено 9-ти бальні шкали оцінок тестових випробувань.

Висновки. Апробовані нами тести враховують специфічні якості необхідні для карате, є логічно та емпірично інформативними та надійними. Вони можуть бути рекомендованими для контролю різних відносно самостійних видів силових здібностей хлопців каратистів 7 років.

Ключові слова: сила, підготовленість, надійність тестів, інформативність тестів, кіокушинкай карате, хлопці.