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How to Measure Muscular Endurance in Children: A New Approach

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A B S T R A C T

The aim of this study was primarily to determine the reliability and factor validity of four muscular endurance tests, and secondly, to identify gender differences in muscular endurance tests. For this purpose, a new muscular endurance test was constructed for pupils aged between seven and eight (CROCO). The research was done on a sample of 71 pupils aged between seven and eight (35 girls and 36 boys), their body height being 129.2±1.3 cm for boys and 127.1±1.4 cm for girls, body weight 29.3±7.2 kg for boys and 27.1±6.5 for girls. According to the results, all tests have shown a good level of reliability and factor validity. Also, the present study confirmed the expected gender differences ($p \leq 0.05$). In all muscular endurance tests, the boys were slightly better than girls ($p \leq 0.05$). The authors recommend the implementation of the CROCO test and other muscular endurance tests used in this study, both for the implementation in the primary school curricula and in sports because of these tests' satisfactory level of reliability and factor validity. The school curricula need to be adjusted to the age and gender differences of children in order to promote positive health behavior from the earliest age on the one hand, and on the other to be able to objectively measure muscular endurance.

***Key words**: muscular endurance, testing, children*

Introduction

Muscular endurance is currently considered a marker of health and well-being, as well as a predictor of mortality and expectancy of being able to live independently[1–4]. Muscular endurance is the ability to perform strength-oriented action in a repetitive manner in a climate of fatigue[5]. According to Bompa[6], muscular endurance is commonly defined as the capacity of a muscle to exert a force repeatedly over a period of time. It also refers to the ability of the muscle to hold a fixed or static contraction, i.e. it is the ability to apply strength and sustain it. Muscular endurance[7], when defined as the capacity of a muscle to exert a force repeatedly, represents the capacity to perform long-lasting work under a certain load. Apart from the conditions under which the exercises are performed, relevant differences also pertain to the type and number of recruited muscles and muscle groups, whereas the level of load during activities primarily depends upon the principles of chronological age, the rate of biological maturation and the inevitable gender-conditioned differences[8]. Intermediate school age (7–11) is characterized by the slowdown of the pace of growth in favor of changes in the structure of the body and its general strengthening. Muscle innervations in children – the growth of motor nerve endings into muscle fibers' interior and the entwining of muscle fibers' nuclei and blood vessels – is completed around said age. This creates better opportunities for increasing a child's physical activity[7]. Considering the fact that strength shows significant increase only after puberty onwards, it is necessary, while working with children of a younger age, to see to it that developmental exercises are performed by using a maximum of 50% of muscle force, while ranges exceeding the specified value, when performed by children, are done by retaining breath, resulting in a significant increase of intrathoracic pressure, thereby interfering with standard blood flow[9]. Furthermore, overly intense and asymmetrically applied stimuli could cause deviations of individual parts of the skeletal system which did not finish growing, or the tearing of still tender muscle vertexes. According to Faigenbaum et al.[10], valid strength training has a number of positive effects on our muscle strength and local muscle durability, and aside from inducing the increase in bone mineral density, the positive influence of strength exercises on the quality distribu-

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tion of body composition is irrefutable. In children participating in sports or recreational activities, muscular endurance training may also have a preventive effect with regard to potential injuries. In practice, we come across an insufficient number of researches pertaining to strength exercises in children of the aforementioned age. Sharkey[12] recommends strength exercises 3 times per week at the ages of 6–10, each time of up to 15 minutes. Children between the ages of 7 and 8 are unfit for long-lasting and intense muscle strain since they tire-out quickly and become easily disinterested in the continuous performance of movements that have been imposed upon them. The accepted battery of tests which are widespread for measuring muscular endurance of children consists of pull-ups, push-ups, long jumps and vertical jumps[12]. The tests most commonly used in Croatian school practices are pull-ups, bent arm hang or rope climbing. The problem of these most frequently used tests in Croatian school practices (pull-ups, bent arm hang or rope climbing) is their lower value of reliability and validity, and consequently, the issue of whether they can objectively detect the level of pupils' motor abilities. Namely, these tests are, in the opinion of the authors of this text, too difficult for the schoolchildren aged between seven and eight. Hence, the purpose of this research was to determine the reliability and factor validity of a new test (termed CROCO) for the assessment of muscular endurance in children who are between 7 and 8 years of age.

Methods

Subjects

The initial assessment of muscular endurance was carried out at the Petrinja First Elementary School on a sample of pupils aged between seven and eight (35 girls and 36 boys). The measurements were done according to the previously determined protocol and by the measurers from the Zagreb Faculty of Kinesiology, who had been previously acquainted with the ways and methods of assessment. The initial assessment was done to determine the muscular endurance level of pupils being between seven and eight years old. The impact on the development of muscular endurance was done by way of applying the program of a general sport school. Furthermore, the Ethics Committee of the Faculty of Kinesiology, University of Zagreb, approved the study. Also, each subject's parent provided the written informed consent in accordance with the Declaration of Helsinki. The participants were aware that they could withdraw from the study at any time.

Procedure

Sit-ups (ST_UP)

The purpose of this test was to assess the muscular endurance of abdominal muscles. Duration: it is assessed that the testing – per item of execution, including the input of results – should last up to 75 seconds. Instrumental aids: 1 stopwatch, 1 thin mat, registration lists for pupils, a pencil and an eraser. Location: the task is performed either indoors or outdoors on a flat firm surface having the minimal size of 2.5 x 2.5 meters. One mat per subject is placed in a selected location. Course of testing and the starting position of the subject: the subject lies down in a supine position on the mat with the knees bent under a 90-degree angle and the feet aligned with one's hips. The arms are crossed and laid on the chest, whereas the palms are placed on the opposite upper arm at the level of the upper arm attachment of the deltoid muscle. In a kneeling position the assistant surveyor/co-exerciser secures the subject's feet with his/her hands. Performing the task: on the start signal, the subject starts to repeatedly raise his/her trunk from the lying to the sitting position, as fast as possible. Upon each lift-up to the seated position, the subject touches the upper third of his/her shank with his/her elbows pointing forwards, whereas upon each return to the lying position the subject touches the mat with his/her shoulder-blades. End of task: the task ends, either when the time of its duration of one minute runs out or earlier, if the pupil is unable to continue the task. Position of the surveyor: the surveyor stands sideways from the subject. Number of test executions: the task is performed once. Measuring, reading and recording the results: the time is measured from the starting signal and until the expiration of one minute. The test result is the number of properly executed sit-ups. A proper sit-up is determined by the contact between the elbows and shanks in the trunk lift-up, as well as between the shoulder-blades and the ground at the moment of lowering the trunk towards the execution surface. During the performance of this task, a noticeable separation of palms from the upper arms (several centimeters) is considered as an inaccurate attempt and it is consequently not taken into account for the overall number of times the task is executed. The result is recorded in the following manner: e.g. 22 or 39. NOTE: the assistant surveyor/co-exerciser holds the feet of the subject firmly in order to prevent the body from moving, in which case the assistant surveyor/co-exerciser counts each repetition out loud, whereas the lead surveyor controls the accuracy of contact between the upper third of the shanks and the elbows, as well as between the shoulder-blades and the ground, while the principal surveyor monitors the time and decides on the number of accurately performed sit-ups.

Back Extensions (BACK_EX)

The purpose of this test is to assess the back muscles' endurance which is defined as the ability of the back muscles to endure a long-lasting activity in an isotonic contraction regimen. Duration: it is assessed that the testing – per item of execution, including the input of results – is to last up to 75 seconds. Instrumental aids: 1 stopwatch, 1 thin mat, 1 stick, registration lists for pupils, a pencil and an eraser. Location: the task is performed either indoors or outdoors, on a flat firm surface having the minimal size of 2.5×2.5 meters. One mat per subject is placed in a selected location. Course of testing and the starting position of the subject: the subject lies down in a prone position on the box, having a stick behind his/her neck, his/her legs extended. The palms are placed at the back of the head. In a kneeling position, the assistant surveyor/co-exerciser secures the subject's feet with his/her hands. Performing the task: on the start signal, the subject starts to repeatedly raise and lower the trunk, as fast as possible. Upon each lift-up, the subject reaches a horizontal position, whereas each lowering of the trunk is finalized by touching the mat. End of task: the task ends, either when the time of its duration of one minute runs out or earlier, if the pupil is unable to continue the task. Position of the surveyor: the surveyor stands sideways from the subject. Number of test executions: the task is performed once. Measuring, reading and recording the results: the time is measured from the starting signal and until the expiration of one minute. The test result is the number of properly executed back extensions. The proper back extension is considered as correctly executed if the subject touches the mat, whereas the number of returns to a horizontal position is counted as a completely executed back extension. The result is recorded in the following manner: e.g. 20 or 39. NOTE: the assistant surveyor/co-exerciser holds the feet of the subject firmly in order to prevent the body from moving.

In this research, the tests were allowed to be simultaneously performed on a maximum of 2 pupils so as to enable control over the accurate execution of tests – in case of this research, the assistant surveyor/co-exerciser counts each repetition out loud, while the principal surveyor controls the accuracy of contact with the mat and the return into the horizontal position, monitors the time and decides on the number of accurately performed back extensions.

Squats (SQT)

The purpose of this test is to assess the muscular endurance of lower extremities which is defined as the ability of leg muscles to endure a long-lasting activity in an isotonic contraction regimen. Duration: it is assessed that the testing – per item of execution, including the input of results – is to last up to 75 seconds. Instrumental aids: 1 stopwatch, 1 thin mat or 1 wooden plate 2–3 centimeters high, registration lists for pupils, a pencil and an eraser. Location: the task is performed either indoors or outdoors, on a flat firm surface having the minimal size of 2.5x2.5 meters. One mat or wooden plate per subject is placed in a selected location. Course of testing and the starting position of the subject: the subject assumes an upright standing position, his/her feet shoulder-width apart, heels leaning against the edge of the mat or the plate and arms lying relaxed alongside the body. Performing the task: on the start signal, the subject starts to perform the squats repeatedly, as fast as possible. Upon executing each squat, the subject lowers his/her trunk to the level which makes it possible to touch the ground with the fingertips of both hands, thereafter rising to an upright position with the legs fully extended. During each squat the back should be kept straight, the tips of one's fingers should touch the ground, whereas the arms should be relaxed alongside the body. End of task: the task ends, either when the time of its duration of one minute runs out or earlier, if the pupil is unable to continue the task. Position of the surveyor: the surveyor stands sideways from the subject, holding his/her hand level with the subject's forehead in order to prevent the subject from bending his/her back. Number of test executions: the task is performed once. Measuring, reading and recording the results: the time is measured from the starting signal and until the expiration of one minute. The test result is the number of properly executed squats. The number of returns to the starting position is counted. The result is recorded in the following manner: e.g. 19 or 24. NOTE: the assistant surveyor/co-exerciser stands sideways from the subject, holding his/her arm extended about 30 centimeters in front of the subject's face with a view of decreasing significant bending of the subject during squats.

Crocodile (CROCO)

The purpose of this test is to assess the muscular endurance of the upper extremities which is defined as the ability of arm muscles to endure a long-lasting activity in an isotonic strain regimen. Duration: it is assessed that the testing – per item of execution, including the input of results – is to last up to 75 seconds. Instrumental aids: 1 stopwatch, 4 thin mats, registration lists for pupils, a pencil and an eraser. Location: the task is performed either indoors or outdoors on a flat firm surface. The mats are placed in a selected location in a form of an 8 m long pathway. Course of testing and the starting position of the subject: the subject assumes the position in which he/she places his/her hands at the beginning of the mat. Performing the task: on the start signal, the subject starts to move along the 8 m pathway with his/her arms extended, as fast as possible. While moving across the mats, the legs are dragged freely, thus mimicking the movement of a crocodile. End of task: the task ends when the subject crosses the distance of 8 meters. Position of the surveyor: the surveyor moves sideways from the subject. Number of test executions: the task is performed three times. Measuring, reading and recording the results: the time is measured from the starting signal and until the distance of 8 m is covered. The test result is expressed in seconds and tenths of a second, e.g. 10.26 sec. NOTE: Should the subject's arms bend, the task is continued after the subject has again assumed a correct position for a push-up, with extended arms. The principal surveyor monitors the time of task execution.

Statistical analyses

Standard statistical parameters (mean, standard deviation and range) were calculated for each trial of the mentioned agility tests. The Kolmogorov-Smirnov test was used for testing the normality of distribution. The statistical power and effect size were calculated using the

TABLE 1
DESCRIPTIVE AND RELIABILITY STATISTICS FOR MUSCULAR ENDURANCE TESTS

Variable	$\bar{X}$±SD	Range	AVR	ICC	α	CV%
ST_UP	33.13±4.61	23.33	0.793	0.912	0.913	19.1
1 ST_UP	32.45±5.55	29.00				
2 ST_UP	32.95±4.53	23.00				
3 ST_UP	34.02±4.95	27.00				
BACK_EX	42.62±10.44	51.00	0.774	0.904	0.901	24.4
1 BACK_EX	37.28±13.06	62.00				
2 BACK_EX	43.51±10.82	54.00				
3 BACK_EX	46.43±10.84	56.00				
SQT	45.96±6.35	28.00	0.629	0.841	0.848	14.0
1 SQT	42.01±6.39	28.00				
2 SQT	45.94±7.35	31.00				
3 SQT	49.94±7.36	31.00				
CROCO	17.77±7.64	25.06	0.871	0.907	0.950	42.9
1 CROCO	18.85±8.71	28.64				
2 CROCO	17.71±7.66	24.25				
3 CROCO	16.75±8.63	28.88				

AVR – average inter-trial correlation; ICC – interclass correlation coefficient, α – Cronbach's alpha reliability coefficient; CV – coefficient of variation; ST_UP – sit-ups; BACK_EX – back extension; SQT – squats; CROCO – crocodile

GPOWER software[14,15]. The analysis of variance, with repeated measures and the correction for sphericity, were used to detect a possible systematic bias between the trials for each muscular endurance test. The Tukey *post hoc* test was used when appropriate. The average inter-trial correlation coefficient (AVR), interclass correlation coefficient (ICC), and Cronbach's alpha reliability coefficients (α) were used to determine the between-subjects reliability of muscular endurance tests. The within-subject variation for all the tests was determined by calculating the coefficient of variation (CV), as outlined by Hopkins[16]. To determine the factor validity of the new endurance test for children, aged between 7 and 8, the intercorrelation matrix of four muscular endurance tests was factorized using the principle components factor analysis. The number of significant factors was determined by the Kaiser-Guttman criterion[17], which retains the principal components with eigenvalues of 1.0 or greater. The structure matrix was used to determine the factor validity. For the purpose of extracting significant factors, the λ value greater than 1 was considered. Construct validity was identified in the test, showing the highest correlation with the extracted factor[17]. A t-test for independent samples, with Bonferroni correction, was used to determine the differences between boys and girls in all tests. The significance was set at $p \leq 0.05$.

Results

All the variables had normally distributed data. The statistical power for all the tests of muscular endurance was 0.95. The effect size for the correlation coefficient was large (0.50), but it was of medium size for the t-test (range from 0.35 to 0.50) and the *post hoc* Tukey test (range from 0.19 to 0.25). The average values of all the trials recorded during the muscular endurance tests showed a very small unsystematic variation. A relatively small systematic increase in the average values was observed among the ST_UP trials. The *post hoc* Tukey analysis subsequently established the differences between the means for trials 1 and 3 in all the tests. The reliability coefficients (α) of the mentioned muscular endurance tests, carried out three times, were very high and varied between 0.84 and 0.95. Of all the muscular endurance tests, the new CROCO test had the greatest reliability α (α=0.95). The ST_UP and CROCO tests had the greatest AVR and ICC (Table 1). The within-subjects variation ranged between 14.0 and 42.9%. A significant difference ($p<0.05$) was found among the means of all muscular endurance tests. Low to moderate statistically

TABLE 2
INTERCORRELATION MATRIX OF ALL MUSCULAR ENDURANCE TESTS*

	ST_UP	BACK_EX	SQT	CROCO
ST_UP	1			
BACK_EX	0.393**	1		
SQT	0.404**	0.583**	1	
CROCO	–0.175	–0.306**	0.372**	1

* statistical significant p≤0.05; ** statistical significant p≤0.01 level; ST_UP – sit-ups; BACK_EX – back extension; SQT – squats; CROCO – crocodile

TABLE 3
EIGENVALUES (Λ) AND PERCENTAGE OF EXPLAINED VARIANCE FOR ALL PRINCIPAL COMPONENTS (%)

Component	Total (λ)	% of Variance	Cumulative %
1	2.146	53.651	53.651
2	0.832	20.809	74.459
3	0.611	15.266	89.725
4	0.411	10.275	100.000

significant correlation coefficients (Table 2) were found among all the tests measured. It was observed that the greatest correlation coefficients existed between the BACK_EX and the SQT (r=0.583), as well as between the ST_UP and the SQT (r=0.404). The principal components factor analysis of four strength tests resulted in the extraction of one significant component. The first component provided an explanation for 53.65% of the total variance of four tests (Table 3). The correlation coefficients with the first component varied between 0.59 and 0.83. In the t-test, statistically significant differences were determined between the boys and the girls ($p< 0.05$), in all four muscular endurance tests.

TABLE 4
CORRELATION COEFFICIENTS OF ALL MUSCULAR ENDURANCE TESTS WITH THE EXTRACTED PRINCIPAL COMPONENTS, EIGENVALUES (Λ), AND THE PERCENTAGE OF EXPLAINED VARIANCE (Λ %)

	Component
ST_UP	0.663
BACK_EX	0.811
SQT	0.838
CROCO	0.590

ST_UP – sit-ups; BACK_EX – back extension; SQT – squats; CROCO – crocodile

TABLE 5
DIFFERENCES BETWEEN BOYS AND GIRLS[a]

	Boys (N=36)	Girls (N=84)
ST_UP	32.06±5.17‡	31.15±0.23
BACK_EX	38.83±7.55‡	34.73±0.65
SQT	41.90±13.97‡	40.78±0.89
CROCO	19.00±8.33‡	23.99±0.37

[a] Values are expressed as $\overline{X}$±SD; ‡ Statistically significant differences between boys vs. girls at $p<0.05$; ST_UP – sit-ups; BACK_EX – back extension; SQT – squats; CROCO – crocodile

Discussion

The purpose of this article was to determine the reliability and factor validity of four muscular endurance tests for four different regions of a human body, conducted on children aged 7–8. The new CROCO test was constructed to evaluate muscular endurance of the upper body. The results of our study showed that the new test is reliable and valid, and that it can consequently be used in children aged between 7 and 8. The tests for measuring muscular endurance of the upper body which are in use in schools, as well as in sports, are usually push-ups and pull-ups[18]. These tests are more suitable for the adult population than for children, because the results of schoolchildren are usually close to zero, meaning that the subjects have no muscular endurance. This may indicate that these two tests are not suitable for the assessment of upper body muscular endurance in children and adolescents[19]. The current field tests often result in a large percentage of zero scores, especially in children who are overweight[20]. The results of the ST_UP test showed approximately the same values in all trials. This test was well known to the children and the obtained results were to be expected. The CROCO test showed small differences between the trials. The results also showed small inconsistent variations, which confirmed that the test was reliable and suitable for children. In spite of small inconsistent variations, the results improved from trial to trial. The reason for this improvement could be the easy motor performance scheme of this test, which is characterized by simple movements. Additionally, with this test the possibility of a zero score was avoided. A significant difference was found among the means of all muscular endurance tests, because each test represented the strength of different regions. Positive correlation coefficients were observed between the BACK_EX and the SQT, as well as between the ST_UP and the SQT. This was indicative of an interaction between different muscle groups in schoolchildren aged 7 to 8. In this research, all the tests measured showed a proper reliability and factor validity. The criterion-related validity, as well as the reliability of muscular endurance tests in children has not been thoroughly examined, and most of the studies available have been mainly confined to correlation analysis[19]. Correlation measures the strength of association between two variables, but is not necessarily a measure of agreement[21]. Validity studies have reported a correlation coefficient of less then 0.51 for upper body muscular endurance tests (i.e., push ups, bent arm hang and pull ups tests)[20]. The factor analysis of four strength tests resulted in the extraction of one significant component, which confirmed the factor validity of the test. We named this component the general factor of muscular endurance. The CROCO test pointed to the smallest correlation with the general factor of strength endurance. The reason for this could be the performance structure and complexity which is different from the one of the other three muscular endurance tests, in spite of the fact that all the tests measured muscular endurance. The differences between girls and boys were expected, so that the present study confirmed the expected gender differences in muscular endurance[22–26]. The reasons for the obtained differences are to be sought in genetic potential and motor experience of boys and girls, i.e. the differences could be interpreted by the trend and the growth/development level of the morphological structure of children, development of the motor structure and the central nervous system, as well as by the intensity of physical activity undertaken, with the intensity being higher in boys than in girls[27]. Younger girls have a significantly greater amount of subcutaneous fatty tissue than male children[26,27]. According to the obtained results, all the tests showed appropriate reliability and factor validity, which indicates that tests are suitable for children being 7–8 years of age. The new CROCO test is an excellent substitute for the previously used tests, such as pull-ups and push-ups. The differences between female and male children were expected. Physical fitness tests provide important diagnostic information about the health status of an individual; however, their use is often ignored in schools and clinical settings. In many circumstances, schools are the best setting in which children with low fitness levels are to be identified and in which positive health behaviors should be promoted[19]. Hence, the authors recommend the implementation of the CROCO test, both in schools and in sports in future work, bearing in mind that the school curricula need to be adjusted to the age and gender of children, in order to promote positive health behavior from the earliest age.

REFERENCES

1. GALE CR MARTYN CN, COOPER C, SAYER AA, Int J Epidemiol, 36 (2007) 228. DOI: 10.1093/ije/dyl224. — 2. METTER EJ, TALBOT LA, SCHRAGER M, CONWIT R, J Gerontol A Biol Sci Med Sci, 57 (2002) 365. DOI: 10.1093/gerona/57.10.B359. — 3. SAFRIT MJ, Introduction to Measurement in Physical Education and Exercise Science (McGraw Hill, Hightown NJ, 1995). — 4. SEGIUN R, NELSON ME, Am J Prev Med, 25 (2003) 141. — 5. GAMBETTA V, Athletic Development Book: The art and Science of Functional Sports and Conditioning, (Human Kinetics, Champaign IL, 2007). — 6. BOMPA T, Periodization: Theory and methodology of training, (Kendall/Hunt Publishing Company, 1999). — 7. DRABIK J, Children and Sports Training: How Your Future Champions Should Exercise to Be healthy, Fit and Happy, (Stadium Publishing Company, Inc. Island Pond, Vermont, USA, 1995). — 8. MIŠIGOJ-DURAKOVIĆ M, Kinanthropology, Biological Aspects of Physical Exercise, (Faculty of Kinesiology, Zagreb, 2008). — 9. MEDVED R, Sports Medicine, (Medicine press, Zagreb). — 10. FAIGENBAUM AD, MILLIKEN LA, WESTCOTT WL, J Strength Cond Res, 17 (2003) 162. — 11. SAFRIT MJ, Complete Guide to Youth Fitness Testing (Human Kinetics, Champaign IL, 1995). — 12. WELK GJ, MORROW J, FALLS H, Fitnessgram Reference Guide (The Cooper Institute, Dallas TX, 2002). — 13. MILES L, Physical activity and health (British nutrition foundation, High Holborn House, London UK, 2007). — 14. ERDFELDER E, FAUL F, BUCHNER A, Gpower: A general power analysis program (Behav Res Methods Instrum, Comput, 1996). — 15. FAUL F, ERDFELDER E, Gpower: A priori, post-hoc, and compromise power analyses for MS-DOS (Computer Program) (Bonn University Department of Psychology, Bonn, 2004). — 16. HOPKINS WG, Sports Med, 30 (2000) 1. — 17. THOMAS JR, NELSON JK, Research Methods in Physical Activity. (Human Kinetics, Champaign IL, 2001). — 18. MILLIKEN LA, FAIGEBAUM AD, LOUD LL, WESTCOTT WL, Strength Cond Res, 22 (2008) 1339. — 19. CASTRO-PINERO J, GONZALES-MONTESINOS JL, MORA J, KEATING XD, GIRELA-REJON MJ, SJOSTROM M, RUIZ JR, J Strength Cond Res, 23 (2009) 2295. — 20. PATE RR, BURGESS ML, WOODS JA, ROSS JG, BAUMGARTNER T, Res Q Exerc Sport, 64 (1993) 17. — 21. ROTHWELL PM, J Neurol, 247 (2000) 825. — 22. BOVET P, AUGUSTE R, BURDETTE H, Int J Behav Nutr Phys Act, 4 (2007) 24. DOI: 10.1186/1479-5868-4-24. — 23. CASAJUS JA, LEIVA MT, VILLARROYA A, LEGAZ A, MORENO LA, Ann Nutr Metab, 51 (2007) 288. — 24. ORTEGA FB, RUIZ JR, CASTILLO MJ, MORENO LA, GONZALEZ-GROSS M, WARNBERG J, GUTIERREZ A, Rev Exp Cardiol, 58 (2005) 898. — 25. ROUND JM, JONES DA, HONOUR JW, NEVILL AM, Ann Hum Biol, 26 (1999) 49. — 26. UJEVIĆ T, SPORIŠ G, MILANOVIĆ Z, PANTELIĆ S, NELJAK B, Coll Antropol, 37 (2013) 75. — 27. BALA G, JAKŠIĆ D, KATIĆ R, Coll Antropol, 33 (2009) 373.

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KAKO PROCENITI MIŠIĆNU IZDRŽLJIVOST DECE: NOVI PRISTUP

SAŽETAK

Primarni cilj ovog rada bio je da utvrdi pouzdanost i faktorsku validnost četiri testa za procenu mišićne izdržljivosti. Sekundarni cilj bio je da identifikuje eventualne razlike u ovim testovima u odnosu na pol. Za potrebe ovog istraživanja konstruisani su novi testovi za procenu mišićne aktivnosti (CROCO) dece izmedju sedam i osam godina. Istraživanje je sprovedeno na ukupnom uzorku od 71 ispitanika starosti izmedju sedam i osam godina od kojih su 35 bile devojčice (telesna visina: 127,1±1,4 cm, telesna masa: 27,1±6,5 kg) a 36 dečaci (telesna visina: 129,2±1,3 cm, telesna masa: 29,3±7,2 kg). Na osnovu rezultata, svi testovi su pokazali visok nivo pouzdanosti i validnosti. Takodje, ova studija je potvrdila očekivanu polnu razliku (p≤0,05). U testovima mišićne izdržljivosti dečaci su bili za neznatno bolji od devojčica (p≤0,05). Autori preporučuju upotrebu CROCO testova kao i ostalih testova za procenu mišićne izdržljivosti koji su korišćeni u ovoj studiji. Njihova primena je moguća kako u nastavnom planu i program u osnovnim školama tako i u sportu zato što su testovi pokazali visok nivo pouzdanosti i validnosti. Nastvni plan i program ptrebno je prilagoditi na osnovu godina i polne razlike dece u cilju promovisanja pozitivnih zdravstvenih navikaod najranije dobi. Sa druge stren, potrebno je omogućiti objektvnu procenu mišićne izdržljivosti.