HOW SAFE IS THE "FLEXED ARM HANG TEST"?

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Abstract

In terms of school physical education classes in Serbia, motor abilities of the entire school population are evaluated twice per year by the use of Eurofit battery of tests. One of the tests is the „flexed arm hang", that assesses the flexor muscle force in the elbow joint (m. biceps brachii and m. brachialis). The biomechanical analysis of the motor test indicates that 35 cranial muscles of the body take part in its execution, which unnecessarily complicates testing. In order to achieve the maximum muscle force, the subject is strained and the chest pressure is increased. The interrupting tension reduces the pressure in the chest, temporarily reserves blood flows in a large quantity to the heart, which leads to a sudden increase in the medium and the pulse pressure and the physiological phenomenon known as the „Valsalva's phenomenon". The problems become more intensive when subjects, in order to achieve the best result possible, raise their chin up, which is why there is extra pressure on the carotid arteries by the neck muscles, especially m. sternoceleidomastoideus. The consequences are lower systolic and minute volume of blood, the possibility of temporary hypoxia of the brain that can cause a loss of consciousness. Therefore, we propose to replace the „flexed arm hang" test with one simpler, easier and less risky test called „two-handed biceps curl", which engages only the flexors of the elbow joint. To avoid straining when testing, the burden should amount to 50% of the maximum possible muscle force

***Key words**: muscle force, test, load, risk, children*

Introduction

In terms of school physical education classes in Serbia, motor abilities of the entire school population are evaluated twice per year, by the use of Eurofit battery of tests. One of the tests is the „flexed arm hang" test that assesses the flexor muscle force in the elbow joint (m. biceps brachii and m. brachialis). Measurement of flexors' muscle force in the elbow joint requires maximum muscle effort and is performed in isometric conditions. The practical usage of this test indicates that for some subjects, the actual motor task is too difficult, which is why some of them fail even to start the test, and the procedure of testing does not provide the possibility of its relief (Šekeljić, Stamatović, Marković, & Marković, 2013). During testing, some students interrupt the test without any reason (Marković, 2009). In the zone of maximum effort, physical activity leads to hemodynamic, morphological and electrophysiological changes in myocardial tissue. These changes can lead to myocardial ischemia (Wight & Jr Salem, 1995) or trigger the occurrence of cardiac arrhythmias (Firoozi, Sharma, & McKenna, 2003). In the intense competitive activity, the risk can't be avoided, but there should exist recommendations on the review of pre-test and defined criteria and contraindications, in order to avoid the risk of unpleasant situations and even sudden cardiac death (Mazić, Ilić, Đelić, & Aranđelović, 2011; Aranđelović, Pavlović, Mazić, & Aleksandrić, 2004; Harmon, Asif, Klossner, & Drezner, 2011; Maron et al., 1996). Due to high peak values of muscular force, the „flexed arm hang" test is very stressful. In children with the sympathetic predominance of every mental and physical stress, blood pressure amplification occurs (Sorof & Daniels, 2002), and testing can be risky for children with high blood pressure. Elevated blood pressure is not uncommon especially in children with metabolic syndrome, and they are most often undiagnosed (Schwimmer et al., 2014; Lešović, 2010). The incidence of primary hypertension increases with age, obesity and physical activity (Piper et al., 2015; Peco-Antić, 2007; Sorof, Poffenbarger, Franco, Bernard, & Portman, 2002).

The aim of actual research is to make an anatomical-physiological and biomechanical analysis of the motor task in this test and to point out on shortcomings and problems that could be caused by this kind of testing. Additionally, the goal is to recommend an easier and safer method by which flexors' muscle force in the elbow joint will be evaluated.

Methods

Starting from the basic criteria for the classification of scientific research, this paper may be assigned the attributes of experimental and theoretical observation in the area of motor abilities.

The research was conducted on a sample of 371 ten-year-old students of both genders (boys, N=187; girls, N=184). The muscular force of arms was measured in isometric conditions using a standardized Eurofit battery of tests, i.e., „flexed arm hang” test. Task: Subject hangs as long as possible in pull up position. Measurement: The time of 1/10 seconds is measured, while the subject maintains the described position; the stopwatch must be stopped when the chin relaxes under the top edge of the bar. Note: The measurer stands on a chair so that his face is the same height as the crossbar. During the test he encourages subjects to persist as long as possible in the described position. The test is completed when the subject's chin falls back below the bar. The subject returns to the starting position with the help of assistant. Information on subjective problems that subjects experienced during the test are collected by one non-standardized questionnaire, specially formulated for this occasion. Just after the test, each subject was asked whether he felt headache, nausea, dizziness, abdominal or chest pain, which muscle groups were the busiest during the test, and if the test caused him any fear. All data obtained were processed using standard descriptive statistical methods [arithmetic mean (X), standard deviation (SD), minimum and maximum values (Min and Max), the coefficient of variation (CV%)], while the Kolmogorov-Smirnoff test for estimating the normality of distribution is calculated for each variable (Pallant, 2007).

Results and discussion

During the data collection, statistical processing and analysis, some deficiencies were observed at all stages of research work. To make the elaboration easier, the observed weaknesses are systematized in several subheadings under this chapter. We want to show that a large number of muscles is unnecessarily included in testing, since the test estimates only the flexor's muscle force of the elbow joint.

BIOMECHANICAL ANALYSIS OF MOTOR TASK IN THE TEST "FLEXED ARM HANG"

With regard to the manner of reliance and type of muscle strain, the posture in the motor test „flexed arm hang” (active form) on the shaft can be described as:

- Free suspension. This means that there is support with arms above the center of gravity in the body, so that the longitudinal axis of the arms, trunk and legs are approximately on the same vertical. The body position is maintained by the hands that hold the bar below. The rest of the body hangs freely, because the feet do not have any point of support;
- Flexed arm hang. The child, with the help of the examiner, raises itself to the position of the flexed arm hang with his hand in an underhand grip (at shoulder width), and with his chin above the bar. This task requires that the participant holds the initial position as long as possible, and the result is expressed in seconds with an accuracy of 0,1 s (Obradović et al., 2011). This means that a total flexion of the elbow joint with a central oncoming was achieved, so that the chin is slightly above the shaft bar. This position is characterized by a stable type of equilibrium, because the body’s center of gravity is below the suspension point.
- The active form of the suspension involves the isometric contraction muscle in order to prevent the force of gravity, in conjunction with body mass, to undermine the position of pull up in a free suspension.

The muscles involved in the maintaining of motor task in the test "flexed arm hang"

The point of support (posture) are the hands that hold the body in suspension position, so that the legs have no point of support. Because of that, the kinetic chain is closed on the side of the upper extremities. The wrist is an egg-shaped two-axle joint, capable of flexion, extension, adduction, abduction and circumduction. The suspension maintenance engages the isometric contraction of the flexor muscles of the wrist and knuckles :m. flexsor carpi radialis, m. flexsorpollicislongus, m. palmarislongus, m. flexsor digitorum superficialis, m. flexsor digitorum profundus, m. flexsor carpi ulnaris.

The elbow joint is a one-axis joint and, together with wrist, forms a complex combination capable of flexion, extension, pronation and supination. The maintaining of the pull up position is enabled by the isometric contraction of flexor muscles of the elbow joint. The flexor muscles (flexors) in the elbow include the following: m. biceps brachii, m. brachialis, m. brachio radialis, m. pronator tensor, m. flexsor carpi radialis, m. palmaris digitorum superficialis, m. flexsor ulnaris.

In order to neutralize the effect of gravity, which tends to move downward through the hoop shoulder belt (shoulder joints) the head-torso-pelvis-leg system, it is necessary to engage all the muscles of the shoulder belt by an isometric contraction. The following are the flexors muscles (anteflexors) in the shoulder joint: m. deltoideus, pars clavicularis, m. pectoralis major, pars clavicularis, m. coracobrachialis, m. biceps brachii. Extensor muscles in the shoulder joint (retroflexio still extensio) are: m. deltoidesus, pars spinalis, m. latissimus dorsi, m. infraspinatus, m. teres minor. Adductor muscles in the shoulder joint (adductio) are: m. pectoralis major, m. coracobrachialis, m. triceps brachii, caput longum, m. supscapularis, m. teres major, m. latissumusdorsi. Turning in of the shoulder joint (hyperpronatio): m. teres minor, m. infraspinatus, m. deltoideus, pars spinalis, m. teres major, m. subsclavica.

The deterioration of the spinal cord through the shoulder belt ring causes the removal of blades (especially its lower corners) from the spine. This removal of the blades is prevented by the isometric contraction of the muscles which perform the oncoming of the blades toward the spine: m. rhomboideus, m. trapezius - pars transversa, m. latissimusdorsi - pars scapularis.

The deep back muscles connect the spinal cord to the bone pelvic ring, and with the reciprocally measured movements ensure its stability, which is essential for opposition to the force of gravity and the fixation of the trunk to the head. The following muscles are involved in the fixing of the body and the head: m. erector spinae, m. spinalis, m.longissimus, m. iliocostalis, m. splenius, m. transversospinalis, m. interspinalis, m. intertransversarii,,m. rectus capitis posterior minor, m. rectus capitis posterior major, m. oblicus capitis superior, m. oblicus capitis inferior, m. rectus capitis lateralis.

Because of the anatomical position of the pelvis, which is located between the hip joints and lumbar spine, there is a constant tendency of turning forward and down of the front edge of the pelvis. In order to prevent a compensatory movement in the spine which would increase the lumbar curve, it is necessary to engage flexors muscles in the hip joint: m. iliopsoas, m. tensor fascia latae, m. sartorius, m. rectus femoris, m. pectineus, m. adductor longus, m. adductor brevis. In this way, the anterior pelvis part is tied to the anterior chest part and its top edge rotation forward is prevented. The analyses showed that in maintaining the pull up position on the shaft, 35 muscles of arms, shoulders, chest, back and abdominal wall take part. All muscles are involved by the isometric contraction. The wrist and fingers flexors m. flexor carpi radialis, m. flexor pollicis longus, m. palmaris longus, m. flexor digitorum superficialis, m. flexor digitorum profundus, m. flexor carpi ulnaris, suffer a significant burden, which connect the body with the rod shaft. But these are not the muscle groups whose fatigue endanger the pull up position, because after leaving of the pull up position, the subjects can still stay in a free suspension position which engages the wrist flexors muscles. It is easier to remain in a free suspension position than in a pull up suspension position. The uninvolvement of the shoulders and back muscles would cause a deterioration of the spinal cord through the ring shoulder belt. The hip flexor muscles prevent a pelvis rotation in the sagittal plane. However, these are not the muscle groups whose exhaustion would cause the disturbance of the pull up suspension position. These muscle fibers belong to the group of type I fibers or slow-convulsion fibers. They have a plumose distribution of the muscle fibers which allows them to develop greater muscle force at low shortening. They have more myoglobin and a denser capillary network between the fibers than the muscle fibers belonging to type II. They are adapted to a long-lasting work and are more resistant to fatigue. Otherwise, the elbow joint flexor muscles of which the most important are the two-headed upper arm muscle (m. biceps brachii) and upper arm muscle (m. brachialis), have a spindle-shaped structure and belong to the II type fibers, or fast-switch fibers, which have half of the quantity of mitochondria present in the I type fibers. They have a low oxidative activity and therefore become quickly tired (Ilić, 2004). Based on these facts, it can be concluded that the weakest link in the kinetic muscle chain that maintains the pull up position of the shaft are the two most important flexor muscles of the elbow joint. These are m. biceps brachii, and m. brachialis. These two muscles are the muscles whose exhaustion caused the subjects to undermine the pull up position and to keep their body in a free suspension.

This assumption is confirmed by the study that included a sample of 371 students of both gendersand which analyzed the subjective problems participants had during the flexed arm hang test. Specifically, after the motor tasks characteristic for the test, each subject was asked whether he/she felt headache, nausea, dizziness, abdominal or chest pain, if the test caused them fear and which muscle groups were the busiest during the test. Based on the answers (Table 3) it can be concluded that almost all subjects (97%) declared that the elbow flexors muscles are the muscles that hurt the most and it was why they had to stop maintaining of the pull position. Fifteen percent of them reported that they also felt pain in hands and fingers flexor muscles. These were the subjects who accomplished the lowest score (a few seconds), and who claimed that they failed to maintain pull up position longer because of sliding of fingers and palms.

It is interesting that 8% of subjects reported a stomach ache, which confirms our supposition that the maintenance of the suspension pull up position also engaged the abdominal muscles that prevent rotation of the front edge of the pelvis forward. Interestingly, 9% of female subjects felt fear of the test, so that it may affect the motivation and the final result of testing. Almost all subjects (91%) reported hand tremor during the test. This phenomenon was more than evident during the testing, and it could be said that it was present in all patients except those who remained in a pull up position for only a few seconds. Namely, after the fatigue, in order to maintain the position, the subsequent contractions occur before the adequate time for completion of the deployment of the structural fiber. If the spacing between the contraction is so short that it does not allow a complete relaxation, an extended contraction, called tetanus, occurs. In the phase of complete tetanus, when the relaxations are completely eliminated, the force generated is 3 to 4 times higher than the force that can be achieved only by one hitch. This increase in tension is called "treppe phenomenon" or stairs phenomenon because of the appearance on cinematographic record. It is obvious that this type of contraction occurs at the end of the test with increasing of fatigue when the pull up maintenance requires the maximum stress of the elbow joint flexor muscle (Ilić, 2004).

Based on biomechanical analysis of the suspension during the flexed arm hang, it can be concluded that almost all cranial muscles of the body take part in the maintenance of this position. The test estimates the muscle strength of the elbow flexors (m. biceps brachii and m. brachialis). Therefore, one may ask why testing is not performed with a simpler and easier motor task, such as the two-handed biceps cuirl.

INSUFFICIENT DISCRIMINATION OF THE TEST

The results shown in Table 1 reveal wide variations in test results (Min-Max), large dispersion of results and high coefficients of variation (CV).The analysis of the standard deviations (Std) values indicates a greater dispersion of the results than mathematical expectations. The coefficients of variation (CV) of these motor variables range up to 82-87%, leading to the conclusion that the test does not have satisfying discrimination and homogeneity. Namely, high positive values of the skewness in all groups show that the values are close to extremely positive asymmetry. The test is too heavy for a significant number of the subjects, thus dominating in the low values. High value of kurtosis considers a large number of the accumulated results, indicating to bad discrimination of the test not adapted to this age. Once more, it confirms our observations that this kind of test is too heavy for a larger number of subjects of both genders. Significance values of Kolmogorov-Smirnov test show that the frequency distributions in our study don't significantly differ from normal distribution (p=.072, p=.322). Thus, the test results in statistical analysis must be considered with the increased level of risk, while in some cases such data must be even discarded.

Table 1. Central and dispersion values of the test results

Time (s)	Mean	Std. Dev	Std. Error	Min	Max	CV%	Confidence interval		Skew	Kurt	p
Girls	12.1	9.9	1.2	.00	54.7	82.0	9.6	14.6	1.76	4.0	.072
Boys	18.6	16.3	2.2	.00	70.0	87.5	14.1	23.1	1.45	2.05	.322

THIS TEST IS TOO HARD FOR SOME STUDENTS

The descriptive results in Table 2 indicate that some schoolgirls and schoolboys achieved the measuring result of 0 second in the test. For those with test scores of 0 seconds, the test was too hard, so it could not estimate the isometric force of arms and shoulders. Out of 184 girls, 24 of them failed to start the test, representing 12.8% of the sample tested. Out of 187 boys tested, 12 of them failed to start the test which is 6.50%. This data refers to the lack of sensitivity of the instrument, because it could not measure any value in a significant number of the subjects despite the fact they certainly have some values of the muscle force in the arms and shoulders.

Table 2. Review of the data achieved by the subjects in the research. The first row shows the time intervals in seconds (up to 5, 5-10, 10-20, 30-40s etc.). The second and third rows show the number and percentage (%) of girls and boys with the results achieved in the above categories.

Time (s)		0	1-5	6-10	11-20	21-30	31-40	41-50	51-60	61+
Girls	N	24	46	52	46	14	2	1	2	0
	%	12,80	24,60	27,80	24,60	7,50	1,10	0,50	1,10	0,00
Boys	N	12	28	26	54	28	16	12	2	6
	%	6,50	15,20	14,10	29,30	15,20	8,70	6,50	1,10	3,30

Endurance exists as a separate factor in the motor area, but it is difficult to determine it uniquely since it is presented in some other motor abilities (speed, force or power), and together with them builds composite physical properties such as speed endurance, endurance in power and force, lactate endurance, alactate endurance, aerobic stamina, etc.

In this study, it is static strength-endurance. This includes the ability to have force or power to manifest for a longer period of time.

Regarding the intensity zone, 4 zones are usually defined: (1) zone of maximum intensity, (2) zone of submaximal intensity, (3) zone of high intensity, (4) zone of moderate intensity. This means that there are a variety of endurance options depending on intensity and therefore the duration of the activity.

In Table 2 it is obvious that 15.20% of boys and 24.60% of girls were not able to perform this motor task more than 5 seconds. For them, such a task is a load of maximum intensity, and it could be said that in this case alactate component of anaerobic endurance was estimated. Most of the examinees (58.6% of boys and 59.9% of girls) accomplished this motor task during 6-30s. For them, this load was within the limits of sub-maximum intensity when lactic components of anaerobic endurance are significantly involved. For the examinees who were able to keep in high longer than a minute, this load was moderately intense (at least until the end of the test), while performing in predominantly aerobic conditions. It is not difficult to conclude that this test measures the different aspects of endurance on the various types of the examinees, depending on the force they possess.

RISKS THAT CAN APPEAR BY APPLICATION OF THE TEST

The flexed arm hang test is the test of the maximum load, because the motor task in the test is done to the end. For those that can perform this test only a few seconds or cannot start at all, this is the test of the maximum load from the beginning. For those who can do it for a long time, at first it is the test of moderate or sub-maximum load, and in the last few seconds it becomes a test of the maximum load. The maximum possible muscle force can be realized only with straining. Straining at maximum strain is achieved by voluntarily closed airways. This increases the effect of muscle that attaches to the bones of the chest. The straining causes an increase in the lungs pressure and irritation of the lungs mechanoreceptors that reflexively alter the functional state of the skeletal muscle, called pneumo muscular reflex. The maximum static stress of large muscle groups causes a large increase in intrathoracic pressure (10.7 to 26.7 kPa), which is transmitted to the vein and because of that the arteries are partially or completely closed, and systolic blood pressure may exceed 40 kPa, and the diastolic 27kPa, which is more than double compared to the rest (15/10kPa) [14]. The big contribution is the accumulation of products of metabolism in the body and mental effort that accompanies higher stress. Increased pressure in the lungs causes a narrowing of the pulmonary capillaries causing "Valsalva phenomenon". The increasing of the pressure in the lungs narrows the volume of pulmonary capillaries, which makes blood flow through the lungs and the heart has to work with greater tension. On the other hand, the pressure in the vena cava makes it difficult for the inflow of blood into the right ventricle, resulting in in the reduction of the inflow of the venous and pulse pressure. The problems can also be caused by pressing the carotid artery by the neck muscles (especially m. Sternocleidomastoidedus). This is particularly characteristic for the pull up position when the subjects, in order to achieve better results on the test, raise their chin and head up, and so enhance the effect of pressure on the carotid artery. The consequences of this situation are lower systolic and minute volume of blood, which causes a reduction of the blood oxygen saturation, increasing the possibility of temporary hypoxia of the brain, which can cause the loss of consciousness. The interruption of the straining reduces the pressure in the chest, a large quality of the temporarily retained blood flows into the heart causing a rapid heart volume increase (because the heart is a hollow, elastic muscular organ) and rapid increase of the medium and pulse pressure. This phenomenon can cause a number of serious cardiovascular problems. The maintaining of the suspense pull up position on the shaft is more difficult for several reasons:

- In this position the arm muscles are involved, and systolic and diastolic blood pressure is about two times higher in muscular work of hands in relation to the same intensity of muscular work of the legs (Nikolić, 2003).

- Small changes of intensity in the static load cause significantly higher heart rate than in the case of similar changes in the dynamic loads. This happens because of a greater influence of the sympathetic, higher level of mental effort and larger quantity of acid products (Ilić, 2004). This means that the need for an increase in heart rate occurs in unfavorable conditions when the heart is under extreme pressure due to the "Valsalva phenomenon".

- The subjects are able to maintain the pull up position for different times depending on the power they have. Some are able to maintain this position for only a few seconds, while others can maintain the position for several minutes. The adaptation of the organism in the area of submaximal stress is achieved by adjusting of the neuro-humoral functions. On the other hand, the adaptation that occurs in the zone of the maximum stress, where the functional heart and blood vessels limits are reached, the impact of neuro-humoral and other regulatory mechanisms is not important, whereas of more importance are the morphological and functional heart and blood vessels potentials (Mijić, Živanović, & Životić-Vanović, 2002).

The described changes that occur in the dynamics of the cardiovascular and respiratory systems with maximum static stresses are very distinct and equally dangerous for children and for adults who are not used to the maximum load. If the blood vessels are damaged by atherosclerotic and other changes, because of increased brittleness of the vessel wall, the rapid increase of the intravascular pressure can cause splashing of blood vessels

(Nikolić, 2003). Normally this does not occur because, with the pressure increase in the blood vessels, the pressure in the intratissue fluid increases, so that the capillaries and venules may, due to the effect of Laplace's law, bear greater pressure than usual without splashing. However, due to the risk that always exists, these loads are not advised to older persons, persons who suffer from cardiovascular diseases and untrained persons (Ilić, 2004). The fact that third grade children are subjected to such load included in the hanging pull up test twice a year is a cause for concern. Therefore, it is not inappropriate to question the security of this test.

The literature does not cite examples of those who lost consciousness or had cardiorespiratory problems during the testing. This, however, does not indicate that there were no such problems. It might be possible that no attention was paid to these problems or that they were not registered in the works. However, some papers (Marković, 2002) stated that a number of subjects stopped the testing for no reason, without any explanation. The author explains this paradox by a motivation factor, which is considered essential to determine the length of the performance of motor tasks in this test. It is possible that a number of subjects terminate the test at the moment when it becomes difficult because of low motivation. It is possible that some subjects have objective difficulties which are due to cardiovascular problems and vertigo. During our research on a sample of 371 students of both genders no significant incident is determined. However, the test caused in some subjects a headache (2.2%), unconsciousness (1.5%), and the 9% of the respondents felt fear before or during the test (Table 3). Therefore, we believe that this issue requires a complex research in the laboratory and a complete scientific answer.

Table 3. Problems caused by the test

Pain or one other problem	Elbow flexors	Wrist flexors	Shoulders	Stomach	Headache	Unconsciousness	Fear	Hands and shoulders trembling
Number of subjects	360	56	8	30	8	6	33	338
%	97%	15%	2,2%	8%	2,2%	1.5%	9%	91%

RECOMMENDATION FOR NEW TESTING METHOD

The previous analyses have shown that the test „flexed arm hang" that is used to estimate muscle force of the elbow joint flexors muscles needlessly engaged 35 cranial body muscles. Therefore, we question the necessity for applying this difficult, risky test which unnecessarily engages few dozen muscles when it can be replaced with a safer, easier and more reliable test, with better metric properties which engage only those muscles whose forces interest us.

The current test can be replaced with the "two-handed biceps curl" test with a rod or on trainer. The testing occurs in a sitting position on the bench, with the upper arm leaning on inclined plane. The bar with weights is held from below on shoulder-width level, and the angle between the upper arm and the forearm should be 90°. The subject must try to maintain the position as long as possible. The measurement starts when, with the help of two persons, the rod is put down into the hands of the subject, and he/she takes full control of the load. The measuring is interrupted when the muscle fatigue disrupts the angle of the elbow joint of 90°. The sitting position on the bench allows the fold static strength-endurance and engages only the elbow and wrist flexors. If the two-handed curl with rod is, for example, performed in standing position, the maintenance of the position would also involve the anterior deltoid muscle. The holding of the rod with weights from below on the level of shoulders requires a forced engagement of interior part (short head) and exterior part (long head) of two-headed upper arm muscle. If, for example, a wider grip is used, a short head is more engaged, and in case of narrow grip, the large head muscles are more engaged. This position allows an optimally equal engaging of both heads of m.biceps brachii. The incline of the trainer enables the load of lower segments of two-headed upper arm muscle. If the back of the trainer is flat and horizontal, the medium segment of the upper arm muscles is more engaged. The angle between the upper arm and forearm should be 90^0 in order to load the medium segment of two-headed upper arm muscles (Evans, 2010).

This method of testing:

- Requires the engagement of the elbow joint flexors, whose muscle strength is tested;
- The load can be precisely dosed; this was not possible in the previous test;
- The test results would be expressed in Newtons (N) and the Newton seconds (Ns) which is in line with international system of measurement units;
- The possibility of loading dose enables the measuring of the muscular force values of each subject, regardless of its strength;

Helps avoid unnecessary maximum body stress in isometric conditions.

Conclusion

This paper analyzes the flexed arm hang test from biomechanical standpoint. The flexed arm hang test is an integral part of Eurofit test battery. It assesses the muscular force of arms and shoulders. The analysis of the motor test indicates that 35 cranial body muscles take part in its execution. In order to maintain the position, the greatest burden is submitted by the upper arm flexors muscles (m. biceps brachii and m. barachialis) and the duration of the test depends on the available power of these two muscles. This test requires maximum muscle strain and the power of subjects that to a greater or lesser extent, causes "Valsalva phenomenon". We think that this test has certain risks for the health of people with respiratory and cardiovascular problems, and sedentary people with a weaker muscle force. We consider that this test should be modified or replaced by a more suitable and less dangerous test such as the „two-handed biceps curl" for this purpose.

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KOLIKO JE SIGURAN TEST „IZDRŽAJ U ZGIBU"?

Sažetak

U okvirima tjelesnog odgoja, u školama se svake godine dva puta godišnje vrši procjena motoričkih sposobnosti cjelokupne školske populacije putem Eurofit baterije testova. Jedan od testova jeste „Izdržaj u zgibu" kojim se procjenjuje mišićna sila pregibača u lakatnom zglobu (m. biceps brachii i m. brachialis). Biomehanička analiza ukazuje da u izvršenju motoričkog zadatka sudjeluje 35 mišića kranijalnog djela tjela, što nepotrebno otežava testiranje. Test zahteva maksimalna mišićna naprezanja, uslijed čega dolazi do napinjanja i povećanja pritiska u prsnom košu. Prekidanjem napinjanja smanjuje se pritisak u prsima, privremeno zadržana krv u većoj količini pritiče u srce, što dovodi do naglog povećanja srednjeg i pulsnog pritiska i fiziološke pojave poznate pod nazivom „fenomen Valsalve". Problemi postaju izraženiji kada ispitanici, u želji da postignu što bolji rezultat, podižu bradu na gore, uslijed čega mišići vrata, naročito m. sternoceleidomastoidedus, dodatno pritiskaju karotidne arterije. Ovo izaziva niži sistolni i minutni volumen krvi i mogućnost privremene hipoksije mozga, što može dovesti do gubitka svjesti. Smatramo da test „Izdržaj u zgibu" treba zamjeniti jednostavnijim i lakšim testom „Izdržaj u dvoručnom lakatnom pregibu", koji angažira samo pregibače u zglobu lakta. Da bi se izbjeglo napinjanje pri testiranju, opterećenje treba iznositi 50% od maksimalno moguće mišićne sile.

Ključne riječi: *sila mišića, test, opterećenje, rizik, djeca*

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