RELATIONSHIP OF TRAINING ABDOMINAL MUSCLE WITH FORCE DEVELOPMENT IN THROWING DISCIPLINES

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Original scientific paper

Abstract
The most common way of development of the mobility abilities is the directed physical training with the exact dosage of the load components. Depending on their relationship depends which aspect of the mobility ability we develop. This is most manifested in the space of the strength and endurance which are very often overlapped and where smaller changes of the load intensity say about the change of subspace which is treated with the directed physical training, for example, if it is about the strength endurance development or about speed endurance development where the space of the strength and endurance, speed and endurance is encompassed and the differences are the consequence dosed load. This aspect of endurance is very up -to-date athlete throwing disciplines and it can give the information about the state of certain region of body, especially if it is about the strength development by applying different types of practices on the basis of the starting position.

Key words: *strength, abdomen, muscle endurance, training*

Introduction

Mobility functioning of the human being is the most complex system which puts him rightfully in the order of natural perfection. Depending on the mobility manifestation which human demonstrates depends the structure of its mobility abilities. That means that if certain mobility forms of movement are very often demonstrated, their whole status in the space of the anthropomobility space will depend. Sometimes those are manifestations of the direct type when by certain directed physical training is acted in the direction of transformation of some abilities, and sometimes they are indirect type when by some other activity is acted on the transformation of morphological, mobility and functional abilities (Wilmore & Costill, 1994; Goodway et all. 2003; Okely et all. 2001). For example doing some sport as recreation we indirectly develop anthropomobility abilities, all aspects of strength, different types of speed, coordination, endurance etc., also training and developing one ability in the scope of one discipline we affect directly on the development of that ability which is predominant in the given discipline. As an example there can be cited athlete sprint disciplines where the mobility ability speed is predominant or jumping disciplines where is great domination of the explosive strength and the body mass of the thrower (Pavlović, 2010). In these situations we can through directed training process, by practicing the concrete discipline, directly influence on the development of some segments of mobility space, speed, strength, endurance, coordination etc. Also there is reverse possibility, that is by improving of some mobility ability we influence on the utmost result in some discipline. These are just some of the examples in sport where the interaction of anthropomobility functioning is represented.

If we observe mans locomobilty apparatus we are known that it is consisited of several segments which are further divided on segments of cranial part and segments of caudally part, and as center is taken the center of gravity of body (TT). Those two regions of the body of the locomobilty apparatus are connected with sinergy performing of muscle kinetic chains of open or closed type. That above all depends from the type of training which is conducted. (Opavsky, 1971; Karović, 1980; Rakovac & Heimar, 2003). Very often is the case in physical training is unequal relationship of muscle strength in manifestation of open and closed type. So for example, if it is conducted the practice which encompasses the action of the closed muscle chain, the strength of the muscle is smaller in relation to the movement in open muscle chain because in open muscle chain we have agonistic and synergistic action which help doing the basic movement, which is not the case in closed type when the movement is conducted from spot to spot of the muscle agonist which does the basic movement (Verhošansky, 1979; Mero et all. 1992; Perić, 1997). Having in mind the complexity and interaction of muscle action while performing the complex structure of movement as throwing disciplines the problem is defined which studies the muscle interdependance of different segments of body with accent on muscle endurance (strength endurance) of abdomen by applying two basic types of trainings. It is important to mention that in training with large load the muscles of abdomen wall deserve special attention. The first reason for that is the fact that these muscles stabilize the torso and take part in walking as in many other movements. Secondly, well developed muscles of abdomen wall help to maintain regular function of internal organs of abdomen.

In the end, the corresponding strength of that muscle group is the best protection against abdomen hernia (protrusion of internal organs or parts of organs through abdomen wall). Hernia can develop if the intra-abdominal pressure is increased which develops when lifting load. If the extensor of spine are strong, and abdomen muscles relatively weak with high intra-abdominal pressure, hernia develops. Practices for abdomen muscles wall are divided into two groups: a) lifting the torso while fixed lower extremity and b) lifting legs while torso is fixed. This is interesting for the reason that muscle endurance is relatively independent ability which most often considered in the scope of endurance. However, the muscle endurance is also performing and improving in activities which are identical to those in where is performed and improved the strength, and the only difference is in dosage of the intensity and scope where for the muscle endurance is load ¼ from maximum (Malacko & Rađo, 2004; Stojiljković et all. 2005). The goal of the research is to determine which type of the training is more efficient and gives better results in view of muscle endurance, as well as achieved level of statistical significant changes.

Methods

The sample of examined

The sample on which is conducted the research encompassed 60 examined students, III year of study of Faculty for Physical Education and Sport who regularly attended and performed practical curriculum from athletics on subject. The development of strength in throwing disciplines~. The measurement of defined variables is conducted in march in 2011.

The sample of variables

Lying positions are often used in physical training, because the practices for the strong rotating moment of gravitational force, are very efficient. By applying practices, from lying position flexor muscles in joints of hips and abdomen muscles are getting stronger, extensor muscles of the knee as well as flexor muscles in joints of spinal column and in the back of the head joint. The intensity of the practices for strengthening is the highest in the beginning, in the first phase of performing, for the maximum rotation moment of gravitational force and in the end of the second phase of performing for maximum static tightening of antagonist muscles and corresponding passive stabilisators of joints (Jarić, 1997; Jovović, 2003). It is necessary to emphasize that the separation of the legs from the ground begins a moment later, because of the equalizing balancing position, in relation to the vertical from center of the gravity of body. For testing of the strength and body endurance of abdomen two variables are applied which are good and most common represents in these kind of researches: 1. Lifting torso while fixed lower extremities, so called sit ups *(MDTK),* 2. Lifting legs while fixed upper extremities *(MDNOG).* For getting necessary information central statistics with all relevant parameters is applied.

For determining the differences by applying different types of practices Student T –test is applied for large depending samples. For the clearer analysis of the results obtained values are presented by graphical solutions especially when it is about function distribution.

Results

Table 1. Descriptive statistics variables MDTK

	Mean	Min	Max	Range	Std.D.	Skew.	Kurt.
MDTK	82	32	300	268	41.88	3.09	14.28

Table 2. Descriptive statistics variables MDNOG

	Mean	Min	Max	Range	Std.Dev.	Skew.	Kurt.
MDNOG	38	15	115	100	19.15	1.84	4.73

Table 3. Correlation matrix variables MDTK-MDNOG

	MDTK	MDNOG
MDTK	1.00	
MDNOG	.87	1.00

Correlation matrix (Table 3) showed high degree of connections of measured variables from .87 which is significant if it is taken into account the engagement mutual muscle kinetic chaines which directly take part in doing the mobility task.

Table 4. T-test for Dependent Samples , p < .050

	Mean	Std.Dv.	t	Df	P
MDTK	83	41.88			
MNOG	38	19.15	11.66	49	.000

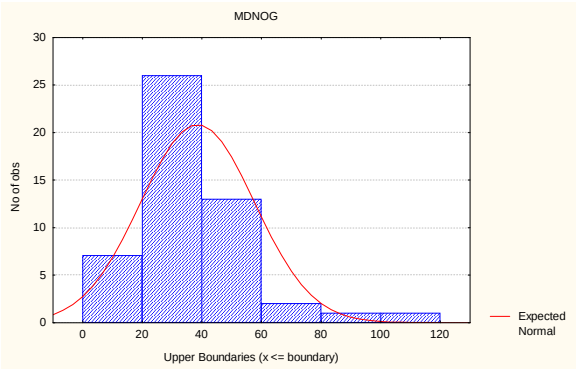


Figure 1. Distribution of MDNOG

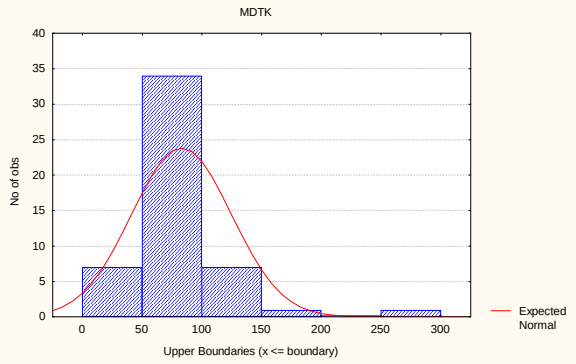
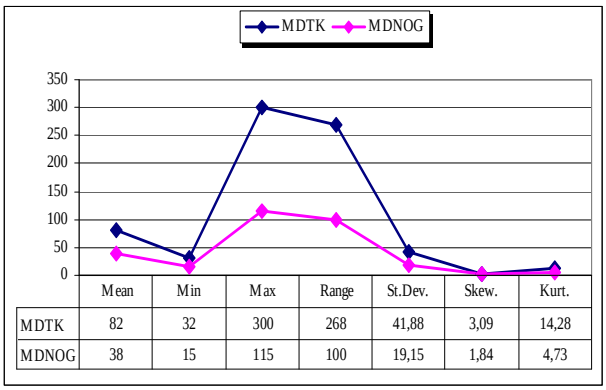


Figure 2. Distribution of MDTK



	Mean	Min	Max	Range	St.Dev.	Skew.	Kurt.
MDTK	82	32	300	268	41,88	3,09	14,28
MDNOG	38	15	115	100	19,15	1,84	4,73

Figure 3. Comparative analysis of the values of variables MDTK – MDNOG

Discussion

By inspection of the results it is obtained one general insight into heterogeneity of the research sample in view abdomen muscle strength-muscle endurance. In Table 1. Are presented the results of the variable lifting the torso while fixed lower extremities (MDTK) stating large span of results. That span confirmed the value of dispersion parameters of skew. (3,09) and especially kurtosis (14,28) which justifies the statement that it is about non homogenous sample when it is about the abdomen strength of the examined student. To those heterogeneity of the result contributed the fact that one number of the examined students (2 or 3) had extremely high values of the test (Max.=300) which contributed to the whole result oscillation of the results in view of lengthening (kurt.14,28) although it is about students of the same year of studies. In chart 2 there are presented the results of variable lifting legs while fixed upper extremities (MDNOG) where situation is somewhat different. The values of parameters of central statistics are of significantly lower values when it is about measures of central tendency and dispersion measures, though also here we have the case of extreme higher values (Max.=115) which are the consequence of measurement two or three subjects with high result efficiency which generally changed the picture the whole defined sample. That is also evident on the basis of values Std. Dev. For both examined variables. The whole correlation is extremely high and it belongs to the zone of the high connection from (.87) and high difference of T-test with significant statistical importance ($p<0.50$). Although whether we accept or neglect these results there is one to be seen, and that is a large difference in view of performing MDTK practice and MDNOG practice and their difficulty. It is about two topologically different body regions and muscle groups that take part in realisation of movement. The question can be asked which factors contributed to this kind of difference? As first that can be named is the action of muscle chains and types of muscles which took part in realisation of movement. We already mentioned that is very important type of muscle kinetic chains, that is is it about open or closed muscle action, because with that we have smaller or larger number of engaged muscles and muscle groups.

It is especially important if it is about engagement of large muscle groups which are also the strongest in the human organism, and that are those muscles and muscle groups which enable the maintenance of stato musculature and vertical position of human (extensors and flexors of spinal column, extensors and flexors of legs and hands, large pectoral muscles). Namely, it is known fact that these muscles contain up to 400 mobility units which are inerved with the same number of mobility neurons which enable strong movements and contract by the principle all or nothing (Mitrović, 2003; Stojiljković, 2003; Malacko & Rađo, 2004; Stojanović, et all. 2006; Pavlović, 2010). Next what is important is the question which kind of muscle is about, are those the pinnate, spindle-shaped, fanlike or square. By its physiology cross section, pinnate, fanlike and square are extremely string thanks to direction of stretching and joint of muscle fibers and results of their actions, in difference from spindle-shaped which does not have strong traction but they are faster and they are situated most commonly in place where the fast movements of extremities occur (Albert, 1995; Jovović, 2003). Anatomy observed human organism divides in two parts caudal and cranial, that is from foot to pelvis and from pelvis to head. Analysing in more detail larger number of stronger muscles by its physiological cross section are placed in upper regions of the body, not taking into consideration extremities and those are mainly pinnate, square and fanlike, so that both direction and action of their movements is more synchronised, which largely depends also from flexibility of their antagonists (Stojiljković i sar. 2005; Enoka, 2002). Also the fact that can explain this difference in muscle endurance is starting position of examined student. In most cases examined students for the development of abdomen strength mean practice of lifting the torso while fixed lower extremities, and significantly rare reverse. That is because this way is partly easier for them, wanting to develop the strength of straight and lean abdomen muscles, often neglecting the strength of the muscle flexor hip joint, which in cooperation with abdomen muscles form kinetic chain and performed the lifting of lower extremities (Verhošanskiy, 1979; Hettinger, 1983). Also what is necessary to know training and way of practising for abdomen musculature is the following. The first manner, *bend of torso*-so called sit ups, are the main practice for real abdomen muscle. Those practises should be performed with bend legs because in that position the load on spin is lower and the work of abdomen wall muscle is larger. That happens because side-thigh muscles, which shorten, do not participate in creation of rotation force. During performing of flexion of torso with stretched legs, maximum force is created by side-thigh musles, while pressure on inter vertebra discs is very high, closely responds to pressure when we bend from vertical position with 20 kg load (Albert, 1995; Mitrović, 2003; Mikić, 2004). Also what should be known is that flexion of torso has its shortages. First 30-45º bends depend from abdomen muscles, and from hip bender last 45º.

Hip flexors are practice through short bow, so their adaptive shortening can be instigated and according to that hyperlordosis (Whiting et all. 1998). Persons that complain on pain in lower part of the back can perform only the first part of the practice, that is they can only mildly lift shoulder belt. If half belts are performed knees are bent under an obtuse angle 140º-150° degrees, and one who practices lifts torso from the floor under angle 30º (Zaciorsky & Kraemer, 2009). In the second manner *lifting legs* while torsi is fixed, legs are lifted from lying position with hip bender (side-thigh muscle, real thigh muscle and others). Real abdomen muscle, is fastened with its lower end for groin symphysis, relatively is inactive. It fixes pelvis and increases intra-abdomen pressure, and it begins to shorten only if legs are raised high enough. In that position, however, the force of gravity which attracts legs down is significantly stronger. Regarding that starting pressure on discs is pretty high, and the activity of three abdomen wall muscle insignificant, only practice is not specially significant and it in training of abdomen muscles must in no way be the only one. It is much more effective the lifting of legs from hanging position (gravity affects most strongest on legs, only real abdomen muscles are contracted), but that can perform only trained persons, so this result can be justified in sample of our examined student. The next reason that can justify this result is of biomechanical nature. We are known that the relationship of branch of the force of the muscle and the branch of the load force changes during movement and most negatively is in the moment when body or part of the body which is in movement is in horizontal position. If the angle in the joint of elbow is 90°, and forearm in horizontal position, the moment arm of the load force is about 10 times larger from the branch of biceps force, which means in order to move forearm up m. Biceps must produce 10 times greater force from the load force (Jarić & Kukolj, 1996). This biomechanical principle can be applied in our manner of tests performing and their results. Moreover, the greater producing of muscle force in case of lifting lower extremities because we have phenomenon that in examined students usually lower extremities are longer in relation to the upper part of the body as soon is increased action of the load force branch-weight of extremity, with the action of gravity force (Opavsky, 1971). Very important role in performing of these movements has the action of radial R-pressure and tangent T-movement component and their relationship which is the greatest in the moment of the starting of momentum, so this reason can be taken as leading. In view of muscle action it is known fact that fixed spot in joint decomposed the action of muscle on components, where one is directed radially, that is it will act toward the center of the joint as pressure –R radial component of pressure, and the other will act tangent-T, it is vertical on radial component and it will act in the direction of movement. Although the result of muscle activity is always the same, the size of components is different. Size of components of muscle action depends on size of result and size of falling angle (α), and that is the angle which is closed by the result of muscle action with the line that connects the center of moving joint with the center of rotation-radial component. With increasing of angle α, to the size of real angle, the component of movement is also increasing, and lowering the component of pressure (R). With optimum size that is angle 90°, the component of movement is equal to the result of muscle movement, that is reaching its highest value, and the component of pressure is equal to zero (Jarić, 1997; Jovović, 2003; Mikić2 2004). If the falling angle is equal to zero, R-component would be maximum, and T-component would be equal to zero. Then the muscle force couldnt perform the movement, although there is no such cases in humans, he is never equal to zerobecause the muscle does not joint in the region of side axis of levers, but the joints are moved away on nono joint bulges-thorns, bumpes, small bumpes, as well as the muscle result is in distance from the center of rotating with joint bulges. So if the line of muscle force and joint aixs are in the same level, or during the contraction they cover each other, muscle can not perform the movement, it becomes only the tenzor of the joint. According to this principle we have also the behavior of components of muscle action in joint of hip during lifting different parts of body. Especially it will be pointed out in longer levels, where is expressed the action of gravity what increases the whole load which in our case presents kaudal extremities, so this fact can also be one of the reasons of different muscle endurance on different types of oractice.

Conclusion

The results of research obtained by data processing of our sample confirmed some earlier researches (Karović, 1980; Enoka, 2002; Kellis et all.1995; Petrović, 2006) which treated the problem of muscle endurance and connection of different topology regions, above all cranial and caudal extremities. The differences about muscle endurance are obtained whiche are reflected in number of repeating of certain movement-defined in the variables sample, and say in favor of the fact that the action of open kinetic action of musculature is much stronger if it is about shorter lever that is about much smaller gravity force action on peripheral spots in relation on basic center, center of the gravity of body, as well as about length of muscle joints on bones.

This state confirms the claims that on larger length of lever weakens the speed of muscle action when muscle is becoming tired. Also the differences in regard of performing the different types of practices contribute differences in regard of synchron synergy action of muscle chains, size and position of muscle groups, types of muscles engaged as well as relationship of muscle force and load force in the moment of performing the movement. Also on the whole result there is the influence of starting position of one who practices, that is if he is during performing the practice fixed torso or legs.

Literature

Albert, M. (1995). *Eccentric muscle training in sports and orthopaedics*. New York: Churcill Livingstone.

Enoka, R.M. (2002). *Neuromechanics of human movement*. Champaign, IL:Human Kinetics.

Goodway, D.J., Crowe, H., & Ward, P. (2003). Effects of motor skill instruction on fundamental motor skill development. *Adapted Physical Activity Quarterly*, *20*(3), 298-314.

Jovović, V. (2003). *Sports biomechanics locomotion*. Podgorica: Faculty of Philosophy Department of PE.

Jarić, S., & Kukolj, M. (1996). Force (strength) and the strength of the movements of man. *Physical Education* (1-2), 15-28.

Kellis, E., & Baltzopoluos, V. (1995). Isokinetic eccentric exercise. *Sport Medicine, 19*, 202-222.

Karović, Ž. (1980). Influence of repetitive muscle strain with a longer duration and greater load on the development potential and muscle size in youth biomotorius pubertal age. (Master Thesis). Belgrade: Faculty of Physical Education.

Mero, A., Komi, P., & Gregor, R. (1992). Biomechanics of Sprint Running. *Sport Medicine*, *13*(6), 376-392.

Mitrović, D. (2003). *Fundamentals of human physiology*. Belgrade: SIA.

Malacko,, J. & Rađo, I. (2004). *Technology of sports and sports training*. Sarajevo: Faculty of Sport and Physical Education, University of Sarajevo.

Mikić, B. (2004). *Biomechanics of sports locomotion*. Sarajevo: Faculty of Sport and Physical Education.

Okely, D.A., Booth, L.M. & Patterson, W.J. (2001). Relationship of physical to fundamental movement skills among adolescents. *Medicine & Science in Sports & Exercise*, *33*(11), 1899-1904.

Opavski, P. (1971). *Fundamentals of biomechanics*. Belgrade: Scientific books.

Pavlović, R. (2010). *Athletics*. Sarajevo: Faculty of Physical Education and Sport.

Petrović, V. (2006). Differences in isometric muscle potential of pupils in primary schools. (Master thesis). Niš: Faculty of Physical Education.

Rakovac, M., & Heimer, S. (2003). Impact strength traning type and strength of the nervous and muscular system of athletes, *Two of the athletes preparing Conditioning* (180-184). Zagreb: Faculty of Physical Education, University of Zagreb.

Hettinger, T. (1983*). Isometrisches muscle training*. Stuttgart: Thieme Verlag.

Stojiljković, S. (2003). *Fundamentals of general antropomotorius*. Niš: Cultural Center.

Stojiljković, S., Mitić, D., Mandarić, S., & Nešić, D. (2005). *Fitness*. Belgrade: Faculty of Sport and Physical Education.

Stojanović, T., Kostić, R., & Ahmetović, Z. (2006). *The theory and methodology of sports training*. Novi Sad: Faculty of Sport and Tourism.

Verkhoshansky, Y.I. (1979). *The development of power in sport* (54-61). Belgrade: Partizan.

Wilmore, J.H., & Costill, D.L. (1994). Physiology of sport and exercise. Champaign IL: Human Kinetics.

POVEZANOST REZULTATA U TRENINGU MIŠIĆA ABDOMENA S RAZVOJEM SNAGE BACAČKIH DISCIPLINA

Sažetak

Najčešći način razvoja motoričkih sposobnosti je usmjereno tjelesno vježbanje točno doziranim komponentama opterećenja. U ovisnosti od njihovog odnosa ovisi i koji vid motoričke sposobnosti razvijamo. To se najviše manifestira u prostoru snage i izdržljivosti koje se vrlo često preklapaju i gdje manje promjene intenziteta opterećenja govore o promjeni subprostora koji se tretira usmjerenim tjelesnim vježbanjem, npr. ako se radi o razvoju snažne izdržljivosti ili o razvoju brzinske izdržljivosti gdje je obuhvaćen prostor snage i izdržljivosti, brzine i izdržljivosti a razlike su posljedica doziranog opterećenja. Ovaj vid izdržljivosti je jako aktualan kod atletskih bacačkih disciplina i može dati sliku stanja određene regije tijela, naročito ako se radi o razvoju snage primjenom različitih tipova vježbanja na temelju početnog položaja.

Ključne riječi: *snaga, abdomen, mišićna izdržljivost, trening*

Received: March 22, 2011
Accepted: June 02, 2011

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