INTRODUCTION

Regarding the mobility manifestation which human demonstrates, the structure of its mobility abilities depends. 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 on it. Sometimes those are manifestations of an open direct type, when by a certain physical training are directed toward the transformation of some abilities, and sometimes they are of indirect type, when by some other activity is influenced on transformation of morphological, mobility and functional abilities (Wilmore & Patterson, Costill, 1994.; Okely 2001.).

For example, by doing some sport as a recreation, we indirectly develop the anthropomobility abilities, the all aspects of the strength, different types of speed, coordination, endurance etc. Also, a training and developing of an ability in the scope of one discipline, affects directly on the development of that ability which is predominant in the given discipline. As an example, regarding the athlete sprint disciplines, where the mobility ability speed is predominant, or the jumping disciplines where the explosive strength is dominant toward the body mass of the thrower (Pavlović, 2010.).

In these situations we can directly influence on the development of some segments of mobility space, speed, strength, endurance and coordination through a directed training process and practicing the particular discipline. Also there is other possibility, which 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 human’s locomotion apparatus we know that it is consisted of several segments which are further divided on segments of cranial part and segments of caudally part, treated as the body’s center of gravity (TT). Those two regions of the body of the locomotion apparatus are synergic connected with performing of muscle kinetic chains of open / closed type. That depends on the type of training which is conducted. (Opavsky, 1971.; Karović, 1980.; Rakovac & Heimar, 2003.). Often could happen during the physical training that there is unequal relationship of the muscle strength and the manifestation of open and closed type. For example, during practicing 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 helps 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, Komi, & Gregor, 1992.).

Having in mind the complexity and interaction of muscle action while performing the complex structure of movement, as the throwing disciplines, the problem is defined by study of different segments of body muscle interdependence, with an accent on the muscle endurance (strength endurance) of the abdomen by applying two basic types of trainings. It is important to mention that in training with larger load the abdominal muscles wall deserve a special attention. The first reason for that is the fact that these muscles are stabilizing the torso and are taking part in walking, as in many other movements. The second one is that well developed muscles of abdomen wall helps to maintain the regular function of internal organs of the abdomen. As last, the corresponding strength of that muscle group is the best protection way against the abdominal hernia (protrusion of internal organs or parts of organs through the abdominal wall). Hernia can develop if the intra-abdominal pressure is increased which develops under load lifting. If the extensor of spine is strong, but the abdominal muscles relatively weak with high intra-abdominal pressure, hernia could be developed. (Hettinger, 1983.). 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 because the muscle endurance is relatively independent ability which most often is considered in the scope of the endurance. However, the muscle endurance is also performing and improving within activities which are identical to those which are performing and improving the strength, and the only difference is in the dosage of the intensity and scope where the muscle endurance is load ¼ from the maximal value (Stojilković, Mitić, Mandarić, & Nešić, 2005.). The goal of the research is to determine which type of the training is more efficient and gives better results by the muscle endurance aspect, as well as the achieved level of statistical significant changes.

**METHOD OF WORK**

The sample of examined

The sample on which the research is conducted encompassed 40 examined students, of the third year of study on the Faculty for Physical Education and Sport who regularly attended and performed practical curriculum from athletics within the subject: strength development in throwing disciplines. The measurement of defined variables is conducted in April 2012.

The sample of variables

Horizontal positions are often used in physical training, because practicing of the strong rotating moment of gravitational force is very efficient. By practicing from lying position, the flexor muscles in joints of hips and abdomen muscles are getting stronger, as the extensor muscles of the knee, as well as the 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 stabilizers of the 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 position from center.

---

**Table 1. Descriptive statistics variables MDTK**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>72</td>
<td>40</td>
<td>250</td>
<td>210</td>
<td>21.88</td>
<td>3.09</td>
<td>11.08</td>
</tr>
</tbody>
</table>

**Table 2. Descriptive statistics variables MDNOG**

<table>
<thead>
<tr>
<th>MDNOG</th>
<th>Mean</th>
<th>Min</th>
<th>Max</th>
<th>Range</th>
<th>Std.Dev.</th>
<th>Skew.</th>
<th>Kurt.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>28</td>
<td>20</td>
<td>90</td>
<td>70</td>
<td>13.12</td>
<td>1.84</td>
<td>3.13</td>
</tr>
</tbody>
</table>

**Table 3. Correlation matrix variables MDTK-MDNOG**

<table>
<thead>
<tr>
<th></th>
<th>MDTK</th>
<th>MDNOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDTK</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>MDNOG</td>
<td>.81</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Correlation matrix (Table 3.) showed high degree of dependence on the measured variables of .81 which is significant if it is taken into account on the engagement of the mutual muscle kinetic chains which directly take part in doing the mobility task.
of the body gravity.

For testing of the strength and body endurance of abdomen two variables are applied which are fair and most common represents in these kinds of researches:
1. Lifting the torso while fixed lower extremities, so called sit ups (MDTK)
2. Lifting legs while fixed upper extremities (MDNOG).

For getting the necessary information, a 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 dependent samples.

RESULTS AND DISCUSSION

By inspection of the results it is obtained one general insight into the heterogeneity of the research sample considering the abdomen muscle strength-muscle endurance. On the Table 1. there are presented the results of the variable lifting the torso while fixed lower extremities (MDTK), stating a large span of results. That span confirms the value of dispersion parameters of the skew (3.09) and especially kurtosis (11.08) which justifies the statement about the non homogenous sample when it is about the abdomen strength of the examined students sample. Toward that results heterogeneity, contributed the fact that one number of the examined students (2 or 3) had extremely high scores at the test (Max.=250) which contributed to the whole result oscillation of the results in view of lengthening (kurt.11.08). The sample consists of students on the same year of studies.

In Table 2. the results are presented on variable lifting legs while fixed upper extremities (MDNOG), where situation is somewhat different. The values of the parameters of central statistics are significantly lower when it is about measuring of the central tendency and the dispersion measures, though also here we have the case of extreme higher values (Max.=90) which are results of measurement of 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 a high connection from (.81) and high difference of T-test with significant statistical importance (p<0.50). Although whether we accept or neglect these results it could be concluded that there is a large difference in view of performing MDTK practice and the MDNOG practice according their difficulty.

It is about two topologically different body regions and muscle groups that are taking part in realisation of the movement. There could be a question on which factors contributed to this kind of difference?

As the first one, it can be the action of muscle chains and types of muscles which took part in the realization of the movement. We already mentioned that is very important type of muscle kinetic chains, depending on the open or closed muscle action type, because of which there is a smaller or larger number of engaged muscles and muscle groups. It is especially important if it is about the engagement of large muscle groups which are also the strongest in the human organism, and that are those muscles and muscle groups which enables the maintenance of static musculature and vertical position of the human body (extensors and flexors of spinal

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

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std.Dv.</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDTK</td>
<td>72</td>
<td>21.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MDNOG</td>
<td>28</td>
<td>13.12</td>
<td>10.16</td>
<td>.000</td>
</tr>
</tbody>
</table>

Diagram 1. Comparative analysis of the values of variables MDTK – MDNOG
column, extensors and flexors of legs and hands, large pectoral muscles). Namely, it is known fact that these muscles contains up to 400 mobility units which are innervated with the same number of mobility neurons which enables strong movements and contract by the principle of all or nothing (Mitrović, 2003.; Stojiljković, 2003.; Malacko & Rado, 2004.; Stojanović, Kostić, R. i Ahmetović, et all. 2006.; Pavlović, 2010.). The next important thing is the question which kind of muscle is about, are those of the pinnate, spindle-shaped, fanlike or square. By its physiology cross section, pinnate, fanlike and square are extremely string thanks to the 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 occurs (Albert, 1995; Jovović, 2003.).

The human anatomy is observing the organism as divided in two parts: caudal and cranial, that is from the foot toward the pelvis and from the pelvis toward the head. Analyzing in more detail the larger number of stronger muscles by its physiological cross section, they are placed in the upper regions of the body, not taking into consideration the extremities and those which are mainly pinnate, square and fanlike, so that both direction and action of their movements is more synchronized, which largely depends also from the 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 the examined student’s sample. In most cases the examined students for the development of abdomen strength means a practice of lifting the torso while fixed the lower extremities, and significantly rare the opposite. 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 the abdomen muscles forms a kinetic chain and performs lifting of the lower extremities (Verhošanskiy, 1979; Hettinger, 1983.). Also what is necessary to know about the training and the way of practising for abdomen musculature is the following. The first manner, bend of torso-so called sit ups, are the main practice way for good 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 the side-thigh muscles, which shortens and are not participating in creation of the rotation force. During performing of flexion of torso with stretched legs, maximum force is created by the side-thigh muscles, while pressure on the inter vertebra discs is very high, closely responds to pressure when we bend from the vertical position with 20 kg load (Albert, 1995.; Mitrović, 2003.; Mikić, 2004.). Also what should be known is that the flexion of torso has its shortages. First, the 30º-45º bends depends of the abdomen muscles, and of the hip bender last 45º bends. Hip flexors are practice through short bow, so their adaptive shortening can be instigated and according to that hyper lordosis (Whiting et all.1998). A person that complains on the pain in lower part of the back can perform only the first part of the practice, by which they can only mildly lift shoulder belt. If half belts the knees are bent under an obtuse angle 140º-150º degrees, and one who practices the lifts of the torso from the floor under an angle of 30º (Zaciorsky & Kraemer, 2009.). In the second manner lifting legs while torso 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 muscles insignificant, only practice is not especially 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 mostly on legs, only the rear abdominal 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 the 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 90º, 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 a primary one. Regarding the muscle action it is known fact that fixed spot in joint decomposed the action of muscle on components, where one is directed radically, 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 zero because the muscle does not joint in the region of side axis of levers, but the joints are moved away on nono joint bulges-thorns, bumps, small bumps, 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 axis are in the same level, or during the contraction they cover each other, muscle can not perform the movement, it becomes only the tensor 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, Baltzopoluos, 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 which 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 weaken 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 synchronal synergic action of the 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 of the fixed torso or the legs.

REFERENCE


Stojiljković, S. (2003). Osnove opšte antropomotrike [Fundam-
ПОВЗАНОСТА НА РЕЗУЛТАТИТЕ ВО МУСКУЛНАТА ИЗДРЖЛИВОСТ КАЈ СТУДЕНТИТЕ

(Оригинален научен јеруд)

Ратко Павловиќ1, Јелица Стојановиќ1 и Наташа Бранковиќ2
1Универзитет во Истино Сарајево, Факултет за физичко воспитување и спорт,
Истино Сарајево, Босна и Херцеговина
2Универзитет во Ниш, Факултет за спорт и физичко воспитување, Ниш, Србија

Апстракт
Најчест начин за развој на моторните способности е насоченото физичко вежбање со прецизно дозирани компоненти на оптоварување. Според нивниот однос зависи видот на развојот на моторните способности. Тоа неколкучо се манифестира во просторот на снагата и издржливоста кои многу често се поклопуваат, така што и помалите промени на интензитетот на оптоварувањето зборуваат за промените подпросторот кој се третира со насочено физичко вежбање. Така на пример, тоа се случува кога се работи за развој на снажна издржливост или на брзинска издржливост, што е последица на степенот на дозиралото оптоварување. Овој вид на издржливост може да биде везан за атлетските фрлчки дисциплини и може да даде слика за состояниот за одреден регион на телото, особено ако се работи за развој на снагата со примена на различни типови на вежбање врз основа на почетната положба.

Ключни зборови: физичко вежбање, моторни способности, интенсивност на мускулно оптоварување, t-test,

Correspondence:
Ratko Pavlovic University of East Sarajevo
Fakultet fizickog vaspitanja i sporta
Stanbulcic bb, 71420 Pale, RS Bosnia and Herzegovina
E-mail: pavlovic.ratko@yahoo.com

Pavlović, Stojanović and Branković