IMPACT OF DIFFERENT TRAINING METHODS 
TO THE MAXIMUM VERTICAL JUMP HEIGHT 
IN JUNIOR BASKETBALL PLAYERS

Abstract
Thirty junior basketball players participated in the survey aimed to explore the impact of complex and plyometric method of training on maximal vertical jump height, in order to determine more effective method of training in practice. Study participants were divided into three equal groups of ten subjects, two experimental groups (group 1 – complex method of training, group 2- plyometric method of training) and control group. More experimental groups, in addition to regular basketball technical and tactical training, twice a week had more complex, ie, plyometric training, while control subjects had only technical and tactical training. Variables are divided into two groups: body weight, body height and skin folds are marked morphological variables and the maximum vertical jump height as the variable motor. It was found, analyzing the results from initial and final measurements that the maximum vertical jump height improved being under the influence of experimental factors in both experimental groups, whereas in the control group no significant changes occurred. Experimental group changes p = 0.05, control group p=0.09. Morphological variables didn’t significantly changed after application of experimental treatments. Further analysis of data showed no significant differences between experimental groups at the final measurements. Research has shown that there is no difference in the efficiency of the complex and plyometric training methods in a manner that is applied to our research and that these methods of training in ten weeks time can significantly affect the improvement of the task as it capped the maximum vertical jump.

Key words: VERTICAL JUMP / POSTACTIVATED POTENTIATION / STRETCH-SHORTENING CYCLE / BASKETBALL PLAYERS

INTRODUCTION

The combination of large and small loads within one training session is usually referred as complex training (Duthie, Young, & Aitken, 2002). Core training is based on the change of maximum and explosive muscle contraction of the same group of muscles (agonistic). Simultaneous mastering of large external loads (eg. weight) and small loads (eg. body weight), it is possible to produce better neuro-muscular adaptation (Sale, 2002). Assumptions of coaches are confirmed in research laboratories, so that combining exercises of large and small loads can achieve great training effect (Blakey, 1987; Duthie, et al., 2002; Ebben, & Blackard, 1998; Ebben, & Watts, 1998; Santos, & Janeira, 2008; Kukric, Karalejic, Petro-
vic, & Jakovljevic, 2009). Performing exercises of a large load can increase the excitation of a central nervous system, which will cause the following actions to be temporarily improved (Ebben, Watts, Jensen, & Blackard, 2000; Jensen, Ebben, Blackard, McLaughlin, & Watts, 1999; Young, Jenner, & Griffiths, 1998; Fatours et al., 2000). CNS excitation is the result of acute physiological adaptation that lasts 8-10 minutes and causes PAP (Sale, 2002). Mechanism of PAP examine the effects of heavy loads that cause a high degree of nervous stimulation which results in the inclusion of a number of motor units and increased frequency of discharge of nerve impulses. There are two basic ways of applying the training complex, combining large and small loads between sets and exercises in the series. First method involves lifting heavy loads in any exercise (over 80% from 1RM) in several series, followed by a performance of biomechanically similar exercises with small load transfer, maximum speed performance. Second method is a grouping of two or more exercises to be performed in a large series (so-called superset), with alternate work with large and small loads, with a maximum speed of execution. This method is known as „Russian complex“. Researches related to the energy of the elastic deformation of muscle appeared for the first time in the sixties in the works of Zachiorsky, and were confirmed through a series of subsequent works (Adams, O’Shea, Katie, & Climstein, 1992; Bosco, et al., 1982; Holcomb, Lander, Rutland, Rodney, & Wilson, 1996; Komi, 2000; Pottegier, et al., 1999). Plyometric training is a hot topic in recent researches (Fatouros et al., 2000; Matavulj, Kukolj, Ugarkovic, Tihanyi, & Jaric, 2001; Luebbers et al., 2003; Potach, Katsavelis, Karst, Latin, & Stergiou, 2009), and its effectiveness is confirmed in practice. Basically, plyometric method is Stretch-Shortening Cycle-SSC. If you stimulate muscle with certain load it will lead to changes in muscle size. Stretching of muscles will store the energy of elastic deformation, and most of it will be stored in muscle tendons. This will enable greater muscle strain tension, which will generate greater muscle force exerted. This is called stretch reflex or miotactical reflex. It’s believed that a quick transition between eccentric and concentric to elastic deformation is used in full (Bosco, et al., 1982; Komi, 2000; Kyrolainen, et al., 2005). Time of transition between eccentric and concentric phase must not be longer than the age-related cross-bridges. If that transfer is too long, cross-bridges dismantle and elastic energy stored in those units can’t be used for concentric contraction anymore, so overall performance of eccentric-concentric contraction is reduced for 20-30%.

The aim of this research is to explore the impact of complex and plyometric method of training on the maximum vertical jump height, and to determine which of those applied methods is more effective in practice.

**METHOD**

**Sample of respondents**

The sample is made of thirty junior basketball players (ages 16-17), they are all members of basketball clubs: “Zvijezda” Banja Luka, „Igokea” Aleksandrovac and „Alfom” Banja Luka. Participants have played basketball in average for 7 years and they compete for the first division of Republic of Srpska. They are divided in three equal groups (ten participants). Group 1 used complex method of training, group 2 plyometric method and group 3 is control group and they had only technical and tactical trainings. At the time of testing all subjects were completely healthy, no injuries of lower extremities. All participants are introduced to the aim of testing as well as with protocol.

**Sample variables**

Variables are divided in two groups: Morphological variables:
- Body weight (BM)
- Body height (BH)
- Subcutaneous adipose tissue (FAT)

Motor variables
- maximum vertical jump height (VJ) (jump from a place with both feet with swing arms)

Using bioelectrical impedance (TANITA BC-418MA) a body weight and percent of adipose tissue are measured. Body height is measured using anthropometer by Martin. Maximum vertical jump is measured on force platform GLOBUS ERGO TESYS SYSTEM 1000
Course and research procedure

After introducing the procedure to the participants, data collection started with initial measurement. After 15 minutes of warming up, each subject performed series of test jumps. Maximum height is tested in a way that subject goes down in the half squat from upright position, after that he performs a maximum vertical jump. A same time hands actively participate in the performance of the jump. The best result is analyzed that is achieved in the two series run with three repetitions and rest 10 second between reps. the break between sets was 2 minutes.

Then the training programs in a period of ten weeks are applied, while the experimental groups had additional complex trainings besides their everyday trainings, twice a week. Control groups had only tactical and technical trainings.

For the scope of the program in Table 1 we present only the content of the complex and plyometric training in the sixth week of program.

Table 1. The scope of complex and plyometric training in the sixth week of program

| Exercise details                                      | Complex method | Series and repetition | Plyometric method                  | Series and repetition |
|------------------------------------------------------|----------------|-----------------------|-------------------------------------|-----------------------|
| standing on toes with load (80% from 1RM)            | 3x5-8R         | halfsquat jumps       | jumps over a hurdle (50cm) deep squat | 3x10R                 |
| alternate jumps on one leg                           | 3x3-5R         |                       | jumps                               |                       |
| leg press (80% from 1 RM)                            | 3x8R           | one leg push          | jump on a crete                      |                       |
| jump over a hurdle (50cm)                            | 3x5-8R         | jump in a deep (60cm) | alternate jumps on one leg in a move |                       |
| step forward with load (80% from 1RM)                | 3x8R           |                       |                                     |                       |
| telemark jumps with leg change                       | 3x5-8R         |                       |                                     |                       |
| half squat with load (80% from 1RM)                  | 3x8R           |                       |                                     |                       |
| jumps over a hurdle (50cm)                           | 3x5-8R         |                       |                                     |                       |
| Break between exercises 5 minutes and between series 3 minutes

RESULTS AND DISCUSSION

Table 2 shows the descriptive parameters of the tested variables on the initial and final measurements. Descriptive parameters of morphological variables on initial and final measurement did not differ significantly. Maximal height of vertical jump changed under the influence of experimental factor. Further statistical procedure will establish if those differences are statistically significant.
tested subjects had dominated training activities of submaximal and maximal intensity, with short periods of strain not enough to involve aerobic mechanisms. Those mechanisms help engaging lipolytic energy and reducing of body weight. In order to get the valid conclusion, it was necessary to implement one more step of discriminative analysis which tested difference between average values on initial and final measurements. To compare these averages calculated on two time points (before and after the experiment) the Paired samples T-test is applied.

Table 2. Values of means (AM) and standard deviations (SD), body height (BH), body weight (BM), subcutaneous adipose tissue (FAT) and jump height (VJ) of participants of experimental and control group on initial measurement

| GROUPS | INITIAL MEASUREMENT | FINAL MEASUREMENT |
|--------|---------------------|-------------------|
|        | AM      | SD | AM      | SD | AM      | SD | AM      | SD | AM      | SD |
| DES.   | AM      | SD | AM      | SD | AM      | SD | AM      | SD | AM      | SD |
| PAR.   |         |    |         |    |         |    |         |    |         |    |
| BH     | 186.00  | 4.36 | 185.60  | 5.85 | 186.40  | 4.19 | 186.40  | 4.22 | 186.00  | 5.52 | 186.80  | 4.21 |
| BM     | 75.00   | 4.57 | 76.53   | 3.32 | 75.80   | 3.08 | 75.30   | 4.78 | 76.75   | 2.71 | 76.15   | 2.71 |
| FAT    | 12.81   | 1.43 | 12.93   | 1.17 | 12.86   | .91  | 12.56   | 1.23 | 13.06   | 1.26 | 12.81   | .74  |
| VJ     | 37.10   | 3.34 | 37.30   | 3.33 | 37.20   | 3.03 | 42.20   | 3.36 | 41.20   | 3.64 | 37.40   | 3.79 |

Table 3. Results of analysis of variance of body height, body weight, subcutaneous adipose tissue and jump height –three subsamples ascertained on initial and final measurement

| VARIABLES | INITIAL MEASUREMENT | FINAL MEASUREMENT |
|-----------|---------------------|-------------------|
|           | F-test  | p   | F-test  | p   |
| BH        | .06     | .93 | .07     | .93 |
| BM        | .42     | .65 | .04     | .67 |
| FAT       | .02     | .97 | .50     | .60 |
| VJ        | .01     | .99 | 5.97    | .00 |

Significance of differences between average values of three subsamples is tested by using the analysis of variance (Table 3), and we can see that there were no statistically significant differences between average values of three subsamples on initial measurement in none of the tested variables. There was a statistically significant difference on a final measurement in jump height variable (p=00), and Post–hock analysis (Tackey’s HSD criterion) showed which of the used method of training was more effective. Logical final results of morphological variables come from the fact that the trainings of
In order to determine more effective method of those conducted, the Post hoc is done (Tackey’s HSD criterion), (Table 4). That analysis showed that there were no significant differences between experimental groups (p = .77), and that both of the training methods improved the maximum vertical jump height, but it cannot be said that some of the training methods is more successful and will have greater efficiency in practice. Although, we must stress that the improvement of maximal vertical jump height is bigger in Group 1 (complex method of training) than in Group 2 (plyometric method of training), but not big enough to consider the complex method more effective in practice. Observing the control group, we see that maximal jump height hasn’t been changed on final measurement, but there is the statistically significant difference with regard to experimental group.

Table 4. Results of Post hoc analysis (Tuckey’s HSD criterion) on final measurement of maximal vertical jump height.

| groups     | N  | p=0,05  |
|------------|----|---------|
|            |    | 1       | 2       |
| Groupe 3   | 10 | 37,40   |         |
| Groupe 2   | 10 |         | 41,20   |
| Groupe1    | 10 |         | 42,20   |
| sig.       |    | 1,00    | .77     |

Figure 1. The significance of differences of means maximum jump height (cm) of three sub-samples of respondents at the initial and final measurement of maximum vertical jump height (cm)

![](image)

Results of discriminative analysis in the test of maximum vertical jump showed the statistically significant difference related to initial measurements. Taking into account analysis of variance (table 3) that are identified by T-test procedure (Figure 1) it can be concluded that training treatments in experimental groups improved the maximum vertical jump height (p = .001). Similar effects of plyometric and complex training on maximum vertical jump height were shown in previous studies (Luebbers et al., 2003; Matavulj, et al.; Santos, & Janeira, 2008). For the same period of ten weeks in control group there were no significant changes (p = .09), so we can say that the improvements made in the experimental groups emerged with great probability can be ascribed to the influence of the applied experimental factors.

Improvements of the value of jump height are influenced by muscle size and central nervous system. In the training programs of experimental group were dominated by strength training, which led to a certain degree of muscle hypertrophy. On the other side CNS is the important factor for muscle force development not only by the amount of the muscle mass involved, but also by the degree to which individual muscle fiber activated. By activating more motor units, increased discharge frequency and synchronization of muscular units, allows the creation of maximal muscle force.
CONCLUSIONS

In the period of ten weeks the effects of complex and plyometric method of training on maximal vertical jump height are tested. Comparing the results from initial and final measurements the following conclusions are here:

• complex method of training improved the maximal vertical jump height. So the influence of physiological mechanism of postactivated potentiation on dynamic tasks as maximal vertical jump is confirmed. Conclusion is: by doing movements with heavy load we can produce an acute improvement in event–type vertical jump explosive power,
• plyometric method of training influenced the improvement of maximal vertical jump height. So the efficiency of Stretch-Shortening Cycle on explosive strength of jump is confirmed,
• it is determined that there is no statistically significant change between complex and plyometric method of training, and that both methods are effective in improvement of jump, and
• there are no statistically significant changes determined after application of experimental treatment.

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