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THE EFFECT OF PLYOMETRICS TRAINING ON EXPLOSIVE POWER OF MEDICAL STUDENTS IN DIPONEGORO UNIVERSITY

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ABSTRACT

Introduction : Explosive power are the combination maximum strength and maximum velocity. High value of muscle strength and velocity can lead to good measurement of explosive power. Plyometrics training known as an exercise that can increased explosive power. This exercise is really popular among athletes and has proven to increase their explosive power. However, there's still no further study that measured explosive power on medical students after given plyometrics training treatment. **Methods** : Quasi experimental study of plyometrics training has done for 6 weeks to medical students Diponegoro University. 28 subjects was divide into 2 groups : plyometrics training (as treatment group) and control group (as non-treatment group). Vertical jump test score was measurement in pre-test, middle-test, and post-test. The explosive power measured by vertical jump test. The results were analyzed by SPSS software. **Results** : The explosive power improved among subjects in plyometrics treatment group. During the plyometrics treatment, vertical jump was singnificantly increase during treatment in pre-test to mid-test (35.93 cm to 49,21 cm ; P : <0.001) and mid-test to post-test measurement (49.21 cm to 54.21 cm ; P : <0.001). Vertical jump score significantly increase in plyometrics group compare to control group ; on middle-test (<0.001 vs 0.344 ; P 0.019) and post-test (<0.001 vs 729 ; P 0.001) measurement respectively. **Conclusions** : Plyometrics training improved lower limb explosive power in male medical students of Diponegoro University. This is marked by significantly increase among subjects in plyometrics treatment group.
Keywords: Plyometrics Training, Explosive Power, Vertical Jump Test

INTRODUCTION

The proportion of people who regularly exercise has not reached one third of total population. The lack of interest in the population to exercise due to the busyness and laziness that makes sports often ignored and even forgotten. The risks of developing various diseases such as osteoporosis, obesity, and injury will increase to those people who rarely exercise.[1,2] Plyometrics training are chosen by some peoples and become popular because they are effective, efficient, and consist of easy movements. Plyometrics training involve the process of SSC (Stretch-Shortening Cycle) by stimulating the body and muscles to produce maximum strength in a short period of time and lead to good explosive power. The high value of muscle strength and velocity can lead to good measurement of explosive power. Plyometrics training is known as exercise that can increase explosive power.[3,4]

According to several studies, there are significant results especially for the musculoskeletal system in people who did plyometrics training. Previous studies showed that plyometrics training can increases muscle strength, jump height, neuromuscular respond, and explosive muscles power in athletes. Athletes need great muscle strength to perform sport

techniques such as jump, sprint, agility, endurance, change the direction of the body and also reduce the potential for muscle injury. This exercise is really popular among athletes and has proven to increase their lower limb explosive power.[4,5]

The purpose of this study is to determine the effects of plyometrics training on the muscle explosive power of medical students in Diponegoro University. The measurement of lower limb explosive power assesed by vertical jump test or sargent jump test by measuring the difference in maximum range when standing and peak point when jumping. There are several reasons why vertical jump test is choosen for this measurement, because it is costly efficient and simple to use. The height of vertical jump is comparable to the enhancement of lower limb explosive power muscles.[6,7]

METHODS

This study used quasi experimental with pre-test, middle-test and post-test control group design. The subjects were 28 male students in Faculty of Medicine Diponegoro University with normal Body Mass Index and between the age of 15-25 years old. Subjects were determined by purposive sampling method with inclusion criteria (male, medical students of Diponegoro University, 15-25 years old, normal BMI : 18.50-25 kg/m^2, do not exercise except plyometrics training in six weeks, and ready to plyometrics training two times a week in 6 weeks) and the exclusion criteria (leg injury, history of leg injuy, posture abnormality, muscle stiffness, use sedative drugs or alcohol, and uncorrected eye refraction). Subjects was divided into 2 groups : plyometrics training (treatment group) and control group (non-treatment group), where each group consists of 14 subjects. The treatment group was given plyometrics training for 6 weeks. Each week consists of 2 sessions exercise with 20 – 30 minutes duration and each session contains 5 movements. Measurement for the explosive power before the exercise (pre-test), after four weeks exercise (middle-test) and after six weeks exercise (post-test). This measurement used vertical jump test.

Ethical clearance was obtained from Medical and Health Research Ethics Commission (KEPK) Faculty of Medicine, Diponegoro University. Ethical clearance number is 113/ EC/ KEPK/ FK-UNDIP/ IV/ 2019. Subjects was given a brief explanation of the purpose, benefits, research protocols, possible side effects, questionnaire, and an informed consent sheet.

Statistical analysis was done by using SPSS program. Data analysis includes descriptive analysis and hypothesis. Data from each group were analyzed using paired t-test or Wilcoxon test. Inter-group muscle strength and explosive power data were analyzed using
an unpaired t test or Mann-Whitney.

RESULTS

28 medical students of Diponegoro University characteristics subjects consist of age, height, weight, Body Mazz Index (BMI), and the results from questionnaire are showed in table 1.

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Table 1. Characteristics of Subjects

Variabel	N	F	%	Mean ± SD	Median (min-maks)
Age (years)	28	-	-	20.21 ± 0.62	20 (19 - 21)
Height (cm)	28	-	-	167.64 ± 5.98	167.5 (155 - 177)
Weight (kg)	28	-	-	61.5 ± 8.74	60 (49 - 76)
BMI (kg/m^2)	28	-	-	21.82 ± 2.30	21.63 (18.44 - 25)
Did you exercise regularity?	28				
Regular	-	6	21.4	-	-
Not regular	-	22	78.6	-	-
Exercise onset?	28				
Never	-	22	78.6	-	-
>1 Month	-	1	3.6	-	-
>3 Months	-	2	7.1	-	-
>6 Months	-	2	7.1	-	-
>1 Year	-	1	3.6	-	-
Weekly frequency of exercise?	28				
Uncertain in one week	-	15	53.6	-	-
1 time each week	-	9	32.1	-	-
2 times each week	-	4	14.3	-	-

Mean±SD for age of the subjects is 20.21 ± 0.62. Mean±SD height of the subjects is 167.64 ± 5.98 cm. Mean±SD for weight of the subjects is 61.5 ± 8.74 kg.. Mean±SD for Body Mass Index (BMI) of the subjects is 21.82 ± 2.30. The questionnaire results, 6 subject (21.4%) exercise regularly, while 22 subjects (78.6%) do not exercise regurlarly. 22 subjects (78.6%) subjects never do the exercise frequently, 1 subject (3.6%) exercise regularly >1 month. Subjects who do not exercise frequently in one week are 15 subjects (53.6%), 9 subjects (32.1%) are exercise for 1 time each week, and 4 subjects (14.3%) are exercise for 2 times each week. All subjects in this research did not categorized in dropout criteria.

Table 2. Lower limb explosive power data

Vertical Jump Test Score	**Groups**		**P**
	Control	**Treatment**	
	Mean±SD ; Median(Min-Max)	Mean±SD ; Median(Min-Max)	
Pre – test	40.71 ± 11,874 ; 40.50 (20-60)	35.93 ± 6,391 ; 37.00 (24-46)	0,196 [I]
Mid – test	39.64 ± 12,119 ; 39.00 (19-59)	49.21 ± 7,116 ; 49.00 (35-61)	0,019 [I*]
Post – test	39.93 ± 12,099 ; 41.50 (20-56)	54.21 ± 8,011 ; 52.50 (38-70)	0,001 [I*]
Pre – Middle	0.344[¶]	<0.001[¶*]	
Middle – Post	0.729[¶]	<0.001[¶*]	
Pre – Post	0.420[¶]	<0.001[¶*]	

Explanation : [*] Signifikan ; [I] Independent sample t test ; [¶] Paired sample t test ; Min : Minimum ; Max : Maximum

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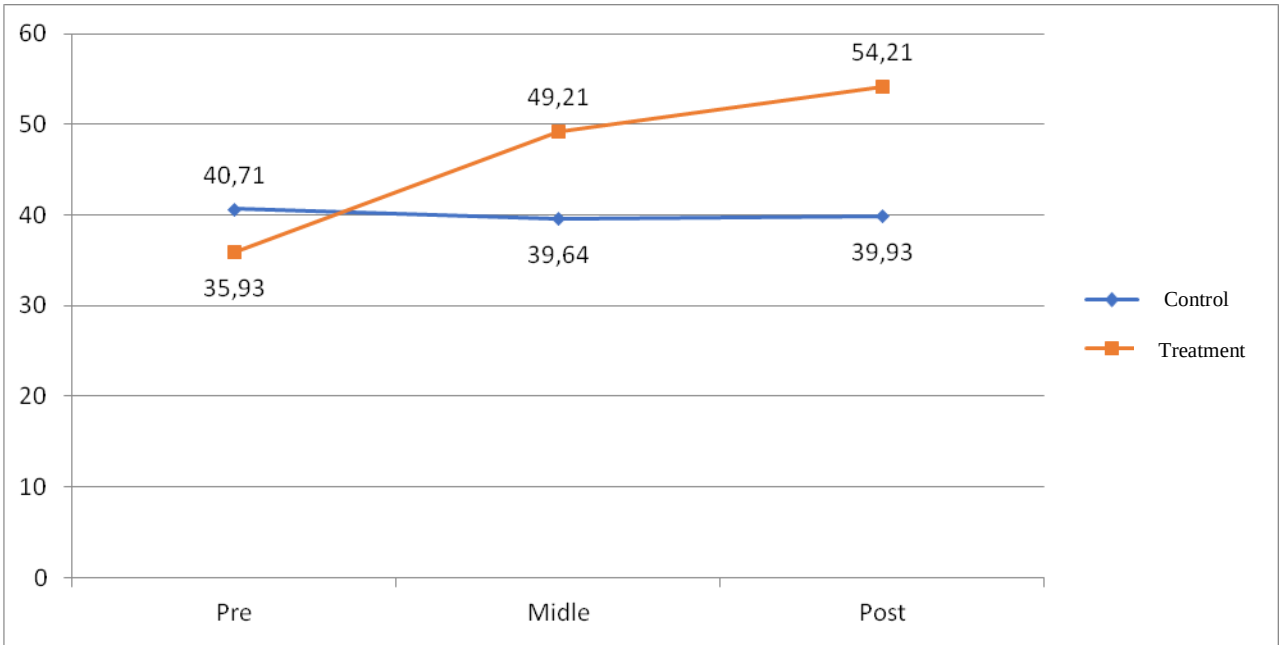

Figure 1. Explosive power chart values between two groups

Table 2 and figure 1 showed the vertical jump test score from control group and treatment group. Data from pre–test, middle–test, and post–test measurement, were analyzed by paired sample t test. The data obtained from treatment group, pre–test to middle-test have increased from (35.93 ± 6.391 to 49.21 ± 7.116; P : <0.001). Data from middle test to post-test of treatment groups increased from (49.21 ± 7.116 to 54.21 ± 8.011; P : <0.001). All of these data from treatment group showed a significant result. In this research, the results of treatment group were significant. Significant results that were obtained from experimental group showed that plyometrics training can increased explosive power.

Control group pre-test to middle-test measurement decreased from (40.71 ± 11.874 to 39.64 ± 12.119; P : 0.344). Data middle-test to post-test have slightly increased (39.64 ± 12.119 to 39.93 ± 12.099). Data from pre-test to post-test control group were decreased (40.71 ± 11.874 to 39.93 ± 12.099; P : 0.420).

Vertical jump score also significantly increase in plyometrics group compare to control group ; on middle-test (<0.001 vs 0.344 ; P : 0.019) and post-test (<0.001 vs 0.729 ; P : 0.001) measurement respectively. Vertical jump test score in plyometrics group are significantly (P <0.05) than non plyometrics group (control group).

DISCUSSION

Explosive power is the most important component in sports because explosive power will determine how hard a punch, how far a throw, and how high a jump can be.[8–10] Lower limb explosion is the ability of muscles to exert maximum strength in the shortest possible time from all lower extremities (muscles, bones, joints, and tendons).[4,11] 11Muscle acts as an active activator and bone as a passive activator. Thus lower limb explosive

power muscle is the ability of muscle group to resist the load using maximum strength and maximum in the shortest time.[8,11]

The principle of Stretch Shortening Cycles (SSC) in plyometrics training is related to the stretching and shortening of muscle fibers. SSC allows muscles and tendons to perform maximum strength in the shortest possible time, which improves the connection between muscle strength and speed contraction.[11,12] SSC is defined as the sequence of muscle actions from the eccentric phase (pre-load), the transition phase, and the concentric phase (after-load). Increased concentric performance is a result of higher and more actives muscles - tendons complex achieved in the pre-load phase. The stretched muscle function is made up of the combination of the speed of neural conduction, muscle contractility, the interaction of contractile components with tendon structure, and chemical potential. The amount of energy produced by the muscle stretch (pre-load) phase will determine the strength in the concentric phase (after-load).[11,13–15]

Plyometrics training increases muscle contraction velocity and lower limb explosive power. Improvements that occur in lower limb muscles due to increased speed of eccentric muscles (pre-load phase). The factors that determine the speed of muscle contraction are the activity of the ATPase myosin (ATP decomposer) of the muscle fibers that contract. The exercise program triggers the improvement of the neuromuscular system by the activation of muscle fibers and the nervous system. Fast type of nerve fibers have a faster myosin ATPase activity than the slow type. The higher of ATPase activity occurs, the faster it breaks down, likewise the faster energy supply for cross-bridge cycles. Instead, the frequency of fast type muscle fibers will increase, resulting in larger energy than other types of muscle fibers.[14,16,17]

In literal translation, plyometrics training means measurable increases. Plyometrics movement includes jumping with one or two legs and the maximum ability to run. The movements are carried out with full strength and high repetition.[4] Plyometrics training increases several performances such as jumping, sprinting, agility, endurance, speed, strength, and musculoskeletal adaptation.[16,18] The increased performance is an adaptation of muscle and another component due to the given exercise load. The physiological adaptations occur in the form of exercise muscle hypertrophy caused by the increased amount in muscle fibers. The higher increment of the muscle mass will lead to greater force produced as a result of increasing motor units. [19,20] In addition to muscular hypertrophy, the other adaptations are the enhancement of muscle contractility, reaction time, contraction strength, and explosive power. This type of exercise causes the adaptation of the neuromuscular system to generate muscle contraction-relaxation cycles.[11,18,21]

The control group who did not exercise for six weeks obtained a decrease in the value of the vertical jump test. The untrained muscle causes muscle protein synthesis diminished, resulting in the reduction of myofibril numbers. Also, it causes a reduction in contractile protein for muscle contraction. In the control group, rarely trained muscle will decrease slowly in the form of reduced strength and muscle mass that affect the decrease values in vertical jump test method.[17,22]

The limitation of this activity was the prior monitoring examination. The

level of fatigue can also affect the result of the vertical jump test. Besides, the limb length was not measured. The length of the limbs is related to the muscle fibers enhancement in contraction and the higher number of sarcomeres involved. The subjects had received verbal explanations about the hard activities and fatigue level, which can affect the results. Verbal explanations are used to maintain the validity of this study.

CONCLUSION

Plyometrics training for 6 weeks proved to increase lower limb explosive power students in Faculty of Medicine Diponegoro University. This is marked by a more significant increase in the group that did plyometrics compared to the control group.

However, further research is needed on the effect of plyometrics training on lower limb explosive power in persons with a larger sample size, a longer duration of study time, and with a more diverse background subject so that results can be obtained with wider and deeper coverage.

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