

THE EFFECT OF PLYOMETRICS TRAINING ON LEG MUSCLE STRENGTH OF MEDICAL STUDENTS IN DIPONEGORO UNIVERSITY

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ABSTRACT

Introduction : Strength is the ability to exert force, which can resist external resistance and its purpose as a basis for human movements. Strength also can be a standard for measuring someone's performance. Plyometrics training known as an exercise that can increased muscle strength. Great muscle strength can lead to great muscle endurance so that the person will become healthier and will not get tired easily. However, there's still no further study that measured leg muscle strenght on medical students after given plyometrics training treatment.

Methods : Intervention of the study was plyometrics training for 6 weeks. This study was a quasi-experimental with pre-test (before training), middle-test (after four weeks training), and post-test (after six weeks training). The subjects were 28 (15 to 25-year old) male medical students of Diponegoro University divided into 2 groups with 14 samples for each group: control group and treatment group. Muscle strength were measured by leg dynamometer. The results were analyzed using SPSS. **Results** : The muscle strength which measured by leg dynamometer improved among subjects who did plyometrics training. The significant results ($P = <0,05$) found on middle-test and post-test proved that plyometrics training affects the enhancement of leg muscle strength. **Conclusions** : Plyometrics training for 6 weeks proved to increase leg muscle strength of medical students in Diponegoro University.

Keywords: Plyometrics Training, Strength, Leg Dynamometer

INTRODUCTION

The risks of developing various diseases such as coronary heart disease, type 2 diabetes mellitus, cancer, and short life expectancy will increase to those people who rarely exercise.¹ According to Basic Health Research Indonesia in 2018,¹ the proportion of the population of those who did not exercise in 2018 compared to 2013 had increased, which was originally 26.1% (in 2013) to 33.5% (in 2018).²

Plyometrics training involves the process of SSC (Stretch-Shortening Cycle) by stimulating the body and muscles to produce maximum strength in a short period and lead to good physical performance.³

Strength is the ability to exert force, which can resist external resistance and its purpose as a basis for human movements. Strength also can be a standard for measuring someone's performance. Muscle contraction depends

¹ Riset Kesehatan Dasar Indonesia 2018

on the number of motor units involved, speed and frequency of the signals received from the motor nerves, and muscle fatigue.^{4,5,6}

According to several studies, there are significant results, especially for the musculoskeletal system in people who did plyometrics training. Previous studies showed that short-term plyometric training (such as 2-3 sessions a week for 6-15 weeks), can increase muscle-tendon flexibility, muscle strength, and explosive power in a healthy individual.⁷ Other studies showed the effect of 8 weeks plyometrics training can increase agility, muscle strength, and explosive power in football players.⁸ Athletes need great muscle strength to perform sports techniques, such as jump, sprint, change the direction of the body and also reduce the potential for muscle injury.⁹ Besides that, great muscle strength can lead to great muscle endurance so that the person will become healthier and will not get tired easily. Therefore, all medical students must have great muscle strength to keep their body healthy.¹⁰

The purpose of this study is to determine the effects of plyometrics training on the muscle strength of medical students in Diponegoro University. The

measurement of muscle strength is assessed by leg dynamometer, due to its good validity and is easy to use.^{11,12}

METHODS

This study used quasi-experimental with pre, middle and post-test control group design. The subjects were 28 male students in Medical Faculty of 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 and exclusion criteria and are divided into 2 groups: control group and treatment group, where each group consists of 14 people. 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.

The subjects will be measured for muscle strength before doing the exercise (pre-test), after four weeks of the exercise (middle-test) and after six weeks of the exercise (post-test). This measurement used leg dynamometer for muscle strength.

Ethical clearance was obtained from the Medical and Health Research Ethics Commission (KEPK) of the Faculty of Medicine, Diponegoro University.

Subjects was given a brief explanation of the purpose, benefits, research protocols, possible side effects, and an informed consent sheet.

Muscle strength used SPSS for data analysis. Data analysis includes descriptive analysis and hypothesis. Data from each group were analyzed using paired t-test or Wilcoxon test. Inter-group muscle strength data were analyzed using an unpaired t test or Mann-Whitney.

RESULTS

Subjects that were used in this research consist of 28 people who are medical students of Diponegoro University. The results obtained from the questionnaire, Mean \pm SD for age of the subjects is 20.21 ± 0.62 , Mean \pm SD for

height of the subjects is 167.64 ± 5.98 , Mean \pm SD for weight of the subjects is 61.5 ± 8.74 , and Mean \pm SD for body mass index of the subjects is 21.82 ± 2.30 . There are 6 people who exercise regularly (21.4%) while 22 others do not exercise regularly (78.6%). 1 subject exercise regularly for >1 month (3.6%), 2 subjects exercise regularly for >3 months (7.1%), 2 subjects exercise regularly for >6 months (7.1%), and 1 subject exercise regularly for >3 months (3.6%). Subjects who do not exercise frequently in one week are 15 people (53.6%), meanwhile there are 9 people who exercise one time each week (32.1%) and 4 people who exercise two times each week (14.3%). There are no subjects that are categorized as dropout criteria in this study.

Table 1. Characteristics of Subjects

Variabel	N	F	%	Mean \pm SB	Median (min-max)
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)
Do you exercise frequently?	28				
Yes	-	6	21.4	-	-
No	-	22	78.6	-	-
Since when did you exercise frequently?	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	-	-
How often do you exercise in one week?	28				
Uncertain in one week	-	15	53.6	-	-
1 time each week	-	9	32.1	-	-
2 times each week	-	4	14.3	-	-
Are you having leg injuries?	28				
Yes	-	0	0	-	-
No	-	28	100	-	-
Since when did you have leg injuries?	28				
Never	-	28	100	-	-
<1 month	-	0	0	-	-
>1 month	-	0	0	-	-
>3 months	-	0	0	-	-
>6 months	-	0	0	-	-
>1 year	-	0	0	-	-
Do you have a history of having leg injuries?					
Yes	-	0	0	-	-
No	-	28	100	-	-
Do you have postural abnormality?					
Yes	-	0	0	-	-
No	-	28	100	-	-
Are you having muscle stiffness?	28				
Yes	-	0	0	-	-
No	-	28	100	-	-
Since when did you have muscle stiffness?	28				
Never	-	28	100	-	-

<1 month	-	0	0	-	-
>1 month	-	0	0	-	-
>3 months	-	0	0	-	-
>6 months	-	0	0	-	-
>1 year	-	0	0	-	-
Do you have a history of having muscle injuries?	28				
Yes	-	0	0	-	-
No	-	28	100	-	-
Are you consuming drugs or alcohol?					
Yes	-	0	0	-	-
No	-	28	100	-	-
Do you have abnormality eye refraction?	28				
Yes	-	0	0	-	-
No	-	28	100	-	-

The muscle strength with leg dynamometer improved among subjects who did plyometrics training. The data obtained from pre-test to middle-test have increased, from 126.6 ± 33.24 to 150.78 ± 39.91 . Data from middle-test to post-test also increased, from 150.78 ± 39.91 to 188.6 ± 46.17 . On the other hand, the data obtained from control group pre-test to middle-test have increased, from 119.35 ± 30.44 to 143.17 ± 173.18 . However, data from middle test to post test have drastically decreased, from 143.17 ± 173.18 to 96.03 ± 33.92 .

Comparison of pre-test between two different groups was not significant ($P = 0.552$). However, comparison of middle-test between two different groups obtained significant results ($P = 0.006$). Significant results also were found in post-test between two different groups ($P = <0.001$). The significant results found on middle-test and post-test proved that plyometrics training affects the enhancement of leg muscle strength.

Besides P values between two groups, there are p values between two tests that were sought. P value between pre-test and middle-test in treatment group

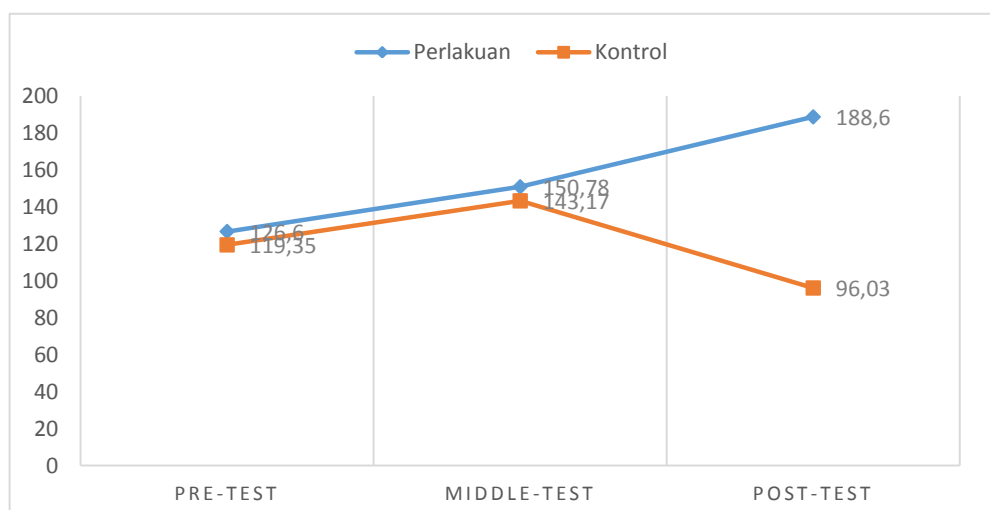
showed significant results ($P = 0.002$), meanwhile in control group was not significant ($P = 0.056$). P value between middle-test and post-test in treatment group also showed significant results ($P = 0.001$), meanwhile in control group was

not significant ($P = 0.975$). P values between pre-test and post-test showed significant results in either treatment or control group ($P = <0.001$ for treatment group and $P = 0.013$ for control group).

Table 2. Leg Muscle Strength Values

Leg Muscle Strength	Groups		p
	Treatment (Mean±SD ; Median (Min – Max))	Control (Mean±SD ; Median (Min – Max))	
Pre – test	126.6 ± 33.24 ; 120.5 (70 – 177)	119.35 ± 30.44 ; 108 (88 – 188)	0.552 ^I
Mid – test	150.78 ± 39.91 ; 142.5 (91.5 – 259.5)	143.17 ± 173.18 ; 99.25 (52.5 – 735)	0.006 ^{€*}
Post – test	188.6 ± 46.17 ; 178.25 (121.5 – 272.5)	96.03 ± 33.92 ; 93.25 (51.5 – 164)	< 0.001 ^{I*}
Pre – Middle	0.002 ^{w*}	0.056 ^w	
Middle – Post	0.001 ^{w*}	0.975 ^w	
Pre – Post	<0.001 ^{I*}	0.013 ^{I*}	

Explanation: ^I = Independent sample t-test, [€] = Mann-Whitney test, ^w = Wilcoxon test, ^I = Paired sample t-test, * = Significant



Picture 1. Leg Muscle Strength Values Between Two Groups

DISCUSSION

This study shows the effect of plyometrics training on leg muscle strength of medical students in Diponegoro University. Based on statistic results, comparison between two groups of middle-test and post-test values showed significant results ($P = <0.05$), which means that there were significant differences in results between treatment group and control group.

The increase in leg muscle strength that occurs is a result of physiological adaptation of the muscle in response to the given exercise. Measurements of leg muscle strength in this study were carried out before plyometrics training, after the 4th week of plyometrics training, and after the 6th week of plyometrics training. The reason for doing the middle-test (measurement at week 4) is due to that on week 4, physiological adaption had been showing. A study proves that squat, leg press and leg extension exercises carried out for 4 weeks have been shown to increase muscle strength.¹³

Plyometrics exercises are said to have better effects to increase muscle strength than other exercises, such as weight training, eccentric strength training, and isometric strength training.^{3,14} A

research on plyometrics that was conducted for 6 weeks in a group of soccer athletes proves the effect of plyometrics training on leg muscle strength. That research showed significant results for leg muscle strength where the muscle strength was assessed by the method of standing broad jump.^{7,9,15}

The limitation of this study is the inability to monitor all physical activities of the research subjects. A verbal explanation of the research subjects related to this matter was submitted before the research took place, so that this will not affect the validity of the study. Another limitation is the time of conducting research, which is concurrent with the month of Ramadhan, and is quite short because it is only carried out in less than 8 weeks. Most of the subjects in this study were fasting, so that fasting can be one of the confounding factors in the results of the study.

CONCLUSION

Plyometrics training for 6 weeks proved to increase leg muscle strength of Diponegoro University medical faculty students. 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 leg muscle strength in a person with a larger sample size, a longer duration of study time that does not collide with the month of Ramadhan, and with a more diverse background subject so that results can be obtained with wider and deeper coverage.

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