

ORIGINAL ARTICLE

The Effect of Plyometrics Training on Memory Function and Mood State Among Medical Students

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ABSTRACT

Introduction: Physical inactivity has been considered as a pathological condition and additionally become a very important risk issue that plays role in inflicting fatalities. Plyometrics training is a form of exercise that can effectively reduce the fatalities prevalence caused by physical inactivity. It also increases the cognitive and affective ability. This study aims at assessing the effects of plyometrics training on short-term memory and mood states in Diponegoro Medical Faculty Students. **Methods:** A quasi-experimental study with 36 medical students (15-25 years old) as subjects. The subjects have been divided into two clusters: EP and C cluster. The EP cluster was given plyometrics training for six weeks and every week consists of two-session exercises and each session contains 5 movements. The C cluster was control group and didn't perform plyometrics training. The subjects were chosen purposively and participated in two tests (scenery picture memory test and profile of mood states) before training and after six weeks of training. Paired t-test and independent t-test were used for statistical analysis. **Results:** There was a major distinction in scenery picture memory test score in the plyometrics training cluster compared to the control with $p < 0,001$. Mood measurement stated in the *total mood disturbance score* (TMD) also showed a significant difference between pre- and post-test in plyometrics training group with $p = 0,001$. **Conclusion:** Plyometrics training may improve short-term memory and mood in Diponegoro Medical Faculty Students.

Keywords: Plyometrics, Short-term memory, Mood state

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INTRODUCTION

It is estimated that 3.2 million deaths worldwide are associated with insufficient physical activities. Mortality rate in individuals with insufficient physical activities are 20-30% higher compared to those who exercise for 30 minutes weekly (1). The lack of physical activities has also contributed to the increased rate of early-onset dementia. Research by the Ministry of Health in 2013 reported that 1 of 4 people in Indonesia were classified as sedentary (2). Sedentary lifestyle if maintained for a long time can lead to various health problems such as obesity, type-2 diabetes, vitamin deficiencies, hypercholesterolemia, cardiovascular impact, cognitive function and also mood. A low energy expenditure that includes prolonged sitting at work, home, long screen time, car driving may increase morbidity and mortality (1).

Plyometrics, an easy exercise only taking 2 – 3 sessions per week and 20 – 30 minutes for each session effectively reduces the risk of physical inactivity due to sedentary lifestyle. Plyometrics is a combination of strength, power, and speed training. This exercise is designed to help muscles reach its maximum potential by performing eccentric and concentric contractions in a fast manner as well as producing immense power at the same time (3,4). This training has been demonstrated to increase systolic blood pressure, diastolic blood pressure, and heart rate along with the increased intensity (5,6). Plyometrics may improve musculoskeletal system especially those of lower limbs, stretch-shortening cycle function, balance, explosive power, and endurance in healthy individuals (7,8).

Studies show that exercise could improve cognitive function and mood states. Memory is one of the cognitive function important for learning and studying in college students. Good memory is especially necessary for medical students (9). Meanwhile, mood states affect desires and motivation to study. The increased cerebral blood flow induced by exercise may underlie

the beneficial effects on cognition and mental health (10). Exercise has been known to improve oxygenated haemoglobin and reduce deoxygenated haemoglobin in prefrontal cortex, increase white and gray matter of prefrontal cortex, and improve pre- and post-synaptic protein in orbitofrontal cortex. Those changes are known to enhance short-term memory of individuals (11,12).

Based on how important the memory ability and mood state are, also based on previous studies, we hypothesized that increasing physical activity by doing plyometrics training could improve short-term memory and mood states. This study examined the effect of plyometrics training on medical students' short-term memory and mood states.

MATERIALS AND METHODS

Participants

This is a quasi experimental study. Subjects were thirty six male of medical students of Diponegoro University (15-25 yo). Ethical clearance was obtained from the Ethical Commission of Faculty of Medicine Diponegoro University (number 112/EC/KEPK/FK-UNDIP/IV/2019) prior to the implementation of this research. Subjects has been given an explanation about risks and benefits of the research. Subjects who agreed to participate in this research were asked to fill out a written consent form. Subjects characteristics including mean and standard deviation of the age, height, weight and body mass index values are shown below in Table I:

Table I : Characteristics of research subjects

Parameter	Mean ± SD
Subjects	36
Age (year)	19,56±0,773
Height (cm)	164,70±17,659
Weight (kg)	64,36±19,051
Body mass index (kg/m ²)	21,97±2,407

Thirty six subjects met the inclusion criteria. This subjects were then divided into two clusters based on the questionnaire data. These cluster are the treatment cluster who did plyometrics training (EP) consisting of 18 subjects and the control cluster (C) who did not do any exercise which also consists of 18 subjects.

Protocol of plyometrics training

The treatment cluster (EP) was given plyometrics training for six weeks and every week consists of two-session exercise and each session contains 5 movements. Movements performed in week 1, 3, and 5 consist of

two-foot ankle hop, single-foot side-to-side ankle hop, standing jump and reach, standing long jump, and front cone hop. While movements performed in week 2, 4, and 6 are side-to-side ankle hop, hip twist ankle hop, standing jump and reach, standing long jump, and diagonal cone hop. Each of these movements are performed 2 sets with 10 repetitions of each set and there is one-minute break between each set. While the control (C) cluster are not allowed to do any exercise for six weeks.

Instruments

Short-term memory was measured using scenery picture memory test (SPMT) while mood states measured using profile of mood states (POMS) questionnaire and stated in total mood disturbance score (TMD).

SPMT was done by showing the subjects an image of the room which contains 23 objects. Subjects were asked to memorize objects in the room as many as they can within a minute. Forward digit span test was then carried out. Seven-digit numbers are shown to the subjects, and then the subjects were asked to mention back the 7 numbers in the correct order. After it is done, the subjects were asked again to mention the objects in the room that has been memorized beforehand. Increased memory function is indicated by an increase in the number of objects memorized on the post test compared to the pre test.

POMS questionnaire consists of 65 items which covers 7 different scales (depression, anxiety, vigour, anger, tension, fatigue, and confusion). The subjects answered the questions within 5 levels as they feel (not at all, a little, moderately, quite a bit, and extremely). The results of this test is stated as TMD Score. Increased mood function in subjects is indicated by the decrease in the TMD's score value on the post test compared with the pre test.

Data collection and analysis

Both EP and C group performed these test for pre-test and after 6 weeks training (post-test). Data analysis includes descriptive analysis and hypothesis. Dependent variables data (short-term memory and mood states) from each group were analyzed using paired t-test/ Wilcoxon and unpaired t-test/Mann – Whitney.

RESULTS

Thirty six male students participated in this study. Table II and III showed the measurement of short-term memory and mood states using scenery picture memory test and profile of mood states:

Table II : Short-term memory

Memory	Group		p
	Treatment (Mean±SD)	Control (Mean±SD)	
Pre	17,393,051	15,063,226	-
Post	20,392,355	16,063,298	<0,001 [‡]
p	<0,001 [∗]	0,001 [‡]	-
Delta	3,001,910	1,001,029	0,001 [‡]

Description: p = significance value; [‡] = Mann whitney;

[∗] = Wilcoxon; [‡] = Paired t test

Table III : Mood

Mood	Group		p
	Treatment (Mean±SD)	Control (Mean±SD)	
Pre	57.77±41.088	57.08±36.605	-
Post	25.69±32.242	40.92±39.129	0.336 [‡]
p	0.001 [∗]	0.059 [‡]	-
Delta	-32.08±28.663	-16.15±27.859	0.169 [‡]

Description: p = significance value; [‡] = Mann whitney;

[∗] = Wilcoxon; [‡] = Paired t test

The results in Table II above show a significant improvement in the intercluster tests to compare the post-test scores between control and treatment clusters, a significant result was obtained with a P value < 0.001. The delta between the pre- and post-test on treatment cluster compared to control cluster showed a significant P value in the memory function which means that the memory scores in the treatment cluster had a significant improvement compared to the control cluster.

In the mood state as shown on table 3, the significant difference was shown in the treatment cluster with the P value of 0.001, meaning that the total mood disturbance (TMD) score is lower in the treatment cluster compared to controls.

DISCUSSION

This research aims to study how plyometrics training affects short-term memory and mood states in medical students of Diponegoro University. During the research, no subjects were found dropped out, all subjects completed the plyometrics training for 6 weeks. This 6-week training time was chosen because nerve and physiological adaptation occurs within the duration of the 6-week exercise (13).

During exercise, regional cerebral blood flow will increase by 16% as blood speed in major cerebral arteries and blood flow in internal carotid artery increase, expected to deliver necessary nutrients and oxygen to the brain to enhance cognitive function and lead to improved memory (10). Besides, exercising has been shown to improve short-term memory through

its mechanism of increasing oxygenated hemoglobin levels and decreasing deoxygenated hemoglobin levels in the prefrontal cortex (11). In addition, there was an increase in pre and postsynaptic proteins in the orbitofrontal cortex which is also part of the prefrontal cortex (12). Previous research has also found that there was an increase in astrocyte cell body areas seen with immunolabeling calcium-binding protein B (S100B) and glial fibrillary acidic protein (GFAP) markers in the medial prefrontal and orbitofrontalis cortex. S100B and GFAP are astrocytic markers used as biomarkers to evaluate activities in some specific brain area. In this study the researchers evaluate these biomarkers to see prefrontal cortex and orbitofrontalis cortex activities. Increased activity in the prefrontal cortex will then make the ability of short-term memory better and optimal (12).

Exercise also increased hypothalamus neurotransmitter such as dopamine, serotonin and norepinephrine. Production of these three neurotransmitters can lead to positive change in the mood of each individual (e.g feeling comfortable, satisfaction, etc) (14). Exercise can also help improve appetite and sleep cycles, which are often negatively affected by depression and promote all kinds of changes in the brain, including nerve growth, reduced inflammation, and can cause feelings of calm and well-being (15,16).

The significant difference found in the control group in the memory test may suggest the effect of practice. Limitation of the study included the sample size, other exercises that the subjects may perform during the experiment, and confounding factors contributing to the results in both memory and mood variables.

CONCLUSION

A six-week plyometrics training is proven to improve short-term memory in students who underwent plyometrics compared to the control group. Similar result is also observed in mood state in male medical students of Diponegoro University. Further studies are necessary to observe the effect of plyometrics training on short-term memory and mood with bigger sample size and more varied subjects' backgrounds.

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