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THE EFFECT OF PLYOMETRICS TRAINING ON ATTENTION LEVEL AMONG MEDICAL STUDENTS

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ABSTRACT

Introduction: Plyometrics are a popular form of physical exercise that plays an important role on the improvement of athlete's performance, such as agility and muscle power. However, the effect of plyometrics training on neurocognitive function has not been studied yet. The aim of this study was to analyze the effect of plyometrics training on attention level among medical students. **Methods:** A quasi experimental study with pre and post-test with control group design. The subjects were 36 male students in Faculty of Medicine, Diponegoro University with range of age 15 to 25 years old. Subjects were divided into 2 groups: C (control group) and EP (experimental group). The EP group undergone plyometrics training for 6 weeks. Each week consists of 2 sessions exercise with 5 movements every session. The indicator of examination was attention level using Attention Networks Test. It was measured before training and after 6 weeks of training. **Results:** A significant improvement of attention function was found in alerting, orienting, and executive function after plyometrics training for 6 weeks with $p<0,001$. After 6 weeks of plyometrics training, there was an improvement of alerting function in EP group with median 77,7 (49,8 – 111,1) ms to 58,45 (4,9 – 90,4) ms, improvement of orienting function with median 24,45 (2 – 89,3) ms to 19,2 (-0,3 – 88,8) ms, and executive function with median 74,1 (39,8 – 220,8) ms to 49,2 (-21 – 102,1) ms. **Conclusion:** Plyometrics training for 6 weeks can improve attention level among medical students.

Keywords: attention level; attention network test; plyometrics training

INTRODUCTION

In recent years, there has been a shift in the lifestyles of various age-groups, people today are leading increasingly to sedentary lifestyles [1]. It has been reported in "Riset Kesehatan Dasar Indonesia" that 1 in 4 Indonesians people has sedentary behavior more than 6 hours per day. 26.1% of Indonesia's population is physically inactive [2]. Furthermore, study in America shows a correlation between physical inactivity and risk factor of numerous chronic diseases and premature death such as heart disease, cancer and diabetes [3]. On the other hand, the CDC (Centers for Disease Control and Prevention) mentions the lack of physical activity as one of the actual causes of the decline in learning process [4].

Physical activity can enhance neurocognitive function, such as memory and attention function [5]. A study by Fernando Maureira, et al shown a correlation between physical exercise and academic achievements, which may be influenced by attention, working memory,

and executive functions [6]. The studies carried out in recent years provide more and more evidence of the beneficial effects of physical exercise on brain function. In fact, attention level plays an important role in academic performance as basic cognitive function whereas attention divided into three functional components: alerting, orienting, and executive function [7].

Another study in 2015 by K.Vadivelan et al suggest that plyometrics training is advantageous for developing lower body explosive power and agility whereas agility is an ability of the neuromuscular system to coordinate explosive changes of direction of an individual and/or multiple body segments in all planes of motion at variable velocities by an efficient and effective manner [8]. An athlete with good agility will most likely to possess qualities such as speed, strength, balance, coordination and spatial awareness [8]. In addition, connections between the vestibular, cerebellum, hippocampus, and the prefrontal and parietal cortex can provide information on cognitive functions such as spatial functions and attention itself by stimulated prefrontal cortex (PFC) as an area of attention [9,10,11]. Plyometrics training also can enhance coordination and balance between both brain hemispheres [8,12]. Fred wilt one of American's more forward-thinking track and field coaches first coined a Latin origin term; Plyometric is interpreted to mean "measurable increase", involves an active muscle switching from a rapid eccentric muscle action to a rapid concentric muscle action (or) from a rapid deceleration to a rapid acceleration known as stretch –shortening cycle. [13,14]

MATERIALS AND METHODS

A quasi experimental study with pre and post test with control group design. The subjects were 36 male students in Medical Faculty of Diponegoro University with age ranged 15 to 25 years old. The subjects was collected by purposive sampling with inclusion and exclusion criteria. 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 and possible side effects.

Subjects were divided into 2 groups: C (control group) and EP (experimental group). The EP group was given plyometrics training for 6 weeks. Each week consists of 2 sessions exercise and 5 movements each session. The indicator of examination was attention level using Attention Networks Test. It was measured before training and after 6 weeks of training.

Data analysis were performed using SPSS. Data analysis includes descriptive analysis and hypothesis. Alerting, orienting, and executive score pre and post were analyzed using Wilcoxon test. Alerting, orienting, and executive score between EC and C group were analyzed using Mann-Whitney U.

RESULTS AND DISCCUSSION

Attention assessment is carried out with the ANT application that can check the level of attention in general and provide

specific information related to the function of each component. Manipulation of instructions and flanker will bring up various conditions that correspond to certain attention components. The alerting function assessment is done by reducing the mean reaction time of the double cue condition from the no cue. The orienting function is measured by reducing the mean reaction time of the spatial cue conditions from the center cue. While the executive control component is assessed by reducing the mean reaction time of congruent conditions from incongruents, both preceded by instructions or without instructions

The research showed significantly different attention scores between EP group who was given plyometrics training for 6 weeks compared with C group (p≤0,001). Statistical analysis data shows that the three components of attention in the form of alerting, orienting and executive functions correlate positively with the training given.

Table 1. The difference of attention function (alerting, orienting, and executive score) between EP and C group

Attention function	Median (min-maks)		$p^{\#}$
	Experiment	Control	
Alerting			
Pre	77,7 (49,8 – 111,1)	79,1 (50,2 – 160,1)	0,203
Post	58,45 (4,9 – 90,4)	74,4 (50 – 151,5)	0,003*
Deviation	-18,6 (-44,9 – (-8,3))	-3,35 (-28,5 – 1,6)	<0,001*
$p^{\$}$	<0,001*	0,005*	
Orienting			
Pre	24,45 (2 – 89,3)	25,35 (2 – 89,3)	0,282
Post	19,2 (-0,3 – 88,8)	25,95 (2,2 – 80,9)	0,012*
Deviation	-7,3 (-24,8 – (-0,5)	0,05 (-8,7 – 22,3)	0,001*
$p^{\$}$	0,001*	0,962	
Executive			
Pre	74,1 (39,8 – 220,8)	85,7 (43,7 – 258)	0,358
Post	49,2 (-21 – 102,1)	83,25 (20,1 – 220,8)	0,001*
Deviation	-30,55 (-118,7– (-1,2)	-0,8 (-57,1 – 11,1)	0,001*
$p^{\$}$	<0,001*	0,063	

Description : [#]the comparison of attention function between EP and C group with the Mann Whitney U test
[$]the comparison of attention function between pre and post test with the Wilcoxon test
* the significant difference with p<0,05

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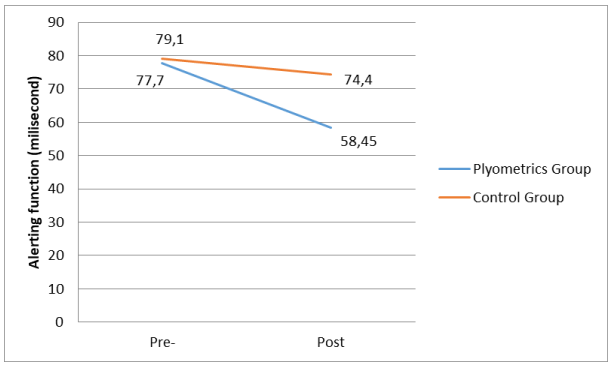

Figure 1. The Comparison of Alerting score (Pre and Post) Between EP and C group (milisecond)

The difference of alerting score pre and post test between EP and C group are shown in Table 1 and Figure 1. The alerting function in EP group showed significant results with a value (p <0.001) between pre and post test after undergoing training for 6 weeks, where there was an increase in the speed of the alerting function in EP group from 77.7 (49.8 - 111.1) millisecond to 58.45 (4.9 - 90.4) millisecond. From the table also found a significant difference for the time difference pre and post test between EP and C group (p <0.001).

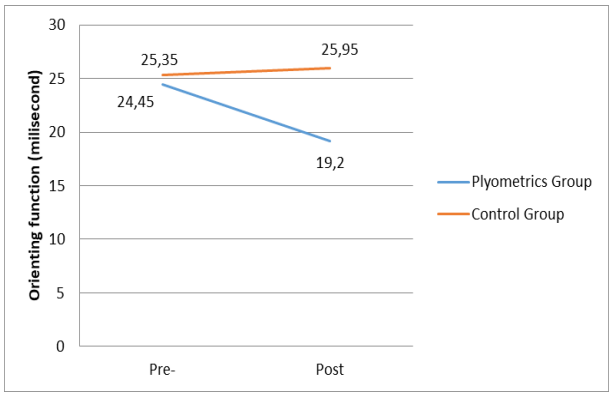

Figure 2. The comparison of Orienting score (Pre and Post) between EP and C group (milisecond)

The difference of orienting score pre and post test between EP and C group are shown in Table 1 and Figure 2. The orienting function in EP group showed significant results with a value (p = 0.001) between pre and post test after undergoing training for 6 weeks, where there was an increase in the speed of the orienting function in EP group from 24.45 (2 - 89.3) millisecond to 19.2 (-0.3 - 88.8) millisecond. From the table also found a significant difference for the time difference pre and post test between EP and C group (p = 0.001).

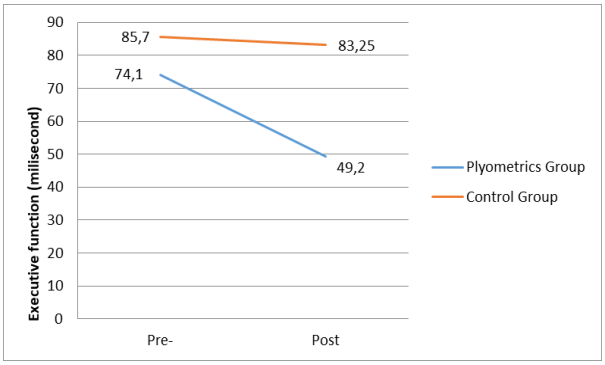

Figure 3. The comparison of Executive score (Pre and Post) between EP and C group (milisecond)

The difference of executive score pre and post test between EP and C group are shown in Table 1 and Figure 3. The executive function in EP group showed significant results with a value (p <0.001) between pre and post test after undergoing training for 6 weeks, where there was an increase in the speed of executive functions in EP group from 74.1 (39.8 - 220.8) millisecond to 49.2 (-21 - 102.1) millisecond. From the table also found a significant difference for the time

difference pre and post test between EP and C group (p = 0.001).

The results of this research are in accordance with previous studies that mentioned a relationship between physical activity or exercise with increased of attention function[10]. Physical activity carried out routinely can increase neural adaptation and neurogenesis processes in the brain. This is induced by an increase in B-endorphins, vascular endothelial growth factor (VEGF), brain derived neurothropic factor (BDNF) and serotonin(5-HT) and cause increased connection between vestibular nuclei and cerebellum, hippocampus, and prefrontal and parietal cortex[15,16].

When doing plyometrics training, balance training is important things to note, since this training allows muscles to reach maximum strength in the shortest possible time so that speed and strength are needed to produce explosive movements[13,17]. In a balanced state the body try to maintain its stabilization, allowing the body to make corrections, and become accustomed to rapid changes. Perception of movement and balance is regulated by the vestibular system in relation to proprioceptive and visual signals. The connection between the vestibular nuclei and cerebellum, hippocampus, and prefrontal and parietal cortex can provide information on cognitive functions such as spatial, navigation and memory functions. This can induce changes in the structure of the hippocampus and parietal cortex through direct pathways between the vestibular system and the brain. In humans the ability to maintain body balance is related to the large volume of the hippocampus, basal ganglia and frontal or parietal cortex. The effect of this balance correlates with activation of the vestibular system in improving memory and spatial cognition[9,10,18].

Attention and memory play an important role in the cognitive process[19]. Attention helps the individual to limit information both from outside (sensation) or from within (mind and memory) so that the individual can focus his mind on something that is interesting or important thing[20,21,22]. This process is related to the activation of mediodorsal thalamus in reinforcing information on the PFC. At the time of doing the training, PFC is activated in making decisions when making movements. This allows PFC to be able to focus only on one thing[10]. From the above explanation it can be concluded that memory will not be formed without the precedence of attention[23,24].

Statistical analysis shows that plyometrics training conducted routinely for 6 weeks on subjects aged 15-25 years positively influences the alerting function. This result is supported by research conducted by Larry Cahil, et al who mentioned that exercise will activate arousing activity, so it is very natural that the alerting function will be modulated by exercise intensity and duration[25]. The Alerting function which is a function of alertness is regulated in the thalamus, parietal and frontal cortex. The influence of thalamus by the mechanism can lead to changes in the alerting function. Research conducted by Ahmad S. Rajab et al, Yale University supports the results of research that is exercising to affect the basal ganglia

area or more specifically to mention the area referred to as the thalamus where the thalamus is an area of the brain anatomy that regulates the alerting system[26].

The orienting score measurement is assessed by reducing the average reaction time with the target that has been given its location clue to the reaction time with the target whose instructions are in the middle (fixation point). This function involves visual stimulus which is the most widely used stimulus. Studies on the students of the Faculty of Medicine at Diponegoro University correlate positively with the training given. In EP group decreased reaction time was different as in the C group.

Visual orienting will increase the efficiency in processing a target by clarifying the sharpness of vision and the priority of objects where in this situation high control and concentration of each individual is needed. If it turns out that the object which is the center of attention is inappropriate then orienting will be shifted towards the object's appearance. This gives rise to activity at the temporo-parietal junction as an anatomical area of the brain that plays a role in regulating orienting functions[7,27]. On the other research shows Spontaneously Hypertensive Rats (SHRs) or commonly used ADHD animal models, showing good orientation responses after being given physical training using a walking wheel through changes in noradrenergic function by blocking noradrenergic receptors during exercise. These results provide information about the potential effects of exercise as a treatment for mental disorders. During exercise, inter-nerve synapses are strengthened and increase of brain acetylcholine levels, especially in the hippocampus and cortex. This increase in acetylcholine supports the formation of hippocampal theta, which serves to increase synaptic plasticity and the formation of memory and attention. In addition, it is also known that acetylcholine is a neurotransmitter involved in orienting function[28].

Some researchs show that executive function is related to academic performance. In previous studies, a positive relationship was shown in subjects from 83.27 ± 41.19 to 49.22 ± 27.22 ($p < 0.001$). The executive process is usually studied by carrying out tests that involve conflict. Executive control in attention network test is calculated by reducing the average time with congruent targets to reaction times with incongruent targets. This significance is supported by Satoko Ohmatsu et al. which showed the activity of anterior cingulates through EEG during exercise[29]. The executive control function involves planning, decision making, error detection, assessment of the conditions encountered and regulation of mind-feelings[30]. This system is associated with the anterior singular cortex, basal ganglia and lateral prefrontal cortex which involve dopamine activity[27].

CONCLUSION

There is correlation between plyometrics training and improvement of attention level among medical student of Diponegoro University. The training programs presented in our study can be successfully applied for increasing attention

level for students who has problem in learning process as well as attention underlie academic performance.

Future research is needed to establish plyometrics training as a non-pharmacological therapeautic intervention of attention deficit disorder such as ADHD.[31]

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