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COMPARISON OF PLYOMETRICS AND AEROBIC EXERCISES ON ATTENTION LEVELS IN YOUNG ADULTS

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ABSTRACT

Background. Plyometrics and aerobic training is a form of exercise that is easily applicable to all people. Plyometrics and aerobic trainings are proven to improve attention level in previous study. **Objective.** The aim of this study is to compare the effect of plyometrics training and aerobic training on attention level of young adults. **Methods.** A quasi-experimental study with pre and post test&control group design. The subjects were all male, with age range from 18 to 23 years old. Subjects were divided into 3 groups: C (control), EP1 (plyometrics training), and EP2 (aerobic training; with 20meters multistage shuttle test design) . Both EP groups was given training for 6 weeks, twice a week. The attention level was measured using Attention Networks Test. **Results.** After 6-weeks of training, attention score in both of experimental groups were better than the control group. In EP1, all of the attention level component which was alerting, orienting, and executive increases significantly ($p<0,01$). In EP2, only alerting ($p<0,01$) and executive ($p=0,01$) increase significantly. Plyometrics training is proven to increase the attention level higher than aerobic training, with significant increase in alerting ($p=0,012$), orienting ($p=0,016$), and executive ($p=0,02$). **Conclusion.** Plyometrics training is proven to increase attention level better than aerobic training in young adults.
Keywords*: aerobic training, attention networking test, attention level, plyometrics training*

INTRODUCTION

Research conducted by Dumith, et al in 76 countries in the world stated that 21,4% of the world's population is physically inactive. [1] In Indonesia, 33,8% of the population is physically inactive.[2]

Lack of physical activity has an impact on various disease that causes highest rate global mortality. [1] Physical activity is proven to enhance on cognitive function and academic achievement at school. [3] Furthermore, physical activity will make structural changes in the brain, such as increasing the volume of gray matter in the frontal and hippocampal areas.[4]

Plyometrics training is a form of training combined basic movements, such as walking, running and jumping with the aim of producing high muscle explosive power. This exercise can be done in both indoors and outdoors within short period of time with minimal equipment. Previous research has shown the benefits of plyometrics training to increase muscle explosive power and agility.[5] Study conducted by Mahardika, et al shows that 6 weeks of plyometrics training can significantly increase attention levels.[6] It activates both hemispheres of the brain so that the brain will try to maintain its stability and rapid correction. In a long term, it will increase spatial awareness and memory.[5]

Aerobic exercise is kind of exercise that is highly whose energy supply depends on aerobic metabolism.[7] Most aerobic exercise can be done without any tools, and also can be performed both indoors and outdoors. Previous studies show that aerobic exercise performed in both short and long term improves overall cognitive function, such as prefrontal region oxygenation enhancement, which is associated with cognitive performance. The effect includes increased Brain Derived Neutrophics Factors, increased catecholamines and hormones on the Hypothalamic-Pituitary-Adrenal axis. [8]

The attention process is one of the components in memory consolidation stage, consisting of three components, which is alerting, orienting, and executive control. [9]

Both of the trainings are highly applicable to people, can be done easily and proven to have benefits on cognitive level. Although previous studies indicated that both plyometrics and aerobics training have its benefit on improving attention level, there is no study that proves which trainings have better result on improving attention level. Researchers are interested to identify which training have better effect on attention level.

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METHODOLOGY

The study design was quasi-experimental with pre and post-test with control group. There were three groups involved in this study: control (C), plyometrics training (EP1), and aerobic training with 20mMST design (EP2).

The subjects were all male, young adults, students of Faculty of Medicine, Diponegoro University aged 18-23 years. The BMI of subjects should be around 18-25 kg/m^2, and have the ability to operate computer. The subject must not have neuromuscular disorders, drugs consumption, and uncorrected eye refractive errors. The sampling was done by purposive sampling. The number of subjects for each group was 18 people, which would make the total of subjects in this study 54 people.

Ethical clearance was obtained from Komisi Etik Penelitian Kedokteran (KEPK), Faculty of Medicine, Diponegoro University. Before signing the informed consent, subject were given a brief explanation of the objective, research regulation, and possible side effects.

Subject were divided into three groups: control (C), plyometrics training (EP1), and aerobic training with 20mMST design (EP2). Both EP groups were given 6 weeks of training, twice a week.

EP1 group was trained to perform a series of movement which consists of following movement: side shuffle, straddle hops, lateral jump lunge, and bunny hops. In this training agility ladder was used to precise each movement. On the other hand, EP2 group did a 20mMST shuttle run on straight tracks. Each experimental group did two sets of the movement initially, and every two weeks another set was added.

Attention level was measured by Attention Network Test software, before training and after 6 weeks of training. Attention level measurement was held in a room with adequate lighting using laptop.

Data analysis was performed using SPSS, including descriptive, analysis, and hypotheses. The pre and post test data analysis was performed using Wilcoxon test, while the comparison after training was analyzed with Kruskal-Wallis test followed by Mann-Whitney test.

RESULTS

This research was conducted from July to September 2020, with the participation of 54 subjects that met a demand of both inclusion and exclusion criteria. In the middle of the experiment, researcher could not follow up one of the subject, and two subjects had technical difficulties. Therefore, the subjects of this study that could be analyzed were 51 people.

The mean age of our subjects was 20,19±0,89, while the average BMI was 22,40±1,18, in the range from 18 to 25. All subject did not have neuromuscular abnormalities (0%), no history of uncorrected eye refractive errors (0%), no history of consuming drugs (0%), and all of them can operate computers (100%).

Attention level itself consists of three component, which was alerting, orienting, and executive control. The score was obtained from the reaction time of pressing the keyboard button that suits the arrow on the screen, so that the smaller the score, the better the attention level is.

There was a positive difference in the alerting score of the control group between pre-test and post-test, but the difference was not significant. ($p = 0.074$; Wilcoxon test). In the plyometrics group, there was an increase in the alerting score from 78,35±6,19 to 32,29±4,04, and the difference was significant ($p = <0.001$; Wilcoxon test). In the aerobic group there was also an increase in the alerting score from 67,70±5,04 to 48,29±4,06 with a significant difference ($p = <0.001$; Wilcoxon test).

The results of the ANT score assessment in the alerting component, comparisons between groups showed that there was an increase in the alerting score after 6 weeks of training, on both plyometrics and aerobics training group. Based on figure 1, the score of the plyometrics group was the highest alerting score among the three groups with significant differences compared to the control group ($p = 0.07$; Mann-Whitney test) and aerobic group ($p = 0.012$; Mann-Whitney test). There was a positive correlation with the alerting score of the aerobic treatment group for 6 weeks, but the difference was not significant compared to the control group. ($p = 0.502$; Mann-Whitney test). (Significance $p < 0.05$; Mann-Whitney test).

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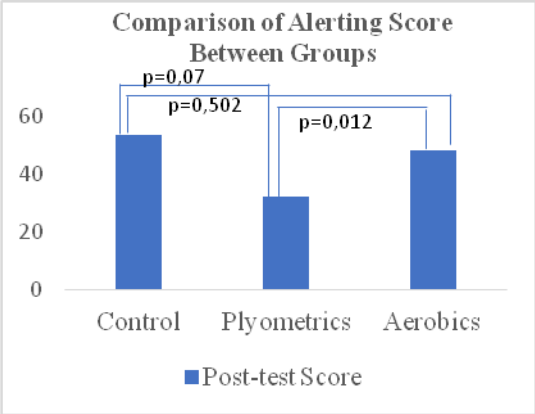

Figure 1. Comparison of alerting score between groups (milliseconds)

The results of the orienting component assessment showed that in the control group there was a decrease in the orienting score from 35,41±4,42 to 40,23±5,71 with no significant difference (p = 0.938; Wilcoxon test). There was an enhancement in scores in both experiment groups, but in the plyometrics group there was a significant difference (p <0.001;Wilcoxon test), while in the aerobic group there was an increase in scores, but there was no significant difference (p = 0.097; Wilcoxon test).

Figure 2 shows that the plyometrics training group was the group with the highest score with significant differences compared to the control group (p = 0.018; Mann-Whitney test) and the aerobic training group (p = 0.016; Mann-Whitney test). Treatment in the aerobic group also caused a positive increase, but there was no significant difference (p = 0.428; Mann-Whitney test).

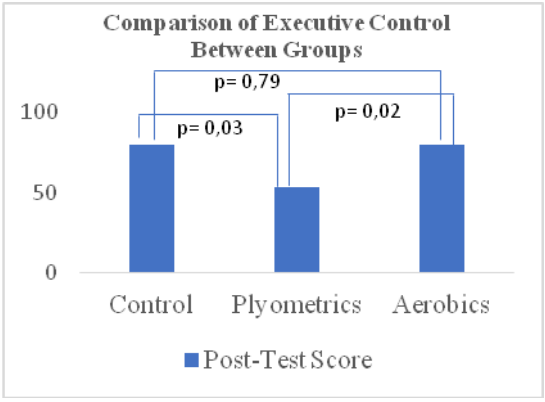

Figure 2. Comparison of executive control score between groups (millisecond)

There was a positive increase in the three groups on the executive control component, but there was a significant difference in the plyometrics group (p <0.001; Wilcoxon test) and the aerobic group (p = 0.001; Wilcoxon test). There was no significant difference in the control group.

From the figure 3 we can conclude that the highest executive control score was the plyometrics group, followed by the aerobic group and the control group. The plyometrics group had a significant difference compared to the control group (p = 0.03; Mann-Whitney test) and also the aerobic group (p = 0.02; Mann-Whitney test). The aerobic group and the control group did not have a significant difference (p = 0.79; Mann-Whitney test).

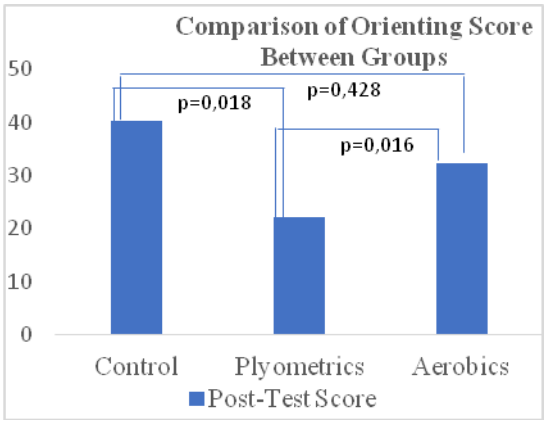

Figure 3. Comparison of orienting score between groups

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Table 1. ANT score from each component

Time of measurements	Groups			p§
	Control	Plyometrics	Aerobics	
ALERTING				
Pre-test	68,41±5,90	78,35±6,19	67,70±5,04	0,499§
Post-test	53,82±5,65	32,29±4,04	48,29±4,06	0,010§*
p¶	0,074¶	<0,001¶*	<0,001¶*	
ORIENTING				
Pre-test	35,41±4,42	48,76±4,90	42,64±5,58	0,226§
Post-test	40,23±5,71	22,23±2,43	32,35±2,75	0,019§*
p¶	0,938¶	<0,001¶*	0,097¶	
EXECUTIVE CONTROL				
Pre-test	102,47±13,39	106,58±6,03	104,58±9,34	0,499§
Post-test	79,82±9,00	53,41±6,75	79,58±8,53	0,036§*
p¶	0,587¶	<0,001¶*	0,001¶	

*Significance (p<0,05); §Kruskal-Wallis Test; ¶Wilcoxon Test

DISCUSSION

Statistical data analysis shows that there was a significant increase in the three components of attention after 6 weeks of plyometrics training group compared to the aerobic training group and the control group. These results indicated that plyometrics training for 6 weeks can improve attention better than aerobic training and not doing any training.

The results of this study are in line with previous studies which stated that physical activity can improve cognitive function. Increased cognitive function can occur due to increased speed of cerebral circulation. If there is an increase in cerebral circulation, there will be an increase in oxygen and energy substrates. [10,11].

After 6 weeks of plyometrics exercise, there was a significant increase in attention level. This can be related to the coordination and balance arrangements during plyometrics training. The balance is regulated in the vestibular system in which
there are connections between the cerebellum, hippocampus, prefrontal cortex, and parietal so that it can provide information on cognitive function.[12,13] During exercise, the prefrontal cortex is activated in making decisions to decide on the next move. This allows the prefrontal cortex to focus attention that is directly correlated with the attention process. [14]

The increase in the attention level of the three components of attention was also found in the aerobic treatment group, with a significant increase in the alerting component and executive control. This is in line with previous research, that aerobic exercise will increase BDNF secretion to help in memory creation which must be preceded by the attention process. [15] Aerobic exercise also increases antioxidants which are believed to increase attention levels. [8]

In previous studies, it was concluded that physical exercise, especially regular aerobic exercise, can increase the monoamine system neurotransmitters, such as dopamine, norepinephrine, and serotonin. [16] This is in line with the results of the study that there was a significant increase in the alerting and executive control components. In a study conducted by Jin

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Fan, et al, the alerting component is believed to be associated and induced with the neurotransmitter norepinephrine, while the executive control component is enhanced by the neurotransmitter dopamine. [9]

There was an increase in the attention score of both the plyometrics group and the aerobic group with the results of the three components of attention in the plyometrics group being better than the aerobic exercise group and the difference between the two groups was significant. This indicates that plyometrics exercise is better at increasing attention than aerobic exercise. This is in line with a study conducted by Netz in 2019 which states that exercises such as aerobic exercise will affect cognitive function in an indirect way, namely by improving cardiovascular function, then affecting the cerebral circulation and improving cognitive function including attention level. Furthermore, aerobic exercise will also increase neuroplasticity in general. On the other hand, patterned motor exercises such as plyometrics exercise will increase the neuroplasticity of the brain in certain areas such as the area of the association prefrontal cortex for attention processes, so that the effects will be more specific. In addition to that, Netz et all proved that in dual task exercise that is composed of several movements performed simultaneously such as plyometrics training needed more cognitive demands balance the body, or to remember the next step of the movement. Therefore, dual-task exercise like this have been shown to significantly improve cognitive function compared to single-task exercises such as the 20mMST exercise. [17]

The limitations of this study were the change of plan in how the study was conducted offline but it must change to half online (monitored via video conference) and half offline due to the Corona Virus Disease-19 (COVID-19) pandemic so researchers could not observe all activities of the subject, for example, nutrition and daily activities of the subjects directly.

It is necessary to do further research on various kinds of plyometrics training or aerobic exercise designs other than 20mMST to develop the study in sports medicine science and its benefits on improving cognitive function.

CONCLUSION

Plyometrics training has been shown to increase attention levels better than 20mMST aerobic exercise and no exercise at all in young adult population.

ETHICAL APPROVAL

Ethical Clearance (No: 103/KEPK/FK-UNDIP/VI/2020) has been obtained from Komisi Etik Penelitian Kedokteran (KEPK), Faculty of Medicine, Diponegoro University

CONFLICT OF INTERESTS

The authors declare no conflict of interest.

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AUTHORS CONTRIBUTION

Conceptualization, KMS, EK, YP. Methodology, KMS, EK, YP. Software, KMS. Writing—review and editing, KMS, EK, YP, M.

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