Regular High Intensity Circuit Training Improves Attention Function and Reaction Time Among Male Young Adults

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ORIGINAL ARTICLE

Regular High Intensity Circuit Training Improves Attention Function and Reaction Time Among Male Young Adults

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ABSTRACT

Introduction: Several studies have analyzed the benefits of High Intensity Circuit Training (HICT) in some cognitive function such as short-term memory. However, the effect of long-term and regular HICT particularly in young adults, who need good cognitive function including attention function to improve the learning process, has not been studied yet. This study is aimed to analyze the effect of regular HICT in attention function improvement of young adults. **Methods:** This study was a quasi-experimental study with pre-test and post-test un-equivalent group method. Samples were taken purposively from medical student of Diponegoro University (n=56, age=18-22 years old), who were divided into two groups, the control and training group. Attention Network Test (ANT) was used to measure attention function in alerting, orienting and executive function before and after HICT. The data were analyzed using Paired t-test, Independent t-test, Wilcoxon test, and Mann-Whitney test. **Results:** A significant improvement of attention function was found in executive function and reaction time after High Intensity Circuit Training for 8 weeks ($p<0.05$), with mean 15.67ms to 14.36ms; 620.46ms ± 110.13 to 573.14ms ± 67.11, respectively. The mean difference between pre-test and post-test attention function test was found increased in alerting, executive function and reaction time ($p>0.05$), that training group had higher score as compared to control group, with mean difference 0.7857ms; 31.3ms; 30.29ms, respectively. **Conclusion:** Regular High Intensity Circuit Training improves attention function particularly in executive function and reaction time in male young adults.

Keywords: Attention function, Attention Network Test, High Intensity Circuit Training, Reaction Time

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INTRODUCTION

Exercise is an effective activity to train the health of body and soul, including cognitive function (1,2). It could reduce the progressivity of cognitive function decline that caused of getting older (3). Attention is a cognitive process to select important information that received from sensory system from around (4). This function is crucial to perform the daily activity properly, such as driving, studying, etc (5). Vigorous intensity exercise, that could rise heart rate to 70-85% of maximum heart rate, is still inconsistent in cognitive function effect. Previous study reported that vigorous intensity exercise could increase cognitive function in executive attention, concentration, and spatial memory particularly in young adult population, however another study informed its decreasing in elderly population (7-9).

High Intensity Circuit Training (HICT) is one of a simple vigorous intensity exercise that combine aerobic and resistance exercise into 12 movements in 7 minutes, can be perform anywhere and only need one chair. It was effective to reduce body weight, increase VO_2 max, as well as improve short term memory in male young adult and children (9,10). However, no report has been found about the effect of HICT in attention function in male young adult, especially in medical student, a known population with tight study activities and rare exercise. This study's aim is to investigate the effect of HICT in attention function, including alerting, orienting, and executive function as well as reaction time in male young adult.

MATERIALS AND METHODS

Subjects of study

This research method was quasi experimental with pre- and post-test comparison group. The subject was taken by purposive sampling method among male medical students of Diponegoro University with age

range from 18 to 20 years old, normal body mass index (BMI) with range 18.5-24.9 kg/m^2, without /repaired impairment of refraction, no impairment of superior and inferior extremities as well as neuromusculoskeletal that have proven by questionnaire filling and physical examination. This male subject was chosen, because to avoid the female hormonal influence in attention by alter the dopamine level (11). There was total of 62 subjects, divided into two groups, control and intervention. The subjects should not consume caffeine routinely, alcohol, smoking, and did not have a habit to perform HICT routinely before. After explained about the concept of study, which was doing HICT only during the study, and taking Attention Network Test (ANT) before and after HICT, subjects signed the informed consent. We excluded subjects who had a history of respiration, cardiovascular and psychiatric disease. Six subjects were drop out, which were neither attended less than 75% of total HICT exercise nor only followed less than 75% of movement, therefore 56 subjects were analyzed for ANT.

High Intensity Circuit Training (HICT)

HICT exercise was done indoor inside the Faculty of Medicine Diponegoro University's building from April to June 2018. The exercise consisted of the simple vigorous intensity exercise that combine aerobic and resistance exercise into 12 movements in 7 minutes using one chair, with the frequency of 3 times a week for 8 weeks.

Attention Function Measurement

The attention value of both groups was measured by Attention Network Test (ANT) software in the beginning and end of 8 weeks HICT performing. The participants undergone ANT test in Computer Laboratory Faculty of Medicine Diponegoro University in the morning time, after taking breakfast.

Ethics Approval

Prior to data collection, ethical approval was obtained from the Medical Research Ethical Committee, Faculty of Medicine Diponegoro University and Kariadi Hospital, Indonesia. The Ethical Clearance of this research was No. 197/EC/KEPK/FK-RSDK/IV/2018.

Statistical Analysis

The normality of data's distribution was determined using Kolmogorov-Smirnov test (n>50). The data that normally distributed was analyzed using the paired and independent T test, and other data used the Wilcoxon and Mann-Whitney test. The data was analyzed using SPSS v.23.0, and the significant difference was determined when the p value < 0.05.

RESULTS

Characteristics of Subject

All subjects were male young adults from age 18 – 20 years old, with the average at 19.75±1.14. The average height of subjects was 167.68±5.68 cm with weight 61.82±6.88 kg. The normal BMI was found in all subjects with the average was at 21.95±2.03 kg/m^2. The subject's characteristic can be seen in Table I.

Table I : Characteristic of Research Subjects

Variable	Control (n=28)	Intervention (n=28)
Height (cm)		
150-159	1	1
160-169	17	12
170-179	9	13
180-189	1	2
Mean (SD)	167.68 (5.677)	170.71 (6.710)
Weight (kg)		
40-49	1	-
50-59	9	9
60-69	12	9
70-79	6	9
80-89	-	1
Mean (SD)	61.82 (6.875)	63.64 (8.795)
BMI (kg/m^2)		
18.0-20.9	8	12
21.0-23.9	12	9
24-24.9	8	7
Mean (SD)	21.953 (2.031)	21.897 (2.132)
Age		
18-19	10	22
19-20	18	6
Mean (SD)	19.75 (1.143)	18.93 (0.716)

Attention Function before and after HICT Exercise

This study found a significant ($p<0.05$) decreasing of attention time in executive function, as well as reaction time (129.32 ± 54.45 ms to 101.21 ± 36.39 ms and 620.46 ± 110.13 ms to 573.14 ± 67.11 ms, respectively), which means improvement of attention function particularly in executive function and reaction time could be obtain after performing regular HICT for 8 weeks (Table II).

Attention Function Difference between HICT and Control Group

The time differences of alerting function and reaction time between HICT and control group are not

significant (p > 0.05). However, the time in exercise group are greater than control group (0.79±27.08 ms vs -3.79±50.23 ms and 47.32±94.94 ms vs 20±19.19 ms for alerting and reaction time, respectively), indicating that HICT exercise for long-time and regular could still have effect on alerting and reaction time (Table III).

Table II : Attention Value Difference before and after High Intensity Circuit Training (HICT)

	Attention Function; Mean±SD (min-max)		*p*
	Pre-test (ms)	**Post-test (ms)**	
Alerting	54.86±36.50 (8-176)	54.07±36.22 (-45-150)	0.95¥
Orienting	33.46±26.86 (-43-107)	41.07±23.55 (-7-93)	0.239#
Executive	129.32±54.45 (35-324)	101.21±36.39 (22-169)	0.000¥*
Reaction Time	620.46±110.13 (471-1028)	573.14±67.11 (464-701)	0.014#*

#= paired-t test; ¥= Wilcoxon test; SD= standard of deviation; ms= milli-second; min= minimum; max= maximum; p= significant value; *=significantly different (p<0.05)

Table III : Attention Value Difference between High Intensity Circuit Training (HICT) and Control Group

Group	**Δ Attention Function (ms) Mean±SD (min-max)**	*p*
Alerting		
Control	-3.79±50.23 (-100-122)	0.505#
HICT	0.79±27.08 (-41-75)	
Orienting		
Control	-2.21±32.00 (-81-104)	0.92¥
HICT	-7.61±33.44 (-89-92)	
Executive		
Control	52.39±164.87 (1-892)	0.198¥
HICT	28.11±42.02 (-66-181)	
Reaction Time		
Control	20±19.19 (-18-62)	0.176¥
HICT	47.32±94.94 (-76-418)	

#= independent-t test; ¥= Mann Whitney test; SD= standard of deviation; ms= milli-second; min= minimum; max= maximum; p= significant value; *=significantly different (p<0.05)

DISCUSSION

Attention is a cognitive process that selecting all the information that come from the five senses (4). There is three kind of attention that can be measured by ANT that are alerting, orienting, and executive function (12). Alerting is an ability to reach or maintain alertness (12). This process is related to neurotransmitter norepinephrine (NE). NE synthesized by the hydroxylation of dopamine. In central nervous system (CNS), NE is released by neurons that located in locus coeruleus. Exercise increases neuron adaptation against the harmful stimuli especially from the stress. This adaptation mechanism is related to the expression of galanin which can hyperpolarize neuron who release NE and inhibit firing from neurons in locus coeruleus making a suppression effect in NE release (13). There is an increment of NE level in several brain regions such as hippocampus and amygdala in continuous treadmill exercise. In this study we found an increment of alerting before and after the intervention also the alerting value difference in intervention group is greater than the control group.

Orienting focused on the ability to prioritize sensory input by choosing the modality or the location. Cholinergic system is related to this process (12). In this study, we found a decrement of orienting before and after the intervention and also the orienting value difference in intervention groups is smaller than the control group. Our finding of this decrement is difficult to explain in previous finding, so additional research may be needed.

Executive function is an ability to solve a problem while giving attention. Dopamine is a neurotransmitter that modulate this process (14). According to a study in mice and primates that has been done before, a lesion in the area that produce Dopamine makes a significant impairment in attention. Tyrosine, catalyzed by tyrosine hydroxylase enzyme become L-dihydroxyphenyl alanine (L-DOPA), then converted into dopamine by DOPA decarboxylase enzyme. In the CNS, dopaminergic neurons located in two nuclei in the midbrain, that are substantial nigral and ventral tegmental nucleus. Axons from the dopaminergic neurons in substantial nigral connected to the striatum (nigrostriatal pathway) which is taking part in controlling the movement. Axons from the dopaminergic neurons in ventral tegmental nucleus can be projected to the whole cortex (mesocortical pathway) or going to the accumbent nucleus (mesolimbic pathway). These two pathway taking part in cognition and reward responses respectively. Exercise induces the increment of dopamine level by inducing the increment of calcium in serum which can affect the tyrosine hydroxylase enzyme and makes the increment of dopamine synthesis (15). In this study, we found a significant increment of executive function after the intervention. The executive function value difference in intervention group is greater than the control group. Executive function is important for organizing, initiating and doing a sequence of complicated work that is very important in our daily lives.

ANT method can also measure the mean of reaction time needed for solving each correct ANT clue. Reaction time is the time between the entry of the stimuli until

the occurrence of response. Reaction time can be the indicator of the ability of CNS to receive the stimuli and synchronize the movement to respond the stimuli that come from the peripheral nervous system (16). The long term exercise effect in the reaction time among basketball and baseball athletes have a faster reaction time than a non-athlete (17). Previous study stated that in comparing reaction time with intensity, the fastest choice reaction time occurring when the intensity is at 75% of Physical Work Capacity (PWC) (18).

This study has some limitations, such as the instrument for the measurement which is ANT has a long duration (around 30 min) and repetitive, this condition could make subject become bored, which can be a confounding variable in the attention value. Some subjective factors such as interest, motivation, habit and emotional status of each subject could be another limitation of this study. Attention value measurement after the intervention was held in the Ramadhan which make half of our subject did the test while fasting. Previous study reported that memory and problem solving was not affected by Ramadhan fasting (19). To minimize the effect of fasting, the test was held in the morning (7.30 am) because the best cognitive performance while fasting was in the morning (20).

CONCLUSION

Regular exercise of High Intensity Circuit Training can improve attention function particularly in executive function as well as reaction time in male young adults. Future studies on specific biomarkers are needed to investigate the detail pathway of HICT effect on cognitive function.

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