



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 in some cognitive function such as short-term memory. However, the long-term effect of High Intensity Circuit Training particularly in young adults has not been studied yet. This study is aimed to analyze the effect of regular High Intensity Circuit Training in attention function improvement of young adults. **Materials and 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 intervention. The data were analyzed using Paired T test, Unpaired T, Wilcoxon, and Mann-Whitney. **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; $620.46\text{ms} \pm 110.13$ to $573.14\text{ms} \pm 67.11$, 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.

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

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

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3 University with age range from 18 to 20 years old, normal body mass index (BMI) with range
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5 18.5-24.9 kg/m², without /repaired impairment of refraction, no impairment of superior and
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7 inferior extremities as well as neuromusculoskeletal. This was to avoid the female hormonal
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9 influence in attention by alter the dopamine level (11). There was total of 62 subjects, divided
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11 into two groups, control and intervention. The subjects should not consume caffeine routinely,
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13 alcohol, smoking, and did not have a habit to perform HICT routinely before. After explained
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15 about the concept of study, which was doing HICT only during the study, and taking Attention
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17 Network Test (ANT) before and after HICT, subjects signed the informed consent. We
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19 excluded subjects who had a history of respiration, cardiovascular and psychiatric disease. Six
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21 subjects were drop out, which were neither attended less than 75% of total HICT exercise nor
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23 only followed less than 75% of movement, therefore 56 subjects were analyzed for ANT.
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31 **High Intensity Circuit Training (HICT)**

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

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

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3 The normality of data's distribution was determined using Kolmogorov-Smirnov test ($n > 50$).
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5 The normal data was continued with the paired t test, and for the un-normal data distribution
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7 was used the Wilcoxon test and Mann-Whitney test. The data was significant difference if the
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9 value of $p < 0.05$.
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14 **RESULT**

15 **Characteristics of Subject**

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17 All subjects were male young adults from age 18 – 20 years old, with the average at $19.75 \pm$
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22 1.14. The average height of subjects was 167.68 ± 5.68 cm with weight 61.82 ± 6.88 kg. The
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24 normal BMI was found in all subjects with the average was at 21.95 ± 2.03 kg/m². The
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26 subject's characteristic can be seen in Table 1.
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31 **Attention Function before and after HICT Exercise**

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33 This study found a significant ($p < 0.05$) decreasing of attention time in executive function, as
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35 well as reaction time (129.32 ± 54.45 ms to 101.21 ± 36.39 ms and 620.46 ± 110.13 ms to
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37 573.14 ± 67.11 ms, respectively), which means improvement of attention function particularly
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39 in executive function and reaction time could be obtain after performing regular HICT for 8
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41 weeks, see Table 2.
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47 **Attention Function Difference between HICT and Control Group**

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49 The time differences of alerting function and reaction time in exercise group are greater
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51 ($p > 0.05$) than control group, indicating that alerting and reaction time could be increased with
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53 doing HICT regularly (please see Table 3).
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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


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3 enzyme. In the CNS, dopaminergic neurons located in two nuclei in the midbrain, that are
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5 substantial nigral and ventral tegmental nucleus. Axons from the dopaminergic neurons in
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7 substantial nigral connected to the striatum (nigrostriatal pathway) which is taking part in
8
9 controlling the movement. Axons from the dopaminergic neurons in ventral tegmental nucleus
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11 can be projected to the whole cortex (mesocortical pathway) or going to the accumbent nucleus
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13 (mesolimbic pathway). These two pathway taking part in cognition and reward responses
14
15 respectively. Exercise induces the increment of dopamine level by inducing the increment of
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17 calcium in serum which can affect the tyrosine hydroxylase enzyme and makes the increment
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19 of dopamine synthesis (15). In this study, we found a significant increment of executive function
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21 after the intervention. The executive function value difference in intervention group is greater
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23 than the control group. Executive function is important for organizing, initiating and doing a
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25 sequence of complicated work that is very important in our daily lives.
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33 ANT method can also measure the mean of reaction time needed for solving each correct ANT
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35 clue. Reaction time is the time between the entry of the stimuli until the occurrence of response.
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37 Reaction time can be the indicator of the ability of CNS to receive the stimuli and synchronize
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39 the movement to respond the stimuli that come from the peripheral nervous system (16). The
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41 long term exercise effect in the reaction time among basketball and baseball athletes have a
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43 faster reaction time than a non-athlete (17). Previous study stated that in comparing reaction
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45 time with intensity, the fastest choice reaction time occurring when the intensity is at 75% of
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47 Physical Work Capacity (PWC) (18).
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54 The instrument for the measurement which is ANT has a long duration (around 30 min) and
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56 repetitive, this condition could make subject become bored, which can be a confounding
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58 variable in the attention value. Some subjective factors such as interest, motivation, habit and
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1
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3 emotional status of each subject could be another limitation of this study. Attention value
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5 measurement after the intervention was held in the Ramadhan which make half of our subject
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7 did the test while fasting. Previous study reported that memory and problem solving was not
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9 affected by Ramadhan fasting (19). To minimize the effect of fasting, the test was held in the
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11 morning (7.30 am) because the best cognitive performance while fasting was in the morning
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15 (20).
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21 **CONCLUSION**

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24 Regular exercise of High Intensity Circuit Training can improve attention function particularly
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26 in executive function as well as reaction time in male young adults. 
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33 **ACKNOWLEDGEMENT**

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35 We thank Computer Laboratory, Faculty of Medicine Diponegoro University to providing the
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37 facilities for this study.
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Table 1. 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/m²)		
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)

Table 2. Attention Value Difference before and after High Intensity Circuit Training (HICT)

	Attention Function; Mean±SD (min-max)		<i>p</i>
	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 3. Attention Value Difference between High Intensity Circuit Training (HICT) and Control Group

Group	Δ Attention Function (ms) Mean±SD (min-max)	<i>p</i>
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)	0.412 [¥]
HICT	47.32±94.94 (-76-418)	

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

Malaysian Journal of Medicine & Health Sciences

Decision Letter (MJMHS-2020-0949.R1)

From: normala_ib@upm.edu.my

To: muflihatul.muniroh@fk.undip.ac.id

CC:

Subject: Malaysian Journal of Medicine & Health Sciences - Decision on Manuscript ID MJMHS-2020-0949.R1

Body: 15-Nov-2020

Dear Dr. Muniroh:

It is a pleasure to accept your manuscript entitled "REGULAR HIGH INTENSITY CIRCUIT TRAINING IMPROVES ATTENTION FUNCTION AND REACTION TIME AMONG MALE YOUNG ADULTS" in its current form for publication in the Malaysian Journal of Medicine & Health Sciences. The comments of the reviewer(s) who reviewed your manuscript are included at the foot of this letter.

Thank you for your fine contribution. On behalf of the Editors of the Malaysian Journal of Medicine & Health Sciences, we look forward to your continued contributions to the Journal.

Sincerely,
Dr. Normala Ibrahim
Editor-in-Chief, Malaysian Journal of Medicine & Health Sciences
normala_ib@upm.edu.my

Associate Editor Comments to Author:

Associate Editor
Comments to the Author:
(There are no comments.)

Reviewer(s)' Comments to Author:

Reviewer: 1

Comments to the Author
(There are no comments.)

Reviewer: 2

Comments to the Author
(There are no comments.)

Date Sent: 15-Nov-2020

Decision Letter (MJMHS-2020-0949)**From:** normala_ib@upm.edu.my**To:** muflihatul.muniroh@fk.undip.ac.id**CC:****Subject:** Malaysian Journal of Medicine & Health Sciences - Decision on Manuscript ID MJMHS-2020-0949**Body:** 09-Nov-2020

Dear Dr. Muniroh: Manuscript ID MJMHS-2020-0949 entitled "REGULAR HIGH INTENSITY CIRCUIT TRAINING IMPROVES ATTENTION FUNCTION AND REACTION TIME AMONG MALE YOUNG ADULTS" which you submitted to the Malaysian Journal of Medicine & Health Sciences, has been reviewed. The comments of the reviewer(s) are included at the bottom of this letter.

The reviewer(s) have recommended publication, but also suggest some minor revisions to your manuscript. Therefore, I invite you to respond to the reviewer(s)' comments and revise your manuscript.

To revise your manuscript, log into <https://mc.manuscriptcentral.com/mjmhs> and enter your Author Center, where you will find your manuscript title listed under "Manuscripts with Decisions." Under "Actions," click on "Create a Revision." Your manuscript number has been appended to denote a revision.

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Because we are trying to facilitate timely publication of manuscripts submitted to the Malaysian Journal of Medicine & Health Sciences, your revised manuscript should be submitted by 23-Nov-2020. If it is not possible for you to submit your revision by this date, please write to us for the extension.

Once again, thank you for submitting your manuscript to the Malaysian Journal of Medicine & Health Sciences and I look forward to receiving your revision.

Sincerely,
Dr. Normala Ibrahim
Editor-in-Chief, Malaysian Journal of Medicine & Health Sciences
normala_ib@upm.edu.my

Associate Editor Comments to Author:

Associate Editor
Comments to the Author:
(There are no comments.)

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Associate Editor
Comments to the Author:
(There are no comments.)

Reviewer(s)' Comments to Author:

Reviewer: 1

Comments to the Author

1. Method

- a. Add ethical clearance information in the method
- b. In the statistical analysis part, change "un-normal" to another word
- c. Add SPSS information software that you used to analyze the data. (such as SPSS Version 25.0 etc)

2. Result

- a. Change the word "see table 2" and "please see table 3" to (Table 2) and (Table 3)
- b. In table 3 seen that there was no difference between HCT and the control group, why your information in the result part give the opposite one?
- c. In table 3, why did you use the Paired t-test and Wilcoxon to comparing the control group and HICT group?

3. Discussion

Add information about the strength and weaknesses/limitations of this research in the last part of the discussion.

4. Change the acknowledgment sentence to a more formal sentence. (Such as the authors would like to thank the study participants,..... etc)

Reviewer: 2

Comments to the Author
(There are no comments.)

Date Sent: 09-Nov-2020

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03-Oct-2020

Dear Dr. Muniroh:

Your manuscript entitled "REGULAR HIGH INTENSITY CIRCUIT TRAINING IMPROVES ATTENTION FUNCTION AND REACTION TIME AMONG MALE YOUNG ADULTS" has been successfully submitted online and is presently being given full consideration for publication in the Malaysian Journal of Medicine & Health Sciences.

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