

## Skipping and Running Improve Short-Term Memory in Young Adults

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### ABSTRACT

**Background:** Aerobic exercise has been reported to improve memory function. Skipping and running are known as sports that easy to do and like by young adults. However, their effect to improve short-term memory in young adults has not been studied yet. **Objective:** to know the effect of skipping and running to improve short-term memory in young adults. **Method:** This study used quasi experimental research design with pre- and post-test unequal group. The subjects were medical students of Diponegoro University (n = 80), aged 18-22 years old, who were selected by purposive sampling and divided into 4 groups: skipping 3 times a week for 8 weeks (n=20), group without exercise as a skipping control (n=20), running with music for 30 minutes (n=20), and running only as its control. Short-term memory in pre- and post-test were measured using Scenery Picture Memory Test and data were analyzed using paired t-test, unpaired t-test, Wilcoxon, and Mann-Whitney. **Results:** There was a significant difference in short-term memory ( $p < 0.05$ ) after skipping or running either with music or not ( $p = 0.000$ ). Short-term memory in skipping and running with music groups were significantly increase ( $p < 0.05$ ) compared with its each control,  $3.6 \pm 2.63$  vs  $0.95 \pm 3.12$ , and  $5.0 \pm 2.66$  vs  $3.05 \pm 1.76$ , respectively. **Conclusion:** Short-term memory can be improved by regular skipping exercise and running particularly with music in young adults.

**Keywords:** aerobic exercise, short term memory, skipping, running

Memory is the storage of acquired knowledge for later recall. It is one of the fundamental cognitive functions for adapt to human environment.<sup>1</sup> It can be classified into two types: short-term and long-term memory. Short-term memory has limited capacity, but has been proved to present one's intelligence.<sup>2</sup> Other study also proven that short-term memory affects long-term academic achievement.<sup>3</sup> Young adults, for example, college students are known to require good memory function. Short-term memory is required for learning as the beginning of long-term memory formation.<sup>1,4,5</sup>

Previous studies reveal that short-term memory functions can be improved through aerobic exercise.<sup>6,7,8,9</sup> However, about 81% of adolescents aged 11-17 years and 23% of young adults aged 18 years and over in the world are still classified to have lack physical activities.<sup>10</sup> This sedentary life lifestyle may interfere the process of learning in student. Many factors affect the process of

memory formation, such as age, genetics, nutrition, hormones, gender, disease, psychology, drugs, and stimulation.<sup>11,12,13-18</sup> One of stimulation that can affect the process of memory formation is aerobic exercise.

Aerobic exercise increases working memory in healthy adults, by increasing vascularization to the brain so that will cause the viability of nerve cells in the brain.<sup>19,20,21</sup> Previous study proves that there is a neurotropic stimulation such as BDNF serum that can increase the volume of hippocampus, the part of the brain that plays a role in memory formation. The other brain structures like gray matter, white matter, and brain glia also show changes.<sup>22</sup>

Skipping and running are included in aerobic sports activities that has been known by all ages group and are favored because of the easy and simple method. Skipping exercises is quite easy, can be done anywhere and anytime. This sport does not depend on location, time or weather, so it

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can be one of the alternative sports in the young age group to improve the quality of lifestyle.<sup>23,24</sup> Running is proven to improve the cardiovascular system function and cognitive function.<sup>25,26,27</sup> Music, especially motivational music with a tempo >120 bpm, has ergogenic properties that is proved to relieve fatigue, improve sports performance, and affect brain activity.<sup>28,29</sup> In this study, we analyzed the effects of aerobic exercise in the form of skipping, running, and running with music as a factor affecting short-term memory as an alternative to aerobic exercise for young adults.

## METHODS

This research used quasi experimental method with pre- and post-test unequivalent group design. Subjects were divided into 4 groups; skipping 3 times a week for 8 weeks (n=20), with group without exercise as control (n=20), running with music for 30 minutes (n=20), and running without music as control. This study was done in March-May 2017 among medical students of Diponegoro University, who are selected by purposive sampling with following inclusion criterias: aged 18-22 years, no sedative drugs and such, Body Mass Index 18.50-24.99 kg/m<sup>2</sup>, and approving to be the subject of this research. Subjects for skipping and no exercise (control) groups should commit to not doing other sports other than skipping during the period of this research, and able to perform the exercise, i.e. skipping 3 times a week for 8 weeks. Otherwise, the subjects for running with and without music should already used to take regular exercise at least twice a week, and have a normal score on Depression Anxiety Stress Scale 42 (DASS-42), which is 0-9 for depression, 0 - 7 for anxiety, and 0 - 14 for stress scale. The exclusion criteria were subjects with a history of psychiatric disorders, head trauma, systemic infections and diseases, epilepsy, injury or limb disability, and consuming electrolyte and caffeine drinks within 2 hours before a short-term memory test.

### Skipping

Skipping has been done indoors with subjects wearing uniform shirts, shoes, and skipping ropes. Warming up and cooling down steps were done for 5 minutes before and after skipping. There were 4 sets of skipping exercises on 1<sup>st</sup> - 4<sup>th</sup> week, while on 5-8<sup>th</sup> week were done as many as 5 sets. 1 set of exercises consisting of 2 cycles. Each cycle was done 30 seconds of skipping and 30 seconds of break. Each odd and even set have different period of rest, i.e. rest for 1 minute on odd set and 5 minutes on even set.

### Running

Running has been done outdoors for 30 minutes at Diponegoro University Stadium with moderate intensity or conversational pace of speed, i.e. running by a normal conversation with a little effort comfortably. Running group was divided into 2 groups; running with music and running without music. The music in this research was motivational music type that were selected by subjects (Self-selected music) with Brunel Music Rating Inventory-2 (BMRI-2). BMRI-2 was used to select the motivational quality of the music, with score range was on 36-42 (highly motivated musics). Playlist of 15 selected musics were made on the phone or iPod and played during running for 30 minutes using headsets or headphones with 50% volume.

### Scenery Picture Memory Test (SPMT)

Short-term memory was measured using SPMT. It has some advantages, i.e. time effectiveness and ease of understanding from respondents, therefor did not cause floor and ceiling effect. Before the measurement, a forward digit span test is done to outwit the subjects.<sup>30</sup>

Subjects were asked to memorize the picture in 1 minute and mention 23 objects contained on the picture. After 1 minute, a forward digit span test was done to outwit the subject by mention sequence of 1-7 digits, then the subjects were asked to recall those number. Then, subjects were asked to mention objects previously memorized on the SPMT test. Short-term memory on running groups were done before and after exercise, while skipping and its control groups were examined before and after 8 weeks.

### Data Analysis

Saphiro-Wilk test was used to analyze the distribution of short-term memory score before and after treatment in all groups. Then, to analyze short-term memory difference between before and after skipping, running, and running with music, Wilcoxon test was used because the post-test data of short-term memory showed non-normal distribution. Meanwhile, unpaired t-test was used to analyze the difference of short-term memory in no exercise group. We analyzed the difference of short-term memory increase between control and treatment groups using Mann-Whitney test because post-test data showed non-normal distribution. The data showed significantly difference if the value of  $p < 0.05$ .

**Table 1.** Characteristic of subject

Characteristic	Skipping and No Exercise Group		Running and Running with Music Group	
	n(%)	Mean±SD; Median (Min-Max)	n(%)	Mean±SD; Median (Min-Max)
Gender:				
- Male	20(50)		20(50)	
- Female	20(50)		20(50)	
- Total	40(10)		40(10)	
Group				
- Treatment	20(50)		20(50)	
- Control	20(50)		20(50)	
	40(10)		40(10)	
Age		20.53±0.72; 20.50 (19-22)		20.65±0.949; 21 (18-22)
Height		161.88±8.95;160.00 (140-180)		162.335±7.32; 162 (152-182)
Weight		54.65±7.44; 54.00 (42-68)		57.14±8.04; 55.00 (42-78)
Body Mass Index		20.72± 1.59; 21.05 (18.59-22.99)		21.65±1.89; 22.05 (18.6-24.7)
History of psychiatric disorder				
· Yes	0(0)		0(0)	
· No	40(10)		40(10)	
Brain Abnormalities				
· Yes	0(0)		0(0)	
· No	40(10)		40(10)	

Note.SD = Standard deviation; Min = Minimum; Maks = Maximum; n= Total subjects

## RESULTS

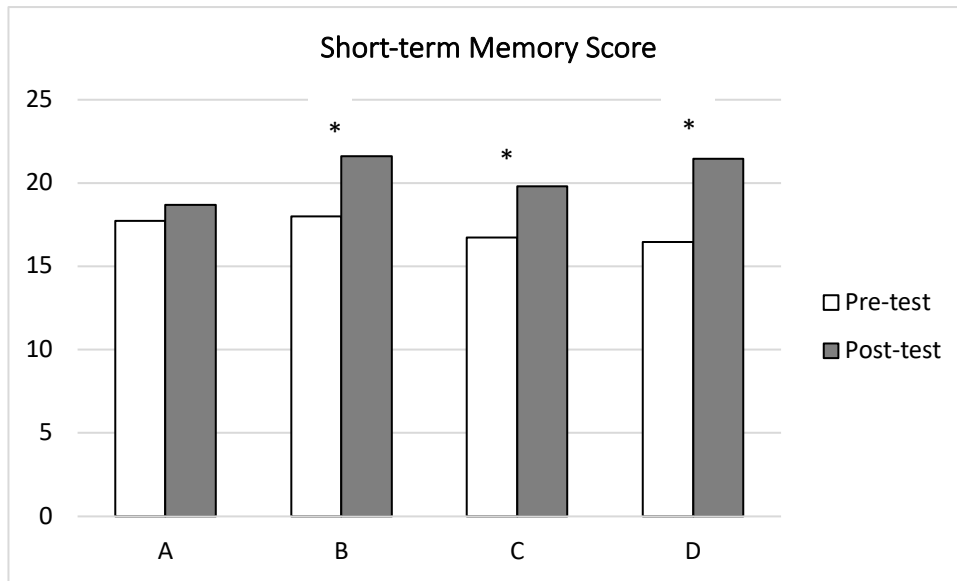
Characteristic of subjects can be seen in table 1.

### Skipping vs without exercise

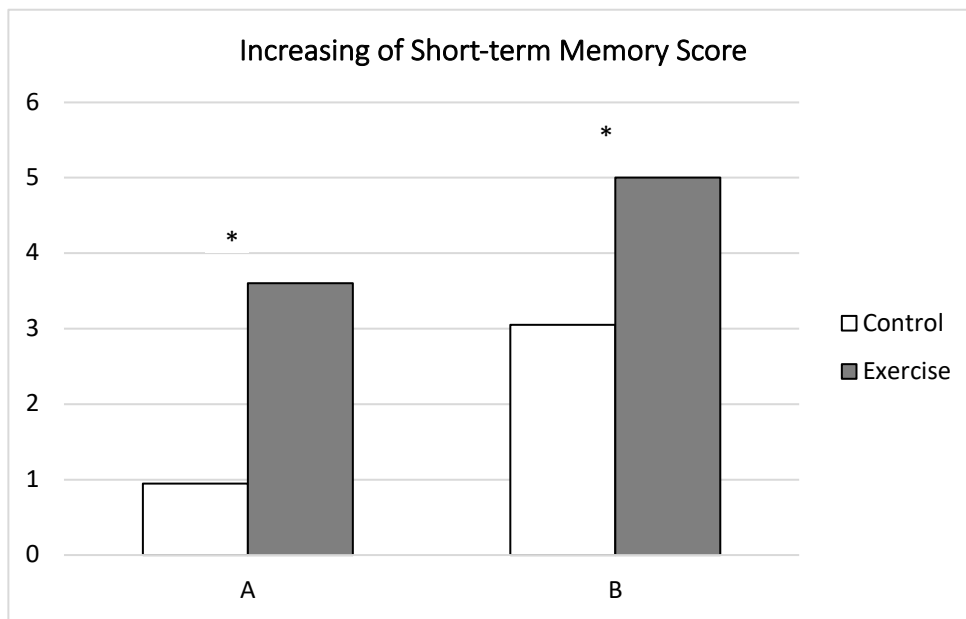
Short-term memory was measured using SPMT scores in eight-weeks aerobic skipping study. The average of group that performs routine skipping at the initial test is  $18.00 \pm 3.08$  and after routine skipping is  $21.60 \pm 1.67$ , with significantly difference ( $p = 0,000$ ). The control is without exercise group, had an initial SPMT score of  $17.75 \pm 2.81$  and increased after 8 weeks became  $18.70 \pm 2.68$ . This group showed a non-significant increase ( $p = 0,189$ , see figure 1). The delta of pre-test and post-test between treatment and control group showed a significant difference ( $p = 0.008$ , see figure 2).

### Running vs running with music

Short-term memory was also done through aerobic treatment which was running with music for 30 minutes and running for 30 minutes as control. The treatment group had an initial value of  $16.45 \pm 2.188$  and became  $21.45 \pm 1.932$  after running with music for 30 minutes. The Wilcoxon test showed significant difference of before and after exercise score ( $p = 0,000$ ). The group that runs for 30 minutes also showed an average difference in the initial score of  $16.75 \pm 2.77$  to  $19.80 \pm 2.387$ . This difference is significant based on the Wilcoxon test ( $p = 0.000$ , see figure 1). Delta between the treatment and control group was tested with Mann-Whitney and showed a significant difference ( $p = 0.015$ , see figure 2).



**Figure 1.** The difference of short-term memory score measured by SPMT between groups; A. No exercise, B. Skipping, C. Running, D. Running with music. \* $p < 0,05$



**Figure 2.** The increasing of short term memory measured by SPMT; A. No exercise (control) and Skipping (exercise), B. Running (control) and Running with music (exercise). \* $p < 0,05$

**DISCUSSIONS**

Results showed significant increase in short-term memory on skipping, running, and running with music group after tested using Wilcoxon and unpaired t-test. This result was in accordance with the hypothesis, which is there is an increase of short-term memory score measured with SPMT

before and after treatment. Mann-Whitney and test was done to compare both groups, which showed that skipping group has significantly higher results compared to control group, and running with music group has significantly higher results compared to running as control group.

In this study, both skipping 3 times a week for 8 weeks and 30 minutes of running, as aerobic exercise, significantly improved short-term memory. This was in accordance with previous studies which stated that aerobic exercise, both routine and acute, can improve cognitive function. This happened because aerobic exercise increases cardiovascular function, thus increasing the peripheral and cerebral blood flow. Increased blood flow in hippocampus and anterior cortex will improve neural connections between these areas. As the blood flow increased, oxygen will optimally distributed to neurons and resulting in increasing the viability of neurons.<sup>7,31,32</sup> Aerobic activity of skipping and running also affects the hippocampus as a brain structure that plays a role in memory and learning. Aerobic activity has been shown to increase serum BDNF, neurotrophin, which helps improve cognitive function including memory.<sup>8</sup>

This study also showed that 30 minutes running with music significantly improved short-term memory of young adults, and was significantly higher compared to control group. This is in accordance with some previous researches that discusses the influence of music during physical exercise. Motivational music used in this study, which has more than 120 beat per minute, can increase ergogenic effects during physical exercise through increased hormone levels, including cortisol and norepinephrine.<sup>33</sup> Increased cortisol in the blood leading to the catabolism in the muscle, adipose, and connective tissue, so that energy will be produced by the metabolism. Increased norepinephrine levels will stimulate the cardiovascular system to increase heart rate and both peripheral and brain blood flow.<sup>34,35</sup>

The limitation of this study is monitoring other daily life factors that may affect short-term memory, for example, learning activities, playing games, long term nutritional factor, hormonal factor, and history of cardiovascular disease.

## CONCLUSION AND SUGGESTION

In conclusion, short-term memory can be improved by regular skipping exercise and running particularly with music in young adults.

This study determines that there is an effect of regular skipping and running in short-term memory on young adults, therefore these exercise can be recommended to young adult group in improving short-term memory performance. Further studies regarding the investigation of the detail mechanisms how skipping and running effect in short-term memory improving are required.

## CONFLICT OF INTEREST

Author declare no conflict of interest.

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