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The Effect of High Intensity Aerobic and Anaerobic Training on the Memory of Healthy People

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ABSTRACT

Background. The evidence indicates that physical activity increases memory and ability to learn in human and animal. That is to say, the brain remarkably responds to exercise.

Objectives. The purpose of this study is to investigate the effect and comparison of anaerobic and aerobic exercise on memory.

Methods. In this study, ninety male students were randomly divided into three equal groups with 30 members. The first group did 3 aerobic exercise sessions (with using treadmill) of 60 minutes per week for 8 weeks. The second group were trained in anaerobic exercise (with treadmill), whereas the third one, the control group of non-exercising subjects, get involved in no intervention/interference. Afterwards, all of ninety students were asked to The IQ TEST lab to carry out a memory experiment both in the beginning and the end of programmed in order to evaluate their memory in the terms of Wechsler Test/ on the basis of Wechsler Test.

Results. The result of this study showed the memory change from Wechsler fragment tests/subtests before and after invention to the group with aerobic training (15.50 ± 5.41), with anaerobic training (17.00 ± 4.89) and in the control group (2.13 ± 1.96). The difference was significant ($p < 0.001$) so that the variation of memory scores between aerobic and control group was ($p < 0.001$). Also, anaerobic and control group was ($p < 0.001$). And in other words, it had a significant difference.

Conclusion. The results will enable us to better comprehend the consequences that exercise can have on learning and memory. In general, the findings of the available research showed that the 8 weeks exercise of aerobic and anaerobic had high positive impact on the memory function of the students undergoing these experimental exercising subjects. We conclude that aerobic and anaerobic exercise probably can serve as a means to improve positively the memory's function so this kind of training is recommended for benefiting memory and learning process.

KEY WORDS: Aerobic Training, Anaerobic Training, Memory, Depression, Wechsler Intelligence Test.

INTRODUCTION

There are evidences indicating exercise has positive effects on brain function. Physical activities improve learning and memory function in humans and animals. In addition, an active lifestyle may help delay or slow decline in cognitive function in older adults or prevent

degenerative nerve diseases. Exercise causes multiple changes in the brain the most important of which is growth and remodeling of the brain. Studies show that people who do physical exercises grow better brain cells. Current studies in this field revealed that the brain remarkably

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responds to exercise and causes changes at molecular, cellular and anatomical levels. Interestingly, many of such changes occur in regions of the brain that are important for better learning, and higher memory and cognitive function (1-5).

The important molecule affecting nerve cell health, learning, and memory is the brain-derived neurotrophic factor (BDNF). BDNF improves growth, health and survival of neurons and plays an important role in regulation of plasticity for neurons (6). The results of a study entitled "the impact of aerobic exercise, age and physical fitness on memory function" demonstrated that no significant difference was observed in the memory retention function during exercise (7). In another study, it was shown that exercise acts as a non-pharmacological simple tool to maintain and restore BDNF levels in the brain (8). In a study, it was shown that vigorous exercise may be most beneficial for healthy adults, especially those with lower cognitive performance. Results also showed that the effects of exercise on cognitive domain are not the same for all people (9). Intense aerobic exercise was introduced as a factor improving short- and long-term memory function in some studies (10-16). Other studies approved that the exercise improves memory in old ages (17-21).

Another study concluded that the reaction time is shorter in active people than inactive ones, however, it was not due to exercise. Working memory was declined during and immediately after short-term maximal exercise but improved after recovery. Short-term maximal treadmill exercise was associated with reduced working memory function during exercise and improved working memory after recovery (22). In another study, it was shown that long-term exercise habits are associated with reduced environmental BDNF and better average memory. However, an intense form of exercise, both aerobic and anaerobic, enhances BDNF level in inactive and athletic people (23). Another study concluded that vigorous exercises in school have positive effects on children's learning and long-term memory (24). Other study concluded that the combined group of milk and exercise and the exercise group significantly outperforms just milk group in terms of the

effect on short-term memory. It also indicated that regular exercise is useful for short-term memory of the students (25). In a study it was shown that hippocampal of VEGF and BDNF levels is increased in both exercise groups compared to the control group. Levels of BDNF and VEGF in the voluntary exercise group were higher than involuntary exercise group (26). Other studies proved the effects of exercise on reducing depression (27-30).

Many studies were conducted in this filed and in some cases the results were contradictory. However, few studies were conducted based on the exercise type (aerobic or anaerobic) or age group. The objective of this study is to evaluate the effect of aerobic and anaerobic exercise on memory in healthy people.

MATERIALS AND METHODS

Participants. 90 male students taking physical education course were selected as the sample population by using Convenience Sample Method and randomly divided into three equal groups with 30 members. The first group was trained in aerobic exercise and the second group was trained in anaerobic exercise (with using treadmill) for 8 weeks in 3 sessions of 60 minutes. The third group was the control group with no intervention. All of 90 participants' depression and anxiety were assessed based on Beck Depression Inventory and (STA) at the first and last of sessions.

Training Protocol. Running on the treadmill (technogym treadmill made in Italy with the option to display heart rate) was selected as the aerobic exercise in this study. People repeated exercise eight weeks by 60 to 70 percent of maximum heart rate. In anaerobic exercise, people practiced by 75 to 85 percent of maximum heart rate. The exercise was repeated three days a week for 60 minutes. The first 20 of it was dedicated, 30 minutes to the main exercise, and the last 10 minutes to cool down.

Measurements. At the beginning of the period, Wechsler memory scale was conducted for all the subjects. The scales of depression feel, generalized anxiety and psychological symptoms of all participants were assessed according to standard questionnaires.

STAI (State Trait Anxiety Inventory) questionnaire based on self-evaluation has been

used to assess participants' anxiety. The validity and reliability of the Persian version used in this study have been measured and confirmed. This test has consisted of two parts:

Part Y-1: It is a questionnaire with 20 expressions (state) which evaluates observed anxiety. Items are rated on a four point scale ranging from (1) never to (4) too much.

Part Y-2: It is a questionnaire with 20 expressions that measure hidden anxiety (trait). Items are rated on the four option scale from (1) almost never to (4) too much.

Overall, the scores of observed and hidden anxiety can be range from 20-80 according to the following table (32-33).

Table 1. interpretation of anxiety scores

(Y-1 State) Observed	(Y-2 State) Hidden
20-31 = mild	20-31 mild
22-24 = medium to low	22-24 = medium to low
43-53 = medium to high	43-53 = medium to high
54-64 = fairly intense	53-62 = fairly intense
65-75 = intense	63-72 = intense
>76 = very intense	>73 = very intense

Beck Scale for evaluation of depression is a questionnaire with 21 questions independent of culture. People with reading and writing skills and over the age of 13 are able to answer this questionnaire, which examines various complaints of depression, including mood, appetite, sleep, energy, and suicidal thoughts. The reliability, validity and internal consistency of the questionnaire in Iran is 78%, 73%, and 86%, respectively (32-34). The minimum score in this test is zero and the maximum is 36. The individual score is obtained directly by totaling the scores in each subject. The following scores can be used to indicate the general level of depression:

Total scores from zero to 13: None or least depression

Total scores from 14-19: low depression

Total scores from 20-28: mild depression

Total scores from 29-63: intense depression

Statistical Analysis. The statistical tests used in this study were Kolmogrov-Smirnov to determine the normality of the distribution, One-Way Anova to analyze the mean differences of 3 independent groups in the case of the normality of data distribution or Kruskal-Wallis test in the absence of normal data distribution. And also the Tukey test was applied for the subsequent comparison One-Way analysis of variance. The level of significance was 5%. The data were analyzed by using SPSS 18.0 Software.

RESULTS

There was no significant difference in the mean for age ($p=0.202$) and body mass index BMI ($p=0.108$) between the three groups (Table 2).

Memory status. Mean changes in memory scores before and after intervention in aerobic and anaerobic training groups as well as the control group were 15.50 ± 5.41 , 17.00 ± 4.89 , and 2.13 ± 1.96 representing a significant difference ($p<0.001$) (Table 3). As table 3 shows, there was a significant difference in mean changes in memory scores between the aerobic group and the control group ($p<0.001$) as well as the anaerobic group and the control group ($p<0.001$).

Table 2. Age and BMI in studied groups (Mean \pm SD)

Variable	Aerobic	Anaerobic	Control	p
Age (year)	23.2 ± 2	22.3 ± 2.7	22.6 ± 1.1	0.202
BMI (kg/m ²)	23.4 ± 2.9	23.4 ± 3.2	25 ± 3.9	0.108

Depression status. Changes in depression before and after the intervention for the aerobic training, anaerobic training, and the control group were 3.30 ± 5.56 and 1.90 ± 6.62 and 1.50 ± 5.37 representing no significant difference ($p = 0.463$) (Table 4).

Table 3. Changes in memory scores before and after the test in the three groups (Mean \pm SD).

Group	Pre-Test	Post-Test	Mean Differences
Aerobic	84.2 ± 7	99.7 ± 4.28	15.5 ± 5.41
Anaerobic	84.43 ± 7.21	101.4 ± 4.31	17 ± 4.89
Control	86.57 ± 7.16	88.7 ± 6.68	2.13 ± 1.96

* $p < 0.001$

Table 4 Changes in depression scores before and after the test in the three groups (Mean \pm SD).

Group	Pre-Test	Post-Test	Mean Differences
Aerobic	10.37 \pm 5.99	7.07 \pm 5.55	3.30 \pm 5.55
Anaerobic	10.16 \pm 7.18	8.80 \pm 7.01	1.9 \pm 6.62
Control	10.27 \pm 5.34	8.77 \pm 6.05	1.5 \pm 5.37

p = 0.463

DISCUSSION

The results demonstrated that a course of aerobic and anaerobic exercise causes significant improvements in memory quotient according to Wechsler test. However, there was significant difference in memory function between anaerobic and aerobic exercises. There are studies concluded that just aerobic exercise improves memory function (7, 22), while others demonstrated only anaerobic exercise improves memory function (10, 11, 21). However, most studies indicated that both aerobic and anaerobic exercises significantly improve the memory (8-12, 15, 20, 21, 23, 24, 26). The main reason for this is the BDNF that is released from the hippocampus and plays an important role in memory improvement. This is confirmed in most studies (7, 8, 23, 26). However, the research findings are inconsistent with those studies (7, 22) that considered only aerobic exercise effective for memory function improvements. A reason for such an inconsistency may be differences in the time and type of exercise.

According to the findings in Wechsler subtests, anaerobic exercise improves short-term memory function which is consistent with some other studies (10, 11, 21). However, most studies showed that exercise (whether aerobic or anaerobic) improves both short and long term memory function (8, 9, 15, 20, 21, 23, 24) and the results of this study also confirm this. Therefore, changes in memory quotient based on Wechsler memory scale measuring both short- and long-term memory were significant in both aerobic and anaerobic exercises group. In other words, exercises improve memory, reflecting the positive impact of exercise. However, there were no significant differences between the two types of exercises. It is suggested to conduct a similar study with larger sample size and longer exercise duration.

The other finding of the study indicated that there were no significant changes in depression scores before and after the intervention in the groups. This may be due to the short time considered for aerobic and anaerobic exercise. Although depression scores were reduced, changes were not significant. Therefore, a study with larger sample size and a longer period of exercise is recommended. Many studies showed that exercise, especially aerobic, is effective in depression reduction (27-30).

CONCLUSION

In general, research findings suggested that aerobic and anaerobic exercise can improve memory function. Therefore aerobic and anaerobic exercise is recommended for improving memory function. A main limitation of the study was the small groups for comparison of aerobic and anaerobic exercises. Therefore, another study with a larger sample size is recommended. Another limitation of the study can be the Wechsler Memory Test. Although, it is a standard test and easy to implement on human samples, further studies using other measurement methods are recommended.

APPLICABLE REMARKS

- Presumably aerobic exercise could have an effective role on memory improvement.
- Presumably anaerobic exercise could serve as a means to improve memory.
- Aerobic and anaerobic exercises could be recommended to people suffering from loss memory to do, presumably.

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