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Effect of Aerobic and Anaerobic Physical Exercises to Brain Derived Neurothropic Factor Plasma Levels on Mice

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Abstract: The purpose of this study was to determine the effect of aerobic and anaerobic physical exercise on BDNF Plasma levels in mice treated with aerobic and anaerobic physical exercise with different frequency for 1 week. This research is an experimental laboratory. The design used in this research is Post Test Control Group Design. Subjects used in this study were Mice, aged 6-8 weeks and 1 control group. Data were taken by doing anaerobic physical exercise at a rate of 35 meters per minute for 20 minutes and aerobic physical exercise at 20 meters per minute for 30 minutes. One way Anova test result showed that there was a high increase in BDNF level of aerobic exercise group 1 times and 3 times a week compared with aerobic exercise group 7 times a week and control group. Furthermore, there was a high increase in BDNF levels of anaerobic physical exercise group 1 times and 3 times a week compared with anaerobic exercise group 7 times a week and control group. However, BDNF levels of anaerobic groups are lower than in the aerobic group. The conclusions of this study showed that physical exercise resulted in increased levels of BDNF.

1 INTRODUCTION

Physical exercise is a physical burden on the body and continuous through proper exercise program (Flora, 2015). Aerobic exercise is physical exercise that uses energy derived from aerobic metabolism or metabolism that requires oxygen. In contrast, anaerobic physical exercise is physical exercise that uses the energy from anaerobic metabolism or metabolism that does not require oxygen. This means that almost all of the energy required for muscle activity during physical exercise is produced through aerobic and anaerobic processes (Fox, 1993; Santosa, 2012; Flora, 2015). According to Santosa (2012), the relationship between aerobics and anaerobics is the basis of the division of sports in accordance with the dominant exercise. It is called aerobic exercise if during its appearance at least two-thirds (70%) of all energy used is obtained through aerobic exercise. This means a maximum of only 30% which is an anaerobic exercise. In contrast, anaerobic exercise, if during its appearance, at least two-thirds (70%) of all the energy used is provided through anaerobic exercise. This means a maximum of only 30% anaerobic exercise that can be covered by aerobic exercise.

Physical exercise may increase the expression of the hippocampal BDNF and result in the emergence of neurotrophic factors (Cheen & Russo, 2011). BDNF plays a major role in neuronal plasticity. Physical exercise results in BDNF (brain derived neurotrophic factor) upregulation that helps increase the brain's resistance to damage and neurodegeneration that occurs with age (Egan et al, 2003). Research conducted by Oliff et al, (1998) mentions that an increase in expression of BDNF mRNA 6 hours after physical exercise in mice treated voluntary running wheel. Similarly, studies conducted by Rhodes et al, (2003) mentioned that, an increase in the concentration of BDNF and neurogenesis in the hippocampus of mice who were treated running wheel. There is a correlation between the distance traveled with neurogenesis. Research on humans conducted by Vega et al, (2006) mentions that there is an increase in serum BDNF in athletes who perform short term aerobics.

The problems of this study is whether there are differences in BDNF levels between aerobic and anaerobic exercise conducted during the first week with a different frequency. The aim of this study was to compare the effect of aerobic and anaerobic physical exercise on BDNF Plasma concentration in

mice treated with aerobic and anaerobic physical exercise with different frequency for 1 week.

2 LITERATURE REVIEW

Physical exercise is a regular physical activity in a certain period of time and intensity, which aims to keep the body in order to always be in good health and fit. Physical exercise is done by muscle regularly, repeatedly and continuously (Flora, 2015). Exercise is a series of organized and planned exercise that people do consciously to improve their functional abilities (Safari, 2011).

Based on the energy source that is used there are two types of physical exercise is aerobic exercise and anaerobic exercise. Aerobic exercise is a physical exercise that depends on the availability of oxygen to help the combustion process of energy sources so that it will also depend on the optimal work of the organs of the body such as heart, lungs and blood vessels to transport oxygen to the combustion process of energy sources to run perfectly. Anaerobic physical exercise is a high intensity physical exercise that requires fast energy in a short time but can not be done continuously for long durations of time.

Physical exercise will increase BDNF. BDNF has been recognized as an important tropic hormone in the regulation of neuron morphology and survival. Endogenous BDNF is known to be involved in cellular development and growth, mood regulation, and cognitive functions such as learning and memory (Schmolesky et al, 2013). BDNF is the most common growth factor in the brain in the central nervous system (CNS) (James, 2012). BDNF is important for CNS development and neuron plasticity. BDNF plays an important role in brain development and plasticity. The results of a study by Cruz (1999) that BDNF has a molecular weight of 32 kDa precursors and a 14 kDa adult BDNF molecular weight. BDNF also has a molecular weight of 27 kDa and originally derived from pig brain that serves as a trophic factor for cells of the dorsal root ganglia (Leibrock et al, 1989) and then comes from the human brain (Barde et al, 1982). Blaydes (2001) mentioned that serotonin, dopamine, BDNF due to physical exercise will strengthen the bond between nerve cells.

The formation of BDNF (brain derived neurotrophic factor) causes neurons to work more efficiently. BDNF is a neurotrophin that acts as a survival regulator, growth and differentiation of neurons during development to the adult nervous

system. BDNF is not formed in the human brain, but also in animals. Like animals Mice (*Mus musculus*). There is a study of experimental animals conducted by Oliff et al. (1998) mentioned that an increase in expression of BDNF mRNA 6 hours after physical exercise in mice treated voluntary wheel running. Similarly, a study conducted by Rhodes et al (2003) mentions that there is an increase in BDNF concentration and neurogenesis in hippocampus of mice that are fed running wheel. There is a correlation between the distance traveled with neurogenesis.

3 METHODS

This research is an experimental laboratory. The design used in this research is Post Test Control Group Design. Subjects used in this study were Mice, aged 6-8 weeks and 1 control group. Data were taken by doing anaerobic physical exercise at a rate of 35 meters per minute for 20 minutes and aerobic physical exercise at 20 meters per minute for 30 minute

4 RESULTS AND DISCUSSION

4.1 Research Results

4.1.1 The Mean of Mice (*Mus musculus*) BDNF Plasma Level in Control and Treatment Group

The result of BDNF Plasma calculation after giving the physical exercise treatment as follows:

Table 1: Average BDNF Levels.

Group	N	Mean ± Standard Deviation (pg/ml)
Control	4	28,62 ± 11,53
Aerobic 1x	4	62,24 ± 17,28
Aerobic 3x	4	58,51 ± 10,76
Aerobic 7x	4	32,53 ± 5,89
Anaerobic 1x	4	45,38 ± 4,76
Anaerobic 3x	4	54,23 ± 7,47
Anaerobic 7x	4	34,36 ± 11,04
Total	28	

Table 1 shows that there was an increase in mean BDNF plasma levels in Mice (*Mus musculus*) treated with aerobic and anaerobic physical exercise once a week, 3 times a week and 7 times a week

compared to the control group. Based on the normality test that the average BDNF plasma level of Mice (*Mus musculus*) in the control group, aerobic and anaerobic physical exercise 1 times a week, 3 times a week and 7 times a week normal distribution ($p > 0.05$).

Then t test is not paired or independent sample test T-Test to know the significant difference between aerobic group, anaerobic with control group. For the aerobic group the result was a significant difference (p value < 0.05) average BDNF plasma level of Mice (*Mus musculus*) treated with aerobic physical exercise 1 x and aerobic 3 x with control group. There was no significant difference (p value > 0.05) mean BDNF plasma level of Mice (*Mus musculus*) treated with aerobic physical exercise 7 x with control group.

For the anaerobic group the result was a significant difference (p value < 0.05) mean BDNF plasma level of Mice (*Mus musculus*) treated with anaerobic physical exercise 1 x and anaerobic 3 x with control group. There was no significant difference (p value > 0.05) mean BDNF plasma level of Mice (*Mus musculus*) treated with anaerobic physical exercise 7 x with control group.

Then to know which groups are different more meaningful, then the next test Anova. Anova test results between aerobic group and control group showed that there was a significant difference (p value < 0.05) average BDNF plasma of Mice (*Mus musculus*) level between aerobic exercise group 1 times a week, 3 times a week, 7 times a week with Control group.

The results of Anova test between the anaerobic group and the control group showed that there was a significant difference (p value < 0.05) the mean BDNF plasma of Mice (*Mus musculus*) between the anaerobic physical exercise group 1 times a week, 3 times weekly, 7 times a week with group control.

4.2 Discussion

Based on the above research statement, it can be concluded that, the mean of plasma BDNF level in the highest aerobic group is 1 x aerobic group (62.24 ± 17.28). While the mean plasma BDNF levels in the highest anaerobic group were the 3 x anaerobic group (54.23 ± 7.47). However, plasma anaerobic BDNF levels of 3 x (54.23 ± 7.47) were lower than the 1 x aerobic group (62.24 ± 17.28). According to the researchers this happens because the treatment of physical exercise there are acute and chronic and depends on the use of exercise intensity, duration of exercise and recovery period of exercise.

The results of treatment from each group obtained the average concentration of aerobic plasma BDNF 1x (62.24 ± 17.28) has a high value due to aerobic physical exercise is acute. Charles H. Hillman et al. (2009) suggests that acute exercise effects improve neurocognitive function and have the intensity and duration of exercise that improve the cognitive functioning and nervous system of the brain. Then the rate decreased in aerobic physical exercise 3x (58.51 ± 10.76). This happens because the mice experience a period of recovery or rest periods. Then the rate decreased again in aerobic physical exercise 7x (32.53 ± 5.89). This happens because aerobic physical exercise is chronic. This exercise is done every day without any recovery period causing fatigue, dehydration and will reduce the accuracy in doing physical activity (Flora, 2015: 43). Research Lawrence E. Armstrong et al, (1998) mentions that the occurrence of fatigue during physical activity due to various things, namely the increase in lactic acid in the muscle, homeostatic disorders, neuromuscular disorders and heat air temperature.

Then, anaerobic plasma BDNF rate of 1x (45.38 ± 4.76) has a high value because the anaerobic physical exercise is acute. In this exercise there is a time interval of 1 minute with a speed of 10 meters per minute of the overall time. This exercise also usually requires a rest interval so that ATP (Adenosine Triphosphate) can be regenerated so that its activities can be resumed. Then again increase in mean of 3 x anaerobic BDNF (54.23 ± 7.47). This happens because the mice experience a period of recovery or rest periods. According Cloud Cenedy et al, (2008) that the intensity of aerobic and anaerobic physical exercise that can improve physical fitness and brain function if done routinely at least 3 times a week. Furthermore, BDNF levels decreased significantly in anaerobic physical exercise 7 x (34.36 ± 11.04). This is because the physical exercise is chronic and done every day without any recovery period resulting in fatigue, dehydration and will reduce the accuracy in physical activity (Flora, 2015: 43).

5 CONCLUSIONS

The conclusion from this study that physical exercise resulted in increased levels of Brain Derived Neurotrophic Factor (BDNF) Plasma of Mice (*Mus musculus*). This is proven based on Anova test result which shows that there is a significant difference (p value < 0.05) mean of

BDNF plasma of Mice (*Mus musculus*) between group of aerobic physical exercise 1 times a week, 3 times a week, 7 times a week with group control. Furthermore, there was a significant difference (p value $<0,05$) mean BDNF plasma of Mice (*Mus musculus*) level between physical anaerobic exercise group 1 times a week, 3 times a week, 7 times a week with control group.

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