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Effect of Aerobic and Anaerobic Interval Training on Oxidative Stress

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Abstract

Physical activity is any body movement produced by skeletal muscles that require energy expenditure. Interval training both aerobic and anaerobic is a form of physical activity that can increase oxidative stress. This study aims to determine: 1) the effect of aerobic and anaerobic interval training on oxidative stress degree and 2) the effect difference between aerobic and anaerobic interval training on oxidative stress. This was experimental research with posttest only control group design. There were 27 samples recruited by purposive sampling. The research instrument used blood MDA level test with TBARS method. Paired t (t-test) was used for data analysis. Findings showed that there was statistically significant different effect between aerobic and anaerobic interval training ($p = 0.000$) on oxidative stress. There was significant different effect between aerobic and anaerobic interval training on oxidative stress where the effect of anaerobic interval training is greater than aerobic interval training on o oxidative stress.

Keywords: Interval Training; Oxidative Stress

Introduction

Oxidative stress is a condition that occurs because of an imbalance between the production of free radicals with the antioxidant defense system in the body. It is an imbalance between free radicals (pro-oxidants) and antioxidants triggered by two common conditions of lack of antioxidants and overproduction of free radicals. Free radicals are the basis for many biochemical processes and show an important part of metabolism.

The free radical is defined as a molecule or molecular portion containing one or more unpaired electrons in the farthest atomic or molecular orbit and can be self-existed (Halliwell B., 1991). The term oxidative stress is also defined as a condition in which an increase in the level of Reactive Oxygen Species (ROS) occurs. In normal numbers, ROS plays a role in various physiological processes such as defense systems, hormonal biosynthesis, fertilization, and cellular signals. However, an increase in ROS

production known as oxidative stress conditions has implications for various diseases such as hypertension, atherosclerosis, diabetes, heart failure, stroke, and other chronic diseases.

Physical activity can increase the formation of free radicals in the body thus increasing oxidative stress. (Candrawati., 2013). It will increase body oxygen consumption 10 to 15 times higher than rest time (Ni Made Dwi Sandhiutami., 2010). Increased use of oxygen mainly by contracting muscles causes an increase in electron leakage from mitochondria to become reactive oxygen compounds (SOR). Generally, 2-5% of the oxygen used in metabolic processes in the body will become superoxide ions so that when heavy physical activity increases the production of free radicals (Jawi., 2008).

Physical activity can be a variety of activities. In this research physical activity in question is a physical exercise with methods both aerobic and anaerobic interval training. Interval training is a series of repetitive physical exercise events that are interrupted by periods of recovery. Mild physical exercise usually fills in the recovery period.

Interval training is an exercise program consisting of periods of repetition of work interspersed by periods of rest, or a series of repetitive exercises interspersed with periods of rest. Mild exercise is usually done during this break period (Donald K Mathews and Edward L Fox., 1988). Aerobic interval training or long interval training is an exercise that includes physical exercises that primarily focus on aerobic systems, while anaerobic interval training is part of anaerobic activity. Anaerobic activity is an example of acute physical activity (Hairrudin dan Dina helianti., 2009). Anaerobic activity is an activity involving anaerobic metabolism where not using oxygen. This is related to activity with high speed and intensity.

Methodology

This was an experimental research with posttest only control group design. There are three group that is control group, aerobic group and anaerobic group. This study was conducted in UNS Stadium for giving treatment aerobic and anaerobic interval training and blood sampling. Fort the measurement of MDA levels conducted in Laboratory of Center Food and Nutrition Studies of Gajah Mada University during October 2017. The population in this study was all football athlete of UNS football team. There were 54 population and recruit by purposive sampling obtain 27 samples. The instrument was used blood MDA ***level test with TBARS (Thiobarbituric Acid Reactive Substances) method. The ethical approval was*** obtained from Health Research Ethics Committee Dr. Moewardi General Hospital and study permission was obtained from Head Coach of UNS football team. The researchers have confirmed that all respondents have obtained an appropriate informed consent. The prerequisite analysis test used in this research are two normality test and homogeneity test. Normality test using Kolmogorov-Smirnov while homogeneity test using Levene test. The different effect between aerobic and anaerobic interval training on oxidative stress were analyzed using Paired t test (t-test).

Result

Table 1 is a description of data, normality and homogeneity test of control group MDA levels, aerobic group MDA levels and anaerobic group MDA levels.

Based on Table 1, can be seen the average results of control group MDA levels 1.21 ± 0.12, for average results of aerobic group MDA levels 4.18 ± 0.11, for average anaerobic group MDA levels 6, 83 ± 0.29. The results of this study can be concluded that there is a significant increase between the results of control group MDA levels, aerobic interval group MDA levels and anaerobic interval group MDA levels.

Table 1 Data description, normality, and homogeneity test of the three groups

Group	N	Mean	StDev	Kolmogorov-Smirnov		Levene	
				Sig	category	Sig	category
Control	9	1,21	0,1096	0,15	Normal	0,06	Homogen
Aerobic	9	4,18	0,1083	0,15	Normal	0,06	Homogen
Anaerobic	9	6,83	0,2888	0,15	Normal	0,06	Homogen

Source: Primary data that is processed, 2017

Normality test of the data in this study was conducted by Kolmogorov-Smirnov test. Where testing is doing for determine whether the data is normal or not. Data is said to be normal if sig> 0.05. The table shows the normality test using the Kolmogorov-Smirnov formula, the MDA content in each group is greater than the significance level, which means that all data in the group is normally distributed.

The homogeneity test was conducted to obtain the assumption that the study started from the same condition, meaning homogeneity test was used to find out whether the three groups of control group, aerobic group, and anaerobic group had the same variant or not. The table shows the result of homogeneity test with Levene's Test method. Levene value is shown on Levene line, that is 3,17 with p value (sig) equal to 0.06 where > 0,05 meaning there is similarity of variance between group or can be concluded homogeneous data. So that the three data can be used for further testing.

Statistical Test Paired t (t Test) Control Group and Aerobic Group

The paired t (t-test) statistical test between the control group and the aerobic group was the statistical test of the control group MDA test result with the treatment group administered by the aerobic interval. Here are the results of paired t test (t test):

Table 2 The result of statistical test paired t (t test) control group and aerobic group

Result	Mean N =9				
	Control Group	Aerobic Group	Δ Test Result	t	p
MDA Levels	1,21 ± 0,12	4,18 ± 0,11	2,97	-60	0,000

Source: Primary data that is processed, 2017

The result of paired t test (t test) above obtained value t-60 with sig probability. (p-value) 0,000. Since p value is 0.000 <0,05 it can be concluded that there is statistically significant difference between control group and aerobic group. So giving aerobic interval training has an effect on blood MDA levels.

Statistical Test Paired t (t Test) Control Group and Anaerobic Group

The paired t (t-test) statistical test between the control group and the anaerobic group was the statistical test of the control group MDA test result with the treatment group administered by the aerobic interval. Here are the results of paired t test (t test):

Table 3 Result of statistical test paired t (t test) control group and Anaerobic group

Result	Mean N =9				
	Control	Anaerobic Group	Δ Test Result	t	p
MDA Levels	1,21 ± 0,12	6,83 ± 0,29	5,62	-61,45	0,000

Source: Primary data that is processed, 2017

The result of paired t test (t test) above obtained value t -61,45 with sig probability. (p-value) 0,000. Since p value is 0.000 <0,05 it can be concluded that there is statistically significant difference between control group and treatment group II. So giving anaerobic interval training has an effect the blood MDA levels.

Statistical Test Paired t (t Test) Aerobic group and Anaerobic Group

The paired t (t-test) between the aerobic group and anaerobic group was the statistical test of the MDA test result of the two treatment groups given aerobic and anaerobic interval training. Here are the results of paired t test (t test):

Table 4 Result of statistical test paired t (t test) aerobic group and anaerobic group

Result	mean N =9				
	Aerobic Group	Anaerobic Group	Δ Test Result	t	p
MDA Levels	4,18 ± 0,11	6,83 ± 0,29	2,69	-25,52	0,000

Source: Primary data that is processed, 2017

The result of paired t test (t test) above obtained the value of t -25,52 with sig probability. (p-value) 0,000. Since p value is 0.000 <0,05 it can be concluded that there is statistically significant difference between aerobic group and anaerobic group. So there is a difference effect between aerobic and anaerobic interval training on blood MDA levels.

Discussion
Effect of Aerobic and Anaerobic Interval Training on Oxidative Stress

Physical exercise will dramatically increase the oxygen consumption by 15 times the normal consumption in the bloodstream. Active muscle can increase the oxygen demand 100 times from passive conditions. This increase is attributed to an increased need for ATP while the supply of ATP in intra-cellular is very limited, resulting in the continuous of ATP through oxidative processes, crew cycle, and electron transport. In the process of formation of ATP requires oxygen, oxygen consumption in the respiratory chains in mitochondria affect the increase in free radical production (Purnomo., 2011).

Meanwhile, according to (Wahyuni., Asj'ari and Sadewa., 2007) during aerobic exercise (including aerobic interval training), total body oxygen consumption is increased to 20 times whereas oxygen consumption in muscle fibers is estimated to increase 100-fold. This increase in oxygen consumption results in increased production of free radicals that can cause cell damage. The imbalance between free radicals and antioxidant defenses within the body is the beginning of oxidative stress.

According to (Candrawati., 2013) aerobic activity is a physical activity involving aerobic metabolism and includes large muscle movements in a rhythm and a certain period. Running, walking, bicycle racing and swimming are some examples of activities that can be classified as aerobic activity. The mechanisms of free radical formation that occur during aerobic activity are:

Hyperoxic Injury in the Mitochondria

Hyperoxic injury can occur in high-intensity aerobic activity. At rest, the human oxygen requirement averages 0.3 L/ min. During physical activity, there is an increased need for oxygen 10 to 20 times compared to rest. This causes the amount of oxygen flowing to the muscles that move increased 100 to 200 times compared to rest. In the resting state, 2-5% of the oxygen will oxidize into free radicals. So when doing physical activity with high intensity, there will be an increase in the number of free radicals. This formation of free radicals occurs in the cellular respiration organs, the mitochondria, which are the places where electron transfer occurs.

Ischemia-Reperfusion Injury Involving the Enzyme Xanthine Oxidase

During the physical activity of several organs such as the liver, kidneys and other organs will experience hypoxia and ischemia due to higher amounts of oxygen in the working muscle. In the event of hypoxia and ischemia, because of the need for energy, the ATP is converted to ADP (Adenosine Di-phosphate) and AMP (Adenosine Monophosphate). If the oxygen supply is insufficient, the AMP will be converted to hypoxanthine. After physical activity is complete, blood flow will be normal again through reperfusion process. In the reperfusion process, in the presence of xanthine oxidase enzyme will convert hypoxanthine into xanthine and uric acid. This process produces free radicals, which will damage the cell membrane through lipid peroxidation reactions.

Meanwhile, anaerobic interval training is also subject to degrees of oxidative stress. Anaerobic interval exercises include anaerobic activity activities involving anaerobic metabolism or not using oxygen. There are two theories underlying the mechanism of free radical formation in anaerobic activity: Ischemia-reperfusion injury involving the enzyme xanthine oxidase

The mechanism that occurs the same as in aerobic exercise, which is ischemia occurs when muscles contract because of activities performed. The need for energy will turn ATP into ADP and AMP. AMP will turn into hypoxanthine due to lack of oxygen. When activity is stopped, when the blood supply returns to normal, hypoxanthine is converted to xanthine and uric acid catalyzed by xanthine oxidase enzyme. This process produces free radicals that will damage the cell membrane.

Inflammation

In excessive weight training it is most likely a trauma, which then progresses into inflammation. This inflammatory process will activate the cells of phagocytes, especially neutrophils to migrate to the injured area. Neutrophils will phagocyte foreign substances, then release proteolysis enzymes to degranulation, and in the last process will form free radicals to break the foreign object. The enzyme released by neutrophils is Nicotinamide Adenine Dinucleotide Phosphate-Oxidase (NADPH). This enzyme will trigger the formation of free radicals through the following reactions: $4O_2 + 4NADPH$ $4H^+ + 4O_2^- + 4NADP^+$.

The formation of excessive free radicals will result in the balance of free radical and antioxidant levels to be disturbed. The levels of free radicals will increase, causing oxidative stress. Oxidative stress can cause cell damage and is the basis of pathogenesis for the process of cardiovascular disease, pulmonary disease, autoimmune disease, malignancy, metabolic disorders and aging.

Differences Effect of Aerobic and Anaerobic Interval Training on Oxidative Stress

The difference in effect is due to different treatments. Aerobic interval exercises have relatively long duration characteristics and less high intensity and vice versa anaerobic interval exercises have short duration and high intensity characteristics. This characteristic difference resulted in differences in the effect on blood MDA levels of the sample.

Some previous researchers have conducted research and obtained mixed results about the effects of acute physical activity on oxidative stress levels, particularly MDA. The things that affect the results include: measurement methods, age, exercise status, diet and physical activity patterns. The difference of measurement method in question is the difference of the method used to measure the oxidative stress level, the difference of oxidative stress biomarker, the difference of sample type used and the difference of sampling time. Age differences show increased levels of oxidative stress with age increase of 40 years, due to decreased endogenous antioxidant capacity in elderly people. Differences in exercise status indicate lower levels of oxidative stress in trained individuals, with respect to increased endogenous antioxidant capacity. Dietary differences show decreased levels of oxidative stress in individuals who consume exogenous antioxidants such as vitamins A, C or E. Differences in physical activity patterns result in increased oxidative stress proportional to the intensity of physical activity. However, the intensity limit that begins to show an increase in oxidative stress levels still varies between 70% and 80% VO2max. In addition to the intensity, duration of physical activity also affects oxidative stress. The duration limit that begins to show an increase in oxidative stress is also still varied between 90 to 120 minutes. It can be concluded that the intensity and duration of exercise is a major factor affecting the degree of oxidative stress.

Conclusion

It is concluded that there were significant effect of aerobic and anaerobic interval training on oxidative stress. There is a difference in the effect between aerobic and anaerobic interval training on oxidative stress in which the effect of anaerobic interval training is greater than that of aerobic interval training.

Conflict of Interest

The authors certify that have NO affiliations and conflict of interest with any organization or entity with any financial interest or nonfinancial interest in the subject matter or materials discussed in this manuscript.

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References

Candrawati, S. (2013). 'Pengaruh Aktivitas Fisik Terhadap Stres Oksidatif', Mandala Of Health, p. 454–461.

Donald K Mathews and Edward L Fox. (1988). The Physiological Basis of Physical Education and Athletics, 4th Edition. 4th edn. philadelpia.

Hairrudin dan Dina Helianti. (2009). 'Efek Protektif Dalam Mencegah Stres Oksidatif Akibat Aktivitas Fisik Berat (Swimming Stress)'.

Halliwell B. (1991). 'Reactive Oxygen Species in Living Systems', (9).

Jawi, I. M. (2008). 'Antioxidant Effect of Water Extract Purple Sweet Potato to Mice Blood and Many Organ that Given Maximal Physical Exercise'.

Ni Made Dwi Sandhiutami. (2010). 'Uji Aktivitas Antioksidan Minyak Buah Merah (Pandanus conoideus LAM'.

Purnomo, M. (2011). 'Asam Laktat dan Aktivitas SOD Eritrosit Pada Fase Pemulihan Setelah Latihan Submaksimal', Jurnal Media iImu Keolahragaan, 1(2): 155–170.

Wahyuni, Asj'ari, S. R. and Sadewa, A. H. (2007). 'Kajian Kemampuan Jus Buah Tomat (Solanum Lycopersicum) Dalam Menghambat Peningkatan Kadar Malondyaldehide Plasma Setelah Latihan Aerobik Tipe High Impact', (1999): 123–132.

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