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Pengaruh konsumsi vitamin C untuk menurunkan indeks fatigue pada olahraga anaerobic

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Abstrak
Penelitian ini bertujuan untuk mendapatkan hasil tentang efek penggunaan vitamin C pada mengurangi tingkat kelelahan dalam latihan anaerobik. Penelitian ini menggunakan metode eksperimen dengan teknik korelasional, sampel yang digunakan adalah mahasiswa program studi kepelatihan FIK-UNJ. Pengambilan sampel menggunakan teknik purposive sampling. Teknik pengujian hipotesis dilakukan dengan menggunakan teknik analisis statistik korelasi sederhana diikuti dengan uji-t pada tingkat signifikansi p = 0,05. Hasil analisis uji awal dan tes akhir kelompok an-aerob, diperoleh rata-rata = 0,268, standar deviasi = 0,639 dan kesalahan standar rata-rata SEMD = 0,165. Hasil ini menghasilkan thitung = 1,623. Kemudian dengan derajat kebebasan (df) = 15-1 pada tingkat signifikan 5%, nilai kritis dari ttabel = 1,761 diperoleh. Dengan hasil ini berarti thitung <ttabel, hasil penelitian tidak signifikan.
Kata kunci: Penurunan Fatigure Indeks; Latihan Anaerobic; Vitamin C

Effect of vitamin C consumption on reduction of fatigue levels in anaerobic sports

Abstract
This study aims to obtain information about the effect of using vitamin C on reducing fatigue levels in an-aerobic exercise. This study uses an experimental method with correlational techniques, the sample used is the FIK-UNJ coaching study program students. Sampling using a purposive sampling technique. Hypothesis testing techniques are performed using simple correlation statistical analysis techniques followed by t-test at the significance level p = 0.05. The results of the initial test analysis and the final test of the an-aerobic group, obtained an average = 0.268, a standard deviation = 0.639 and a mean standard error of SEMD = 0.165. These results produce tcount = 1.623. Then with degrees of freedom (df) = 15-1 at a significant level of 5%, a critical value of ttable = 1.761 was obtained. With these results it means tcount <ttable, the results of the study are not significant.
Keywords: *decreased level of fatigue; aerobic exercise; use of vitamin C*

INTRODUCTION

Physical activity provides major changes to the body's metabolic rate. Physical activity with different intensity of exercise will demand different energy expenditure, for example when someone sprints or bikes with high intensity will require energy expenditure 40–50 times greater than energy expenditure during rest. Whereas the marathon runners with submaximal intensity require energy expenditure of only 20-25 times compared to energy expenditure during the resting state.

When an athlete performs exercises in large volumes or at very high intensities, fitness will increase, however fatigue will also increase (Bompa, 2009). Fatigue occurs in everyone who does physical activity with high intensity. Fatigue cannot be overcome only by resting, because fatigue can occur due to an energy metabolic system when exercising imperfectly. Fatigue can be divided into two types, mental fatigue and physical fatigue. Mental fatigue is usually caused by mental work while physical fatigue is due to muscle work.

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Fatigue is just a symptom of the underlying condition, so to overcome it can depend on many things. Fatigue in high-intensity exercise and short duration is caused by excessive accumulation of lactic acid. While fatigue in moderate intensity exercise and long duration due to lack of energy, lack of fluids and electrolytes and boredom.

Moderate intensity exercise in a long duration is a picture of aerobic exercise. Aerobics is a type of exercise that stimulates heart rate and breathing rate to increase rapidly during a sports session. Aerobics is known as cardio, a sport that requires oxygen to be sent to the working muscles. The oxygen in question is derived and supplied from the heart through the blood. Therefore, both breathing and heart rate will usually increase rapidly during aerobic activity.

The energy source of aerobic exercise comes from burning carbohydrates and fats. Fats function as an important source of energy to produce ATP. The main source of fat is from free fatty acids that result from the breakdown of triglycerides (glycerol + three fatty acids) that originate from inside or outside the cell. Free fatty acids in cells originate from intramuscular triglyceride storage, while free fatty acids from outside cells originate in adipose tissue (fatty tissue) and free fatty acids in the blood. Free fatty acid chains vary in length from 4 to 28 carbons. Palmitic acid is a 16-carbon free fatty acid, the main free fatty acid that is oxidized in skeletal muscle.

Activation of the sympathetic nervous system will initiate the breakdown of triglycerides in the muscles and adipose tissue. Activation of the sympathetic nervous system occurs in response to stress imposed on the body (eg exercise with moderate to severe intensity) which triggers the release of the hormone epinephrine. Furthermore, this hormone will activate the lipase enzyme, an enzyme that is responsible for the breakdown of triglycerides.

Free fatty acids produced in adipose tissue will enter the blood circulation, and most are bound to the protein albumin. As is known, that water and oil / fat cannot be mixed, the albumin protein will bind free fatty acids and carry it into the body's cells. The nature of fat rejects water or cannot mix with water is called hydrophobic. Albumin is a plasma protein that can dissolve in water. After free fatty acids from outside the cell reach its destination, then it passes through the cell membrane and enters the cytosol with the help of specific transport.

However, the energy obtained from fat burning runs slower and less efficiently than from the energy obtained from the breakdown of glucose (requires more oxygen to produce ATP molecules), so fat is best used when oxygen is sufficient. For example in intensity training low to moderate.

The American Journal of Clinical Nutrition, Volume 54, Issue 6, December 1991 published a study, that Vitamin C can reduce the level of fatigue in sports with a long duration. As is known, long duration exercise uses fatty acids as an energy source. Vitamin C functions as an alpha-ketoglutarate co-factor 2 required in the reaction of epsilon-N-trimethyllysine hydroxylase and gamma butyrobetaine hydroxylase in the carnitine biosynthetic pathway. Carnitine serves as a mobilization of fat metabolism in the formation of energy. So through carnitine biosynthesis, vitamin C will increase energy production from fat burning. This will reduce the level of fatigue.

Whereas in anaerobic exercise, fatigue is caused by the accumulation of lactic acid, and not because of lack of energy. Does vitamin C can play a role in decreasing the level of fatigue as well as in sports with a long duration? Then this research will find it.

Anaerobic Sports

The body has two main pathway systems for supplying energy; the aerobic pathway that can only work when there is oxygen, and the anaerobic pathway, which works without the need for oxygen. The anaerobic pathway is further divided into two systems: phosphate as a ready-made energy system and anaerobic glycolysis system or lactate system. Each of these systems can produce ATP. There are fundamental differences between aerobic and anaerobic pathways:

- The aerobic pathway is capable of producing large amounts of ATP, whereas the anaerobic pathway only produces a limited amount of ATP.
- The aerobic pathway produces ATP slowly, while the anaerobic pathway has the capacity to produce ATP faster.
- Aerobic respiration occurs in the mitochondria of cells, whereas anaerobic respiration occurs in cell sarcoplasms. In general, the aerobic and anaerobic pathways can be distinguished by how intense or how fast the exercises are. The intensity of this exercise will affect the path of energy production.

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If training with maximum intensity and short duration, the path used is the anaerobic pathway, while if the training with submaximal intensity and long duration then the system used is aerobic system. In summary, ATP is sourced from;

- ATP PC (phosphagen system)
- Anaerobic Glycolysis (lactic acid system)

Oksigen Oxygen system, divided into 2 namely:

1). Carbohydrate oxidation, and

2). Fatty Acid Oxidation.

The fastest way to produce ATP is through the posfagen system. The posfagen system is a ready source of energy because it does not require a long series of reactions, does not require oxygen and is stored in the muscles. In high intensity exercises and short durations, such as in 100m sprints, 25m swimming, pole vaulting or throwing heavy weights all require a ready source of energy. There are two types of ready-made energy namely Adenosine Triphosphate (ATP) and Posfo-creatin (PCr) which are stored in the muscles.

The order in which this system produces ATP might be best understood if presented in the following order; 1). The need for ATP increases because of high-intensity activities, 2). Because the need for ATP increases, ATP hydrolysis occurs, which is catalyzed by the ATP-ase enzyme, thereby increasing the amount of ADP as a result of ATP breakdown reaction, 3). The increasing amount of ADP will activate the creatine kinase enzyme, which functions to facilitate the hydrolysis of PCr to creatine (Cr) and phosphate (P), accompanied by the process of releasing some energy. Conversely, this creatine kinase activity will be inhibited if the amount of ATP returns to normal, 4). Free energy that occurs, is also used to produce (phosphorylate) an ATP molecule by adding phosphate to the ADP molecule, 5). This process continues as long as ATP demand is present or until the concentration of PCr decreases to the point where it can no longer provide energy to phosphorylate ATP from ADP and phosphate.

The design of this system enables the fulfillment of ATP requirements in high intensity activities, where the production of ATP from the phosphating system is twice as fast as that of glycolysis. Unfortunately, the concentration of PCr in skeletal muscle is limited, and in the duration of about 10 seconds in activities with high intensity the supply of PCr will be depleted.

As explained earlier, ATP and PCr are stored in the form of posfagen. Each kilogram (kg) of skeletal muscle stores about 5 millimoles (mmol) of ATP and 15 mmol PCr. In someone who has 30 kg of muscle mass will store a number of 570 to 690 mmol posfagen. If the physical activity of someone who is doing brisk walking will activate 20 kg of skeletal muscle, then store available posfagen energy can meet energy needs for 1 minute and if running slow can provide energy needs for 20 to 30 seconds and when running fast or swimming fast can last for about 6 to 8 seconds. If someone runs fast, then he can not do these activities in the long run, because he will run out of reserves of energy ready to use, then at a certain limit he will stop running. So it can be concluded, that the energy of the phosphagen system despite the use of its energy without the need for oxygen but can only meet the body's energy needs in a short time.

The phosphorus in the muscles must be continually synthesized quickly to meet energy needs during high-intensity and short-duration exercises. In addition, during high-intensity exercise, muscles also provide glycogen as an energy source in the anaerobic process called glycogenolysis (the breakdown of glycogen to produce ATP) anaerobic. In this anaerobic glycogenolysis, the body in addition to producing ATP also produces lactic acid. During high intensity exercise, the oxygen that can be used is inadequate, so that all hydrogen ions formed in anaerobic glycolysis cannot be oxidized. This hydrogen ion will convert with pyruvate to lactate in a chemical reaction: Pyruvate + 2H akt lactate.

Anaerobic glycolysis (the breakdown of glucose to produce ATP) allows the formation of ATP quickly and sustainably through the process of phosphorylation. Anaerobic glycolysis for the formation of ATP can be seen as a "backup fuel" that will be activated when oxygen demand exceeds availability. As often happens during the last "sprint" phase of a mid-range race (1.5 Km). ATP production from anaerobic glycolysis is very important during 440m running or 100m swimming or in some sports that require sprints, such as field hockey and football. In this sport, the body needs energy transfer quickly which exceeds the availability of muscle posfagen. If this high intensity exercise continues then the energy requirements will be provided from the anaerobic glycolysis process and as is known, this reaction will produce lactic acid.

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Our understanding of the role of lactate has changed from what is thought to be the final metabolic waste and the main cause of skeletal muscle fatigue to be a compound that plays an important role in the path of energy metabolism. The human body continues to produce lactate, especially in mitochondria lacking red blood cells. In mitochondria that lack red blood cells, it means that the mitochondria lack oxygen in their energy metabolism. If this mitochondrion is burdened to produce energy, it can only produce energy through the anaerobic glycolysis pathway. However, at rest or during training under steady-state conditions, there is a balance between lactate production and disposal. At rest, lactate is converted back to pyruvate and can be used as fuel again.

During glycolysis, blood glucose or muscle glycogen is converted to pyruvate, which then enters the mitochondria to continue aerobic respiration or conversely is converted to lactate. This depends on the intensity of the exercise and the availability of oxygen. However both conditions can also occur simultaneously. Nearly all pyruvate enters the mitochondria at rest or during low intensity exercise is converted into energy, but at a higher intensity when the mitochondrial aerobic respiration capacity is exceeded, more pyruvate is converted to lactate. In training with higher intensity, an increase in lactate depends on the amount of glucose that is transferred to pyruvate via glycolysis in the form of ATP. The researchers believe that, the higher the level of glycolysis, pyruvate is produced faster than what enters the mitochondria for mitochondrial respiration. Thus, the excess pyruvate which cannot enter the mitochondria will be converted to lactate, which then by a series of reaction processes can be used as fuel again.

Vitamin C

Vitamin C is a type of vitamin that is soluble in water and has an important role in various bodily functions. This vitamin is also known by the chemical name of its main form, ascorbic acid. Vitamin C is a class of antioxidant vitamins that are able to ward off various extracellular free radicals. Some of its characteristics include being very easily oxidized by heat, light and metals. Although oranges are known as the most vitamin C-producing fruit, it is actually a big mistake, because lemons contain 47% more vitamin C than oranges.

Vitamin C is needed to maintain the structure of collagen, which is a type of protein that connects all fibrous tissue, skin, veins, cartilage, and other tissues in the human body. In addition, vitamin C functions as an alpha-ketoglutarate co-factor 2 required in the reaction of epsilon-N-trimethyllysine hydroxylase and gamma butyrobetaine hydroxylase in the carnitine biosynthetic pathway. Carnitine serves as a mobilization of fat metabolism in the formation of energy. Carbohydrates can only meet energy needs when exercising for 30 minutes, so the energy needs are met from the breakdown of fat. Conversely, fat can not work in anaerobic conditions or without oxygen.

Fatigue

According to Santosa Giriwijoyo and Dikdik Zafar Sidik (2012: 51), fatigue can be defined as a condition of decreased work capacity caused by doing work. Fatigue is divided into 2 types, mental fatigue and physical fatigue. Mental fatigue is fatigue that is a result of mental work. Mental fatigue is caused by boredom and lack of interest. Physical fatigue is caused by physical or muscular work and becomes a very interesting problem that attracts the experts in Physiology (Santosa Giriwijoyo and Dikdik Zafar Sidik, 2012: 52). The first cause of physical and mental fatigue must be in the form of activities that use power (energy), because there will not be fatigue if there is absolutely no use of power (Santosa Giriwijoyo & Dikdik Zafar Sidik, 2012: 54).

In exercises with submaximal intensity PCr is converted back into ATP, and the breakdown of glucose (glycolysis) to maintain the availability of ATP. If muscle contractions occur continuously, PCr will soon run out and will no longer be able to provide ATP. In skeletal muscle contraction, PCr is only able to provide energy for about 10 seconds, then runs out. To cover up the lack of ATP, the glycolytic process (glycolysis) will increase to produce additional ATP. But unfortunately, the increase in the process of glycolysis will be accompanied by a buildup of lactate and protons (H +), both of these products will cause fatigue. Proton accumulation causes a decrease in cellular pH (acidosis), which will interfere with muscle contraction through various mechanisms including inhibiting the action of the enzymes ATPase and PFK. Protons resulting from increased glycolytic processes will also interfere with the reaction of calcium ions with muscle myofilament proteins during muscle contraction, thus

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inhibiting the ability of muscle contractions. Furthermore, enzymes involved in cellular sodium and potassium regulation will also be disrupted by an increase in proton accumulation.

Both in the blood and in muscle cells there is a natural buffer system to respond to the acidosis (due to the accumulation of protons). Given the relationship between metabolic acidosis and fatigue, it is necessary to set an exercise strategy to increase the natural buffer. This natural buffer can neutralize the acidosis caused by the accumulation of protons and lactate. However, for people who are not trained, this system is easily overwhelmed during training with high intensity.

Proper exercise will increase muscle buffering capacity, which ultimately increases the body's ability to tolerate high-intensity exercise, thus preventing fatigue and accelerating recovery. High cellular proton concentrations produced during high-intensity exercise will increase the stimulation of natural buffer formation in muscles, such as high-intensity (6- 12-interval) interval training for 2 minutes each with a workload of 90% –100% V˙ O2max with a rest interval of 1 minute is a good way to produce buffer formation in muscles.

RESEARCH METHODS

This research method using purposive sampling technique data collection of an-aerobic exercise groups using Vitamin C which is taken is the reduction in fatigue level data, which will be examined which is more influential between an-aerobic exercise and aerobic exercise using vitamin C,

Research purposes

Based on the background above, the purpose of this study was to determine the effect of using vitamin C on decreasing the level of fatigue in an-aerobic exercise.

Place and time of Research

This research was conducted at Rawamangun Stadium, East Jakarta and was conducted in July - October 2019.

Data Analysis Techniques

The data analysis technique used is the t test.

RESULTS

The results of the initial test analysis and the final test of the an-aerobic group, obtained an average = 0.268, a standard deviation = 0.639 and a mean standard error of SEMD = 0.165. These results produce tcount = 1.623. Then with degrees of freedom (df) = 15-1 at a significant level of 5%, a critical value of ttable = 1.761 was obtained. With these results it means tcount <ttable, the results of the study are not significant, H0 is accepted and H1 is rejected, where the hypothesis is:

H0 = There is no decrease in the level of fatigue in an-aerobic exercise. (Be accepted)
H1 = There is a decrease in the level of fatigue in an-aerobic exercise. (Rejected)

Tabel 1. Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Awal	6.000867	15	1.1319893	.2922784
	Akhir	6.268733	15	1.0294563	.2658045

Tabel 2. Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	awal & akhir	15	.829	.000

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Tabel 3. Paired Samples Test

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	awal-akhir	-.2678667	.6391856	.1650370	-.6218359	.0861025	-1.623	14	.127

DISCUSSION

Based on the results of research that has been done, it can be found the results of research that show that: In the group that was given vitamin C and did an aerobic test or RAST test, there was no visible decrease in the level of fatigue. This is because the RAST test is carried out in a short time, the energy used comes from anaerobic processes, namely ATP-PC and carbohydrate anarobic glycolysis. In the RAST test, fat burning has not yet occurred. However, carbohydrates can only meet energy needs when exercising for 30 minutes, then energy needs are met from the breakdown of fat.

From the statistical calculations, there was no significance in reducing fatigue in the group that did the RAST test, while there was a significant decrease in fatigue in the group that did the performance test using ergocycle. It can be concluded that vitamin C does not contribute positively to the reduction in fatigue levels in anaerobic exercise.

CONCLUSION

Based on the results of the study, it can be concluded that: the effect of the use of vitamin C did not contribute significantly to the reduction in the level of fatigue in an-aerobic exercise.

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