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A COMPARISON OF THE EFFECTS OF GENDER, ACTIVE RECOVERY AND COLD BATH METHODS ON LACTIC ACID LEVELS

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Abstract:

This study aims to determine: (1) The difference effect of *active recovery* and *cold bath* to lactic acid levels. (2) The difference of lactic acid levels between men and women. (3) The effect of the interaction between recovery method (active recovery and cold bath) and gender of the lactic acid levels after the maximum exercise. The research is using experimental methods research factorial design 2 x 2. The exercise maximum award is 400 m sprint. The population in this study is composed by a number of 32 volleyball athletes, consisting of 16 male and 16 female athletes. Groups of men and women were divided into two groups, each group consisting of 8 people. Each member of the group will be given exercises with maximum intensity of 400 m. After sprint exercise maximum intensity samples were then measured, the levels of lactic acid in the blood (pretest). Next, do recovery method that is active recovery for 20 minutes and the cold bath for 20 minutes with a temperature of 15^0C- 10^0C in the group of men and women. After 20 minutes, the samples are re-measured for the blood lactic acid levels (posttest). The analysis technique of the data in this study is *Two Way Analysis of Variance* (ANOVA Two-Way).

The results showed that: (1) There is a significant difference between the active recovery and cold bath of lactic acid levels, which gained $F_{(o)}$ at 45.96 and the value of p

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= .00 (P <.05). Better cold bath method with an average value reducing in lactic acid levels by 4.63 mM/L compared to active methods of recovery with the average value reducing levels of lactic acid of 3.50 mM/L. (2) There is a difference in lactic acid levels between men and women, which gained $F_{(o)}$ at 14.18 and the value of p = .00 (P <.05). Men are more rapid of reduction lactic acid levels with an average value reducing levels of lactic acid at 4.38 mM/L compared to women with an average value reducing lactic acid levels at 3.06 mM/L. (3) There is no significant interaction effect between recovery method and sex, which gained $F_{(o)}$ at .16 and .41 p = (P>.05). (1) There are differences between the effects of active recovery method and a cold bath to the reduction in blood lactic acid levels. The effect of cold bath method is better than the active recovery method in lowering levels of blood lactic acid. (2) There are differences in blood lactic acid levels between men and women. The reduction in lactic acid levels in men is faster than women. (3) There is no interaction effect between recovery methods and sex against lactic acid levels. Both groups of men and women have a reduction in blood lactic acid levels that are higher with cold bath recovery methods.

Keywords: recovery methods, active recovery, cold bath

1. Introduction

Fatigue is a physiological phenomenon, a reducing in tolerance to physical work. The muscle fatigue is defined as the failure which maintains the strength or off power during the contraction which is sustained or repeated (Zulhal, 2006:376). Fatigue can cause the reducing of physical work capacity. The reducing of work capacity will affect to the declining quality and quantity of an athlete. The cause is very specific and it depends on the working characteristic. The causes of fatigue can be observed from the anatomy aspects such as center nervous fatigue, neuromuscular, and skeleton muscle as well as functions aspects such as electrochemical fatigue, metabolic, the reduction of energy substrate, hyper/hypothermia, and dehydration (Septiani et al, 2010:179). Lactic acid accumulation of free H^+ derived from the hydrolysis of ATP and anaerobic glycolysis in muscle exercise cause of fatigue. Due to the body's ability to neutralize a stack of lactic acid is not comparable to the speed of the lactic acid formed by the severity of exercise activities. According to (Giriwijoyo and Sidik 2013:51), fatigue can be defined into 2 types, mentally fatigue and physically fatigue. Mentally fatigue is fatigue which is caused by mental working while physically mental is caused by physical working or muscle working. Muscular fatigue limits the muscle working. Muscular fatigue can be local or general. It can accompany endurance sports and high-

intensity exercise in short duration (Sarifin, 2010). The accumulation of lactic acid in blood becomes the basic problem in physical performance. It causes a chronic fatigue and decreases physical performance (Ahmaidi, 1996: 450). In general, the fulfilling of the energy in sport activities will be able through of two processes. Two processes are the anaerobic and aerobic. Anaerobic is high-intensity physical activity sport with a relatively short time, whereas aerobic is low-intensity physical activity sport with relatively for long time.

The process of aerobic energy metabolism stated as a clean process to generating energy, the process will only produce carbon dioxide (CO_2) and water (H_2O). This is different from anaerobic metabolic processes which will also produce such as lactic acid which accumulated can inhibit muscle contractions cause fatigue and soreness in muscles. Lactic acid will lower pH in the muscle or blood. This reducing in pH will inhibit and degrade enzymes work and interfere with chemical reactions in the muscle cells. This situation will cause muscle contractions become weak and eventually fatigue. In competitive sports, athletes sometimes face a lot of competition schedule that also has implications for the tight schedule of training. In this condition, the coach should as much as possible to restore the condition of the athlete to the state before practice or game to face the next game without any significant fatigue. Therefore, after a practice or game should do the recovery. The recovery phase is needed by the body in order to restore the body to the state condition before practice or game. In the inappropriate recovery training will not give any benefit for athletes, athletes are only taught to overcome fatigue than improving the certain capabilities aspects (Rushall and Pyke, 1992: 60). If there is no balance between training and inappropriate recovery, there will be a fatigue accumulation. It causes the adaptation process to the exercise get delayed, performance decreased as well as injury and disease risk increased risk (Rushall and Pyke, 1992: 61). The Forms of activities that can speed up the lactic recovery are improving oxidation process and gluconeogenesis, involving a lot of red muscle fibers, and accelerating the lactic distribution from active muscles to the less-active muscles (Falks, 1995: 7). According to (Haryanto in Purnomo 2011: 156) that the recovery phase, there are active and passive recovery. Active Recovery usually calls the cooling done with low-intensity exercise such as jogging and walking to preventing muscle cramps, stiffness and facilitating the recovery process. Instead of passive recovery, someone just sitting or lying down. Active recovery is an exercise with low-intensity or mild-intensity. The active recovery refers to the exercise recovery which uses low-intensity activity with the recovery purposes. The active recovery helps to cleaning the muscles from lactic acid which causes pain and fatigue. It can be done through jogging activities. The active recovery can help, as follows: a. Reducing the muscle pain faster, b.

Repairing the broken tissue through muscle, c. Increasing the psychologically/mentally recover, d. Increasing the mentally and physically relaxation (Setiawan, 2011).

In addition, there are several methods to recover fatigue so these athletes can re-show the best performance. The therapy using cold water as a medium known as cold therapy (cold therapy). Various forms of application techniques such as *Massase ice cold temperatures, ice packs, cold bath, cyrokinetics, and vapocoolant spray* used to treat inflammation and reduce the time needed for recovery. Cold bath is soaking in part or whole body with cold water at a certain temperature for a few minutes to reduce metabolic waste (lactic acid). Cold bath is done within a maximum period of 20 minutes at a temperature range from 15 ^{0}C to 10 ^{0}C (Wahyuni, 2014: 29). According to (Hayes and Hall 2016: 10) temperature range that is usually used about 0^0 C to 27^0 C. Cold applications commonly used to reduce physiological functions, such as blood flow, inflammatory response, or muscle activity. This therapy is usually done for recovery after exercise or competition (Wahyuni, 2014: 30). According to (Hayes and Hall 2016: 1) that the local cold application produces effects as follows: a) local vasoconstriction; b) The decreasing in local metabolism and oxygen needed, decreasing the response to acute injury or inflammation; c) The reduction of micro vascular permeability due to reduced tissue edema; d) intra-articular reduction in temperature on exposuring towards cold in the long term (≥ 20 min), decrease metabolism articular tissues, and activation of cartilage-degrading enzymes; e) Slowing of nerve conduction, until there is a failure of conduction; f) The increase of pain threshold. Besides causing vasoconstriction, the cold sensation in implementing cold therapy also decreases the endings electability of free nerve so that it decreases the sensitivity to pain stimulation. The cold application can also reduce the cell metabolism level that results the decreasing of metabolism waste. The decreasing of metabolism waste can decrease the muscle spasm at the end. Physiologically, the first 15 minutes after the cold application (temperature at 10^0C occurs arterioles vasoconstriction and venules locally). This vasoconstriction is caused by the reflective action of smooth muscles which appeared due to the simulation of autonomic nervous system and the epinephrine releasing as well as the norepinephine. However, if the cold is continued to give for 15 to 30 minutes, it will cause vasodilation phase which occurs intermittently for 4 to 6 minutes (Arovah, 2010:23). This period is well known as hunting response. The hunting response occurs to prevent the tissue damage as the result of tissue which experienced anoxia tissue. (According Ascensao et al 2011: 218) states that cold therapy can cause a reducing in metabolism, local vasoconstriction, reduce muscle spasms; reduce the inflammatory effects, pain relief, and reduction in nerve conduction velocity. The

reducing in metabolic rate can further reduce the cell's metabolism and metabolic wastes. A reducing in metabolic waste can ultimately reduce fatigue and muscle spasm.

2. Methods

This type of research is an experimental research. The design used in this study was a factorial design or a 2 x 2 factorial design. The sample in this study was the athletes of Volleyball with a number of athletes as much as 32 consisting of 16 men and 16 women. Groups of men and women were divided into two groups, each group consisting of 8 people. Each member of the group will be given exercises with maximum intensity is 400 m. After sprint exercise, maximum intensity samples were then measured the levels of lactic acid in the blood (pretest). Next, do recovery method that is active recovery for 20 minutes and the cold bath for 20 minutes with a temperature of 15^0C- 10^0C in the group of men and women. After 20 minutes, the samples are re-measured the blood lactic acid levels (posttest).

The data from the trials were compared using two-factor (time and treatment) analysis of variance (ANOVA) two way. Simple main effects analyses and Newman-Keuls post hoc tests were used to locate differences when ANOVA revealed a significant interaction. The level of probability to reject the null hypothesis was set at $p < .05$.

3. Result

Table 1: Comparison between active recovery method and cold bath for the decreasing in of lactic acid levels

Kelompok	Pretest	Posttest	Penurunan kadar asam laktat
Active Recovery	13.86	10.35	3.5
Cold Bath	13.95	9.32	4.63

Table 2: Comparison of lactic acid levels between men & women

Kelompok	Active Recovery			Cold bath		
	Pretest	Posttest	Penurunan kadar asam laktat	Pretest	Posttest	Penurunan kadar asam laktat
Laki-laki	14.22	10.48	3.75	14.33	9.32	5.01
Perempuan	13.50	10.23	3.26	13.57	9.32	4.25

1. In Table 1, we can see the results of the comparison between the methods of active recovery and cold bath to the reducing of blood lactic acid levels, where the average reducing of blood lactic acid levels in active recovery methods 3.5 mM / L while the cold bath method 4.63 mM / L.
2. In Table 2, it can be seen comparing blood lactic acid levels between men and women by the treatment of *active recovery* method and *cold bath*. The average value of decreasing lactic acid levels in the group of men with treatment active recovery methods 3.75 mM / L, while in the group of women 3.26 mM / L and the average value of decreasing blood lactic acid levelsin a group of men with treatment cold bath methods 5.01 mM / L, while in the group of women 4.25 mm / L.
3. In Table 2, it can be seen there is no interaction effect between recovery methods and sex against lactic acid levels. Both groups of men and women have a reduction in blood lactic acid levels that are higher with cold bath recovery methods.

4. Discussion

A. The difference in the effect of active recovery method and a cold bath to reduce blood lactic acid levels. Water is a good conductor of heat than the air, the ratio could reach 24: 1 so the post-exercise muscle temperature can drop quickly. When soaking, the water exerts pressure on the body called hydrostatic pressure. This pressure can cause fluid shifts in the body from the extremities toward the *central cavity*. Besides, the hydrostatic pressure causes the fluid from the extravascular moving to the intravascular moving (blood system) through the process of diffusion. Diffusion is the movement of molecules through the pores. Basically, the fluid in the body will move from high concentration to the low concentration fluid. This fluid displacement can increase the substrate translocation of muscles, increase blood volume and distribute to the central cavity, which in turn increases *cardiac preload, stroke volume, cardiac output and blood flow* throughout the body. The smooth flow of blood throughout the body can help the heart work more efficiently. With the increasing activity of extra-intravascular fluid, it causes the increasing metabolic wastes without expenditure of additional energy.

One of the first effects of the use of water by the cold temperatures in the body system is vasoconstriction given to the area. This vasoconstriction can reduce the cells for metabolism. The reducing in metabolic rate system will lower the temperature. The body's physiological response to cold temperatures was reducing local metabolism can help to halting the metabolic wastes, for example lactic acid no accumulate more to

muscle. A reducing of metabolic waste can reduce muscle spasms. However this temporary vasoconstriction, water exposure to cold temperatures in the long term will cause a response by the body's hunting.

The occurrence of vasodilatation will increase blood flow and improve metabolism, but also to prevent the anoxia system. According to Guyton and Hall (2014: 205) is getting less supply of oxygen greater the speed formation of vasodilator substances that can cause vasodilatation. The Increasing blood flow will also increase the binding of oxygen by hemoglobin in the blood. This process will also ensure the availability of oxygen, especially on the soaking part of the body, thus "cleansing" lactic acid as waste products will be faster in the presence of oxygen, especially on the part of the soaking, lactic acid was converted to pyruvic acid which pyruvate will entry into the Krebs cycle and converted into energy. Thus, the lactic acid formed during anaerobic glycolysis process is not lost from the body. When oxygen is available again, lactic acid can be oxidized to ATP or into glucose and glycogen. Actually, most of this re-changing process occurs in the liver.

B. The difference reduction in blood lactic acid levels between men and women hormonal differences, body size and body composition in men and women become the causes of the differences between men and women in regard to their participation and achievements in sports. The differences can be seen in terms of both anatomical and physiological. The difference of physical dimensions between men and women is about 7-100%. Under the influence of testosterone secreted by the testes in men, men grow taller with broader shoulders, narrower pelvis, and longer legs. The testosterone hormone also has the strong anabolic effect in leading to the increase large protein storage throughout the body especially in muscle which causes the muscles growth of men around 40 % larger than women. The power of men muscle is 20-25% larger than women, and this is also the muscle structure of men that has less fat than women. In addition, men have blood which is approximately one liter more than women, with higher hemoglobin as well. Because of the differences that cause the endurance ability of men is bigger than women.

In women, estrogen hormone does not only affects on the body composition but also affects the respiratory and cardiovascular systems. Women have a smaller size heart which causes heart volume and the volume of the pulse is smaller than men.

Per kilogram of muscle, mass in the capacity of the ATP-PC system at women is not different from men. But because of women weight is lower, then the total women is lower than men. It is obtained VO_2 max in girls that is almost equal to boys. As you age, the difference is getting bigger. The differences in heart size, total blood volume, hemoglobin and cardiovascular cause men can provide more blood and oxygen to the

working of muscles per minute, where hemoglobin is the oxygen-carrying. Because of the differences of ATP-PC and VO_2 max in both men and women cause the differences in performance capabilities in both aerobic exercise and anaerobic as well as the recovery process. Oxygen plays a very important in recycling metabolic waste such as lactic acid into energy in the process of recovery. Therefore, women need a longer recovery time compared to men. It is obtained from the data analysis that the average value reduction levels of lactic acid in men are higher than in women.

C. The Interactions between recovery methods and gender. Active recovery methods and the cold bath are method that can be applied to accelerate the reduction in lactic acid levels after maximal exercise. The comparison of two recovery methods in connection with the study both in women and men showed that the application of cold bath method is better than the active recovery method. Therefore, there is no interaction between recovery methods and sex to decrease blood lactic acid levels.

The obvious exercise benefits on women in doing exercise are the same as male and these benefits brought through the same physiological changes, significant improvements in aerobic capacity and aerobic. The physiological changes of physical exercise program are essentially the same in both sexes relation to the exercise response. The changing of blood volume increase, total hemoglobin, cardiac increase output, stroke volume are some of the changes that occur as a result of the exercise. It could be found physiologically that women are superior to men if the comparison is compared to men who are untrained. It might be found that woman is more superior than man in terms of both anaerobic and aerobic capacity, or we compare trained women with trained men with different sports, for example, anaerobic exercise women with aerobics exercise men might be obtained that women anaerobic capacity is more superior than men, and vice versa when comparing aerobic exercise women with anaerobic sport man might be obtained that women will excel in aerobic capacity compared with men. In the case of this study, both of genders as well as men and women are athletes from the same anaerobic sport. The changes that occur both in men and women in an anaerobic exercise such as the increase of the myofibril size, the increase in the number of ATP-PC saving in muscles, the activity of enzymes that support ATP-PC metabolism system, the increase of phosphofructokinase enzymes which is one of the enzymes in the glycolysis process by 83%, the increase of glycolytic enzymes affect the rapid breakdown of glycogen to lactic acid. Furthermore, the tolerance to lactic acid blood levels becomes increased and fatigue can be maintained. This increase does not mean making women would be superior to men, but the earlier great difference between men and women on the physiological side would be cramped with exercise. This difference is caused by the

fundamental differences of men and women under hormonal influences as previously described.

In the acceleration to eliminate lactic acid as a result of anaerobic metabolism requires adequate oxygen in transforming lactic acid into energy or energy sources that can be utilized by the body, besides the body's ability to secrete lactic acid from muscle into the blood circulatory system is important in terms of acceleration reduction levels of lactic acid in body. Although the benefits of cold water immersion is equal between men and women and the possible speed of lactic acid out of the muscles to the blood vessels is equal between men and women, but in terms of transforming the lactic acid into energy will be obtained difference in speed, but in terms of transforming the lactic acid into energy will be obtained difference in speed because of the differences in the capacity of maximal oxygen and the oxygen-carrying is hemoglobin between men and women. So in general, women need a longer recovery time compared to men. Female athletes with aerobic capacity or good VO_2 max may require a shorter time in the recovery than other women in general.

5. Conclusions

Based on the results of the research and the data analysis that has been done can be drawn some conclusions as follows:

1. There are differences between the effects of active recovery method and a cold bath to the reduction / change in blood lactic acid levels. The average reduction / change in blood lactic acid levels after the treatment of active recovery method is 3.50 mM/L and the average reduction / change in blood lactic acid levels after the treatment of cold bath method is 4.63 mM/L. The effect of cold bath method is better than the active recovery method in lowering levels of blood lactic acid.
2. There are differences in blood lactic acid levels between men and women. The average reduction / change in blood lactic acid levels in men areat 4.38 mM / L and an average reduction / change in blood lactic acid levels in women is at 3.75 mM/L. The reduction / change in lactic acid levels in men is faster than women.
3. There is no interaction effect between recovery methods and sex against lactic acid levels. Both groups of men and women have a reduction / change in blood lactic acid levels that are higher with cold bath recovery methods.

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