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Research Article

Influence of Combination of Weight Training with Sport Massage on 200 Meter Runners

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Abstract

Background and Objective: Explosive power movement in a 200 m race will potentially yield free radicals. The energy source of a 200 m runner, based on his movement, comes from anaerobic predominant metabolism, which also potentially yield high lactic acid. The increase in lactic acid causes the decrease in pH which tends to suffer from acidosis so that the establishment of ATP is hampered and cau pain in muscles. This condition can influence the performance of the 200 m runners. The objective of the research was to find out the influence of combination of weight training with sport massage, on the change in glutathione peroxides (GPX) and lactic acid elimination in the 200 m runners. **Materials and Methods:** The research used experimental method with pre and post test design. The research subjects were 20 students of Faculty of Sports Science, Medan State University, who had not been trained as 200 m runners and had fulfilled the inclusive and exclusive criteria, taken by using random sampling technique. Students were divided into two groups: WT+SM (Combination of weight training with sport massage) group and WT-SM (weight training without sport massage). The treatment was performed in 8 weeks with the frequency of exercise 3 times a week. **Results:** The research showed that there was significant influence of the treatment ($p \leq 0.05$) in the pre and post treatment in the WT+SM group and in the WT-SM group on the mean value of increase in glutathione peroxides content and the mean value of decrease in lactic acid content in 200 m runners. There was no significant differe ($p \geq 0.05$) of the increase in glutathione peroxides in 200 m runners in the post treatment done by WT+SM group and by WT-SM group. There was significant difference ($p \leq 0.5$) in the mean value of decrease in lactic acid content in the 200 m runners in the post treatment done by WT+SM group and by WT-SM group. **Conclusion:** Combination weight training with sport massage was better in increasing glutathione peroxides content and decreasing lactic acid content in the 200 m runners than that of only weight training.

Key words: Weight training, sport massage, glutathione peroxides, lactic acid, 200 m runner

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Weight training is a kind of exercise which is known as resistance exercise. The positive effects of this kind of exercise include improvement in physical condition, fitness and performance, therefore, it is usually recommended because it can decrease the risk for injury and it functions as prophylaxis, compared with the other exercises[1,2]. Every physical exercise like weight training has the potency for the incidence of free radicals which can bring about the incidence of oxidative stress. Humans body has a number of limited antioxidants, while the activity of free radicals can reach 20% during the training. Therefore, the body have its own defense to protect from the attack of free radicals by performing regular exercises. The activity of antioxidant depends upon the intensity and the duration of exercises[3,4]. Even though exercise can increase antioxidant defense system, a long period and heavy weight training can cause imbalance between free radical production and antioxidants which is called oxidative stress[5].

The mechanism of the establishment of free radicals in 200 m runners begins from muscle contraction during exclusive power movement. In the incidence of explosive power, ischemia will occur in muscles and be followed by muscle relaxation alternately. This muscle movement will cause blood flow to be hampered because of muscle contraction and when the muscles are relaxed, blood will flow rapidly. Ischemic reperfusion can cause the release of one electron of respiration chains so that free radicals are established[6-8]. The establishment of free radicals in 200 m runners can disturb mitochondria and can even damage mitochondria. The disturbance of mitochondrion function which will cause the establishment of ATP, needed by 200 m runners, is not fulfilled so that it causes fatigue easily. Therefore, the body has to have its own defense system, namely, antioxidants in order to protect from the attack of free radicals[5].

Regular and rated standardized exercises like weight training should be done in order to decrease the negative impact of oxidative stress because of the increase in free radical production. Weight training is intended to increase physical condition of the 200 m runners. The measurement of antioxidant enzyme content like glutathione peroxides (GPx) should also be done in order to find out whether there is the increase in oxidative stress or not. In the use of energy in the 200 m runners during the explosive power movement, most of the predominant source of energy is anaerobic latticed which potentially yields high lactic acid[9]. Physiologically, the increase in lactic acid content will decrease pH in body fluid. The decrease in pH can cause disturbance in the activity of oxidative enzyme in muscle cells so that the capacity of metabolism to produce ATP which is needed during muscle contraction is disturbed[9,10].

Recovery should be done immediately after doing the exercises in order to eliminate lactic acid in muscles by conducting sport massage. Immediate recovery after doing exercise is the most crucial factor in increasing an athlete's performance[11,12]. Researches on the effect of sport massage therapy are relatively limited and even some of them have different results about the influence of sport massage. For example, in the research conducted by Hemming *et al.*[13] on 8 amateur boxers, the treatment group was provided by sport massage within 20 min by using effleurage and petrissage techniques on the whole body, while the other group was provided with passive-relaxing treatment. The result showed that there was no significant difference in lactic acid content and the performance of the boxers who were given sport massage treatment from those who were given passive-relaxing treatment[13]. Another controversial research result was conducted by Wiltshire *et al.*[11] on untrained individuals, it revealed that sport massage performed during the recovery in decreasing lactic acid content in blood was better than that with passive-relaxing treatment after 200 m running activity[14].

The above two researches indicate two different results about the influence of sport massage on athletes' physical condition. Therefore, this research was conducted because up to the present, there has been no research which is concerned with the influence of sport massage on the performance of 200 m runners that is measured with the duration of 200 m race.

MATERIALS AND METHODS

Subjects: This study was not commercial research but part of doctoral dissertation. This research project was conducted from July-November, 2016 in Pharmacology Laboratory, Faculty of Medicine, North Sumatera University and Sport Science Laboratory of Medan State University. The research subjects were 20 students of Sports Science Study Program, UNIMED, with the criteria of males, 18-19 years old, untrained as 200 m runners, physically healthy, willing to be the research subjects and active in participating in the whole series of research procedure. Students were divided randomly into two groups with 10 participants in the combination of weight training with sport massage (WT+SM) group and 10 participants in weight training without sport massage (WT-SM) group.

Study design: The research used experimental study method with experimental randomized pre and post test group design.

Materials and device: Materials used in this research were vena cava blood to analyze GPx content and lactic acid content. The device used in the research was GPx kit to measure antioxidant glutathione peroxides content and Accutrend Plus to measure lactic acid content.

Research preparation: This research had been approved by the Research Ethics Committee of the Faculty of Medicine, USU, in its Letter No. 270/KOMET/FKUSU/2016 after the research subjects had understood the objective of the research and its benefit. They were then willing to fill out their personal data and informed consent forms and to sign them. The measurement of physiological characteristics included body weight, body height, IMT, pulse while in rest and blood pressure. Schedule for exercises was determined to be in 8 weeks with the frequency of exercises 3 times a week. Exercise was performed in the afternoon, starting from 4:00 pm until 5:00 pm. The research procedure was done by professionals according to their fields. The subjects' blood and lactic acid content were taken by 3 medical analysts. Weight training program was trained by certified trainers who were competent as athletic trainers, while sport massage was done by 12 certified masseurs. During the process of the research, the subjects were not allowed to consume antioxidant substances like vitamin C and vitamin E or other supplements. Subjects were also disallowed to do other physical activities except training program in the scope of the research. There would be no physical exercise for them and had to take enough rest.

Weight training procedure: The schedule for training was held in 8 weeks with frequency of exercise 3 times a week in the afternoon. Physical exercise was in the form of weight training plus technical training and sprint running tactics. The weight training was as follows: Leg press: 8-12 RM, 3 sets, squat jump: 12-15 RM, 3 sets, leg curl: 15-25 RM, 3 sets, sit ups: 15-25 RM, sets and Proprioceptive Neuromuscular Facilitation (PNF) exercise was done 3 times a week.

Sport massage treatment procedure: Each time the exercise was done, WT+SM group was given specific sport massage to the 200 m runners, it was partial massage in the lower legs by using effleurage technique. The method was by doing rubbing movement in the body, using the whole palms and fingers stuck on the lower leg areas, the movement was from the lower parts toward the upper ones. The duration of sport massage was 12 min (6 min from the right lower part of the legs and the other 6 min from the left lower part of the legs).

Measuring glutathione peroxides and lactic acid

Pre-exercise program: Two days before measuring the glutathione peroxides and lactic acid, the research subjects were suggested not to consume any drugs or other supplements, not allowed to do any physical exercise and had to take enough rest. Subjects began to do warming-up in 15 min. After that, subjects did 200 m race by recording their travel time. After they got to the finish line, 10 min later, their blood was taken from vena mediana cubiti for assaying their glutathione peroxides and lactic acid content. The assaying of glutathione peroxides content was based on ELISA method with GPx Qayee-Bio Kit, stated in ng mL^{-1} unit and spectrophotometer UV gauge with wavelength of 450 nm. The assaying of lactic acid content was done by using Accutrend Plus device with milimoles per liter (mmol L^{-1}) unit. By the end of the training program, the measurement of glutathione peroxides and lactic acid was the same as what had been done in sport massage (WT-SM).

Statistical analysis: All data were statistically analyzed with SPSS software (version 16). One-way analysis of variance (ANOVA) was used to study significant difference between means and significance level at $p = 0.05$.

RESULTS AND DISCUSSION

The research subjects in the two groups, based on age were 18.65 years old, based on body weight were 61.65, based on height were 167.8, based on IMT were 22 based on systole blood pressure were 119.5, based on diastole blood pressure were 78. and based on pulse while in rest were 64.8. All in all, they showed no significant disparity ($p \geq 0.05$), therefore, all of them were homogeneous, had the same characteristics, either physically or physiologically.

Glutathione peroxides of the 200 m runners increased significantly ($p \leq 0.05$) in the two groups in the pre-exercise, compared with that in the post-exercise, in the WT±SM group and in the WT-SM group (Table 1). The increase in glutathione peroxides in the 200 m runners in the post-exercise in WT±SM group was higher than that WT-SM group. The percentage of the increase in glutathione peroxides content of the 200 m runners. However, there was no significant difference ($p \geq 0.05$) in the increase in glutathione peroxides

Table 1: Mean value of glutathione peroxides and lactic acid content in the 200 m runners

	Mean±SD		
Variables	WT+SM	WT-SM	p-value
Glutathione peroxides			
Pre-exercise	218.35±10.31	220.17±12.66	0.155
Post-exercise	248.57±16.59	232.82±23.38	
t-dependent	0.000*	0.01*	
Lactic acid			
Pre-exercise	8.23±0.27	8.23±0.46	0.000*
Post-exercise	6.34±0.31	7.82±0.21	
t-dependent	0.000*	0.02*	

*Significance (p = 0.05), SD: Standard deviation

content in the 200 m runners in the post-exercise between WT+SM group and WT-SM group (Table 1).

Lactic acid content in the 200 m runners decreased significantly ($p \leq 0.05$) in the two groups in pre-exercise, compared with that in the post-exercise (Table 1). The decrease in lactic acid content in the 200 m runners in the post-exercise in the WT+SM group was higher than that in the WT-SM group at the percentage of the decrease in the lactic acid content in the 200 m runners. There was significant difference ($p \leq 0.05$) in the decrease of lactic acid content in the 200 m runners between the WT+SM group and the WT-SM group (Table 1).

Disparity in glutathione peroxides content in the 200 m runners: Weight training is a type of sport which is intended to develop strength which uses gravitation against the gravity which is yielded by muscles through concentric or eccentric contraction. In this exercise, body muscles undergo contraction by using body weight or other devices to stimulate muscle growth/work strength and resistance and by targeting certain muscle groups and types of movement. The exercise program can give benefit as maximal as possible and the risk as minimal as possible if it fulfills the training formulation which is called FITT (Frequency of Training, Intensity of Training, Time Spent, Type of Exercise)[15].

Standardized exercise which is measured, guided and programmed well can increase the physical condition of the 200 m runners so that free radicals which exist as the result of the high intensity of physical exercise can be eliminated by the runners who have good physical condition. If subjects have good physical condition, their capability of producing endogenous antioxidants like glutathione peroxides will be better than the 200 m runners who do not have good physical condition[4]. Weight training program is more focused on anaerobic exercise so that it will potentially yield relatively more lactic acid and can cause purine catabolism to become xanthenes and veins. This indicates the transition and acute vein deoxygenating which has the same problem with ischemic reperfusion. Purine catabolism and ischemic reperfusion will activate xanthenes oxides system which, in turn, establishes free radicals (O_2)[4,16-18]. The research which was done by Be *et al.*[19] on 100 m swimmers revealed that there was the increase in oxidative stress biomarker like Thiobarbituric Acid Reactive Substances (TBARS) (4.1±0.7 versus 4.9±1.1), creatinine kinase (206±170.7 versus 244±176.9) and glutathione peroxides (0.52±0.06 versus 0.62±0.05). This research concluded that anaerobatic exercise could cause oxidative stress, this increase in oxidative stress could hamper the establishment of glutathione peroxides and increased the use of endogenous antioxidants like glutathione peroxides[19].

The result of this research was in accorda with the research done by Groussard *et al.*[20], it was aimed to determine the effect of implementing the combination of exercise with massage regularly on oxidant and antioxidant content. In its research, the research subjects were 25 people who did not do their sp regularly and did not receive any sport massage. Subject were randomly divided into three groups: Control group (CG, n = 9), exercise group (EG, n = 8) and massage and exercise group (MEG, n = 8). The result of the research showed that there was significant decrease ($p<0.05$) in malondialdehyde (MD) content in the EG and MEG groups. It was also found that there was significant increase ($p<0.05$) in glutathione peroxides in the EG and MEG groups and there was significant increase ($p<0.05$) in Superoxide Dismutase (SOD) content in the EG and MEG groups, compared with that in CG group. This indicated that physical activity which is done regularly and combined with massage can cause positive effect on the increase in antioxidants and endogen-GPx and SOD[20].

The result of this research was also in accordance with another research done by Azizbeigi *et al.*[14], it was aimed to find out the influence of progressive resistance exercise on oxidative weight and the activity of enzymatic antioxidant in erythrocyte[14]. The research subjects were 20 men who were divided into two groups: Progressive resistance exercise group with moderate intensity (50%) within 8 weeks and control group. The result of the research showed that progressive resistance exercise with moderate intensity significantly increased the activity of SOD erythrocyte ($p = 0.014$), decreased MDA concentration ($p = 0.030$) and GPx content tended to increase. The role of sport massage in the WT+SM group could give positive effect on the increase in Gpx

content even though statistically, there was no significant disparity from WT-SM group but there was the difference in the increase in WT+SM group.

Disparity in lactic acid content in the 200 m runners: Exercise in WT+SM group was more significant in decreasing lactic acid in the 200 m runners than that in the WT-SM group. This indicated that LPK and sport massage had significant influence on the decrease in lactic acid content in the 200 m runners. The increase in lactic acid content is more significant in the WT+SM because weight training with standardized exercise which is measured, regular and programmed well can increase tolerance against lactic acid and increase the capacity of bicarbonate buffer and phosphate in muscles. Besides that, sport massage can be efficient to eliminate lactic acid in the 200 m runners[21].

The 200 m race athletics is the category of sprint and most of its predominant energy source is anaerobic lactacyd® which will yield relatively high lactic acid. The result of measuring lactic acid in the pre-exercise program in all treatment groups indicated the average increase of 8.23 mmol L^{-1} measured 10 min in the post 200 m race. The increase in lactic acid was caused by the incidence of hypoxia in muscle tissues so that anaerobic metabolism which yields lactic acid occurs. The increase in lactic acid is in accordance with the result of the research done by Kawczynski *et al.*[22], which found that there was the increase in lactic acid content in the 100 m runners at the mean value of 9.51 mmol L^{-1} which was measured in the 10th min in the post 100 m race. The higher the physical activity, the more increasing the need for oxygen. The need for oxygen can be increased by increasing the function of heart and lungs. When physical activity is high while oxygen intake from heart and lungs is not optimal, anaerobic metabolism exist to fulfil the need for energy. This condition increases lactic acid content in blood and muscles. The increase in lactic acid can change reactive oxygen compound to be more reactive so that the physical condition of the 200 m runners will noot maximal[19].

Physiologically, the increase in lactic acid content will decrease pH in the body liquid. The decrease in pH will affect the establishment of ATP which is needed during muscle contraction. Muscle contraction occurs because nervous impulse will reach axon terminal, followed by the release of acetylcholine (Ach) which immediately potentially stimulates muscle action in the membrane of muscles sarcolemma. Potential action in muscles spreads through tubules T and causes reticulum sarcoplasm to release calcium ion to sarcoplasm. When there was the increase in lactic acid, the releasing process of acetylcholine and calcium ion from reticulum sarcoplasm will be disturbed. In consequence, there is no calcium bond with troponin. This bond will open tropomyosin which covers cross-bridge receptor. The opening of cross-bridge receptor from tropomyosin bond causes the actin to shift and the caput myosin to be stuck, in this process, ATP is needed[23]. The increase in lactic acid will disturb the ATP splitting metabolism to be the energy.

Calcium ion low content in cytosol will decrease the muscle contraction power (leg muscle strength, abdominal and leg muscle resistance, leg muscle explosive power, running speed and reaction speed). During the resting period, calcium ion enters again into reticulum sarcoplasm and tropomyosin will close cross-bridge receptor again so the bond of actins and myosin is released and contraction will not occur. Physical activity will cause the bond of actins and myosin to become smooth so that muscle contraction highly depends on the higher or lower content of lactic acid in the 3200 m runners[23].

Sport massage given in the pre-exercise to the WT+SM group in the 200 m runners was an active recovery. It can cause muscles to be relaxed and regain the condition of blood vessel which used to be pinched by muscle contraction. Optimal relaxation can increase the backflow of vena blood in the lower muscle part of legs in bringing optimally lactic acid to the hearts of the 200 m runners, therefore, it could increase the oxygen of muscle tissues and expedite the elimination of lactic acid[24].The increase in tissue oxygenation will increase the conversion of lactic acid in heart through the Cori cycle to pyruvate acid which, in turn, will be changed to glucose so that it will expedite the supply for energy and expedite recovery[9].

Physiologically, massage is proved to be able to decrease heartbeat, to increase blood pressure, to increase blood circulation and lymph, to decrease muscle tension, to increase the range of joint movement and to decrease pain. Physiology is widely used by athletes, either for their physical performance or for prevention, therapy and rehabilitation for injuries and the side effect of sport[25]. Sport massage on the body will give physiological effect such as increasing blood flow and lymphatic flow, stimulating nervous system and increasing vena blood backflow. The increase in this vena blood backflow will efficiently return blood to the heart and drain off lactic acid which is deposited in muscles and expedite the elimination of lactic acid in blood and muscles. It has been proved that effleurage technique is more effective in decreasing lactic acid deposit in muscle cells than that with moderate intensity sport[24,26].

This glucose can be reused as metabolism in active muscles or kept in muscles through the process of

gluconeogenesis to become glycogen and can be used as an energy source. Pyruvate acid will enter mitochondria when the exercise is done below the lactate threshold (LT) and the establishment of energy is processed anaerobically, while in the exercise which is done over the lactate threshold (LT) like conventional exercise (heavy intensity exercise), pyruvate acid will be changed to lactic acid because the supply of oxygen is not enough to enter mitochondria[27]. In a research done by Groussard *et al.*[20] by using Wingate test, the research subjects pedaled bicycles within 30 seconds. Wingate test would stimulate anaerobic glycolysis metabolism by activating purine catabolism and lactic acid production. The data showed that anaerobic exercise by using Wingate test is the potential factor which causes oxidative stress. It is relatively the same as its movement pattern increase anaerobic glycolysis in the 200 m runners[20,27].

According to Best *et al.*[19], an athlete can carry on his exercise in relatively high intensity in the condition of lactic acid of 6-7 mmol L^{-1}. Therefore, the research with the mean value of lactic acid content in the 200 m runners in the LPK+SM of 6.34 mmol L^{-1} showed that the level of fatigue was still low so the performance in the WT+SM group was better than that in the WT-SM group. The research done by Weerapong *et al.*[25] on individuals who were not trained found that sport massage during the recovery period could decrease lactic acid content in blood more than passive rest after the activity in 200 m race[25,28]. The research done by Monedero and Donne[28] also found that sport massage could increase the elimination of lactic acid during the recovery period after doing high intensity exercise[28].

Pyne *et al.*[27] pointed out that sport massage done within 20 min could cause the decrease in lactic acid content in blood of 36.21% and sport massage done within 45 min could decrease lactic acid in blood of 72.4%[27]. The research done by Hanon *et al.*[29] was aimed to evaluate the influence of three methods for recovery-massage, active and passive recovery on the change in lactic acid concentration in blood and the time of performance in swimming athletes[29]. The research subjects were 17 swimming athletes. The result of the research showed that there was no difference between active recovery and massage and massage was more effective that passive recovery to eliminate lactic acid in blood. The research result was also in accordance with the research done by Devlin, *et al.*[30], stated that active recovery after heavy exercise would eliminate more quickly the accumulation of lactic acid in blood than passive recovery.

The explanation above indicates that in regular physical exercise and measured standardized exercise the body will be adjusted so that the capacity to work in higher intensity will be able to use lactic acid during the exercise[31,32]. This will cause more lactic acid to enter mitochondria and to be used for aerobic metabolism so that it can decrease the amount of lactic acid released to the blood flow. The combination with sport massage can increase the elimination of lactic acid more quickly than that of passive recovery, exercise without sport massage.

CONCLUSION

Combination of weight training with sport massage was better in increasing glutathione peroxides and decreasing lactic acid content in the 200 m runners than weight training only.

SIGNIFICANCE STATEMENT

This research showed that there is significant impact of combination of weight training with sport massage can increase the elimination of lactic acid more quickly than that of passive recovery, exercise without sport massage. This research provide scientific proof of the features of the combination of weight training with sport massage to improve the 200m runner's performance. Future research that needs to be done is to know the most effective type of weight training and type of sport massage to eliminate lactic acid and increase glutathione peroxide for a successful 200m runner achievement.

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