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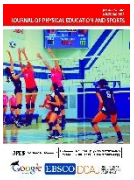

The Effect of Endurance and Leg Muscle Strength Training Method on the Increase of VO2Max

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Abstract

VO2Max is the ability to breathe oxygen as much as possible during exercise. The objectives of this study were: to analyze the differences of the effect of continuous running and interval running exercises, to analyze differences of the effect between athletes with high and low leg muscle strengths, and to analyze the interaction of endurance training and leg muscle strength to increase VO2Max. Method: This study deployed a 2x2 factorial design, using pre-test and post-test. The population of the study is 44 athletes of Persatuan Drum Band Indonesia (Indonesian Drum Band Association) of Semarang. The sample of the study was 24 athletes selected through a purposive sampling technique. This current study consisted of two independent variables, which were manipulative and attributive variables, and one dependent variable. The instruments used were the Leg Dynamometer test and the Cooper Test. Results of the study: The training method F_{value} = 12.712 > 3.44 with a significance level of 0.05, leg muscle strength F_{value} = 0.992 < 3.44 with a significance level of 0.05, training method and leg muscle strength F_{value} = 0.535 < 3.44 with a significance level of 0.05. Conclusion: Endurance training method with interval running using low leg muscle strength is better than continuous running using low leg muscle strength. Trainers are suggested to use interval running to increase VO2MAX to obtain better endurance.

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INTRODUCTION

According to Jensen in Ambarukmi (2007) in a sport with a duration of more than 120 seconds, the dominant system is aerobics which relies so much on endurance. Thus, to win short distance marching competition a good endurance is needed. In short distance marching competitions, athletes should compete in a brisk walk of 800 m in a group while playing musical instruments. The main scoring criteria are time to reach the finish line, line order, and music quality. If it is seen from its distance, this type of competition requires good endurance since the instruments used in this competition can weight up to 12 kg. Based on the identification of drum band sports game on the branch of short distance marching competition where the energy system uses more aerobics, training is needed to level up aerobic capacity by training endurance to increase VO2Max.

From the results of the test to 21 athletes regarding the VO2Max physical condition, it was found that 6 athletes were insufficient category while the rest 16 athletes were in not sufficient category. Drum band sports game is a group sport that cannot rely on just a few athletes, all athletes have a very significant role. If some group members are physically weak it will destroy their line, disturb the music (not focused), and et cetera. From this background, researchers were interested to investigate the obstacles and also provide training to increase the physical condition of PDBI athletes in Semarang. The physical condition elements needed in each branch of sport differ, therefore an athlete's physical condition needs to be improved through training programs that are carried out systematically, consistently, and continuously. Through physical training, an athlete's physical fitness will increase so that it can support the achievement of optimal performance (Miftakudin Nur, 2017).

Strength is a muscle ability to use maximum energy to lift weights. It is defined as the power used to change the state of motion or shape of an object (Nana Suryana in Yanse Betna Arte, 2019). According to Yoda 2006 in Ketut Mertayasa (2016), the strength of leg muscle is one of the physical components that must be possessed by athletes since athletes should be able to exert explosive strength in the shortest possible time. Muscle strength is a component of a person's physical condition related to his ability to use muscles to accept the loads at work (Sajoto, 1995). Strength is the ability of muscles to generate tension towards workloads. From those several definitions, it can be concluded that strength is the ability of muscles to accept loads while working by generating muscle tension to accept the loads (Harsono, 1988).

Strength is one of the basic physical components that is important because it is related to the quality of the athlete's movements. Athletes can move fast, overcome certain burdens and maintain body position in a moving situation if they are equipped with a good quality of muscle strength. To support all activities and to be able to do maximum work, the skeletal muscles must be trained to achieve a certain quality according to their needs. There are about 400 skeletal muscles that work on the human body as a motor driving the body. (Mansur, 2010).

Physical condition is a unified of whole-body components that cannot be separated, both its improvement and care. This means that as an effort to improve physical conditions, all of these components must be developed. This development can be performed by considering a priority system (M.Sajoto, 1995)

If the principles of training are not obeyed, it does not only lead to unfulfilled target but also wrong training, no increase in physical and technical abilities, and even further athletes can also experience injury (Johansyah Lubis, 2016).

VO2Max is the ability of the human respiratory organ to breathe oxygen as much as possible during exercises. Achievements at the VO2Max level can only be maintained for a short period, the longest can only take place for a few minutes. During workloads with VO2Max, the supply of energy occurs through aerobic and anaerobic processes. Due to the effect of exercise, VO2Max will increase. More importantly, energy at increased load can be provided through aerobic processes, thus the providing of anaerobic energy

occurs when workloads are above the VO2 Max percentage (Sukadiyanto, 2009).

The physical component is an integral part of physical fitness. So, the factors that affect physical fitness also affect a person's physical condition. The factors that affect physical conditions among others are age, sex, genetics, physical activity, and smoking habits (Ministry of National Education, 2000). In sports, the definition of aerobic endurance is the ability to fight fatigue in long-lasting muscle workloads and the ability to recover in the shortest possible time (Pasurney, 2013).

Continuous running

Continuous running or long-distance running is running exercise with a specified speed and distance, without time to rest until the entire distance traveled (Sajoto: 1988). This long and continuous form of exercise increases the ability to breathe oxygen and allows metabolism to take place more efficiently. Regular running exercises will enable the lungs to work more effectively which later allows more air to reach the blood. This exercise also increases the number of red blood cells in the blood and muscles, so that it binds more oxygen that enters the lungs (Ambarukmi, 2007).

Interval Running

Interval running exercise is a training system interspersed with interval running in the form of breaking times. So, its flows are as follows exercises (eg: running) - breaks - exercises - breaks - exercises and so on. (Harsono, 1988). There are three types of interval running exercises, namely: long interval running with long-running distance, intermediate interval running, and short interval running (Rushall & Pyke, 1990). Elite cyclists have demonstrated significant physiological adaptation and performance gained within 2 weeks of training using high-intensity interval training plans. Although the literature has shown significant performance improvements in both cyclists and runners as a result of at least 2 weeks of high-intensity interval training, further research is needed to establish guidelines for the duration of training needed to optimize performance (Tudor O. Bompa and G. Gregor Haff, 2009 in Abdul Rahman, 2015).

One important element in physical fitness is muscle strength and endurance. Having excellent muscle strength is the basis for success in sports in addition to optimization of other physical abilities including agility, power, speed and muscular endurance. Muscle strength is considered as one of the most important aspects of physical fitness related to health and fitness (health-related physical fitness) and physiological performance in children and adults (Mansur, 2010).

Muscle strength becomes a very important foundation in the development of other biomotor (Bompa, 1999). It will reduce the risk of injury when practicing or competing. Muscle strength also contributes to increasing self-confidence. Muscle strength is considered as the key to success in competition. According to Sukadiyanto (2005) in Daluhana Dwi Permana (2019), the training is a process of change for the better, and a process to improve the physical quality, the functional ability of the body, and the psychological quality of the trainers.

The hypothesis is a temporary answer to the formulation of the research problem, where the research problem formulation is stated in the form of a question. It is said temporarily because the answers given are only based on relevant theories, they are not yet based on empirical facts obtained through data collection (Sugiyono, 2009).

METHODS

This study is categorized as an experimental study using an experimental method of 2x2 factorial design where 2 variables were manipulated simultaneously to investigate the effect of each dependent variable and the effects caused by interactions between variables. The athletes with high and low leg muscle strengths were divided into two groups, then by using ABBA matching they were assigned into four groups. The population of this study is 44 athletes, which is less than 100 people. Then, 24 male athletes of the PDBI Semarang with the

same gender, same training programs, same sports branch, and the same trainer were selected as the sample of the study.

RESULTS AND DISCUSSION

The research revealed that the average VO2MAX for respondents given the method of Continous Running training was 2.244 while the average VO2MAX for respondents given the Interval Running method was 3.747. Reviewed from the category of leg muscle strength, the average VO2MAX on respondents who had a high leg muscle category was 2.786 while the average of those who had a low leg muscle category was 3.206.

Group	Leg muscle strength	Mean	Std. deviation	N
	High	1.8800	1.09880	6
Experiment 1	Low	2.6083	.74290	6
	Total	2.2442	.97177	12
	High	3.6917	1.26845	6
Experiment 2	Low	3.8033	.94800	6
	Total	3.7475	1.06923	12
	High	2.7858	1.47488	12
Total	Low	3.2058	1.02412	12
	Total	2.9958	1.26015	24

The effect between Continuous Running and Interval Running training on the increase of VO2Max from the table above shows that athletes given Interval Running exercise have higher average increase compared to athletes given Continuous Running training because, in athletics, the running distance is divided into three types including short distances, medium distance, long distance. Short distance dominantly uses speed, middle distance dominantly uses endurance and speed, and while long-distance dominantly uses endurance. According to (Mansur, 2010: 74), endurance based on duration or time can be divided into three types that includes endurance for a short time that lasts three to ten minutes, endurance for a medium time that lasts ten to thirty minutes, and endurance for a long time that lasts more than thirty minutes. From the theory, Cooper Test can be classified in medium distance running based on the distance and time of the test in which the dominant energy used is aerobic and anaerobic or mixture so that the physical condition elements needed are endurance and speed. So if the assessment instruments use the Cooper Test, the treatment given will result in more significant treatments that in training are dominant to increase endurance and speed because it is related to the needs of the physical condition elements used for the Cooper Test. The Interval Running method is more dominant in increasing endurance and speed because in Interval Running the steps used tend to be long and fast steps.

The different effect between high leg muscle strength and low leg muscle strength on the increase of VO2Max. The results of calculations using SPSS analysis showed that F_{value} = 0.992 while F_{table} at the 0.05 significance level was 3.44, which means that F_{value} is higher than F_{table} ($F_{value} > F_{table}$). And it also resulted that athletes having low leg muscle strength had an average VO2Max value of 3.2058 and athletes having high leg muscle strength had an average VO2Max of 2.7858. Based on the results, athletes with low leg muscle strength have higher average VO2Max than athletes with high leg muscle strength. In an endurance test such as Cooper Test, it needs the element of strength, according to (Mansur, 2010) Muscle strength becomes a very important foundation in the development of other biomotor (Bompa, 1999). Strength is an element of physical condition that is very important in the development of techniques, tactics, strategy, and mentality. The strength is to form an ideal posture. Muscle strength will reduce the risk of injury when practicing or competing. Muscle strength contributes to increasing self-confidence. Muscle strength is the key to success in facing the match. Based on the results of the study, it was indicated that athletes having low leg muscle strength have higher average VO2Max when compared to athletes having high leg muscle strength. So, it can be concluded that leg muscle strength is not the main determinant to increase VO2Max. Based on the Cooper Test, if the endurance and speed of cardiovascular are dominant, so the strength element is also dominant in which the needed

thing is the endurance strength. According to (Mansur, 2010) strength is divided into 3 types including endurance strength, maximum strength, and fast strength. It is in contrast to short-distance running test that requires maximum strength and speed to produce explosive power because in the test one has to run in short distance with maximum speed so that the dominant energy used is anaerobic.

The interaction of endurance and leg muscle strength training method to increase VO2Max.

After conducting research and calculating the research data, the results indicated that there is an interaction between endurance training methods and the level of leg muscle strength to increase VO2Max. The average increase in samples having high muscle strength with the Interval Running method is better with an average VO2Max of 3.6917 compared to samples having a high level of leg muscle strength with the Continous Running method with an average VO2Max of 1,8800. Whereas, samples having low levels of leg muscle strength using Interval Running training methods are better with an average VO2Max of 3.8033 than samples having low levels of leg muscle strength using Continous Running training method with an average VO2Max of 2.6083. There is an interaction between endurance and leg muscle strength training methods to increase VO2Max. The average number of samples that have low levels of leg muscle strength with the Interval Running training method is better than the samples that have low leg muscle strength with the Continuous Running training method. Whereas samples that have high leg muscle strength with Interval Running training method are better than samples that have high leg muscle strength with Continous Running training method.

CONCLUSION

Based on the results and discussion, it can be concluded that there is a different effect between the Continous Running training method and the Interval Running training method on the increase of VO2Max on PDBI athletes in Semarang. The Interval Running training method has a higher increase than the Continous Running training method, there is a difference between athletes who have high leg muscle strength and athletes who have low leg muscle strength on the increase of VO2Max of PDBI athletes in Semarang, there is an interaction between endurance training methods and leg muscle strength on the increase of VO2Max.

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