

The Effect of Circuit Weight Training on VO2Max

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Abstract—Weight training with the circuit training method is widely used by physical condition coaches whose benefit is to improve the body's abilities in general and is often used by coaches if they do not have enough training time before the match. Weight training has the aim to strengthen the ability of muscles; however, seeing the potential of circuit training methods that can improve overall physical condition, it needs to be explored further whether there is an impact on the ability of VO2Max because it is one of the most important parts for athletes. Seeing the athlete's need for improving muscle ability and increasing VO2max, the researchers tried to find out whether there was an effect of weight training using circuit training methods on VO2max. This research used an experimental method. The total sample was 12 people; each sample received treatment in the form of weight training using the circuit training method for 18 times, which were divided into 3 times a week for 6 consecutive weeks. The sample did the VO2max test beforehand and received treatment to find out the difference. The test resulted an average value of VO2max in which there was a very significant difference with a significance value of $P < 0.005$. The average of VO2max was $(46 \pm 5.7 \text{ mL / (kg.min)})$. Before getting treatment, the VO2Max value only reached $(43.9 \pm 5.4 \text{ mL / (kg.min)})$. Data processing was carried out with the Anova system. The conclusion of this study is that there is a significant difference in VO2max after receiving treatment. With this result it is hoped that the trainer will get references and choices of training methods to avoid athletes feeling bored because of the unvarying training methods, given the great benefits for muscle and cardiovascular.

Keywords: circuit training, weight training, VO2Max

I. INTRODUCTION

Regular physical activity is a non-pharmacological intervention that is important for health control and maintenance. The American College of Sports Medicine [1] recommends systematic physical exercise to develop physical abilities and functions such as cardiorespiratory, neuromuscular, and neuromotor fitness. Generally, strength training and cardiovascular endurance training are carried out in different training sessions. Strength training is often identical to training using external weights, such as training at a fitness center. Likewise exercises to strengthen cardiovascular abilities or more often heard as exercises to improve VO2Max, it is more often done on the running track because special exercises to improve VO2Max are easier to do by running.

Each year, the development of training methods is getting better. This is based on the increasing need for coaches and

athletes to continue to improve their performance in spite of all the obstacles they face. Basically, to achieve the best performance, athletes must have physic, technique, tactic, and mentality [2]. Physical needs are divided into several criteria. There is a need for speed, strength, endurance and flexibility [3]. Develop an ideal, at least 3 months, training program for athletes; a one-year training for novice athletes. On the way, it is not uncommon for coaches and athletes to experience various non-technical problems. The example is feeling sick before the game starts. As we know, illness or excessive rest has a risk of decreasing physical performance which results in athletes failing to reach peak performance as designed by the trainer in their training program.

Especially in reducing VO2Max; VO2Max is an important part of athlete performance which is included in the endurance section. VO2Max is a direct measurement of maximum oxygen absorption recognized as the best single index for aerobic fitness [4]. The need for better reference standards for VO2max was recognized in a 2013 policy statement by the American Heart Association (AHA) [5]. Strength training aims to improve muscle ability, an important part of performance that is included in strength groups.

Cardiorespiratory fitness, typically determined by maximal oxygen uptake (VO2max), is a fundamental measurement for the exercise physiologist. VO2max refers to the highest rate at which oxygen can be taken up and consumed by the body during intense exercise [6]. Traditionally, the magnitude of an individual's cardiorespiratory fitness has been viewed as both a characteristic of endurance athletes and a symbol of overall health. Elevated VO2max has long been considered an essential attribute required for success in endurance-related events. A landmark study conducted at Ball State University in the 1960's confirmed the importance of cardiorespiratory fitness to endurance performance, with findings demonstrating a strong correlation between VO2max values and 10-mile run times [7]. Additionally, studies have consistently demonstrated an inverse relationship between VO2max values and risk of cardiovascular disease and all-cause mortality [8]. In fact, Franklin has recently suggested that cardiorespiratory fitness should be employed as the ultimate marker for risk stratification and health outcomes [9].

Given its relationship to enhance athletic performance and positive health, the parameters of an exercise program required to improve cardiorespiratory fitness have been studied extensively, and subsequently well-defined guidelines have been published [10]. The American College of Sports Medicine

(ACSM) currently recommends 20-60 minutes of aerobic exercise 3-5 days/week at an intensity of 64/70-94% of heart rate maximum, and 40/50-85% of heart rate reserve (HRR) or oxygen uptake reserve (VO2R). Exercise intensity is arguably the most critical component of the exercise prescription model. Failure to meet minimal threshold values may result in lack of a training effect, while too high of intensity could lead to over-training and negatively impact adherence to an exercise program [9].

In a classic study 50 years ago on exercise prescription guidelines, Karvonen and colleagues [11] introduced the concept of HRR (the difference between maximal and rest heart rate) and noted a threshold intensity existed for the improvement of cardiorespiratory fitness. Historically, exercise intensity prescription by oxygen uptake (VO2) has been based on a straight percentage of VO2max [12]. The relationship between %HRR and %VO2max has been inconsistently reported in the literature. In the 1978 Position Stand Recommended Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory Fitness in Healthy Adults, the ACSM recommends a minimum training threshold of 60% HRR or 50% VO2max. The citation for this recommendation is the work by Karvonen et al., although VO2 was not actually measured in that study. The revised 1990 Position Stand Recommended Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory and Muscular Fitness in Healthy Adults again cites Karvonen et al., however in this report %VO2max is considered equivalent to %HRR, and recommended an intensity threshold for improving cardiorespiratory fitness of 50 %HRR or %VO2max [13]. In contrast to the 1990 Position Stand, the findings which were reported in several papers from the 1980's and 1990's suggest a discrepancy between %HRR and %VO2max. These inconsistencies prompted Swain and colleagues [14] to address the issue in the mid-1990 at the Wellness Institute and Research Centre at Old Dominion University.

Prior to the specific training of VO2Max improvement, then it seems necessary to look for other solutions if it turns out there are other ways or methods to improve VO2Max. The needs in the field will surely be fulfilled with the data. Therefore, researchers are interested in answering the needs of athletes and coaches to answer this problem. By trying to discover the other effects of strength training on VO2Max, these two items are basically important in improving athlete performance. Likewise, the training circuit training method is claimed to improve physical performance in a short amount of time [15]. Nonetheless, there is no research that links the circuit training method applied in weight training or the one commonly called as the circuit training method with VO2Max increase.

II. MATERIAL AND METHOD

The research used experimental methods. There was a preliminary test, further treatment given to the sample, and a final test performed to determine the impact of the treatment given. The total sample was 12 people; the sample has a background of frequent physical exercise and weight training during last month. To make sure that the sample has passed

through the anatomical adaptation phase, and can make the treatment go as expected. The sample has a vulnerable age between 20-25 years.

Samples underwent initial tests and final tests with the 2.4KM cooper method to determine VO2Max before and after getting treatment. After the initial test, the sample underwent treatment in the form of strength training using the circuit training method. The evenly trained muscle part was chosen from the upper body, middle and bottom to create muscle balance. The exercise was done 3 times a week, accomplished in 6 consecutive weeks. Total samples received 18 treatments.

Significance was made between the initial test and the final test to discover whether the impact of treatment during 18 meetings was on VO2Max. Data would be managed using the ANOVA method.

III. RESULT

From the preliminary tests, data show that the sample had an average 23.75 ± 0.71 , average body weight was 70.57 ± 2.16 (kg), average height was 169 ± 3.32 (cm), and the average VO2Max value is 43.90 ± 5.48 (ml / kg / min). After getting the treatment it was found that there is a significant difference in VO2Max between the initial and final tests, where the sample reached 46 ± 5.41 in the final test VO2Max. This means that the treatment significantly affects VO2max ($p < 0.05$).

TABLE I. ANTHROPOMETRY CHARACTERIZATION AND PRE TEST OF THE SAMPLES (MEAN \pm SD)

Samples	
Age	23,75 \pm 0,71
Weight (kg)	70,57 \pm 2,16
Height (cm)	169 \pm 3,32
VO2Max (ml/kg/min)	43,90 \pm 5,48

TABLE II. PRE TEST AND POST TEST VO2MAX (MEAN \pm SD)

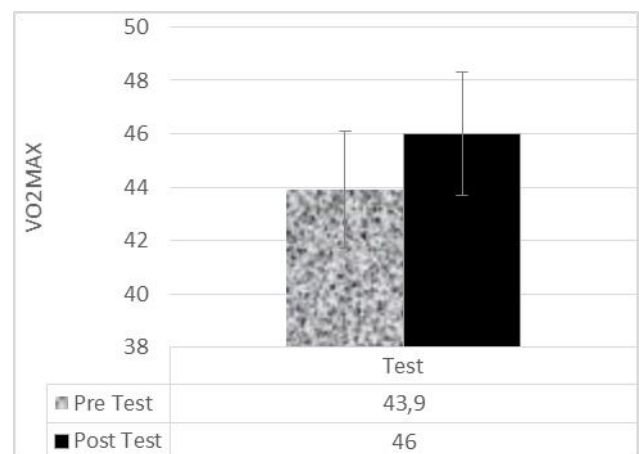


Fig. 1. Pre test and post test VO2Max (mean \pm sd).

IV. DISCUSSION

These findings suggest, therefore, that high intensity, variable-resistance strength training results in adaptive

improvements in cardiovascular function. The physiological response measured during the training session provides evidence that cardiovascular adaptation is probably due to the high percentage of VO₂max generated by this form of exercise.

The main finding of this study is that circuit weight training significantly increases VO₂max significantly for 18 meetings and 6 week training periods. Increased VO₂Max can occur because the circuit training method is a method that forces athletes to do a little rest, they are forced to do more repetitions between sets that make them trained in terms of endurance. Usually the sample for a little rest increases muscle endurance which ultimately contributes to increasing cardiovascular endurance. Muscles that were built in a balanced manner for 18 meetings supported the samples to run 2.4 km. Likewise cardiovascular endurance that is accustomed to doing exercises with minimal resting period makes cardiovascular development.

As for other findings that need to be clarified is, not necessarily this exercise method can have a significant effect on VO₂Max if the sample is a professional athlete. Because professional athletes usually have high VO₂Max, and need special training to increase VO₂Max if the athlete already has a high number. But the sample of this study is a beginner; it could be an increase because it is theoretically a practice that is routinely done one week three times for six consecutive weeks will improve one's fitness [16]. One of the definitions of fitness is cardiovascular endurance or can be measured by a VO₂Max test.

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