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THE EFFECT OF COMPLEX TRAINING MANIPULATION ON VO2 MAX

Mansur

Background: The physical condition is an important component and the basis for the development of techniques, tactics, strategies and mental development. Application of appropriate training methods will greatly affect the development biomotor and reduce the risk of injury. **Purpose:** (1) Effect of Pyramid Complex Training (PCT) on VO_2 max, (2) Effect of Square Complex Training (SCT) Exercises on VO_2 max, and (3) Differences in Effect of Pyramid Complex Training (PCT) and Square Complex Training (SCT) to VO_2 max. **Methodology:** This study used quasi experiment design with two group pretest posttest design. The population of this study is a new student of Sport Training Program (PKO) 2013 which is 21 non Athlete. Based on the ranking of the T score pretest the subject is divided into 2 groups, PCT group (11 people) and SCT Group (10 people). **Result:** The research findings showed that: (1) there was no significant influence of Pyramid Complex Training (PCT) manipulation on VO_2 max, with a significance value of 0.055> 0,05; (2) no significant effect of Square manipulation Complex Training (SCT) to VO_2 max, with a significance value of 0.240> 0.05; (3) there was no significant difference between Pyramid Complex Training (PCT) training and Square Complex Training (SCT) to VO_2 max. **Conclusion:** Complex Training Manipulation Training (Pyramid Complex Training (PCT) and Square Complex Training (SCT)) are less effective to improve VO_2 max.

Keywords: Pyramid complex training, Square complex training, VO_2 max

I. INTRODUCTION

The physical capacity of the athlete is an important element in the success of sporting achievements. It involves a large number of different capacities, with aerobic capacity being the main component (Rankoviæ, et al., 2010). New regulations and fierce competition require the exceptional aerobic capacity of every athlete. Sports competition is a test of ability and physical athlete capacity test. Aerobic capacity is an integral indicator of the functional capacity of all systems involved in the supply, transport and energetic transformation of oxygen (cardiopulmonary capacity, functional capacity of muscle to produce ATP in the presence of oxygen). The functional impairment of each link in the chain to some extent may affect the decrease in the physical capacity of the athlete (Ranković, *et al.*, 2010).

Aerobic endurance (VO2 max) is a very important foundation and is considered the best indicator of individual cardiorespiratory capacity, determined by the availability of oxygen, involving the transport components of oxygen pathways including ventilation, cardiac output, conductance of oxygen diffusion of the lungs, conductance of muscle oxygen diffusion, and hemoglobin concentrations (Osteras, Hoff, and Helgerud., 2005). According to Dalleck, and Dalleck., (2008), VO2 max is the highest level of oxygen can be taken and consumed by the body during

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intense exercise. Traditionally, the magnitude of one's cardiorespiratory fitness has been accepted as a characteristic of athlete endurance and the overall health symbol. Increased VO2 max has long been considered an important attribute needed for success in endurance related events. Mierke, (2006) states that the higher the max VO2 an athlete, the greater the contribution of aerobic systems to producing energy. This means that having a greater endurance will be able to complete high intensity physical exercise repeatly.

Physical and conditioning training becomes a very important part in the life of athletes, especially the sports that maintain the performance. Aerobic endurance becomes the foundation in the development of anaerobic endurance. Foundation is the basic structure that must be met for development at a high level. If the structure is weak, it will affect the development of the next stage. High aerobic endurance (VO2 max) will determine the peak performance of athletes in the future. VO2 max is an essential component that is essential for the development of other components, such as agility, power, speed and anaerobic resistance. Weak aerobic endurance will be a barrier to the development of anaerobic resistance. While the dominant energy system in competitive sport is largely anaerobic, including forward, backward, sideways motion at high speed (agility), power-jumping, repetitive power endurance and maintained in a relatively long time (anaerobic endurance). The development of more interesting training methods poses challenges to the sports coaches so as to stimulate the development of aerobic endurance to a minimum level of need and more importantly the development of power, agility, speed and anaerobic durability.

II. STUDY REFERENCE

VO2 Max

Endurance is associated with the ability to perform large, dynamic, medium to high intensity for long periods of time. Relating to that endurance depends on the cardiovascular, respiration and muscle system. Bompa, T.O. (2009) states that there are four factors that make up the athlete's resistance ie 1) the spirit (willpower), 2) aerobic capacity, 3) anaerobic capacity and 4) speed reserve. Endurance becomes an important biomotor component and is key in achieving competitive sporting achievements.

Endurance is the length of time displaying performance at a certain intensity. Komi., (2003) defines the ability to fight fatigue. In this case the factors that limit the performance of endurance are fatigue. Besides, the power of tahanjuga influenced by the speed, muscle deployment, skills and psychological aspects.

Aerobic Endurance

The term "maximal oxygen uptake" was first created by Hill and Herbst in 1920. They postulate that there is an upper limit for the absorption of oxygen and that

there are differences between individuals in VO2 max. Also, they theorize that high max VO2 is required for success in long-distance running and that VO2 max is limited by the ability of the cardiorespiratory system to transport oxygen to the muscles (Bassett and Howley, 2000).

Aerobic capacity is another term of cardiac endurance (cardiorespiratory endurance) or cardiovascular fitness or aerobic fitness, ie the functional ability of the heart's lungs to supply oxygen for long-term muscle activity (Wilmore, et al., 2008). Sharkey (2003: 351) defines aerobic fitness as the maximum ability of cardiorespiratory function to inhale, circulate and utilize oxygen. Based on these definitions can be summarized that aerobic fitness is the ability of heart lung function to inhale or take some oxygen, circulate and utilize it for the process energy formation. Someone who has good aerobic fitness, will not quickly experience fatigue after doing a series of work, which means able to do the exercise with a higher intensity. Besides, it also accelerates the recovery of exercise and match. According to Wilmore, *et al.* (2008) among the fitness components, the heart-lung resistance is a very important component, because the endurance of the lungs is needed for the smooth functioning of the oxygen transport system and nutrients in the body to meet energy needs.

Traditionally, VO2 max has been seen as a key component of success in long duration exercises (Bassett & Howley2000). However, more recently researchers have proposed that the lactate threshold is the best and most consistent predictor of aerobic endurance performance. Research studies have repeatedly found a high correlation between aerobic endurance such as running, cycling, fast road race and teady-state maximals workload with lactate threshold (Chandler, and Brown., 2008). At rest and steady-state exercise, there is a balance between lactate production and the removal of blood lactate (Brooks: 2000). The lactate threshold refers to the intensity of the exercise that there is a sudden increase in blood lactate levels if the intensity increases.

Some experts argue that the intensity of exercise that greatly increases VO2 max is 75-85% maximum pulse rate. Bassett, and Howley, (2000) say that the relatively high intensity of exercise (above 85% maximal pulse rate) will positively affect the shift of the anaerobic deflection point to the aerobic. Lance, *et al.* (2005), stated that aerobic endurance exercise negatively affects the production of lactate and is positive for the ability to remove lactate. Decrease in lactate production after endurance exercise may contribute to an increase in mitochondrial size, number of mitochondria, and mitochondrial enzymes. The combined result of the adaptation of the exercise is to improve the ability to generate energy through mitochondrial respiration, thereby decreasing the amount of lactate production in the given workload. Chmura and Nazar, (2010) argue that aerobic endurance exercise not only improves exercise tolerance due to its effect on metabolism, but also facilitates psychomotor performance during strenuous exercise. From a practical point of

view it is important that athletes who are able to maintain high-level psychomotor skills beyond the onset of blood lactate acid (OBLA) are at the domin of the intensity of strenuous exercise. It means that physical exercise improves performance resilience along with shifting the threshold of psychomotor fatigue toward the intensity of work to a higher level.

The law of practice says that Intensity is inversely proportional to volume, meaning that the athlete will not be able to maintain a long duration when the intensity is relatively higher. Conversely, at the intensity of exercise is athlete able to maintain the duration of exercise is relatively longer. Some experts also say that the intensity of exercise is relatively high (aerobic) more influence on stroke volume (stroke volume). Moderate duration intensity exercise is more influential in increasing blood volume, capillary density, number and size of mitochondria in muscle cells.

Cardiac function and the ability to deliver oxygen throughout the body can be enhanced by resistance training. The increased size of the heart, thicker and stronger causes the heart to be more efficient. Based on some of these definitions can be interpreted that aerobic fitness is the ability of heart lung function to inhale or take some oxygen, circulate or transport and utilize it for the process of energy formation. Someone who has good aerobic fitness, will not experience fatigue soon after doing a series of work, for example when climbing up and down stairs from the ground floor to the third floor will not be exaggerated panting. The quality of aerobic endurance is expressed by VO2 max, indicating the maximum amount of oxygen consumed. Stephen, (2005) states that VO2 max is the maximum oxygen volume the body consumes during intensive training at sea level with units (ml / kg / min). Consumption of linear oxygen with energy expenditure so that the measurement can be done indirectly (indirectly measuring). Bompa, (2000) states that achievement of durability is strongly influenced genetically. This is reinforced by the assumption that the proportion of slow muscle fibers and fast muscle fibers greatly determines the potency of the endurance.

Increasing the max VO2is an important step in maximizing the power performance in each event takes place more or more minutes. The higher the VO2max an athlete, the greater the contribution of the aerobic system to energy production. This means that a greater power of decay will be able to complete high intensity physical exercise over and over (Powers, and Howley, 2004).

Anaerobic Endurance

The term threshold batamba was introduced in 1960 based on the concept that in high intensity exercise, it causes low oxygen content in muscle (Chandler, and Brown., 2008). At this point, to continue the exercise, the required energy supply shifts from the aerobic energy system (respiration mitochondria) to the anaerobic energy system (glycolysis and phosphagen systems).

The definition of anaerobic threshold is related to exercises involving large muscle masses, therefore the concept of anaerobic thresholds only applies to whole bodies when most muscle mass is large. To understand the concept of anaerobic thresholds, it is important to understand the metabolic system that provides energy during exercise (Svedahl, and MacIntosh., 2003). Technically, if "anaerobic metabolism" is defined as charging ATP without the use of oxygen, anaerobic level phosphorylation substrate will be considered. These include reactions related to creatine kinase, glycolysis, and the Krebs cycle. Because oxygen absorption measurements allow accounting for some of these steps, the presence of glycolytic activity is not necessarily evidence that exercise has exceeded the limits of aerobic (Svedahl, and MacIntosh., 2003).

Complex Training

Complex training is a relatively new method of training and is the concern of practitioners and sports scientists. Complex training training methods are methods devoted to developing power. It is also called a combination method or a combined method of weight training and pliometric training. More specifically, complex training is a physical exercise method that combines weight training and pliometric training, the combination of both types of exercises is biomechanically similar.

Practitioners generally use either of these two methods of weight training or pliometric training. Weight training is a physical training method designed to develop athletic performance. Weight training programs can be designed to meet the needs of specific physical training, based on the nature of the training of the sport so as to enable control over the progress of the physical exercise program through volume manipulation, intensity, frequency, and duration of exercise.

Muscles have a natural tendency to rebound when stretched quickly (eg rubber band). Theoretically, the faster the eccentric contraction, the more likely the stretch reflex is activated. For a truly pliometric activity, there must be a movement beginning with the action of eccentric muscles. Pliometric training can promote changes in the neuromuscular system that allow people to have better muscle contraction control.

In principle, complex training is a training method that combines high intensity load training methods and pliometric training methods. With regard to the study of complex training training, it includes two methods of training, there are:

Pyramid *Complex Training* (PCT)

PCT is a modified training method developed from the training of complex training. In principle, PCT is no different from complex training training. Since complex training is a combination of weight training and pliometric exercises performed at the same session, PCT also follows that rule. Modification and development of PCT focuses on aspects of pliometric training. The pliometric training involves a

series of one leg lateral jump, rope-hurdle side jump, side-box combination jump twist jump (± 450) and twist knee tuck jump (± 900).

Exercise	*Reps*	*Rest/Set*
Half Squats	1 × 8RM	
	3 minutes	
One leg lateral jump	1× 6	30 seconds
Rope-hurdle side jump	1× 8	30 seconds
Side-front box jump	1× 9	30 seconds
Twist jump (45^0)	1×11	30 seconds
Twist knee tuck jump(90^0)	1× 12	30 seconds
	3 minutes rest	
Half Squats	1 × 6RM	
3 minutes rest		
One leg lateral jump	1× 6	30 seconds
Rope-hurdle side jump	1× 8	30 seconds
Side-front box jump	1× 9	30 seconds
Twist jump (45^0)	1× 11	30 seconds
Twist knee tuck jump(90^0)	1× 12	30 seconds
	3 minutes rest	
Half Squats	1 × 4RM	
	3 minutes rest	
One leg lateral jump	1× 6	30 seconds
Rope-hurdle side jump	1× 8	30 seconds
Side-front box jump	1× 9	30 seconds
Twist jump (45^0)	1× 11	30 seconds
Twist knee tuck jump(90^0)	*1× 12*	*30 seconds*

Square Complex training (SCT)

In principle, SCT is no different from the usual training training, while combining the load and pliometric exercises that are carried out in the same session. Modification and development of SCT focuses on aspects of pliometric training as well. The pliometric training involves a series of one leg front jump, side jump, front box jump, hurdle side jump, and knee tuck jump. All obstacles are placed across the right and left of the subject.

Exercise	*Reps*	*Rest/Set*
Half Squats	1 × 8RM	
	3 minutes	
One leg front jump	1× 10	30 seconds
Side jump	1× 10	30 seconds
Front box jump	1× 10	30 seconds
Hurdle side jump	1× 10	30 seconds
Kknee tuck jump(90^0)	1× 10	30 seconds

	3 minutes rest	
Half Squats	1 × 6RM	
3 minutes rest		
One leg front jump	1× 10	30 seconds
Side jump	1× 10	30 seconds
Front box jump	1× 10	30 seconds
Hurdle side jump	1× 10	30 seconds
Kknee tuck jump(90^0)	1× 10	30 seconds
	3 minutes rest	
Half Squats	1 × 4RM	
3 minutes rest		
One leg front jump	1× 10	30 seconds
Side jump	1× 10	30 seconds
Front box jump	1× 10	30 seconds
Hurdle side jump	1× 10	30 seconds
Kknee tuck jump(90^0)	*1× 10*	*30 seconds*

III. RESEARCH METHOD

3.1. Scope and Types of Research

The present study was a quasi experimental research design with two groups pretest posttest design. This research has two variables, that is independent variable and dependent variable. The independent variable in this research is Pyramid Complex Training (PCT) and Square Complex Training (SCT) training, while the dependent variable is VO2 Max.

3.2. Population and Sample Research

The study population was the new students of Sport Coaching Education Study Program (PKO) of 2013. Based on the ranking of the pre-test T score, the subjects were divided into two groups, that is PCT (Pyramid Complex Training) group and SCT (Square Complex Training) group. The PCT group was treated by combination of 8 RM, 6 RM, 4 RM weight training and plyometrics with pyramid system (6 contacts lateral single leg jump, 8 contacts side jump, 10 contacts box's jump, 12 contacts twist front jump and 14 contacts twist tuck jump), The SCT group was treated by combination of 8 RM, 6 RM, 4 RM weight training and plyometrics with square system (10 contacts single leg jump, 10 contacts side jump, 10 contacts front box's jump, 10 contacts hardle front jump and 10 contacts tuck jump). The training was conducted in three training sessions per week for 7 weeks.

3.3. Data Collection and Data Analysis Technique

The type of research data is quantitative data obtained from VO2 max test. The data were analysed by using t-test, which was previously carried out by normality and homogeneity tests.

IV. RESEARCH RESULTS AND DISCUSSION

Before stepping into the t-test, there is a requirement that must be fulfilled by the researcher is the data analyzed must be normal distribution, therefore it is necessary to test normality and homogeneity test.

Normality Test

TABLE 1: NORMALITY TEST RESULT

Group	*P*	*Sig.*	
PCT			
Pretest VO2 max	0,945	0,05	Normal
Posttest VO2 max	0,997	0,05	Normal
SCT			
Pretest VO2 max	0,999	0,05	Normal
Posttest VO2 max	0,860	0,05	Normal

Based on table 1, the data result showed that all data has a value of p (sig.) > 0.05, then all of data has normal distribute.

Homogenity Test

TABLE 2: HOMEGENITY TEST RESULT

Group	*Sig.*	
PCT		
Pretest-Posttest VO2 max	.378	Homogen
SCT		
Pretest-Posttest VO2 max	.603	Homogen

Based on table 2, the data result showed that all data has a value of p (sig.) > 0.05, so the data are homogeneous.

Testing of research hypothesis is done based on result of data analysis and interpretation t test analysis. The sequence of results of hypothesis testing is adjusted with the hypothesis, as follows:

TABLE 3: RESULT OF PAIRED T TEST FOR PCT AND SCT GROUP

Item	*Mean Difference*	*p*
PCT	2,654	0,055
SCT	1,89	0,240

Based on table 3, the data result showed a statistically not significant effectiveness PCT (p= 0,055) to improve VO2 max, and not significant effectiveness also showed on SCT group (p=0,240). That means both of PCT and SCT not significant effectiveness improve VO2 max.

In addition, statistically no significant difference was found between the PCT (M=2,654) and SCT (M=1,89), P value= 0,210 for the VO2 max. Data analysis result of difference between PCT and SCT on table 4.

TABLE 4: RESULT OF INDEPENDENT T TEST FOR VIDEO AND SCRIPT IMAGERY

Item	*Mean*	*p*
PCT	2,654	0,210
SCT	1,89	

DISCUSSION

The results showed that PCT and SCT manipulation had no significant effect on the increase of VO2 max (P> ½ α = 0,025). The average increase in PCT manipulation (2.65) is greater than that of SCT (1.89). The cardiopulmonary adaptation to chronic strength exercises is minimal and varied depending on the specific protocols used. A similar opinion was given by Chandler, and Brown. (2008) that cardiovascular adaptation is due to minimal load training and depends on the manipulation of weight training. Still according to Chander and Brown, (2008) adaptations are more on the morphological aspects such as the time and diameter of the left ventricle, and the thickness of the left ventricular wall and the thickness of the septum.

The maximum aerobic capacity of the top athlete is achieved between 17-22 years, after which the linear decreases with age. Training at age above 22 years can not expect significant improvement in VO2 max. After age 22 the possibility of VO2 max increase is only 10% (Rankoviæ, et al., 2010). The investigation of maximal oxygen uptake (VO2 max) provides relevant data on player health, planning and follow-up of training effects, also useful for athlete selection. For this reason, an increase in the VO2 max value reflects the athlete's physical performance indicators indispensable to reach the upper limit of sports achievement.

Some experts argue that the intensity of exercise that greatly improves VO2 max is 75-85% maximum pulse rate. Holly (2001: 452), argues that exercises to improve heart lung resistance is recommended intensity 75-85% maximal pulse rate and duration of exercise 20-60 minutes of persesi. American College of Sport Medicine (2006) recommends frequencies 3 - 5 times per week, intensity 60% - 90% HRmax or 50% - 85% VO2 max, duration 15-60 minutes, depending on the intensity used. Exercise with the intensity of 75% HRR will increase the heart rate until it reaches Cardiovascular endurance zone or aerobic exercise treshold, which in turn will increase the activity of cardiorespiration system such as increased blood circulation, stroke volume, heart rate frequency and cardiac output. Continuous, tiered and sustained exercise over a period of time will lead to positive adaptation of the heart muscle so that the work of the cardiorespiratory system is more efficient. This is in line with Djoko P's dissertation (2009) that low intensity

weight training circuits respond to a higher heart rate increase making it more significant in increasing VO2 max than in jogging exercises for people with overweight. Bassett, and Howley, (2000) say that the relatively high intensity of exercise (above 85% maximal pulse rate) will positively affect the shift of the anaerobic deflection point to the aerobic. Other researchers have suggested that the onset of blood lactate acid (OBLA) 4mM is the best predictor of endurance performance. To know how the response of PCT and SCT training methods can be seen in Figure 1 as follows;

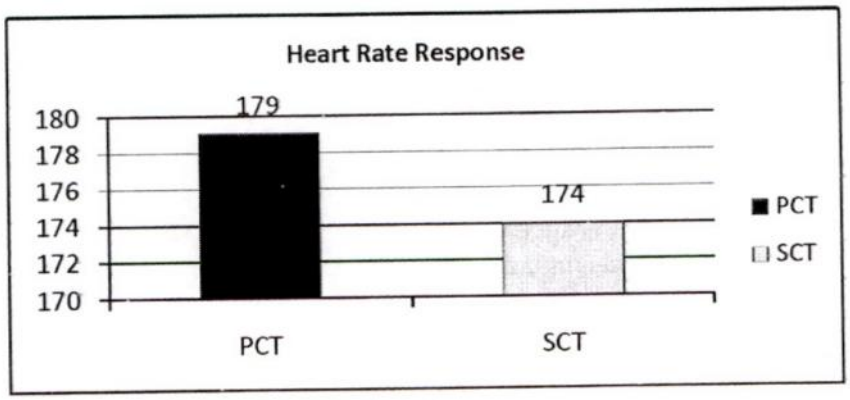

Figure 1: Heart Rate Response Postpartum Training

In this study, the PCT training method had a higher DJ response (179 times per minute) than the SCT training method (174) (Figure 5.7). Based on the theoretical and experimental studies the above experts indicated that the PCT training method further increased the VO2 max from the SCT training (Figure 5.5), albeit statistically insignificant with the error rate ½ $\alpha = 0.025$. According to Shephard (2008), Factors that affect maximal oxygen consumption (VO2 max) in healthy adults are age, gender, heredity, body composition, training conditions and exercise methods. One of the training methods that can be proposed to maintain and increase VO2 max is to manipulate the intensity and volume of exercise approaching the OBLA limit of 4 mMol. From the intensity side (Figure 5.6) shows that both exercise intensity variables can stimulate the cardiorespiration system to the OBLA limit of 4 mMol (75-85% maximal heart rate).

Shephard (2008) summarizes cross-sectional studies showing that aerobic ability declines steadily in men, with mean values in the region of 45 ml / kg / min at age 20 and about 25 ml / kg / min at 60 years. In inactive women, Shephard also noted that aerobic ability began to decline at 35 years of age from about 38 ml / kg / min and about 25 ml / kg / min at 60 years of age. Consecutive approaching 44% and 34% loss of aerobic endurance in both men and women. The decrease in VO2 max with age varies greatly, possibly due to decreased maximal heart rate, stroke

volume (blood pumped per pulse), free fat mass, and oxygen extraction on cells (arteriovenous oxygen difference). The maximum aerobic capacity of the top athlete is achieved between 17-22 years, after which the linear decreases with age. Training at age above 22 years can not expect significant improvement in VO2 max. After age 22 the possibility of VO2 max increase is oniy 10% (Ranković, *et al.*, 2010). The subject age in this study is 18-22 years old, in theory the age is within the gold age limit for the development of VO2 max.

As already known that resting heart rate for trained athletes is lower than those of untrained athletes. In theory a poorly trained athlete is more easily increased than a trained athlete. In this case the SCT group (Figure 5.8) should have a better effect than the PCT group.

V. CONCLUSION

Based on the reseach result and discussion there are several conclusion:

1. There was no significant influence of Pyramid Complex Training (PCT) manipulation on VO_2 max, with a significance value of 0.055> 0,05
2. No significant effect of Square manipulation Complex Training (SCT) to VO_2 max, with a significance value of 0.240> 0.05
3. There was no significant difference between Pyramid Complex Training (PCT) training and Square Complex Training (SCT) to VO_2 max

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