4.The Effect of Complex Training Manipulation on Student Speed of Sport Coaching Department

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The Effect of Complex Training Manipulation on Student Speed of Sport Coaching Department Universitas Negeri Yogyakarta

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Abstract

This study aimed to reveal: (1) the effect of Pyramid Complex Training (PCT) on speed, (2) the effect of Square Complex Training (SCT) exercises on speed, and (3) the differences in the effect of PCT and SCT on speed. This research was a quasi-experiment with the two-group pretest posttest design. The population was the new students of Sport Coaching (PKO) Department of 2013 consisting of 21 non-athletes, whose age ranging from 19 to 22 years old (± 19.3), height ranging from 162.3 cm to 187.0 cm (± 171.053 cm), weight ranging from 51.22 kg to 75.5 kg (± 63.0527 kg) and resting heart rate ranging from 50 per minute to 81 per minute (± 63). Based on the rank of T pretest score (speed) the subject was divided into two groups: PCT group (11 people) and SCT group (10 people). The PCT group was treated with weight training combination of 8 RM, 6 RM, 4 RM and plyometric training with pyramid system (6 repetitions of lateral single leg jump, 8 repetitions of side jump, 10 repetitions of box jump, 12 repetitions of twist front jump and 14 repetitions of twist tuck jump). The SCT group was treated with the weight training combination of 8 RM, 6 RM, 4 RM and plyometric training with square system (10 repetitions of single leg jump, 10 repetitions of side jump, 10 repetitions of front box jump, 10 repetitions of hardle front jump and 10 repetitions of tuck jump). The training was conducted three weekly training sessions for 7 weeks. All groups were given pretest and posttest. The speed testing used the 40 meter dash. The data analysis used a *t* test. The results were as follows. (1) There was no significant effect of manipulation of

PCT on speed, with the significance value of 0.096> 0.05 and percentage increase of 1.98%. (2) There was no significant effect of manipulation SCT on speed, with the significance value of 0.853> 0.05 and the percentage increase of -0.27%. (3) There was no significant difference between PCT and SCT on speed, with the significance value of 0.688> 0.05. Based on the analysis results, the raising percentage of PCTgroup was higher than that of SCT group, although statistically it was not significantly different p> 0.05. In conclusion, the Complex Training Manipulation (PCTand SCT) was not very effective in raising speed. Based on the raising percentage value, PCT is better than SCTexercise for speed.

Keywords: *Pyramid Complex Training, Square Complex Training, Speed*

Introduction

The peak performance in sports is the final estuary in the process of sports coaching. High achievement is the result of the actualization of various elements such as physical condition, technical ability, mastery of tactics, and mental maturity. Physical condition plays an important role, because it is the absolute and major requirement for achievement. Excellent physical condition should become the necessity for every athlete, especially for sports that require long-lasting heavy performance. Many advantages are obtained from the prime physical condition, among others the ease to master complex skills, reduction of risk of injury, maintenance of physical performance, acceleration of post-exercise recovery and increase in confidence.

The development of sports achievement in developed countries is inseparable from the physical exercise process that started from early age. Rudi Hartono, Liem Swie King, Icuk Sugiarto, Susi Susanti, Muhammad Ahsan, Hendra Setiawan, Tontowi Ahmad, Liliyan Natsir and several prominent athletes in Indonesia whose track record in training is good. This is in line with the research by Bompa (2009) which showed that 20 top athletes in the world practiced more than 1000 hours each year. This proves that high achievement must be based on excellent physical condition. The athlete is said to have a component for prime physical condition if they have the ability to do exercise cycles and a series of high intensity matches without causing significant fatigue. Physical condition parameters can be seen based on the quality of athlete physical condition components such as strength, aerobe endurance, anaerobic endurance, speed, power, agility, flexibility, coordination and balance. Without the support of prime physical condition, the achievement of peak performance will experience many obstacles. One of them is inability to maintain performance in long time. The ability to maintain athlete performance quality is desperately needed to achieve victory, especially on single or multi event demanding a large number of matches with short intervals. The experience of high performing athletes shows that athletes strive consistently to develop physical conditions to an excellent level.

Physical condition is an important element and becomes the basis in the development of techniques, tactics, strategies and mental development. So that, it needs a programmed exercise from the trainer. This means the training program must be planned, measurable, and sustainable. Herring, et al. in Mansur (2014: p.167) state that the purpose of physical condition training is to optimize performance and minimize the risk of injury and disease. Biological and network systems in sports training are set up by applying physical demands which are heavier based on the development of athlete's physical

condition (Bompa & Buzzichelli, 2015, p.19). Achieving these objectives requires a proper training approach. In the training terminology, it is commonly called the training method. Singh (2012. p.26) states that the exercise is a basic process of the preparation for higher performance whose processes are designed to develop motor and psychological abilities that enhance one's ability. Further, Sukadiyanto and Muluk (2011. p.9-10) state that the main objective of physical exercises is to improve the quality of physical fitness (energy fitness) and muscle fitness (muscular fitness). According to Bompa (1993, p.1) an exercise is a systematic, progressive repetition process with the ultimate goal of improving sports performance. So, the training method is the procedure of the systematic repetition process to master the skill or achieve the functional quality of the body maximally. With the suitable training method, the body will experience adaptation in the form of enhancement of the body functional ability so it can perform heavy performance for a long time.

Functional adaptation of muscles has been well documented by previous researchers, and muscle quality development strategies/methods have been published through various reports with different types of sports activities. The effect of exercise depends on the intensity and volume of the exercise. Failure to meet minimum threshold values may result in the lack of exercise effect, while too much weight can lead to overtraining and adversely affect an athlete's physical condition. Osteras and Hoff (2005, p.377) suggest that exercise adaptation varies greatly depending on many factors such as initial physical condition status and exercise intensity. In this case, the less trained athlete is relatively easier to increase positive adaptation when getting exercise treatment (Chandler and Brown, 2008), whereas a trained athlete requires an outstanding effort to get the same effect as the less trained athlete does by modifying the intensity, frequency, volume, recovery and exercise density.

Speed is a multidimensional motor capability that is primarily manifested in four forms: latency time of motor reaction, individual speed of movement, speed of frequency movement, and running speed (Stojiljković, 2003). Speed is distance per time, which means that speed will be measured by the unit of distance divided by the time unit. According to Sukadiyanto (2011. p.174) speed is the ability of muscles to respond to stimuli as fast as possible. Speed is the result of the combination of the length of the leg swing and the number of steps. According to IAAF (1993, p.73) speed is the ability to walk and move very quickly. Harsono (2015, p.216) adds that speed is the ability to perform similar movements in a row in the shortest time or the ability to travel a distance in the shortest time. From these statements, it can be concluded that speed is the ability of multidimensional motor muscle to respond to stimuli to make the movement very quickly or in the shortest time (as short as possible).

Suharjana (2013, p.140) states that speed components are used by almost all sports. For this reason, speed training are considered to be crusial for athletes. One of the speed training is a complex exercise. According to Bompa & Buzzichelli, (2015, p.19), success in strength training depends on knowing the types of strengths and how to develop them, as well as the types of contractions and which are best for a given sport. A complex training is an exercise method that aims to improve athlete's physical condition by doing high intensity strength training followed (transferred) by a plyometric exercise. Biomechanically, there is a similarity in terms of muscle and joint involvement between weight training and plyometric training, for example squat exercises3-6 RM followed by 8-12 repetitions of knee tuck jump exercises and bench press exercises 2-5 RM followed by 8 repetitions of clap push exercises (Mackenzie, 2000). The modification of complex training by varying the repetition pyramid load training decreased from 8 repetitions maximum (8 RM), (6 RM) and (4 RM) with the ascending intensity that has not much

been investigated deeply. Most researchers use high intensity external resistance (1-3 RM) with constant methods. Similarly, with plyometrics, there is less research comparing pyrometric pyramidal exercises (jumping to lateral, forward, sideways and twist), height of varied obstacles (20-50 cm), number of tiered repetitions increased (6-12) and plyometric training square (jumping in the same direction with the same high hurdle and the same number of repetitions). In addition, the majority of complex training studies were applied to trained athlete groups.

Modified forms of explosive exercises such as jump up and down, side-jump, knee tuck jump, single leg jump, lateral jump and box jump either by normal jumping or by twist was the main focus of this study. Single-leg training has many benefits and attention to injury prevention, rehabilitation, and performance improvement of sports programs. According to Boone and Cook, (2006), sports movement skills in the field are dominated by the cycle gait taking off from one foot and landing with another foot appropriately to improve the performance of the athlete. Other studies have shown that a complex training can have a positive effect on motor skills of basketball players (Cheng, Lin, & Lin, 2003; Santos &Janeira, 2008; Nageswaran, 2014; Roden, Lambson, &DeBeliso, 2014).

Complex training studies on the sample of poorly trained athletes have not been widely practiced. In this case, the students majoring in sports coaching at the Faculty of Sports Science, State University of Yogyakarta are mostly not athletes so it is possible for them to be the subject of research. Furthermore, the main focus of this study was to reveal: (1) effect of PCT on speed, (2) effect of SCT exercises on speed, and (3) differences in PCT and SCT effects on speed.

Methods

This study is a quasi experiment. The research design was the two-groups pretest-posttest design, which have a pretest before treatment and a posttest after treatment, thus the result can be more accurate, because it can be compared with the result before treatment (Sugiyono, 2007, p .64).

Research variables

This research has two variables, that is the independent variable and dependent variable. The independent variable in this research are PCTand SCT training, while the dependent variable is speed.

Research subject

The subjects in this study are the third semester students of Department of Sports Coaching Education, Faculty of Sports Science, Yogyakarta State University in their academic year of 2012 aged 19 to 20 years and not athletes, consisting of 80 male students. They were established as the subjects by using the simple random sampling method with the assumption that the population is humogeneous. Twenty-one students were treated on speed test (40m print). After that they were ranked and divided into two groups: 11 students as a PCT training group, 10 students as a SCT training group.

Instruments were used to measure: 1) physical readiness checks, 2) body height and weight, and 3) speed.

1. Examination of physical readiness
    a. Measurement of resting heart rate (DJ) was performed at 05.00 in the morning before the subjects did physical activities. DJ measurements were performed in a sitting position, using a heart rate monitor from Pollar FT1TM and FT2TM brands
    b. Blood pressure measurement used the Rister Measurement brand tensiometer.

2. Measurement of the height of the barefoot subject, standing upright, and viewing straight forward. The measurement of height used microtois brand Design type 26 BC made in Indonesia, with cm unit measurement, accuracy up to 0.1 cm.
3. Weight measurements used SmcBrandtype RGZ -120 made in PRC with kg measurement and accuracy up to 0.1 kg.
4. Speed measurement was through 400m sprint (Pretest).
5. The PCT group was given a combination of 8 RM, 6 RM, 4 RM and plyometric training with the pyramid system (6 repetitions of lateral single leg jump, 8 repetitions of side jump, 10 repetitions of box's jumps, 12 repetitions of twist front jump and 14repetitions of twist tuck jump). The SCT group was treated with a combination of 8 RM, 6 RM, 4 RM and plyometric training with square system (10 repetitions of single leg jump, 10 repetitions of side jacks, 10 repetitions of front jacks, 10 hard repetitions and 10 repetitions of tuck jumps). The training was conducted three weekly training sessions for 7 weeks.
6. Measurement of speed used 40 meter run (posttest)

Data analysis technique

Before proceeding to the t-test, there is a requirement that must be fulfilled by the researcher. The data that will be analyzed must be in the normal distribution, therefore it is necessary to test normality and homogeneity test (Arikunto, 2006, p.299).

Research Results and Discussion

The data in this research are the strength of pretest and posttest speed capability. The pretest and posttest data on PCTgroup speed capabilities are as follows:

Table 1. Pretest and Posttest of Pyramid Complex Training (PCT) Group Speed

No Subject	*Pretest*	*Posttest*	Difference
1	7.33	7.84	0.51
2	6.9	7.19	0.29
3	6.96	6.64	-0.32
4	7.46	7.41	-0.05
5	6.92	6.99	0.07
6	7.55	7.63	0.08
7	7.04	7.46	0.42
8	7.04	7.3	0.26
9	7.41	7.42	0.01
10	6.9	6.79	-0.11
11	7.18	7.58	0.4
Mean	**7.1536**	**7.2955**	**0.1418**
SD	**0.24394**	**0.36533**	**0.25600**
Min	**6.90**	**6.64**	**-0.32**
Max	**7.55**	**7.62**	**0.51**

The pretest and posttest data on Square Complex Training (SCT) Group speed capabilities can be seen as follows:

Table 2. Pretest and Posttest of SCTGroup Speed

No Subject	*Pretest*	*Posttest*	Difference
1	7.34	7.23	-0.11
2	7.35	7.6	0.25

3	7.27	7.34	0.07
4	7.22	7.66	0.44
5	7.58	7.26	-0.32
6	7.34	7.41	0.07
7	7.62	7.03	-0.59
8	7.12	7.38	0.26
9	7.52	7.31	-0.21
10	7.33	7.27	0.06
Mean	**7.3690**	**7.3490**	**-0.008**
SD	**0.15913**	**0.18138**	**0.30608**
Min	**7.12**	**7.03**	**-0.59**
Max	**7.62**	**7.66**	**0.44**

Prerequisite Test Results

Normality test

The result of the normality test is presented in Table 3 as follows:

Table 3. Normality Test Results

Group	**P**	**Sig.**	**Explanation**
PCT group			
Pretest Speed	0.635	0.05	Normal
Posttest Speed	0.914	0.05	Normal
SCT group			
Pretest	0.939	0.05	Normal

Speed			
Posttest Speed	0.572	0.05	Normal

Table 3 above shows that all data have the *p* value (Sig.)> 0.05 and therefore they are normally distributed.

Homogeneity Test

The results of the homogeneity test of this study can be seen in Table 4 as follows:

Table 4. Homogeneity Test Results

Group	**Sig.**	**Explanation**
PCT group		
Pretest-Posttest Speed	.297	Homogeneous
SCT group		
Pretest-Posttest Speed	.796	Homogeneous

Table 4 above shows that all data have the *p* value (Sig.) > 0.05, and thus they are homogeneous.

Hypothesis Test Results

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

Hypothesis of the Effect of PCT Training Method on Speed

The first hypothesis states: "There is no significant effect of the manipulation of PCTon speed", based on pretest and posttest results. The analysis of the t-test results shows the data in Table 5 as follows:

Table 5. T-Test Results of Pretest and Posttest of PCT

Group	Average	*t-test for Equality of means*				
		t value	t table	Sig.	Difference	%
Pretest	**7.1536**	-1.837	2.26	0.096	0.1419	1.98 %
Posttest	**7.2955**					

Table 5 above shows the t-value of -1.837 and t-table of 2.26 (df 10) at the significance level of 0.096. Since the t-value is -1.837 <t-table 2.26, and the significance level is 0.096> 0.05, then this result shows there is no significant difference. Therefore, the hypothesis stating "There is a significant effect of manipulation of PCTon speed" is rejected. The data above show that the PCT exercise decreased the speed of 0.1419 and increased the by 1.98%.

The Hypothesis of the Effect of SCT Method on Speed

The first hypothesis reads "There is a significant effect of SCTmanipulation on speed", based on pre-test and post-test results. The analysis of the t-test results shows the data in Table 6 as follows:

Table 6. T-Test Results of Pre-Test and Post-Test of SCT

Group	Average	*t-test for Equality of means*				
		t value	**t table**	**Sig.**	**Difference**	**%**
Pretest	**7.3690**	-0.191	2.23	0.853	-0.02	-0.27 %
Posttest	**7.3490**					

Table 6 above shows that the t-value of -0.191 and t-table of 2.23 (df 9) with significance value of p equal to 0.853. Therefore, the t-value is -0.191 < t-table 2.23, and the significance value is 0.853> 0.05. This shows that there is no significant difference. Therefore, the hypothesis stating "There is a significant effect of SCT manipulation on speed" is rejected. Based on the data above, the training of SCT has increased by 0.02 or 0.27%.

Hypothesis of the Differences in the Effect of PCT Methods and SCT Methods on Speed

The third hypothesis is "There is a difference in the effect of PCTand SCTmethods on Speed". Based on the results of the analysis, the data obtained in Table 7 are as follows:

Table 7. Test-t Group of PCTand Group SCT

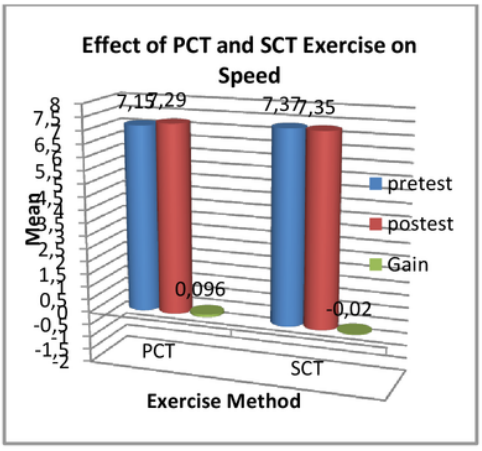
Group	Sig.	Explanation
PCT-SCT Group	.688	Not significant

Table 7 above shows that the significance value of 0.688 is > 0.05. This means that there is no significant difference. So, there is no significant different effect of PCTand SCTon speed. The analysis results show that the percentage increase of PCTis higher than that of SCT, although statistically it is not significantly different from 0.688> 0.05.

Discussion

The data analysis results showed that the manipulation of PCTand SCT have no significant effect (p => 0.000) on speed improvement, and that the percentage increase of SCT is higher than that of PCT. Thus, SCT training is better than PCT training in terms of speed improvement.

The results of this study need to be investigated based on the theory and findings of previous researchers related to the variables in this study. The following is the result of the average score of the pretest, posttest and speed gain as shown in Picture 1 below



Picture 1. Pretest, posttest and speed gain values

Picture 1 above shows that the training method of PCT is able to increase the average speed by 0.096 m/sec, which is higher than that using the SCT, i.e. -0.02 m/sec. This means that the PCT training method is better at increasing speed than the SCT training, although it is statistically not significantly different at p> 0.05. In sports, the achievement is very meaningful and it will determine the victory in competitions, especially in sports, that require time records such as sprint record breaking. This study shows how important the improvement of time records, even to improve the record of 0.5 seconds in 100m sprint takes up to several years.

Complex training seems to be an attractive option for developing strengths for untrained people. This includes strength training from initial training strengths to modalities which are an important aspect allowing for more specific training and practicing competitive techniques from the very beginning (Juares, Rave, Navaro, 2009, p.240). One way to combine the two forms of training (weight training and plyometric training) is complex training or contrast methods. According to Ebben, (2001), the design of complex training programs should consider important variables such as exercise selection, load, and break between sets. Furthermore, the study offers additional guidance to this variable as well as how it effects on age and gender. Complex training may be effective for the upper body (Evans, et al., 2000) and lower body training.

In this research, the technical variables are considered to be the same because the sample is from a homogeneous population of students majoring in sports coaching FIK UNY. The quality of leg muscles, including three components, namely: limb strength, power, and reactive power. Based on the theory, a good leg strength will increase reactive power, which is defined as the ability to change rapidly from eccentric to concentric phase in a stretch-shortening-cycle sequence (SSC). The treatment in this study is a combination of weight training and plyometric training. The weight training

treatments of both groups (PCT and SCT) were the same as those of the APS method (ascending pyramid system) 8 RM, 6 RM and 4 RM so that the effect on the increase of leg muscle strength was assumed to be the same. Plyometric training in the PCT group was focused more on the manipulation of functional training and the SCT group emphasized more on the manipulation of amortization. Functional training in PCT group plyometric training involves twist, rotational, lateral, and integrated balance movements. This type of exercise involves acceleration, deceleration, and stabilization during multipurpose movements in all three areas (sagittal, frontal, and transverse), and must be proprioceptively challenged (Yep, et al, 2000). Theoretically, both forms of training will increase speed.

The stretch shortening cycle is more influential with rapid movement and minimal ground contact (Komi, 2003). A decrease in contact time increases the movement strength and the stored elastic energy is not lost. The faster the clutch of eccentric action, the more concentric the effect of the exercise will be. Quick eccentric-concentric clutch acts resulted in greater power and muscle deployment and in turn the athlete ran faster, jumped higher, and changed direction very fast. Based on the theory, the SCT training method should have a better effect on increasing the speed due to the shorter amortization time of 6.53 seconds per type of exercise than the 6.67 seconds PCT training method per exercise type.

While in PCT training, although contact time (amortization) is longer, it has the advantage inbiomechanical adaptation, physiological and neurological systems due to synchronization and coordination of vertical and horizontal jumping movements, sideways, forward, backward, lateral, and twist. The similarity of treatment with the test used also affects the results, the more similar treatment to the type of the test used, the higher the effect on the measurement results. The illustration of the similarity theory is

shown by the fact that more economical runners generally outperform the less economical runners in similar actions. Physiologically, they consume less oxygen for an identical work rate. In other words, at certain running speeds, they do not have to work harder. In this case the SCT training method is more identical to the type of test used than the PCT training method, so it can provide better results. Additionaly, it can be reinforced by training specifications, which refer to methods and mechanisms responsible for physiological systems in response to stress in acute and/or chronic exercises.

A similar study conducted by Tricoli et al. (2005) evaluated the effect of the eight-week training on weightlifting and plyometric training programs, both training methods achieved significant improvements in 1RM squats and high vertical jumps, but they were unable to significantly increase the time 30m sprint and COD speed (change of direction). This study also succeeded in increasing the strength of RM 1 squat (picture 5.3) so that it was in accordance with the research by Tricoli et al. (2005). The increased muscle strength becomes the foundation of speed development. Stone, et al., (2002) states that squat ability > 2 times body weight is a minimum requirement to express power (vertical and horizontal). Wisløff, et al. (2004) showed that soccer players who were capable of squats > 2 x body mass are significantly faster and capable of jumping higher than those who squat <2 x body mass. Increased power is not automatically transferred to all movement speeds performed. Therefore, even if there is a significant increase in power, it does not necessarily affect the speed increase. Further research by Nikolic et al (2017, p.25) discovered that a combination of weight training and plyometric exercise for 12 weeks showed progress on sprint ability in 17-18 years old basketball players.

The principle of training speed includes: 1) use of high speed motion. 2) short run, 3) enough rest to minimize lactic acid levels in the blood, 4) low training volume to avoid exhaustion of the neuromuscular system, and 5) restricted repetition using

maximum intensity (Bompa, 2009; Komi., 2003). Not all of these rules are applicable in this study and there are even some rules which are so conflicting that the effect on speed increases is not significant. Moreover, the SCT training group actually decreased (-0.02 m/sec). Turner (2009) suggests that high loads for speed strength training (SPD-STR) should be <30% 1RM and low SPD-STR training loads> 30% 1RM. Weight training in this study used 8 RM - 4 RM (60% 1 RM - 80% 1 RM) which is in contrast to Turner 's opinion. However, Turner (2009) confirmed that the emphasis on gradual decrease in load (% 1RM) shifts from maximum strength to STR-SPD, SPD-STR and ends at speed training which in essence involves much of plyometric training such as the concept of exercise periodization.

It can be inferred that the PCT training method is more effective in increasing the speed than the SCT training method, but both exercises are less effective in significantly improving the speed. These findings simultaneously provide new information that shorten the time of contact (amortization) alone is still not enough to increase speed. Plyometric training involving a combination of vertical and horizontal jumping movement, sideways, forward, backward, to and from the lateral direction, twist, and shorten the amortization stage is crucial for the development of speed quality.

Conclusion

Complex Training Manipulation (PCTand SCT) are less effective in improving speed. Based on the percentage increase value, PCT is better than SCT exercise for speed.

Suggestion

Based on the results of the study, the following suggestions are given to trainers, sports teachers or sports coaches, spots club policy makers, and other researchers: there is a

need for similar research with more trained athletes, both male and female subjects. The PCT method is an alternative training method that can be used by trainers and athletes by modifying the number of contacts as it proves to be more effective in increasing speed.

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