Influence of Training Method and Leg Power on Running Speed

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Abstract—the objectives of this study were to find the (1) differences in the influence of repetition of sprint and acceleration sprint training method on running speed; (2) differences in the influence of high and low leg power on running speed; and (3) interaction between training method and leg power on running speed. The research method used was 2 x 2 factorial method. For the purpose of this research, 20 athletes were sampled. The measuring instrument used was a 60-meter run speed test. The data analysis technique employed was ANOVA at $\alpha = 0.05$. Results of the research revealed that (1) there is a significant difference in the influence of repetition of sprint and acceleration sprint training method on running speed at 60 meters, proved with a p value = 0.022 < 0.05. Repetition of sprint training method is higher (good) than acceleration sprint training method; (2) there is a significant difference in the influence of athlete with high and low leg power on running speed 60 meters, proved with a p value = 0.002 < 0.05. Athlete with high leg power is better than athlete with low leg power; (3) there is a significant interaction between training method and leg power on 60 meters running speed, proved by p value = 0.002 < 0.05.

Keywords—repetition sprint, acceleration sprint, leg power

I. INTRODUCTION

Athletics is a flagship sport that is composed of many multi-event activities such as running, walking, jumping, and throwing and that is why it is more important when compared with other sporting activities. Sprint competition is the most prestigious event among others, because it requires running from start to finish at full speed, demanding athletes to have good reaction and running speed. There is a requirement for a clear calculation as well as a complex movement analysis of both knowledge, purpose and procedure of training in improving the performance of athletic sports, including 60-meter running, because there are many factors that determine its achievement. "The decisive factor on short distance running is strength, speed, and acceleration" [1]. The phenomenon of the most gold medals in sprinting is Usain Bolt. In the last four years Usain Bolt improved the world record in the 100m sprint three times, from 9.74s to 9.58s. Over the last 40 years this record has been revised up to thirteen times from 9.95s to 9.58s. The improvement equals 0.37s (from 1968 to 2009) which is an increase in performance of 3.72%. By comparison, during the same time period, the 200m world record was revised six times from 19.83s to 19.19s what amounts to 3.33% [2].

Attaining an achievement in sprinting involves good coaching as well. Athletics coaching should be first applied to young children, so as to be able to nurture talented athletes. "The coaching process take a long time, starting from childhood or early age until the child reaches the highest level of competition efficiency". Therefore, physical formation exercises such as power, speed, endurance, flexibility, coordination, and agility must be developed in them so as to make it easy for them to master a certain sport in the future [3].

SMP Negeri 13 Yogyakarta is one of the schools that held a Special Class of Sport. Special Class of Sport in athletic branch is aimed at creating talented and qualified athletes with good personalities. It also serves as a coaching and training place with the objective of searching and developing talented youths in order to compete with other areas as a of establishing positive atmosphere in the community.

Based on the field observation conducted in November 2017, the problems faced by the coach of SMP Negeri 13 Yogyakarta, especially in sprint competition, include difficulty in choosing the proper training method, lack of training variation, and difficulty in determining training intensity to improve sprint competence as well as in organizing an efficient training that is relevant to the training's goals. SMP Negeri 13 Yogyakarta should have good achievements considering the students' high enthusiasm during the training. However, their enthusiasm is not supported by proper training methods and techniques. Several achievements of SMP Negeri 13 Yogyakarta in running competition include 1st place in Provincial Level in 2016, 2nd place of O2SN DIY in 2016, 2nd place of O2SN DIY in 2017, and 2nd place of POPDA in 2017. The shortcomings of the school are due to lack of proper training methods that are suitable for the improvement of running speed (sprint), lack of variation in teaching running ability, and lack of ability to master the running technique.

Actually, from a closer perspective, many factors can be attributed to the lack of athletic sports achievement, especially short distance sprint number (50m, 60m, 100m and 200m) at SMP Negeri 13 Yogyakarta and they include human resources (HR), in this case, sports teacher/trainer and students/athletes; the application of science and technology; training methods;

techniques/tactics as well as the search for talented talents (talent scouting) that has not been so maximized. Creation of athletic performance is easier said than done, but it can be achieved through a long-term process, various coaching and training processes, and science and technology implementation. Research activities are one of the key successes that support the development of sports supporting sciences such as exercise methodology, physiology, functional anatomy, psychology, and several other disciplines [4].

As a result of this, there is need for serious handling of selection and delivery of training methods to students/athletes. This certainly requires a review of methods employed in athletic teaching and training. It is important to point out that the lack of achievement in a sport causes decrease of motivation and interest from students to participate in extracurricular activities and the lack of variation in each activity also leads to boredom for student/athlete and this ultimately reduces the interest and lack of interest which is one of the causes of the withdrawal of achievement.

Exercise is a process that is carried out repeatedly by increasing the burden of the exercise that is gradually performed regularly and that has been programmed to attain the highest achievement. There are various forms and training methods that can be used in developing speed in 60 meters run. A 100-meter sprint requires a short duration of 4-2 minutes and an anaerobic primary energy source from phosphagen and lactate systems. In running 100 meters, the anaerobic energy system makes a contribution of 80%, while the rest is aerobic. Anaerobic exercise is generally an attempt to improve the system of ATP-PC glycoses (Adenosine Triphosphate-Phosphocreatine) or lactic acid system. There are several exercises that develop ATP-PC training systems to bring about the improvement in the 100 meters running performance, including acceleration sprint workout, hollow sprint workout, interval training, and fast-running exercises. These four exercises explore the dominant energy of ATP-PC. The methods employed in increasing the 100 meters running speed in this research include the acceleration sprint and repetition sprint. The implementation of a 60-meter sprint exercise should be carried out with a good and proper exercise. The acceleration sprint and repetition sprint exercise are forms of exercise that place emphasis on the repetition of motion.

Acceleration sprint is a form of practice that starts slowly, faster, and running as quickly as the execution is interspersed with a break between hours of practice. Acceleration sprint exercise is a gradual acceleration of slow running, fast pacing, followed by a sprinting run which is interrupted by rest periods in each exercise. Components of this acceleration sprint practice include jogging, striding, and sprinting. On the other hand, walk repetition sprint is an exercise program that is done with intensity or full speed interspersed with rest time in each training session [5].

These two exercises have different characteristics, therefore, they have different effects on increasing the ability to run 60 meters. In addition, the running speed of an athlete is not only influenced by training methods and programs applied in the training but also on other internal factors. Speed training must be done through a systematically programmed training. Moreover, the exercise program can run in accordance with expectations. It is necessary to choose the most powerful training methods that can increase the ability to run 60 meters. The selection of this method is based on the most dominant use of energy systems in a 60-meter run. For a 60-meter run that requires taking power in less than 30 seconds, the required energy system is ATP-PC [5].

There are some exercises that can develop ATP - PC training systems for the purpose of improving sprint run performance, these include acceleration sprint, hollow sprint, sprint training and interval training. In a variety of sports movements that start from zero such as sprinting, a very important factor is to obtain maximum speed in the shortest time. "Running short distances can be analyzed from different aspects of quality of speed through four phases, namely reaction time and reaction speed, acceleration, bottom speed and sprint speed, and speed resistance" [6].

Speed is influenced by muscle strength, muscle power, anaerobic endurance, movement coordination, running technique skills, and also by the type of muscle fibers held by the athlete. The muscle fibers in humans consist of "red muscle fibers and white muscle fibers". The type of muscle fibers possessed by a person are innate. "An athlete whose muscles consist primarily of red muscle fibers cannot develop into a sprinter, athletes who have white muscle fibers are more likely to become sprinters" [6].

"Starting power is an essential and often determinant ability in sports in which the initial speed of action dictates the final outcome. This shows that starting power is an important ability and a determinant in sports where the initial speed of action determines the final result [7]. Explosive power is defined as the ability of the body to mechanize muscles or a group of muscles to work explosively [8]. Power or explosive power can also be defined to be the combination of strength and speed. It is more useful if there is need to move objects relatively light with the use of enlarged velocity, if the object is heavy, it needs a more dominant power.

From several methods based on the above speed-quality analysis, the acceleration sprint and repetition sprint training methods are the appropriate methods to be used in training run speed and reaction speed, but the trainer is less concerned with the difference in the exercise. This kind of condition needs to explored so as to know the causative factors for all aspects including students, trainers as well as the training. Based on the problems that have been mentioned above, this research took the title "The Effect of Training Method and Leg Power on Running Speed of KKO Student at SMP Negeri 13 Yogyakarta"

II. RESULTS

The hypothesis tests carried out are presented in sequence as follows (a) differences in the influence of repetition sprint and acceleration sprint training methods on the speed of running 60 meters of KKO students at SMP Negeri 13 Yogyakarta; (b) differences of athlete's influence with high

and low leg power on 60 meters running speed of KKO students at SMP Negeri 13 Yogyakarta; and (c) the interaction between the training method (repetition sprint and acceleration sprint) and leg power (high and low) to the speed of running 60 meters for KKO students at SMP Negeri 13 Yogyakarta.

TABLE I.   DESCRIPTIVE STATISTICS PRETEST AND POSTTEST RUNNING SPEED 60 METERS

Leg Power	Statistics	*Pretest*	*Posttest*
High (A1B1)	Total	54,44	48,07
	Mean	10,8880	9,6140
	SD	.47257	.20132
Low (A1B2)	Total	56,95	54,34
	Mean	11,3900	10,8680
	SD	1,09697	.39638
High (A2B1)	Total	54,59	53,42
	Mean	10,9180	10,6840
	SD	.47981	.46290
Low (A2B2)	Total	57,93	53,26
	Mean	11,5860	10,6520
	SD	.71995	.39664

Data normality test employed in this research was the Komogorov Smirnov method. The results of normality test of the data performed on each group of analysis was carried out with the use of SPSS software program version 20.0 for windows with a significance level of 5% or 0.05. The data gotten is summarized in the table below:

TABLE II.   NORMALITY TEST

Data	*P*	Note
Pretest A1B1	0.998	Normal
Posttest A1B1	0.993	Normal
Pretest A2B1	0.888	Normal
Posttest A2B1	0.750	Normal
Pretest A1B2	0.845	Normal
Posttest A1B2	0.339	Normal
Pretest A2B2	0.989	Normal
Posttest A2B2	0.801	Normal

Based on statistical analysis of the normality test that was carried out on all pretest and posttest data obtained from significance value of data normality test $p > 0.05$ using Kolmogorov Smirnov Z test, it was revealed that data is normally distributed.

Homogeneity test was carried out to test the equation of several samples to check if they are homogeneous or not and to test the similarity in variance between pretest and posttest. Homogeneity test used in this research is the Levene Test. The results are presented in Table III below:

TABLE III.   HOMOGENEITY TEST

Group	*Levene Statistic*	Note
Pretest	0.177	Homogeneous
Posttest	0.115	Homogeneous

The statistical analysis of the homogeneity test carried out through the use of the Levene Test revealed a significance value of $p \geq 0.05$ from the pretest-posttest. The result shows that the data group has a homogeneous variant. Therefore, the population variant is homogeneous.

The research hypothesis test was conducted on the basis of data analysis results and an interpretation of ANOVA two-way analysis. Hypothesis Test Result is presented in Table IV below:

TABLE IV.   ANOVA TEST

Source	Type III Sum of Squares	F	Sig.
Training Method	.912	9.660	0.007
Leg Power	1,867	18.264	0.001
Training Method * Leg Power	2,067	94.340	0.000

From the ANOVA test result, the significance value of p is $0.022 < 0.05$, therefore, this shows that Ho is rejected. This means that there is a significant difference in the influence of repetition sprint and acceleration sprint training method on running speed in 60 meters. Based on the analysis, it was found that the repetition sprint training method is higher (good) with an average posttest score of 10.241s, compared to acceleration training method which has an average posttest score of 10.668s. This means that the research hypothesis which states that "there are significant differences in the effects of repetition sprint and acceleration sprint training method on the 60-meter run speed of KKO students in SMP Negeri 13 Yogyakarta" has been proven.

At the same time, it can also be seen that from the ANOVA test result the significance value of p is $0.002 < 0.05$, which shows that Ho is rejected. Based on this, it was found that there are significant differences in the influence of athletes who have high and low leg power to run speed of 60 meters. Based on the analysis, it can be concluded that athletes with high leg power ability is better (good) with an average posttest score of 10.149 seconds, compared to athlete with low leg power ability with an average posttest score of 10.76 seconds. This means that the research hypothesis which states that "there are significant differences in the influence of athletes who have high and low leg power to the speed of running 60 meters KKO students in SMP Negeri 13 Yogyakarta" has been proven.

From the ANOVA test result, it was also discovered that the significance value of p is $0.002 < 0.05$, which means that Ho is rejected. Based on this, it can be concluded that the hypothesis that there is a significant interaction between the practice method (repetition sprint and acceleration sprint) and limb power (high and low) to the speed of running 60 meters of KKO students in SMP Negeri 13 Yogyakarta has been proven.

The diagram of interaction results between training methods (sprint repetition and sprint acceleration) and leg power (high and low) to the speed of running 60 meters of KKO students in SMP Negeri 13 Yogyakarta can be seen in the picture below:
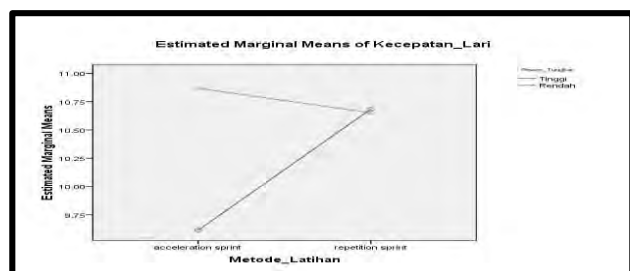
Fig. 1.   Interaction between Practice Methods and Coordination

The results of paired variance analysis with Turkey's advanced test showed that there are 5 significantly different pairs, which are (1) A1B1-A2B1, (2) A1B1-A1B2, (3) A1B1- A2B2, (4) A2B1-A1B1, (5) A1B2-A1B1, (6) A2B2-A1B1, while the other pairs show no difference: (1) A2B1-A1B2, (2) A2B1-A2B2, (3) A1B2-A2B1, (4) A1B2-A2B2, (5) A2B2- A2B1, (6) A2B2-A1B2.

Discussion

Differences in the influence of the acceleration sprint and repetition sprint training methods on 60-meter running speed

Based on the result from the hypothesis testing, it was discovered that there is significant difference between acceleration sprint and repetition sprint training methods on the speed of running 60 meters of KKO students in SMP Negeri 13 Yogyakarta. Acceleration sprint training method was found to be better than repetition sprint training method in 60 meter running speed. Sprints performed on continuous or sustained repetition sprints training have an impact on the ability of adaptation of muscles supporting rapid running movement and developing physical conditions that are appropriate to the physical needs which are characteristics of running speed.

The form of activity and technique of repetition sprints exercise method consists of multiple repetitions at a maximum speed. The repetition here involves a certain distance, constant velocity and a sufficiently long recovered period in order to maintain the required shape and quality level. The repetition sprints repetition duration should be done very briefly (5-10 seconds) for maximum speed to be achieved without early fatigue. In terms of the influence of the components of the activity form carried out, each method of fast running exercise has its own influence, in accordance with the characteristics of these components. The effect of repetition sprints is better than that of acceleration sprints.

Running fast repetition is a fast run that is done at maximum speed, repeatedly, interspersed with periods of recovered origin (recovery) which is carried out perfectly between replications. In repetition sprint practice, the distance is required, constant running speed (75-60% of maximal speed) must be maintained and there is need for long recovery time to maintain shape and quality of motion. During the process of using any of the training methods to increase speed, training pressure should be focused on maintaining good running techniques. Focusing on the sprint mechanics has more benefit compared to heavy workouts [9].

Recovering from a break in a fast-running exercise repetition usually involves the use of jogging or walking activities. Distance and recovering the origin of the break for a fast-track repetition training is a fast run with 3 repetitions

in 6-8 series at a distance of 50 meters with maximal speed and interspersed recovered active origin between replications performed. According to Repetition sprints, repeating sprint at a distance of 20-70 meters at maximum speed and interspersed recovered jogging origin between replications performed [10]. The results of the training obtained from the repetition training program are in addition to the increase in anaerobic power and not only aerobic power, an increase in fast muscle fibers and also a mechanical increase in neuromuscular [11].

Weight training will make the training to be very effective because it is very good for developing white muscle fibers which is one of the supporting components of speed, that is, strength, explosive power, and endurance. Accelerated running and running reps training is a training that uses the body and the intensity of the exercise as a training burden. Both of these trainings develop anaerobic system, which is very influential on running speed of the athlete, especially in the sprint (60-meter run). Anaerobic glycolysis in humans can occur in a short time on extreme muscle activity, such as running fast. When oxygen cannot be brought at sufficient speed to be carried to the muscles and oxidize pyruvate to form ATP during exercise, many O_2 is carried to the muscle, but the O_2 only reaches insufficient muscle cells, especially during training. Lactic acid builds up and diffuses into the blood. The presence of lactic acid in the blood is the cause for muscle fatigue. The choice of fuel during heavy training illustrates many important facets of energy formation and metabolic integration. Myosin directly derives energy from ATP, but the amount of ATP in muscle is relatively small and lasts for only about 2 seconds. Training acceleration sprints and repetition sprints develop anaerobic systems, because they are forms of exercise used in training for endurance. In addition, both of these trainings also develop the dominant energy system namely, ATP-KP.

With the interval of rest in the form of jogging, there is recharge of energy by activating a backup system called the phosphagen system (ATP-PC). The phosphagen system is a system in which the creatine phosphate, which is a high-energy phosphate bond, is broken down to synthesize ATP to be energized when the ATP supply cannot be satisfied by the tissue. Refueling for 30-60 seconds leads to a rapid recovery and limit the excessive production of lactic acid when the muscles relax so that the next exercise will not experience significant fatigue [12].

Differences in the influence of athletes who have high and low limb power to run speed of 60 meters

The results showed that there are significant differences in the influence of athletes who had high and low limb power to the speed of running 60 meters of KKO students in SMP Negeri 13 Yogyakarta. Athlete with high leg power is better than athlete with low leg power in 60 meter running speed. Leg muscle power supports the speed of running motion. Limb muscle power is the physical basis for the establishment of running speed and increasing the length of the stride when running.

Considerable research has indicated significant correlations between sprinting performance over various distances and a range of measures of strength 7-10 and power. 8-12 significant relationships between strength and power and sprint performance imply that the muscle function assessed by strength and power tests has some commonality with performance. This might suggest that improvement in strength and power may lead to improvement in sprint performance, but because correlation does not indicate cause

and effect, it is necessary to examine longitudinal studies involving resistance-training programs [13].

Leg muscle power is the ability of a muscle or a group of leg muscles to perform or against burden or resistance in the shortest possible time. Leg muscle power is required in almost all sports, especially in running, jumping, leaping, kicking, and other movements involving maximal leg muscle in a short time. Power is the ability of muscles to exert maximum power in a very fast time. Explosive power or power is a combination of two biomotoric elements which are elements of speed and strength combined together to produce power. For the purpose of increasing power, training should pay attention to the elements of speed and strength in order to obtain maximum results [14].

In sprinting, a person's running speed is determined by biomotoric factors such as the speed itself and other biomotoric factors that are not less important such as strength. Running speed is the result of a combination of speed and strength, especially power from the leg muscles. Leg muscle power of every person is not the same, there is a high and there is a low. High and low leg muscle power of an individual affect the speed of running of such individual. An individual with high leg muscle power will find it easy to develop running speed, either at the reaction speed (at start), the speed of motion (in the first few meters), the base speed (as the maximum speed) and the pace when compared with an individual with low leg muscle power. An individual with high leg muscle power will have a higher stride rate and longer stride length at run when compared to someone with low stride frequency. It is very useful to produce maximum running speed at run, because running speed is the result of stride frequency and length of one's stride. The development of running speed in students with high leg muscle power is better than those with low leg muscle power.

Power is described as the rate at which work can be done, therefore power = work/time. The more work that can be done in a given amount of time, the greater the power. The sprinter out of the blocks at the start of a race exerts great muscle power to overcome gravity and body inertia in order to reach maximum velocity. The sprinter's task as mentioned by Hall (1999) is to drive or thrust downward and backward against the ground [15].

From the definition above, power can be described as the rate at which work can be done, therefore, power is equals to work done per time. The more work that can be done in a certain amount of time, the greater the power. A fast runner out of the beam, at the start of the race, gives greater muscle strength to overcome the gravity inertia and the body in order to reach maximum speed. The sprinter's duty is pushing or pushing down and back against the ground.

The interaction between the training method (acceleration sprint and repetition sprint) and leg power (high and low) to the running speed of 60 meters

Based on the research results, a significant interaction between the training method (acceleration sprint and repetition sprint) and leg power (high and low) to 60 meter running speed of KKO students in SMP Negeri 13 Yogyakarta was discovered. The results showed that the repetition sprint training method is the most effective method used for athletes with high leg power while acceleration sprint training method is more effective for athletes with low leg power. In this research, interaction means that every cell or

group has different influences to every group that is paired. Pairs that has real different interaction or partner (significant) are as follows:

a. Groups of athletes trained using repetition sprints training method with high leg power are better than athletes trained through the use of acceleration sprints method with high limb power, with a significance value of 0.002 <0.05.

b. Groups of athletes trained using repetition sprints training method with high leg power are better than athletes trained with the use of repetition sprints training with low leg power with a significance value of 0.000 <0.05.

c. Groups of athletes trained using repetition sprints training method with high leg power are better than athletes trained with the use of acceleration sprints method with low limb power with a significance value of 0.003 <0.05.

d. Groups of athletes trained using repetition sprints training method with high leg power are better than athletes trained with the use of acceleration sprints method with high limb power with a significance value of 0.002 <0.05.

e. Groups of athletes trained using repetition sprints training methods with high leg power are better than athletes trained with the use of repetition sprints training with low leg power with a significance value of 0.000 <0.05.

f. Groups of athletes trained using repetition sprints training method with high leg power are better than athletes trained

with the use of acceleration sprints method with low limb power with a significance value of 0.003 <0.05.

III. CONCLUSIONS

Based on the results and data analysis of this research, it can be concluded that (1) there is a significant difference in the influence of repetition sprint and acceleration sprint training method on running speed 60 meter of KKO students in SMP Negeri 13 Yogyakarta. Repetition sprint training method is better than acceleration sprint training method in 60 meter running speed. (2) There is a significant difference in the influence of athlete with high and low leg power on running speed 60 meter of KKO students in SMP Negeri 13 Yogyakarta. Athlete with high leg power is better than athlete with low leg power in 60 meter running speed. (3) There is a significant interaction between training method (repetition sprint and acceleration sprint) and leg power (high and low) of KKO students in SMP Negeri 13 Yogyakarta in 60 meter running speed.

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