

The Effect of Plyometric and Resistance Training on Increasing The Speed And Explosive Power of The Leg Muscles

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Abstract

Physical conditions in all sports, especially football, need to be trained with good training. The purpose of the study was to analyze the effect of plyometric and resistance training on increasing the speed and explosive power of the leg muscles. This research is an experimental research with a match subject pretest and posttest design. The population is 80 students, the sample is 60 students. Sampling technique purposive random sampling. The test instrument in this study was a 30-meter run test and a standing broad jump test. The data analysis technique used Manova. The results showed that Sig. The resulting variables for speed (pre-test), leg muscle explosive power (pre-test), speed (post-test), and leg muscle explosive power (post-test) were 0.614; 0.742; 0.985; and 0.729. Value Sig.=0.002. Sig.=0.002. Sig.=0.031. Sig. = 0.031 because the value of Sig <0.05 then H₀ is rejected, so it is concluded that there is an influence between the type of exercise with the speed and explosive power of the leg muscles. Tuckey pre-test and post-test there are differences between plyometric knee tuck jump exercises and resistance squats on increasing speed. As for the plyometric knee tuck jump exercise and the resistance leg press exercise there is no difference, there is no difference between the types of exercises to increase leg muscle explosive power. Conclusion: there was an increase in the speed and explosive power of the leg muscles for each experimental group after being given plyometric and resistance training.

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INTRODUCTION

Football is a very popular sport throughout the world, almost all corners of the world have both professional and amateur football leagues (Ghozali et al., 2017). The game of football involves two teams than normally between 11 and 18 players. Each team tries to score a goal or a point, by moving the team to the opposite end of the field and either being a goal or over the line. The goal is defended by the opposing team and players are required to move the ball by kicking (Ali et al., 2016).

Physical condition in terms of physiology is a person's ability to know the extent of his ability as a supporter of sports activities. Physical condition can also be interpreted as a player's body condition (Wiwoho, 2014).

Improving physical condition is one of the indicators for achieving better physical fitness (Adhi et al., 2017). One of the important elements that must be included in football coaching efforts is coaching in physical condition, considering that sport involves both physical and spiritual components. This requires a player to have the ability well and also fast. For this reason, it is necessary to support elements of good physical condition such as strength, endurance, explosive power, speed, flexibility, balance, coordination, agility, accuracy and reaction. All these elements are the driving force for any physical activity. Speed and explosive power provide the ability to move faster.

Speed is a person's ability to carry out activities continuously in the form of the same movement in the shortest possible time. Running speed is defined simply, step length from the frequency of steps, is a determinant of running speed (Khoirul Huda, Hadi Setyo Subiyono, 2012). Speed is needed by a soccer player, especially when dribbling a soccer ball (D. Kurniawan et al., 2016). Dribbling a soccer ball doesn't just carry the ball down the ground and straight ahead, but also faces opponents who are quite close and close. Speed is the most important component in sports, because speed is

needed when competing to achieve maximum performance (Shava et al., 2017).

Explosive power is a movement that is produced explosively and takes place in dynamic conditions (Widhiyanti, 2013). One form of exercise used in all types of sports to increase the speed and explosive power of the leg muscles is plyometrics and resistance (Perikles et al., 2016).

Plyometric exercise is an exercise program to increase the power and speed of athletes (Chu & Myer, 2013). According to Radcliffe and Farentinos (2015: 234) the forms of plyometric exercises for the lower body are pogo, squat jump, box jump, rocket jump, star jump, double-leg slide kick, and knee tuck jump. *Plyometric* It is a combination of speed and strength training. The combination of speed and strength is the embodiment of muscle explosive power (K. Kurniawan & Ramadan, 2016).

Research result (Ikhwan Abduh, 2020) shows the effect of plyometric knee tuck jump and Scissors Jump exercises on the running speed of players at SMA Negeri 1 Paleleh Barat. Research result (Ratno & Darmawan, 2019) showed that plyometric knee tuck jump and squat jump exercises increased leg muscle explosive power. Radcliffe & Farentinos (1985:6) say that there are several types of plyometric exercises, including squat jumps and knee tuck jumps.

The form of plyometric exercises used in this study were knee tucks jumps and squat jumps. Plyometric exercises combine strength and speed to produce leg muscle explosive power that engages more muscle fibers to activate muscle spindles.

Knee interpreted knee, tuck means fold, jump means jump, so the knee tuck jump exercise in this study is a form of jumping exercise that begins with a standing position and bends the knee joint. The position of the two arms hanging beside the body, the movement is done by swinging both arms up followed by a vertical jump (Jaya & Rohmat, 2019).

This form of exercise involves two hands tied behind the head, then jumping, squatting, standing. explosive movement, Squat to a squat position, press the toes and push the body into

the air as high as possible, and When descending, immediately bend the knees, lower back into the squat position and jump again (Revelation Santosa, 2015).

Resistance training is an integral part of almost every way of training athletes and has become a popular mode of recreational training for many physically active individuals (Volek, 2004). Resistance training is an ideal partner for plyometric training because it helps prepare the muscles for the fast impact loading of plyometric exercises. (Taheri et al., 2014), plyometric and resistance training methods are able to provide an increase in speed, endurance, agility and explosive power of the leg muscles (Alauddin Shaikh, 2012).

Research result (Taheri et al., 2014) concluded that resistance exercises to increase agility, speed and explosive power of leg muscles using exercises as smith press, seated press, squat, lying dumbbell leg curl, leg extension, leg press, standing barbell curl, lying barbell extension and sit up, have an effect on increased agility, speed and explosive power of the leg muscles. Research conducted (Haghighi et al., 2012), concluded that the resistance training model for increasing speed using leg extension exercises, leg curls, leg press and seated calf raises, had an effect on increasing speed.

The forms of resistance training that will be used in this study are leg press and squat exercises because these exercises dominate the speed and explosive power of the leg muscles.

The leg press is an excellent exercise for building leg muscle mass, which consists of upper leg muscles, lower leg muscles and leg muscles (Mahayasa Hadiwijaya, 2013). The main purpose of the leg press exercise is to train the leg and thigh muscles, namely the front thigh muscles, back thigh muscles, and calf muscles (Wahyuddin et al., 2019).

Squat exercise is a type of weight training to increase strength development, especially in the leg muscles, and weights are the basic basis of exercise. This squat exercise is done by overloading the body organs with a barbell with the intensity, set, frequency and duration of the exercise can cause an exercise effect in the form

of increasing strength (strength), (Rachman Ahmad Yani, 2012). The squat movement aims to train the gluteus, hamstring, quadriceps, spinal erector and shoulder girdle muscles, which play a role in vertical jump movements, Wiguna (2017:103).

In several sports that require the speed and explosive power of the leg muscles, the researcher directs the sample of this study to the sport of football, namely the soccer extracurricular participants at SMA Negeri 1 Jebus, West Bangka Regency. So those researchers are interested in examining the effect of plyometric exercises (knee tuck jump and squat jump) and resistance (leg press and squat) on increasing the speed and explosive power of the leg muscles.

Plyometric and resistance training is one form of exercise that is often used to increase the speed and explosive power of the leg muscles. For this reason, researchers are interested in applying this plyometric and resistance training program to soccer extracurricular participants. In addition, researchers want to prove the existing theory, it is said that plyometric and resistance training programs can increase the speed and explosive power of the leg muscles (Haghighi et al., 2012).

The aims of this study were 1) To determine the effect of plyometric exercises (knee tuck jump and squat jump) on increasing speed. 2) To determine the effect of plyometric exercises (knee tuck jump and squat jump) on increasing leg muscle explosive power. 3) To determine the effect of resistance exercises (leg press and squats) on increasing speed. 4) To determine the effect of resistance exercises (leg press and squats) on increasing leg muscle explosive power. 5) To know the difference between plyometric training and resistance training to increase speed. 6) To find out the difference between plyometric exercises and resistance exercises to increase leg muscle explosive power.

METHODS

This research is an experimental research. With the research design using a matching-only design (Maksum, 2012:100). The research design can be described as follows:

Table 1. Research Design

Group	Pre-test	Treatment	Post-test
I	T1	X1	T2
II	T1	X2	T2
III	T1	X3	T2
IV	T1	X4	T2

Information:

T1: Pre-test (Speed and Explosive Power)

X1: Treatment of group plyometric exercises (knee tuck jump)

X2: Treatment of the experimental group plyometric exercises (squat jumps)

X3: Treatment of group resistance training (leg press)

X4: Treatment of group resistance training (squats)

T2: Post-test (Speed and Explosive Power)

The population used in this study amounted to 80 people. The number of samples used in this study were 60 people. Purposive sampling technique is a sampling technique based on the characteristics or characteristics (objectives) set by the researcher: male soccer extracurricular participants KU I (age group) 16-18 years, male gender, physically and mentally healthy, willing to be a sample and follow the training program. The sample in this study amounted to 80 students. Then all samples were subjected to a pretest to determine the treatment group. In the treatment, the pre-test scores were ranked by means of ordinal pairing, then matched with the ABBA pattern in four groups of 15 athletes or students each. The purpose of using ordinal pairing is to generalize the ability of the sample in each group. Based on the ordinal pairing technique, the sample was divided into four experimental groups consisting of: (1) Group I: this group was treated with plyometric exercises (knee tuck jumps), (2)

Group II: this group was treated with plyometric exercises (squats). jumps). (3) Group III: this group was treated with resistance training (leg press). (4) Group IV: this group was treated with resistance training (squats).

The variables of this study consisted of the independent variable, the manipulative variable, which consisted of two treatments: plyometric training and resistance training, the dependent variable in this study was an increase in the speed and explosive power of the leg muscles.

The instrument of this research is to collect data using tests and measurements including: The technique used in measuring speed by sprinting 30 meters (Fenanlampir and Faruq, 2015: 130). The technique for measuring leg muscle explosive power uses a standing broad jump (Widiastuti, 2015: 111).

The data analysis technique used the MANOVA (Multivariate Analysis of Variance) test with the help of SPSS 21.0. Before arriving at the use of MANOVA, it is advisable to test the requirements, including: the lilliefors kolmogrov-smirnov test with the help of SPSS 21.0 at a significance level (α) of 0.05.

The decision-making criteria if the significance value obtained is greater than , then the sample comes from a normally distributed population, whereas if the significance value obtained is less than sampel, then the sample does not come from a normally distributed population. The homogeneity test of the data used the Levene test with the help of SPSS 21.0 at a significance level (α) of 0.05. Decision criteria if the significance value of Levene is greater than then the sample comes from the same population (homogeneous), whereas if the significance of Levene is less than , then the sample comes from an unequal/nonhomogeneous population.

After the normality test and the homogeneity of variance test, the use of MANOVA in data analysis can be done. The data from the latest test results were analyzed by MANOVA statistics and SPSS 21.0 hypothesis testing at a significant level of 0.05% which had previously been tested for prerequisites.

The alternative hypothesis (Ha) is accepted if the significance value is less than α (Sig<0.05), whereas if the significance value is greater than (Sig>0.05) the alternative hypothesis (Ha) is rejected and the null hypothesis (Ho) is accepted.

After testing the hypothesis successfully, the researcher conducted further tests to find out the differences between each training method, the researchers used the Tukey test.

RESULTS AND DISCUSSION

The results and discussion of this study include data description, data analysis, analysis prerequisite testing, and hypothesis testing based on the results and interpretation of the data using the multivariate variant test (manova) with the help of SPSS 21.0. The facts from the results of the exercise are more visible in the following diagram:

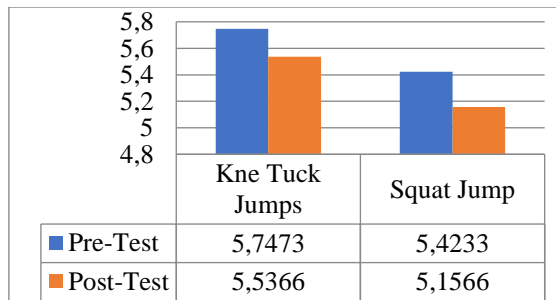


Figure 1. Pre-Test and Post-Test Running Speed (seconds)

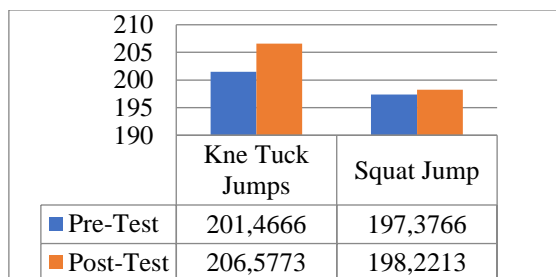


Figure 2. Pre-Test and Post-Test Limb Muscle Explosive Power (cm)

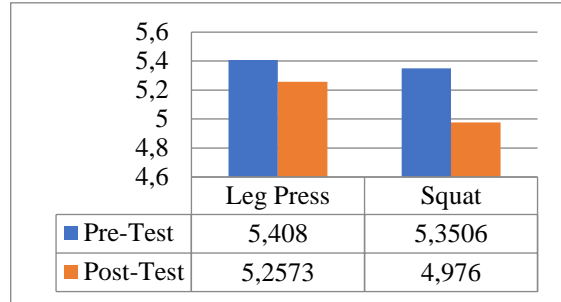


Figure 3. Pre-Test and Post-Test Running Speed (seconds)

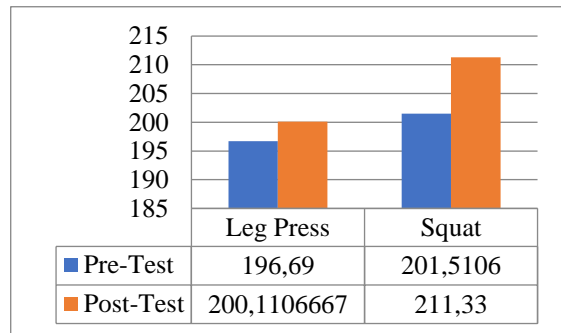


Figure 4. Pre-Test and Post-Test Limb Muscle Explosive Power (cm)

By looking at the diagram above, it can be concluded that after the treatment of plyometric exercises and resistance training for six weeks, it can have a significant effect on increasing the speed and explosive power of the leg muscles.

The results of the data normality test using Kolmogorov Smirnov assisted by the SPSS 21.0 program. Based on the normality test of the data using the One-Sample Kolmogorov-Smirnov Test, it can be seen that Sig. The resulting variables for speed (pre-test), leg muscle explosive power (pre-test), speed (post-test), and leg muscle explosive power (post-test) were 0.614; 0.742; 0.985; and 0.729. This shows that the value of Sig.> 0.05 or the value of Sig.> α . So it can be concluded that the data used comes from a normally distributed population.

Table 2. Levene's Test

Pre-Test And Post-Test Running Speed

Data	F	df1	df2	Sig.
Pre-Test	3.614	3	56	0.019
Post-Test	1.514	3	56	.221

Based on the output of Levene's test of equality of error variances, it is known that the pre-test Sig. = 0.019 and the post-test Sig. = 0.221. This shows that the value of Sig. > 0.05 or the value of Sig. > α . So it can be concluded that the data used has the same variance or is homogeneous, so that the Manova assumption is fulfilled.

Table 3. Levene's Test
Pre-Test and Post-Test Limb Muscle Explosive Power

Data	F	df1	df2	Sig.
Pre-Test	1.118	3	56	.350
Post-Test	.340	3	56	.797

Based on the output of Levene's Test of Equality of Error Variances, it is known that the Pre-Test Sig. = 0.350 and Post-Test = 0.797. This shows that the value of Sig. > 0.05 or the value of Sig. > α . So it can be concluded that the data used has the same variance or is homogeneous, so that the Manova assumption is fulfilled. Based on the results of the follow-up test (Tukey's test), both the test results on the pre-test and post-test data that there is a difference in the increase in speed between the plyometric knee tuck jump exercise and the resistance squat exercise. As for the plyometric squat jump exercise and the resistance leg press exercise there is no difference. There is no difference between types of exercise to increase leg muscle explosive power.

The Effect of Plyometric Training (Knee Tuck Jump and Squat Jump) on Speed Increase

Sig. generated from Hotelling's Trace. Based on the resulting output, Sig.=0.002. Because Sig <0.05, the null hypothesis is rejected, so it can be concluded that there is an influence between the type of exercise and the speed and explosive power of the leg muscles.

The results of this study are in line with previous studies conducted by (Taheri et al., 2014), (Irmansyah, 2016), (Ikhwan Abduh, 2020) in his research journal showed that there was a significant effect of plyometric and

resistance exercises on increasing the speed and explosive power of the leg muscles.

Speed is the most important component in sports, because speed is needed when competing to achieve maximum performance (Shava et al., 2017). In general, speed training is done after athletes are trained in endurance and strength. This is in accordance with the training pyramid, that speed training is carried out after the athlete has been trained in endurance or has an adequate aerobic basis, followed by anaerobic excitability threshold skills training, and good anaerobic ability, then speed training (Sukadiyanto, 2011).

Thus the knee tuck jumps and squat jump training methods can be used as a form of training to increase speed in several sports that use leg muscle explosive power. Many factors affect the increase in speed and explosive power, including exercise, endurance training, nutritional intake, drinks and so on. Although other factors cannot be controlled, there are two factors that must be completely controlled, namely exercise and nutritional intake (Ozgur, 2012).

From the research results obtained and support from previous studies, it can be concluded that there is an effect of plyometric exercises (knee tuck jump and squat jump) on increasing speed.

The Effect of Plyometric Training (Knee Tuck Jump and Squat Jump) toward Improving Limb Muscle Explosive Power

Sig. generated from Hotelling's Trace. Based on the resulting output, Sig.=0.002. Because Sig <0.05, the null hypothesis is rejected, so it can be concluded that there is an influence between the type of exercise and the speed and explosive power of the leg muscles.

The results of this study are in line with research-Previous research conducted by,(I Gst Nym Harimbawa, I Nym Kanca, 2014), (Nabizadeh et al., 2013), (Khodajo et al., 2014), (Literature & Irawan, 2020) in his journal showed that there was an effect of plyometric exercises (knee tuck jump and squat jump) on increasing leg muscle explosive power.

Plyometric training combines speed with strength to produce explosive power (power), therefore plyometric training is one of the ways that trainers need to consider to maximize and increase explosive power.

Thus the knee tuck jump and squat jump training methods can be used as a form of training to increase leg muscle explosive power in several sports that use leg muscle explosive power. Many factors affect the increase in speed and explosive power, including exercise, endurance training, nutritional intake, drinks and so on. Although other factors cannot be controlled, there are two factors that must be strictly controlled, namely exercise and nutritional intake (Ozgur, 2012).

From the research results obtained and support from previous studies, it can be concluded that there is an effect of plyometric exercises (knee tuck jump and squat jump) on increasing leg muscle explosive power.

The Effect of Resistance Exercises (Leg Press and Squats) on Increasing Speed

Sig. generated from Hotelling's Trace. Based on the resulting output, Sig.=0.031. Because Sig <0.05, the null hypothesis is rejected, so it can be concluded that there is an influence between the type of exercise and the speed and explosive power of the leg muscles.

The results of this study are in line with previous studies conducted by(Ikhwan Abduh, 2020), (Irmansyah, 2016), (Haldankar, 2014), (Zearei et al., 2013), (Mahayasa Hadiwijaya, 2013) in his journal showed that there was the effect of resistance exercises (leg press and squats) on increasing speed.

The leg press exercise concentrates the load on the soles of the feet so that when doing the pushing movement the only muscle components involved are the leg muscles. (Rachman Ahmad Yani, 2012). Squat exercises have a greater improvement than leg press exercises. This is due to the difference in characteristics between the leg press and squat exercises where in the squat exercise the load is on the shoulders so that when doing the up and down movement the complexity of the muscles

involved is more, compared to the leg press exercise. Leg press and squats are types of exercises that aim to increase strength, especially in the leg muscles. Speed (speed) as the underlying basis in the formation of biomotor components, necessary physical components that are important in order to achieve optimal performance. With leg press and squat exercises that are carried out systematically, it will affect the increase in speed.

From the research results obtained and support from previous studies, it can be concluded that there is an effect of resistance training (leg press and squats) on increasing speed.

The Effect of Resistance Training (Leg Press and Squats) toward Increasing Limb Muscle Explosive Power

Sig. generated from Hotelling's Trace. Based on the resulting output, Sig.=0.031. Because Sig <0.05, the null hypothesis is rejected, so it can be concluded that there is an influence between the type of exercise and the speed and explosive power of the leg muscles.

The results of this study are in line with previous studies conducted by(Sushant Ranganath Haldankar, 2014), (Matavulj et al., 2001), (Ronnestad et al., 2008) in his journal showed that there was an effect of resistance training (leg press and squats) on increasing leg muscle explosive power.

The right weight training to increase leg muscle power is leg press and squat. Leg press is an exercise performed by pushing a certain weight with the feet (Riyadi, 2008:82). Squats are a form of strength training with weights placed on the shoulders (Yuganthari, 2011: 72). This weight training exercise is suitable for runners, because they both focus on training the lower extremities, especially leg muscle power (Wirth K, et All, 2016:201)

As stated by Sudarsono (2011: 42), the main thing in strength training is having to fight the load or resistance. Thus, the most effective training program for increasing muscle is weight training. This opinion is in line with that stated by Thomas R Baechle (2003) in(S. Indra

Lesmana, 2008), the advantages of a weight training program using leg presses and squats can increase the explosive power of the legs, so that it can make it easier for the legs to lift body weight.

The research results obtained and the support from researches From previous research, it can be concluded that there is an effect of resistance training (leg press and squats) on increasing leg muscle explosive power.

The Effect of Plyometric and Resistance Training toward Speed Increase

Tukey test shows there is a difference between plyometric knee tuck jumps and resistance squats at increasing speed. As for the plyometric squat jump exercise and the resistance leg press exercise there is no difference.

The results of this study are in line with previous studies conducted by (Irmansyah, 2016), (Suprpto et al., 2019), (Mahayasa Hadiwijaya, 2013) in his journal showed that there was a difference in the effect of plyometric training and resistance training on increasing speed.

To have a great speed, biomotor development is needed, biomotor coaching is the initial coaching as the main basis for participating in sports training. Good biomotor development will be able to produce good physical conditions as well.

The difference in the squat jump movement is to jump with both legs straight, while the knee tuck jump is a jump movement with both legs bent with the knees touching both hands in front of the chest. In practice, the knee tuck jump requires faster leg muscle contractions than the squat jump exercise because the knee tuck jump exercise must jump with the knee touching the hand in front of the chest which stimulates the speed of contraction and reflexes of the leg muscles.

In strenuous exercise, the initial increase in strength depends on two factors: the involvement of more motor units with each contraction and the provocation of nerve impulses that activate more motor units in turn.

Leg press and squat exercises are exercises that can improve the ability of the legs to impact muscle performance that can improve a person in carrying out sports activities, especially sports that rely on leg function.

This is due to the difference in characteristics between the leg press and squat exercises where in the squat exercise the load is on the shoulders so that when performing up and down movements the complexity of the muscles involved is more, compared to the leg press exercise. Leg press and squats are types of exercises that aim to increase strength, especially in the leg muscles. Speed (speed) as the underlying basis in the formation of biomotor components, necessary physical components that are important in order to achieve optimal performance. With leg press and squat exercises that are carried out systematically, it will affect the increase in speed.

From the research results obtained and support from previous studies, it can be concluded that there is an effect of resistance training (leg press and squats) on increasing speed.

The Effects of Plyometric and Resistance Training toward Increasing Limb Muscle Explosive Power

UTukey's test showed that there was no difference in the effect of plyometric and resistance exercises on leg muscle explosive power.

The results of this study are in line with previous studies conducted by (Sukadarwanto & Utomo, 2014), (Rachman Ahmad Yani, 2012), (Ratnasari & Komarudin, 2015), (Primary & Erawan, 2019) in his journal showed that there was no difference in the effect of plyometric and resistance exercises on leg muscle explosive power

One of the basic factors that affect the ability of an athlete is the explosive power of the leg muscles (power). Power is a combination of strength and speed. For the plyometric training model, more emphasis is placed on the body's own weight, while resistance uses more weight from outside the body. In fact, both of these

training models have an effect on explosive power.

Plyometric exercise is a form of exercise in which there is a rapid contraction and stretching of muscles, a combination of isometric and isotonic exercises that allow muscles to achieve maximum strength in a short time. While exercises to develop muscle strength can be done using weights, both isometric (static), isotonic (dynamic) and isokinetic exercises. Therefore, the effect of leg muscle explosive power training using plyometric and resistance training models is believed to have an equally influential effect on the results (Ratnasari & Komarudin, 2015). His research also showed that there was no significant difference between the plyometric training model and weight training on the results of the javelin throwing. This is also possible because the athletes who were the sample of the study and the same treatment and who already had the same conditions.

From the research results obtained and support from previous studies, it can be concluded that there is no difference between plyometric and resistance training in increasing leg muscle explosive power.

CONCLUSION

Based on the results of the analysis and discussion above, conclusions can be drawn: (1) There is an effect of plyometric training on increasing speed; (2) There is an effect of plyometric exercise on increasing leg muscle explosive power; (3) There is an effect of resistance training on increasing speed; (4) There is an effect of resistance training on increasing leg muscle explosive power. Based on the research results obtained, as well as support from previous studies after the treatment of plyometric exercises and resistance training for six weeks, there was a significant increase in the speed and explosive power of the leg muscles; (5) There is a difference in speed improvement between the plyometric knee tuck jump exercise and the resistance squat exercise. Based on the results obtained, the plyometric knee tuck jump

and resistance squat exercises have a significant difference compared to the plyometric squat and resistance leg press exercises. It can be concluded that plyometric knee tuck jump and resistance squat exercises are more effective and efficient for speed training. As for the plyometric squat jump exercise and the resistance leg press exercise there is no difference; (6) No difference for the overall comparison between types of exercise on leg muscle explosive power.

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