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The effect of uphill and downhill exercise on soccer player's leg power

Stanis Kristiyanto Yuwono*, Hari Amirullah Rachman

Department of Sport Science, Postgraduate Program, Universitas Negeri Yogyakarta. Colombo Street No. 1, Karangmalang, Yogyakarta 55281, Indonesia.

* Corresponding Author. E-mail: staniskristiyanto@gmail.com

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***Abstract**: The uphill and downhill training method is one of the exercises that must be applied because it is an important component in the success of the soccer game. The objectives were to examine (1) the difference in the effect of uphill and downhill training on leg power, (2) the difference between players with high and low leg strength on leg power; and (3) the interaction between uphill and downhill training with leg strength (high and low) on leg power of football players. This type of research is an experiment with 2 x 2 factorial. The sample of Sleman United football players is 20 players. Leg and back dynamometer and vertical jump instruments. ANOVA data analysis technique α = 0.05. Research result. (1) There is a significant difference between uphill and downhill training on leg power. The results showed that the uphill training group was better than the downhill group. (2) There is a significant difference between the players with large and small leg strength concerning leg power. Players with large limb strength are better than small legs. (3) There is a significant interaction between the training method and leg strength on the leg power of football players. The research results are expected to be a reference in developing and implementing uphill exercises*

***Keywords**: uphill, downhill, leg muscle strength, leg power.*

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INTRODUCTION

Talking about achievements, in the ball game, four kinds of components must be met to get optimal performance, namely, physical development, technical development, mental development, and maturity of champions (Sajoto, 2002). Based on these four components, there is one component that has the most influence on soccer, namely physical condition. One of the elements of physical condition that is important in soccer is power. In line with this opinion, (Wahyu Santosa, 2015) that power is one of the elements of the physical condition needed for sports including football. The dominant sport of football is kicking technique. Where leg power plays an important role in the success of kicking the ball at the target, with the power of the leg muscles for power so that the ball can be right towards distant targets (Sukatams, 2001).

In football, the element of explosive power is needed by a player, because in football it requires jumping, dribbling, and especially kicking. In line with this expression, Martens, (2012) stated that muscle ability is the ability to move muscle strength quickly, it is a combination of strength and speed. In terms of just jumping, if a defender has good power, he can do aerial duels which are useful for blocking or passing the ball to avoid the opponent's threat. For midfielders and attackers, you can use it to score goals and pass. Therefore, a player must have enormous power to achieve the desired performance.

Based on the results of preliminary observations made by researchers on August 1, 2019, it was seen that there were still players who did not have good leg power. This can be seen when the player takes a kick that is still weak. Another problem is that when players jump, they make a header to receive a corner, always losing to the opposing team. This is because the opposing player can jump higher to head the ball, while the player's jumping ability is less than the opposing player. Appropriate training methods are needed for the mastery of basic football skills. The training method is a procedure and how to choose the type of exercise and its arrangement according to the difficulty level of complexity and weight.

Increasing the explosive power of the leg muscles can be done by providing an exercise program using either weight training or body weight training (Lesmana & Nasrulloh, 2020). One of the body weight exercises that can be done to train the explosive power of the leg muscles is plyometric exercises. Plyometric is a method for developing explosive power, which is an important component in the achievement of some athletes' Adiclife. & Farentinous., (2002) To get good power abilities, structured and continuous training must be done. The exercises applied are uphill and downhill.

Power is influenced by one of them by strength. Jaya et al., (2016) state that two main components affect the explosive power among the bio motor components, namely speed, and strength which can increase explosive power when done during training. Weight training is training that is carried out in an organized manner in which the muscles of the body contract. This reaction in response to external loads, body resistance, or other equipment used to stimulate strength and growth is weight training. As in a study it was found that bodyweight training with total-body resistance exercise can increase muscle strength, (Nasrulloh & Wicaksono, 2020).

Concerning weight training, a good training method to apply is training on the ascending track. In this case (Lee et al., 2015) state, "Uphill running, that is, athletes are required to run uphill at medium speed over and over again. This exercise aims to develop dynamic strength in the leg muscles. Downhill training can also train isometric nervous system contraction because running downhill for an athlete will train a constant speed and full swing motion. The distance covered in this descending exercise is between 30-40 meters, so it is possible to get stimulation of a fast step frequency.

Weight training is known as a technique to improve the appearance of an athlete, whereas in doing weight training there must be a clear training program so that the objectives of the training can be achieved, (Nasrulloh et al., 2018). The preparation of an exercise program, both weight training, and plyometric training require an assessment of muscle contraction, exercise dose which includes training load, number of sets, rhythm, repetitions, and recovery. Because these elements are very influential and determine the achievement of a training goal. Plyometric exercises include the strength and speed used for muscle contraction in the characteristic stretch-shorten cycle (SSC) explosive motion. Plyometric training is a training method for developing explosive power, an essential component of most muscle performance. Nowadays plyometrics refers to exercises that are associated with very strong muscle contractions in response to dynamic fast loads and involve muscle stretching (Hanafi, 2015). Based on the literature review and the problems raised, researchers are interested in researching the Effect of Uphill and Downhill Training on Leg Power in Football Players in terms of Leg Muscle Strength. This research is considered important because until now there has not been found any research results that reveal uphill & downhill training in football players Sleman United Yogyakarta, Indonesia

METHODS

This study used an experimental method with a 2x2 factorial research design. According to (Sukmadinata, 2012), experimental research is research that is intended to determine whether or not there is a result of something imposed on the subject investigating. The experiment used was a 2x2 factorial design. The exercise is carried out in 4 stages. Each stage has 4 meetings. The four stages last for 2 months because each stage lasts 2 weeks. So that a week, the sample practiced for 2x every Tuesday and Thursday. The difference between the four stages of the exercise is in the number of repetitions of ascending and descending an incline. In stage 1, the sample performs 5 reps and 4 sets with 1-minute intervals accompanied by a 15-second recovery. In stage 2, the sample performs 6 reps and 5 sets with 1-minute intervals accompanied by a 15-second recovery. In stage 3, the sample performs 7 repetitions and 6 sets with 1-minute intervals accompanied by a 15-second recovery. In stage 4, the sample performs 8 reps and 7 sets with 1-minute intervals accompanied by a 15-second recovery. The form of training starts from warm-up then goes to core training, namely uphill training by climbing 30-40m uphill roads by running. For downhill training by going down an incline of 30-40m by running.

Sudjana & Ibrahim, (2009) state that factorial experiments are experiments in which almost or all levels of a factor are combined or crossed with all levels of every other factor in the experiment. The design can be seen in Table 1:

Table 1. Design Factorial Design

Muscle Strength (B)	Exercise (A)	
	Uphill (A1)	Downhill (A2)
High (B1)	A1. B1	A2. B1
Low (B2)	A1. B2	A2. B2

Information:
A1B1: Players trained using uphill exercises with large leg muscle strength
A2B1: Players trained using downhill training with large leg muscle strength
A1B2: Players trained using uphill exercises with small leg muscle strength
A2B2: Players trained using downhill exercises with small leg muscle strength

The research population consisted of 30 football players in Sleman United, while the subjects or the research sample were 20 people. These 20 people had passed muscle strength tests and met the requirements for the study. This test is used to determine the leg muscle strength possessed by the player. After the leg muscle strength data has been collected, then an analysis is carried out to identify groups of players with large and small leg muscle strength by ranking them.

Based on the ranking, 27% of the upper group and 27% of the lower group were determined from the test results (Miller, 2008). Thus, the grouping of samples is taken from players who have large leg muscle strength as much as 27% and players who have small leg muscle strength as much as 27% of the data that has been ranked. Based on this, 10 players had high leg muscle strength, and 10 players had low leg muscle strength. Then from each of these data, it was divided into two groups utilizing ordinal pairing, and every 5 players who had large leg strength were treated with uphill and downhill exercises, the same was done for groups of players who had little leg muscle strength.

The division of the group in this way will be more objective for all research subjects. This is based on the equal opportunity for all objects to enter into each group. After being divided into four groups, then each group of large and small limbs did a pretest using the vertical jump test instrument before giving the treatment. The variables in this study consisted of two independent variables (independent) manipulative, namely uphill and downhill exercises, while as attributive independent variables, namely leg muscle strength. Then the dependent variable (dependent) is leg power.

The leg muscle strength instrument was performed using the leg and back dynamometer test. The leg and back dynamometer test aims to measure the static strength ability of the leg muscles. The target of this test is boys and girls aged 10 years and over. The leg power test instrument uses a vertical jump, with a validity of 0.978 and reliability of 0.989 (Widiastuti, 2015, p.109). This study did not measure body weight. The measured leg power included the height of the jump, because the greater the leg power, the higher the jump.

The data analysis technique used in this study was SPSS 20, namely by using two-way ANOVA (two-way ANOVA) at the significance level □ = 0.05. Furthermore, to compare the average pairs of treatments using Tukey's test. Considering that the research data analysis was carried out using ANOVA, before arriving at the use of two-way ANOVA (two-way ANOVA) it is necessary to conduct prerequisite tests which include: (1) normality test and (2) variant homogeneity test and hypothesis testing.

RESULTS AND DISCUSSION

RESULTS

The results of the research and discussion will be presented sequentially, including: (1) research data, (2) analysis prerequisite test, and (3) hypothesis testing. The hypothesis testing will be presented sequentially, including (a) differences in the effect of uphill and downhill training on leg power of football players; (b) differences in influence between players who have high leg muscle strength and low leg muscle strength on leg power of football players; and (c) the interaction between uphill and downhill training with leg muscle strength (large and small) on leg power of football players. The descriptive statistics of the pretest and posttest arm muscle strength are presented in Table 2

Table 2. Descriptive Statistics of the Pretest and Posttest of Leg Power

Method	Muscle Strength	***Pretest***	***Posttest***
Uphill	High	50,20±1,64	56,60±1,34
	Low	40,60±3,44	42,60±3,44
Downhill	High	50,20±1,79	50,80±1,92
	Low	40,20±3,90	42,80±3,83

When displayed in diagrammatic form, the leg power data is presented in Fig 1:

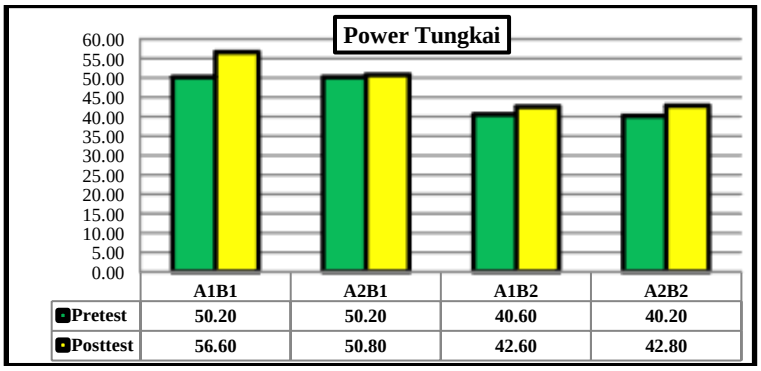

Figure 1. Trunk diagram of limb pretest and posttest power

Based on the graph above, it shows that the leg power of the A1B1 group has an average pretest of 50.20 and has increased at the posttest of 56.60, the A2B1 group has an average of 50.20 and an increase in the posttest of 50.80. , Group A1B2 had an average pretest of 40.60 and had an increase at posttest of 42.60, group A2B2 had an average of 40.20 of pretest and an increase of 42.80 was posttest.

Prerequisite Test Results

Normality test

The data normality test in this study used the Kolmogorov Smirnov method. The data summary is presented in Table 3:

Table 3. Normality Test

Data		***P***	**Information**
Pretest	A1B1	0,578	**Normal**
	A2B1	0,930	**Normal**
	A1B2	0,893	**Normal**
	A2B2	0,945	**Normal**
Posttest	A1B1	0,214	**Normal**
	A2B1	1,000	**Normal**
	A1B2	0,893	**Normal**
	A2B2	0,990	**Normal**

Based on the statistical analysis of the normality test that has been carried out using the Kolmogorov Smirnov test, all pretest and post-test power leg data were obtained from the results of the normality test of the data with a significance value of p> 0.05, which means that the data were normally distributed

Homogeneity Test

The homogeneity test is carried out to test the equations of several samples, namely whether they are homogeneous or not. The homogeneity test is intended to test the similarity of variants between the pretest and posttest. The homogeneity test in this study is the Levene Test. The results of the homogeneity test are presented in Table 4

Table 4. Homogeneity Test

Group	***Sig***	**Information**
Pretest-Posttest	0,054	Homogen

Based on the statistical analysis of the homogeneity test that has been carried out using the Levene Test. At the pretest-posttest, a significance value of 0.054 ≥ 0.05 was obtained. This means that the data group has a homogeneous variant. Thus the population has the same variant or homogeneity.

Hypothesis Test Results

The research hypothesis testing was carried out based on the results of data analysis and the interpretation of the two-way ANAVA analysis. The results of the Hypothesis Test are presented in table 5:

Table 5. ANOVA test

Source	*Type III Sum of Squares*	*F*	*Sig.*
Method Exercise	39.200	4.900	0.042
Limb Strength	605.000	75.625	0.000
Exercise_ Method * Leg Strength	45.000	5.625	0.031

From the ANAVA test results in Table 5 above, it can be seen that the p significance value is 0.038 and the F value is 4.900. Because the p significance value is 0.042 <0.05, it means that H0 is rejected. Thus there is a significant difference in the effect of uphill and downhill training on the leg power of football players. Based on the results of the analysis, it turns out that the uphill training group is 49.60 higher (good) compared to the downhill of 46.80 with a posttest difference of 2.80. This means that the research hypothesis which states that "There is a significant difference in the effect between uphill and downhill training on leg power of football players" has been proven.

From the ANAVA test results in Table 5 above, it can be seen that the significance value of p is 0.000 and the F value is 75.625. Because the p significance value is 0.000 <0.05, it means that H0 is rejected. Based on this, it means that there is a significant difference in the effect of players who have the high leg muscle strength and low leg muscle strength on leg power. amounted to 42.70, with a difference in the average posttest of 11.00. This means the research hypothesis which states that "There is a significant difference in the effect between players who have the high leg muscle strength and low leg muscle strength on leg power of football players", has been proven.

From the ANAVA test results in Table 5 above, it can be seen that the significance value of p is 0.004 and the F value is 5.625. Because the p significance value is 0.031 <0.05, it means that Ho is rejected. Based on this, it means that the hypothesis which states "There is a significant interaction between uphill and downhill training with leg muscle strength (high and low) on the leg power of football players", has been proven.

The diagram of the interaction results between uphill and downhill training with leg muscle strength (high and low) on leg power of football players can be seen in Figure 2:

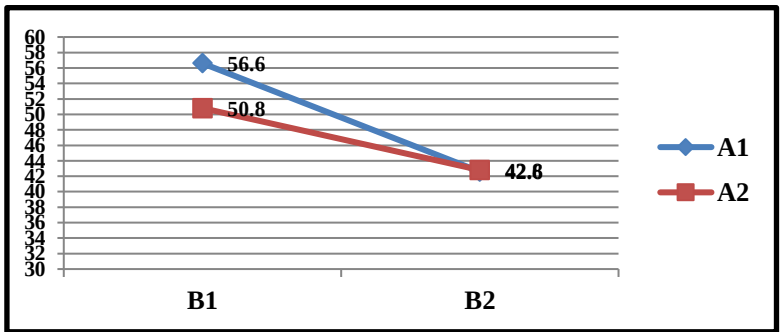

Figure 2. Results of the Interaction between Uphill and Downhill Exercises with Leg Muscle Strength (High and Low) on Leg Power of Football Players

Based on the results of Tukey's test calculations on the asterisk (*), it shows that the pairs that have significant (significant) interactions or pairs are: (1) A1B1-A2B1, (2) A1B1-A1B2, (3) A1B1-A2B2, (4) A2B1-A2B2, (5) A1B2-A2B2 while the other pairs stated that they did not have a different effect were: A1B2-A2B2.

Discussion

Based on hypothesis testing. Based on hypothesis testing, it is known that there is a significant difference in the effect between uphill and downhill training on the leg power of football players. The uphill training group was higher (good) than the downhill group on the leg power of football players. Uphill exercise is a concentric contraction of the muscles, (Douglas et al., 2017) states that “Eccentric contractions, whereby the muscle is actively lengthened under an external load, display several molecular and neural characteristics which distinguish them from isometric and concentric

contractions". Stride frequency can be increased with training, and research has focused on improving cadence both when walking flat (Baumgartner et al., n.d.) and on the gradual ascent (Padulo et al., 2013). Interestingly, the grade test resulted in not only an increase in steps per minute but also a slight increase in stride length. One study identified that athletes ran, on average, 23% slower uphill and 13.8% faster downhill compared with their speed on flats, with speed changes primarily caused by decreasing stride length on the uphill (Townshend et al., 2010). Paradisis et al., (2015) stated that "However, training for 6 to 8 weeks on the combined uphill-downhill (U + D) sloping surfaces (3 °) produced superior improvements ($p < 0.05$) for both MRS (from 3.5% to 5.9%) and step rate (from 3.4% to 7.4%) when compared to any other training method on sloping surfaces".

Dewolf et al., (2016) stated (1) When running uphill at a certain speed, the average external power developed during the positive work phase appears to be a limiting factor. As the slope increases, to maintain a long air time, the vertical speed of COM at takeoff will increase as the minimum vertical displacement (Smin) increases. This will require more power during the push. (2) When running downhill, the average external power developed during the negative work phase appears to be the limiting factor. Indeed, despite the lower vertical speed at takeoff, ta and thus T - increase with slope and speed due to decreased ballistic COM increases. The longer increases the external power developed during the brakes because the energy that will be expended after a touchdown is greater. Apart from better muscle performance during eccentric rather than concentric contraction, force during braking is limited by (1) increased brake at the expense of push and (2) reduced upward shift COM. As a result, the bouncing mechanism while walking decreases gradually disappears as the speed and slope increase.

Paradisis et al., (2013) stated that the increase in MRS and the step rate was mainly due to the concentric phase 17% shorter than the contact time. Interestingly, these changes were related to the improvements observed in the strength properties of the leg flexor muscle generation. U + D training increased maximal bilateral isometric strength by 7.1% and relative and absolute force production time by 24.7%. During uphill walking, ankles and knees exhibit greater torsion-flexion / flexion angles and torsion during the standing phase compared to walking on the ground (Franz & Kram, 2014). Lowery et al., (2014) investigated the effect of upward interval training versus level grade interval training on maximal oxygen consumption (V2 O2max). About running performance, the results suggest that incline interval and level-well training can lead to a significant increase in all-out trials in trained runners at speeds associated with V̇ O2max but that traditional level-level training yields greater gains.

According to (Harsono, 2015) states that: "Uphill is running up hills; to develop dynamic strength in the leg muscles. Dynamic strength can also be developed by running in shallow water, sand, snow or soft ground". The uphill running training method is an exercise in a strength training model for a runner that aims to increase the applied leg muscles in a specific form. Why can it increase, because the assumption is that if a person is running in a field that is not the field of the race, a runner is running in a horizontal plane but he has to run in a diagonal plane automatically requires more muscle strength. The hope of this exercise will increase the power because the increased power is the strength that is increased to be fast, it will automatically increase the ability to run.

Kyriazis (2009) investigated the effects of static stretching on 1 mile uphill running performance, electromyography (EMG), ground contact time (GCT), and flexibility. There was a significant condition-per-time interaction for muscle activation, without change in the non-stretch state (pre 91.3 ± 11.6 mV to post 92.2 6 12.9 mV) but increased under stretching conditions (pre 91.0 6 11.6 mV to post 105.3 ± 12.9 mV). A significant condition-by-time interaction for GCT was also present, with no change in the non-stretching condition (pre 211.4 ± 20.8 ms for post 212.5 ± 21.7 ms) but increased in the stretching trial (pre 210, 7 ± 19.6 ms for post 237.21) ± 22.4 ms).

The difference in the influence of players who have the high leg muscle strength and low leg muscle strength on the leg power of football players

The results of the analysis show that there is a significant difference in the effect between players who have the high leg muscle strength and low leg muscle strength on the leg power of football players. Players who have high leg muscle strength are better than low leg muscle strength against the leg power of football players. This shows that the power of a person's leg is influenced by the strength of the leg muscles. It is stated by Mylsidayu & Kurniawan, (2015) that power can be defined as "strength and speed that are carried out together in carrying out a motion. Therefore, the power training sequence is given after the athlete has been trained in the elements of strength and speed". The power of the leg

muscles is the most important factor in achieving the ability of the jump angle to the power value. Jump power or explosive power has two components, namely strength, and speed, which are the ability to move important to support activities in any sport.

Leg power is the ability to overcome weight resistance or with high (explosive) leg muscle strength in one complete movement that involves the leg muscles as the main mover. Strength, muscular endurance, and power are interrelated and the main element is strength. Strength is the basis (basic) of muscle power and endurance. Based on this, strength is the main element for generating muscle power and endurance. According to (Widiastuti, 2015): "power or often called explosive power is an ability to move which is very important to support activities in every sport". Power, especially the leg muscles, has an important role to play in achieving long jump abilities. Leg power plays an important role in making high jumps when supporting and repelling the legs at a certain angle. Explosive power is the ability of a muscle or a group of muscles to resist a load/resistance with high leg muscle strength in one motion. According to (Bompa, 1994) said that: "power is the result of both abilities; maximum leg muscle strength and maximum strength in the shortest possible time". Leg muscle power is a very important component in achieving maximum performance in the angle of repulsion to the value of power. This is because by having great power in the leg muscles, an athlete will be able to overcome the load or resistance to shoot at the goal to achieve the maximum power value**.**

The interaction between triceps press down and seated rowing exercises with muscle endurance (high and low) to arm muscle strength

Based on the results that have been stated in the results of this study that there is a significant interaction between uphill and downhill training with leg muscle strength (high and low) on leg power of football players. The results showed that the uphill training group was more appropriate for players with high leg muscle strength, while the downhill training group was suitable for players with low leg muscle strength.

From the results of the form of interaction, it appears that the main factors of the study in the form of two factors show a significant interaction. In the results of this study, the interaction means that each cell or group has a different effect on each group being paired. Couples who have interactions or partners that are significantly different (significantly) are as follows. (1) Players who are trained using uphill training with high leg muscle strength are better than players who are trained using downhill training with high leg muscle strength, with a p-value <0.05. (2) Players who were trained using uphill training with high leg muscle strength were better than the group of players who were trained using uphill training with low leg muscle strength, with a p-value <0.05. (3) Players trained using uphill training with high leg muscle strength were better than the group of players trained using downhill training with low leg muscle strength, with a p-value <0.05. (4) Players trained using downhill training with high leg muscle strength were better than the group of players trained using downhill training with low leg muscle strength, with a p-value <0.05. (5) Players who were trained using uphill training with low leg muscle strength were better than the group of players who were trained using downhill training with low leg muscle strength, with a p-value <0.05**.**

CONCLUSION

Based on the results of the research and the results of the data analysis that has been done, the following conclusions are obtained. (1) There is a significant difference in the effect of uphill and downhill training on the leg power of soccer players. The uphill training group is higher (good) than downhill on the leg power of football players. (2) There is a significant difference in the effect between players who have the high leg muscle strength and low leg muscle strength on the leg power of football players. Players who have high leg muscle strength are better than low leg muscle strength on the leg power of football players. (3) There is a significant interaction between uphill and downhill training with leg muscle strength (high and low) on leg power of football players.

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