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A Half Squat Free weight and Machine Training Model to Increase Leg Muscle Strength and Mass

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Abstract

The strength and mass of leg muscles are the important parts in forming an ideal body. Leg muscles are the part of the body that has the most and largest muscles compared to other parts of the body (presenting ± 50% of the entire front body muscle area). Achieving an ideal body requires several important aspects, one of which is a structured and consistent training program. This research aims to analyze the influence of half squat free weight and machine training models on leg muscle strength and muscle mass. This research method that is used is a quasi experiment with pre-test and post-test with two groups with 20 male samples aged 20-25 years. This research instrument uses a Leg Dynamometer to measure leg muscle strength and an InBody 270 scale to measure muscle mass. Data analysis used one way anova test, paired sample T-test. The result of T-test shows that half squat exercises using 1 kg of free weight and 8.4 kg of machine weight both result in an increase in leg muscle strength, with a significance value of 0.030 0.05, indicating that both exercises have some effect on this increase but that the half squat machine exercise is more effective. Half squat exercises using free weights (0.27 kg) and machines (0.3 kg) result in an increase in muscle mass with a significance level of 0.042-0.05, indicating that both exercises have an impact on the growth of muscle mass but that the half squat machine exercise is more effective.

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INTRODUCTION

Leg muscles are the part of the body that has the most and largest muscles compared to other parts of the body (presenting ± 50% of the entire front body muscle area). Daily activities are always related to the role of leg muscle strength which function is to support the human body. Leg muscles have the function of jumping, running, kicking, walking, and so on. Leg muscles are the most vital and important muscles in everyday life (Ade Rai, 2009), (Setyo Budiwanto, 2015).

A weight training can increase muscle strength, muscle endurance, neuromuscular coordination and bone density, improve heart health by lowering blood pressure. Endurance is the ability of the body to carry out sports activities for a long time without experiencing significant fatigue. While endurance is the ability of a person to carry out motion with the whole body for a long time and in a moderate to fast tempo without experiencing pain and severe fatigue (Morici, G., 2016). An increase in muscle mass is not due to an increase in the number of muscle cells but an increase in myofibrils, so that enlarged muscles because of the exercise are not due to the increase in the number of muscle cells (hyperplasia) but due to the increase in muscle volume (hypertrophy) (Herman, 2010).

Muscle strength is the maximal contraction produced by a muscle or group of muscles. Physiologically, muscle strength is the ability of the muscles to perform one maximum contraction. Mechanically, strength is defined as the maximum work (maximal force) produced by a muscle or group of muscles (Bompa, 2009). Muscle strength can also prevent injury and promote long-term health. Muscle strength can increase by balancing the right training program and considering the influencing factors, including frequency, intensity, time, type. (Small et al., 2008).

A free weight exercise is the exercise with free equipment that allows for movement in many directions and requires a greater degree of balance. Free weights utilize isotonic resistance with equal resistance or load throughout the range of motion. Smith Machine is a tool specially designed to make it easier for everyone to do weight training. Machine exercises require sitting, leaning against, or standing next to the equipment. The athlete moves a piece of machinery (such as a handle or rod attached to a chain or cable) to lift the weight rather than lifting the weight itself. The two most common types of weight training machines are the cam and pulley machines, (Baechle, T. R., & Earle, 2014), (Cotterman, M. L., Darby, L. A., & Skelly, 2015).

Dumbbell/ Barbell Squat, Leg Press, Leg Extension, Lying Leg Curl, Squat Smith Machine are fitness tools that are useful for training leg muscles. Physiological characteristics underlie and become consideration in athlete training programming which can affect maximum muscle strength, a coach or athlete must be able to understand the form of training, such as giving sets of loading, intervals for each set, intensity of light to heavy loads, and variations of exercises (Suchomel et al., 2018).

Anhesa Gym is a fitness center in Semarang, precisely in Gunungpati, Sekaran. Based on the importance of squat training on leg muscle strength and muscle mass, researchers are interested in researching "The Effect of Squat Exercise and Physical Fitness Index on Leg Muscle Strength and Muscle Mass in Fitness Center Members Anhesa Gym.

METHOD

The method used in this research is a quasi experiment with pre-test and post-test with two factorial which aims to compare the two treatments (Half Squat Free Weight Exercise and Smith Machine) to research subjects on leg muscle strength and muscle mass.

The samples in the study were 20 people with inclusion criteria including active gym

members, men, aged 20-25 years, physically and mentally healthy. Strong muscles can prevent injury and promote long-term health. Muscle strength can increase if it is balanced with the right training program by taking into account the influencing factors, including frequency, intensity, time, type. (Small et al., 2008), (Bompa, 2009).

The factors that affect a person's physical fitness include health problems, nutritional problems, such as lack of protein, calories, low nutrition and inadequate nutrition, physical exercise problems, such as the age at which exercise begins, exercise frequency, exercise intensity, and exercise volume, problems hereditary factors, such as anthropometry and congenital abnormalities (Roji, 2006). Other factors that affect physical fitness are heredity, age, gender and body fat (Sharkey, 2003).

The exclusion criteria for this study including; injury, training 1 week less than 3 times techniques using purposive sampling. The instruments in this research include the Leg Dynamometer to measure leg muscle strength and the InBody 270 scale to measure muscle mass.

This study consisted of 2 groups, namely the free weight group and the Smith machine group with half squat treatment. Half squats maximize the level of activity of the gluteus maximus muscle and related stabilizer muscles. Studies that compare half squats and full squats also explain that the volume of the adductor and gluteus maximus muscles shows a greater increase in full angle conditions. Similar increases in muscle volume were noted between extensive muscle conditions. Neither condition significantly increases the volume of the rectus femoris and hamstrings (Kubo K, 2019), (Da Silva et al., 2017), (Weiss LW, Frx AC, 2000).

The samples carried out the initial test in the form of measuring muscle strength using a leg dynamometer and muscle mass using the InBody 270 scale. After carrying out the initial test the samples carried out half squat treatment based on each group with a training frequency of 1 week, 3 training times for 6 weeks, training intensity between low 60 % - 80% high, with repetitions 5-12 times according to the intensity and training program that has been prepared in table 1. After 6 weeks of training, all samples carried out a final test to find out whether there were differences and influences during training using a leg dynamometer to measure muscle strength legs and InBody 270 scales to measure muscle mass.

After the final test was carried out, the researcher collected all the data obtained to be analyzed using the SPSS.16 application. The first step in testing this research is to test whether all research data is normally distributed using the normality test. After the data is normally distributed, the next step is to test homogeneous or heterogeneous data with a homogeneity test. After all of these prerequisite tests have been met, it can be continued with the Anova test, paired t-test, and independent t-test to find out whether the research data has influences and differences.

Table 1 Half squat free weight and machine training program to increase leg muscle strength and mass

Sunday	Half Squat Exercise	
	Freeweight	Smith machine
1-2	Reps: 8-12, Low intensity: 60%	Reps: 8-12, Low intensity: 60%
3-4	Reps: 7-10, Moderate intensity: 70%	Reps: 7-10, Moderate intensity: 70%
5-6	Rep: 5-8, High intensity: 80%	Rep: 5-8, High intensity: 80%

Remarks: 3 times a week, set: 4

RESULTS AND DISCUSSION

The results of the research on half squat free weight and half squat machine training showed

that there was a significant influence in increasing leg muscle strength and the results of muscle mass showed that the influence was not that significant. The characteristics of the sample in this study are described in table 2 as follows.

Table 2 Characteristics of the research sample

Variable	Freeweight N=10	Smith machine N=10	Δ
Age (years)	22±2.98	24±5.18	2
Body Weight (kg)	68,7±6.06	64,7±9.55	4
Height(cm)	173±4.76	168±3.34	5
BMI (kg/m2)	23,2±2.41	23,3±2.00	0.1

Table 3 describes pre-post half squat free weight and machine data on leg muscle strength and mass

Variable	N	Freeweight		Δ	Smith machine		Δ
		Pre-test	Post-test		Pre-test	Post-test	
Leg muscle strength (Kg)	10	177.5±40.5	178.5±48.33	1	131.5 ± 22.9	139.9 ± 18.92	8,4
Muscle mass (Kg)	10	19.11±1.64	19.38 ± 1.77	0.27	17.22±1.89	17.52±2.00	0.3

Table 4 Effect of half squat free weight and machine on leg muscle strength and mass

Variable		N	Fcount	Ftable	Sig.	Information
Leg muscle strength	Freeweight	10	5.52∞	4,41	0.000*	There is influence
	Smith machine	10	4.80	4,41	0.000*	There is influence
Muscle mass	Freeweight	10	5.52∞	4,41	0.028*	There is influence
	Smith machine	10	4.80	4,41	0.029*	There is influence

Description: Anova∞; *p<0.05 paired t-test

Table 6 Differences between free weight and machine half squats on leg muscle strength and mass

Freeweight half squatsand Machines	N	Fcount	Ftable	Sig.	Information
Leg muscle strength	20	5,52	4,41	0.030*	There is a difference
Muscle mass	20	4.80	4,41	0.042*	There is a difference

Description: Anova∞; *p < 0.05 independent t-test

DISCUSSION

1) The effect of half squat free weights and machine on leg muscle strength

The earlier research demonstrated that squat training can effectively distribute weight to target specific areas, maximizing the exercise's impact while minimizing the potential for spinal cord injuries. (Barton, 2016). Other research shows that squat training with variations can provide different structural changes including muscle and soft tissue development as a functional aspect it can develop strength, muscle coordination and body control. (Southwell, 2016).

The research conducted on male futsal athletes with a total of 20 athletes conducted for 18 meetings with a training frequency of 3 times a week for 6 weeks which aims to find the effect of squat training on increasing leg muscle strength at Malang State University concluded that there is a

significant effect of squat training on increasing leg muscle strength (Saudini & Sulistyorini, 2017).

A weight training with free weight tends to be more effective because it can be done with a variety of movements, so that the impact on each muscle is more focused. However, in practice it must be done in fitness places. Before doing weight training using free weights, a person should know the types of equipment, their characteristics and how to use them. This is so that in the process of weight training does not pose a risk of injury (Baechle, TR, & Earle, 2014).

2) The effect of half squat free weights and machines on muscle mass

Training using weights can increase a person's ability to exert force with the aim of increasing strength, muscle endurance, hypertrophy, athlete performance or a combination of these goals. Weight training can increase muscle strength, muscles will become more efficient and stronger as a result of the stress the muscles receive when doing weight training. Weight training can also prevent muscle atrophy when growing old, Baechle, TR and Earle (2012), Nasrulloh et al., (2018).

The previous studies explain that muscle mass index with moderate and low physical fitness index has an inverse correlation with fitness level and this study has clearly established that physical activity is an important determinant and predictor of a person's physical fitness.(Hanifah et al., 2014).

There is no different effect between the circuit training method and the interval training method on increasing basketball extracurricular VO2Max capacity. The results of previous research also explain that there is a weak relationship between fitness level and leg muscle strength in 23 male samples of PPSKPD UNUD students Class of 2016 (Prakoso & Sugiyanto, 2017), (Utami et al., 2020).

The factors that affect a person's physical fitness include health problems, nutritional problems, such as lack of protein, calories, low nutrition and inadequate nutrition, physical exercise problems, such as the age at which exercise begins, exercise frequency, exercise intensity, and exercise volume, problems hereditary factors, such as anthropometry and congenital abnormalities (Roji, 2006). Other factors that affect physical fitness are heredity, age, gender and body fat (Sharkey, 2003).

3) The difference between free weight and machine half squats on leg muscle strength

The training with quarter squats resulted in a higher increase in quarter squat 1 rep maximum (1RM) of strength while training using a half squat resulted in a larger increase of 1RM in a half squat exercise. Previous research explained in its journal that the range of motion of half squats changes the activity of the main mover muscles (gluteus maximus) and stabilizers (soleus and bicep femoris). Therefore, in conclusion the half squat maximizes the level of activity of the gluteus maximus muscle and stabilizer muscles. Studies that compare half squats and full squats also explain that the volume of the adductor and gluteus maximus muscles shows a greater increase in full angle conditions. Similar increases in muscle volume were noted among the broad muscle conditions. (Kubo K, 2019), (Da Silva et al., 2017), (Weiss LW, Frx AC, 2000).

4) The difference between free weight and machine half squats on muscle mass

The results of the research showed: (1) There is no significant different effect between quarter squat jump and knee tuck jump exercises on increasing leg muscle power. (2) There is a difference in the increase in leg muscle power between men's volleyball extracurricular participants who have high leg muscle strength and low leg muscle strength. (3) There is no interaction between training methods and leg muscle strength on leg muscle power (Adhi et al., 2017).

The results of the previous research also concluded that (1) there is a significant effect of squat training using free weights on muscle strength, power and hypertrophy, (2) there is a

significant effect of squat training using a gym machine on muscle strength, power and hypertrophy, and (3) there is a significant difference between squat training using free weights and squat training using a gym machine on muscle strength, power and hypertrophy. The percentage increase in pretest and posttest scores for strength, power, and muscle hypertrophy showed that the squat training group using free weights was better than the gym machine group. (Mansur et al., 2018).

A weight training with free weights tends to be more effective because it can be done with a variety of movements, so that the impact on each muscle become more focused. However, it should be done in fitness places. Before doing weight training using free weights, a person should know the types of equipment, their characteristics and how to use them. This is so that in the process of weight training does not pose a risk of injury (Baechle, TR, & Earle, 2014).

CONCLUSION

Based on the research data, analysis and discussion above, it can be concluded that there is an increase in leg muscle strength of 1 kg during exercisehalf squatsfree weight and an increase of 8.4 kg in the half squat smith machine exercise, which means that the free weight half squat exercise and the squat machine both affect the increase in leg muscle strength and the half squat machine exercise is better in terms of increase.

There is an increase in muscle mass of 0.27 kg in the free weight half squat exercise and an increase of 0.3 in the half squat machine exercise, which means that the free weight half squat exercise and the squat machine both affect the increase in muscle mass and the half squat machine exercise is better in terms of improvement.

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