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The impact of arm strength training model on the success of South Sumatra rock climbing athletes

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ABSTRACT

Abstract The model of strength training that combines and varies from arm exercises on the success of South Sumatera rock climbing athletes. The subjects of this study were 30 rock climbing athletes participate in this study. The method used in this research is an experiment with a pre-post-test design (two-group pretest and posttest design). To determine the results of climbing, rock climbing athletes use climbing tests that have been validated by rock climbing experts, coaches, and academics. As the calculation results, it is shown that the value of Sig. group 1 (2-tailed) 0.00 < 0.05 then there is a remarkable difference between the pre-test and post-test strength training three push up movements. While the value of sig. group 2 (2-tailed) 0.00<0.05 thus there is a significant difference between the pre-test and post-test strength training three pull up movements. The variation of the three-movement push up strength training model and the three pull-up strength training model both provide a significant increase in the climbing results of rock-climbing athletes. The three push up and three pull up arm strength training model in this study provide a noticable contribution. Therefore, this study provides a scientific contribution and a reference for further research.

Keywords: *arm strength, rock climbing, push up, pull up*

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INTRODUCTION

Significance of sport and its existential components create qualitatively new standards (Hardiyono et al., 2023).Achievement in sports is an effort to improve the ability and potential of athletes in order to increase the dignity of the nation. Achievements are accomplished by everyone who has talent, ability, and passion to achieve achievement. However, the efforts to achieve these achievements are achieved through a planned, tiered, and sustainable coaching and development process with the support of sports science and technology (Bompa & Buzzichelli, 2019). Not only coaching that has been designed, the role of the coach is very important in the process, included preparing motor skills (physical), technical, tactical, and mental athletes (Clark et al., 2018). Coaching starts from the multilateral stage with the introduction of various sports to the specialization stage of one particular branch involved for the maximum achievement (Clemente et al., 2016).

In order to realize the achievement, the sport of rock climbing offers a huge opportunity for it. Wall climbing is one of the most challenging sports and has a big risk. As time goes by, in the current era rock climbing has become a sport that has been well known and quite popular in Indonesia (Abadi, 2016). This sport was originally derived from rock climbing. Through the time, rock climbing has been modified into wall climbing. What distinguishes rock climbing from wall climbing is the medium. The difficulty category is one of the groups or classes that are contested in wall climbing by taking a predetermined path with a certain level of difficulty.

In getting ahigh achievement in competitive sports, an athlete needs to be in prime physical condition according to the needs and demands of the sport climbing (Hardiono et al., 2020). Physical condition as the main aspect must be required in achieving optimal performance. It also supports technique, tactics, and mentality (Supriyoko & Mahardika, 2018). Rock climbing requires athletes to have great physical conditions; the dominant physical conditions needed in the difficult category are muscle strength, balance, and flexibility, (Hardiyono et al., 2019).

These three physical conditions have a vital role in succeeding the achievement of wall climbing in the difficult category. Physical element, such as strength- is needed to support performance at practice or competition (Asadi, 2016). Strength is one of the components of the physical condition that is required by rock climbing athletes (Hardiyono, 2019). However, the effective form of exercise to increase strength is still being debated (Bompa & Buzzichelli, 2019). To improve the functional quality of athletes, some training methods used (Syahriadi, 2020) and modification (Arsyendi et al., 2022). In the modern era, the purpose of sports has been expanded as a means of competing for achieving achievement so that it can give pride at the regional and national levels. Efforts in achieving andining an achievement are closely related to the quality of training (Bakhrudin & Pramono, 2023).

Arm muscle strength is the ability to fight a prisoner performed by the contraction of a group of muscles from the shoulder to the palm of the wrist and this is one of the supporters for an athlete to maximum performance (Costa et al., 2016). Arm strength becomes the foundation of the biomotor component that an athlete must possess. (Fikri et al., 2022). The exercise is a process of repeated activity with the implementation of materials and forms of training that have been previously planned (Gunawan & Irawadi, 2020). The purpose of the condition training arm muscle strength is to improve the ability to train arm muscles strength to be able to perform the maximum movements to performance (Nurjana et al., 2022). Variations of arm strength

training (Firmansyah, 2022; Rustiawan & Rohendi, 2021; Segara et al., 2020), pull up (Izzuddin et al., 2022).

The research that I've done in the past is related to the relationship between the power of the limb muscles and the strength of the arm muscles with the results of rock climbing (Baiq satrianingsih dan Putra Muhammad Yusuf, 2016), relationship of arm muscle strength with cliff climbing (Muhammad Ali Parinduri, 2021), giving handgrip clamping exercises with a pressure load of 20 kg for rock climbing athletes (Virgita et al., 2022), giving pull up and single rope exercises for rock climbing athletes (Hardiyono et al., 2022), creating a combination of power training and calf raises training model for rock climbing athletes and making a game model for rock climbing (Nuraini et al., 2022). From some of these studies, no one has ever created a model of strength training that combines and varies from some types of pull up, push up and chin up exercises. This is the purpose of my research that will make a model of the strength training.

METHODS

Study participants

This is a sample population (Swarjana, 2022), diamond population is the entire rock climbing athlete in southern Sumatra. The subjects of the study were 30 and had agreed to participate in this study. The criteria for the subjects in this study were the absence of a history of serious injury that affected the exercise to be given.

Training Model

Subjects will be grouped into two groups, the first group will be given three push up exercises:wide grip push up, triangel push up, reverse palm push up and the second group will be given three pull up exercises: reguler pull up, chin up, side to side pull up. Here's a more detailed explanation table 1:

Table 1. The training model

Training Model	Information
Group 1	
1. Wide Grip Push up	This push up prioritizes the chest muscles, focus on the triceps muscle. The trick is to start with a standard push-up position, and then bring your palms together to form a The push up is more targeted at the shoulder and bicep muscles. This push-up starts with a standard push-up position, and then rotates the palms so that our fingers are facing backwards. In this position the arms have to work harder, because this push up position is a bit more difficult to do than other push ups, and requires great hand strength. As the palms are turned upside down and it's a little difficult for the arms to push up so that the bed is lifted up. With this the arm will be more provoked to do difficult things.triangle, spread your legs apart to maintain balance. The weight of the body in this position will be more focused on the arms. In this position, the arm will get more weight, because the smaller surface will make the load heavier. And in this position the arms will be trained to accommodate heavy loads, and at the same time doing the same activity.
2. Triangle Push up	Triangle push up model is more targeted at the triceps muscle. The trick is to start with a standard push-up position, and then bring your palms together to form a triangle, spread your legs apart to maintain balance. The weight of the body in this position will be more focused on the arms. In this position, the arms will get more weight, because the smaller surface will make the load heavier. And in this position the arms will be trained to accommodate heavy loads, and at the same time doing the same activity
3. Reverse palm push up	The push up is more targeted at the shoulder and bicep muscles. This push-up starts with a standard push-up position, and then rotates the palms so that our fingers are facing backwards. In this position the arms have to work harder, because this push up position is a bit more difficult to do than other push ups, and requires great hand strength. As the palms are turned upside down and it's a little difficult for the arms to push up so that the bed is lifted up. With this the arm will be more provoked to do difficult things.
Group 2	
1. Reguler pull up	Regular pull up style is the most common standard pull ups. In a pull-up, your wrists are facing the opposite side of the pull-up bar and then raise your torso and lower it back down. This pull is very focused on working the back muscles, neck muscles, shoulder muscles, and arms as a whole.
2. Chin up	Chin up style is the opposite of pull ups. Chin ups focus more on training your biceps and back muscles. This chin up exercise is generally lighter than pull ups. Therefore, if you have not been able to do pull ups, try starting to do chin ups as an initial step
3. Side to side pull up	This style is a pull up movement that focuses on training the shoulder muscles, especially the side deltoids.

Study organization

The subjects would be given an explanation of the data collection procedure that would be carried out for 12 weeks, with 36 practice sessions of 60 minutes each. One micro-cycle consists of 7 days, with 3 training sessions conducted on alternate days (i.e. Monday, Wednesday, and Friday). To test the results of climbing, rock climbing athletes use climbing tests that have been validated by rock climbing experts, coaches, and academics. Subjects will be given the opportunity to try climbing three times and the highest score will be taken for analysis.

Statistical analysis

The data that has been collected will be saved in the Excel program, and will be statistically analyzed using the program IBM SPSS Statistics 25. The analysis step in this study is hypothesis testing. The hypothesis test in this study is a T-test to determine how much the impact of strength training has- on the success of rock climbing athletes.

RESULTS AND DISCUSSION

Result

In the results of this study discuss the mean, standard deviation, variance, maximum and minimum values, as well as the increase in the average obtained from the results of the strength test given to each group. The test results will be recorded and calculated based on the group and type of exercise given. Therefore, the results of the four groups will be analyzed based on research data using the IBM SPSS for Windows 21 program, then the description of the research data can be further elaborated in the form of a table as follows:

Table 2. Description Result Three-Movement Push-Up Exercise

Value	Pre-Test	Post-Test	Difference
Avarage	24.4	31	6.60
Deaviation	1.673	0.934	0.739
Variance	2.431	0.942	1.489
Max. Value	40	44	4
Min. Value	17	24	7

According to the data above, it can be concluded that the measurement results of the climbing pretest with a sample of 15 athletes, had an average pretest of 24.4, standard deviation of 1.673; with 2431 variants; a maximum score of 40 and a minimum of 17. For the measurement results from the climbing posttest with a sample of 15 athletes, the average

increase was 31, the standard deviation was 0.934; with a variant of 0.942; maximum score of 44 and minimum of 24. There was an average increase of 6.60; standard deviation 0.739; with 1,489 variants; maximum score 4 and minimum 7.

Table 3. Description Result Three-Movement Pull-Up Exercise

	Pre-Test	Post-Test	Difference
Avarage	31.4	38.26	7.06
Deviation	1.778	0.974	0.804
Variant	2.431	0.981	1.45
Max.	42	44	2
Min.	21	25	4

It can be concluded from the data above that the measurement results of the climbing pretest with a sample of 15 athletes, had an average pretest of 31.4, standard deviation of 1.778; with 2431 variants; a maximum score of 42 and a minimum of 21. For the measurement results from the climbing posttest with a sample of 15 athletes, the average increase was 38.26, standard deviation 0.974; with a variant of 0.981; maximum score of 44 and minimum of 25. There was an average increase of 7.06; standard deviation 0.804; with a variant of 1.45; a maximum score of 2 and a minimum of 7.

The both results can be seen that there are differences in the test results of the two groups. This can be also shown from the difference in the average value of the pretest which is lower than the posttest. This means that giving exercise to each group has an effect on increasing strength in all rock climbing athletes. The magnitude of the difference in the strength changes of rock climbing athletes in each group can be described in the following histogram form:

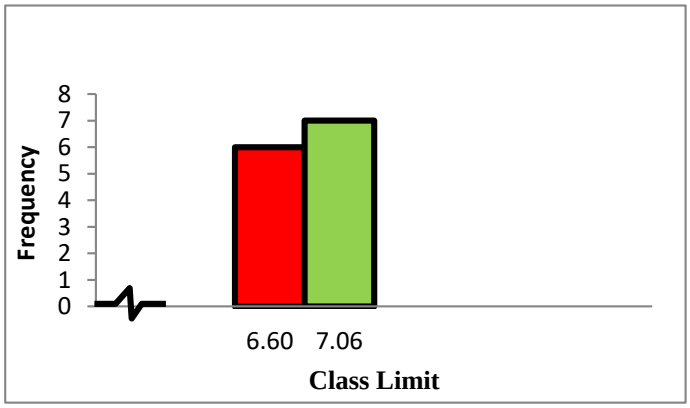

Figure 1. The magnitude of the difference in the strength changes of rock climbing athletes in each group

In the test efficiency, hypothesis will be analyzed based on the tabulation results of the data obtained from the tests that have been given. Mean differences to test the effectiveness that has been proposed as the analytical test used in this study is also the average difference test (mean difference test) using t-test analysis (Paired t-test). The value used in calculating the t-test (Paired t-test) is the value of the pre-test and post-test of each group, with the presentation of the data, the results of the calculation of the t-test (Paired t-test) are as follows:

Table 4. Paired Sample Average Difference Test Results

Climbing Results of Athletes		Mean	**t**	**d**f	Sig (2-tailed)
Group 1	Pretest	6.06	21.32	14	0.00
	Posttest				
Group 2	Pretest	7.06	29.21	14	0.00
	Posttest				

Based on the table above, it is shown that the value of Sig. group 1 (*2-tailed*) 0.00<0.05 then there is a remarkable difference between the pre-test and post-test strength training Three Push Up Movements. While the value of sig. group 2 (*2-tailed*) 0.00<0.05 thus there is a significant difference between the pre-test and post-test strength training Three Pull Up Movements. Thus, the variation of the Three-Movement *Push Up* strength training model and the Three *Pull-Up* strength training model both provide a significant increase in the climbing results of rock-climbing athletes.

Testing the mean difference simultaneously between groups to determine the difference in the effect of treatment on increasing the dependent variable (strength training of three push up movements and pull up movement exercises) before and after treatment between groups using statistical independent samples test. From the calculation of IBM SPSS 21.*0 for Windows*, the following results are obtained:

Table 5. Calculation Results Independent Samples

Climbing Athletes	Results of	df	Mean difference	F	Sig.
Equal Assumed	Variances	28	3.472	3.569	0.00

It is known that the value of Sig. (*2-tailed*) 0.00 < 0.05 then there is an impact of strength training three push up movements and pull up movement exercises on the success of rock climbing athletes.

Discussion

According to the results presented above, it solidifies that the three-movement *push up* strength training model and the *pull up* movement training model have a significant impact on the results of rock climbing athletes in South Sumatra and can be used as alternative exercises that can increase arm strength.

Arm strength training plays a crucial role in the performance of rock-climbing athletes. According to the study by, Physiological parameters of high climbing performance are forearm flexor strength and a good strength (Saul et al., 2019). Successful climbers exhibit efficient climbing styles characterized by focus, accuracy, high speed, and low exhaustion due to adaptation to repeated isometric exercises. Anthropometric traits such as low body fat, large forearm volume, and optimized kinematic motions are also favorable for climbing performance. The study also highlights the importance of constant training to enhance physical performance in rock climbing athletes. Success sport climbing: training method (maximum strength, hypertrophy, and endurance) and static or dynamic exercises (Langer et al., 2023). In highly skilled climbers the potential for further strength-specific adaptations to increase performance may be marginal in elite climbers (Saeterbakken et al., 2024). The climbing efficiency was determined by selected somatic features were measured: body height, body mass, adipose tissue, upper limb length, circumferences of the forearm, arm, thigh and shank (Rokowski, 2020).

In terms of specific training methods, fingerboard training and dynamic eccentric-concentric training of the finger flexors have been shown to have positive effects on grip strength, dead hang time, and the maximal achievable grade of climbing (Saul et al., 2019). Additionally, integrating physical training with rock climbing training has been found to significantly improve strength, speed, agility, endurance, motor coordination, and speed quality in athletes (Deng & Ding, 2023). These findings emphasize the importance of incorporating arm strength training exercises and techniques into the training programs of rock-climbing athletes to enhance their physical performance and climbing abilities.

The study on arm strength training for rock climbing athletes found that increasing the volume of resistance training (RT) can lead to greater gains in muscle hypertrophy (Schoenfeld et al., 2015) The systematic review and meta-analysis by Schoenfeld et al showed a significant effect of weekly sets on changes in muscle size, with each additional set associated with an increase in effect size and percentage gain. The study also found that higher weekly volumes of sets resulted in a greater percentage gain in muscle size compared to lower volumes. Higher weekly resistance training frequencies may provide superior hypertrophic benefits. These

findings highlight the importance of incorporating sufficient volume and frequency of resistance training in arm strength training programs for rock climbing athletes to optimize muscle hypertrophy and improve performance (Schoenfeld et al., 2017).

These results illustrate that the exercise in the implementation of the research has met the standards of the principles of sports training. The training rules in question are fulfilling the requirements for exercise duration, exercise frequency, exercise intensity and any type of exercises. It can also show that rock climbing athletes who have good arm strength will make it easier for rock climbing athletes to complete the predetermined path. This is reinforced (Chan, 2012), Strength is one element of physical condition that is important in exercising because it can help improve components such as speed, agility and accuracy. To become a reliable rock climbing athlete, physical conditions such as flexibility, balance and arm muscle strength are needed (Erliana, 2015). One of the dominant physical conditions in rock climbing is arm muscle strength. Rock climbers always use their hands to work to lift the body up. All parts of the hand are involved in the movement of lifting the body up (Nugroho, 2014).

Furthermore, it is clear that muscle strength is one of the components of physical condition that supports the ability of a rock climber in performing climbing activities and as the determination of people achievement- and definitely to use in rock climbing competitions. Maintaining strength is one of the keys to a successful climbers (Rokowski et al., 2021).

Apart from that, the success of rock climbing athletes is also influenced by the muscles that attach and wrap the arm; the arm itself is the most important part in climbing activities that function to find points that have been installed on the climbing board and to increase height. The occurrence of movement in the arms of a rock climber is due to the presence of muscles and bones. Muscles are active locomotion and bones are passive locomotion. Muscular strength is the ability of muscles to generate tension against a resistance while the arm is a limb from the wrist to the human shoulder, which functions to hold an object.

The success factors of a rock climbing athlete include the means of training, techniques, training programmes, physical condition, motivation and mentality (Risman et al., 2024). Strength is the ability of a muscle or group of muscles to overcome a load or resistance (Sukadiyanto & Muluk, 2011). This opinion emphasizes that strength is the ability of muscles to overcome or withstand loads during activities. In rock climbing, of course, the burden that must be held is the dominant body itself. The success of a wall climbing can be seen from the potential strength it has. Because strength is so important in all sports, strength training should always be included in a physical training program to improve performance. Because people who have only strength or muscle strength by themselves will be able to achieve high if that

person does not also have fast muscles, therefore wall-climbing athletes are not enough just to practice to increase strength, but the strength must be increased to what is needed- called power. Muscular strength is the ability of muscles to work to withstand a load, so there are basic mechanical elements that play a role in muscle strength.

CONCLUSION

The variation of the Three-Movement Push Up strength training model and the Three Pull-Up strength training model both gave a significant increase in the climbing results of rock-climbing athletes. Therefore, this study provides a scientific contribution and a reference for further research.

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