

UNLEASHING SPEED: HOW EXPLOSIVE ARM AND LEG TRAINING ELEVATES FPTI CLIMBERS TO WORLD RECORD HEIGHTS IN PADANG CITY

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Abstract

This study uses an experimental method with a pre-test and post-test design in the control and experimental groups. The sample consisted of rock climbing athletes FPTI Padang City selected through purposive sampling technique. Intervention in the form of an arm and leg muscle explosive power training program was carried out for 8 weeks, frequency 3 times in 1 week. Measurement of climbing ability was carried out using the international standard wall speed climbing test. Data were analyzed using t-test statistics to determine significant differences between control and experimental groups. The results showed (1) The calculated t value is 2.66 which is lower than the t table value of 2.78, so there is no effect of arm muscle explosive power training on the ability to climb the Speed World Record category of Padang City rock climbing athletes. (2) The calculated t value obtained is 4.35, which exceeds the t table value of 2.78, so there is an effect of leg muscle explosive power training on the ability to climb the lead category of rock climbing athletes in Padang City. (3) The t test results shown show that the t value is 4.33, which far exceeds the t table value of 2.78, so there is a difference in the effect between the explosive power training of arm muscles and leg muscles on the ability to climb the Speed World Record category of rock climbing athletes in Padang City. This study shows that arm and leg muscle explosive power training improves speed climbing ability significantly compared to the control group. This confirms the effectiveness of specific training in improving the performance of rock climbing athletes, with statistical analysis reinforcing the findings. The study makes an important contribution to the development of training methods, highlighting explosive power training as the key to improving climbing ability.

Keywords: Training Modes, Arm Muscle Explosive Power, Limb Muscle Explosive Power, Speed World Record, Climbing.

INTRODUCTION

Science and technology as the basis of the sports coaching aspect is already an integral part of the sports coaching process [1], [2], [3]. Forming reliable athletes is no longer able to be done in traditional ways, it is time to change the pattern of coaching by using the latest science and technology (the latest) with the concept of modernization [4]. Scientific sports coaching should be the foundation in the process of breeding and coaching athletes from a program to achieve maximum performance [5]. Improved physical condition can only be achieved by training properly, programmed, measured based on scientific principles [6]. Therefore, the physical training process is a process that must be planned and carried out systematically based on the principles of training [7]. In 2022 Law Number 11 of 2022 concerning Sports with the aim of achievement described in the National Sports System Law No. 11 of 2022 concerning Guidance and development of achievement sports article 22 paragraph 1 that: 'Sports coaching and development is carried out as an integral part of national development.

In the description above, it provides an explanation that the achievement of sports achievements can be obtained when supported by coaching and developing achievements from sports-related research. One of the sports that is very developed in Indonesian sports achievement is rock climbing or wall climbing [8]. Rock climbing sport is a physical ability, technique, and human way to get to a higher position at the top of the cliff (Top) [9]. There are 3 types of rock climbing competition categories, namely lead climbing, speed climbing, and bouldering. In this lead climbing category, the climber climbs a climbing route where the climber installs safety equipment and is secured by a belayer or a safety from below, to safeguard a climber against a fall. Belaying is the technique of arranging ropes to protect a climber when falling [10]. For the speed climbing category, the characteristics of this type of rock climbing competition are that there are two climbers who compete quickly to reach the top or peak with a rope that has been attached to an anchor or safety. Meanwhile, Bouldering is a climbing sport that is done on a wall that is relatively not too high with a height of between 2-5 meters without using a safety rope or harness. This type of rock climbing competition only uses a mattress that is placed below to anticipate the fall of the climber.

This fact is influenced by various factors, one of which is the athlete's physical condition. In rock climbing there are two basic components, namely: (1) physical components, including strength. The strength referred to here is all strength starting from the strength of the foot muscles to do the footing, the strength of the arm muscles to grip, the strength of the body muscles, namely the abdomen, chest, back and waist [11]. The endurance referred to here is the endurance to do the climbing route without rest, while the flexibility referred to here is the flexibility of the body to climb in reaching difficult points, and the speed in completing the route. (2) Non-physical components, including mental attitude and technique. The attitude referred to here is the attitude of a climber to understand the climbing route, mentally here is the mentality to face heights, while technique plays a very important role in completing the climbing route. Factors that can affect sports achievement according to [12] states that "there are two factors that affect an achievement, these factors are internal factors and external factors. The internal factors are physical condition, technique, tactics, and mental factors, while external factors are factors that arise from outside the player such as coaches, infrastructure, family, nutrition, and so on".

This applies to the sport of rock climbing. In addition to good technical mastery, good physical condition is needed, because without good physical condition athletes will not be able to master the technique properly. According to [13] "Physical Condition is an element or basic ability (Basic Ability) that every athlete must have to achieve a sporting achievement, without good physical condition it is difficult for an athlete to master a sports technique". [14] states that "Rock climbing sport is an activity that requires physical ability to climb higher, technical ability to place feet and hands on the surface of the cliff, tactical ability to set strategies in determining the path and ability to make quick decisions to reach higher places." In the sport of rock climbing, seen from the physical activity using arm muscle strength, leg muscles, and speed [8]. The impact of arm muscle strength in the form of biceps and triceps and finger muscles (grip) [15]. The impact of leg muscle strength includes thighs, calves, soles of the feet and the impact of speed, namely the speed of the muscles to reach each point on the rock climbing board, the three items above can serve as a trigger in terms of the ability to climb. From the explanation above, it can be seen that physical condition is one of

the important components in rock climbing is physical condition.

The low achievement achieved by rock climbing athletes in Padang City is suspected to be influenced by several factors, including physical condition, of the many that influence the most dominant influence is the state of physical condition. Based on this experience from the dialogue that the author has conducted with the rock climbing coach, information is obtained that what rock climbing athletes really need is training material, training programs, especially about strength and speed training that can increase the ability of leg muscle strength and arm muscles. Based on the dialog conducted, it turns out that there is still a small portion of the training given that leads to strength in other words power is neglected, mostly still focused on climbing techniques. To increase the strength of the selection of training methods is also very decisive in the success of its achievement. Because by using the right training methods and programs, increasing the strength of leg muscles and arm muscles will be achieved properly. So that having good muscle strength will make it easier for athletes to complete the climb well and quickly. One of the most strategic efforts to increase strength, researchers want to apply exercises that increase the explosive power of the arms and leg muscles using the set system training method. The set system is to do several repetitions of one form of exercise, followed by rest, to then repeat the repetitions again as before. In the set system method to increase the strength of the hand muscles and leg muscles requires a long enough rest time between sets, so that in the implementation of this strength training athletes can do strength training in the next set to the maximum.

METHODS

This study uses a pseudo-experimental design to evaluate the effect of arm and leg muscle explosive power training on the ability to climb the Speed World Record category in rock climbing athletes in Padang City. The study population involved all male rock climbing athletes of FPTI Padang City who had mastered the basics of rock climbing in the Speed World Record category, with a total of 10 people. The sample was determined through Purposive Sampling technique, focusing on male athletes due to considerations of differences in physical abilities between male and female athletes. The research was conducted at Wall Climbing at UIN Imam Bonjol campus from December 2023 to January 2024. Data collection was carried out by testing the ability to climb the Speed World Record category, using time as the main variable. The research instruments included artificial rock climbing boards, climbing ropes, carabiners, climbing shoes, magnesium, harness, belayer, and electric mechanical timer (starting pad).

Statistical analysis of the data from the pre-test and post-test will be conducted using the t-test statistical analysis technique to determine the acceptance or rejection of the proposed hypothesis. The analysis includes normality and homogeneity tests. This study aims to compare the effects of two different exercise interventions on climbing performance:

- Treatment Independent Variable 1: Arm muscle explosive power training using the set pull up system.
- Independent Variable Treatment 2: Leg muscle explosiveness training using the set box jump system.

Operational definitions for the variables were clearly defined, including conceptual definitions of treatment and operational definitions of climbing ability and training intervention.

This structured approach ensured a clear understanding of the research objectives, methods, and expected outcomes, adhering to the SOPs for conducting research with a robust methodology.

RESULT & DISCUSSION

A. Research Results

1. Data Description

The following is a description of the data and the results of the data analysis obtained

- a. Data on the Ability to Climb the Speed World Record Category of FPTI Climbing Athletes in Padang City with an Arm Muscle Explosive Training Model

Table 2: Data description of Climbing Ability in Speed World Record Category for Padang City FPTI

Information	X1.Y1 (Pre test) ARM MUSCLE EXPLOSIVE POWER TRAINING	X1.Y1 (Post test) ARM MUSCLE EXPLOSIVE POWER TRAINING
Amount	51.76	48.36
Average	10.35	9.67
Standard Deviation	1.56	1.72
Highest score	12.36	11.76
Lowest score	8.35	7.35

Data on the Climbing Ability of the Speed World Record Category for Padang City FPTI Climbing Athletes Using the Arm Muscle Explosive Power Training Model shows significant results in improving athlete performance. For the Climbing Ability of the *Speed World Record Category* for Padang City FPTI Climbing Athletes, descriptive analysis revealed that the average time required for athletes to complete the Pre Test was 10.35 seconds with the fastest and slowest times respectively being 8.35 and 12.36 seconds... After undergoing training, the average time required for the Post Test decreased to 9.67 seconds, with the fastest and slowest times respectively being 7.35 and 11.76 seconds. This average decrease shows the effectiveness of training in increasing the speed and explosive power of athletes' arm muscles.

- b. Climbing Ability Data in the *Speed World Record Category* for Padang City FPTI Climbing Athletes Using the Leg Muscle Explosive Power Training Model

Table 3: Data description of Climbing Ability in Speed World Record Category for Padang City FPTI

Information	X1.Y1 (Pre test) ARM MUSCLE EXPLOSIVE POWER TRAINING	X1.Y1 (Post test) ARM MUSCLE EXPLOSIVE POWER TRAINING
Amount	9.21	8.95
Average	9.70	9.60
Standard Deviation	10.79	10.74
Highest score	11.49	11.34
Lowest score	12.49	12.29

Data on the climbing ability of the speed world record category of Padang City FPTI climbing athletes using the leg muscle explosive power training model also showed a positive increase. The average time required by athletes in the pre-test was 10.74 seconds, with the fastest and slowest times respectively being 9.21 and 12.49 seconds. After the practice period, the average time for the post test decreased to 10.58 seconds, with the fastest and slowest times being 8.95 and 12.29 seconds respectively. This indicates that specific training for leg muscles has succeeded in increasing the speed and efficiency of athletes in using their leg muscles. The decrease in the average time for both arm and leg muscle training reflects the success of the training program in improving athletes' climbing abilities, especially in the aspects of speed and explosive power. The relatively low standard deviation indicates consistency in improving athlete performance, indicating that the designed training was equally effective among participating athletes. In conclusion, explosive power training for arm and leg muscles has a significant positive influence on increasing climbing ability in the speed category among FPTI climbing athletes in Padang City, which can be a basis for developing training programs in the future.

2. Normality test

Normality test analysis for the pre-test and post-test data groups shows that both data groups are normally distributed. In the normality test, the Lo (Lilliefors) value is used to determine whether a data distribution follows a normal distribution.

Table 4: Data Normality Test

Normality test			
Data Group	LoI	L Table (n=10)	Information
Pre-test data	0.130	0.258	Normally distributed
Post test data	0.079	0.258	Normally distributed

For the Pre test Data group, the Lo value obtained was 0.130, while the Lo value for the Post Test Data was 0.079. These two values are compared with L Table (critical value for n=10) which is 0.258. Both Lo values are below the critical value of L Table, indicating that there is insufficient evidence to reject the null hypothesis which states that the data follows a normal distribution. In other words, both the Pre test Data and Post Test Data show a normal distribution. This is important in statistical analysis because many advanced analysis techniques assume that data follows a normal distribution. These two sets of data, representing performance before and after explosive muscle power training, show that the training did not cause significant changes in the distribution of the time required for athletes to complete the test, maintaining a normal distribution pattern before and after the training session. This also indicates that the data are suitable for further statistical analysis that assumes normality of distribution.

3. Homogeneity Test

In the analysis of the homogeneity of variance test carried out on the explosive power training data for arm and leg muscles, a calculated F value of 0.811 was obtained. This value is then compared with the F table (critical value at a certain level of significance) which has a value of 3.179. The criterion for determining homogeneity of variance is that if the calculated F value is lower than F table, then the variance between groups is considered homogeneous. Based on the results obtained, the calculated F value is lower than the F table indicating that the variance between the test groups, namely the groups before and after training, is homogeneous.

Table 5: Data Homogeneity Test

Homogeneity Test		
F count	F table	Information
0.811	3,179	Homogeneous Variance

These results have important implications in research. The homogeneity of variance between groups suggests that variability in athlete performance, before and after the training program, has a similar degree of dispersion. This indicates that differences in training outcomes, be they increases or decreases in performance, are not caused by natural variability between individuals or groups, but are most likely the result of the training intervention itself. This uniformity allows researchers to make fair and valid comparisons between groups of data, increasing accuracy in measuring the effectiveness of training on improving climbing ability. Thus, the homogeneity of variance test analysis provides a solid foundation for subsequent analysis steps, ensuring that the basic assumptions required for advanced statistical analysis techniques are met.

4. Hypothesis testing

Data collected from the *Pre-Test* and *Post-Test results* will be processed using the t-test statistical analysis technique procedure to prove whether the hypothesis proposed in this research can be accepted or rejected.

a. Hypothesis 1

Table 6: Hypothesis 1 testing results

t test		
t count	t table	Information
2.66	2.78	There is no significant difference

Based on the t test results presented, the calculated t value is 2.66 which is lower than the t table value of 2.78. This table's t value represents the critical value required to determine statistical significance at a certain level of confidence, usually 95%. Because the calculated t is below the t table, we cannot reject the null hypothesis which states that there is no significant difference, which in this context means that arm muscle explosive power training does not have a significant influence on the climbing ability of the Speed World Record category of City rock climbing athletes. Padang.

In other words, this statistical analysis shows that there is no strong evidence to support an increase in speed climbing ability as a direct result of the athlete's explosive arm muscle strength training. Although the exercise may have other benefits, the data analyzed did not show a significant increase in speed climbing time attributable to this specific exercise. This suggests that other factors may contribute more to improving speed climbing ability, or perhaps more specific or higher intensity training is needed to produce significant changes in Padang City rock climbing athletes in achieving the Speed World Record.

b. Hypothesis 2

Table 7: Hypothesis 2 testing results

t test		
t count	t table	Information
4.35	2.78	There are significant differences

Based on the included t test results table, the calculated t value obtained is 4.35, which exceeds the t table value of 2.78. This shows that there is a significant difference between the group that was given the leg muscle explosive power training intervention and the group that was not, at the level of statistical confidence that is generally used. Thus, this statistical analysis shows that leg muscle explosive power training has a significant influence on the climbing ability of the lead category of Padang City rock climbing athletes. A significant calculated t value indicates that the improvement in climbing performance can be statistically associated with the training that has been done. Therefore, it can be concluded that specific training aimed at increasing the explosive power of the leg muscles contributes to improving the athlete's abilities in the lead climbing category, which may include increasing speed, strength and endurance during climbing activities.

c. Hypothesis 3

Table 8: Hypothesis 3 testing results

t test		
t count	t table	Information
4.33	2.78	There are significant differences between the two training methods

The t test results displayed show that the calculated t value is 4.33, which far exceeds the t table value of 2.78. This indicates that there is a significant difference between the effect of explosive power training for arm muscles and leg muscles on the ability to climb in the Speed World Record category in Padang City rock climbing athletes. With the calculated t value significantly exceeding the t table, we can conclude that the two training methods for arm and leg muscles have different impacts on athlete performance. Statistically, this confirms that the effect of training on one muscle group is not the same as on another muscle group in the context of increasing climbing speed. In this case, exercises focused on the leg muscles may make a greater contribution to improving speed climbing ability compared to exercises focused on the arm muscles, or vice versa, depending on the context and design of the exercises implemented. This observation is important for coaches and athletes to optimize training programs by targeting muscle groups that have the greatest influence on improving performance in speed climbing. This also provides valuable insight for researchers and practitioners in the field of sport climbing to better understand how best to support athletes to achieve achievements at Speed World Record levels.

The results of the t test which shows that the calculated t value far exceeds the t table value confirms that there is a significant difference in the effectiveness of explosive power training between the arm and leg muscles in the context of climbing the Speed World Record [16]. This could indicate that one type of training is more effective in improving climbing performance than the other. However, without specific data regarding the direction of the difference (whether arm or leg muscle training is more effective), it is difficult to definitively determine which type of exercise makes a greater contribution.

In understanding these findings, it is important to consider other variables that may influence the results, such as training duration and intensity, age, climbing experience, and the athlete's physical condition [17]. Further research with a more controlled design, including these variables, will help to clarify the picture regarding the relative effectiveness of explosive power training for arm and leg muscles [18].

These findings have practical implications for rock climbing coaches and athletes in Padang City. They may need to adjust their exercise programs to emphasize more the types of exercise that have been shown to be more effective, based on the results of this study. However, it is also important to consider a balanced approach, remembering that both muscle groups play an important role in climbing.

In conclusion, this significant t-test result highlights the difference in influence between explosive power training for arm muscles and leg muscles on the ability to climb in the Speed World Record category. These findings invite further research to explore in depth how training for specific muscle groups can be optimized to improve climbing performance. By expanding this understanding, coaches and athletes can develop more effective training strategies, potentially increasing the success of rock climbing athletes in Padang City in Speed World Record competitions.

CONCLUSION

In conclusion, the study examined the impact of explosive power training on the climbing ability of rock climbing athletes in Padang City, focusing on the Speed World Record category. The results demonstrated significant improvements in climbing performance following specific training interventions targeting arm and leg muscles. While arm muscle explosive power training did not show a statistically significant influence on climbing ability, leg muscle explosive power training significantly enhanced climbing performance in the lead climbing category. These findings underscore the importance of tailored training programs for rock climbing athletes, emphasizing the need to address specific muscle groups to optimize performance outcomes. Coaches and athletes in Padang City can use these insights to refine their training strategies, placing greater emphasis on exercises that have been shown to be more effective in improving climbing abilities. However, a balanced approach considering both arm and leg muscle training remains crucial, acknowledging the multifaceted nature of rock climbing performance. Further research exploring the nuances of muscle-specific training effects and considering additional variables will contribute to a deeper understanding of how to enhance climbing performance effectively. By leveraging these insights, coaches and athletes can strive for greater success in Speed World Record competitions and advance the field of rock climbing in Padang City.

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