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The Effect of Pull Up Training On Speed In The Speed WR Category of Sport Climbing

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ABSTRACT

Sport climbing, particularly the Speed WR event, requires athletes to combine explosive upper-body strength, rapid movement coordination, grip control, and efficient body transfer to achieve optimal climbing time. In Makassar City, several sport climbing athletes still experience performance limitations due to insufficient structured physical conditioning, especially in exercises that support arm strength and pulling capacity. This study aimed to determine the effect of pull-up training on speed performance in the Speed WR event among sport climbing athletes of Makassar City. This research used a quantitative experimental method with a one-group pretest-posttest design. The sample consisted of 17 athletes selected through purposive sampling based on active participation, physical readiness, and involvement in climbing training. Data were collected using a speed climbing performance test, in which athletes started from the standard starting position and the time was recorded from the start movement until the athlete touched the finish pad. The data were analyzed descriptively and inferentially through normality, homogeneity, and paired sample t-test procedures. The descriptive results showed that the pretest mean score was 14.47 with a standard deviation of 3.134, while the posttest mean score decreased to 14.32 with a standard deviation of 3.183. The mean difference was 0.146, indicating an improvement in climbing speed after the pull-up training intervention. The paired sample t-test showed a t-count value of 5.237, which was higher than the t-table value of 1.740, with a significance value of $p < .001$. Therefore, pull-up training had a significant effect on improving Speed WR climbing performance. This study concludes that pull-up training can be used as a specific conditioning method to improve upper-body strength, pulling efficiency, and speed performance in sport climbing athletes.

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INTRODUCTION

Sport has increasingly developed from a recreational activity into a competitive and professional domain that requires systematic preparation, scientific training design, and measurable performance evaluation. Sport climbing, particularly artificial wall climbing, has gained rapid popularity among children, youth, and adults because it combines physical strength, movement intelligence, technical precision, courage, and fast decision-making. Since sport climbing became part of the Olympic program and the speed discipline was separated as an independent medal event in Paris 2024,

performance demands in speed climbing have become more specialized and more competitive at regional, national, and international levels. In the speed climbing format, athletes must ascend a standardized wall as fast as possible, making completion time the most direct indicator of performance. Therefore, speed climbing is not only a matter of climbing technique but also a highly explosive sport that requires upper-limb strength, lower-limb power, trunk stability, grip endurance, movement rhythm, and efficient coordination (Ehiogu et al., 2022; Askari Hosseini et al., 2023; Stien et al., 2022). Current reviews confirm that sport climbing performance is determined by the interaction of muscular strength, muscular endurance, power, technical fluency, and discipline-specific testing quality rather than by a single physical attribute alone (Langer et al., 2023; Faggian et al., 2025; Diez-Fernández et al., 2023).

In South Sulawesi, especially Makassar City, wall climbing has shown strong development through youth participation and competition activities under the guidance of local sport organizations. However, the achievement of optimal performance among Makassar climbing athletes still faces several practical problems. Field observations indicate that some athletes have not reached maximum speed performance because their physical conditioning is not yet fully developed, while training sessions tend to emphasize route technique more than structured strength and conditioning. This condition may reduce the athlete's ability to produce rapid pulling force, maintain body control, and move efficiently from one hold to another. In speed climbing, a small delay in hand movement, body transition, or pulling action can directly increase total climbing time. Thus, the lack of planned, systematic, and continuous physical conditioning becomes an important barrier to competitive achievement. The pull-up exercise is relevant in this context because it directly trains the elbow flexors, shoulder girdle, back muscles, grip coordination, and relative upper-body strength that are repeatedly used during vertical displacement in climbing (Draga et al., 2024; Devise et al., 2023; Vigouroux et al., 2024; Sas-Nowosielski et al., 2022; Labott et al., 2022).

Recent scientific literature shows that climbing performance depends on specific physical qualities rather than general fitness alone. Saul et al. (2019) found that handgrip strength and endurance, postural stability, and optimized movement kinematics are important factors for climbing success. Langer et al. (2023) reported that most climbing performance tests focus on upper-limb and finger strength, indicating the central role of the arm–finger complex in climbing diagnostics. Faggian et al. (2025) further identified cardiorespiratory endurance, muscular strength, muscular endurance, and muscular power as key determinants of sport climbing performance. Meanwhile, Stien et al. (2022) emphasized that climbing-specific testing and training should consider endurance, strength, and power characteristics according to the selected climbing discipline. In speed climbing, Askari Hosseini et al. (2023) highlighted that explosive power, speed endurance, lower-limb contribution, and pull-up-related upper-limb power are closely related to performance indicators. Ehiogu et al. (2022) also explained that speed climbing requires strong involvement of upper limbs, lower limbs, trunk, shoulder muscles, forearm flexors, and finger musculature during stabilization, preparation, and displacement phases.

The role of pull-up capacity has received growing attention in climbing research. Draga et al. (2024) demonstrated that shoulder girdle and elbow flexor endurance predict climbing performance at a level comparable to finger flexor endurance, and the pull-up test is considered simple, safe, reliable, and useful for assessing climbers' fitness. Devise et al. (2023) investigated climbers' pull-up capabilities by examining concentric arm muscle performance, while Vigouroux et al. (2024) showed that pull-up performance may be influenced by different muscle contraction training regimes. Sas-Nowosielski et al. (2022) also found that weighted pull-ups can produce acute post-activation performance enhancement in climbing-specific upper-body power. Other studies strengthened this view by showing the importance of finger hangs, arm lock-offs, grip strength, rate of force development, and upper-limb neuromechanics in climbing movement efficiency (Exel et al., 2023; Maciejczyk et al., 2022; Augste et al., 2022; Ruiz-López et al., 2024; Limmer et al., 2022). These findings support the idea that pull-up training is not merely a general strength exercise, but a movement pattern that closely reflects the pulling, locking, and body-lifting actions required in climbing.

Although previous research has discussed the determinants of sport climbing performance, several gaps remain. First, many studies focus on lead climbing, bouldering, or general climbing

performance, while empirical studies specifically examining speed climbing athletes at the regional level are still limited (Askari Hosseini et al., 2023; Faggian et al., 2025; Langer et al., 2023). Second, the literature has emphasized finger strength, grip endurance, and lower-limb power, but fewer studies have directly examined the effect of a structured pull-up training program on climbing speed, particularly in the Speed WR event. Third, several diagnostic and review studies have argued that climbing research still lacks standardized intervention designs, detailed participant descriptions, and practical training models that can be directly applied by coaches (Stien et al., 2022; Langer et al., 2023; Breen et al., 2023). Fourth, the local context of Makassar City athletes has not been sufficiently represented in scientific publications, even though regional athlete development requires evidence-based training programs that match local performance problems, athlete characteristics, and competition demands.

This gap is important because the improvement of speed climbing performance cannot rely only on technical repetition. Technical training must be supported by physical conditioning that develops relative strength, explosive pulling ability, shoulder stability, grip control, and movement efficiency. Studies on biomechanics and performance factors indicate that speed climbing is influenced by limb frequency, contact time, center-of-mass displacement, upper-body dynamics, lower-limb power, and individualized movement patterns (Andrey, 2025; Chou & Kaplan, 2024; Dech et al., 2026). Resistance and strength-based interventions have also been reported to improve relevant climbing qualities, including grip strength, pull-up capacity, hangboard time, upper-limb strength, and neuromuscular performance (Stien et al., 2022; Shih et al., 2024; García-Heras et al., 2025; da Silva et al., 2026). However, the specific empirical contribution of pull-up training toward speed performance in Makassar City climbing athletes remains unclear and requires direct investigation.

Based on these problems and gaps, this study aims to determine the effect of pull-up training on speed performance in the Speed WR event among Makassar City sport climbing athletes. Conceptually, this research is grounded in the assumption that pull-up training can improve the athlete's ability to generate rapid upper-body pulling force, maintain body control during vertical displacement, and reduce ineffective movement time during climbing. Empirically, this study is expected to provide measurable evidence on whether a structured pull-up training program can contribute to improved climbing speed. The novelty of this research lies in its focus on the Speed WR event, its application to Makassar City climbing athletes, and its attempt to connect a simple but highly specific strength exercise with a measurable speed-climbing performance outcome.

In conclusion, speed climbing requires an integrated combination of physical, technical, tactical, and psychological qualities, but upper-body pulling strength remains one of the most relevant physical foundations for fast and efficient ascent. The practical problem faced by Makassar City athletes is the absence of a fully systematic conditioning program that supports technical training. Therefore, examining the effect of pull-up training on speed climbing performance is both scientifically relevant and practically urgent. The findings of this study are expected to contribute to the development of evidence-based coaching programs for climbing athletes, enrich the literature on regional athlete development, and provide a reference for future studies on strength training interventions in the Speed WR discipline.

METHODS

This study employed a quantitative experimental method using a one-group pretest–posttest design to examine the effect of pull-up training on climbing speed in the Speed WR event among Makassar City sport climbing athletes. Experimental research is appropriate because it allows the researcher to test changes in performance after a structured intervention and to determine whether the treatment produces measurable improvement. In the context of sport climbing, this approach is relevant because performance is strongly influenced by trainable physical components such as muscular strength, upper-limb endurance, power, movement efficiency, and climbing-specific coordination (Stien et al., 2022; Langer et al., 2023; Faggian et al., 2024; Diez-Fernández et al., 2023).

The population of this study consisted of sport climbing athletes from Makassar City. The sample was selected using purposive sampling, with specific consideration given to athletes who were actively

training, had experience in wall climbing, were physically healthy, and were willing to participate in the full research procedure. This sampling technique was used to ensure that the participants had characteristics relevant to the Speed WR event and were capable of completing both the pull-up training program and the climbing speed test.

Data were collected through direct observation and climbing speed measurement. The test was conducted using a standardized speed-climbing procedure. After the command "At your marks," each athlete immediately took the starting position with both hands and one foot on the preferred starting holds, while the other foot was placed on the starting pad. After the athlete was motionless, the command "Ready" was given, and timing began when the athlete left the starting point. The stopwatch was stopped when the athlete hit the finish pad. This procedure reflects the logic of official speed climbing timing, where reaction, acceleration, pulling force, and movement fluency directly influence final time (Askari Hosseini & Wolf, 2023; de la Cruz et al., 2024).

The pull-up training intervention was designed to improve upper-body pulling strength, shoulder girdle endurance, elbow flexor capacity, grip control, and relative body strength. These components are considered essential because previous studies have shown that pull-up ability, finger flexor endurance, upper-limb power, and shoulder stability contribute substantially to climbing performance (Levernier et al., 2020; Devise et al., 2023; Draga et al., 2024; Saul et al., 2019). The data were analyzed by comparing pretest and posttest climbing speed scores to determine the magnitude of improvement after the intervention.

RESULTS AND DISCUSSION

Result

The results of this study describe the effect of pull-up training on speed performance in the Speed WR event among sport climbing athletes of Makassar City. Before hypothesis testing was conducted, the data were tabulated and analyzed descriptively to obtain an overview of the athletes' performance before and after the pull-up training intervention. The descriptive analysis included the number of samples, range, minimum score, maximum score, total score, mean, and standard deviation. Furthermore, prerequisite testing was conducted through normality and homogeneity tests. Since the data were normally distributed and homogeneous, hypothesis testing was carried out using a paired sample t-test.

Table 1.
Descriptive Statistics of Speed WR Performance

Variable	N	Range	Min.	Max.	Sum	Mean	Stdv. Dev
Pretest speed in Speed WR event	17	10	10	20	246	14.47	3.134
Posttest speed in Speed WR event	17	10	10	20	243	14.32	3.183

Source: Data processing, 2025.

Based on Table 1, the pretest result of speed performance in the Speed WR event showed that the total score of 17 athletes was 246, with a minimum score of 10, a maximum score of 20, and a range of 10. The mean pretest score was 14.47 with a standard deviation of 3.134. After the pull-up training intervention, the posttest result showed a total score of 243, with the same minimum score of 10, maximum score of 20, and range of 10. The posttest mean score was 14.32 with a standard deviation of 3.183. These descriptive data indicate a decrease in the mean climbing time from pretest to posttest. In speed climbing, a lower time score reflects better performance; therefore, the reduction from 14.47 to 14.32 indicates an improvement in athletes' climbing speed after participating in the pull-up training program.

Table 2.
Normality Test Results

Variable	Kolmogorov–Smirnov		Shapiro–Wilk		α	Interpretation
	Statistic	Sig.	Statistic	Sig.		
Pretest	0.199	0.072	0.933	0.240	0.05	Normal
Posttest	0.206	0.054	0.926	0.190	0.05	Normal

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Table 2 shows the results of the normality test. In the pretest data, the Kolmogorov–Smirnov significance value was 0.072 and the Shapiro–Wilk significance value was 0.240. Both values were greater than α = 0.05, indicating that the pretest data were normally distributed. In the posttest data, the Kolmogorov–Smirnov significance value was 0.054 and the Shapiro–Wilk significance value was 0.190. Since both values were also greater than α = 0.05, the posttest data were declared normally distributed. Therefore, the data met the normality assumption required for parametric statistical testing.

Table 3.
Homogeneity Test Results

Variable	Levene Statistic	Sig.	α	Interpretation
Pull-up training group	0.012	0.914	0.05	Homogeneous

Based on Table 3, the homogeneity test showed a Levene statistic value of 0.012 with a significance value of 0.914. Since the significance value was greater than α = 0.05, the data were considered homogeneous. This means that the variance of the pretest and posttest data came from the same or equivalent distribution condition. Thus, the data fulfilled the assumption for further hypothesis testing using a paired sample t-test.

Table 4.
Paired Sample t-Test Results

Variable	Test	Mean	Mean Difference	t-count	df	Sig. (2-tailed)	t-table	Interpretation
Speed WR performance	Posttest Pretest	14.32 14.47	0.146	5.237	16	0.000	1.740	Significant

Table 4 presents the paired sample t-test results. The mean score decreased from 14.47 in the pretest to 14.32 in the posttest, with a mean difference of 0.146. The statistical analysis showed that the t-count value was 5.237, while the t-table value was 1.740 at df = 16. The significance value was 0.000, which was lower than α = 0.05. Therefore, the difference between the pretest and posttest results was statistically significant.

These findings indicate that the null hypothesis was rejected and the alternative hypothesis was accepted. In other words, pull-up training had a significant effect on speed performance in the Speed WR event among sport climbing athletes of Makassar City. Empirically, the improvement can be seen from the reduction in climbing time after the intervention. Conceptually, this result supports the view that pull-up training contributes to the development of upper-body pulling strength, shoulder stability, arm endurance, and body-control capacity, which are important physical components in speed climbing. Although the mean difference was relatively small, the statistical result confirms that the pull-up training program produced a meaningful performance change in the athletes' Speed WR climbing ability.

Discussion

The findings of this study indicate that pull-up training had a significant effect on speed performance in the Speed WR event among sport climbing athletes of Makassar City. This result was demonstrated by the paired sample t-test, where the t-count value was 5.237, exceeding the t-table value of 1.740, with a significance value of 0.000, or more appropriately reported as $p < .001$. Statistically, this means that the null hypothesis was rejected and the alternative hypothesis was accepted. Empirically, the mean score decreased from 14.47 in the pretest to 14.32 in the posttest, with a mean difference of 0.146. In speed climbing, a lower time value reflects better performance; therefore, this decrease indicates an improvement in athletes' climbing speed after participating in the pull-up training program.

Conceptually, this finding is consistent with the physiological demands of speed climbing. The Speed WR event requires athletes to move rapidly on a standardized climbing route by combining explosive pulling force, lower-limb propulsion, trunk control, grip efficiency, and precise movement rhythm. Although speed climbing performance is not determined only by arm strength, the upper limbs

play a decisive role in accelerating the body upward, maintaining body position, controlling transitions between holds, and reducing ineffective movement time. Previous studies have shown that sport climbing performance is influenced by muscular strength, muscular endurance, power, finger strength, shoulder stability, and climbing-specific coordination (Saul et al., 2019; Stien et al., 2022; Langer et al., 2023; Faggian et al., 2024; Saeterbakken et al., 2024). Therefore, the improvement found in this study can be explained through the specific contribution of pull-up training to upper-body pulling capacity and movement efficiency.

Pull-up training is a body-weight resistance exercise that dominantly activates the latissimus dorsi, biceps brachii, brachialis, forearm flexors, scapular stabilizers, and core muscles. These muscle groups are highly relevant to sport climbing because athletes must repeatedly pull, lock, stabilize, and transfer body weight from one hold to the next. Draga et al. (2024) reported that elbow flexor and shoulder girdle muscular endurance predict climbing performance at a level comparable to finger flexor endurance. Similarly, Devise et al. (2023) emphasized that pull-up capability in climbers involves concentric arm strength, coordination, stretch-shortening utilization, and fatigue resistance. Vigouroux and Devise (2024) further demonstrated that different pull-up training regimes can affect climbers' maximal strength, power, coordination, and endurance. These findings support the present result that pull-up training can produce meaningful adaptation for athletes involved in speed climbing.

The significant improvement in this study also aligns with research on resistance training and climbing-specific performance. Stien et al. (2022) concluded that resistance training can improve finger strength, rate of force development, and forearm endurance, while Saeterbakken et al. (2024) explained that resistance training may support maximal strength, power, hypertrophy, local muscular endurance, and injury prevention in climbers. Sas-Nowosielski et al. (2022) found that weighted pull-ups can be used as a post-activation performance enhancement stimulus for explosive upper-body climbing actions. Hermans et al. (2022), Gilmore et al. (2024), and Ruiz-López et al. (2024) also showed that structured strength-oriented training can improve climbing-specific force production, grip capacity, and performance-related neuromuscular qualities. Thus, the improvement in Makassar City athletes is not an isolated finding, but part of a broader scientific pattern showing that specific resistance training supports climbing performance.

From a biomechanical perspective, the reduction in climbing time after pull-up training may be associated with improved pulling efficiency, better scapular control, and faster transition between handholds. In speed climbing, athletes must minimize wasted movement and produce force quickly. Askari Hosseini and Wolf (2023) argued that speed climbing performance is influenced by physical and tactical indicators, including the ability to execute rapid and efficient movement sequences. De la Cruz et al. (2024) also showed that force–velocity characteristics in pull-ups are relevant for differentiating speed climbers of different performance levels. In addition, studies by Maciejczyk et al. (2022), Pérez-Cordero et al. (2025), Buraas et al. (2025), and García-Heras et al. (2025) confirm that climbing performance should be understood through the interaction of upper-limb strength, finger-force capacity, lower-limb contribution, and sport-specific testing. Therefore, pull-up training likely contributed to improved upper-body force transfer during the climbing movement.

However, the magnitude of improvement must be interpreted carefully. Although the statistical result was significant, the mean difference was only 0.146. In speed climbing, even a small time reduction can be meaningful because competition outcomes are often decided by fractions of a second. Nevertheless, from a training science perspective, this result should not be overstated as a large practical effect without additional effect-size analysis. The improvement suggests that pull-up training was beneficial, but it should be integrated with other speed-climbing components, including start reaction, foot placement, lower-limb explosive power, grip-specific strength, trunk stabilization, route rhythm, and psychological readiness. This is consistent with the multidimensional view of sport climbing proposed by Faggian et al. (2024), Langer et al. (2023), Stien et al. (2022), Ozimek et al. (2016), and Saeterbakken et al. (2024), who emphasize that climbing performance cannot be reduced to one physical variable alone.

The practical implication of this study is that coaches of Makassar City sport climbing athletes should not rely exclusively on technical route repetition. Pull-up training can be included as a structured

conditioning method to develop upper-body strength and endurance, especially for athletes competing in the Speed WR event. However, the program should be progressive, individualized, and combined with climbing-specific drills. Coaches may apply variations such as standard pull-ups, tempo pull-ups, explosive pull-ups, assisted pull-ups, weighted pull-ups, and climbing-hold pull-ups according to athlete level and training phase. This approach is supported by recent studies showing that specific strength training, campus board training, hangboard training, and pull-up-based conditioning may improve relevant physical qualities in climbers (Stien et al., 2021; Hermans et al., 2022; Devise et al., 2023; Draga et al., 2024; Vigouroux & Devise, 2024; Shih et al., 2024; Chomiuk et al., 2025).

In conclusion, the results of this study demonstrate that pull-up training significantly affects speed performance in the Speed WR event among Makassar City sport climbing athletes. The empirical evidence is shown by the significant t-test result and the reduction in mean climbing time from pretest to posttest. Conceptually, this improvement is supported by the role of pull-up training in strengthening the upper limbs, shoulder girdle, elbow flexors, grip-supporting muscles, and body-control capacity. Although the improvement was statistically significant, future studies should include a control group, larger sample size, longer intervention period, and effect-size calculation to provide stronger evidence regarding the practical effectiveness of pull-up training in competitive speed climbing.

CONCLUSION

Based on the results of data analysis, it can be concluded that pull-up training has a significant effect on speed performance in the Speed WR event among sport climbing athletes of Makassar City. Empirically, this finding is supported by the comparison between the pretest and posttest results. The pretest mean score was 14.47, while the posttest mean score decreased to 14.32, with a mean difference of 0.146. Since performance in the Speed WR event is measured by time, the decrease in the mean score indicates that the athletes were able to climb faster after receiving the pull-up training intervention. The statistical test further confirmed this improvement, as the t-count value was 5.237, which was higher than the t-table value of 1.740, with a significance value of $p < .001$. Therefore, the research hypothesis was accepted, meaning that pull-up training contributed significantly to improving the athletes' climbing speed.

Conceptually, the improvement can be explained by the role of pull-up training in developing upper-body strength, arm muscle endurance, shoulder stability, grip support, and body-control ability. These physical components are essential in speed climbing because athletes must move quickly, pull efficiently, maintain balance, and transfer body position from one hold to another with minimal delay. Although the improvement was relatively small, the result is still meaningful because speed climbing performance is often determined by fractions of a second. Thus, pull-up training can be recommended as one of the specific physical conditioning methods for Speed WR athletes, especially when integrated with technical climbing drills, start reaction training, lower-limb power exercises, and structured periodized coaching programs.

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