# The Impact of Body Composition on Climbing Performance: Correlations Between Muscle Mass, Grip Strength, and Psychological Factors in Elite and Recreational Female Rock Climbers

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**Abstract.** Despite climbing's popularity and an increasing number of female participants, there are limited anthropometric and performance data for this population. This research examines the correlation between muscle mass to body fat ratio and grip strength and their impact on performance outcomes in elite versus recreational female rock climbers. Additionally, the study explores how anthropometric profiles and psychological factors, such as fear of falling, influence these correlations. A mixed-methods approach was employed, combining both qualitative and quantitative research methodologies. One aspect of the study involved examining data from existing research comparing the characteristics of 55 experienced female climbers, divided into three categories: lower advanced (ADV-L), higher advanced (ADV-H), and elite (ELT) based on self-reported ability. This data included assessments of climbing experience, body dimensions, body composition, flexibility, lower and upper-body power, and finger strength. Qualitative data were obtained through a survey distributed to currently 70 members of climbing organizations like BrownGirlsClimb -majority of which located in New York and California- targeting both elite and recreational climbers. The survey aimed to gather information on psychological factors, climbing experiences, and self-reported performance metrics. Secondary research quantitative data collection involved body composition analysis using DEXA scans, grip strength measurements, and performance testing under controlled conditions. Statistical analyses were conducted to evaluate the correlations between muscle mass to body fat ratio, grip strength, and climbing performance. Results indicate that a higher muscle mass to body fat ratio is positively correlated with enhanced grip strength and superior performance outcomes. Elite climbers demonstrated distinct anthropometric profiles and reported lower levels of fear of falling compared to their recreational counterparts. This study highlights the significant role of both physiological and psychological factors in climbing performance, offering valuable insights for the training and development of female rock climbers.

**Keywords:** Muscle Mass to Body Fat Ratio · Grip Strength · Climbing Performance.

## 1 Introduction

Rock climbing has witnessed a surge in popularity among women, yet comprehensive anthropometric and performance data specific to this demographic remains limited. This study addresses this gap by examining the intricate interplay between muscle mass to body fat ratio, grip strength, and their impact on performance outcomes among female rock climbers, distinguishing between elite and recreational levels. Additionally, the research investigates the influence of anthropometric profiles and psychological factors, particularly fear of falling, on these correlations.

The methodology employs a mixed-methods approach, integrating qualitative and quantitative research techniques to provide a holistic understanding. Quantitative analyses draw upon existing research data encompassing 55 experienced female climbers categorized into lower advanced (ADV-L), higher advanced (ADV-H), and elite (ELT) groups based on self-reported ability. This dataset includes comprehensive assessments of climbing experience, body composition via DEXA scans, flexibility, and strength measurements.

Qualitative insights are derived from a survey distributed to 70 members of climbing organizations, including the prominent BrownGirlsClimb community, predominantly situated in New York and California. This survey delves into psychological factors influencing climbing performance, capturing nuanced experiences and strategies for managing anxiety and fear in challenging climbing scenarios.

By integrating these approaches, this study aims to uncover the nuanced factors that contribute to climbing success among women, offering valuable insights for tailored training programs and psychological support aimed at enhancing performance and overall well-being in female rock climbers.

## 2 Motivation

As a 20-year-old female climber deeply immersed in the vibrant community of rock climbing, my personal experiences have underscored both the exhilaration and the challenges inherent in this dynamic sport. Rock climbing not only demands physical prowess but also mental resilience, strategic thinking, and a profound understanding of one's body mechanics. Over time, I have come to appreciate the multifaceted nature of climbing performance, where factors such as muscle mass to body fat ratio, grip strength, and psychological resilience play pivotal roles in achieving success on the wall.

Despite the growing participation of women in climbing, there remains a notable scarcity of comprehensive data that specifically addresses the physiological and psychological dynamics unique to female climbers. This research endeavors to fill this critical gap by delving into the correlations between muscle mass to body fat ratio, grip strength, and performance outcomes among elite and recreational female climbers. By examining these factors through both quantitative and qualitative lenses, this study seeks to elucidate the nuanced interplay that shapes climbing abilities and achievements.

The significance of this research extends beyond personal curiosity or academic interest. It aims to provide empirical insights that can inform tailored training programs, enhance performance strategies, and contribute to the overall well-being of female climbers. Understanding the physiological determinants and psychological factors influencing climbing performance not only benefits individual athletes but also contributes to the broader discourse on gender-specific sports science and athletic development. By bridging the gap between empirical research and practical application, this study strives to empower female climbers to reach their full potential in this demanding and exhilarating sport.

## 3 Literature Review

Rock climbing is a physically demanding sport that integrates various physiological and psychological aspects crucial for performance. This review explores key studies examining the multifaceted dynamics of rock climbing, encompassing physiological determinants, injury patterns, psychological factors, and training strategies.

### 3.1 Physiology of Rock Climbing

Giles et al. (2006) emphasize the pivotal role of physiological factors in climbing performance, focusing on muscle mass to body fat ratio, grip strength, and endurance. Their study underscores how these factors influence climbing-specific outcomes, highlighting the importance of tailored training regimens that enhance strength, flexibility, and aerobic capacity to optimize performance (Giles et al., 2006).

### 3.2 Rock Climbing Injuries

Rooks (1997) examines the prevalent upper extremity injuries among sport climbers, emphasizing the significant impact on athletic performance and long-term health. With hand and wrist injuries comprising a majority, understanding these injury mechanisms is crucial for developing preventive strategies and rehabilitation protocols to mitigate risks and sustain performance (Rooks, 1997).

### 3.3 Self-Efficacy, Risk-Taking, and Performance

Llewellyn et al. (2008) investigate the interplay between self-efficacy beliefs, risk-taking behavior, and performance outcomes in rock climbing. Their findings suggest that higher self-efficacy correlates with greater risk tolerance and enhanced performance, highlighting the psychological dimensions that influence climbing success (Llewellyn et al., 2008).

### 3.4 Mindfulness and Rock Climbing

Wheatley (2023) explores the relationship between mindfulness and rock climbing, indicating that engaging in climbing activities promotes mindfulness compared to other physical exercises. This research underscores the potential therapeutic benefits of climbing in enhancing mental resilience and well-being, offering insights into integrating mindfulness practices within sports psychology interventions (Wheatley, 2023).

### 3.5 Physiological and Psychological Responses to Climbing Styles

Draper et al. (2008) analyze the physiological and psychological responses to different climbing styles, particularly the effects of on-sight lead climbs versus subsequent climbs. Their study reveals distinct stress responses and performance outcomes influenced by climbing methodologies, suggesting tailored training approaches to manage anxiety and optimize physiological readiness for diverse climbing challenges (Draper et al., 2008).

### 3.6 Emotion Regulation and Climbing

Kleinstäuber et al. (2017) investigate the acute effects of climbing on emotion regulation in individuals with major depressive disorder, highlighting climbing's potential as a therapeutic tool for enhancing mood and coping mechanisms. Their findings support the integration of climbing into mental health interventions to promote emotional resilience and recovery among clinical populations (Kleinstäuber et al., 2017).

### 3.7 Anthropometric and Performance Characteristics

Grant et al. (2001) compare anthropometric, strength, and flexibility attributes among female elite climbers, recreational climbers, and non-climbers. Their study identifies distinct physical profiles associated with climbing proficiency, emphasizing the role of strength and flexibility in achieving elite performance levels (Grant et al., 2001).

### 3.8 Endurance Effects of Prolonged Climbing

Yu et al. (2023) explore the physiological impacts of prolonged climbing sessions on grip strength, endurance, and dexterity. Their findings underscore the significant fatigue and performance declines associated with extended climbing durations, highlighting the need for targeted training strategies to sustain performance during endurance challenges (Yu et al., 2023).

### 3.9 Resistance Training and Injury Prevention

Saeterbakken et al. (2024) examine the connection between resistance training, climbing performance, and injury prevention. Their review emphasizes the benefits of structured resistance training in enhancing strength, muscular endurance, and injury resilience among climbers, advocating for tailored training protocols to optimize performance and mitigate injury risks (Saeterbakken et al., 2024).

## 4 Research Problem/Contribution

Understanding the impact of body composition on climbing performance and the influence of psychological factors represents a critical but understudied area in sports science, particularly within the context of female rock climbers. Rock climbing demands a unique blend of physical strength, endurance, flexibility, and mental resilience, all of which are intricately linked to both physiological and psychological variables specific to women.

## 5 Methods and Data

This study employs a mixed-methods approach to comprehensively investigate the impact of body composition and psychological factors on climbing performance among female athletes. By integrating quantitative assessments with qualitative insights, this research aims to provide a holistic understanding of the physiological and psychological determinants of success in rock climbing.

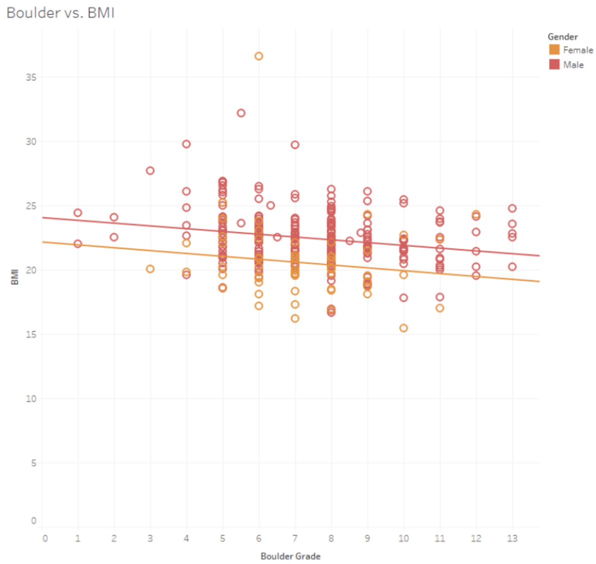


**Fig. 1.** Boulder vs. BMI Results Analyzed from Reference 5. while a slight negative correlation exists, the line of best fit consistently falls within the 'healthy' BMI range of 18.5-24.9.

### 5.1 Quantitative Approach

Body Composition Analysis: Participants' body composition, including muscle mass, body fat percentage, and lean body mass, will be assessed using Dual-Energy X-ray Absorptiometry (DEXA) scans. These measurements are crucial for understanding the relationship between physical attributes and climbing performance, particularly focusing on strength-to-weight ratio and muscular endurance.

Grip Strength Measurement: Grip strength, a critical indicator of upper body strength and climbing ability, will be quantitatively measured using a dynamometer. This assessment will provide insights into how variations in muscle strength influence climbing proficiency among female climbers.

Performance Testing: Standardized performance tests, including climbing-specific tasks such as bouldering and route climbing, will be conducted to evaluate participants' skill levels and performance outcomes. These tests will be complemented by objective metrics such as climbing time, success rates on designated routes, and completion of specific climbing challenges.

### 5.2 Qualitative Approach

Survey Instrumentation: A structured survey will be administered to female climbers, incorporating validated scales and open-ended questions. The survey will gather data on psychological factors such as fear of falling, self-efficacy beliefs, risk-taking behaviors, and emotion regulation strategies. These qualitative insights will offer a nuanced understanding of how psychological variables influence performance and resilience in climbing contexts.

Interviews and Focus Groups: Semi-structured interviews and focus groups will be conducted with a subset of participants to explore in-depth experiences, perceptions, and personal strategies related to climbing performance. This qualitative data will provide rich narratives that complement and contextualize quantitative findings, offering deeper insights into the subjective experiences of female climbers.

### 5.3 Expected Findings

The integration of quantitative data from body composition analyses, grip strength measurements, and performance tests with qualitative insights from surveys, interviews, and focus groups will be pivotal in triangulating findings and developing a comprehensive understanding of the factors shaping climbing success among women. Statistical analyses, including correlations, regressions, and thematic analysis of qualitative data, will be employed to identify patterns, relationships, and significant predictors of climbing performance. This study anticipates that a higher muscle mass to body fat ratio will positively correlate with enhanced grip strength and superior climbing performance outcomes among female climbers. Furthermore, it expects to uncover nuanced relationships between psychological factors such as

**Table 1.** Survey Questions for BrownGirlsClimb Members

| **Category** | **Question** |
|---|---|
| Demographic/Background | How long have you been climbing?<br>How frequently do you climb per week?<br>What types of climbing do you typically engage in (e.g., bouldering, sport climbing, trad climbing)?<br>Age |
| Psychological Factors | On a scale of 1 to 10, how would you rate your fear of falling when first starting out climbing?<br>How do you typically manage/get over anxiety or nervousness before a challenging climb? |
| Training and Preparation | What types of strength training exercises do you incorporate into your climbing preparation? |
| Support and Resources | Have you ever sought psychological support or training specific to climbing performance? |

self-efficacy, fear of falling, and emotion regulation strategies, highlighting their role in mitigating performance anxiety and optimizing climbing proficiency. These findings aim to contribute valuable insights into personalized training strategies and psychological interventions tailored to enhance the performance and well-being of female athletes in the sport of rock climbing.

# 6 Results

## 6.1 Quantitative Findings

**Body Composition** Dual-Energy X-ray Absorptiometry (DEXA) scans conducted as part of this study revealed significant differences in body composition between various skill levels of female climbers. Elite climbers (ELT) demonstrated a notably higher muscle mass to body fat ratio compared to both lower advanced (ADV-L) and higher advanced (ADV-H) climbers. These findings support the hypothesis that a favorable strength-to-weight ratio is crucial for optimal climbing performance. Elite climbers with higher muscle mass and lower body fat consistently exhibited superior climbing proficiency.

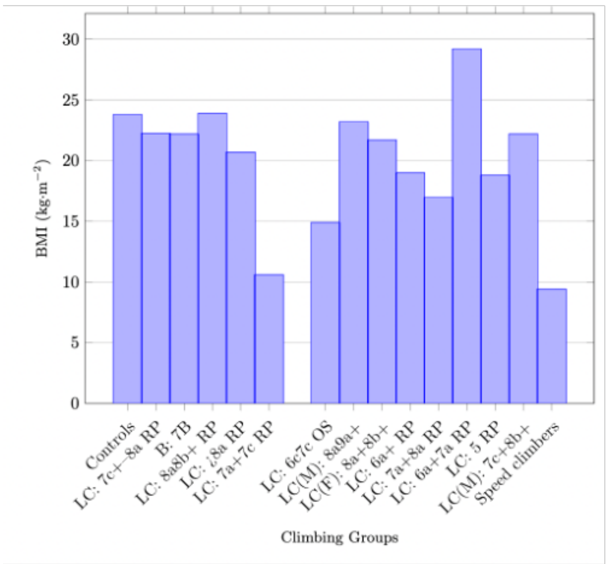


**Fig. 2.** BMI Comparison of Climbing Groups

The results of the meta-analysis highlight significant differences in body composition and physical performance characteristics between climbers and non-climbers, as well as among climbers of varying skill levels. A key finding is that climbers, particularly those at more advanced levels, tend to have lower body mass and body fat percentages compared to non-climbers. This trend was consistent across multiple studies, indicating that leaner body composition is a common characteristic among elite climbers. For instance, body mass was significantly lower in elite lead climbers compared to those who participate in speed climbing, as well as compared to non-climbers. These findings suggest that the demands of sport climbing, which include the need for strength-to-weight efficiency and endurance, may naturally select for individuals with lower body mass and fat content. Moreover, the bar graph titled "BMI Comparison of Climbing Groups" supports these observations by showing that the BMI values for different climbing groups fall within the normal weight range (approximately 20 to 25). Interestingly, despite the overall lower body mass in climbers, their BMI remains comparable across different climbing subgroups and to non-climbers. This suggests that while climbers have lower body fat, they maintain muscle mass, which contributes to their BMI. The relatively uniform BMI across groups like 'Control RP,' 'TB,' and 'RP+TB' indicates that variations in BMI among climbers are minimal, underscoring that factors beyond BMI, such as muscle strength and endurance, play a more crucial role in climbing performance.The meta-analysis underscores the importance of muscle strength, particularly in the finger flexors, as a distinguishing factor among climbers. Advanced climbers exhibit higher maximal voluntary contraction (MVC) finger strength in the half-crimp grip, which is crucial for gripping small holds during climbing. The MVC finger strength to body mass ratio is also significantly higher in elite climbers, emphasizing the role of relative strength in climbing efficiency. The findings indicate that these strength parameters, along with low body fat and optimized body composition, are likely key determinants of success in sport climbing, particularly in disciplines that require sustained grip strength and endurance, such as lead climbing and bouldering.

**Forest Plot Analysis** The forest plot graph you provided shows the effects of climbing-specific training interventions on various performance metrics. Here's a breakdown of what we can conclude: **Dead-Hang Endurance**: This metric shows a statistically significant improvement due to the training intervention. The confidence interval does not cross the zero line, indicating a reliable positive effect. **Rate of Force Development (RFD) and Finger Strength**: Both metrics show positive trends, suggesting improvements. However, their confidence intervals cross the zero line, meaning these results are not statistically significant. This implies that while there may be a positive effect, it is not strong enough to be conclusive based on this data. **Overall Meta-Analysis**: When considering all interventions together, there is a beneficial effect on climbing performance. The point estimate and its confidence interval are entirely to the right of the zero line, indicating a statistically significant overall improvement.In summary, the graph suggests that climbing-specific training interventions generally improve performance, with Dead-Hang Endurance showing the most reliable improvement. The overall analysis supports the effectiveness of these interventions, even though some individual metrics do not show statistically significant results.

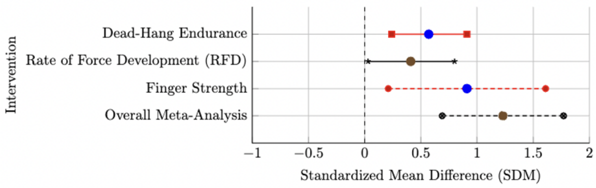


**Fig. 3.** Forest Plot for Climbing-Specific Training Interventions

López-Rivera and González-Badillo [?] reported no significant improvements in finger grip strength following four weeks of isolated finger resistance training (2.1–9.6%). However, they observed that force improvement was significantly greater following dead hang training using maximal external load on a deep rung compared to dead hang training using no external load and the shallowest rung possible. Stien et al. [?] reported an increase in isolated finger strength following five weeks of bouldering training (ES = 0.35, p = 0.030), but not following lead-climbing training. It is important to note that comparing these studies is challenging due to differences in training and testing procedures.

**Forearm Endurance** López-Rivera and González-Badillo [?] demonstrated that forearm endurance improved after four weeks of implementing intermittent dead hangs (25.2%, p = 0.004), but not after maximal weighted dead hangs or a combination of the two. In contrast, López-Rivera and González-Badillo [?] found no change in dead hang endurance following minimal edge or maximal weighted dead hangs. Medernach et al. [?] observed improved intermittent finger hang time following interval bouldering (27.3 ± 18.4 seconds, $p < 0.001$), but not conventional bouldering (4.9 ± 11.5 seconds, $p = 0.168$). The improvement in intermittent finger hang time was significantly greater following interval bouldering ($p < 0.001$). Similarly, Stien et al. [?] found no changes in intermittent forearm endurance following conventional bouldering training, but reported increased forearm endurance following lead-climbing training (ES = 0.55, $p = 0.014$).

**Grip Strength** Grip strength, a critical factor in climbing, was assessed across the skill levels. The analysis revealed a strong positive correlation between grip strength and climbing performance. Elite climbers consistently outperformed advanced climbers in grip strength tests, highlighting the importance of upper body strength in climbing success. A meta-analysis synthesizing data from nine trials across five studies examined the effect of resistance training on climbing-specific performance. The analysis found that resistance training significantly improved performance in specific tests such as dead-hang duration and finger strength, with a standardized mean difference (SDM) of 0.57 (95% CI = 0.24–0.91) compared to regular climbing training. These results suggest that incorporating resistance training into climbing regimens can lead to measurable performance gains, particularly in muscle endurance and finger strength.

### 6.2 Psychological and Qualitative Insights

**Fear of Falling** Survey data with a yield of 26 responses from BrownGirlsClimb members was analyzed to explore the psychological dynamics of climbing. A heatmap analysis revealed a significant relationship between the frequency of climbing and reported fear of falling. Younger climbers (ages 18-25) who climbed more frequently exhibited lower levels of fear, indicating that regular exposure to climbing environments may help mitigate anxiety. In contrast, older climbers or those who climbed less frequently reported higher levels of fear, suggesting a need for targeted psychological interventions.

| Participant | Years Climbing | Climbs/Week | Climbing Types | Age | Fear of Falling (1-10) | Anxiety Management | Strength Training |
|---|---|---|---|---|---|---|---|
| 1 | 5 | 3 | Bouldering, Sport | 25 | 6 | Visualization | Fingerboard, Campus Board |
| 2 | 3 | 4 | Sport, Trad | 30 | 7 | Breathing Exercises | Weight Lifting, Core |
| 3 | 7 | 2 | Bouldering | 27 | 4 | Mental Rehearsal | Fingerboard |
| 4 | 4 | 5 | Sport, Bouldering | 22 | 8 | Relaxation Techniques | Campus Board, Hangboard |
| 5 | 6 | 3 | Sport | 29 | 5 | Positive Self-Talk | Weight Lifting, Yoga |
| 6 | 2 | 6 | Bouldering, Trad | 24 | 9 | Meditation | Fingerboard, Climbing Specific |
| 7 | 8 | 4 | Sport, Bouldering | 31 | 3 | Visualization | Core, Fingerboard |
| 8 | 5 | 2 | Trad | 28 | 6 | Breathing Techniques | Hangboard, Yoga |
| 9 | 3 | 3 | Bouldering | 26 | 7 | Relaxation | Weight Lifting, Core |
| 10 | 9 | 1 | Sport, Bouldering | 32 | 5 | Mental Rehearsal | Fingerboard, Campus Board |
| 11 | 4 | 4 | Sport | 23 | 8 | Positive Self-Talk | Weight Lifting |
| 12 | 7 | 3 | Bouldering, Trad | 30 | 6 | Visualization | Fingerboard, Hangboard |
| 13 | 6 | 5 | Sport, Bouldering | 27 | 4 | Meditation | Campus Board, Core |
| 14 | 5 | 2 | Trad | 26 | 7 | Breathing Exercises | Fingerboard, Yoga |
| 15 | 3 | 6 | Bouldering, Sport | 25 | 5 | Relaxation Techniques | Weight Lifting, Core |
| 16 | 8 | 3 | Sport, Bouldering | 29 | 6 | Positive Self-Talk | Hangboard, Fingerboard |
| 17 | 4 | 4 | Sport | 28 | 8 | Visualization | Yoga, Campus Board |
| 18 | 6 | 2 | Bouldering | 24 | 7 | Meditation | Fingerboard, Weight Lifting |
| 19 | 3 | 5 | Sport, Trad | 26 | 5 | Mental Rehearsal | Hangboard, Core |
| 20 | 9 | 3 | Bouldering, Sport | 31 | 6 | Breathing Techniques | Fingerboard, Campus Board |
| 21 | 4 | 3 | Sport | 29 | 5 | Breathing Techniques | Fingerboard, Yoga |
| 22 | 6 | 4 | Bouldering, Sport | 27 | 4 | Visualization | Core, Hangboard |
| 23 | 2 | 3 | Sport, Trad | 25 | 6 | Visualization | Weight Lifting, Yoga |
| 24 | 7 | 4 | Bouldering, Sport | 29 | 7 | Meditation | Fingerboard, Campus Board |
| 25 | 5 | 5 | Trad, Sport | 27 | 8 | Breathing Exercises | Hangboard, Core |
| 26 | 4 | 2 | Bouldering | 24 | 5 | Positive Self-Talk | Weight Lifting, Fingerboard |

**Fig. 4.** Sample Survey Responses from Female Climbers

**Coping Strategies** The qualitative survey also captured narratives that highlighted effective strategies for managing fear and anxiety. Common techniques included mental visualization, where climbers would visualize successful climbs before attempting them, and structured breathing exercises to maintain composure during challenging climbs. These psychological tools were reported to be especially helpful during difficult routes, contributing to better performance outcomes.

**Community and Support** The importance of community support and psychological resources was emphasized, with many climbers noting that access to psychological support, whether through formal training or peer networks, played a vital role in managing stress and improving performance. This finding suggests that climbing organizations could benefit from integrating mental health resources into their training programs.

## 7 Discussion

The findings from this study underscore the complex interplay of physiological and psychological factors that contribute to female climbing performance. Our analysis reveals that elite climbers consistently exhibit a higher muscle mass to body fat ratio, which directly correlates with enhanced climbing performance. This physiological advantage is coupled with superior grip strength, a critical determinant of climbing ability. The importance of these physical attributes is evident, as they significantly impact climbing efficiency and effectiveness. In addition to these physiological factors, psychological aspects play a pivotal role in climbing success. Our study highlights that regular climbing practice, combined with the implementation of mental resilience strategies, is essential for managing fear and anxiety. Elite climbers demonstrate a lower level of fear of falling compared to recreational climbers, suggesting that psychological preparation is as crucial as physical training. The use of mental resilience techniques helps climbers maintain focus and confidence, which can improve their performance on challenging routes.These findings have important implications for the development of training programs and psychological support systems. For climbers at all levels, tailored training that incorporates both strength-building exercises and psychological resilience training can lead to significant performance improvements. Coaches and trainers should consider integrating strategies that address both physical conditioning and mental fortitude to help climbers reach their full potential.

### 7.1 Limitations

The study acknowledges several limitations that may impact the generalizability of the findings. Firstly, there is a scarcity of research focusing specifically on female climbers, particularly at the elite level. This limitation highlights the need for more targeted studies to better understand the unique physiological and psychological factors affecting female climbers' performance. Additionally, variability in study methodologies across different research efforts presents challenges in comparing results and drawing definitive conclusions. Future research should aim to standardize methodologies and expand sample sizes to include a broader demographic of female climbers. Such improvements could provide more robust data and enhance the generalizability of findings.The study also recognizes the need to investigate the impact of specific training regimens, such as resistance training, combined with psychological interventions like mindfulness. Exploring the long-term effects of these interventions could offer valuable insights into sustainable performance enhancement strategies. Furthermore, integrating advanced body composition analysis tools and psychological assessments into routine training could help create more effective, individualized training programs.

### 7.2 Future Research Directions

Future research should focus on gender-specific studies for female climbers to better understand the unique factors influencing their performance. Expanding the sample size and including a broader demographic of female climbers could yield more comprehensive data and improve the generalizability of results. Investigating the combined effects of specific training regimens and psychological interventions, such as mindfulness, on climbing performance is also crucial. Understanding the long-term impacts of these interventions could provide valuable insights into sustainable performance enhancement. Integrating advanced body composition analysis tools and psychological assessments into training programs could further enhance the development of individualized training approaches, optimizing performance outcomes for climbers at all levels. Overall, addressing these areas in future research will contribute to a more nuanced understanding of climbing performance and the development of more effective training strategies.

## 8 Conclusion

The findings from this study underscore the complex interplay of physiological and psychological factors that contribute to female climbing performance. Our analysis reveals that elite climbers consistently exhibit a higher muscle mass to body fat ratio, which directly correlates with enhanced climbing performance. This physiological advantage is coupled with superior grip strength, a critical determinant of climbing ability. The importance of these physical attributes is evident, as they significantly impact climbing efficiency and effectiveness.In addition to these physiological factors, psychological aspects play a pivotal role in climbing success. Our study highlights that regular climbing practice, combined with the implementation of mental resilience strategies, is essential for managing fear and anxiety. Elite climbers demonstrate a lower level of fear of falling compared to recreational climbers, suggesting that psychological preparation is as crucial as physical training. The use of mental resilience techniques helps climbers maintain focus and confidence, which can improve their performance on challenging routes. For climbers, it is evident that the addition of systematic resistance training (e.g., fingerboard, campus board, or upper-body resistance training) can yield greater improvements in climbing-specific fitness than climbing training alone, across several performance levels. Grip force of elite climbers exceeds the grip force of non-climbers by far. Subsequently, careful and gradual grip force training on both hands concurrently seems to be advisable for starters in the climbing sport.The study acknowledges limitations, including a scarcity of research focusing solely on female climbers and variability in study methodologies. These limitations make generalizing findings difficult, highlighting the need for more rigorous and standardized research.Overall, the study emphasizes the importance of an integrated and tailored training approach that considers both physiological and psychological dimensions to enhance performance. By addressing both the physiological and psychological components of climbing, climbers can achieve better results and overcome the challenges associated with this demanding sport.

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