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ROCK CLIMBING AS A HEALTH-PROMOTING ACTIVITY: BENEFITS AND RISKS ACROSS POPULATIONS

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ABSTRACT

Rock climbing has been steadily gaining popularity worldwide, particularly after its inclusion in the Olympic Games in 2020. As a physically and mentally demanding activity, it uniquely combines strength, endurance, balance, coordination, and problem-solving. This review aims to explore the physical and mental health benefits of recreational rock climbing, with a focus on outdoor settings, as well as the associated risk of injury. Current evidence indicates that climbing can enhance muscular strength, cardiovascular fitness, and body composition, especially among youth and young adults. Additionally, it has been linked to psychological benefits such as improved mood, stress relief, and greater overall well-being. Outdoor climbing, in particular, is associated with higher levels of enjoyment and satisfaction compared to indoor activity, which may promote long-term participation. However, climbing also presents a risk of injury, particularly chronic overuse injuries in the upper limbs, with elite climbers experiencing higher injury rates. Despite these risks, the overall findings support the role of rock climbing as a multidimensional, health-promoting activity. Further research is needed to better understand injury prevention and the long-term health impacts of climbing across different populations.

KEYWORDS

Rock Climbing, Physical Activity, Well-Being, Mental Health

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Introduction.

In recent years, climbing has gained increasing popularity as both a recreational activity and a competitive sport. This multifaceted discipline, encompassing indoor and outdoor formats such as bouldering, sport climbing, and traditional climbing, has been recognized not only for its physical demands but also for its potential psychosocial and cognitive benefits. As physical inactivity continues to pose a major global health concern (Bull et al., 2020), climbing emerges as an engaging form of exercise that supports adherence through enjoyment and challenge, especially among youth and young adults (Guthold et al., 2018; Li et al., 2018).

The physical advantages of climbing are well-documented. Research indicates significant improvements in muscular strength, body composition, and insulin sensitivity following climbing interventions, even among overweight or sedentary populations (Balas et al., 2009; Gaesser, Angadi, 2021). Climbing's full-body engagement, particularly its emphasis on grip and upper-body strength, contributes to enhanced functional fitness and metabolic health (Jones, Asghar, Llewellyn, 2008; Woollings et al., 2015). Beyond its somatic impact, climbing may also foster psychological resilience and emotional wellbeing. Increased physical activity levels have been associated with greater happiness in the hours that follow, while higher levels of happiness also tend to lead to more physical activity shortly afterward. (van Woudenberg et al. 2020)Studies suggest participation in climbing can reduce symptoms of anxiety and depression, improve self-efficacy, and enhance overall mood, particularly in youth and clinical populations (Chen et al., 2025; Gürer et al., 2024; Luttenberger et al., 2015).

An emerging area of interest is the relationship between climbing and cognitive performance. Due to the complex and problem-solving nature of the activity, climbers must continuously adapt strategies, plan movements, and maintain focus under stress. Recent findings suggest associations between climbing performance and working memory capacity, as well as broader executive functions (Garrido-Palomino et al., 2024; Marczak et al., 2018). These cognitive demands position climbing as a potentially beneficial intervention not only for physical fitness, but also for neurocognitive health and development.

Despite its increasing popularity and documented benefits, climbing also presents injury risks, particularly to the upper limbs. Understanding the epidemiology and mechanisms of these injuries is crucial

for developing effective prevention strategies, especially as climbing becomes more accessible to novice participants (Woollings et al., 2015; Jones, Asghar, Llewellyn, 2008).

This review aims to synthesize current evidence on the physical, psychological, and cognitive benefits of climbing, as well as to address potential injury risks. By examining climbing through a multidisciplinary lens, we highlight its potential as a comprehensive health-promoting activity suitable for diverse populations

Advantages of body composition // Muscle Mass, Strength, and Fat Distribution: Health Impacts of Rock Climbing

Rock climbing enhance handgrip, strength, lower limb power and muscular endurance (Li et al. 2018). Muscular fitness is strongly associated with a reduced risk of chronic disease and all-cause mortality, and this relationship appears to be independent of body mass index (BMI). Meta-analyses have shown that greater handgrip and knee-extension strength, as well as participation in strength training, correlate with lower mortality risk (Gaesser, Angadi, 2021). In metabolically healthy young men with overweight or obesity who are at risk for type 2 diabetes mellitus (T2DM), higher muscle mass is linked to better insulin sensitivity, regardless of the presence of harmful fat depots. This suggests that greater muscle mass may offer protective metabolic effects regardless of body fat distribution. Assessing muscle mass in relation to individualized norms—accounting for sex, age, weight, and height—can serve as a valuable tool in identifying those at higher risk of developing T2DM due to low muscle mass, even in the absence of current metabolic abnormalities (Haines et al. 2019).

Moreover a review by Siegel, Fryer (2015) found that while active youth climbers generally had lower body fat than non-climbers, short-term training interventions (8–12 weeks) did not significantly reduce total fat mass. Nonetheless, reductions in localized skinfold thickness (e.g. biceps, supraspinale) and associations between higher climbing volume and lower fat percentage suggest that climbing may contribute to improved body composition over time, particularly with longer duration and higher intensity training.

Injury Risk and Prevention

While rock climbing offers numerous physical and mental health benefits, it may also be an injury promoting activity. A review by Jones, Asghar, Llewellyn (2008) found that 50% of surveyed climbers (n = 101) reported sustaining at least one injury in the previous 12 months, totaling 275 distinct anatomical injuries. Of these, 10% were acute injuries caused by falls, 33% were chronic overuse injuries, and 28% resulted from strenuous climbing movements. Although fall-related injuries were less frequent, they included incidents such as abrasions and trauma, while overuse injuries—often affecting tendons and joints—were the most prevalent. A cross-sectional study conducted on 528 experienced climbers found that over 65% reported at least one climbing-related hand injury (CRIH) in the past three years, with tendon injuries being the most common. Higher climbing level and BMI ≥21 were significantly associated with increased injury risk, likely due to the greater strain placed on fingers and tendons when using smaller grips and more advanced techniques (Lion et al. 2015).

A higher injury prevalence among elite climbers is also confirmed by a study examining injury rates in youth climbers. It found that 63% of participants reported at least one new climbing-related injury within the previous 12 months, with 31% experiencing multiple injuries. Notably, 82% of elite climbers sustained injuries, with an incidence rate of 168 injuries per 100 participants per year, compared to 48% of recreational climbers, who had a lower incidence rate of 88 per 100 participants per year (Woollings et al. 2014). These findings further support earlier studies indicating that injuries occur more frequently among elite climbers. Moreover, while overall injury patterns are similar across age groups, older climbers show a slightly higher risk of degenerative conditions, such as shoulder impingement or finger osteoarthritis. Therefore, age-appropriate, sport-specific medical supervision and education are recommended to support injury prevention in this population.(Lutter et al. 2019) Additionally, a warm-up consisting of approximately 100 climbing moves has been shown to reduce the risk of finger injuries by improving tendon movement and distributing load more evenly along the flexor tendon sheath. (Schweizer 2001)

Role of Outdoor Climbing

A systematic review found that participating in physical activity in outdoor natural environments was associated with greater feelings of enjoyment and satisfaction compared to indoor activity. Participants also reported a stronger intention to repeat the activity, suggesting that outdoor environments may enhance long-term engagement in physical exercise (Thompson Coon et al. 2011).

Evidence also shows that outdoor sports contribute to a wide range of physical and mental health benefits while also supporting long-term engagement in physical activity. Due to their accessibility and broad appeal, outdoor sports offer inclusive advantages for diverse populations. Additionally, their impact extends beyond individual well-being, promoting social and personal development as well as community-level benefits. From a policy perspective, investments in outdoor sports are considered highly cost-effective, making them valuable for public health and social planning (Eigenschenk et al. 2019).

These findings highlight the potential of outdoor physical activity to support mental well-being, including feelings of revitalization and calmness.

Psychological and cognitive benefits

Adolescent rock climbers showed significantly lower levels of Separation Anxiety Disorder and Generalized Anxiety Disorder compared to non-athletes. While other mental health scores were also lower, these differences were not statistically significant. A moderate correlation was found between longer sport participation and reduced symptoms of SAD, OCD, and panic disorder (Gürer et al. 2024). Supporting these findings, a survey of 748 individuals identified depression and anxiety as the most common issues, with 73.3% of respondents reporting that rock climbing was more beneficial than medication, and 64.8% finding it more helpful than therapy (Chen et al. 2025). An 8-week bouldering psychotherapy program conducted in groups of 10 to 14 participants was found to reduce self-reported depressive symptoms by an average of 6 points on the BDI-II scale (Luttenberger et al. 2015). Compared to the control group, climbers (with at least five years of regular climbing experience) demonstrated better memory and spatial recall, and completed tasks more quickly. The groups also differed in the strategies used to solve the tasks. Overall, sport climbers exhibited enhanced neurocognitive functioning, characterized by quicker processing and identification of tactile information, as well as superior spatial and tactile perception and movement-related memory (Marczak et. at 2018).

Climbing Enhances Strength and Endurance

Higher climbing volume in youth leads to a significantly greater improvement in relative grip strength, with gains up to nine times higher compared to those with lower climbing exposure. This finding highlights the strong positive effect of indoor climbing on upper body strength development in young individuals (Baláš et al. 2009).

Similarly evidence from a meta-analysis indicates that rock climbing can significantly enhance multiple components of physical fitness in young adults. Across nine studies involving 149 participants aged 18 to 38 years, climbing was associated with improvements in VO_2 max, handgrip strength, lower limb power, vertical jump, muscular endurance (push-ups, pull-ups, sit-ups), and flexibility (Li et al. 2018). These findings suggest that climbing offers a comprehensive physical stimulus, particularly for college-aged individuals. The authors also noted that long-term participation may yield even greater benefits.

Discussion

The findings summarized in this review indicate that rock climbing is a highly beneficial form of physical activity that contributes to improvements in physical fitness, mental well-being, and cognitive function. Climbing challenges both the body and the mind, offering a unique health-promoting experience, especially in outdoor environments. Studies such as those by Li et al. (2018) and Baláš et al. (2009) consistently show that climbing improves VO_2 max, grip strength, muscular endurance, and flexibility, particularly among youth and college students. These physical benefits are further supported by evidence indicating improved body composition and insulin sensitivity in overweight individuals who engage in climbing (Gaesser, Angadi, 2021).

Beyond physical health, climbing is strongly associated with psychological well-being. Several studies highlight reduced symptoms of anxiety and depression following regular climbing participation (Gürer et al., 2024; Luttenberger et al., 2015). Outdoor climbing, in particular, appears to offer enhanced psychological benefits compared to indoor settings, likely due to increased exposure to natural environments and greater perceived enjoyment (Thompson Coon et al., 2011; Eigenschenk et al., 2019). The short-term reciprocal relationship between physical activity and happiness in adolescents (van Woudenberg et al., 2020) reinforces the idea that activities like climbing may positively influence emotional states and foster long-term physical activity engagement.

Emerging evidence also suggests that climbing may enhance cognitive functioning. The activity requires constant decision-making, spatial awareness, and problem-solving, which can translate into improved executive function and working memory (Garrido-Palomino et al., 2024; Marczak et al., 2018). These findings

open promising avenues for using climbing as a cognitive training or therapeutic tool, especially in youth and clinical populations.

Despite its benefits, climbing carries an inherent risk of injury, particularly chronic overuse injuries in the upper limbs. Studies show a higher injury prevalence among elite climbers and those with higher BMI, with tendons and finger pulleys being the most affected structures (Jones, Asghar, Llewellyn, 2008; Lion et al., 2015; Woollings et al., 2014). However, many injuries can be avoided with proper warm-up techniques (Schweizer, 2001).

Taken together, the reviewed literature supports rock climbing as a multidimensional activity that can promote physical, mental, and cognitive health. Nonetheless, future research should further explore injury prevention strategies and the long-term effects of climbing in different populations and settings.

Conclusions

This review highlights recreational rock climbing as a multifaceted activity that offers significant physical, psychological, and cognitive benefits. Climbing improves muscular strength, endurance, flexibility, and cardiovascular health—components that are vital for both performance and long-term health. These adaptations are especially valuable in combating sedentary lifestyles and metabolic disorders.

Beyond physical fitness, climbing has shown potential in enhancing mental well-being by reducing symptoms of anxiety and depression and promoting mood regulation. The combination of physical exertion and cognitive engagement appears to support both emotional balance and neurocognitive performance. Outdoor climbing, in particular, may amplify these effects by fostering enjoyment, motivation, and sustained engagement through interaction with natural environments.

However, these benefits come with an increased risk of injury, particularly chronic overuse injuries among experienced, elite and older climbers. This highlights the need for education and injury prevention strategies to ensure safe participation.

Although the current body of evidence is promising, it remains limited by small, homogenous samples and a lack of long-term studies. Future research should aim to include more diverse populations and explore the sustained health impacts of climbing across different settings and experience levels.

In summary, with proper safety measures and guidance, recreational rock climbing—especially in outdoor contexts—can serve as a powerful, engaging tool for promoting both physical and mental health across a broad range of populations.

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