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Cracks in the Climb: Health Problems Faced in Bouldering

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ABSTRACT

Bouldering is a distinctive discipline within the broader realm of climbing sports, characterized by its dynamic nature and the absence of ropes, which leads to a higher frequency of falls. This climbing style has seen a surge in global popularity, with an increasing number of indoor bouldering facilities emerging worldwide. Bouldering, regarded by some authors as parkour adapted to vertical terrain, involves more dynamic movements than other climbing disciplines. This contributes to a considerable risk of overuse injuries in specific areas of the upper limbs and traumatic injuries in the lower limbs. Furthermore, bouldering, like other climbing disciplines, presents a risk of nail damage and subsequent fungal infections.

In addition to examining injury risks, this review also touches on the issue of airborne chalk dust exposure, a well-documented concern in enclosed spaces during indoor bouldering. Our study aims to consolidate the available information, highlighting the potential health hazards of indoor bouldering, raising awareness of these risks, and underscoring the need for further research to better understand and mitigate these dangers.

Keywords: climbing, bouldering, indoor climbing, sports injury, traumatic injury, overuse injury, onychomycosis, climbing chalk, magnesia alba, dust exposure, respiratory tract, asthma

Introduction

Climbing is a diverse sport with the primary goal of reaching the highest point of a rock wall or completing a designated route. The sport includes various disciplines such as sport climbing (which encompasses lead climbing, speed climbing, and bouldering) as well as traditional climbing. In recent decades, climbing has gained worldwide popularity, with approximately 9 million people participating in the USA alone. This increase in climbers is largely due to the growing availability of climbing venues [1]. Sport climbing was also included in the Olympic programs for Tokyo 2020 and Paris 2024 [2] [3].

Bouldering is a type of rock climbing that emphasizes tackling short, demanding routes called boulder problems. Unlike traditional climbing, it does not require ropes or harnesses and can be practiced in both indoor gyms and outdoor locations. The maximum height for bouldering is typically around 4.5 meters.

The unique techniques and movement patterns used in bouldering frequently lead to injuries specific to this climbing discipline, both acute and chronic [4] [5]. These injuries can lead patients to consult orthopedic surgeons or physical therapists and may also be linked to nail injuries that increase the risk of fungal infections [5] [6]. Another concern involves the use of magnesia alba by athletes to enhance grip between their hands and the holds. The powdered form, which is widely used, generates airborne dust during application, leading to air pollution [7]. This issue primarily affects indoor climbing gyms, with the highest concentration of airborne particles observed in bouldering facilities [8]. This review article highlights the most common health issues affecting climbers, with a particular focus on those prevalent in indoor bouldering.

Climbing injuries

As bouldering has developed, it has grown more acrobatic, necessitating increased strength and gymnastic precision. It is often compared to parkour but adapted to vertical terrain [1]. The discipline encompasses three distinct activities where injuries can occur: 1) climbing the boulder itself, 2) falling, and 3) spotting others while they boulder, particularly in outdoor settings. Among these, injuries to the limbs are the most commonly experienced [9]. Notably,

Kovářová et al. [1] highlight that injuries linked to bouldering typically require the most intensive treatment and results in the highest ratio of hospitalizations lasting over five days.

In the study by Backe et al. [10], injuries sustained by climbers were classified into two categories: overuse injuries, which comprised 93% of the cases, and traumatic injuries, which accounted for 7%. The most common anatomical locations for overuse injuries were the fingers and wrists. Of the traumatic injuries, 50% involved the lower extremities (foot, toe and ankle), while upper extremities accounted for 36%. Injuries tend to affect different body parts depending on the climbing discipline. In bouldering, injuries to the hand and thumb, wrist, elbow, and ankle are more common, with medial epicondylopathy being the most typical elbow overuse injury. It develops from repeated stress that leads to incomplete healing and scarring, causing tendinopathy at the common flexor origin [1] [11]. The strain placed on elbows and shoulders during climbing is as intense as, or even exceeds, that in gymnastics on rings. Meanwhile, the pressure exerted on the fingers is far greater than in any other sport or activity [12]. As a result, climbing leads to mechanical adaptations within the cortical bones, soft tissues, and cartilage of athletes' fingers. Evidence from the literature suggests that both these mechanical adaptations and the size of osteophytes increase throughout an athlete's career [13]. Research by Josephsen et al. [9] identified a markedly higher risk of finger injuries during outdoor bouldering, while indoor bouldering posed a greater risk of injuries related to falls.

Because ropes are not utilized, falling to the ground is a frequent occurrence in bouldering and the primary equipment for fall protection is the use of mattresses or crash pads [14]. Zieliński et al. [15] found that bouldering on an artificial wall has an injury rate (requiring specialized treatment) of 1.66 per 1,000 climbing hours. Remarkably, all documented incidents were attributed to falls from a height.

In a five-year prospective analysis of 515,337 indoor climbing wall visits conducted by Schöffl et al. [16], most bouldering injuries were caused by falls onto the mat. These falls often led to sprains and dislocations. This study focused exclusively on injuries that necessitated immediate medical intervention, either from a paramedic or an on-site doctor, including all instances where an ambulance was called. Chronic overuse injuries were not included in the analysis.

Although some of the literature does not emphasize injuries in this area, Lutter et al. [14] investigated the mechanisms of injury (MOI) of acute knee injuries in climbers. They identified four main types of MOIs: high step positions, drop knee positions, heel hook techniques, and uncontrolled landings during falls. Their study found that most knee injuries (69%) occurred during bouldering, despite both research locations being in areas renowned for outdoor rope climbing. The most common structural damage to the knee was a medial meniscal tear, identified in 28.6% of all cases. Iliotibial band sprains occurred in 19.5% of the injuries, and these sprains were solely attributed to heel hook positions.

An important consideration is that modern bouldering includes the use of more aggressively curved climbing shoes, which alter the dynamics of landing [1]. Grønhaug [12] highlighted a notable gender disparity in foot and ankle injuries, with 3.8% of males and 10.4% of females reporting such issues. The author proposed that anatomical differences in the ankle might account for this variation, suggesting that climbing shoes, which are predominantly designed for male ankles, create a tighter and more stressful pressure point on the female Achilles' tendon.

While much of the existing literature on lower limb injuries focuses on traumatic incidents from falls, Cobos-Moreno et al. [5] examined chronic foot injuries in climbers of the FEXME (Extremadura Federation of Mountain and Climbing). Their research found that over 70% of participants had some form of foot alteration or injury. The most common digital issue was claw toes, affecting 59% of climbers and leading to metatarsalgia. The most prevalent skin condition was bursitis of the first toe, reported by 62% of respondents, particularly among those using smaller shoes and facing greater climbing challenges. Additionally, the most frequent joint injury was hallux limitus, affecting 52% of climbers, compared to 40% with hallux valgus.

Chronic injuries in climbers are frequently caused by wearing overly narrow and concave shoes, called “aggressive,” or downsized shoes that are smaller than standard sizes to enhance performance [17]. Such footwear might increase the likelihood of nail injuries which in turn elevate the risk of fungal infections. Athletes, in general, are more susceptible to foot issues and superficial fungal infections, with onychomycosis being 1.5 times more prevalent among those engaged in sports [18]. In the context of climbers, the most severe nail issues are seen in individuals who face the highest levels of difficulty in climbing [5].

Dust exposure

Climbing chalk, a soft white powder made of magnesium carbonate hydroxide (1-4MgCO3·Mg(OH)2·3-5H2O), also known as magnesia alba, helps dry hand sweat and improve grip. Initially used in gymnastics, it is nowadays considered essential for all types of climbing activities, with its use being most prevalent in bouldering [19]. Although the data regarding the harmfulness of the compound itself are not entirely clear, there have been reports indicating a deterioration in respiratory function due to airborne magnesium dust. It is also proposed that magnesia lacks specific toxic effects, with its observed impact being primarily attributed to the mechanical irritation of epithelial tissues [7]. It can lead to coughing, wheezing, and chest tightness. Prolonged exposure over several years may also trigger or exacerbate respiratory issues [20].

According to data provided by Weinbruch et al. [8] particle mass concentrations in indoor climbing gyms are significantly higher than in other indoor sports facilities and can reach levels comparable to those found in industrial settings. During peak activity times, such as weekday evenings and weekend afternoons, mean PM10 values ranged from 1000 to 4000 $\mu g/m^3$, while mean PM2.5 concentrations varied between 200 and 500 $\mu g/m^3$. Importantly, these particles do not undergo deliquescence even at high relative humidities up to 100%. As a result, they remain solid and are deposited in the human respiratory tract, with approximately 14% of the inhaled particles being retained in the alveolar region [20].

Although climbers typically do not report severe health issues related to dust exposure, individuals with asthma or increased respiratory sensitivity may experience symptoms like coughing and elevated mucus production. These symptoms might indicate an asthma attack occurring during or after climbing in indoor facilities [21]. Another aspect to consider is that suspended airborne magnesia, along with its drying properties, are factors that may exacerbate the course of atopic dermatitis [7].

A possible solution, other than applying modern air ventilation systems, involves the use of liquid chalk, which has shown a significant reduction in particle mass concentrations, achieving levels comparable to those observed when magnesia alba was banned. Liquid chalk thus seems to be an effective way to reduce dust exposure in indoor climbing. However, liquid chalk requires both hands for application, limiting its use to pre-climbing only and making it less practical for extended routes where reapplication is necessary. Nonetheless,

liquid chalk remains a cost-effective solution for reducing dust exposure in bouldering gyms, where routes are significantly shorter [22].

Conclusions

While bouldering is generally considered a safe activity, it presents specific health risks. Due to its unique, dynamic style and the absence of ropes, bouldering places significant strain on the upper extremity joints and may be associated with a higher incidence of fall-related injuries. We concluded that these challenges should be addressed through research on risk factors that increase the likelihood of injury during bouldering, as well as potential preventive measures.

Additionally, the issue of airborne dust from loose magnesia is well-documented in bouldering environments. There may be a need for stricter legislation or enforcement of existing regulations to address this concern. Considering banning the use of loose magnesia in poorly ventilated areas could be a viable option to protect both climbers and staff who are exposed to high dust concentrations for extended periods.

Disclosure:

Authors' contribution:

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