Title

A critical review of the incidence and risk factors for finger injuries in rock climbing

Authors: Gareth Jones (g.j.Jones@leedsbeckett.ac.uk) [1, 2] & Mark I. Johnson (m.johnson@leedsbeckett.ac.uk) [1, 2]

Author affiliations

1. Faculty of Health and Social Sciences, Leeds Beckett University, Leeds, U.K.

2. Leeds Pallium Research Group, Leeds, U.K.

Corresponding author

Gareth Jones, Faculty of Health and Social Sciences, Leeds Beckett University, Leeds, LS1 3HE,

U.K., Telephone: +44 113 81 25727, Fax: +44 113 2833124, e-mail: g.j.Jones@leedsbeckett.ac.uk

Abstract

Rock climbing is a popular sporting activity and indoor sport climbing has been shortlisted for inclusion in the 2020 Olympic Games. The aim of this article is to critically review research on the incidence and risk factors associated with injuries during rock climbing. A semi-systematic approach in reviewing literature on incidence and prevalence was applied. Articles were identified following searches of the following electronic databases: Discover, Academic Search Complete (EBSCO), PubMed, Embase, SPORTDiscus, and ScienceDirect. Despite methodological shortcomings of the studies contained within the review the frequency of climbing-related injuries is high and can be challenging to diagnose. The fingers are the most common site of injury with previous injury a significant risk factor for reinjury. The annular pulleys of the fingers is the most commonly injured structured and evidence suggests epiphyseal fractures in adolescent sport climbers is increasing. A diagnostic and therapeutic algorithm for climbing-related finger injuries is proposed.

1.0 Introduction

Rock climbing is a mainstream sporting activity that takes place outdoors on natural rock formations and indoors on artificial holds and surfaces. Up to date participatory figures are unavailable although in 2003 it was estimated that 1.27 million individuals regularly climbed in Britain (5). Popularity has increased over the years with 386 indoor climbing walls in the U.K compared with 40 in 1988 (4). Competitive climbing disciplines include indoor sport, indoor speed, indoor bouldering and indoor para-climbing. Indoor climbing has been shortlisted for inclusion at the 2020 Olympic Games. The increase in climbing is likely to result in an increase in climbing-related injuries presenting to physicians and other health care professionals.

Climbing-related injuries may be categorised as:

- Impact injury caused by the climber falling onto a climbing surface and/or ground, or an object such as a rock falling on to the climber
- Non-impact injury resulting from acute trauma to the body
- Chronic overuse of the body from repetitive climbing

Common injuries associated with impact injuries include fractures and contusions; common injuries associated with non-impact acute trauma injuries include strains and ruptures; and common injuries associated with chronic overuse injuries include tendinopathy. The most common site of non-impact acute injury and chronic overuse injuries are the upper limbs, particularly the fingers (1, 9, 38). Diagnosis of finger injuries is challenging due to the complex anatomical structure of fingers and the variability of cause of damage.

The aim of this article is to critically review research on the incidence and risk factors associated with injuries during rock climbing with a focus on non-impact injuries to the fingers. We will discuss the pathophysiology of injuries of the fingers and discuss challenges in treatment and present a diagnostic and therapeutic algorithm for annular pulley and epiphyseal finger injuries.

We adopted a semi-systematic approach to reviewing literature on incidence and prevalence. Articles were identified following searches of the following electronic databases: Discover, Academic Search Complete (EBSCO), PubMed, Embase, SPORTDiscus, and ScienceDirect. MESH search terms included “mountaineering”; “risk Factors”; “athletic injuries” and text search terms rock climb* (Boolean Phrase); climb* (Boolean Phrase); injury* (Boolean Phrase) risk factors* (Boolean Phrase). Text search terms were used in combination. Titles and abstracts were reviewed for relevance according to the following eligibility criteria: A primary study or review article on any type of rock climbing that reported an estimate of the prevalence and/or incidence of injury and/or investigation or discussion of potential risk factors. We only considered studies and reviews published in English. Prior to discussing the literature it is important to contextualise the environment in which climbing injuries occur.

2.0 Rock Climbing: Behaviours and Techniques

Rock climbing is an activity in which participants aim to reach the end of a pre-defined route without falling and can take place outdoors on natural rock formations, or indoors using artificial holds on an artificial surface. Climbs are graded according to technical difficulty and grades act as a reference measure of operational performance. Types of climbing include traditional climbing, sport climbing, bouldering and soloing (fig. 1). Movements may include ascending, descending and traversing. Traditional climbing takes place outdoors and utilises a rope which is attached to the climber who is belayed during the ascent. The belayed rope is connected to protective equipment placed in the climbing surface by the climber, and it acts as a safeguard in the event of a fall. Aid-climbing takes place outdoors and utilises a rope, protective equipment placed by the climber and pre-fixed protection to directly aid the ascent and pull themselves up the climbing surface. Sport climbing takes place both indoors and outdoors, and utilises a belayed rope which is attached to the climber and connected to pre-fixed anchor points during the ascent. Soloing takes place outdoors and involves an ascent of a pre-determined climbing route. Bouldering involves a series of low level movements performed on a pre-determined direction of travel. Bouldering and soloing does not use a rope so safety mats and spotters may be used as a safeguard to reduce injuries in the event of a fall. The severity of an impact injury depends on the length of fall and the type of landing sustained. Bouldering takes place at relatively low distances from the ground so the consequence of a fall is usually less serious than soloing, which can be serious or even fatal.

[Insert Fig. 1 here]

Most climbing takes place with a rope which absorbs and lessens impact forces on the climber in the event of a fall. Climbing ropes are typically 30-60 meters in length and are dynamic in design construction to allow elongation and therefore energy absorption in the event of a fall. The rope is belayed and connected to anchor points to prevent significant fall lengths. Leading involves climbing and connecting the rope to protective equipment or pre-fixed anchor points, whereas seconding involves following the lead climber and removing the rope from the protective equipment or pre-fixed anchor points. Falls whilst leading can be serious and dependent on the length of fall, whether impact is made with the climbing surface or ground and the ability of the belayer to arrest the fall. The second climber is protected from a rope above and the risks are far less serious.

The diversity of climbing activities contributes to a variety of types of injury. Climbers are classified as injured if they reported damage to the body from climbing that: caused pain and/or disability; and/or required medical attention; and/or caused withdrawal from climbing activity. Research estimating the incidence of injuries associated with rock climbing is discussed below.

3.0 Prevalence and Incidence of Injuries

There are no systematic reviews that have investigated injury prevalence in rock climbing. Studies that have estimated the reported prevalence of injuries associated with rock climbing vary between 10% and 81% irrespective of cause; between 10% and 50% for impact injuries (9, 11, 17, 37); between 28% and 81% for non-impact acute trauma injuries (9,11,18); and between 33% to 44% for chronic overuse injuries (1, 9, 37, 38). Variance is likely to be associated with differences in the nature, operational level of performance, frequency of performance and duration of activity between climbing disciplines.

Injuries that result from impact with the ground or climbing surface usually involve the lower limb at the site of the ankle and foot. Non-impact acute trauma injuries usually result from excessive loading of contractile and/or non-contractile tissue whilst performing a strenuous or dynamic climbing movement. They often involve the upper limb at the site of the fingers, wrist, elbow and shoulder but may also be sustained through loss of contact of the foot with the climbing surface where the climber resists the fall using their upper limbs. Chronic overuse injuries result from repetitive and forceful exertion on the body overtime, this leads to mal-aligned healing and tissue damage. Injuries that result from chronic overuse in climbing usually involve the upper limb at the site of the fingers, wrist, elbow and shoulder.

4.0 Incidence of Injuries

We found two systematic reviews of risk factors for injury in climbing. Schöffl, Morrison, Schwarz, Schöffl and Küpper (25) reviewed research on injury and risk of fatality in rock and ice climbing and analysed more than 400 sport-specific injury studies. They did not report an overall incidence statistic but concluded incidence and severity of injuries in climbing sports was lower than basketball, sailing and soccer. Indoor climbing had the lowest incidence of all sports analysed. They noted that there was no standard method for reporting injuries and that comprehensive sport-specific scoring systems were needed. In 2015, Woollings, McKay and Emery (36) conducted a systematic review of 19 studies that investigated risk factors for injury in sport climbing and bouldering and reported that potential risk factors for injury were lead climbing, increasing age, increasing years of climbing experience, higher skill level and higher climbing intensity. They noted that data was not robust when compared with other sports and that higher quality prospective studies were needed.

4.1 Clinical Incidence

Clinical incidence provides a useful statistic as to how many injuries medical staff are likely to see and the likely bearing on resources. Incidence proportion refers to the probability of an athlete sustaining at least one injury and is calculated by the number of injured athletes divided by the number of athletes at risk (13). In their systematic review Woollings, McKay and Emery (36) reported clinical incidence in the form of incidence proportion and included 5 studies that reported incidence proportion over the entire career as 428 (95% CI 409, 447) injuries/100 participants (32); 300 (95% CI 250, 357) injuries/100 participants (20); 152 (95% CI 133,172) injuries/100 participants (16); 131 (95% CI 126, 136) injuries/100 participants (7); and 194 (95% CI 175, 214) injuries/100 participants (19). Two studies estimated incidence proportion over one year as 137(95% CI 121,154) injuries/100 participants/year in general climbing (9); and 103 (95% CI 71,146) and 127(95% CI 85,184) injuries/100 participants/year for outdoor and indoor bouldering respectively (11). Our search of the literature failed to find any additional primary studies.

4.2 Incidence Rate

In their systematic review Woollings, McKay and Emery (36) found 1 study that estimated incidence rate as 53.87 (95% CI 40.58, 70.12) injuries/million visits (15). Woollings, McKay and Emery (36) found 4 studies that estimated incidence rate in injuries/1000h climbing (1, 17, 21, 27). We found an additional 6 studies that had data that had been used to estimate incidence rate. The characteristics of these 11 studies, including estimates of incidence rate are presented in Table 1.

Simple descriptive analysis of the estimates of incidence rate from these 11 studies reveals useful information. The mean ± SD from all 11 studies was 5.81/1000h ± 11.19. The maximum incidence rate was 37.5/1000h by Bowie, Hunt and Allen (3) and the minimum incident rate was 0.02/1000h by Schoffl, Hoffmann and Kupper (27). The mean ± SD of the four studies that sampled injuries caused by impact and non-impact acute trauma and chronic overuse injuries was 5.61 ± 5.24/1000h. The mean ± SD of the seven studies that sampled injuries caused by impact and non-impact acute trauma excluding chronic overuse injuries was 5.93 ± 13.97/1000h.

[Insert Table 1 here]

Although the difference between the maximum and minimum incidence rate is large it is interesting that the mean of the various descriptive analyses are analogous. This suggests that despite individual differences in the reported climbing behaviour all climbers appear to be sustaining injury at a similar rate. Variability in standard deviations between these descriptive analyses is likely to be due to the high incidence rate reported by Bowie, Hunt and Allen (3) as only those climbers who had sustained an injury were used to calculate the incidence rate.

Interpretation of study findings across studies is difficult because of variability in the definitions of injury used by study investigators. Analysis according to the type of climbing behaviour found that mean ± SD injury rate from the 6 studies that only sampled indoor climbers was 2.83 ± 5.14/1000h. Mean ± SD injury rate calculated from the 2 studies that only sampled outdoor climbers was 19.03 ± 26.12/1000h. Mean ± SD from the 3 studies that sampled both indoor and outdoor climbers was 2.95 ± 2.38/1000h. In summary analysis suggests that there was a lower incidence rate of injuries per 1000 hours of activity in indoor sport climbing.

5.0 Challenges in Interpreting Prevalence and Incidence Data in Climbing Studies

Severe challenges in interpreting prevalence and incidence data in climbing studies exist. The variability in study design confounds comparison of estimates between studies. Incidence had been determined using both prospective and retrospective cross sectional design methodologies and the problem with this is that both methods are compromised by the accuracy of exposure reporting.

Reporting injuries per 1000 hours of exposure controls for variations in exposure, especially between different types of climbing and is recommended by the International Climbing and Mountaineering Federation medical commission (24). However, reporting injuries per 1000 hours of exposure is an imprecise measure because it may not account for non-climbing activities such as preparation, rest periods between attempts and belaying a fellow climber.

Inconsistency in the criteria used to categorise type of injury between studies can lead to under or over reporting of particular type of injuries. Failure to inform the reader of the category of injury makes interpretation of the findings of limited use as individuals may sustain injury at multiple body sites and/or repeated injuries (i.e. re-injury).

The various aspects of climbing activity and the permeations of combinations of climbing activity makes categorising climbing activity challenging. The main categories of climbing behaviour described in the studies in our review were indoor sport climbing and outdoor sport climbing. However, these categories are broad in their definition and may hide a variety of specific activities also taking place. Studies rarely stated that they gathered precise information about the situation in which the injury occurred so that a direct link could be made between the specific situations in which the injury occurred.

Standardisation of the criteria used to attribute injury and climbing activity coupled with more accurate methods of calculating exposure will overcome these limitations in future studies.

6.0 Risk Factors Associated with Injuries

The systematic review by Woollings, McKay and Emery (36) included an analysis of 19 studies and identified 35 potential risk factors for injury. They categorised these risk factors as Intrinsic (sex, age, difficulty (skill) level, Body Mass Index (BMI), body weight, and grip strength) and Extrinsic (lead climbing and top roping, climbing volume, climbing intensity score, indoor versus outdoor climbing, influence of drugs/alcohol). The authors concluded that future research should focus on previous injury as a risk factor as shown in other sports.

Since the systematic review by Woollings, McKay and Emery (36), Jones, Llewellyn and Johnson (10) have published a secondary analysis of data from their retrospective cross-sectional cohort survey of active rock climbers and found that re-injury was a common occurrence in climbing. The average probability of sustaining at least one re-injury was 35.6% (95% CI 34.7% to 36.8%) and relative risk was 1.55 (95% CI 1.34 to 1.80), with the average probability of sustaining at least one re-injury through repetitive overuse being 63% (95% CI 49% to 77%) accounting for 80.5% of the total injuries reported. Fingers were the most common site of re-injury associated with non-impact acute injury or chronic overuse. Re-injury due to non-impact acute trauma was associated with outdoor sport lead grade and bouldering grade. Re-injury due to chronic overuse was associated with indoor and outdoor sport lead climbing grade and bouldering frequency and grade. As finger injuries in climbers have a unique aetiology it is important that clinicians are knowledgeable about pathophysiological mechanisms and the challenges faced in diagnosis.

7.0 Types of Finger Injury

Finger injuries are the most common site of climbing injuries and account for approximately 33% to 52% of all injuries sustained (7, 20, 26, 34). Other common sites of injury include the shoulder (typically accounting for 17% of all injuries) and the elbow (typically accounting for 8% of all injuries). The middle and ring fingers are the most common site of digit injuries in climbing. Finger injuries are related to methods used by the climber to grip the climbing surface and knowledge of these methods will aid subjective assessment of the injury improving the accuracy of diagnosis.

Grip refers to the method by which the climber holds the climbing surface to facilitate movement. The type of grip the climber uses largely depends on the size and shape of the available hand-holds, the climber’s body orientation in relation to the hand-hold and the strength of the climber. The common types of grip used in climbing are the closed crimp, open crimp, hooked, pinch, pocket, and under cling. It is usual for climbs of a higher standard to be comprised of smaller hand-holds and crimp grip techniques are often preferred as large forces can be generated. In the crimp grip position force distribution between the fingers is unequal with the greatest force exerted on the middle and ring fingers. In the crimp position the ring finger controls the rotational movement of the hand along its longitudinal axis (31). The closed crimp grip is often used on small edges of rock. In this position the proximal interphalangeal joint is flexed to approximately 100° and the distal interphalangeal joint (DIP) is hyperextended to approximately 210° (Fig 2). Contact with the climbing surface is made by the distal palmar surface of the index, middle and ring fingers with the thumb often placed over the dorsal surface of the index finger. An open crimp position is used on wider edges of rock (Fig. 2). The joint angle at the proximal interphalangeal joint is decreased and the thumb is not in contact with the index finger (Fig 2).

[Insert Figure 2 here: Closed Crimp Grip; Open Crimp Grip; Hooked Grip; Under Cling Grip; Pinch Grip; Pocket Grip]

In a ‘hooked’ grip (Fig 2) both the proximal interphalangeal and distal interphalangeal joints are flexed and the degree of flexion depends on the shape of the hold. In the under cling grip the hand position is similar to the hooked grip with the forearm supinated (Fig. 2). However, dependent on the shape of the hold the distal interphalangeal joint may occasionally be extended. The pinch grip involves flexion of the proximal and distal interphalangeal joints at one or more of the fingers and the interphalangeal joint of the thumb in a pincer movement (Fig 2). The pocket grip uses one or more fingers, most often the middle and ring fingers, which are held between 10-20° of flexion at the distal interphalangeal joint and approximately 40° of flexion at the proximal interphalangeal joint (Fig 2). When holding a one finger pocket the remaining fingers may be held in flexion which can increase the maximum holding force up to 48%, due to the musculo-tendonous interconnection of flexor digitorum profundus (29).

Schöffl, Popp, Küpper and Schöffl (26) evaluated injury trends in sport climbing and bouldering over a 4 year period and found that the annular pulleys of the fingers the most commonly injured structure. Annular pulleys are fibrous bands of tissue that retain the position of the finger flexor tendon close to the underlying bone when gripping. There are five annular pulleys within each finger and referred to as the A1, A2, A3, A4 and A5 (Fig. 3), The A2 and A4 are considered to be the most structurally important in maintaining the integrity of the flexor tendon system due to their direct attachment to the underlying bone. The A2 is situated at the proximal phalanges and the A4 at the distal phalanges. Bollen (2) and Tropet, Menez, Balmat, Pem and Vichard (33) were the first to publish reports of closed traumatic ruptures of the A2 annular pulley in climbers. Annular pulley damage is considered to be a climbing specific injury and may be due to non-impact acute trauma or chronic overuse. The A2 is capable of withstanding up to 400 newton of force, although climbers often expose the A2 to forces in excess of this limit (12).

[Insert Figure 3 here: used by permission Primal Pictures]

Non-impact acute trauma to the annular pulley system usually results from sudden dynamic loading. Chronic overuse annular pulley injuries result from repetitive loading which may have been historically preceded by a non-impact acute trauma. Kubiak (14) suggests many chronic overuse injuries in climbing populations go undiagnosed; this may in part be due to the perception by climbers that some health care professionals are not familiar with climbing related injuries. Interestingly Jones, Asghar and Llewellyn (9) found 'other' climbers were key sources of treatment information for climbing related injuries.

Climbers with a suspected annular pulley injury usually present with pain and tenderness on the palmar aspect of the pulley site and this is often accompanied by swelling. Subjectively the injured climber may report hearing an audible 'pop' at the time of injury. Objective confirmation can be made using ultrasound when greater than 2mm of dehiscence exists between tendon and bone; this is termed 'bowstringing'. If less than 2mm of dehiscence exists, a pulley sprain is diagnosed. A magnetic resonance image may be necessary if symptoms are suggestive of pulley damage but ultrasound is inconclusive. Repetitive loading resulting in chronic degenerative change of the annular pulleys and increased dehiscence of the flexor tendon in climbers has been observed (6).

Schöffl, Winkelmann and Strecker (22) conducted a prospective study and found that 122 of 247 finger injuries to involve the pulley system. Of these 122 pulley injuries 74 were diagnosed as a pulley rupture and 48 as a pulley strain. The criteria used for a pulley rupture was the existence of < 2mm of dehiscence between tendon and bone due to either non-impact acute trauma or chronic overuse. Greater than 2mm of dehiscence has been found in climbers without a torn pulley and may be a result of chronic overuse (6). Single pulley ruptures present most frequently at the site of the A2, A3 and A4. Evidence suggests the incidence of injuries to the A4 is greater than to the A2. Schöffl, Popp, Küpper and Schöffl (26) compared the occurrence of pulley injuries between 2 prospective studies using similar design methodologies. From 1998 to 2001 a total of 122 pulley injuries were reported in 604 participants with 81 single pulley injuries at A2 and 28 single pulley injures at A4 (22). From 2009 to 2012 a total of 140 pulley injuries were sustained by 836 participants with 48 single pulley injuries at A2 and 61 single pulley injuries at A4 (26). The authors suggested that this change in the incidence of pulley injuries over time may be due to increased use of open handed grips which places less force at A2 but increased force at A4. Multiple pulley ruptures occur at A2 and A3 or A2/A3 and A4. Importantly observed bowstringing of the flexor tendon is seen when ruptures of the A2, A3 and A4 occur simultaneously. Associated damage to collateral ligaments and the lumbrical muscles can occur with single or multiple pulley ruptures and is considered a high grade injury. Schöffl, Winkelmann and Strecker (22) found that 6% of 122 pulley injuries were high grade. Surgical management is recommended for high grade injuries. Schöffl, Winkelmann and Strecker (22) suggest surgical reconstruction in climbers should be made using the loop and a half technique with an auto graft of the palmaris longus muscle developed by Widstrom, Doyle, Johnson, Manske and McGee (35). This results in strong and functional reconstruction that is capable of withstanding high loads and thus reducing the chance of re-rupture. A return to full climbing activity is usually possible approximately 6 months after surgery.

The majority of finger injuries are less severe with conservative management highly effective, although surgical preferences may still exist. Conservative management includes relative rest, thermal therapy, manual therapy, taping and progressive resistance training. Corticosteroid injection is a highly debatable subject as intratendinous injections may result in tendon rupture. However in climbers for whom non-invasive therapeutic techniques have failed and a differential diagnosis of chronic tendinitis or tenosynovitis has been established this may be justified. Schöffl, Winkelmann and Strecker (22) suggests that full return to climbing activity can take place with conservative rehabilitation within 6 weeks for a pulley strain, 6 weeks to 12 weeks for a complete pulley rupture and approximately 6 months for a high grade injury. The rehabilitation period of an isolated complete rupture of an A4 pulley is considered to be shorter than that of an A2.

Other injuries to the fingers that commonly present in climbers include flexor tendinopathies, capsular inflammation, extensor hood rupture and collateral ligament damage of proximal and distal interphalangeal joints. Repeated effusions and morning stiffness may be indicative of osteoarthritis and degenerative change. Less well known presentations include injuries to the lumbrical muscles within the hand and fractures of the epiphyses in young climbers. Shweizer (30) reported the occurrence of discreet tears of the lumbrical musculature within the hands of rock climbers and suggested that a tear to the third or fourth lumbrical muscle may occur either at the ring or small finger if dynamically loaded whilst holding a one-finger pocket. The bi-pennate attachment of lumbrical muscles may be susceptible to trauma due to a movement shift of the flexor digitorum profundus tendons whilst in this position (29) .

Recent evidence has found an increase in the reported occurrence of epiphyseal fractures of the proximal interphalangeal joint in adolescent sport climbers who routinely perform dynamic finger training using such methods as campus boarding (26). Pain and/or tenderness is reported on the dorsal aspect of the proximal interphalangeal joint usually of the middle or ring finger. Those individuals with a long symptomatic history and who have continued to climb unrestricted are at an increased risk of sustaining a partial or complete separation of the epiphysis from its attachment (8). Epiphyseal injuries need to be identified early and treated accordingly to avoid significant implications on skeletal maturation in adolescence such as premature growth plate closure leading to deformity.

7.1 Diagnostic Algorithm for Finger Injuries

We have developed a diagnostic algorithm for finger injuries based on this information about the aetiology, pathophysiology and presenting symptoms. Schöffl, Hochholzer, Winkelmann and Strecker (23) proposed a diagnostic and therapeutic algorithm for the identification of annular pulley injuries and suggested that in all cases an initial x-ray is necessary to rule out a fracture and that this can be followed by ultrasound and/or a magnetic resonance image to establish injury severity. This approach has significant cost implications to health service providers and may expose individuals to unnecessary diagnostic procedures. As fractures typically account for only 3% of all finger injuries and the occurrence of high grade and multiple pulley injuries is significantly lower than the occurrence of single pulley ruptures we offer an alternative algorithm in Figure 4. Our algorithm considers both injury mechanism associated with annular pulley injuries and epiphyseal fractures in adolescents.

[Insert Figure 4 here - Diagnostic Algorithm]

8.0 Summary

Rock climbing is a popular mainstream sporting activity with increasing participation.
Our review found that the prevalence of injuries associated with rock climbing studies to vary from 10% to 81% irrespective of cause; from 10% to 50% for impact injuries; from 28% to 81% for non-impact acute trauma injuries; and from 33% to 44% for chronic overuse injuries. We found that clinical incidence varied from 428 to 131 injuries/100 participants and from 103 to 137injuries/100 participants/year. We found that mean ± SD incidence rate from 6 studies of indoor climbers was 2.83 ± 5.14/1000h; from 2 studies of outdoor climbers was 19.03 ± 26.12/1000h and from 3 studies that sampled both indoor and outdoor climbers was 2.95 ± 2.38/1000h. However, it was impossible to determine a robust measure of the prevalence and incidence rate of injuries because of methodological limitations in climbing studies. Nevertheless, the frequency of climbing related injuries presenting to health care professionals is increasing and these injuries can be challenging to diagnose. We suggest that climbing injuries should considered as those resulting from impact, non-impact acute trauma, and chronic overuse. All types of climbing behaviour may result in an individual presenting with an injury from one or more of these causes. We propose a diagnostic and therapeutic algorithm to aid clinical reasoning and management of climbing-related finger injuries.

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Conflicts of Interest

The results of the present study do not constitute endorsement by ACSM.

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Figure Captions

Fig 1. Rock Climbing Behaviours

Fig 2. Climbing Hand Grip Positions

Fig 3. Annular Pulley System of the Fingers

Fig 4. Diagnostic & Therapeutic Algorithm for Suspected Annular pulley and Epiphyseal Injuries