



Evaluation of Injury Risk in Indoor Climbing Athletes and Provision of Specialized Care in Greece: A Review and Study Protocol

Eleftherios Paraskevopoulos

Department of Physiotherapy, Aegean College, Athens, Greece

<http://dx.doi.org/10.18415/ijmmu.v11i10.6281>

Abstract

Competitive climbing has witnessed significant growth in recent years, leading to an increased focus on both indoor and outdoor training. This rise in popularity has been accompanied by a higher frequency of climbing-related injuries, particularly in the upper limbs, with finger tendon injuries being the most prevalent. The rapid evolution of the sport, including the introduction of more complex climbing walls and movements, has further elevated the risk of injury among athletes. Despite the increasing number of injuries, there is a noticeable gap in specialized knowledge and treatment of these injuries, particularly in Greece, where healthcare providers may lack the expertise needed to effectively manage and rehabilitate climbing-related injuries. This study aims to address these gaps by conducting a detailed investigation into the epidemiology of climbing injuries. The research involves distributing comprehensive questionnaires to climbers, focusing on the types of injuries sustained, the level of climbing difficulty at the time of injury, and the specific types of climbing holds involved. Additionally, the study will document clinical symptoms and assess the level of specialized care provided by healthcare professionals. By correlating injury patterns with factors such as training intensity, climbing hold design, and the expertise of healthcare providers, this study seeks to develop targeted prevention and treatment strategies. The findings will not only contribute to safer climbing practices but also provide valuable insights into improving injury management and rehabilitation. This research is particularly relevant given the sport's inclusion in the Olympic Games, highlighting the need for a deeper understanding of the unique demands and risks associated with competitive climbing.

Keywords: *Competitive Climbing; Climbing Injuries; Finger Tendon Injuries; Upper Limb Injuries; Training Intensity; Epidemiology; Injury Prevention*

Introduction

In recent years, competitive climbing has grown at a rapid pace, both in indoor and outdoor settings. Despite the potential risks involved, there has been remarkable growth in the sport and an increasing number of specialized indoor climbing facilities being constructed. The development of indoor climbing facilities has allowed athletes to train frequently and in all weather conditions. The increased frequency of athlete training has raised the level of the sport but also the frequency of injuries.

The involvement in the sport of climbing led me to a significant observation: the high frequency of injuries among athletes and, often, the lack of specialized knowledge in treating and preventing these injuries among healthcare providers. According to Chang et al. (2016), over 75% of climbing athletes suffer from chronic or acute upper limb injuries, with the wrist and fingers being the most frequently injured areas. More specifically, the flexor tendons of the fingers and their sheaths appear to be the most commonly affected by traumatic injuries (Rohrbough et al., 2000).

The finger sheaths are responsible for holding the tendons in place during the flexion and extension of the fingers. The A2 pulley in particular appears to be the strongest, as it can withstand forces exceeding 400 N (Chang et al., 2016). Studies have shown that during climbing, the sheaths of a 70-kilogram athlete are subjected to forces reaching up to 380 N, and in the event of a sudden fall, these forces can rise to 450 N (Crowley, 2012). This frequency is demonstrated through epidemiological studies involving a significant number of participants, such as those conducted by Gerdes et al. (2006), where data were collected from 1,887 climbers, recording 2,472 injuries during climbing, with the fingers being identified as the most common injury site. Additionally, more recent studies support these observations, such as those conducted by McDonald et al. (2017a), Jones and Johnson (2016) and Chang et al. (2016).

Despite the increasing number of epidemiological studies on climbing-related injuries, there is a lack of relevant knowledge in Greece, particularly regarding the treatment of these injuries within the country. Furthermore, there is limited understanding of the clinical characteristics of these injuries, as well as of the climbing handholds or the difficulty levels where these injuries occur. Lastly, it is important to document the healthcare providers that injured climbers most frequently consult, their level of satisfaction, and the degree of specialized knowledge these providers have regarding the sport of climbing. The need for further study of climbing athlete injuries is underscored by the fact that the International Olympic Committee, on August 3, 2016, decided to include the sport in the official program of the 2020 Olympic Games in Tokyo.

Such a significant decision, both for climbing athletes and for the sport's enthusiasts, should be accompanied by a scientific investigation into the factors contributing to athlete injuries. It is important to note that the modern form of climbing and the training methods used for elite climbers have evolved, resulting in a broader range of injuries being observed compared to the past (Lutter et al., 2017). In the past, climbing was primarily done on nearly vertical walls, whereas now, walls feature various inclines and are relatively more three-dimensional. This change forces climbers to perform more complex movements, which increases the risk of injury (Schoffl et al., 2016). For this reason, Lutter et al. (2017) They recommend a more careful and evidence-based medical involvement, alongside the use of more ergonomic climbing holds, to prevent injuries.

Review

An electronic search of relevant articles was conducted as previously performed (Paraskevopoulos, Karanasios, et al., 2023; Paraskevopoulos, Plakoutsis, et al., 2023) using Scopus as the primary database, based on the keywords: 'Rock Climbing Injuries', 'Epidemiology of Rock Climbing Injuries', 'Bouldering Injuries', and 'Treatment of Rock Climbing Injuries'. The search was further restricted to studies published in English. The search was also extended to other bibliographic databases such as Medline and Google Scholar, but no additional studies were found beyond those identified through Scopus.

Table 1. Literature search

Words	Articles
1. Rock Climbing Injuries	213
2. Epidemiology of Rock Climbing Injuries	17
3. Bouldering Injuries	19
4. Treatment of Rock Climbing Injuries	66

The selection of articles was based on their relevance as indicated by their titles. The most pertinent studies that were identified through the search and review are discussed in detail in the analysis of the literature findings. Due to the volume of similar findings across many studies concerning the injury area, the most recent studies were chosen to be included in the analysis of the findings as previously suggested.

Analysis of the Literature Findings

The search revealed that most epidemiological studies on climbing injuries are not limited to a specific type of climbing. It is important to note that there are four main categories of climbing: bouldering, indoor climbing, traditional climbing (trad) which takes place outdoors, and sport climbing outdoors (McDonald et al., 2017b). Some studies focused on a specific type of climbing but did not examine epidemiological data regarding the frequency of injuries.

McDonald et al. (2017b) In their latest research effort to highlight some epidemiological data regarding the most frequent injury areas in climbing athletes, it was shown that across all types of climbing, the finger area was the most commonly injured. This study, which included data from 553 men and 155 women, found that tendon injuries, including those of the sheaths, were the most frequent type of injury. Similar findings were reported by Backe et al. (2009) and also identified an increased risk of injury with a rising Body Mass Index (BMI). Also, Jones et al. (2008) showed an increased frequency of finger injuries.

The intensity of training appears to play a significant role in the risk of injury, considering both the frequency of training days and the difficulty of climbing problems. Logan et al. (2004) by using information on the number of training days and the difficulty level of climbing problems, they developed a formula to calculate each athlete's training intensity. The results confirmed their initial hypothesis regarding the increased risk of finger injuries associated with higher training intensity.

Similarly, Woollings et al. (2015), reported similar findings regarding injury locations. Their results showed a relatively high injury frequency among young climbers (ages 15-19), comparable to the injury rates seen in hockey and soccer. It is important to note that in studies such as that of Woollings et al. (2015) and McDonald et al. (2017a) injured climbers were referred to a physical therapist for their injury rehabilitation, while in the study by Jones et al. (2008), physical therapists were the primary healthcare providers that injured climbers initially sought out. Therefore, it is crucial to investigate the knowledge and specialization of physical therapists regarding such injuries.

The review observed that as the athletes' level and the difficulty of climbing problems increased, so did the risk of injury. However, only the study of Woollings et al. (2015) referred to what occurred during the injury, such as 'intense movement'. However, there was no study that specifically addressed the documentation of climbing holds that were most likely to cause injuries to athletes (i.e. Edges, Pockets etc.)

Methodology

Therefore, this research will initially involve distributing questionnaires based on the protocol proposed by Jones et al. (2008) to collect epidemiological data, including anthropometric details, climbing-related injuries, the level of climbers (Metric Scale), the type of climbing hold used during the injury, the healthcare providers consulted, the methods of injury management, and the level of satisfaction of the injured climbers. Subsequently, a detailed documentation of the clinical symptoms associated with each injury will be carried out to facilitate grouping for easier future diagnosis and correlation with difficulty levels. Additionally, further data will be gathered on the clinical specialization of physical therapists and other healthcare providers regarding climbing injuries and their management methods.

The questionnaires will be distributed to climbing clubs and gyms that operate exclusively for climbers. Initially, the study will focus on boulder athletes, and if deemed necessary, data collection will be extended to climbers from other categories. The validity (face validity) will be assessed through interviews with a sample of participants. The initial questionnaire will be developed based on methods proposed in the existing literature (Auer et al., 2021). Experienced bouldering athletes will be consulted for consent and feedback. It will be further refined for validity through consultations with experienced clinical researchers (Dorscht et al., 2019; Paraskevopoulos et al., 2024; Paraskevopoulos, Plakoutsis, & Papandreou, 2023).

The analysis will be conducted using Microsoft Excel for data collection and SPSS (SPSS Inc., Chicago, IL) for statistical analysis. All values will be reported as means and standard deviations. The Kolmogorov-Smirnov test will be used to assess the normality of the data distribution. Homogeneity of variances will be investigated using Levene's F test. Variables with a normal distribution will be tested for statistical significance using appropriate parametric tests. Where normal distribution is not present, significance testing will be conducted using non-parametric tests.

Clinical Significance

This study underscores the critical need for a comprehensive understanding of injury patterns in competitive climbing, especially given the sport's rapid evolution and increasing popularity. The high frequency of upper limb injuries, particularly in the fingers and tendons, highlights a significant concern for both amateur and elite climbers. The observation that injuries commonly occur in areas subjected to substantial forces during climbing—such as the A2 pulley in finger tendons—illustrates the physical demands and potential risks inherent in the sport.

The findings from various studies indicate that the risk of injury escalates with increased training intensity (Paraskevopoulos, Kottaridis, et al., 2023; Paraskevopoulos, Pamboris, & Papandreou, 2023) and the complexity of climbing routes. This correlation emphasizes the necessity for tailored training programs that balance intensity with adequate injury prevention strategies. Moreover, the study reveals a gap in specialized care and knowledge among healthcare providers in Greece, which could impact the effectiveness of injury management and rehabilitation for climbers.

The documentation of climbing handholds and the associated risk of injury is another crucial area that requires attention. Understanding which climbing holds are more likely to cause injuries can lead to better design and usage recommendations, potentially reducing the incidence of specific injuries. This insight will also benefit climbing facility operators in designing safer climbing environments.

Conclusion

The rapid growth of competitive climbing and the increasing frequency of injuries among athletes necessitate a focused approach to understanding and managing climbing-related injuries. The study highlights several key areas for future research and intervention:

1. **Injury Patterns:** A detailed analysis of injury types, particularly in the upper limbs and finger tendons, is essential for developing targeted prevention and treatment strategies.
2. **Training Intensity:** The relationship between training intensity and injury risk calls for guidelines that help climbers balance training loads with injury prevention.
3. **Specialized Care:** There is a pressing need to enhance the specialized knowledge of healthcare providers, including physical therapists, regarding climbing injuries. This will ensure more effective treatment and rehabilitation tailored to the unique demands of the sport.
4. **Climbing Holds:** Further research into the types of climbing holds associated with injuries can inform better design and usage practices, contributing to a safer climbing experience.
5. **Data Collection:** The proposed methodology, including detailed questionnaires and clinical symptom documentation, aims to fill existing knowledge gaps and provide a foundation for improved injury management practices in climbing.

Overall, this research will contribute to a more nuanced understanding of climbing injuries and support the development of strategies to enhance athlete safety and performance. The insights gained will be valuable not only for the climbing community in Greece but also for the broader global climbing population.

References

- Auer, J., Schöffl, V. R., Achenbach, L., Meffert, R. H., & Fehske, K. (2021). Indoor bouldering—a prospective injury evaluation. *Wilderness & Environmental Medicine, 32*(2), 160-167.
- Backe, S., Ericson, L., Janson, S., & Timpka, T. (2009). Rock climbing injury rates and associated risk factors in a general climbing population. *Scandinavian Journal of Medicine and Science in Sports, 19*(6), 850-856. <https://doi.org/10.1111/j.1600-0838.2008.00851.x> .
- Chang, C. Y., Torriani, M., & Huang, A. J. (2016). Rock Climbing Injuries: Acute and Chronic Repetitive Trauma [Review]. *Current Problems in Diagnostic Radiology, 45*(3), 205-214. <https://doi.org/10.1067/j.cpradiol.2015.07.003>.
- Crowley, T. P. (2012). The Flexor Tendon Pulley System and Rock Climbing. *Journal of Hand and Microsurgery, 4*(1), 25-29. <https://doi.org/10.1007/s12593-012-0061-3>.
- Dorscht, L., Karg, N., Book, S., Graessel, E., Kornhuber, J., & Luttenberger, K. (2019). A German climbing study on depression: a bouldering psychotherapeutic group intervention in outpatients compared with state-of-the-art cognitive behavioural group therapy and physical activation—study protocol for a multicentre randomised controlled trial. *BMC psychiatry, 19*, 1-13.
- Gerdes, E. M., Hafner, J. W., & Aldag, J. C. (2006). Injury patterns and safety practices of rock climbers. *Journal of Trauma, 61*(6), 1517-1525. <https://doi.org/10.1097/01.ta.0000209402.40864.b2>.

- Jones, G., Asghar, A., & Llewellyn, D. J. (2008). The epidemiology of rock-climbing injuries. *British Journal of Sports Medicine*, 42(9), 773-778. <https://doi.org/10.1136/bjism.2007.037978>.
- Jones, G., & Johnson, M. I. (2016). A Critical Review of the Incidence and Risk Factors for Finger Injuries in Rock Climbing. *Current Sports Medicine Reports*, 15(6), 400-409. <https://doi.org/10.1249/jsr.0000000000000304>.
- Logan, A. J., Makwana, N., Mason, G., & Dias, J. (2004). Acute hand and wrist injuries in experienced rock climbers. *British Journal of Sports Medicine*, 38(5), 545-548. <https://doi.org/10.1136/bjism.2002.003558>.
- Lutter, C., El-Sheikh, Y., Schoffl, I., & Schoffl, V. (2017). Sport climbing: medical considerations for this new Olympic discipline. *British Journal of Sports Medicine*, 51(1), 2-3. <https://doi.org/10.1136/bjsports-2016-096871>.
- McDonald, J. W., Henrie, A. M., Teramoto, M., Medina, E., & Willick, S. E. (2017a). Descriptive Epidemiology, Medical Evaluation, and Outcomes of Rock Climbing Injuries. *Wilderness and Environmental Medicine*. <https://doi.org/10.1016/j.wem.2017.05.001>.
- McDonald, J. W., Henrie, A. M., Teramoto, M., Medina, E., & Willick, S. E. (2017b). Descriptive Epidemiology, Medical Evaluation, and Outcomes of Rock Climbing Injuries [Article in Press]. *Wilderness and Environmental Medicine*. <https://doi.org/10.1016/j.wem.2017.05.001>.
- Paraskevopoulos, E., Christakou, A., Karanasios, S., Louka, A. P., Pamboris, G. M., & Papandreou, M. (2024). Translation, Adaptation and Validation of the Greek Version of the Kerlan-Jobe Orthopaedic Clinic Shoulder and Elbow Score in Greek Overhead Athletes. *J Funct Morphol Kinesiol*, 9(1). <https://doi.org/10.3390/jfmk9010049>.
- Paraskevopoulos, E., Karanasios, S., Gioftsos, G., Tatsios, P., Koumantakis, G., & Papandreou, M. (2023). The effectiveness of neuromobilization exercises in carpal tunnel syndrome: Systematic review and meta-analysis. *Physiotherapy Theory and Practice*, 39(10), 2037-2076. <https://doi.org/10.1080/09593985.2022.2068097>.
- Paraskevopoulos, E., Kottaridis, F.-M., Moutzouri, M., Koumantakis, G. A., Antonakis-Karamintzas, D., Tsolakis, C., Koulouvaris, P., Christakou, A., & Papandreou, M. (2023). Preliminary Insights into the Diagnostic Accuracy of the Modified Arm Care Screen Test for Overhead Athletes: An On-Field Tool for Injury Prevention. *Healthcare*, 11(23), 3046. <https://doi.org/10.3390/healthcare11233046>.
- Paraskevopoulos, E., Pamboris, G. M., & Papandreou, M. (2023). The Changing Landscape in Upper Limb Sports Rehabilitation and Injury Prevention. *Sports*, 11(4), 80. <https://doi.org/10.3390/sports11040080>.
- Paraskevopoulos, E., Plakoutsis, G., Chronopoulos, E., & Maria, P. (2023). Effectiveness of Combined Program of Manual Therapy and Exercise Vs Exercise Only in Patients With Rotator Cuff-related Shoulder Pain: A Systematic Review and Meta-analysis. *Sports Health*, 15(5), 727-735. <https://doi.org/10.1177/19417381221136104>
- Paraskevopoulos, E., Plakoutsis, G., & Papandreou, M. (2023). A Pilot Test of the Measures of the Greek Version of Upper Extremity Functional Index in Patients with Lateral Elbow Tendinopathy. *Med Sci (Basel)*, 11(3). <https://doi.org/10.3390/medsci11030045>.
- Rohrbough, J. T., Mudge, K. M., & Schilling, R. C. (2000). Overuse injuries in the elite rock climber [Article]. *Medicine and Science in Sports and Exercise*, 32(8), 1369-1372.

<https://www.scopus.com/inward/record.uri?eid=2-s2.0-0033853993&partnerID=40&md5=f909064a360bf0eb71bb7265a693b05c>.

Schoffl, V., Lutter, C., & Popp, D. (2016). The "Heel Hook"-A Climbing-Specific Technique to Injure the Leg. *Wilderness and Environmental Medicine*, 27(2), 294-301. <https://doi.org/10.1016/j.wem.2015.12.007>.

Woollings, K. Y., McKay, C. D., Kang, J., Meeuwisse, W. H., & Emery, C. A. (2015). Incidence, mechanism and risk factors for injury in youth rock climbers. *British Journal of Sports Medicine*, 49(1), 44-50. <https://doi.org/10.1136/bjsports-2014-094067>.

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).