CARE OF THE WILDERNESS ATHLETE

Preparticipation Evaluation for Climbing Sports

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Climbing is a popular wilderness sport among a wide variety of professional athletes and amateur enthusiasts, and many styles are performed across many environments. Potential risks confront climbers, including personal health or exacerbation of a chronic condition, in addition to climbing-specific risks or injuries. Although it is not common to perform a preparticipation evaluation (PPE) for climbing, a climber or a guide agency may request such an evaluation before participation. Formats from traditional sports PPEs can be drawn upon, but often do not directly apply. The purpose of this article was to incorporate findings from expert opinion from professional societies in wilderness medicine and in sports medicine, with findings from the literature of both climbing epidemiology and traditional sports PPEs, into a general PPE that would be sufficient for the broad sport of climbing. The emphasis is on low altitude climbing, and an overview of different climbing styles is included. Knowledge of climbing morbidity and mortality, and a standardized approach to the PPE that involves adequate history taking and counseling have the potential for achieving risk reduction and will facilitate further study on the evaluation of the efficacy of PPEs.

Key words: preparticipation physical evaluation, preparticipation examination, wilderness sports, climbing, mountaineering

Introduction

Individuals participating in climbing are of a variety of ages and experience levels. It is presumed that as with many sports showing increased participation, there is also an increase in injuries related to participation in climbing.

The aim of this article was to draw upon the standard of a traditional sports preparticipation evaluation (PPE) as outlined by *PPE: Preparticipation Physical Evaluation, Fourth Edition*¹ and translate this standard to the broad sport of climbing. This is done by discussing the different types of climbing, providing a background on the epidemiology of climbing injuries across the different styles, giving a brief discussion on nutrition,

and finally going over an outline for performing such a PPE. The focus of this climbing PPE is on low altitude climbing, deferring climbing at high altitude to other articles. Moreover, further discussions on altitude and cold and heat issues in climbing sports are also deferred to other articles.

The authors realize many different styles of climbing, and climbing environments make it difficult to group all types of climbing into one PPE and that terminology may not be agreed upon. Despite this difficulty, the authors feel it is possible and relevant to have a generalized PPE for climbing that can obtain a thorough history, a generalized examination that emphasizes areas of concern from the history, and risk reduction counseling based on the climbing style or environment.

It is important to define terms for clarity in understanding the breadth of climbing. Although some definitions may include one type of climbing, but not others,² with the increase in participation, there has also been an increase in the variety of terms available to describe the sport, making it challenging to discern

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what is meant by *climbing*. The authors feel the term *climbing* encompasses a much broader definition, and for the purpose of this article, although the literature did not yield consistency on climbing terminology, the authors use terminology commonly heard in the United States. *Alpine* typically refers to being in the mountains. *Traditional* or “*trad*” climbing typically involves carrying one’s own gear for protection, which is removable and reusable, and often involves crack climbing. *Sport* climbing typically refers to the use of preestablished protection on a route often in the form of *bolts* (literally a bolt permanently drilled into the rock with a hanger on it for clipping into), allowing ascent of rock faces with otherwise little to no available protection. *Bouldering* refers to climbing without ropes or protection, and close to the ground (often only a few meters, but height from the ground can be variable). This style emphasizes rehearsing only a few moves in a sequence to complete the route, which is often referred to as a “problem.” Boulders often use thick pads (“crash pads”) to protect falls from serious injury or death. Bouldering should be distinguished from *free soloing*, in which climbers would ascend longer routes without ropes or protection that would otherwise require such gear or that most climbers would elect to use gear for protection.

Four broad terms can be used to further categorize climbing styles. These are (1) *mountaineering*, semantically representing a variation of climbing in the mountains and may include rock and/or ice, as well as glacial travel; (2) *rock climbing* (alpine, traditional, sport, and bouldering); (3) *indoor climbing* (gym climbing using plastic holds for one’s hands and feet, and arguably may not be a wilderness sport); and (4) *ice climbing* (using pointed tipped tools that look like axes, and *crampons* for boots to allow the ability to ascend the ice, where protection from falls includes the use of hollow screws, or traditional protection). It is possible that climbers may participate in more than one style, where one style may prepare them for another style. With the use of varying terminology, isolated study of injury patterns across climbing styles can be methodologically difficult.

It is not uncommon for individuals who climb to present to clinicians with climbing-related injuries or for annual physical examinations, during which participation in one or more style of climbing may be identified. Additionally, professional, semiprofessional, or amateur climbers may present with the specific interest in a PPE based on an upcoming climbing event or trip. Guide agencies may also request a PPE to ensure the fitness and general health of their clients before an expedition. Established guidelines for PPEs exist for traditional or organized team sports, but translation of these principles

to climbing has little discussion in the literature. Although the basics of traditional sports PPEs can be applied, augmenting this assessment for climbing specific issues is needed.

Despite that PPEs may not be common to climbing, opportunities exist for clinicians to evaluate and educate climbers. Preparticipation evaluations for climbing will involve a clinical skill set that crosses over areas of sports medicine, wilderness medicine, primary care, and travel medicine. By using a stepwise approach, clinicians can be comprehensive, including risk identification, shared decision-making, and anticipatory guidance. Ideally, a clinician performing such a PPE will have previous experience conducting sports physicals and will have familiarity with the different styles of climbing. It is possible, however, that by considering the points and discussion of this article, a clinician with less experience in wilderness or sports medicine could still conduct a PPE for climbing, paying attention to the nuances and specific risks of this sport.

CLEARANCE ISSUES

Climbers may present to their physician seeking “clearance” to participate when using guide agencies. This tends to be a release of liability from the agency to the evaluating clinician, who is supposed to assess an ability to participate. This term is controversial in wilderness sports because they are not governed like sanctioned sports on the high school, college, or professional team level. As in traditional sports, the purpose of a climbing PPE is not to disqualify a participant, perhaps a better term is “optimization of health.” Moreover, even if a PPE for a climbing expedition is requested by a guide agency, it is more likely that the recommendations of the clinician will not disqualify the participant but rather educate the individual (and possibly the agency) so they may either self-select whether they participate or not and/or will be advised on their risks to make that decision appropriately.

Methods

The authors relied heavily on wilderness medicine textbooks and expert opinion from professional societies, such as Wilderness Medical Society and American Society for Sports Medicine. A literature search using EMBASE, MEDLINE, and Cochrane databases was performed to identify pertinent articles for review. Specific key terms used were preparticipation physical evaluation, preparticipation examination, climbing, and mountaineering. These terms were cross-referenced in a variety of combinations with other key terms pertinent to climbing, such as nutrition, pathophysiology, and

training for climbing. Articles chosen were those written in English, yielding articles published over the past 30 years. These findings were organized and consolidated in the recommendations presented in this article.

Findings

PHYSIOLOGY OF CLIMBING

Knowledge of the physiology of climbing can provide the evaluating clinician with an understanding of the demands of climbing and allow one to direct climbers to resources that may better prepare them.

In adults, the physiological adaptation of noncompetitive rock climbers is comparable with other typical aerobic activities at an intensity fitting with American College of Sports Medicine (ACSM) cardiovascular fitness recommendations.³ Proper training and fitness is an essential component to climbing safety. Aerobic fitness accounts for only 40% of performance variability, the remainder being other physiological and technical factors, such as efficiency.⁴ In a study of rock climbers repeating the same route over a 10-week period, time and absolute energy expended was lower by the ninth climb than it was for the first climb.⁵ They went on to find initial gains in efficiency were offset during recovery-phase energy consumption, but by the ninth climb, overall energy consumption was reduced. This is consistent with other sports and suggests that training for one's style of climbing is associated with improvements in the sport.

With training, climbers can become more efficient by taking fewer exploratory moves, thus lessening energy consumption. For example, beginning ice climbers use repetitive axe swings and crampon placements, which in expert climbers become more patterned upper and lower extremity movements, with improved perception and calibration to the environment.⁶ A discussion of training for climbing is beyond the scope of this article, but references are available for those interested.⁷

NUTRITION ISSUES

A simple overview of the basic principles of nutrition can be helpful to a clinician performing a PPE for climbing.

Any sport requires fluid replacement and proper caloric intake that should be appropriately matched to the intensity and duration of the activity. This is true across the spectrum of climbing styles, although some styles may be more demanding than others. The ACSM reports multiple benefits to optimal hydration and fuels, stating that meeting fluid needs means a less pronounced increase in heart rate and core body temperature,

improvements in cardiac stroke volume, output, and skin blood flow (allowing better internal climate control between sweating and cooling mechanisms), and maintenance of blood volume, as well as a reduction in net muscle glycogen usage.⁸ Electrolyte solutions, when compared with free water alone, can help with salt loss and diminish tissue edema and muscle cramping.⁸ Moderate to intense activities lasting over an hour should include fluids containing a 6% to 8% carbohydrate solution along with 100 to 200 g of sodium per cup of fluid, which is optimal for gastric emptying and intestinal absorption as well as for limiting mental and physical fatigue.⁸

Climbers will benefit from choosing foods that supply both adequate nutritional value and the ability to replace caloric losses because of physical exertion during the climbing style they participate. Food choices for climbing are highly individualized and require experience and planning. Thus, experimenting with new foods or drinks would be best in settings close to home, such as the gym or short singleday outings. Climbers should avoid trying new foods on longer expeditions to avoid gastrointestinal (GI) upset in wilderness locations. In depth, discussion about nutrition for climbing is beyond the scope of this article, but books that offer expert advice on nutrition principles specific to climbing are available.^{7,8}

INJURY PATTERNS ACROSS CLIMBING STYLES

Medical providers should recognize that climbing risks and injury patterns are different across the spectrum of climbing styles. Differing statistics make direct comparison of studies difficult, but general trends can be inferred.

MOUNTAINEERING

Schussman et al⁹ reported an incidence of 0.56 injuries per 1000 hours of mountaineering in Grand Teton National Park; the fatality rate in this series was 0.13 fatalities per 1000 hours. In comparison, the case fatality rate for climbing Mount Everest was reported to be 1.3% (including both trauma and environmental causes).¹⁰ Gender does not seem to have a significant effect on injury rates in mountaineering.¹¹ However, males seem to be at higher risk of fatal accidents.¹² In this same series, mountaineering was associated with higher injury severity rates along with higher rates of multisystem trauma when compared with sport climbing; 36% of injuries involved the head or spine, whereas 26% of injuries involved the lower extremities.¹²

Mountaineering may involve mixed and unpredictable terrain translating to a greater risk of injury, and climbers may be ill prepared for snow or ice travel and lack

proper shoes and safety equipment.⁹ It also requires a significant level of physical fitness and a healthy cardiopulmonary system. Participants with prior myocardial infarction or untreated hypertension may be at risk for sudden cardiac death and other medical emergencies while engaging in mountaineering.¹³

ROCK CLIMBING

Backe et al¹⁴ reported an injury rate of 4.2 injuries per 1000 hours of rock climbing. In this case series, 93% of these injuries were classified as “overuse.” A separate study, which excluded overuse injuries, reported a rate of 0.2 injuries per 1000 hours.¹⁵ Regardless, there is a subset of climbers who struggle with chronic overuse injuries that impede activities of daily living.¹⁶ Although there seems to be minimal gender effect on injury rates, Gerdes et al¹⁷ reported that males were less likely to use helmets and more likely to climb under the influence of drugs or alcohol, and the mean age of those having injuries ranged from 26 to 28 years. There was a relatively equal distribution of upper extremity (42.6%) to lower extremity injuries (41.3%).¹⁵ Upper extremity and hand injuries are often overuse injuries, whereas lower extremity injuries more often result from falls.^{14,15}

INDOOR CLIMBING

Indoor climbing seems to have a lower risk of injury when compared to outdoor climbing with a reported range of 0.01 to 0.079 injuries per 1000 hours.^{18,19} However, the reported injury rate during the 2005 world indoor climbing championships was much higher at 3.1 injuries per 1000 hours suggesting that climbers may take more risks in competition, thus leading to more injuries.²⁰ In one series, upper extremity injuries were more common than lower extremity injuries.¹⁹

ICE CLIMBING

Although the data are limited, injury rates for ice climbing are relatively high at 4.07 injuries per 1000 hours.^{21,22} More than 40% of ice climbing injuries involved the head, often from icefall, where upper extremity injuries accounted for approximately 20% of injuries, primarily during lead climbing (where the route is climbed from the ground without a rope above as in top-roping).²² Lacerations and abrasions accounted for more than 55.2% of these injuries, whereas hematomas accounted for 21.9%.²² Table 1 summarizes injury rates among the different climbing disciplines.

Table 1. Summary of Injury Rates Among Climbing Disciplines

<i>Climbing Type</i>	<i>Injuries Per 1000 hours of Participation</i>
Mountaineering	0.56
Rock climbing (alpine, sport, bouldering)	4.2
Indoor climbing	0.027–0.079
Ice climbing	4.07

GENERAL TRENDS

Overall, acute injuries are more common in traditional and alpine climbing when compared with sport or indoor climbing and are most often the result of a fall,²³ whether caught by a rope or not. If caught by a rope, falls on more difficult routes were associated with less severe injuries. This may be because of “cleaner” falls (little to no risk of hitting the wall) secondary to the steeper, more difficult terrain.²⁴ In contrast to alpine climbing, sport and indoor climbing have a roughly equal distribution of acute and overuse injury. Most injuries while rock climbing and mountaineering occur in the afternoon, suggesting that fatigue is an important precipitant for acute injury.²³

Broadly, climbing injuries typically occur from overuse or from falls.^{9,14} Overuse injuries in both rock and ice climbers most commonly involve ligaments and tendons of the fingers and wrists but may also include the elbow or shoulder.^{14,25,26} Early signs of overuse of the finger joints include early morning stiffness and fine motor deficits.^{14,25} Chronic cases may exhibit pain on palpation, capsular swelling, or instability, and carpal tunnel syndrome, medial and lateral epicondylitis, and shoulder impingement syndromes are also prevalent.²⁵ A stepwise increase in training that works on diverse skills on varying routes may prevent overuse injuries, and rest days should also be incorporated into the training regimen.¹⁴ For those who have suffered ligamentous injuries of the fingers, a rest period of several weeks is suggested, where this may involve partial or complete cessation of climbing, depending on the severity of the injury, and retraining should only commence after full recovery from the injury.²⁵ Climbing with an open grip and postinjury therapeutic taping can be helpful when resuming climbing activity to prevent reinjury or the development of chronic injuries.^{14,25}

Traumatic injuries from falls tend to involve the lower extremity.^{14,15} These occur more often in experienced climbers who climb at a high difficulty level and may take falls while climbing at their limits.^{9,15} In sport

climbing, certain moves are rehearsed and falls may be anticipated. However, the climber may still strike the rock and result in injury. Inexperienced climbers also suffer traumatic injuries but this is believed to be secondary to inadequate training, underestimating the environment, overestimating their own abilities, or having insufficient equipment.^{27,28} These individuals should have appropriate training, physical conditioning, and familiarity with the equipment needed for the activity to decrease the risk of injury.²⁷

ENVIRONMENTAL ISSUES

Understanding variables such as temperature extremes, wind exposure, and UV exposure (ocular and skin) is essential to ensure preparedness for climbers. For adequate counseling, however, it is also important to assess conditions affecting rescue and health hazards, including degree of remoteness, short versus long climbing approaches, infectious disease/immunizations if traveling internationally, local health hazards, and availability and extent of search and rescue services.

Many environmental variables have been linked to safety in climbing. Climate variables are much more difficult to quantify, but clearly affect morbidity. Higher altitude and unpredictable weather increase injury rates, whereas easier access and shorter approaches increase the volume of climbers and thus higher total injury volumes.^{23,29-31} Education on recognizing environmental risk factors, such as strong winds, severe cold, or heat, may also dissuade individuals from engaging in these activities in unfavorable conditions.²⁷ Preparedness of the participant, although elusive to define, is likely of high importance, and younger participants with less experience are generally less prepared.³²

Rock or ice fall, avalanches, climate issues leading to exposure (as in cold or heat injuries),³¹ and personal hygiene and attention to group camping issues and tent life are all possible risk factors in climbing depending on the style. For example, a climber on an expedition could also be exposed to issues such as carbon monoxide poisoning, and the spread of illnesses such as gastroenteritis, as well as the environmental issues mentioned above.³³⁻³⁵

Conclusions

By understanding climbing injury patterns, clinicians performing PPEs can be thorough and provide appropriate counseling directed toward risk reduction of overuse and acute traumatic injuries as well as environmental considerations. Documentation can also be thorough and informative. Basics of nutrition, and climbing physiology and training can be broad and oversimplified for a clinician not well versed in the nuances of climbing

as a sport. More in-depth knowledge can be provided to a climber through some of the references mentioned above, referral to a personal trainer or physical therapist, and in some cases referral to a clinician who is well versed in climbing injury and health issues.

Chronic conditions, such as asthma, heart disease, diabetes, kidney disease, and seizure disorders, should be optimized. Many times, advice will not be evidence based, and clinicians must exercise judgment in counseling patients, who in turn will need to make their own decisions based on the best available information. A customized plan with shared decision-making will be the most effective way to handle any health concerns for the climber. Part of the consultation should be addressing first aid preparedness and an emergency action plan, in addition to addressing individual needs based on climbing style, travel, or medical conditions. Allowing ample time in advance of an activity may be all that is needed to optimize one's health conditions, in that this gives the participant an opportunity to undergo any additional testing or initiate any interventions that may be recommended by the evaluator.

SUGGESTED RECOMMENDATIONS FOR THE CLIMBING PPE

A systematic and stepwise approach should be undertaken to ensure completeness and to avoid missing essential information or examination findings. The history will likely represent the majority of the evaluation and guide recommendations; the physical examination (of the likely healthy participant) will contribute only a minority of the evaluation.¹

SUBJECTIVE DATA

An extensive history should be performed, including all chronic conditions, past health issues, surgeries, medications, and allergies to medications. Documentation of any history of known climbing-specific risk factors, such as finger pulley injuries, lateral epicondylitis, wrist injuries, shoulder dysfunction, knee or ankle injuries, history of concussion, or other activity-specific injuries, should be noted. Other relevant history might also include active dermatologic, respiratory, GI, or neurologic issues.

Additional documentation should include the type of climbing style activity, which may be one or several of the subtypes, duration of prior experience (years, months, new to sport), level of involvement (how often they participate), and level of physical activity outside of climbing/mountaineering (other forms of exercise or cross training). Such information gives the clinician a

snapshot of experience with climbing as well as overall level of fitness.

OBJECTIVE DATA

The authors recommend a face-to-face evaluation whenever possible to allow assessment of physical findings. However, in some situations, a physical examination may not be performed, for example, if a clinician is simply reviewing health history forms. Important variables are the measurement of vital signs, specifically noting blood pressure and body mass index. If a physical examination is performed, using traditional principles of the sports physical, the clinician would complete a head to toe examination, with special emphasis on vision, the cardiac system to evaluate for murmurs, the presence of musculoskeletal laxities, strength or balance deficits, and deficits in the neurologic examination. Any acute issues should then be more thoroughly evaluated with further focused examinations on specific findings as needed. Clinicians should use specialty consultation resources when indicated, such as laboratory studies, pulmonary function testing, stress testing, or other studies.

ASSESSMENT/PLAN

An overall assessment of the individual using a primary diagnosis code of “physical examination” or “sports physical” is adequate. It is important to use well-recognized terminology, such as “cleared,” “cleared with specific recommendations,” or “not cleared” (if disqualification is being considered), to avoid confusion in documentation. Any additional diagnoses with an associated assessment and plan can be documented below the primary diagnosis.

If completing a form for a guided agency, often all that is needed is a signature from the clinician. It is unlikely that there will be a template for which to assess “clearance.” This issue can be avoided by following the format provided and signing a document if the participant is deemed cleared for full participation without restrictions.

COUNSELING

In general, 3 areas should be considered. Participants should (1) demonstrate adequate knowledge of local climate variables and how to prepare for them, (2) demonstrate adequate knowledge of self and local rescue resources and how to effectively access them in a medical event, and (3) possess basic medical self-management knowledge and team safety/management principles.

Clinicians should remind climbers to use sunscreen, adequately hydrate and intake proper nutrition, protect from heat and cold, as well as attending to location-specific issues with typical travel consultations. Pretravel consultation may also be involved in such evaluations, in which clinicians may advise updated immunization status or recommend medications for illnesses common to endemic areas.³⁶ For more information on travel abroad considerations, individuals can be referred to the Centers for Disease Control and Prevention.³⁷ Resolving any acute health issues before a trip, making specific recommendations based on physical deficits, and counseling on surveillance of chronic health conditions are essential to any climbing PPE.

CLINICIAN TRAINING

The PPE for climbing can serve a valuable role in climber health and safety during participation. This type of PPE should be tailored to the unique aspects of one’s climbing style, not simply adapted from a traditional sports physical examination model. Clinicians performing such PPEs should educate themselves on the issues specific to climbing. Such knowledge may be obtained by specialty training in sports medicine, wilderness medicine, or additional educational certificates, such as a Diploma in Mountain Medicine, a fellowship of the Academy of Wilderness Medicine, or a fellowship of the American College of Sports Medicine. If a clinician is not comfortable with performing a PPE for climbing, then the authors recommend referral to a physician who is familiar with these PPEs.

As PPEs for climbing occur more frequently, future research should be directed at how to evaluate this process for effectiveness in reducing injury and illness rates.

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