BRIEF REPORT

Rock Climber Self-Rescue Skills

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Introduction—Rock climbing involves some inherent danger, and rock climbers should be able to carry out basic rescue techniques for their own safety. This study seeks to assess such abilities by examining self-rescue skills in a cohort of rock climbers.

Methods—Climbers who participate in multipitch sport or traditional climbing styles were recruited via posters at a local climbing gym and on social media. Participants completed a survey assessing climbing history and confidence in their rescue skills and then were evaluated on 3 rescue scenarios in an indoor, standardized setting. Scenario pass rates were calculated and compared with rescue skill confidence on the survey.

Results—Twenty-five climbers participated in the study. Mean confidence in rescue skills varied from 4 to 4.5 (on a 7-point scale). The pass rates for the 3 scenarios were 28%, 68%, and 52%. Only 24% of climbers passed all 3 scenarios. Surveyed confidence in rescue skills and pass rate statistically correlated in only 1 scenario.

Conclusions—Self-rescue skills were generally lacking in our study population. Climber confidence, experience, training, and climbing frequency did not appear to be associated with a higher level of rescue skills. Self-rescue skills should be emphasized in climbing instruction and courses to increase overall safety.

Keywords: rock climbing, rescue, mountain medicine, mountaineering, climbing accidents, search and rescue

Introduction

Outdoor rock climbing involves inherent danger, and athletes should have a basic knowledge of self-rescue techniques. Traditionally, climbers acquired these skills in an outdoor setting through years of mentoring by those with more experience. It is estimated that over 25 million people climb regularly, and 1000 to 1500 people per day try climbing for the first time in the United States.¹ New climbers entering the sport through climbing gyms are acquiring skills through novel mechanisms, spurring a growing concern about the disruption of the traditional mentorship model, often referred to as “the mentorship gap.”^{2,3}

Currently, few studies have examined climbers' abilities to self-rescue.⁴ In this study, we assess self-rescue

skills that would be considered fundamental in multipitch sport or traditional climbing styles. We chose 3 basic skills (escaping the belay, improvising a belay, and ascending a fixed line) that would be useful for many self-rescue situations. We examined climbers' proficiency in these skills and compared that proficiency with self-reported confidence in rescue ability. We also assessed for associations between rescue skills and frequency of climbing, years of climbing experience, and formal training. Information derived from this study may help to identify a knowledge gap among climbers and guide the climbing community to improve fundamentally important self-rescue skills.

Methods

DESIGN AND STUDY POPULATION

This study was conducted at an indoor climbing gym in Salt Lake City, Utah. Participants were recruited via a poster placed at the climbing gym, through social media, and onsite through solicitation by the research staff. Participants included men and women aged

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≥ 18 y. Climbers who did not climb using traditional or multipitch sport styles were excluded from the study because they would not be expected to have the skills being tested. The University of Utah institutional review board approved this study, and all participants gave written informed consent before participating in the study.

PROCEDURE

Participants were informed that they would be participating in a “rock climbing research study” to prevent them from studying rescue methods beforehand. They were not allowed to observe other participants in the research area before participation. Participants completed a survey assessing their years of climbing experience, typical climbing style, rescue training, and confidence in their rescue abilities (Appendix A). Participant confidence in rescue skills was reported on a 7-point scale, with 1 being “not at all” and 7 being “completely confident.” Confidence in lead rescue was defined as perceived ability to rescue a person who is injured while climbing first up a multipitch climb; second rescue was defined as perceived ability to rescue an injured person who is the second climber on the route.

After the survey, participants were asked to select the equipment they would typically carry with them on a day of multipitch climbing. They were then asked to complete 3 scenarios (Appendix B). Scenario 1 required participants to escape a belay or remove themselves from the rope safety system to call for help or initiate a rescue. In scenario 2, participants were asked to improvise a belay with a Munter hitch, a specialized knot that would allow them to belay if the primary belay device was lost or inaccessible as a result of unforeseen circumstances. Scenario 3 required participants to ascend a fixed rope, an activity that may be required to reach an injured climber above or if a climber has rappelled in the wrong place or with an inappropriately short rope. Participants were given 10 min to complete each scenario. Participants were allowed to stop the scenario at any time for any reason. Participants also were allowed to stop the scenario early and move on if they believed the scenario had been completed.

Participant performance in each scenario was judged using a predetermined pass/fail scoring system based on task completion and errors (Appendix C). Two assessors independently graded each scenario. Both assessors held the Diploma in Mountain Medicine certification and had significant personal climbing and teaching experience in traditional and multipitch sport styles. If one assessor assigned a pass and the other a fail, that scenario was ultimately assigned a fail.

DATA ANALYSES

For each scenario, we calculated the mean and standard deviation of reported confidence on the 7-point scale. Our decision to calculate means from the ordinal scale is supported by Norman⁵ and Sullivan and Artino.⁶ We also calculated the mean and standard deviation for participant age and climbing experience.

Survey results were dichotomized in the following manner: Participants were considered “confident” for any survey question if they scored ≥ 5 out of 7; participants were considered “experienced” climbers if they reported >5 years of climbing experience; participants who reported climbing on at least a weekly basis were deemed “frequent” climbers; and participants who reported taking any type of climbing or rescue course were termed “formally trained.”

We calculated the proportion of individuals who passed each scenario and the proportion who passed all 3 scenarios (termed “cumulative pass rate”). We then calculated the odds of passing each scenario among participants we considered to be “confident” in their rescue abilities and among those we did not consider “confident” and compared them using an odds ratio (OR). The *P* value for the OR was calculated using a χ^2 analysis with Yates correction. A 95% CI was calculated for each comparison. We performed the same analysis for cumulative pass rate with the following variables: confidence, experience, frequency of climbing, and formal training. We considered *P* values <0.05 to be significant.

Results

A total of 25 climbers were recruited for participation during March and April 2017. The age of participants was 30 ± 5 (21–37) y, and they had 6.6 ± 4.0 (0.8–15.0) y of climbing experience (presented as mean $\pm$ SD [range]). Participant demographic characteristics are shown in Table 1.

Survey responses are shown in Table 2 with mean confidence rating, SD, and the proportion of participants classified as “confident” for each survey question. Examples of “formal training” include National Outdoor Leadership School courses, search and rescue training, Diploma in Mountain Medicine certification, and classes taken through climbing gyms or rescue organizations. Table 3 shows scenario and cumulative pass rate for all participants, as well as pass rates for various demographics. The 2 assessors agreed in 72 of 75 scenarios assessed.

The pass rate for scenarios 1, 2, and 3 were 28%, 68%, and 52%, respectively. Only 24% of the participants passed all 3 scenarios. Participants who were considered “confident” in the corresponding survey question had pass rates of 40%, 100%, and 67%, respectively, for scenarios 1, 2, and 3. Of the participants who were

Table 1. Participant demographics

<i>Characteristics</i>	<i>n</i>	<i>%</i>
Sex		
Male	13	52
Female	12	48
Frequency of climbing		
1–4 times per year	3	12
Once a month	1	4
More than once a month	6	24
Weekly	10	40
More than once a week	5	20
Primary discipline		
Bouldering	0	0
Single-pitch sport	6	24
Multipitch sport	2	8
Traditional	10	40
No response	5	20
Leader or second		
More often lead climbing	12	48
More often second climbing	8	32
Equal lead and second	5	20
Formally trained	10	40

Table 2. Participant confidence in rescue skills

<i>Survey</i>	<i>Mean confidence (out of 7)</i>	<i>SD</i>	<i>% Confident (≥5/7)</i>
Lead rescue	4.2	1.4	40
Second rescue	4.3	1.6	48
Self-rescue	4.5	1.4	48
General	4.0	1.7	48

considered “confident” in “general rescue abilities,” only 45% passed all 3 scenarios.

Scenario 2 yielded a positive relationship between confidence and success in the task (OR, 19.2; 95% CI, 2.4–∞; $P=0.004$), whereas scenarios 1 (OR, 2.7; 95% CI, 0.3–23.2; $P=0.52$) and 3 (OR, 3.2; 95% CI, 0.5–23.6; $P=0.3$) did not. For cumulative pass rate, our analysis did not yield significant results when comparing groups

according to general climber confidence (OR, 10.8; 95% CI, 0.8–309; $P=0.08$), frequency (OR, 1.5; 95% CI, 0.2–15.3; $P=1$), experience (OR, 5.6; 95% CI, 0.4–152.4; $P=0.28$), or formal training (OR, 2.8; 95% CI, 0.4–19.3; $P=0.4$).

Discussion

We found that the majority of the participants did not pass our basic rescue skill scenarios, even though many were experienced, frequent, and formally trained climbers, and many rated themselves as “confident” in their rescue skills. The scenario pass rates were low, ranging from 28% to 68%, and the cumulative pass rate was only 24%, suggesting that only 1 in 4 climbers in our population had basic self-rescue skills. We suggest that this knowledge foundation is inadequate, and steps should be taken to increase awareness and rescue skills in the rock climbing population.

Climbers’ confidence in their rescue skills was not associated with performance in these skills. Furthermore, climbing frequency, experience, and formal training were not associated with success in our scenarios. This lack of association may present potential barriers to further skill acquisition because climbers may be unaware of their own skill level and may falsely assume that experience, training, and climbing frequency correlate with an increase in rescue ability.

The scenarios had a large degree of variability in the technical skills required. Scenario 1: Escape the Belay involved a moderate to high level of complexity; trial and error usually did not result in a successful outcome. A small number of participants were able to pass the scenario by improvising. For example, 2 participants were able to safely tie off the belay and secure it with a backup knot, thus ensuring the safety of the lead climber, after which they simply removed their harness, leaving their belay loop as part of the system and “successfully” escaping the belay. Although some improvisation may be required in real-life rescues, the improvisation described here bypasses fundamental rope skills and is not usually ideal for rescue scenarios. Furthermore, the strategy employed by these participants would probably

Table 3. Scenario pass rates

<i>Scenario</i>	<i>Pass rate (%)</i>			
	<i>Total (n=25)</i>	<i>Experienced (>5 y) (n=14)</i>	<i>Formally trained (n=10)</i>	<i>Frequent (>once/wk) (n=15)</i>
1 (Escape the Belay)	7 (28)	5 (36)	5 (50)	5 (27)
2 (Improvised Belay)	17 (68)	12 (86)	8 (80)	12 (80)
3 (Fixed Rope Ascension)	13 (52)	9 (64)	6 (60)	8 (53)
Cumulative	6 (24)	5 (36)	5 (50)	4 (27)

not be successful above the first pitch on a multipitch climb because the rescuer would immediately be unsafe without a harness and would likely require a harness to get to safety. Thus, the pass rate of 28% for this scenario may overestimate this skill in our population.

The higher pass rate for Scenario 2: Improvised Belay could have resulted from trial and error. In this scenario, many participants recognized that they needed to tie a Munter hitch but could not immediately recall how to tie it. However, during 10 minutes of trial and error several participants eventually tied the correct knot.

Our review of literature only revealed 1 relevant study. That study, published in 2002,⁴ found that 81% of climbers felt confident they could escape a belay and 91% felt confident they could ascend a fixed rope. That study did not include an independent assessment of climbers' skills. We could not identify any other studies that assess rescue skills in the rock climbing community. Although there are several limitations in our study, this research does suggest that the climbing population may be insufficiently prepared to perform basic self-rescue skills.

To improve self-rescue skills in rock climbers, the community must first become aware of the need for such skills. Climbing gyms act as hubs of climbing culture and information and are ideal starting points for highlighting the importance of these skills. Climbing magazines and social media could publish articles promoting safety and self-rescue skills training. Climbing gyms could support self-rescue courses, remind climbers to practice these skills via posters and active instruction, and set aside a small area of the gym specifically for practice. Anecdotally, after completing the study many of the participants were grateful for the opportunity to practice rescue skills and requested that self-rescue training scenarios be available to practice in the gym.

LIMITATIONS

This study was conducted with a small sample size at a single climbing gym and thus may not accurately represent the general population of outdoor rock climbers. We only included multipitch sport and traditional climbers, and thus the results cannot be extrapolated to other styles of climbing, including mountaineering and ice climbing. We recognize that competence in the skills tested is not sufficient for one to be considered competent in rescue in general. However, these basic skills are often necessary to perform a successful rescue.

Defining climber experience is not straightforward. In this study we defined "experienced" as >5 y of climbing. We acknowledge that an individual climber could gain more experience in 1 year of climbing than another may

gain in 10 y or more. Furthermore, our definition of formal training was liberal, with participants who reported any type of rescue training being described as "formally trained."

Performing the scenarios in a controlled indoor setting may have simplified them for participants by removing factors such as temperature, wind, rain, fear, and fatigue. Participants were assessed indoors to standardize the conditions and to ensure safety of participants with gym mats and easily accessed backup belay systems. Finally, our method of assessment relied on the experience and training of the 2 assessors because no widely accepted tool could be identified for assessing these types of skills.

FUTURE RESEARCH

Future studies should consider consultation with climbing associations (for example, American Mountain Guides Association or International Federation of Mountain Guides Associations) for scenario development and grading. A more nuanced method of assessing climbing experience by combining years of climbing, frequency, and style could also be helpful. Although assessing these scenarios indoors is logistically simpler, future research may benefit from performing them outdoors to incorporate realistic stresses from weather, exposure, fear, and fatigue. Lastly, to get a more complete picture of the climbing community in general, future studies should recruit a larger study population from a wider geographic area.

Conclusions

Our study was a novel and focused assessment of rescue skills in a sample of rock climbers. Self-rescue skills in our study population were below what we believe necessary to be safe and self-sufficient while undertaking this potentially dangerous activity. Rescue skill proficiency did not appear to be associated with increased climbing experience, training, or frequency. Association with confidence was variable. Although our conclusions may not be generalizable to the entire climbing community, our results do suggest the need for improved self-rescue education and further investigation in this area to improve climber safety.

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Disclosures: None.

Appendix A: Survey

Name: _____

Participant number: _____

Age: _____

Sex (circle one): Male Female

What style of climbing do you practice outdoors? (circle all that apply)

- a) bouldering d) single pitch traditional climbing
 b) single pitch sport climbing e) multipitch traditional climbing
 c) multipitch sport climbing f) Other: _____

Which of these styles do you practice primarily outdoors? (circle one)

- a) bouldering d) traditional climbing
 b) single pitch sport climbing e) Other: _____
 c) multipitch sport climbing

When climbing sport or trad, how often do you climb as a leader as opposed to a second? (circle one)

Never Half of the time Always
 1 2 3 4 5 6 7

How long have you been rock climbing trad or multipitch sport outdoors? _____

How often do you climb trad or multipitch sport outdoors (when in season)?

- a) 1-4 times per season d) Weekly
 b) Once a month e) More than once a week
 c) More than once a month

Please estimate how many pitches of trad or multipitch sport you have climbed outdoors. _____

How did you learn to climb outdoors? (circle all that apply)

- a) Self-taught
 b) A climbing mentor or friend
 c) A formal climbing course
 d) Other (please explain): _____

Of the above, which was the primary method that you learned to climb outdoors? Please elaborate.

How often do you wear a helmet when climbing or belaying outdoors?

Never Half of the time Always
 1 2 3 4 5 6 7

Have you had any rock climbing rescue training? If yes, please explain.

How confident are you that you could rescue an injured lead climber?

Not at all Neutral Completely confident
 1 2 3 4 5 6 7

How confident are you that you could rescue an injured second climber?

Not at all Neutral Completely confident
 1 2 3 4 5 6 7

How confident are you that you could rescue yourself (as a lead or a second)?

Not at all Neutral Completely confident
 1 2 3 4 5 6 7

How confident are you in your rescue abilities in general?

Not at all Neutral Completely confident
 1 2 3 4 5 6 7

Appendix B: Scenarios

Set up: Participants will be given a selection of standard climbing gear that climbers might have available during a multipitch or traditional climbing route. Available gear will include:

- Locking carabiners
- Quickdraws
- Camelots on non-locking carabiners
- Individual non-locking carabiners
- Belay devices: plaquette and assisted braking devices
- Prussiks (long and short)
- Purcell prussiks (long and short)
- Cordelette material: Untied 6 and 7 mm cord in 15' sections

Participants will be prompted as follows:

"You and your partner are gearing up for a multipitch sport route. The crag is a 30-minute hike from the car and you may expect to see 1 or 2 other parties during the day. Assume your partner has a similar skill level and the same gear as you. The route is a challenging grade for you but within your leading abilities. It is 4 pitches long with an established rappel that is separate from the route. You have a single 70 m rope, which is long enough for the rappels. You will be swapping leads. Because the route is hard for you, you would like to be prepared and keep weight down. Please select the gear that you would normally bring with you for this route (separate from the rope, quickdraws, food/water/clothing)."

After selecting their initial gear, the participants will not be allowed further access to the other available gear. They must work with what they have selected.

Scenario 1: Escape the belay

Set up: The participant will be on the ground belaying a simulated lead climber (using whatever belay device they choose) off of their harness. An anchor near ground

level will be created for them to simulate a tree or other appropriate ground level anchor.

Stem: You are belaying on the first pitch of the route. Your lead climber is 50 m up a 60 m pitch on your 70 m rope when he gets struck by rock fall and becomes unconscious. You have no cell phone service at this location and you did not bring a radio or other GPS device. You have decided that escaping the belay in order to seek out a cell phone signal or get help for your partner is the best plan. Please demonstrate how you would safely escape the belay, so that you can walk around the crag and see if there is anyone else around who can help.

Scenario 2: Improvised belay device

Set up: An anchor will be set up in order to simulate the participant belaying the second climber from above. Any standard belay devices will be removed from their harness before starting the scenario.

Stem: You finish leading the third pitch and build an anchor at the bolts. Unfortunately, as you go to set up the belay, you realize that you left your belay device at the last anchor. The pitch is too long and winding to rappel down to get a device from your partner or to pull one up. Please improvise a belay system in order to safely belay your partner up to you. Assume your personal anchor is already attached to the bolted anchor.

Scenario 3: Ascend a rope

Set up: The participant will be rigged on a two-rope rappel through a rappel device and hanging in space. The rappel should be rigged however the participant normally rappels.

Stem: You throw your ropes cleanly down what you believe to be the designated rappel tree of the first rap and rig to rappel. The terrain is overhanging and as you rappel over the edge you quickly realize you rappelled at the wrong place. You are now hanging in space and are unable to swing back to the wall. Please demonstrate how you would ascend your rope the 2 m to get back to the rappel edge.

Appendix C: Grading Scheme

Date: _____

Participant Number: _____

Incomplete: the participant is not able to accomplish the task in the time allotted.

Major error: an action that would put the participant or partner at risk of serious injury or death

Minor error: an action that would put the study subject or partner at risk of minor injury OR a minor variation in the accepted standard but safety is not compromised

Pass: task completed to accepted standards with no safety concerns

3 minor errors constitute a major error. One major error constitutes a fail.

Scenario 1 (escaping the belay):

Result (please circle)

Incomplete Fail – major error Pass- 1-2 minor errors Pass

Task	Pass	Minor error	Major error
Constructs appropriate braking system (prussik, brake knot, etc.) in order to be hands free			
Able to attach weighted rope to bottom anchor			
If a system requiring a back up is used, back ups are built adequately			
Attachment to bottom anchor is adequate and hands free			
Able to safely escape belay device			
Able to complete task without lowering climber significant distance (<1-2 m)			

Minor errors (please detail):

Major errors (please detail):

Scenario 2 (improvised belay device):

Result (please circle):

Incomplete Fail – major error Pass- 1-2 minor errors Pass

Task	Pass	Minor error	Major error
Able to set up an improvised belay device			
Able to operate the improvised belay in a safe manner			
Able to safely belay a simulated climbing partner for a few meters			

Minor errors (please detail):

Major errors (please detail):

Scenario 3 (ascending a rope):

Result (please circle):

Incomplete Fail – major error Pass- 1-2 minor errors Pass

Task	Pass	Minor error	Major error
Able to safely be hands free for transition into ascent (ie: constructs braking system or uses appropriate device)			
Maintains full strength attachments throughout scenario			
Able to ascend approx. 2 m			
Ascends in a controlled manner			

Minor errors (please detail):

Major errors (please detail):

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