Skeletal Injuries and Their Pattern Following Mountaineering and Climbing Accidents in Iranian Athletes

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Abstract- The number of mountaineers and climbers has increased over the last few years. Considering the geographical features of Iran, this increase in the number of climbers is more significant in this country. Because of the importance of mountaineering injuries, a comprehensive survey of these injuries is needed. In this base, we designed a survey to investigate skeletal injuries in mountaineering accidents. This cross-sectional study was conducted on athletes from the Mountaineering Federation of Islamic Republic of the Iran (MFIRI) in 2015 and 2016. A total of 110 athletes were included using a simple random sampling method, and they were examined for any complications after skeletal injuries. Their medical records were reviewed. A total of 110 mountaineers completed the checklists, and 15 mountaineers reported a rock-climbing trauma and injury during 2015 and 2016. The most traumatic location was the lower extremities (46.7%). Additionally, most of trauma occurrences were in descent (80%) and times of day between noon and midnight (64.3%). The mean age of the mountaineers who had a trauma incidence was 37.95±8.76 years. Smoking was significantly different between the two groups. Skeletal injuries during mountaineering and rock climbing mostly affect the lower extremities, followed by the upper extremities and spine. There was no significant difference in age, sex or climbing equipment between the group who had an accident and the group who did not. In this study, there was a relationship between smoking cigarettes and an increased incidence of climbing accidents. Longitudinal studies with larger sample sizes are needed to evaluate this relationship.

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Introduction

Mountaineering and climbing sports are interesting and have become increasingly popular in recent decades. These sports spread out globally and have different majors, such as ice climbing, rock climbing, stone climbing, bouldering, speed and aid climbing. All these types have led to a dramatic increase in the number of climbers recently (1). These climbers have different skill levels, which increase the number of injuries related to this sport (2). A wide range of activities in mountaineering presents different physiological demands and risks depending on climbing style, height, environmental circumstances, and expertise and so on. Generally, there are five major types of climbing: 1. mountaineering; 2. traditional rock climbing; 3. sport climbing; 4. indoor climbing, and 5. vertical ice climbing. Accidents, injuries and altitude illness at higher altitudes are important. Hands, fingers, and shoulder girdles are the most involved parts of the body in climbing activities, which often result in injuries in these organs. Some studies in Germany, America, and England have evaluated the incidence of different injuries (3-5). Most reports indicate that the hand, shoulder and generally the upper extremities, are more commonly involved in mountaineering injuries. Climbing injuries are classified into acute and chronic (overusing organs). Falling is an acute climbing injury and the most important one, but its prevalence is low. Distinguishing between acute and chronic injuries in

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climbing is important because ignoring the overuse of organs can lead to permanent injuries, but it is not easy (6).

The climbing risks are divided into subjective and objective risks. Objective risks included the weather condition, stone falling, storms, and high altitude and so on, which is a mountain nature and have no relevance to climbers' skills. The subjective risks such as wellbeing, climbing expertise, awareness of objective risks, and equipment can be more improved by educating and experiencing. The subjective and objective risks are dependent on each other and cannot be evaluated separately (7). Common causes of death between high-altitude climbers, such as sudden cardiac death, trauma, high-altitude illness, cold injury and avalanche burial, have been reported in reports and studies. However, falling is the most common mechanism of accidents among Iranian mountaineers (8).

According to its geographical features and the mountains of Iran, the number of climbers is growing rapidly, but there is not sufficient evidence and analysis of the prevalence injuries among Iranian climbers. Several epidemiologic studies have shown injuries sustained by climbers, but there is no comprehensive database that records region and body injuries. Therefore, it is necessary to collect a survey of injuries in this popular sport to plan for further discussion.

The samples of this study were from different regions of Iran. Due to the lack of equal access to the climbers of different regions, as well as the cost- and time-consuming attendance, data were collected through a checklist (Google Docs form) and an online checklist.

Materials and Methods

This cross-sectional study was conducted on all 110 registered athletes in the mountaineering federation of the Islamic Republic of Iran (MFIRI) in 2015 and 2016. According to a study by Jones *et al*., indicating 50% prevalence of injuries≥1 injury in the past 12 months (4), using the following formula and considering 10% attrition and an alpha of 0.05, 110 subjects were selected.

$$n = \frac{Z^2_{(1-\alpha/2)}\, P(1-P)}{d^2}$$

This study was approved by the Iran University of Medical Sciences ethics committee, Code: IR. IUMS. REC 1395.8921215091.

Since the athletes were from different regions and we did not know how many forms to be exactly filled, we intended to perform the study based on 110 participants. In this two-year period, the athletes were included using a simple random sampling method, and they were contacted by their phone numbers reported in their MFIRI profile.

All 110 athletes were selected at random, and of the total athletes registered in the mountaineering federation of the Islamic Republic of Iran, the phones were specified by a unique number. All numbers were placed in a box, and 110 numbers were taken to be called and participated in our study.

The importance of this research, the process of study and the benefits of this study to other athletes were described to the participants. They were assured of the anonymity of their personal and health data and signed an informed consent form for participating in the study. Then, the Google Docs online form was sent to them, and to the members of the research team helped and accompanied the climber in the completion of the form through a phone call. The Google Docs online form was designed to ask questions in 7 basics in Persian. The steps of the checklist were designed in such a way as to avoid the Mountaineer's confusion. The design of the form was that if the answer to a question was positive, the number of questions related to it would appear to the mountaineer; otherwise, it would be possible to respond to the original form.

After receiving their consent, an online form was sent to them. The checklist consisted of the items listed below:

- Demographics (age, sex, marital status)
- How many climbs do you make in a year? (athletes' experience)
- Did you have a skeletal injury in 2015 or 2016?
- The exact location of the injury?
- What was the main cause of your injury in your opinion?
- At what height did the injury occur?
- Did the injury happen during climbing or descending?
- What is the past medical history of the athlete at the time of injury?
- What time did your injury occur?
- On which day of the week did your injury occur? (Was it holiday or not?)
- In which season did you have your injury?
- Were you accompanied by an experienced and trained co-climber?
- How were you equipped for climbing? What equipment did you have with you?

- Are you a member of a group for mountaineering?

Participants who reported skeletal injury were asked to come to one of three designated place for physical examination and in-person interviews. Additionally, they were told to bring any medical documents relating to their past injuries due to mountaineering. Three places that were equipped for this interview were Rasool Akram Medical Complex, MFIRI Office and Tehran Mountaineering Board Office.

Participant with a history of skeletal injury were examined for any complications after their injuries. Additionally, their medical documents and reports of their injuries in MFIRI were reviewed. For athletes of other parts of the country, they were asked to go to their provincial Mountaineering board office, and they were examined by trained physicians. If the athlete did not pick up the phone at the first time, he or she was contacted 3 more times at different times of day and on different days. If they did not answer after this, a letter was sent to their address. If they did not reply to the mail for 2 weeks, they were removed from the sample.

Statistical analysis was performed using Statistical Package for Social Sciences, version 22.0 (IBM SPSS Statistics Inc., Chicago, IL, USA) and Statistical Analysis Software, version 9.1 (SAS Institute Inc., Cary, NC, USA). The mean±standard deviation was used to describe quantitative data, and categorical variables were expressed using counts and percentages. After describing the data, the demographic features of the two groups were analyzed. Using the t test and Mann-Whitney test, quantitative variables were compared. To compare qualitative variables, the chi square test and Fisher's exact test were performed. Correlations between quantitative variables were investigated by the Pearson correlation coefficient and Spearman rank correlation. The level of significance was considered to be α=0.05 in statistical tests.

Results

A total of 110 mountaineers completed the questionnaire, and 15 mountaineers reported a rock-climbing trauma and injury during 2015 (40%)-2016 (60%). The mean age of the mountaineers that had a trauma incidence was 37.95±8.76 years old, and the age of the mountaineers that had no injury was 37.52±9.99 years old (P>0.05). There were 13 male mountaineers (86.7%) with traumatic injuries, while 73 male mountaineers (76.8%) were in the non-traumatic group (P>0.05). The most traumatic location was the lower extremities (46.7%). Upper extremities, spine and vertebrae, and other locations were 20%, 13.3%, and 20%, respectively. Additionally, most trauma occurrences were in the descending (80%) and afternoon (64.3%) periods. Thirty-three percent of traumatic mountaineers were smokers, while 6.3% of non-traumatic mountaineers were smokers. There was a significant difference in smoking between the two groups (P<0.05). Eleven (73.3%) traumatic mountaineers mentioned that they were accompanied by trained co-climbers during injury occurrence. In 11 mountaineers (73.3%), traumatic injury occurred on weekends, while in three climbers (20%); this was at other days of the week. One climber also did not remember. Other checklist question data are shown in Table 1. (N/A: unavailable)

As shown in Table 2, only smoking was significantly different between the two groups. Other differences were not significant. (NS: not Significant, S: Significant)

Table 1. Checklist questions data

Variable [n, (%)]		Incidence: Yes	Incidence: No
Season	**Spring**	4, (26.7%)	N/A
	Summer	5, (33.3%)	N/A
	Autumn	3, (20%)	N/A
	Winter	3, (20%)	N/A
Athletes experience		22 times	10 times[ǂ]
>Median		7.85 times	5.66 times
>Median		37.75 times	29.89 times
Grade of injury	**1**	16, (80%)	N/A
	2	2, (10%)	N/A
	3	1, (5%)	N/A
	4	1, (5%)	N/A

Cont. table 1

Main cause of injury	**Lack of proper equipment**	1, (6.7%)	N/A
	Lack of proper training for preventing fatigue	2, (13.3%)	N/A
		3, (20%)	N/A
	Inappropriate atmospheric conditions	1, (6.7%)	N/A
	Others	8, (53.3%)	N/A
Height of Injury occurrence		2860±1059.14	
>Mean		2077.14	N/A
<Mean		3642.85	N/A
Not mentioned		1 Case	N/A
Member of a Group	**Yes**	11, (73.3%)	72, (75.8%)ǂ
	No	4, (26.7%)	23, (24.2%)
Equipment	**Hiking Boots**	9, (64.3%)	93, (97.9%)ǂ
	Climbing gloves	7, (50%)	82, (86.3%)ǂ
	Climbing baton	8, (57.1%)	79, (83.2%)ǂ
	First aid box	10, (71.4%)	68, (71.6%)ǂ
	Others	5, (35.7%)	35, (36.8%)ǂ
Age, mean□ SD		37.95□8.76	37.52□9.99ǂ
Male gender		13(86.7%)	73 (76.8%)ǂ
Smoking		5 (33%)	6 (6.3%)*

* Statistically significant difference compared with the Incidence: Yes (P<0.05);
ǂ Statistically not significant difference compared with group Incidence: Yes (P>0.05).(N/A: not Available)

Table 2. *P* of variables

Age	***P*, (Significance)**
Gender	0.647, (NS)
Athletes experience	0.516, (NS)
Smoking	0.145, (NS)
Membership	0.007, (S)
Equipment	1.000, (NS)
Age	>0.05, (NS)

(NS: not Significant, S: Significant)

Discussion

Iran is a vast country that includes the Zagros and Alborz mountains. One of the most common complications of mountaineering is skeletal injuries.

In our study, 15 athletes out of 110 reported a rock-climbing trauma and injury for 2 years (13.63%). This prevalence is higher than that in other studies reporting mountaineering injuries; this could be because both mountaineers and rock climbers were enrolled in this study.

Ninety-five percent of the mountaineers completed the form correctly. Our goal in this project was to investigate the prevalence of skeletal injuries in mountaineers from all over Iran, and for this purpose, we used a checklist (designed by Google Docs) and one member of the research team helped in the process of completing the form.

Our results for the time of accident show that 73.3% of accidents occurred during weekends. This is slightly higher than other studies, reporting 53% of accidents on weekends (9). The higher number of accidents on weekends compared to weekdays might be because of the higher mountain climbing rate on weekends.

An evaluation of the anatomical location of the injury showed that the lower extremities were the most commonly injured body part (46.7%), followed by upper extremity injuries (20%) and spinal injuries (13.3%). Compared to similar studies conducted on climbing injuries, our results showed fewer injuries to the upper extremities and more injuries to the lower extremities, and the prevalence of spinal injuries was similar (10). This difference may be because of differences in the study populations. Grading injuries for severity showed that most of the injuries evaluated in this study were mild and grade one (80%).

There was no significant difference in demographic variables such as age and sex between the group who had an accident and the group who did not. However, our results showed a relationship between smoking cigarettes and an increased incidence of climbing accidents. In an existing study conducted in 2002 army recruits also reported that smoking may be a risk factor for musculoskeletal injury and fracture during basic training in the army, with a significantly higher adjusted injury rate in recruits who reported smoking at least one cigarette in the prior month than in those who did not smoke (11). Further studies are required to confirm these results. Other studies also found smoking to be a risk factor for delayed recovery and poor bone and soft tissue healing (10).

Membership in a group and climbing equipment was not significantly different in the injured and non-injured groups, but there was a lower rate of climbing boots, gloves and batons in the injured group. Therefore, more studies with larger sample sizes are needed to determine the effect of climbing equipment on mountaineering injuries. A similar study evaluating the effect of footwear on injuries among long-distance hikers showed no association between the type of footwear and musculoskeletal injuries, such as fractures and tendon injuries (12). Given the 95% success using this method, it is recommended that future studies should be conducted with a larger population.

Skeletal injuries during mountaineering and rock climbing mostly affect the lower extremities, followed by the upper extremities and spine. There was no significant difference in age, sex, or climbing equipment between the group who had an accident and the group who did not. In this study, there was a relationship between smoking cigarettes and an increased incidence of climbing accidents. Longitudinal studies with larger sample sizes are needed to evaluate this relationship.

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