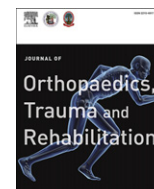


Contents lists available at ScienceDirect

Journal of Orthopaedics, Trauma and Rehabilitation

Journal homepages: www.e-jotr.com & www.ejotr.org

Original Article

The Epidemiology of Ankle Sprain During Hiking in Uniformed Groups

制服團體成員在徒步旅行中踝關節扭傷的流行病學

Lam Wai-Ho Oscar ^a, Lui Tun-Hing ^{b,*}, Chan Kai-Ming ^c^a Hong Kong Christian Service Pui Oi School, Hong Kong^b Department of Orthopaedics and Traumatology, North District Hospital, Hong Kong^c Department of Orthopaedics and Traumatology, Prince of Wales Hospital, The Chinese University of Hong Kong, Hong Kong

ARTICLE INFO

Article history:

Accepted September 2010

Keywords:

ankle
injury
sprain
hiking
uniformed group

ABSTRACT

Purpose: To determine the prevalence of ankle sprain during hiking training in uniformed groups and identify the risk factors of ankle sprain and the risk factors associated with residual problems after ankle sprain.

Methods: A retrospective cross-sectional study involved 590 members of a uniformed group from secondary schools and their leaders by means of a self-administered anonymous questionnaire.

Results: The prevalence of ankle sprain was 9.15%. Most of them were lateral sprains (70.4%) and occurred in scree ground (51.9%) and downhill slope (50.0%). Subjects who are “older” aged, are overweight, are leaders in uniformed groups, have a past history of ankle sprain or problem, have a long-term lower limb injury, wear inadequate sized or tight shoes, and use hiking poles, have significant risks. The prevalence of having residual problems after ankle sprains was 48.14%, and the most common one was residual ankle pain (25.0%).

Conclusion: Uniformed group leaders and members should be aware of the risk factors of ankle sprain during hiking training in the countryside. They should also be aware of the importance of proper treatment and rehabilitation to prevent residual ankle problem.

Level of Evidence: Level II prognostic study.

中文摘要

目的: 探討制服團體成員在徒步旅行中踝關節扭傷的患病率，並明確踝關節扭傷及傷後殘留症狀的危險因素。

方法: 本次回顧性橫斷面研究的設計為對來自中學的590位制服團體成員及其領導者進行自行無記名問卷調查。

結果: 踝關節扭傷的患病率為9.15%。多數為外側扭傷 (70.4%)，扭傷多發生在石子路面 (51.9%) 和下傾坡面 (50.0%)。踝關節扭傷的危險因素為年齡較大、超重、團體中的領導者、踝關節扭傷或疾病的既往史、長期的下肢損傷史、穿的鞋不合尺寸或過緊、應用旅行杖等。踝關節扭傷後殘留症狀的患病率為48.14%，最常見的症狀為殘留踝關節疼痛 (25.0%)。

總結: 制服團體領導者和成員在戶外進行徒步旅行時需要注意踝關節扭傷的危險因素。同時他們應該知道正確治療和康復的重要性以防止殘留踝關節病患。

證據分級: II 級預後研究。

Introduction

Uniformed groups introduce different kinds of challenges and training, such as backpacking and wild camping, to youngsters in the countryside to develop their positive values and acquire leadership skills. Hiking becomes an important training to the members. Although hiking is a long continuous exercise with low

intensity, which can promote cardiopulmonary health,¹ safety is still a main concern for the parents and public.

Ankle sprain is considered to be a very common type of sport injury.² It results in the stretching of collagen fibres of the ankle ligaments, whereby the fibres are partially or completely disrupted.³ Residual problems, such as chronic pain, instability, are also very common after ankle sprain.^{4–9} There were many studies that investigated the risk factors of lower extremity injuries on various kinds of sports. Age, gender, body mass index (BMI), hand

* Corresponding author. E-mail: luiderek@yahoo.co.uk.

dominance, shoe type, and skill level have been identified as the risk factors, but there is little agreement among different studies.^{3,10–17} The lack of consensus may be caused by dissimilar baseline risks associated with different sports, differences in the measurement techniques, disparities in statistical analyses, differences in definitions of injury and severity, and the differences in methods of data collection.¹⁶

There was little information about the risk factors of ankle sprain during hiking in uniformed groups in the literature.¹⁸ As ankle sprain commonly occurs and is often associated with residual problems, risk factors associated with ankle sprain must first be identified and understood with a view to develop preventive strategies and education programmes.

The aims of this study were:

1. To determine the prevalence of ankle sprain during hiking training in uniformed groups.
2. To identify those risk factors associated with ankle sprain.
3. To determine the prevalence of having residual problems after ankle sprain.
4. To determine those risk factors associated with having residual problems after ankle sprain.

Materials and Methods

This was a retrospective cross-sectional study. Members of the uniformed groups in Hong Kong and leaders who provide training to them were invited to participate. Those without hiking training in the past 12 months were excluded. They were asked to fill in a self-administered anonymous questionnaire. The study was approved by a local clinical research ethics committee.

A pilot study was carried out to give adjustment to the questionnaire. Ten members from the uniformed groups were invited to fill the questionnaire and provided comments. Adjustments of the questionnaire were made before sending the final version to the study subjects.

One thousand questionnaires in Chinese version were sent to the chief executives of different uniformed groups. They were asked to send those questionnaires to different groups in different districts to minimise regional differences. The questionnaires were returned by post.

The questionnaire consists of four parts (Appendix). The first part comprises the guidelines, instructions, and the definitions of terms. The second part comprises the demographic data of the subject. The third part comprises injury-related data of those with ankle sprain during hiking training. The fourth part is filled by subjects without a history of ankle sprain during hiking training. Except injury-related information, the questions were the same as those of the third part. To minimise misunderstanding of the questions, leaders from each uniformed groups were requested to provide supervision for their members.

The data were analysed with SPSS 16.0 (SPSS Inc., Chicago, IL, USA). The life-time prevalence of ankle sprain and injury information was evaluated by descriptive statistics. Chi-squared test was used to study the association of each possible risk factor with ankle sprain or residual problems. Some subgroups in each possible risk factor were combined, as the number of responses was too small to meet the assumption of χ^2 test. These variables were age, BMI, frequency of hiking, damage of shoes, sizes of shoes, and tightness of shoes. The odds ratios were calculated for those risk factors that had significant associations with ankle sprain or residual problems. Binary logistic regression analysis was used to study the association of each risk factor with ankle sprain after the adjustment for the effect of other risk factors. Risk factors with significant

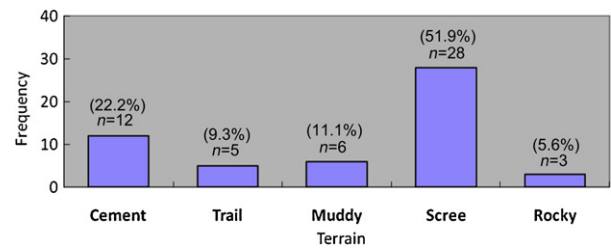


Figure 1. Injured subject distribution among different terrains.

relationships with ankle sprain were used as adjustment factors for potential confounding in the logistic models, and 5% level of significance ($p < 0.05$, 2-tailed) was used. Finally, adjusted odds ratios were calculated. A p value less than 0.05 (2-tailed) was considered to be statistically significant.

Results

Ankle sprain

There were 590 questionnaires returned (return rate of 59%) from 20 uniformed groups. Fifty-four subjects had sprained their ankles during training (prevalence of 9.15%). Among the 54 subjects with ankle sprain, 51.9% got sprained in scree ground (Figure 1) and 50.0% in down slope (Figure 2). 40.7% of injured subjects were able to walk immediately and another 40.7% were able to walk after rest (Figure 3). Most of them (70.3%) suffered from lateral sprain (Figure 4). There was no significant relationship between injury side and dominant hand side ($p = 0.411$). 29.7% did not manage the injury immediately (Figure 5), and more than half (59.3%) of the subjects did not consult any professionals (Figure 6).

The injured and control groups differed on the number of descriptive characteristics (Table 1). Age, BMI, position, number of times of hiking, past history of ankle sprain, long-term lower limb injury, shoe size, shoe lace condition, use of hiking poles, and past history of ankle problems had significant relationship with ankle sprain during hiking training. Gender, uniformed groups, shoes types, height of the shoes, damage of the shoes, and volume of the backpack did not show a significant relationship with ankle sprain. The odds ratios for each significant risk factor are also shown in Table 1. Only past history of ankle sprain, shoe lace condition, use of hiking poles, and past history of ankle problems could fit into the regression model with significant values (Table 1).

Residual problems

Among the 54 injured subjects, 26 had residual problems (prevalence, 48.14%). Pain was the most common residual problem, followed by weakness and recurrent sprain, instability, stiffness, and swelling (Figure 7). Only past history of ankle sprain and ankle problems had a significant relationship with residual problems (Table 2).

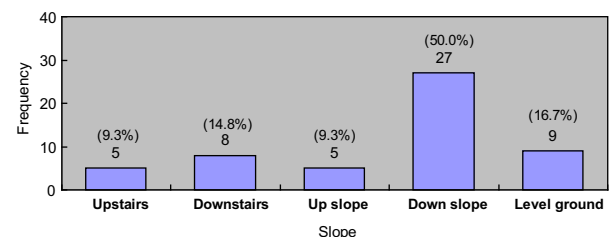


Figure 2. Injured subject distribution among different slopes of the ground.

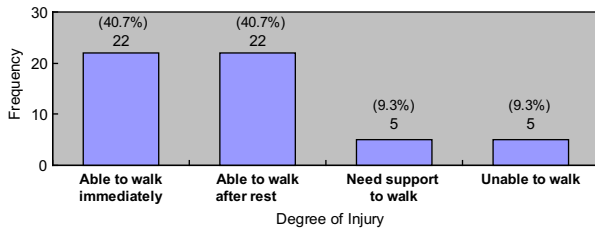


Figure 3. Injured subject distribution among different degrees of injury.

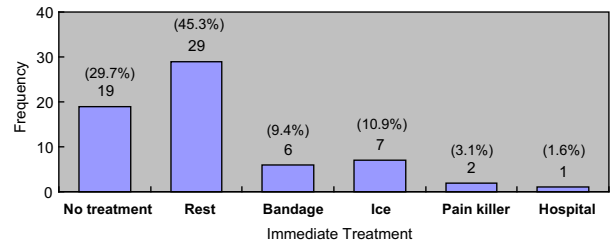


Figure 5. Injured subject distribution among different immediate management methods.

Discussion

Our study showed that the prevalence of ankle sprain during hiking training in uniformed group was 9.15%. It was suggested that the prevalence was lower than that in other sports,^{2,4,5,7–9} because the nature of hiking activities is of far lower speed and less demanding than that of other competitive sports. Other sports, such as soccer, basketball, and volleyball, required a lot of body contact, sudden turning, and jumping, all of which tend to cause ankle sprain.⁵

In our study, half of the injured subjects sprained their ankles on scree ground and down slope. Downhill walking was associated with increased lower extremity joint loading that may cause injuries.¹⁹ Robbins and Waked²⁰ suggested that most ankle sprains occurred during foot contact on landing or locomotion associated with either unanticipated foot placement on a sloped surface or inappropriate positioning of the foot in space before contact with a surface. Moreover, as the ankles were in plantarflexed position on down slope, there was an increased risk of injury to anterior talo-fibular ligaments. Therefore, scree ground and down slope that were uneven and slippery were considered to be a high-risk environment to ankles.

Many of the uniformed groups undergo hiking training in the daytime (85.2%), as it is easier for the leader to manage the whole team. The environment with sufficient sunlight was considered to be safer for young members. Therefore, most of the injured subjects spraining their ankles in the daytime may be solely because of greater exposure only.

Most of the injured subjects in the study had lateral ankle sprain, which was consistent with that of other studies.^{21,22} Garrick²³ suggested that forced ankle inversion and plantar flexion were the common mechanisms of injury for most ankle sprains. Medial ankle sprain was less common because of the structural stability of the deltoid ligament.²⁴

In our study, subjects aged 21 years or older had a higher risk of ankle sprain. It can be attributed to the potential impact of ageing on proprioception and motor control that may increase the risk of ankle sprain. On the other hand, it may be their seniority and increased frequency of hiking training that would have resulted in increase in exposure to ankle sprain.

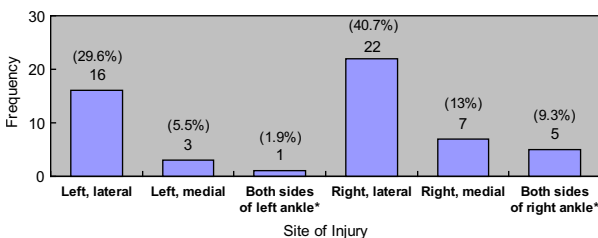


Figure 4. Injured subject distribution among different sites of ankle sprain. *Injured subjects complain of pain and swelling on both sides of the ankle.

Leaders who were supposed to be more experienced in hiking training than the members had 2.6 times higher risk of ankle sprain than that of the members. Subjects with a higher skill level may have a greater chance of having an ankle sprain.¹⁵ Furthermore, they often have to carry heavier loads, such as first-aid kits, spare food, and water. The increase in loading force to the joints of lower extremities increased the risk of ankle injury.^{25,26}

Subjects who were overweight (BMI > 22.9) were also prone to ankle sprain. They have higher loading force to their joints of lower limbs that increase the chance of getting injured.^{13,15} The risk was also higher in subjects who had four or more times of hiking training in the past 12 months, which may be related to the increased exposure to ankle injury.

Past history of ankle sprain and past history of ankle problems were other risk factors. Improper rehabilitation to the previous injury could lead to residual problems.²⁴ Proprioceptive defects, muscle strength impairment and imbalance, persistent ligamentous laxity, diminished muscle flexibility and joint movement, and the presence of localised scar tissue were possible causes of repeated ankle sprain.²⁷

The most common long-term lower limb problems written down at the remarks field by the subjects in our questionnaire were knee pain and patellofemoral joint pain. The young subjects with these problems probably had anatomical alignment problems in their knee joints that resulted in increased risk of ankle sprain.^{3,28}

Inadequate size and tightness of the shoes were other risk factors. Footwear diminishes the individual's perception of the plantar surface with respect to their leg compared with barefoot.²⁰ Inadequate size and tightness of the shoes provided improper platform for the feet to land. It may further increase such errors and cause ankle sprain.

In contrast to other studies,^{1,29,30} the use of hiking poles was a risk factor of ankle sprain. Our subjects, mostly teenagers, may not really familiarise on how to use hiking poles properly. Misuse of hiking pole may disturb the natural balanced walking movement and increase the chance of having ankle sprain in a difficult terrain.

Similar to other studies,^{6,8} the prevalence of having residual problems after ankle sprain was considered quite high (48.14%) in our study. From our study, it was found that 29.7% of subjects did

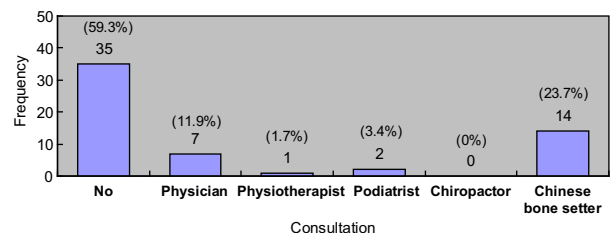


Figure 6. Injured subject distribution among different sources of consultation.

Table 1
Comparison between injured uniformed group members and controls

Characteristic	Ankle sprains (n = 54) n (%)	Controls (n = 536) n (%)	p ^a	Odds ratio (95% CI)	Adjusted odds ratio ^b (95% CI)
Age, yr					
11–20	40 (74.1)	464 (86.6)	0.015	2.256 (1.169, 4.325)	
≥ 21	14 (25.9)	72 (13.4)			
Gender					
Male	32 (59.3)	321 (59.9)	0.928		
Female	22 (40.7)	215 (40.1)			
BMI					
Underweight to normal	38 (70.3)	426 (79.5)	0.020	2.151 (1.129, 4.098)	
Overweight	15 (27.8)	77 (14.3)			
Missing	1 (1.9)	33 (6.2)			
Uniformed groups					
Scout	17 (31.5)	134 (25.0)	0.058		
The Boy's Brigade	14 (25.9)	91 (17.0)			
HK Adventure Corp	2 (3.7)	90 (16.8)			
HK Sea Cadet	7 (13.0)	66 (12.3)			
CAS	10 (18.5)	78 (14.6)			
Others	4 (7.4)	77 (14.4)			
Position					
Member (student)	37 (68.5)	455 (84.9)	0.002	2.581 (1.387, 4.803)	
Leader	17 (31.5)	81 (15.1)			
No. of times of hiking					
1–3	30 (55.6)	388 (72.4)	0.011	2.097 (1.187, 4.803)	
≥ 4	24 (44.4)	148 (27.6)			
Past history of ankle sprain					
Yes	34 (63.0)	138 (25.7)	< 0.001	4.903 (2.731, 8.803)	4.602 (2.492, 8.498)
No	20 (37.0)	398 (74.3)			
Long-term lower limb injury					
Yes	7 (13.0)	29 (5.4)	0.027	2.604 (1.082, 6.264)	
No	47 (87.0)	507 (94.6)			
Shoe types					
Hiking	17 (31.5)	145 (27.1)	0.224		
Running	19 (35.2)	234 (43.7)			
Basketball	5 (9.3)	18 (3.4)			
Marching	9 (16.7)	91 (17.0)			
Others	4 (7.4)	48 (9.0)			
Shoe height					
High top	18 (33.3)	202 (37.7)	0.528		
Low top	36 (66.7)	334 (62.3)			
Shoe damage					
New to mild	39 (72.2)	420 (78.4)	0.301		
Moderate to severe	15 (27.8)	116 (21.6)			
Shoe size					
Adequate	46 (85.2)	505 (94.2)	0.014	2.833 (1.231, 6.522)	
Inadequate	8 (14.8)	31 (5.8)			
Shoe lace tightness					
Adequate	42 (77.8)	499 (93.1)	< 0.001	3.853 (1.869, 7.942)	3.216 (1.456, 7.101)
Inadequate	12 (22.2)	37 (6.9)			
Backpack volume, L					
0–20	17 (31.5)	153 (28.5)	0.565		
21–40	12 (22.2)	159 (29.7)			
41–60	19 (35.2)	185 (34.5)			
≥ 61	6 (11.1)	39 (7.3)			
Use of hiking pole					
Yes	14 (25.9)	81 (15.1)	0.039	1.966 (1.023, 3.777)	2.125 (1.048, 4.308)
No	40 (74.1)	455 (84.9)			
Past history of ankle problems					
Yes	21 (38.9)	78 (14.6)	< 0.001	3.523 (1.942, 6.391)	2.498 (1.320, 4.727)
No	33 (61.1)	458 (85.4)			

^aBold values represents statistically significant; ^bafter adjustment by binary logistic regression. CI = confidence interval; BMI = body mass index; HK = Hong Kong; CAS = civil Aid Service.

not manage the ankle immediately after injury, and 59.3% did not consult any professionals afterwards, which were similar to those in other sports.¹⁴ Although most of our subjects were not severely

injured, proper rehabilitation would still be beneficial. People not seeking early medical attention would defer proper rehabilitation, which would result in residual problems.^{9,24}

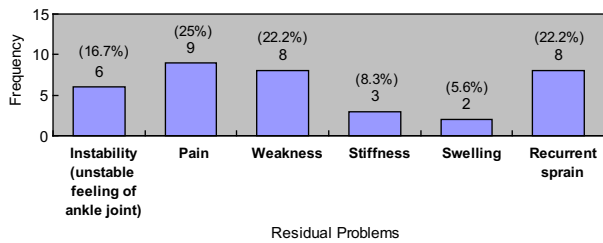


Figure 7. Injured subject distribution among different kinds of residual problems.

10.9% of the subjects who had their ankles sprained in the countryside used ice therapy as an immediate management. Instant cold pack, which relies on reactions of chemicals, has become a popular first-aid equipment in environments where ice is not readily available. Further study is indicated to find the efficacy of instant cold pack in first-aid management of acute ankle sprain.

Chinese bonesetters were the most common medical professionals sought by the injured. It was related to a strong traditional background of Hong Kong people.⁴ However, the scientific basis of traditional Chinese method of treating ankle sprain needs to be further studied.

Among the residual problems, pain was the most common one. It may be because of the chronic post-traumatic ankle instability resulting from improper management of the ankle sprain.³¹

In the study, those had a past history of ankle sprain or ankle problems were prone to have residual ankle problems. As most of them did not manage the injury properly, residual problems, such as recurrent sprain, were not uncommon⁹ and resulted in damage of the ankle joint. Hopefully, this study can provide guidelines for those designing hiking training program for the uniformed groups and avoid ankle injury during hiking training.

There were some limitations of this study. Like all retrospective cross-sectional studies, recall bias is likely to be a significant factor. Subjects were requested to write down the injury

Table 2
Comparison between injured uniformed group members with residual problems and controls

Characteristic	Residual problems (n = 26)	Controls (n = 28)	p
Degree of injury			
Able to walk	7 (26.9)	15 (53.6)	0.107
Able to walk after rest	14 (53.8)	8 (28.6)	
Need support or unable to walk	5 (19.2)	5 (17.9)	
Immediate treatment			
Yes	19 (73.1)	16 (57.1)	0.221
No	7 (26.9)	12 (42.9)	
Consultation			
Yes	11 (42.3)	8 (28.6)	0.291
No	15 (57.7)	20 (71.4)	
Days of normal gait return			
0–3	17 (65.4)	23 (82.1)	0.160
> 3	9 (34.6)	5 (17.9)	
Past history of ankle sprain			
Yes	20 (58.8)	6 (30.0)	0.041
No	14 (41.2)	14 (70.0)	
Past history of ankle problem			
Yes	14 (53.8)	7 (25.0)	0.030
No	12 (46.2)	21 (75.0)	

Bold values represents statistically significant.

information in the past 12 months, and confusion to the details may occur.

Some of the answers in the questionnaire were based on the subjective opinion of the subjects, such as the “degree” of damage of shoes, “size” of the shoes, and “tightness” of the shoes. If the subjects had severe ankle sprain with massive swelling spreading to both sides of the ankle, they may think that both sides of the ankle were injured. Concerning to the residual problems, subjects may not know they had residual problems. They may not have suitable challenge to the ankle in the urban environment if the problem was not severe.

The survivor effect was likely to be observed in the study. Subjects who sprained their ankles so severely that it needed hospitalisation, home boundedness, or quitting from the uniformed groups may not have a chance to be involved in the study. As a result, the prevalences of ankle sprain and residual problems may be underestimated.

The return rate of 59% may be because of the fact that the questionnaires were sent to the leaders for distribution rather than to the individual members. Return of the questionnaire by post may also affect the return rate.

The subject size was still not large enough to detect the relationship of ankle sprain, residual problems, and some of the risk factors. Further investigations with larger number of injured subjects are highly recommended.

In conclusion, uniformed-group leaders and members should be aware of the risk factors of ankle sprain during hiking training in the countryside. They should be aware of the importance of proper treatment and rehabilitation of ankle sprain to prevent residual ankle problem. Ankle sprain prevention programme included in hiking training materials would be desirable.

Appendix. Questionnaire of Study on Ankle Sprain During Hiking Training Held by Uniformed Groups

Part I: Definitions and instructions

Please kindly read the following definitions and instructions before filling the questionnaire and choose **the most suitable answer**.

Please write down the answer on _____ provided in fill-in-the-blank question. Please complete the **whole** questionnaire.

Definition: Ankle sprain: ankle inversion or eversion injury with **detectable swelling and pain** around the injured ankle. (e.g. Swelling on lateral side of ankle).

Hiking training: Participating hiking activities held by uniformed groups with a backpack for 2 hours or over in Hong Kong countryside.

Damage of the shoes: Determine by the degree of wearing over outsole and upper materials.

High top shoes: Shoes that can **cover** both sides of malleoli.

Part II: Demographic information

1. Age: _____ years old
2. Gender: Male Female
3. Body Height: _____ cm
4. Body Weight: _____ kg
5. Left/Right hand dominant: Left hand dominant Right hand dominant
6. The name of the uniformed group joined: _____
7. Your position in the uniformed group: Leader Member

8. No. of times of hiking training held by uniformed group you had joined in the past 12 months: 1–3 times 4–6 times 7–9 times 10 times or over
9. Do you have long-term lower limb injury? Yes, please specify and briefly describe your injury: _____ No
10. From Question 9, if yes, which side you have the injury? Left Right Both sides Not applicable
11. Have you sprained your ankle **other than** during hiking training held by uniformed group before?
 Yes, **left** ankle Yes, **right** ankle Yes, **both** ankles No
12. Have you sprained your ankle **during hiking training held by uniformed group**? Yes, please go to **Part III** No, please go to **Part IV**

Part III: Injured-related information

(For subjects who **sprained ankles during hiking training held by uniformed groups**)

Please answer the following questions referring to the **latest ankle sprain situation** during hiking training held by uniformed groups

13. What type of terrain you were walking on during the accident?
 Cement Trail Muddy Grassland Scree Rocky Other, please specify: _____
14. What was the slope of terrain you were walking on during the accident?
 Upstairs Downstairs Up slope Down slope Level ground Other, please specify: _____
15. When was the accident happened? Day-time Night-time Other, please specify: _____
16. Site of ankle sprain:
 Left, lateral side Left, medial side Pain and swelling over both sides of left ankle
 Right, lateral side Right, medial side Pain and swelling over both sides of right ankle I don't know
17. Degree of ankle sprain: Able to walk immediately Able to walk after rest Need support to walk after rest Unable to walk after rest Other, please specify: _____
18. What type of shoes you were wearing during the accident? Hiking boots Trail running shoes Road running shoes Basketball shoes Canvas shoes Sandals Marching boots Other, please specify: _____
19. What was the height of your shoes you were wearing during the accident? (**refer to the definition**)
 High top Low top Other, please specify: _____
20. How much was the damage of your shoes you were wearing during the accident? (**refer to the definition**) New Mild Moderate Severe
21. What was the size of your shoes you **were wearing during the accident?** (**refer to the definition**)
 Too small Adequate Too large I don't know Other, please specify: _____
22. What was the tightness of your shoelaces during the accident?
 Too tight Adequate Too loose I don't know Other, please specify: _____
23. What was the volume of your backpack you were wearing during the accident?
 0–20 Liter 21–40 Liter 41–60 Liter 61–80 Liter 81 Liter or over Other, please specify: _____
24. Were you using hiking poles during the accident? Yes No
25. What was/were your immediate management(s) for the injury? (you can choose more than 1 answer)

- No treatment Rest Bandage Ice therapy Pain killer Hospitalization Other, please specify: _____
26. Have you consult any of the following person after injury? (you can choose more than 1 answer)
 No Physician Physiotherapist Podiatrist Chiropractor Chinese bone setter Other, please specify: _____
27. How many day(s) did you need to restore normal walking gait? _____ day(s)
28. After 3 months from injury, did you have any of the following problem(s) over the injury site? (you can choose more than 1 answer)
 Complete recovery Instability Pain Weakness Stiffness Swelling Recurrent ankle sprain Other, please specify: _____
29. Did you have any of the following problem(s) over the ankle before the accident? (you can choose more than 1 answer)
 Instability Pain Weakness Stiffness Swelling No problem Other, please specify: _____
30. From Question 29, if yes, which side you have the problem?
 Left ankle Right ankle Both ankles Not applicable

Part IV

(For subjects who **have not sprained ankles during hiking training** held by uniformed groups)

Please answer the following questions referring to the **latest hiking training** held by uniformed groups

31. What type of shoes you were wearing during the latest hiking training?
 Hiking boots Trail running shoes Road running shoes Basketball shoes
 Canvas shoes Sandals Marching boots Other, please specify: _____
32. What was the height of your shoes you were wearing during the latest hiking training? (**refer to the definition**)
 High top Low top Other, please specify: _____
33. How much was the damage of your shoes you were wearing during the latest hiking training? (**refer to the definition**)
 New Mild Moderate Severe
34. What was the size of your shoes you were wearing during the latest hiking training? (**refer to the definition**)
 Too small Adequate Too large I don't know Other, please specify: _____
35. What was the tightness of your shoelaces during the latest hiking training?
 Too tight Adequate Too loose I don't know Other, please specify: _____
36. What was the volume of your backpack you were wearing during the latest hiking training?
 0–20 Liter 21–40 Liter 41–60 Liter 61–80 Liter 81 Liter or over Other, please specify: _____
37. Were you using hiking poles during the latest hiking training?
 Yes No
38. Did you have the following problem(s) over the ankle before the latest hiking training? (you can choose more than 1 answer)
 Instability Pain Weakness Stiffness Swelling No problem Other, please specify: _____
39. From Question 38, if yes, which side you have the problem? Left ankle Right ankle Both ankles Not applicable

~ End ~

References

- Schwameder H, Roithner R, Muller E, et al. Comparison of lower extremity joint kinetics during downhill walking with and without hiking poles. *J Sport Sci* 1999;**17**:969–78.
- Fong TP, Hong Y, Chan LK, et al. A systematic review on ankle injury and ankle sprain in sports. *Sports Med* 2007;**37**:73–94.
- Beynon BD, Renstrom PA, Alosa DM, et al. Ankle ligament injury risk factors: a prospective study of college athletes. *J Orthop Res* 2001;**19**:213–20.
- Chan KM, Fu F, Leung L. Sports injuries survey on university students in Hong Kong. *Br J Sports Med* 1984;**18**:195–202.
- Chan KM, Yuan Y, Li CK, et al. Sports causing most injuries in Hong Kong. *Br J Sports Med* 1993;**27**:263–7.
- Freeman MAR, Dean MRE, Hanham IWF. The etiology and prevention of functional instability of the foot. *J Bone Joint Surg Br* 1965;**47**:678–85.
- Hansen H, Damholt V, Termansen NB. Clinical and social status following injury to the lateral ligaments of the ankle. *Acta Orthop Scand* 1979;**50**:699–704.
- Smith RW, Reischl SF. Treatment of ankle sprains in young athletes. *Am J Sports Med* 1986;**14**:465–71.
- Yeung MS, Chan KM, So CH, et al. An epidemiological survey on ankle sprain. *Br J Sports Med* 1994;**28**:112–6.
- Baumhauer JF, Alosa DM, Renstrom AF, et al. A prospective study of ankle injury risk factors. *Am J Sports Med* 1995;**23**:564–70.
- Ekstrand J, Gillquist J. The avoidability of soccer injuries. *Int J Sports Med* 1983;**4**:124–8.
- Hosea TM, Carey CC, Harrer MF. The gender issue: epidemiology of ankle injuries in athletes who participate in basketball. *Clin Orthop Relat Res* 2000;**372**:45–9.
- Jones BH, Bovee MW, Harris III JM, et al. Intrinsic risk factors for exercise related injuries among male and female army trainees. *Am J Sports Med* 1993;**21**:705–10.
- McKay GD, Goldie PA, Payne WR, et al. Ankle injuries in basketball: injury rate and risk factors. *Br J Sports Med* 2001;**35**:103–8.
- Milgrom C, Shlamkovitch N, Finestone A, et al. Risk factors for lateral ankle sprain: a prospective study among military recruits. *Foot Ankle* 1991;**12**:26–30.
- Murphy DF, Connolly DAJ, Beynon BD. Risk factors for lower extremity injury: a review of the literature. *Br J Sports Med* 2003;**37**:13–29.
- Ostenberg A, Roos H. Injury risk factors in female European football: a prospective study of 123 players during one season. *Scand J Med Sci Sports* 2000;**10**:279–85.
- Blake RL, Ferguson HJ. Walking and hiking injuries: a one year follow-up study. *J Am Podiatr Med Assoc* 1993;**83**:499–503.
- Schwameder H, Lindenhofer E, Muller E. Effect of walking speed on lower extremity joint loading in graded ramp walking. *Sports Biomech* 2005;**4**:227–43.
- Robbins S, Waked E. Factors associated with ankle injuries: preventive measures. *Sports Med* 1998;**25**:63–72.
- Fong DTP, Hong Y, Shima Y, et al. Biomechanics of supination ankle sprain. *Am J Sports Med* 2009;**37**:822–7.
- Renstrom P. Swedish research in sports traumatology. *Clin Orthop Relat Res* 1984;**191**:144–58.
- Garrick JG. The frequency of injury, mechanism of injury, and epidemiology of ankle sprains. *Am J Sports Med* 1977;**5**:241–2.
- Pijnenburg ACM, van Dijk CN, Bossuyt PMM, et al. Treatment for lateral ankle ligament rupture: a meta-analysis. *J Bone Joint Surg Am* 2000;**82**:761–73.
- Laursen B, Ekner D, Simonsen EB, et al. Kinetics and energetics during uphill and downhill carrying of different weights. *Appl Ergon* 2000;**31**:159–66.
- Simonsen EB, Dyhre-Poulsen P, Voigt M, et al. Mechanisms contributing to different joint movements observed during human walking. *Scand J Med Sci Sports* 1997;**7**:1–13.
- Engstrom BK, Renstrom PA. How can injuries be prevented in the World Cup soccer athlete? *Clin Sports Med* 1998;**17**:755–68.
- Cowan DN, Jones BH, Frykman PN, et al. Lower limb morphology and risk of overuse injury among male infantry recruits. *Med Sci Sports Exerc* 1996;**28**:945–52.
- Bohne M, Abendroth-Smith J. Effects of hiking downhill using trekking poles while carrying external loads. *Med Sci Sports Exerc* 2007;**39**:177–83.
- Jacobsen BH, Caldwell B, Kulling FA. Comparison of hiking pole use on lateral stability while balancing with and without load. *Percept Mot Skills* 1998;**87**:435–8.
- Landeros O, Frost HM, Higgins CC. Post-traumatic anterior ankle instability. *Clin Orthop Relat Res* 1968;**56**:169–78.