MILITARY MEDICINE, 184, 7/8:e337, 2019

Medical Encounters During the United States Army Special Forces Assessment and Selection Course

Joseph J. Knapik†; Emily K. Farina*; SFC Christian B. Ramirez‡; Stefan M. Pasiakos*; James P. McClung*; Harris R. Lieberman**

ABSTRACT Introduction: The Special Forces Assessment and Selection (SFAS) is an extremely physically and mentally demanding 19- to 20-day course designed to determine whether Soldiers are qualified to enter the Special Forces Qualification Course. As a first step to understand medical problems during SFAS, this study examined injuries, illnesses, and activities associated with injuries during the course. Materials and Methods: Medical events during the SFAS course were compiled from Sick Call Trackers (a log of medical encounters maintained by medical personnel in the field) and Chronology of Medical Care (Standard Form 600). Descriptive statistics were calculated for each injury and illness and injuries were compiled by the activities performed when the injuries occurred. Results: Of the 800 Soldiers who volunteered for the study, 38% (n = 307/800) and 12% (n = 97/800) experienced one or more injuries and/or illnesses, respectively. The most common injuries were blisters and abrasions/lacerations with incidences of 20% (n = 158/800) and 13% (104/800), respectively. The most common illnesses were respiratory infections, other infections, contact dermatitis, and allergies with incidences of 7% (n = 57/800), 2% (n = 14/800), 2% (n = 14/800), and 2% (n = 13/800), respectively. Among all injuries recorded (n = 573), the most common were blisters (46%), abrasions/lacerations (24%), pain (not otherwise specified) (19%), tendonitis (3%), and sprains (3%). Among all illnesses recorded (n = 133), the most common were respiratory infections (56%), allergies (11%), contact dermatitis (11%), and other infections (11%). Most injuries were experienced during land navigation (44%), team events (20%), and foot marching (11%), running (6%), and the obstacle course (5%), but when the estimated time involved for each event was considered, activities with the highest injury rates were the obstacle course (65 injuries/hr), running (27 injuries/hr), the Combat Readiness Assessment (activity involving combat-related tasks) (20 injuries/hr), and foot marching (16 injuries/hr). Conclusion: The major limitations of this investigation were: 1) the low specificity with regard to many of the diagnoses/complaints; and 2) the fact that the medical problems reported here are only those seen by medical care providers and are likely an underestimate of the total morbidity in the SFAS course. Soldiers often self-treat and some may be reluctant to see medical personnel because of how it might affect their rating in the course. Nonetheless, this investigation alerts medical personnel to the injuries and illnesses to expect, and public health workers and leadership with activities to target for injury prevention measures during SFAS.

INTRODUCTION

Special Forces Assessment and Selection (SFAS) is a required course for soldiers who aspire to become members of the United States (US) Army Special Forces. SFAS is a 19- to 20-day extremely physically and mentally demanding course designed to determine whether or not soldiers are eligible to enter the Special Forces Qualification Course. The difficulty of the course is reflected by the facts that in a previous report as many as 40% of SFAS candidates voluntarily drop-out citing insufficient physical fitness to complete the required tasks[1] and final graduation rates are about 36%.[2] Candidates begin the course by taking a fitness test (push-ups, sit-ups, two-mile run, pull-ups and a swim test) and numerous psychological examinations. During the course they perform long distance runs; foot marches with rucksacks, weapons, and load bearing equipment; an obstacle course event; a Combat Readiness Assessment (CRA); several day and night land navigation events; and a series of team events involving constructing items and carrying heavy loads. The CRA involves high and low crawls, casualty drags and carries, ammunition can carries, and other tasks. Land navigation events are conducted individually and have a maximal allowable time. Team events are typically done in squads and involve construction with limited equipment and moving heavy loads. A very long foot march with full equipment (weapon, rucksack, equipment) is included. The terrain on which the course is conducted is hilly and rough. Soldiers are continually evaluated on their performance by the course cadre and can be: (1) selected to continue to the Qualification Course; (2) voluntarily withdrawn (and cannot return); (3) involuntarily withdrawn because of failure to meet specific standards; (4) medically withdrawn; or (5) not selected.

*Military Nutrition Division, US Army Research Institute of Environmental Medicine, Natick, MA 01760.

†Henry M Jackson Foundation for the Advancement of Military Medicine, Bethesda, MD 20817.

‡John F Kennedy Special Warfare Training Center and School, Camp Mackall, NC 28315.

doi: 10.1093/milmed/usz056

Previous studies have examined injury rates in various military activities including Basic Combat Training,[3–7] One Station Unit Training,[8–10] Ranger training,[11,12] training in specific military occupational specialties,[13,14] and during military operations.[15,16] However, no previous investigation has provided data on medical events during the SFAS course. Due to the diverse types of military training and operations, soldiers are at different risks and thus investigation of medical events during specific military operations provides the most accurate information on the types of injuries and illness experienced. The purpose of this investigation was to describe injuries, illnesses, and activities associated with injuries during the SFAS. The goal is to provide medical care providers, public health workers, and military leaders with data on the medical problems to expect during SFAS so they can adopt appropriate treatment and prevention measures.

METHODS

The study protocol was approved by the Human Use Review Committee of the US Army Research Institute of Environmental Medicine. Participants were active duty male US Army Soldiers recruited from 12 SFAS courses between May 2015 and March 2017. After a briefing on the purposes, requirements, and risks of the study, 821 of the 1,750 potential candidates (47%) provided written consent to participate. Seven participants, after not being selected on their first SFAS attempt, enrolled in the study a second time. After excluding data from the first enrollment of these participants ($N = 7$), and those who voluntarily withdrew after providing consent ($N = 14$), there were 800 soldiers included in the study. After signing the informed consent, date of birth (used to calculate age) was self-reported by the soldier, height was measured in cm using a stadiometer (Hopkins Medical Products, Caledonia, MI), and weight was measured with a calibrated electronic scale (Befour, Staukville, WI). Body mass index (BMI) was calculated as weight/height^2.

Medical data was obtained from two sources, the Sick Call Tracker and the Standard Form 600 (SF 600), Chronology of Medical Care. The Sick Call Tracker was a log maintained by medics and physician's assistants who examined candidates in the field and accompanied them during all activities. The log contained the course number, date, the activity at the time of injury, the soldier's roster number, and the complaint or diagnosis. The latter contained a very brief description of the injury or illness. Examples included "blister, foot", "knee pain", "ankle sprain", "ruck rash", "cut on right knee", "URI" (upper respiratory infection), "allergy", and "poison oak". Activities listed on the Sick Call Tracker included the fitness test, long-distance runs, foot marches, the land navigation events, obstacle course, team events, and final road march.

The SF 600 s contained more detailed information than the Sick Call Tracker. Generally it provided the medical care providers' evaluation including: (1) the patient's subjective reported or chief complaint; (2) objective finding from the physical examination; (3) assessment (diagnosis); and (4) plan (i.e., the "SOAP" note[17]).

Medical data from the Sick Call Tracker and SF 600's were entered into a Statistical Package for the Social Sciences (SPSS) spreadsheet (Version 24.0) and analyzed with that software. Descriptive data (frequencies and percentages) was compiled on all documented diagnoses (injuries and illnesses), anatomical locations, and activities associated with injury; means and standard deviations (SD) were calculated for age and physical characteristics. Injuries were defined as physical damage to the body and included cases involving blisters, abrasions/lacerations, tendonitis, strains, sprains, pain (not otherwise specified), fractures, contusions, impingements, and other types of physical damage. Illnesses were generally systemic disorders and included respiratory and other infections, allergies, contact dermatitis, and other types of systemic disorders. Injuries were also compiled by each major activity category including the fitness test, long-distance runs, foot marches, land navigation, obstacle course, CRA, team activities, and the long-distance road march. Injury incidence was calculated as the number of soldiers with one or more injuries divided by the total number of soldiers and expressed as a percent; illness incidence was the number of soldiers with one or more illnesses divided by the total number of soldiers and expressed as a percent. Incidences of individual diagnoses/ complaints were calculated in the same manner, number of soldiers with one or more diagnosis/ complaint divided by the total number of soldiers expressed as a percent.

RESULTS

The mean ± SD age, height, weight, and BMI of the soldiers was 25.1 ± 3.6 years, 177.4 ± 6.7 cm, 83.2 ± 9.5 kg, and 26.4 ± 2.5 kg/m^2, respectively. There were a total of 708 medical encounters recorded for the 800 men in the 12 SFAS classes. The incidence of soldiers with one or more injuries was 38.4% (307/800), and those with one or more illnesses was 12.1% (97/800). The most common injuries were blisters and abrasions/lacerations with incidences of 19.8% (158/800) and 13.0% (104/800), respectively. The most common illnesses were respiratory infections, other infections, contact dermatitis, and allergies with incidences of 7.1% (57/800), 1.8% (14/800), 1.8% (14/800), and 1.6% (13/800), respectively.

Table I shows the injury and illnesses encounters. There were 6.6% (47/708) medical events reported in SF600s and 93.4% (661/708) obtained from Sick Call Trackers. Blisters, abrasions/lacerations, and pain (not otherwise specified) accounted for 88.7% (508/573) of the injuries. Respiratory infections, allergies, contact dermatitis, and other infections accounted for 88.0% (117/133) of the illnesses. For fractures, there was one case each of a femoral neck stress fracture, femur fracture, tibia fracture, and large toe fracture. All the impingements were listed as "rucksack palsy".[18] The contact dermatitis cases involved encounters with poison oak or poison ivy.

Table II shows the anatomical locations of the injuries. Only 47.1% (270/573) of the injury cases listed an anatomic location. Of the known locations, the upper body accounted

TABLE I. Injury and Illnesses Among 800 Special Forces Candidates in the SFAS Course

Category	Diagnosis/Complaint	N	Proportion of Category (%)
Injury	Blister	263	45.9
	Abrasion/laceration	139	24.3
	Pain (not otherwise specified)	106	18.5
	Tendonitis	19	3.3
	Sprain (joint injury)	17	3.0
	Strain (muscle injury)	13	2.3
	Fracture	4	0.7
	Impingement	4	0.7
	Contusion	3	0.5
	Degenerative joint disease	1	0.2
	Eye laceration	1	0.2
	Ingrown toenail	1	0.2
	Inguinal hernia	1	0.2
	Shin splints	1	0.2
Illness	Respiratory infection	74	55.6
	Allergy	15	11.3
	Contact dermatitis	14	10.5
	Other infections	14	10.5
	Nausea/ vomiting	3	2.3
	Paronychia	3	2.3
	Conjunctivitis	2	1.5
	Heat illness	2	1.5
	Stomach pain	2	1.5
	Diarrhea	1	0.8
	Impetigo	1	0.8
	Tooth pain	1	0.8
	Dehydration	1	0.8
Unknown (unable to read)		2	100.0

TABLE II. Anatomic Locations of Injuries

Anatomic Location	N	Proportion of All Injuries (%)	Proportion of Known Anatomical Locations (%)
Head/face	8	1.4	3.0
Eye	4	0.7	1.5
Neck	1	0.2	0.4
Chest	1	0.2	0.4
Shoulders	16	2.8	5.9
Arms/elbow	4	0.7	1.5
Hands/fingers	29	5.1	10.7
Back	16	2.8	5.9
Pelvis/hip	15	2.6	5.6
Thigh	18	3.1	6.7
Knee	32	5.6	11.9
Calf/shin	21	3.7	7.8
Ankle	43	7.5	15.9
Feet/toes	62	10.8	23.0
Unknown (no anatomic location listed)	303	52.9	0.0

for 23.3% (63/270) and the back and lower body, 76.6% (207/270). Of the unknown anatomic locations, blisters were listed for 74.3% (225/303), abrasions/lacerations for 24.8% (75/303), tendonitis for 0.7% (2/303) and pain (NOS) for 0.3% (1/303). For abrasions/lacerations, 62.6% (47/75) of the unknown anatomic locations included the term "ruck rash".

Table III shows the number of injuries associated with each activity. The activities with the largest proportion of injuries were land navigation (43.6%) followed by team events (20.4%), foot marches (11.2%), runs (6.1%), obstacle course (5.2%), CRA (3.5%), final foot march (3.1%), and fitness test (1.0%). No activity was listed in 5.8% of the injury cases.

DISCUSSION

To our knowledge, the present investigation was the first to quantify visits to medical care providers during the SFAS course. Injuries accounted for most of the medical visits

TABLE III. Activities Associated with Injuries

Diagnosis/Complaint	Number of Injuries								
	Land Nav	Team Events	Foot March	Run	Obstacle Course	CRA	Final Foot March	Fitness Test	No Activity Listed
Blister	123	80	21	8	14	12	3		2
Abrasion/laceration	87	20	11	5	7	4	2	1	2
Pain (NOS)	26	12	24	15	6	2	11	4	6
Tendonitis	3	4	3	3	1		1		4
Sprain (joint injury)	7		2	2			1		5
Strain (muscle injury)	1		1	2				1	8
Fracture						1			3
Impingement		1	1		1				1
Contusion	1				1				1
Degenerative joint disease						1			
Eye laceration	1								
Ingrown toenail	1								
Inguinal hernia									1
Shin splints			1						
Total	250	117	64	35	30	20	18	6	33

NOS = not otherwise specified, Nav = navigation, CRA = Combat Readiness Assessment.

(81%) with blisters and abrasions/lacerations accounting for 46% and 24% of these, respectively. Illnesses accounted for 19% of the medical visits, with respiratory infections, allergies, other infections, and contact dermatitis accounting for 56%, 11%, 11% and 11% of these, respectively. In the 19- to 20-day period, 38% of soldiers experience one or more injuries and 12% of soldiers experienced one or more illnesses.

Injury Rates

Among all activities, the highest number of injuries occurred during the land navigation events. However, examining just the total number of injuries does not take into account that land navigation events were conducted over several days and involved much of the SFAS course. More informative is accounting for the time each activity was conducted and examining the number of injuries experienced per hour of activity since this controls for time of exposure to the activity. Thus, estimated average times for the events in the activity categories in Table III were obtained from or estimated by the SFAS cadre and injury rates were calculated as the number of injuries per estimated hours of activity (injuries/hr). For most activities, there were several tasks of varied time, length, and intensity; the calculated time included the sum of the average times for all tasks within the activity without regard to intensity. Estimated injury rates for the obstacle course, running, CRA, shorter foot marches, land navigation, fitness test, team events, and long foot march were 65, 27, 20, 16, 3, 3, 2, and 2 injuries/hr, respectively. Thus, the obstacle course had the highest estimated injury rate after duration of exposure was considered; the fitness test, land navigation, team events, and final road march had relatively low estimated injury rates. A previous study in Army basic training also indicated that obstacle course activities had the highest injury rate of all activities during that type of training.[19]

The SFAS obstacle course was conducted in wooded terrain and there were numerous impediments and barriers candidates had to traverse in certain ways to successfully navigate through them. Movements involved running, crawling, wall and rope climbing, jumping, balancing, and other activities engaging multiple joints and muscle groups, often in unfamiliar and/or little practiced movements. The length of the course, the number of obstacles, the fact that the event was timed, and investigator or cadre observations indicated candidates experienced progressive fatigue as they progressed through the course. These factors are likely related to the high injury rate.

Despite the high number of injuries recorded during the land navigation events, these were conducted over several days, for long periods each day, and involved mostly walking and cognitive activity. These facts likely explain the much lower estimated injury rate. Team events were also conducted over several days for long periods and the tasks were shared among the soldiers, likely accounting for the low injury rate. It was not clear why the final road march had a low injury rate but this was the concluding activity in the SFAS course and many candidates had dropped out by this time, possibly leaving the more physically capable candidates to complete this activity. Further, since this was the final event and rest and sleep were a high post-event priority for candidates, they may have been less motivated to seek medical care unless the problem was a serious one.

Anatomic Locations

The number of missing anatomical locations in the data made it difficult to fully document where injuries were occurring, but the available data suggested the lower body was the most common site of injury, in agreement with much of the literature on military personnel.[4,20–22] Almost all of the missing anatomic locations (99%) were associated with blisters and abrasions/lacerations. Discussions with medical personnel indicated almost all blisters without a documented anatomical location were likely on the feet, and that abrasions/lacerations on the lower back and hips were associated with carrying loads (as suggested by the term "ruck rash").

Blisters

Blisters accounted for the largest number of injuries. Previous studies have found that during foot marches, blisters have accounted for 54%[23] and 35%[24] of all injuries, and in basic training they accounted for 14% of all injuries.[19] Blisters occur due to frictional forces that oppose the movement of materials or objects across the skin. For example, when the skin of the foot is in contact with a boot and sock external forces generated by locomotion move the sock and boot across the skin resulting in friction. If there are sufficient frictional cycles (movement of foot inside the boot) and the frictional forces are high enough (boot pressing on the foot) a mechanical separation will occur in the epidermis at the level of the stratum spinosum and it will fill with fluid due to hydrostatic pressure, thus forming a blister.[25] Blisters are often ignored or de-emphasized because many investigations focus on just "musculoskeletal injuries".[3,8,26–28] This is despite the fact that when included in injury definitions, blisters can account for a large number of medical problems and blisters can alter gait patterns resulting in or exacerbating musculoskeletal injuries.[29] Furthermore, blisters are open wounds that are susceptible to infection[30,31] and can have debilitating effect on locomotion necessary for many military operations.[23,24,30,32] A case series reported a soldier death and hospitalizations due to *Staphylococcus aureus* infections in association with blisters.[33]

Primary blister prevention includes the use of antiperspirants without emollients,[34] covering blister prone areas with paper tape (e.g., Micropore, 3 M Corporation, St Paul MN),[35] and specific types of sock systems.[36,37] When blisters do occur, detailed treatment procedures are available[38] and medical care providers in the field can be prepared by stocking their medical kits with number 11 surgical blades, moleskin, and protective coverings for treating or avoiding blisters.[38] Especially important for early intervention is identification of "hot spots". During repetitive rubbing of the socks and boots on foot skin, soldiers typically experience areas of friction known as "hot spots," the subjective experience of which is a localized warming or burning sensation. This presumably pre-blister stage is characterized as a local red (erythema) and tender area. When hot spots are detected, blisters may be avoided by shielding the affected area with a low-friction skin covering such as Bursatec (Bursatec, Mexico City, Mexico) or Dr. Scholl's Moleskin Plus (Schering-Plough HealthCare Products, Inc., Memphis, TN). If candidates are expected to care for their own blisters, providing them with instruction on hot spot detection and proper application of protective coverings prior to the start of the course may aid in blister prevention and treatment

Abrasions and Lacerations

Abrasions and lacerations accounted for the highest number of injuries after blisters. Abrasions are superficial skin wounds caused by frictional forces that remove superficial epidermal layers, while lacerations involve cuts into the epidermis that can involve deeper structures in the dermis depending on the depth of the wound.[39,40] Observations by medical personnel indicated many lacerations resulted from candidates traversing through thick vegetation during land navigation. Abrasions or lacerations that occur during the obstacle course were often rope burns on the palms of the hands as a result of fatigue during a climb and the candidate sliding down the rope because he was unable to continue to climb. Like blisters, abrasions and lacerations are generally considered minor injuries, but depending on their depth and how much of the epidermis and/or dermis are involved they can be susceptible to infection, particularly if exposed to dust, dirt, or equipment that has been colonized with infectious agents,[41–43] as can occur during SFAS training. Several studies involving long-distance hikers found that abrasions and lacerations accounted for a large portion of the injuries seen,[44–47] often ranking second to blisters[44,45] or actually exceeding the number of blisters.[46,47] Although we are not aware of any studies on prevention of abrasions/lacerations, a reasonable approach is to cover areas where friction or cuts might develop with protective material like Moleskin (Dr Scholls, Memphis TN) or Nexcare Coban (3 M Company, Saint Paul MN) or by wearing appropriate gloves. Medical personnel in the field could stock these materials in their medical kits. Standards of care have been developed for cleaning, debridement, dressing, and monitoring of abrasions and lacerations.[48]

Non-specific Pain

With regard to the non-specific pain, observations of the medical staff suggested many were associated with overuse and involved joints and occasionally soft tissue. In general, candidates would complain of pain at a specific anatomical location, but there was no significant history, the examination did not show anything remarkable, and there were no visible signs to assist with a specific diagnosis. In some cases, the pain may have involved delayed onset muscle soreness[49] due to the fact the candidate had performed a difficult task he was not familiar with, or that total amount of activity to that point had produced the muscle soreness.

Respiratory Infections

Respiratory infections accounted for the largest proportion of the illnesses. Among the entire US military forces, the rate of ambulatory visits for respiratory illnesses in 2016 was 468/1,000 Armed Forces personnel, the sixth leading diagnostic category in that year.[50] Many of the factors associated with respiratory illnesses are those present during SFAS including intense physical activity, sleep deprivation, close quarters, psychological stress, and environmental factors like dust and smoke exposure.[51] Periods of heavy and prolonged physical activity result in a decrease in secretory immunoglobulins which consensus suggests is associated with increased risk of respiratory diseases.[52] Other than vaccinations which all soldiers receive on entry to service, annually, and for specific military deployments,[53] effective primary prevention for respiratory infections appear to include personal hygiene (especially hand washing), sufficient barracks ventilation, adequate living space, and cohorting (i.e., isolation of groups or individuals).[54–57]

Limitations

The major limitation of this investigation was the low specificity with regard to many of the diagnoses/complaints. For example, a number of injuries were classified as pain without a specific diagnosis and many of the infections were not specific as to the agent causing the infection. Nonetheless, this study does provide broad classifications of injuries and illnesses and provides medical personnel with data on common maladies they are likely to see during SFAS and those that can be targeted for prevention and future research. Another limitation was that the medical problems reported here are only those seen by medical care providers and these are likely an underestimate of the total morbidity in the SFAS course. This is because soldiers often self-treat and some may be reluctant to see medical personnel unless absolutely necessary because of how it might affect their rating in the course.

CONCLUSIONS

The data presented here showed that skin lesions were the most common injuries and respiratory infections the most common illness during SFAS. Activities resulting in the highest injury rates were the obstacle course, running activities, CRA, and foot marching. Medical personnel should be trained and ready to treat these common medical problems and references are provided here to assist with these efforts. Where possible, prevention is preferred over treatment and medical personnel, in conjunction with public health workers and leadership, should target prevention toward common injuries and illnesses as well as activities associated with these injuries. Additional actions that might be considered by SFAS leadership and medical personnel involves education and preparation of SFAS candidates through read-ahead literature on how to prevent or mitigate the major injuries and illnesses outlined here. The SFAS leadership, in coordination with medical personnel, could consider if barracks have sufficient ventilation and living space. These efforts will help assure that soldiers attending SFAS stay healthy and are best able to demonstrate their skills, knowledge, and abilities so that the most qualified soldiers, unimpeded by medical problems, are selected for the Special Forces.

DISCLOSURE

The investigators have adhered to the policies for protection of human subjects as prescribed in Department of Defense Instruction 3216.02 and the research was conducted in adherence with the provisions of 32 CFR Part 219. The views, opinions, and/or findings contained in this report are those of the authors and should not be construed as official Department of the Army position, policy, or decision, unless so designated by other official documentation. Citations of commercial organizations and trade names in this report do not constitute an official Department of the Army endorsement or approval of the products or services of these organizations. Approved for public release; distribution is unlimited.

FUNDING

The study was funded internally by USARIEM.

ACKNOWLEDGMENTS

We would like to thank the following individuals and groups who assisted us with this study: Mr William Boden, Ms Lauren Thompson, the technical staff of the US Army Research Institute of Environmental Medicine, and the cadre and staff of the John F. Kennedy Special Warfare Center and School.

REFERENCES

1. Beal SA: The roles of perseverance, cognitive ability, and physical fitness in US Army Special Forces Assessment and Selection. Arlington VA: US Army Research Institute Technical Report No. 1927, 2010.
2. Zazanis MM, Hazlett BA, Kilcullen RN, Sanders MG: Prescreening methods for Special Forces Assessment and Selection. US Army Research Institute for the behavioral and Social Sciences Technical Report No. 1094, 1999.
3. Jones BH, Bovee MW, Harris JM, Cowan DN: Intrinsic risk factors for exercise-related injuries among male and female Army trainees. Am J Sports Med 1993; 21: 705–10.
4. Knapik JJ, Sharp MA, Canham-Chervak M, Hauret K, Patton JF, Jones BH: Risk factors for training-related injuries among men and women in Basic Combat Training. Med Sci Sports Exerc 2001; 33: 946–54.
5. Bell NS, Mangione TW, Hemenway D, Amoroso PJ, Jones BH: High injury rates among female Army trainees. A function of gender? Am J Prev Med 2000; 18(Suppl. 3): 141–6.
6. Kowal DM, Patton JF, Vogel JA: Psychological states and aerobic fitness of male and female recruits before and after basic training. Aviat Space Environ Med 1978; 49: 603–6.
7. Knapik JJ, Swedler D, Grier T, et al: Injury reduction effectiveness of selecting running shoes based on plantar shape. J Strength Cond Res 2009; 23: 685–97.
8. Jones BH, Cowan DN, Tomlinson JP, Robinson JR, Polly DW, Frykman PN: Epidemiology of injuries associated with physical training among young men in the Army. Med Sci Sports Exerc 1993; 25: 197–203.
9. Knapik JJ, Graham B, Cobbs J, Thompson D, Steelman R, Jones BH: A prospective investigation of injury incidence and injury risk factors among Army recruits in combat engineer training. J Occup Med Toxicol 2013; 8(1): 5.
10. Knapik JJ, Graham B, Cobbs J, Thompson D, Steelman R, Jones BH: A prospective investigation of injury incidence and injury risk factors among Army recruits in military police training. BMC Musculoskelet Disord 2013; 14(1): 32.

11. Martinez-Lopez ME, Friedl K, Moore RJ, Kramer TR: A longitudinal study of infections and injuries of Ranger students. Mil Med 1993; 158(7): 433–7.
12. Teyhen DS, Shaffer SW, Butler RJ, et al: What risk factors are associated with musculoskeletal injuries in US Army rangers. A prospective prognostic study. Clin Orthop Relat Res 2015; 473: 2948–58.
13. Knapik JJ, Jones SB, Darakjy S, et al.: Injuries among Army wheel vehicle mechanics. Aberdeen Proving Ground MD: Army Center for Health Promotion and Preventive Medicine Technical Report No. 12-MA-7193A-06, 2006.
14. Knapik JJ, Jones SB, Darakjy S, et al: Injuries and injury risk factors among members of the United States Army Band. Am J Ind Med 2007; 50: 951–61.
15. Knapik JJ, Steelman R, Hodedbecke K, et al: Injury incidence with T-10 and T-11 parachutes in military airborne operations. Aviat Space Environ Med 2014; 85(12): 1159–69.
16. Roy TC, Knapik JJ, Ritland BM, Murphy N, Sharp MA: Risk factors for musculoskeletal injuries for soldiers deployed to Afghanistan. Aviat Space Environ Med 2012; 83(11): 1060–6.
17. Pearce PF, Ferguson LA, George GS, Langford CA: The essential SOAP note in an EHR age. Nurs Pract 2016; 41(2): 29–36.
18. Knapik JJ, Reynolds K, Orr R, Pope R: Load carriage-related paresthesias. Part 1: rucksack palsy and digitalia paresthesiaa. J Spec Oper Med 2016; 16(4): 74–9.
19. Knapik JJ, Graham BS, Rieger J, Steelman R, Pendergrass T: Activities associated with injuries in initial entry training. Mil Med 2013; 178: 500–6.
20. Knapik JJ, Jones SB, Darakjy S, et al: Injury rates and injury risk factors among United States Army Wheel Vehicle Mechanics. Mil Med 2007; 172: 988–96.
21. Jennings BM, Yoder LH, Heiner SL, Loan LA, Bingham MO: Soldiers with musculoskeletal injuries. J Nurs Scholarsh 2008; 40(3): 268–74.
22. Piantanida NA, Knapik JJ, Brannen S, O'Connor F: Injuries during marine corps offer basic training. Mil Med 2000; 165: 515–20.
23. Knapik J, Reynolds K, Staab J, Vogel JA, Jones B: Injuries associated with strenuous road marching. Mil Med 1992; 157: 64–7.
24. Reynolds KL, White JS, Knapik JJ, Witt CE, Amoroso PJ: Injuries and risk factors in a 100-mile (161-km) infantry road march. Prev Med 1999; 28: 167–73.
25. Knapik JJ, Reynolds KL, Duplantis KL, Jones BH: Friction blisters: pathophysiology, prevention and treatment. Sports Med 1995; 20: 136–47.
26. Almeida SA, Williams KM, Shaffer RA, Brodine SK: Epidemiological patterns of musculoskeletal injuries and physical training. Med Sci Sports Exerc 1999; 31: 1176–82.
27. Almeida SA, Trone DW, Leone DM, Shaffer RA, Patheal SL, Long K: Gender differences in musculoskeletal injury rates: a function of symptoms reporting? Med Sci Sports Exerc 1999; 31: 1807–12.
28. Hauret KG, Jones BH, Bullock SH, Canham-Chervak M, Canada S: Musculoskeletal injuries. Description of an under-recognized injury problem among military personnel. Am J Prev Med 2010; 30(Suppl1): S61–70.
29. Bush RA, Brodine S, Shaffer R: The association of blister with musculoskeletal injuries in male Marine recruits. J Am Podiatr Med Assoc 2000; 90(4): 194–8.
30. Akers WA, Sulzberger MB: The friction blister. Mil Med 1972; 137: 1–7.
31. Hoeffler DF: Friction blisters and cellulitis in a Navy recruit population. Mil Med 1975; 140: 333–7.
32. Ressman RJ: Epidemiology of friction blisters. J Assoc Mil Dermatol 1976; 2: 13–7.
33. Berkley SF, McNeil JG, Hightower AW, Graves LM, Smith PB, Broome CV: A cluster of blisters associated with toxic shock syndrome in male military trainees and a study of staphylococcal carriage patterns. Mil Med 1989; 154(1): 496–9.
34. Knapik JJ, Reynolds K, Barson J: Influence of an antiperspirant on foot blister incidence during cross country hiking. J Am Acad Dermatol 1998; 39: 202–6.
35. Lipman GS, Sharp LJ, Christensen M, et al: Paper tape prevents foot blisters: a randomized prevention trial assessing paper tape in endurance distance II (Pre-TABED II). Clin J Sport Med 2016; 26(5): 362–8.
36. Knapik JJ, Hamlet MP, Thompson KJ, Jones BH: Influence of boot sock systems on frequency and severity of foot blisters. Mil Med 1996; 161: 594–8.
37. vanTiggelen D, Wickes S, Coorevits P, Dumalin M, Witvrouw E: Sock systems to prevent foot blisters and the impact on overuse injuries of the knee joint. Mil Med 2009; 174: 183–9.
38. Knapik JJ, Reynolds K: Loads carried in military operations: A review of historical, biomechanical and medical aspects. Available at https://ke.army.mil/bordeninstitute/other_pub/LoadCarriagePDF.pdf; accessed 23 August 2018.
39. Basler RSW, Hunzeker CM, Garcia MA: Athletic skin injuries. Combating pressure and friction. Phys Sportsmed 2004; 32(5): 33–40.
40. Honsik KA, Romero MW, Hawley CJ, Romero SJ, Romero JP: Sideline skin and wound care for acute injuries. Curr Sports Med Rep 2007; 6: 147–54.
41. Hill AA, Mayo M, Kaestli M, et al: Melioidosis as a consequence of sporting activity. Am J Trop Med Hyg 2013; 89(2): 365–6.
42. Beavis RC, MacDonald PB: *Staphylococcus Aureus* specticemia secondary to hand abrasions in a professional hockey player–a case report. Clin J Sport Med 2008; 18(2): 174–5.
43. Sejvar J, Bancroft E, Winthrop K, et al: Leptospirosis in "Eco-Challenge" athletes, Malaysian Borneo, 2000. Emerg Infect Dis 2003; 9 (6): 702–7.
44. Anderson LS, Rebholz CM, White LF, et al: The impact of footwear and packweight on injury and illness among long-distance hikers. Wilderness Environ Med 2009; 20: 250–6.
45. Boulware DR, Forgey WW, Martin WJ II: Medical risks of wilderness hiking. Am J Med 2003; 114(4): 288–93.
46. Lobb B: Load carriage for fun: a survey of New Zealand trampers, their activities and injuries. Appl Ergon 2004; 35: 541–7.
47. Twombly SE, Schussman LC: Gender differences in injury and illness rates on wilderness backpacking trips. Wilderness Environ Med 1995; 4: 363–76.
48. Beam JW, Buckley B, Holcomb WR, Ciocca M: National Athletic Trainers' position statement: management of acute skin trauma. J Athl Train 2016; 51(12): 1053–70.
49. Lewis PB, Ruby D, Bush-Joseph CA: Muscle soreness and delayed onset muscle soreness. Clin Sports Med 2012; 31(2): 255–62.
50. Ambulatory visits among members of the active component, US Armed Forces, 2016. MSMR 2017; 24(4): 17–25.
51. Korzeniewski K, Nitsch-Osuch A, Chcialowski A, Korsak K: Environmental factors, immune changes and respiratory disease in troops during military activities. Respir Physiol Neurobiol 2013; 187: 118–22.
52. Walsh NP, Gleeson M, Shepard RJ, et al: Position Statement. Part One. Immune function and exercise. Exerc Immunol Rev 2011; 17: 6–63.
53. Sanchez JL, Cooper MJ, Myers CA, et al: Respiratory infections in the US military: recent experience and control. Clin Microbiol Rev 2015; 28(3): 743–800.
54. Ryan MAK, Christian RS, Wohlrabe J: Handwashing and respiratory illness among young adults in military training. Am J Prev Med 2001; 21(2): 79–83.
55. Coldren RL, Feighner B, DuVernoy T, Jordan N, Gonzalea R, Alsip B: Adnovirus Type 4 outbreak among basic trainees at Ft Benning, Georgia, April-May 2000. MSMR 2000; 6(6): 7–8.
56. Brundage JF, Scott RM, Lednar WM, Smith DW, Miller RN: Building associated risk of febrile acute respiratory diseases in Army trainees. JAMA 1988; 259(14): 2108–12.
57. Lee T, Jordan NN, Sanchez JL, Gaydos JC: Selected nonvaccine interventions to prevent infectious acute respiratory disease. Am J Prev Med 2005; 28(3): 305–16.