

Activities Associated With Injuries in Initial Entry Training

Joseph J. Knapik, ScD*; Bria S. Graham, MPH†; CPT Jennifer Rieger, SP USA‡; Ryan Steelman, MPH*; LTC Timothy Pendergrass, SP USA§

ABSTRACT Previous studies have not reported activities associated with injuries in initial entry training (IET) because these data were seldom available in medical records and not contained in electronic databases. This investigation obtained activities associated with outpatient encounters in IET recorded by primary medical care providers at Fort Leonard Wood, Missouri. Data were entered into a standard database that included fields for diagnosis and activity associated with the injury. Fifty percent of the new injury encounters (i.e., exclusive of follow-ups) were not associated with a specific event but were reported as having a gradual onset. Other activities included physical training (16%), road marching (15%), confidence/obstacle courses (5%), and barracks activities (3%). Risks per unit of training time were estimated at 13, 62, and 97 injuries per hour for physical training, road marching, and the confidence/obstacle courses, respectively. The most frequently recorded diagnoses were joint pain (27%), strains (15%), blisters (14%), sprains (13%), and tendonitis (12%). The types of injuries and their anatomical locations were similar to those reported in other IET investigations, although blister-related encounters were higher. This investigation identifies activities with the highest risk of injury in IET and those that should be targeted for injury prevention efforts.

INTRODUCTION

A number of investigations have described the injury incidence, injury risk factors, and types of injuries in the U.S. Army Basic Combat Training (BCT) and Infantry One-Station Unit Training (OSUT).¹⁻⁷ However, these studies have not included the specific training activities associated with these injuries. Early studies¹⁻³ involved surveys of individual hard-copy medical records in entire BCT companies or battalions. In these records, activities associated with injuries were so seldom recorded (<25%) that they were not included in publications to avoid reporting bias. Later studies⁵⁻⁷ relied on routinely collected outpatient surveillance data from the Defense Medical Surveillance System that did not contain data fields for activities associated with injuries.

As part of the Soldier Athlete Initiative established by the Army Training and Doctrine Command and the Army Medical Command,⁸ certified athletic trainers (ATs) and musculoskeletal action teams (MATs) were proposed as a means of reducing serious injury and medical attrition in Initial Entry Training (IET). ATs and a single MAT began providing care at Fort Leonard Wood, Missouri, in April 2011 and were required to keep a de-identified log of their patient

encounters. Included in this log was the patient-reported activity associated with the injury treated by the MAT or the ATs.

Identifying activities associated with injuries is one of the early steps in the injury prevention process. Once these activities have been identified, they can be targeted for interventions that might reduce injury incidence.⁹ The purpose of this article is to provide descriptive information from the databases maintained by the ATs and MATs with emphasis on the activities associated with injuries. Also provided is descriptive information on diagnosis and anatomical locations of the injuries.

METHODS

This investigation involved three BCT battalions, two Military Police (MP) OSUT battalions, and two engineer (EN) OSUT battalions at Fort Leonard Wood, Missouri. The lengths of training for BCT, MP OSUT, and EN OSUT were 10, 19, and 14 weeks, respectively. By doctrine,¹⁰ the first 10 weeks of MP and EN OSUT involved the same training activities as BCT. BCT activities included physical training, marksmanship, road marches, confidence/obstacle course negotiation, high tower operations, team and individual movement exercises, land navigation, and other activities. Subsequent training of MPs and ENs included physical training in addition to instruction specific to their occupational specialty. For MPs, the latter weeks training included activities such as suspect apprehension, civil disturbance training, area security exercises, intelligence operations, enemy prisoner of war/civilian internee exercises, use and setup of tactical control points, convoy and patrol operations, and search and seizure operations. For ENs, subsequent training involved activities such as operation of heavy equipment, erection of obstacles and defensive positions, placement and detonation of explosives, route clearance of obstacles, use of fixed or floating bridges, preparation

*U.S. Army Institute of Public Health, 5158 Blackhawk Road, Aberdeen Proving Ground, MD 21010.

†Hawaii Department of Health, 1250 Punchbowl Street, Honolulu, HI 96813.

‡Martin Army Community Hospital, 7950 Martin Loop, Fort Benning, GA 31905.

§Office for Rehabilitation and Reintegration (R2D), Defense Health Headquarters Building, 7700 Arlington Boulevard, Falls Church, VA 22042.

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and installation of firing systems for demolition and explosives, and training in techniques to detect mines either visually or with mine detectors.

The purpose of the ATs and the MAT was to provide early, on-site medical care to the IET units. Three ATs were employed, one in each type of battalion (BCT, MP, and EN). The MAT provided care to two BCT battalions, one MP OSUT battalion, and one EN OSUT battalion. Medical care providers in the MAT included a physical therapist, a physical therapy technician, and two ATs. Each time an AT or a MAT member had a patient encounter, they were required to record that encounter in a standard spreadsheet developed jointly by the U.S. Army Institute of Public Health and the U.S. Army Surgeon General's Office for Rehabilitation & Reintegration. The spreadsheet contained data fields with drop-down menus and options to include other information within the data fields. Data fields included gender, battalion, activity associated with the injury, injury diagnosis, anatomic location of the injury, whether the encounter was a new injury or a follow-up of a previous injury, and date of the encounter. The activity associated with the injury was obtained by interviewing the recruit. Diagnosis was based on the care provider's clinical judgment. Analysis of this de-identified database for the purposes of this investigation was approved by the Public Health Review Board of the U.S. Army Institute of Public Health.

Data were analyzed from May 2011 to April 2012 (1-year period). Information from the spreadsheet maintained by the ATs and MAT was downloaded into the Predictive Analytic Software, version 18.0, and analyzed with this statistical package. Descriptive information (frequencies and percents) was compiled on activity associated with the injury, injury diagnosis, and anatomic location of the injury for each type of training (i.e., BCT, MP OSUT, and EN OSUT).

RESULTS

There were 4,128 total encounters among the men (58.2%), 2,907 total encounters among the women (41.0%), and 61 cases (0.9%) where gender was not recorded. Of these, there were 4,136 encounters for new injuries (58.3%), 2,940 follow-up encounters (41.4%), and 20 cases that did not specify if the injury was new or a follow-up (0.3%). It should be emphasized that these are patient encounters and that a single recruit could have seen a provider on more than one occasion.

Table I shows the activities associated with new injury encounters (i.e., exclusive of follow-ups) by gender and type of training. All activities with a frequency of three injury cases or more in any type of training are shown. Fifty percent of the encounters ($n = 2,037$) were not associated with a specific event but were reported as having a gradual onset. Of the specific activities reported, the most common ones were physical training (16%, $n = 636$), road marching (15%, $n = 625$), the confidence/obstacle courses (5%, $n = 194$), and barracks activities (3%, $n = 115$). Among the male

recruits, these four categories combined accounted for 56% ($n = 416$) of all injury-related encounters in BCT, 41% ($n = 222$) in MP training, and 20% ($n = 278$) in EN training. Among female recruits, these four categories combined accounted for 52% ($n = 416$) of reported injury-related encounters in BCT, 40% ($n = 211$) in MP training, and 27% ($n = 27$) in EN training. Basic rifle marksmanship and drill and ceremony were associated with few injury encounters.

Table II shows the diagnoses and anatomical locations of the new injury encounters by gender and type of training. The five most frequently recorded new injuries were joint pain (27%, $n = 1,123$), strains (15%, $n = 621$), blisters (14%, $n = 568$), sprains (13%, $n = 515$), and tendonitis (12%, $n = 490$). Among male recruits, these five diagnostic categories accounted for 83% ($n = 2,212$) of all male injuries for all types of training combined, or 82% ($n = 609$) for BCT, 76% ($n = 415$) for MP training, and 85% ($n = 1,188$) for EN training. Among female recruits, these five diagnoses accounted for 78% ($n = 1,105$) of all injuries for all types of training combined, or 79% ($n = 628$) for BCT, 75% ($n = 394$) for MP training, and 81% ($n = 83$) for EN training.

The most common anatomical locations of injuries were in the lower body, predominately the knee (24%, $n = 999$), foot (24%, $n = 994$), ankle (15%, $n = 607$), and leg (shin) (10%, $n = 404$). Among male recruits, lower back and lower body injuries accounted for 88% ($n = 2,356$) of all male injuries for all types of training combined, or 88% ($n = 654$) in BCT, 87% ($n = 472$) in MP training, and 88% ($n = 1,230$) in EN training. Among female recruits, lower back and lower body injuries accounted for 91% ($n = 1,298$) of all female injuries for all types of training combined or 93% ($n = 736$) in BCT, 88% ($n = 466$), in MP training, and 94% ($n = 96$) in EN training.

Among the men, the most common specific diagnoses (i.e., diagnosis with anatomical location) were foot blisters (15%, $n = 402$), knee joint pain (11%, $n = 294$), ankle sprains (10%, $n = 255$), knee tendonitis (7%, $n = 191$), shin splints (7%, $n = 175$), foot pain (6%, $n = 165$), and hip joint pain (4%, $n = 119$). Among the women, the most common specific diagnoses were foot blisters (11%, $n = 158$), knee tendonitis (9%, $n = 124$), ankle sprains (8%, $n = 119$), knee joint pain (8%, $n = 118$), hip joint pain (7%, $n = 100$), shin splints (5%, $n = 77$), and foot pain (4%, $n = 53$).

DISCUSSION

This is the first investigation to provide data on the activities associated with injuries in IET. We examined men and women in different types of training, including BCT, MP OSUT, and EN OSUT. Regardless of the type of training, the results were very similar: the largest proportion of recruits reported that their injury had a gradual onset and they could not identify a specific injury-inducing event. BCT has a very large volume of physical activity as suggested

TABLE I. Activities Associated With New Injury Encounters

Gender	Activity	BCT		MP OSUT		EN OSUT	
		<i>n</i>	Proportion of BCT (%)	<i>n</i>	Proportion of MP OSUT (%)	<i>N</i>	Proportion of EN OSUT (%)
Men	No Specific Activity (Gradual Onset)	218	29.5	204	37.6	1,033	74.0
	Physical Training	189	25.5	92	16.9	86	6.3
	Road Marching	174	23.5	75	13.8	95	6.8
	Confidence/Obstacle Courses	39	5.3	33	6.1	46	3.3
	Barracks Activities	14	1.9	22	4.1	51	3.7
	Army Physical Fitness Test	9	1.2	3	0.6	1	0.1
	Combatives	18	2.4	5	0.9	7	0.5
	Corrective Training	9	1.2	7	1.3	10	0.7
	Land Navigation	6	0.8	6	1.1	10	0.7
	Grenade Range	3	0.4	1	0.2	0	0.0
	Pugil Stick	1	0.1	4	0.7	6	0.4
	Boots	0	0.0	15	2.8	0	0.0
	High Tower Training	0	0.0	13	2.4	4	0.3
	Basic Rifle Marksmanship	3	0.4	2	0.4	0	0.0
	Drill and Ceremony	3	0.4	0	0.0	0	0.0
	Unsure	7	0.9	13	2.4	9	0.6
	Other	47	6.4	48	8.8	38	2.7
	Total	740	100.0	543	100.0	1,396	100.0
	Women	No Specific Activity (Gradual Onset)	299	37.7	211	39.9	72
Physical Training		188	23.7	67	12.7	14	13.7
Road Marching		182	22.9	91	17.2	8	7.8
Confidence/Obstacle Courses		32	4.0	41	7.8	3	2.9
Barracks Activities		14	1.8	12	2.3	2	2.0
Army Physical Fitness Test		9	1.1	2	0.4	0	0.0
Combatives		11	1.4	5	0.9	0	0.0
Corrective Training		6	0.8	5	0.9	2	2.0
Land Navigation		6	0.9	8	1.5	0	0.0
Grenade Range		5	0.6	1	0.2	1	1.0
Pugil Stick		0	0.0	5	0.9	0	0.0
Boots		2	0.3	20	3.8	0	0.0
High Tower Training		1	0.1	5	0.9	0	0.0
Basic Rifle Marksmanship		0	0.0	4	0.8	0	0.0
Drill and Ceremony		0	0.0	0	0.0	0	0.0
Unsure		8	1.0	12	2.3	0	0.0
Other		31	3.9	40	7.6	0	0.0
Total		794	100.0	529	100.0	102	100.0

by a pedometer investigation that reported an average of about 11 km of ambulatory activity each day.¹¹ Another analysis showed that the greater the amount of ambulatory activity in BCT the greater the likelihood of injury.¹² The cumulative amount of activity and not a specific event likely leads to overuse in susceptible recruits. Studies in Army BCT and Marine Corps basic training have suggested that overuse-type injuries account for the majority of the injuries seen in BCT.^{1-3,13} These injuries are presumably because of the repetitive use of specific parts of the body that lead to tissue microtrauma and inflammation¹⁴⁻¹⁶ and prompts the recruit to seek medical care because of the associated pain. It is possible that many of the gradual onset injuries might have been aggravated by running, marching, or other repetitive weight-bearing activities that recruits perform in IET.

Of the specific activities identified, physical training had the highest proportion of injuries. This finding was similar to that of a number of other military groups including infantry

soldiers,^{17,18} wheel vehicle mechanics,¹⁹ MP,²⁰ and students in training for ordnance specialties.²¹ Previous studies of physical training in BCT have shown that injuries can be reduced and fitness increased by a program called Physical Readiness Training (PRT)^{6,7}, i.e., currently the type of physical training specified for use by doctrine in IET.¹⁰ Compared to previous traditional physical training programs used in IET, PRT reduces running mileage, employs systematic progressive overload, and includes a wide variety of exercises for cross-training to minimize overuse because of overtraining.⁶ Despite this, many medical encounters still appear to be associated with physical training in IET. In physical training, individuals are often performing activities for relatively long periods at relatively high exercise intensities. Previous studies have shown that physical activity is associated with injuries in a dose-response manner.²²⁻²⁵ Thus, although it has been shown that risk can be reduced by appropriate physical training in BCT,^{6,7} this study indicates

TABLE II. Diagnoses and Anatomical Locations of New Injury Encounters

	BCT				MP OSUT				EN OSUT			
	Men		Women		Men		Women		Men		Women	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Diagnoses												
Joint Pain	124	16.8	188	23.7	129	23.8	144	27.2	506	36.2	32	31.4
Muscle Strain/Tear	147	19.9	148	18.6	62	11.4	55	10.4	198	14.2	11	10.8
Blisters	82	11.1	79	9.9	54	9.9	54	10.2	272	19.5	27	26.5
Sprain	136	18.4	94	11.8	83	15.3	69	13.0	129	9.2	4	3.9
Tendonitis	120	16.2	119	15.0	87	16.0	72	13.6	83	5.9	9	8.8
Shin Splints	41	5.5	53	6.7	40	7.4	40	7.6	109	7.8	5	4.9
Stress Fracture/Reaction	30	4.1	63	7.9	9	1.7	23	4.3	17	1.2	11	10.8
Inflammation	8	1.1	5	0.6	1	0.2	3	0.6	0	0.0	0	0.0
Contusion	13	1.8	16	2.0	12	2.2	21	4.0	22	1.6	2	2.0
Swelling, Localized	11	1.5	7	0.9	16	2.9	17	3.2	4	0.3	0	0.0
Weakness	2	0.3	8	1.0	6	1.1	10	1.9	7	0.5	0	0.0
Paresthesia	1	0.1	2	0.3	1	0.2	0	0.0	6	0.4	0	0.0
Spasm	6	0.8	1	0.1	8	1.5	5	0.9	0	0.0	0	0.0
Abrasion/Laceration	6	0.8	2	0.3	19	3.5	5	0.9	17	1.2	0	0.0
Fracture	0	0.0	0	0.0	1	0.2	0	0.0	2	0.1	0	0.0
Dislocation	0	0.0	1	0.1	3	0.6	2	0.4	2	0.1	0	0.0
Other	11	1.5	8	1.0	10	1.8	9	1.7	22	0.2	1	1.0
Missing From Database	2	0.3	0	0.0	2	0.4	0	0.0	0	0.0	0	0.0
Anatomical Location												
Head/Face	1	0.1	1	0.1	4	0.7	0	0.0	2	0.1	0	0.0
Neck	9	1.2	5	0.6	1	0.2	1	0.2	2	0.1	0	0.0
Chest	2	0.3	0	0.0	2	0.4	7	1.3	5	0.4	0	0.0
Abdomen	1	0.1	1	0.1	0	0.0	0	0.0	3	0.2	0	0.0
Upper Back	13	1.8	13	1.6	13	2.4	12	2.3	24	1.7	0	0.0
Shoulder	38	5.1	29	3.7	19	3.5	19	3.6	63	4.5	4	3.9
Elbow	6	0.8	2	0.3	6	1.1	4	0.8	8	0.6	0	0.0
Arm	0	0.0	1	0.1	1	0.2	3	0.6	4	0.3	0	0.0
Wrist	6	0.8	3	0.4	5	0.9	7	1.3	27	1.9	1	1.0
Hand/Fingers	10	1.4	3	0.4	20	3.7	10	1.9	28	2.0	1	1.0
Lower Back	25	3.4	23	2.9	23	4.2	27	5.1	52	3.7	4	3.9
Hip	44	5.9	97	12.2	30	5.5	57	10.8	99	7.1	17	16.7
Thigh	25	3.4	26	3.3	9	1.7	9	1.7	41	2.9	1	1.0
Knee	205	27.7	226	28.5	148	27.3	123	23.3	277	19.8	20	19.6
Leg (Shin)	73	9.9	75	9.4	56	10.3	51	9.6	140	10.0	9	8.8
Ankle	135	18.2	115	14.5	91	16.8	90	17.0	166	11.9	10	9.8
Foot ^a	139	18.8	154	19.4	113	20.8	105	19.8	449	32.2	34	33.3
Multiple Regions	1	0.1	4	0.5	0	0.0	4	0.8	1	0.1	0	0.0
Other	2	0.3	14	1.8	2	0.4	0	0.0	5	0.4	1	1.0
Missing From Database	5	0.7	2	0.3	0	0.0	0	0.0	0	0.0	0	0.0

^aIncludes toes.

that it is unlikely that injury risks associated with physical training can be completely eliminated even by well-designed programs.

Another activity that accounted for a large proportion (15%) of injury-related encounters was road marching. Recruits were often required to walk out to training areas and performed four longer distance road marches with load carrying equipment and rucksacks during the course of training. These longer road marches were generally performed in a systematic manner with progressive increases in distances totaling 4, 8, 12, and 16 km. Loads carried by recruits included uniform, weapon, load carrying equipment (with pistol belt and canteen), and a rucksack. The rucksack

load was about 48 lb or 30% of the recruit's body weight. Previous studies have indicated that road marching accounted for 16% of injuries in an infantry unit¹⁷ and 7% to 9% of all injuries among military wheel vehicle mechanics attached to an airborne unit.¹⁹

The confidence/obstacle courses accounted for about 5% of the new injury encounters, ranking as the activity with the fourth highest proportion of injuries. The confidence/obstacle courses were two separate events performed on a confidence course and on a conditioning obstacle course. The confidence course had 24 stations involving activities such as climbing, vaulting, stepping over barriers, climbing up and over ladders, balancing on logs, descending a tower on ropes, using

ropes to climb objects, climbing an inclined wall, climbing and descending cargo netting, crawling under low wire, climbing a high tower, and other actions. The conditioning obstacle course was similar, having obstacles for jumping, dodging, vertical climbing and descending, horizontal traversing, vaulting, balancing, and crawling. Both courses were designed to build the recruit's confidence in negotiating obstacles and overcoming fear of heights. Recruits performed on each course three times, first a walk, then an untimed run, and finally a timed run. Injury risk may be associated with the variety of movements required, height of some objects, and the possibility of errors because of unfamiliarity with some movements. Also of interest was the fact that 27% of injuries associated with the obstacle course involved the upper body, as contrasted to 8% for all other activities. The Defense Safety Oversight Council of the Department of Defense has funded a project to identify, isolate, and possibly mitigate injury risk factors associated with obstacle courses in basic training. The project will include recommendations for training modifications, maintenance standards and procedures, and attempt to determine the training value and return on investment of obstacle course training.

When considering activities associated with injury attention must be paid to the total amount of time spent in each activity (i.e., exposure time at risk).²⁶ Activities that produce more injuries per amount of training time may be more important targets for injury prevention. In this investigation, the exact amount of times each unit spent in the various activities is not known, but for routine major activities such as physical training, road marching, and the confidence/obstacle course, time can be estimated based on observations, training schedules, and consultations with the training cadre. Physical training was conducted on most mornings unless other moderate or heavy physical activity was scheduled for the day (e.g., road marching, confidence/obstacle course, field training exercises, and team and individual movement techniques). In general, there were 35 physical training sessions in BCT, 67 sessions in MP OSUT, and 46 sessions in EN OSUT. Each session was about 1 hour. The confidence and obstacle course were each conducted once during the training cycle for a scheduled 6 hours each, but the recruit spent <1 hour on each course in actual physical activity. Time spent road marching can be estimated based on the distances and assuming a pace of 4 km/h.²⁷ This was about 10 hours of actual foot marching (not including preparation, assembly time, rest periods). Based on the time at risk, physical training, road marching, and the confidence/obstacle course resulted in an estimated 13, 62, and 97 injuries per hour, respectively.

The types and variety of injuries reported in this investigation appears to be generally similar to that reported in other basic training studies. In consonance with this investigation, previous studies have reported that 77% to 88% of BCT and infantry OSUT injuries occur in the lower body/lower back, with the knees, ankles, and feet the most common

specific locations.^{1,3} Also, in consonance with this investigation, sprains, strains, and tendonitis appear to be among the most common types of diagnoses in these types of training,^{1,28} as well as in other types of athletic training.²⁹⁻³⁷

In contrast to much of the BCT injury literature, this investigation reported a high incidence of blisters, accounting for 14% of all new injury encounters, and the injury with the third highest number of encounters. When diagnoses and anatomical locations were combined, foot blisters were the most common type of injury seen. It is noteworthy that 90% ($n = 514$) of the blisters were associated with road marching and in past studies specifically investigating road marching, blisters have also accounted for the largest proportion of injuries.^{38,39} Injuries of this type are often ignored or de-emphasized because many investigations focus on just "musculoskeletal injuries."^{1,2,13,16,40} However, blisters are open wounds that are susceptible to infection^{41,42} and can reduce the operational strength of military units because of their debilitating effect on locomotion.^{38,39,41,43} Treatment procedures are available⁴⁴ and primary prevention includes the use of antiperspirants without emollients⁴⁵ and specific types of sock systems.^{46,47}

Male EN recruits had the highest number of encounters accounting for 34% of all new injury encounters recorded, while female EN recruits had the lowest number of total encounters, only 2%. There are few women in EN training and this likely explains the low number of encounters in that group. The EN recruits also had the largest proportion (74%) of encounters listed as having a gradual onset. This tended to reduce the proportion of other activities associated with injuries in this group. If only BCT and MP training were considered, gradual onset would have accounted for 36% of encounters. Nonetheless, the male ENs still followed the same general pattern as the other types of training with gradual onset associated with the largest proportion of encounters followed by road marching, physical training, barracks activity, and the confidence/obstacle course.

Limitations to this investigation included possible recall bias on the part of the recruit and the accuracy of the diagnosis on the part of the medical care providers. The activity associated with the injury was obtained from the recruit by interview and the recruit had to remember the incident that caused the injury. In most cases, it appears that the recruit provided an activity because only 1% ($n = 49$) of the cases were listed as "unsure." In many cases, the injury would likely have been in proximity to the medical visit and past studies suggest that recall of injuries is most accurate at this time and progressively declines over time.⁴⁸⁻⁵⁰ Another limitation may have been the accuracy of the diagnoses. ATs and the MAT members diagnosed the injuries by signs and symptoms and generally did not have access to the clinic or hospital for more definitive tests. Nonetheless, all care providers were trained in diagnostic procedures and the distribution of injuries was similar to that seen in other BCT and OSUT investigations.

In conclusion, the findings of this investigation show the value of obtaining activities associated with injuries as recommended by the DOD Injury Surveillance Work Group and the Armed Forces Epidemiology Board in 1996.^{51,52} Without knowledge of the causes of injuries, it would be difficult to know how to prevent them or to set priorities for prevention. Clear targets for prevention during IET include physical training, road marching, and confidence/obstacle courses. Data from this investigation further indicate that it is important to document the amount of time soldiers are exposed to various hazardous activities, such as the confidence/obstacle courses. The confidence/obstacle courses placed recruits at 7.5 times more risk per unit of time than physical training. In keeping with previous recommendations,⁹ it is suggested that activities associated with injuries be routinely documented in the outpatient medical record and coded in the Army's automated databases. It is further recommended that more research be devoted to determining the risks of injury per unit of exposure time that soldiers experience to help target the riskiest activities for injury prevention. Finally, since so many of the injuries were recorded as "gradual onset", it would be useful in the future to query the recruit on what activity might have aggravated the injury.

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